3Com® Switch 5500 Family
Configuration Guide

Switch 5500-SI
Switch 5500-EI
Switch 5500G-EI

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CONTENTS

CONTENTS

ABOUT THIS GUIDE

1 GETTING STARTED

2 ADDRESS MANAGEMENT CONFIGURATION

3 PORT OPERATION

7 GVRP Configuration

8 VLAN-VPN Configuration

9 DHCP Overview

10 DHCP SERVER CONFIGURATION

11 DHCP RELAY CONFIGURATION

12 VRRP CONFIGURATION

13 MSTP CONFIGURATION

17 NETWORK PROTOCOL OPERATION

19 ACL CONFIGURATION

22 FILE SYSTEM MANAGEMENT

23 PORT TRACKING CONFIGURATION

24 DYNAMICALLY APPLY ACL BY RADIUS SERVER CONFIGURATION

25 AUTO DETECT CONFIGURATION

26 RSTP CONFIGURATION

27 POE PROFILE CONFIGURATION

28 SNMP CONFIGURATION

32 CLUSTERING

33 HWTACACS CONFIGURATION

A PASSWORD RECOVERY PROCESS

B RADIUS Server and RADIUS Client Setup

C Authenticating the Switch 5500 with Cisco Secure ACS

D 3Com XRN

ABOUT THIS GUIDE

This guide provides information about configuring your network using the commands supported on the 3Com® Switch 5500 Family.

The descriptions in this guide apply to the Switch 5500-SI and Switch 5500-EI. Differences between the models are noted in the text.

Organization of the Manual

The Switch 5500 Family Configuration Guide consists of the following chapters:

- **Getting Started—**Details the main features and configurations of the Switch 5500.
- **Address Management—**Details how to configure the switch on which the Address Manage (AM) feature is enabled.
- **Port Operation—**Details how to configure Ethernet port and link aggregation.
- **XRN Fabric—**Details how to configure an XRN fabric.
- **DLDP—**Drtails overview and fundamentals for Device Link Detection Protocol.
- **VLAN Operation—**Details how to configure VLANs.
- **GVRP Configuration**—Details GARP VLAN Registration Protocol configuration.
- **VLAN-VPN**—Details configuration information to create VLAN-VPNs.
- **DHCP**—Details Dynamic Host Configuration Protocol.
- **Reliability**—Details Virtual Router Redundancy Protocol (VRRP).
- **MSTP**—Details Multiple spanning tree protocol.
- **Centralized MAC address authentication—**Details Centralized MAC address authentication configuration.
- **SSH**—Details Secure Shell authentication.
- **IP Routing Protocol Operation—**Details how to configure routing protocols.
- **Network Protocol Operation—**Details how to configure network protocols.
- **Multicast Protocol—**Details how to configure multicast protocols.
- **ACL Configuration—**Details how to configure QoS/ACL.
- **QoS**—Detais Quality of Service
- **RSTP Configuration—**Details how to configure RSTP.
- **802.1x Configuration—**Details how to configure 802.1x.
- **File System Management—**Details how to configure file system management.
- **Port Tracking**—Details Port Tracking Configuration.

- **ACL by RADIUS**—Details ACL by RADUIS Configuration.
- **Auto Detect**—Details Auto Detect Configuration.
- **RSTP**—Details Spanning Tree Protocol Configuration.
- **PoE**—Details PoE profile Configuration.
- **SNMP**—Details Simple Network Management Protocol Configuration.
- **Source IP Address**—Details Source IP Address Configuration for the FTP client and server .
- **Password Control**—Details Password Control Configuration.
- **MSDP**—Details MSDP Configuration.
- **Clustering**—Details Clustering Configuration.
- **HWTACACS**—Details HWTACACS Configuration.

Intended Readership

The manual is intended for the following readers:

- Network administrators
- Network engineers
- Users who are familiar with the basics of networking

Conventions

This manual uses the following conventions:

Table 1 Icons

Icon	Notice Type	Description
ℹ	Information note	Information that describes important features or instructions.
⚠	Caution	Information that alerts you to potential loss of data or potential damage to an application, system, or device.
⚡	Warning	Information that alerts you to potential personal injury.

Table 2 Text conventions

Convention	Description
`Screen displays`	This typeface represents text as it appears on the screen.
Keyboard key names	If you must press two or more keys simultaneously, the key names are linked with a plus sign (+), for example: Press Ctrl+Alt+Del
The words "enter" and type"	When you see the word "enter" in this guide, you must type something, and then press Return or Enter. Do not press Return or Enter when an instruction simply says "type."
`Fixed command text`	This typeface indicates the fixed part of a command text. You must type the command, or this part of the command, exactly as shown, and press *Return* or *Enter* when you are ready to enter the command. Example: The command **`display history-command`** must be entered exactly as shown.

Table 2 Text conventions (continued)

Convention	Description
Variable command text	This typeface indicates the variable part of a command text. You must type a value here, and press *Return* or *Enter* when you are ready to enter the command. Example: in the command **super** ***level***, a value in the range 0 to 3 must be entered in the position indicated by ***level***
{ x | y | ... }	Alternative items, one of which must be entered, are grouped in braces and separated by vertical bars. You must select and enter one of the items. Example: in the command **flow-control {hardware | none | software}**, the braces and the vertical bars combined indicate that you must enter one of the parameters. Enter either **hardware**, or **none**, or **software**.
[ ]	Items shown in square brackets [ ] are optional. Example 1: in the command **display users [all]**, the square brackets indicate that the parameter **all** is optional. You can enter the command with or without this parameter. Example 2: in the command **user-interface** [**type**] **first-number** [**last-number**] the square brackets indicate that the parameters [**type**] and [**last-number**] are both optional. You can enter a value in place of one, both or neither of these parameters. Alternative items, one of which can optionally be entered, are grouped in square brackets and separated by vertical bars. Example 3: in the command **header [shell | incoming | login]** ***text,*** the square brackets indicate that the parameters **shell**, **incoming** and **login** are all optional. The vertical bars indicate that only one of the parameters is allowed.

Related Manuals

The *3Com Switch 5500 Family Getting Started Guide* provides information about installation.

The *3Com Switch 5500 Family Command Reference Guide* provides all the information you need to use the configuration commands.

1 GETTING STARTED

This chapter covers the following topics:

- Product Overview
- XRN Overview
- Product Features
- Logging in to the Switch
- Command Line Interface
- User Interface Configuration

Product Overview

The Switch 5500 Family are Layer 3 switching products supporting expandable resilient networking (XRN). The Switch 5500 can be one of two series: Switch 5500-SI or the Switch 5500-EI. The Switch 5500 family supports simple routing, basic service features, and basic XRN; the Switch 5500 family supports rather complex routing protocols, abundant service features and enhanced XRN. Besides saving user cost otherwise invested on module rack-type switches, the Switch 5500 family with XRN also offer excellent network availability, upgrade ability, performance, and power network control capacity.

Table 3 lists the models in the Switch 5500 family:

Table 3 Models in the Switch 5500 family

Model	Power supply unit (PSU)	Number of service ports	Number of 100 Mbps ports	Number of 1000 Mbps uplink ports	Console port
5500-SI 28-Port	AC-input, DC-input	28	24 10/100 Mbps	4 SFP	1
5500-SI 52-Port	AC-input, DC-input	52	48 10/100 Mbps	4 SFP	1
5500-EI 28-Port	AC-input, DC-input	28	24 10/100 Mbps	4 SFP	1
5500-EI 52-Port	AC-input, DC-input	52	48 10/100 Mbps	4 SFP	1
5500-EI PWR 28-Port	AC-input, DC-input	28	24 10/100 Mbps	4 SFP	1
5500-EI PWR 52-Port	AC-input, DC-input	52	48 10/100 Mbps	4 SFP	1
5500-EI 28-Port FX	AC-input, DC-input	28	24 100 Mbps	2 10/100/1000 plus2 SFP	1
5500G-EI 24-Port	AC-input, DC-input	24	—	20 10/100/1000 Mbps plus 4 10/100/1000 or SFP	1
5500G-EI 48-Port	AC-input, DC-input	48	—	44 10/100/1000 Mbps plus 4 10/100/1000 or SFP	1
5500G-EI PWR 24-Port	AC-input, DC-input	24	—	20 10/100/1000 Mbps plus 4 10/100/1000 or SFP	1

Table 3 Models in the Switch 5500 family (continued)

Model	Power supply unit (PSU)	Number of service ports	Number of 100 Mbps ports	Number of 1000 Mbps uplink ports	Console port
5500G-EI PWR 48-Port	AC-input, DC-input	48	—	44 10/100/1000 Mbps plus 4 10/100/1000 or SFP	1
5500G-EI 24-Port SFP	AC-input, DC-input	24	—	20 10/100/1000 Mbps plus 4 10/100/1000 or SFP	1

The Switch 5500 family supports the following services:

- Internet broadband access
- MAN (metropolitan area network), enterprise/campus networking
- Multicast service, multicast routing, and audio and video multicast service.

XRN Overview

With the XRN (eXpandable Resilient Networking) feature, you can connect several devices into a combined device and manage them as a single unit. The combined device is called the Fabric, while the member devices are units. With XRN you can:

- Manage multiple devices in centralized manner, with low management cost.
- Extend the number of ports and switching capacity just by adding devices. You can decide which equipment to purchase as needed, and better protect your existing investment while upgrading the network.
- Provide backup between multiple devices to improve reliability and to eliminate single points of failure.

Major Technologies

XRN includes three technologies: distributed device management (DDM), distributed link aggregation (DLA), and distributed resilient route (DRR).

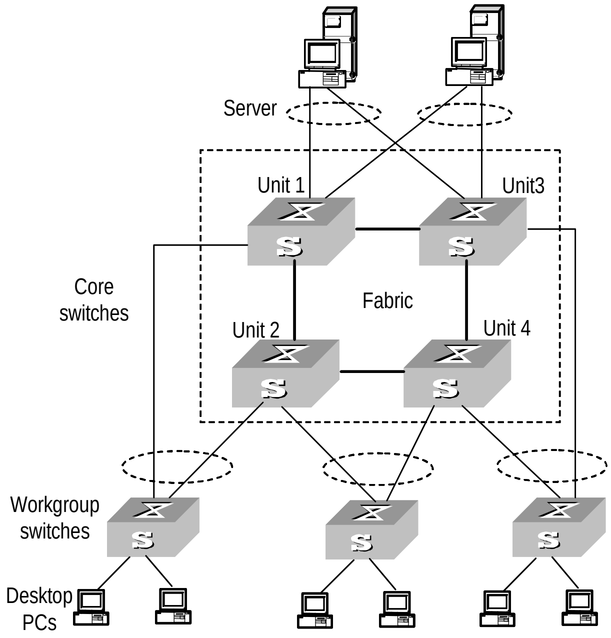
- DDM: Users can treat the Fabric as a single device. They can manage the Fabric through any port or IP address connected into the Fabric, and from any unit in the fabric.
- DRR: The multiple units of a Fabric route and forward packets as a single unit, and provide uniform VLAN interfaces, routing table and L3 forwarding table, so the Fabric is regarded as a single Layer 3 switch. Failure of one of the units will not affect routing protocol and data forwarding.
- DLA: Users can aggregate multiple ports of several different units in a Fabric into a group, for centralized management within the Fabric. Trans-unit link aggregation can bring convenient aggregation setting and effectively reduce single points of failure.

The Switch 5500-SI supports basic XRN, that is DDM and DLA; the Switch 5500-EI supports enhanced XRN, including DDM, DRR, and DLA.

Typical Networking Topology

Typical XRN networking topology is as shown in Figure 1. Switches of the same type (that is, units) form a Fabric. As a core switch, the Fabric can be downlinked to workgroup switches through several aggregation links, and uplinked to the server group also through several aggregation links.

Figure 1 Networking Topology with XRN



Product Features

Table 4 describes the features:

Table 4 Function Features

Features	Description
Port	802.1D Learning
	Static MAC (unicast/multicast)
	Jumbo Frame (9k) (EI models only)
	Unidirectional Link Detection (UDLD)
VLAN	VLAN compliant with IEEE 802.1Q Standard
	Port-based VLAN
	Protocol Based VLAN, compliant with IEEE 802.1v Standard (EI models only)
	Voice VLAN
	8021.Q in Q Double Tagged VLAN Support (EI models only)
STP protocol	Spanning Tree Protocol (STP) / Rapid Spanning Tree Protocol (RSTP), compliant with IEEE 802.1D/IEEE802.1w Standard
	Multiple Spanning Tree Protocol (MSTP), compliant with IEEE 802.1s Standard
	BPDU Guard
	Spanning Tree Root Guard
Flow control	IEEE 802.3 flow control (full-duplex)
	Back-pressure based flow control (half-duplex)
Traffic Suppression	Broadcast/Unicast/Multicast Suppression

Table 4 Function Features (continued)

Features	Description
Multicast	Internet Group Management Protocol (IGMP) Snooping
	Multicast VLAN Registration (MVR)
	Internet Group Management Protocol (IGMP) (EI models only)
	Protocol-Independent Multicast-Dense Mode (PIM-DM) (EI models only)
	Protocol-Independent Multicast-Sparse Mode (PIM-SM) (EI models only)
	Mulitcast Source Discovery Protocol (MSDP) (EI models only)
IP routing	Static route
	RIP V1/v2
	OSPF (EI models only)
	IP routing policy
	Forwarding IP layer 3 broadcast packets
	DHCP (Dynamic Host Configuration Protocol) Client
	DHCP Server (EI models only)
	DHCP Options 60, 82 and 184
	DHCP Relay
	UDP Relay
Link aggregation	Link aggregation
	Link Aggregation Control Protocol (LACP), compliant with IEEE 802.3ad Standard
Mirror	Mirror based on the traffic classification
	Port-based mirror
	VLAN-based mirror
	Remote mirroring
Security features	Multi-level user management and password protect
	802.1X Network Login
	MAC Based Network Login
	Mixed 802.1X and MAC Based Network Login
	RADIUS and TACACS+ Authentication, Authorization and Accounting
	PAP, CHAP, EAP-MD5,TLS,TTLS and PEAP Authenticating
	Packet filtering
Quality of Service (QoS)	Traffic classification
	Bandwidth control
	Priority
	Queues of different priority on the port
	Queue scheduling: supports Strict Priority Queuing (SP), Weighted Round Robin (WRR), WFQ, SP+WFQ, and SP+WRR
	QoS profile management manner

Table 4 Function Features (continued)

Features	Description
Management and Maintenance	Command line interface configuration
	Configuration through console port
	Remote configuration through Telnet or SSH
	Configuration through dialing the Modem
	SNMP v1/2c/3
	System log
	Level alarms
	Output of debugging information
	Ping and Tracert
	Remote maintenance with Telnet, Modem and SSHv2
Loading and updates	Loading and upgrading of software through the XModem protocol
	Loading and upgrading of software through File Transfer Protocol (FTP) , Trivial File Transfer Protocol (TFTP) and Secure File Transfer Protocol (SFTP)

Logging in to the Switch

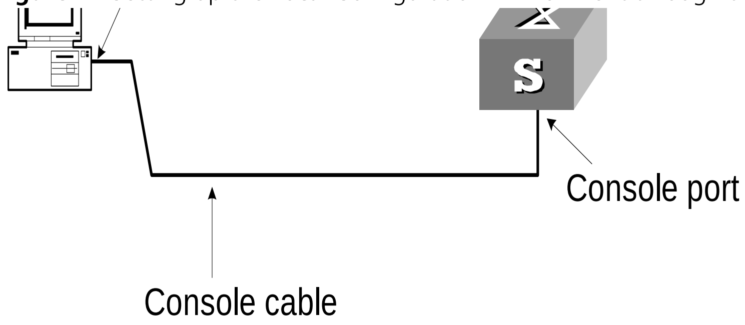
This section describes how to log in to the switch.

Setting up Configuration Environment through the Console Port

Perform the following procedure to set up the configuration environment through the console port.

1 To set up the local configuration environment, connect the serial port of a PC (or a terminal) to the console port of the Switch with the console cable (see Figure 2).

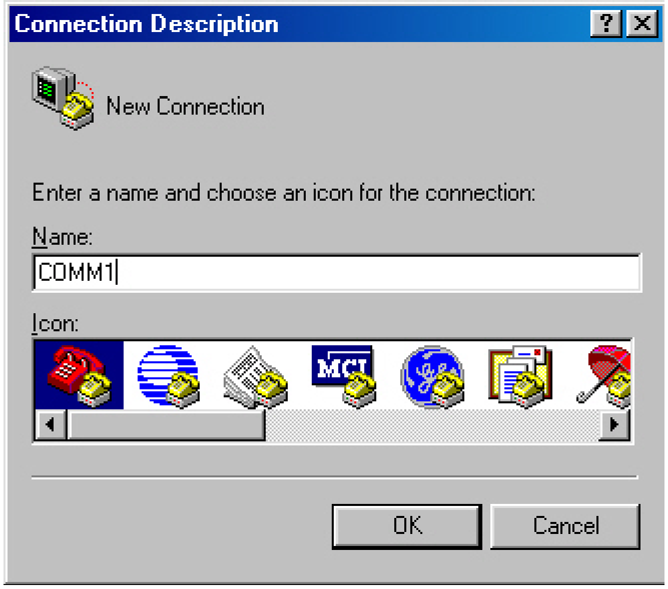
Figure 2 Setting up the Local Configuration Environment through the Console Port



2 Run terminal emulator (such as Terminal on Windows 3X or the Hyper Terminal on Windows 9X) on the PC. Set the terminal communication parameters as follows:

- Baud rate = 19200
- Databit = 8
- Parity check = none
- Stopbit = 1
- Flow control = none
- Terminal type = VT100

Figure 3 Setting up a New Connection



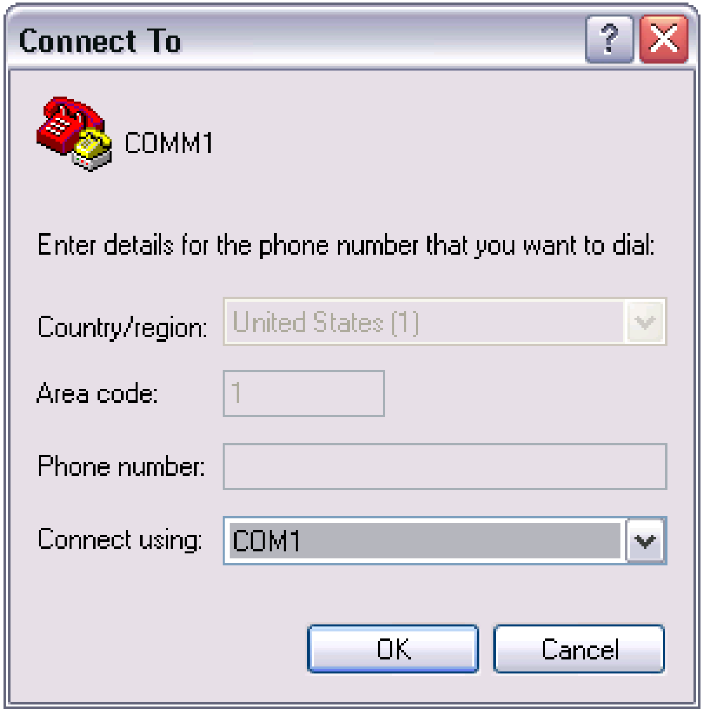
Connection Description

New Connection

Enter a name and choose an icon for the connection:

Name: COMM1

Figure 4 Configuring the Port for Connection



Connect To

COMM1

Enter details for the phone number that you want to dial:

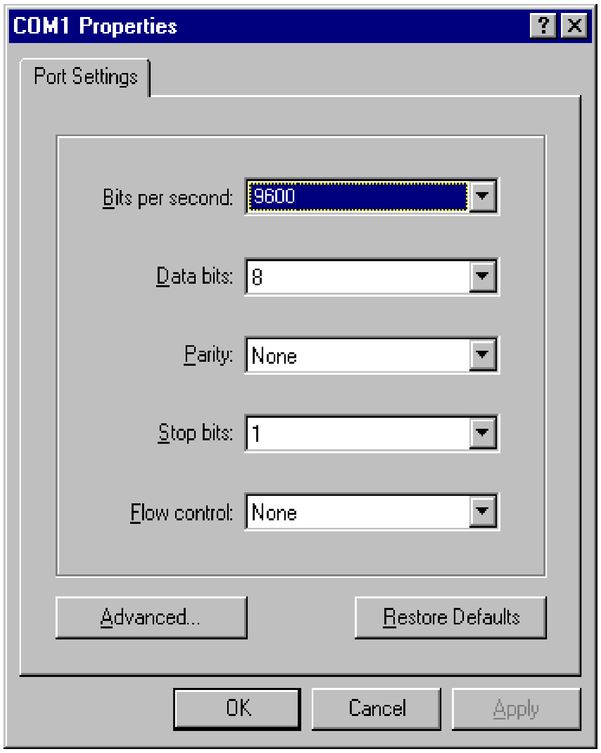
Country/region: United States (1)

Area code: 1

Phone number:

Connect using: COM1

Figure 5 Setting Communication Parameters



Bits per second: 9600

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

3 The Switch is powered on and it displays self-test information. Press < Enter> to show the command line prompt such as `<SW5500>`.

4 Enter a command to configure the Switch or view the operation state. Enter a **`?`** to view online help. For details of specific commands, refer to the following sections.

Setting up Configuration Environment through Telnet

Connecting a PC to the Switch through Telnet

After you have correctly configured the IP address of a VLAN interface for the Switch through the console port (using the **`ip address`** command in VLAN Interface View), and added the port (that connects to a terminal) to this VLAN (using the **`port`** command in VLAN View), you can Telnet this Switch and configure it.

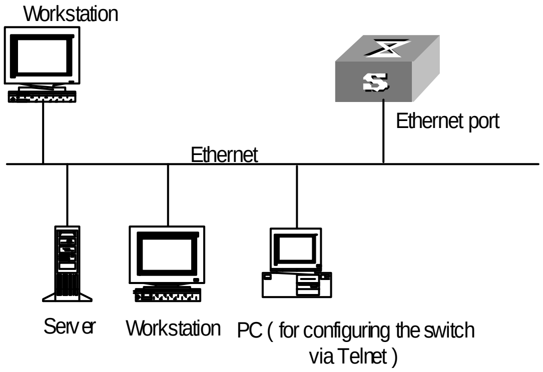
1 Authenticate the Telnet user through the console port before the user logs in by Telnet.

By default, the password is required for authenticating the Telnet user to log in to the Switch. If a user logs in through the Telnet without password, he will see the prompt `Login password has not been set!`

```
<SW5500>system-view
[SW5500]user-interface vty 0
[SW5500-ui-vty0]set authentication password simple xxxx (xxxx is the
preset login password of the Telnet user)
```

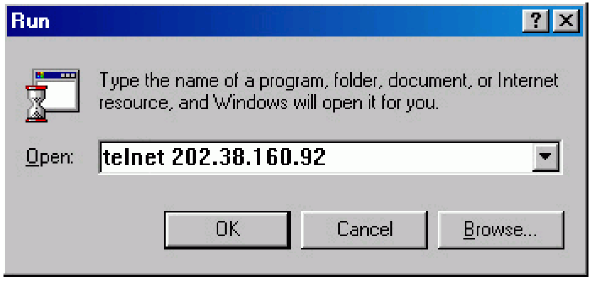
2 To set up the configuration environment, connect the network port of the PC to a port on the Switch through the LAN.

Figure 6 Setting up the Configuration Environment through Telnet



3 Run Telnet on the PC and enter the IP address of the VLAN connected to the network port on the PC.

Figure 7 Running Telnet


Run
?
Type the name of a program, folder, document, or Internet resource, and Windows will open it for you.
Open:
OK
Cancel
Browse...

```
telnet 202.38.160.92
```

4 The terminal displays `Login authentication` and prompts the user to enter the logon password. After you enter the correct password, it displays the command line prompt (such as `<SW5500>`). If the prompt `All user interfaces are used, please try later!` appears, too many users are connected to the Switch through Telnet. At most five Telnet users are allowed to log on to the SW5500 Switch simultaneously.

5 Use the corresponding commands to configure the Switch or to monitor the running state. Enter **?** to view online help. For details of specific commands, refer to the following chapters.

When configuring the Switch through Telnet, do not modify the IP address of the Switch unnecessarily, for the modification might end the Telnet connection.

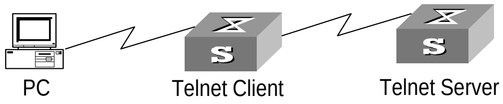
By default, when a Telnet user passes the password authentication to log on to the Switch, the access level for commands will be Level 0.

Telneting a Switch through another Switch

After a user has logged into a Switch, it is possible to configure another Switch through the Switch through Telnet. The local Switch serves as Telnet client and the peer Switch serves as the Telnet server. If the ports connecting these two Switches are in the same local network, their IP addresses must be configured in the same network segment. Otherwise, the two Switches must establish a route to communicate with each other.

As shown in Figure 8, after you Telnet to a Switch, you can run the **`telnet`** command to log in to, and configure, another Switch.

Figure 8 Providing Telnet Client Service



1 Authenticate the Telnet user through the console port on the Telnet Server (a Switch) before login.

By default, the password is required to authenticate Telnet users and to enable them to log on to the Switch. If a user logs in through Telnet without the password, the unit displays an error prompt .

```
<SW5500> system-view
[SW5500] user-interface vty 0
[SW5500-ui-vty0] set authentication password simple xxxx
```

(where xxxx is the preset login password of Telnet user)

2 The user logs in to the Telnet Client (Switch). For the login process, refer to "Connecting a PC to the Switch through Telnet" on page 31.

3 Perform the following on the Telnet Client:

```
<SW5500> telnet xxxx
```

(xxxx can be the hostname or IP address of the Telnet Server. If it is the hostname, use the `ip host` command to specify.)

4 Enter the preset login password and you will see the prompt such `<SW5500>`. If the prompt `All user interfaces are used, please try later!` appears, it indicates that too many users are connected to the Switch through Telnet. In this case, connect later.

5 Use the corresponding commands to configure the Switch or view it running state. Enter **?** to view online help. For details of specific commands, refer to the following chapters.

Setting up Configuration Environment through a Dial-up Modem

Perform the following procedure to set up the configuration environment through a dial up modem.

1 Authenticate the modem user through the console port of the Switch before the user logs in to the Switch through a dial-up modem.

By default, the password is required for authenticating the Modem user to log in to the Switch. If a user logs in through the Modem without the password, the user will see the prompt `Login password has not been set!.`

```
<SW5500>system-view
[SW5500]user-interface aux 0
[SW5500-ui-aux0]set authentication password simple xxxx
```
(xxxx is the preset login password of the Modem user.)

2 Perform the following configurations on the Modem that is directly connected to the Switch. (You are not required to configure the Modem connected to the terminal.)

```
AT&F-------------------Reset Modem factory settings

ATS0=1-----------------Set auto response (ring once)

AT&D-------------------Ignore DTR signal

AT&K0------------------Disable flow control

AT&R1------------------Ignore RTS signal

AT&S0------------------Force DSR to be high-level

ATEQ1&W----------------Bar the modem to send command response or
execution result and save the configurations
```

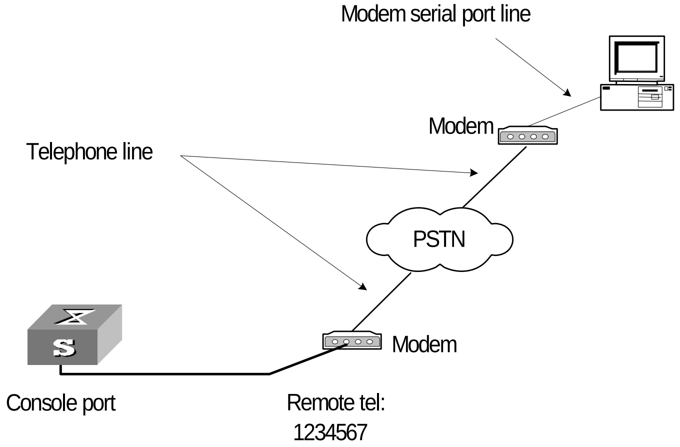
After the configuration, enter **AT&V** to verify the Modem settings.

The Modem configuration commands and outputs may be different according to different Modems. For details, refer to the User Manual of the Modem.

3Com recommends that the transmission rate on the console port must lower than that of Modem, otherwise packets may be lost.

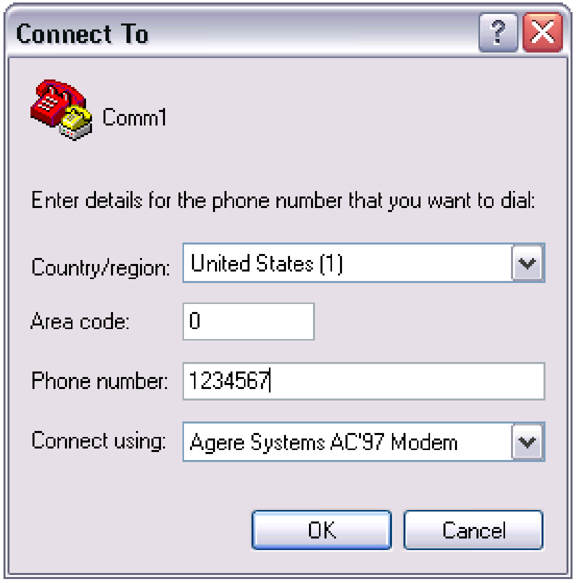
3 To set up the remote configuration environment, connect the Modems to a PC (or a terminal) serial port and the Switch console port respectively (see Figure 9).

Figure 9 Setting up Remote Configuration Environment



4 Dial for connection to the Switch, using the terminal emulator and Modem on the remote end. The number you dial is the telephone number of the Modem connected to the Switch. See Figure 10 and Figure 11.

Figure 10 Setting the Dialed Number



Comm1

Enter details for the phone number that you want to dial:

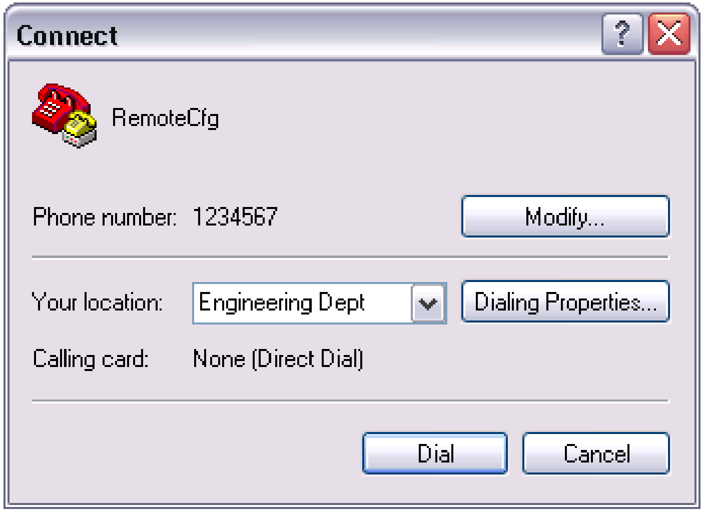
Country/region: United States (1)

Area code: 0

Phone number: 1234567

Connect using: Agere Systems AC'97 Modem

Figure 11 Dialing on the Remote PC



Phone number: 1234567

Your location: Engineering Dept

Calling card: None (Direct Dial)

5 Enter the preset login password on the remote terminal emulator and wait for the prompt `<SW5500>`. Then you can configure and manage the Switch. Enter **?** to view online help. For details of specific commands, refer to the following chapters.

By default, after login, a modem user can access the commands at Level 0.

Command Line Interface

The Switch 5500 family provide a series of configuration commands and command line interfaces for configuring and managing the Switch. The command line interface has the following characteristics:

- Local configuration through the console port.
- Local or remote configuration through Telnet or SSH.
- Remote configuration through a dial-up Modem to log in to the Switch.
- Hierarchy command protection to avoid the unauthorized users accessing the Switch.
- Access to online Help by entering **?**.
- Network test commands, such as Tracert and Ping, to troubleshoot the network.
- Detailed debugging information to help with network troubleshooting.
- Ability to log in and manage other Switch 5500 units directly, using the Telnet command.
- FTP service for users to upload and download files.
- Ability to view previously executed commands.
- The command line interpreter that searches for a target not fully matching the keywords. You can enter the whole keyword or part of it, as long as it is unique and unambiguous.

Command Line View

The Switch 5500 Family provides hierarchy protection for command lines to avoid unauthorized users accessing it illegally.

Commands are classified into four levels, namely visit level, monitoring level, system level and management level:

- Visit level: Commands in this level include network diagnosis tools (such as **ping** and **tracert**), commands for the different language environments of the user interface (**language-mode**) and the **telnet** command. The saving of the configuration file is not allowed at this command level.
- Monitoring level: Commands in this level include the **display** command and the **debugging** command, and are used for system maintenance, service fault and diagnosis. The saving of the configuration file is not allowed at this command level.
- System level: Commands in this level include service configuration commands, including routing commands and commands for each network layer, and are used to provide direct network service to the user.
- Management level: Commands in this level include those that influence basic operation of the system and system support module, which plays a support role for services. Commands in this level include file system commands, FTP commands, TFTP commands, XModem downloading commands, user management commands, and level setting commands.

Login users are also classified into four levels that correspond to the four command levels respectively. After users of different levels log in, they can only use commands at the levels that are equal to or lower than their own level.

To prevent unauthorized users from illegal intrusion, the user will be identified when switching from a lower level to a higher level with the **super** [*level*] command. User ID authentication is performed when users at lower level become users at a higher level. In other words, the user password for the higher level is needed. (Suppose the user has entered **super password** [**level** *level*] { **simple** | **cipher** } *password*..) For the sake of confidentiality, on the screen the user cannot see the password that they entered. Only when correct password is input three times, can the user switch to the higher level. Otherwise, the original user level will remain unchanged.

Different command views are implemented according to different requirements. They are related to one another. For example, after logging in to the Switch, you will enter User View, in which you can only use some basic functions such as displaying the running state and statistics information. In User View, enter **system-view** to enter System View, in which you can key in different configuration commands and enter the corresponding views.

The command line provides the following views:

- User View
- System View
- Ethernet Port View
- VLAN View
- VLAN Interface View
- Local-User View
- User Interface View
- FTP Client View
- RSA Public Key View
- RSA Key Code View
- PIM View
- RIP View
- OSPF View
- OSPF Area View
- Route Policy View
- Basic ACL View
- Advanced ACL View
- Layer-2 ACL View
- User-Defined ACL View
- QoS Profile View
- RADIUS Server Group View
- ISP Domain View

Table 5 describes the features of different views and the ways to enter or quit.

Table 5 Features of Command Views

Command view	Function	Prompt	Command to enter	Command to exit
User View	Show the basic information about operation and statistics	`<SW5500>`	This is the view you are in after connecting to the Switch	**quit** disconnects to the Switch
System View	Configure system parameters	`[SW5500]`	Enter **system-view** in User View	**quit** or **return** returns to User View
Ethernet Port View	Configure Ethernet port parameters	`[SW5500-Ethernet1/0/1]`	100M Ethernet Port View: Enter **interface ethernet 1/0/1** in System View	**quit** returns to System View **return** returns to User View
		`[SW5500-GigabitEthernet1/0/24]`	GigabitEthernet Port View: Enter **interface gigabitethernet 1/0/24** in System View	
VLAN View	Configure VLAN parameters	`[SW5500-Vlan1]`	Enter **vlan 1** in System View	**quit** returns to System View **return** returns to User View

Table 5 Features of Command Views (continued)

Command view	Function	Prompt	Command to enter	Command to exit
VLAN Interface View	Configure IP interface parameters for a VLAN or a VLAN aggregation	[SW5500-Vlan-interface1]	Enter **interface vlan-interface 1** in System View	**quit** returns to System View **return** returns to User View
Local-User View	Configure local user parameters	[SW5500-luser-user1]	Enter **local-user user1** in System View	**quit** returns to System View **return** returns to User View
User Interface View	Configure user interface parameters	[SW5500-ui0]	Enter **user-interface 0** in System View	**quit** returns to System View **return** returns to User View
FTP Client View	Configure FTP Client parameters	[SW5500-ftp]	Enter **ftp** in User View	**quit** returns to System View
RSA Public Key View	Configure RSA public key of SSH user	[SW5500-rsa-public-key]	Enter **rsa peer-public-key SW5500003** in System View	**peer-public-key end** returns to System View
RSA Key Code View	Edit RSA public key of SSH user	[SW5500-rsa-key-code]	Enter **public-key-code begin** in RSA Public Key View	**public-key-code end** returns to RSA Public Key View
PIM View	Configure PIM parameters	[SW5500-PIM]	Enter **pim** in System View	**quit** returns to System View **return** returns to User View
RIP View	Configure RIP parameters	[SW5500-rip]	Enter **rip** in System View	**quit** returns to System View **return** returns to User View
OSPF View	Configure OSPF parameters	[SW5500-ospf]	Enter **ospf** in System View	**quit** returns to System View **return** returns to User View
OSPF Area View	Configure OSPF area parameters	[SW5500-ospf-0.0.0.1]	Enter **area 1** in OSPF View	**quit** returns to OSPF View **return** returns to User View
Route Policy View	Configure route policy parameters	[SW5500-route-policy]	Enter **route-policy policy1 permit node 10** in System View	**quit** returns to System View **return** returns to User View
Basic ACL View	Define the rule of basic ACL	[SW5500-acl- basic-2000]	Enter **acl number 2000** in System View	**quit** returns to System View **return** returns to User View
Advanced ACL View	Define the rule of advanced ACL	[SW5500-acl-adv-3000]	Enter **acl number 3000** in System View	**quit** returns to System View **return** returns to User View
Layer-2 ACL View	Define the rule of layer-2 ACL	[SW5500-acl-ethernetframe-4000]	Enter **acl number 4000** in System View	**quit** returns to System View **return** returns to User View

Table 5 Features of Command Views (continued)

Command view	Function	Prompt	Command to enter	Command to exit
User-defined ACL View	Define the rule of user-defined ACL	`[SW5500-acl-user-5000]`	Enter **acl number 5000** in System View	**quit** returns to System View **return** returns to User View
QoS profile View	Define QoS profile	`[SW5500-qos-profile-h3c]`	Enter **qos-profile h3c** in System View	**quit** returns to System View **return** returns to User View
RADIUS Server Group View	Configure radius parameters	`[SW5500-radius-1]`	Enter **radius scheme 1** in System View	**quit** returns to System View **return** returns to User View
ISP Domain View	Configure ISP domain parameters	`[SW5500-isp-3Com.net]`	Enter **domain** 3Com.net in System View	**quit** returns to System View **return** returns to User View

Features and Functions of Command Line

Command Line Help

The command line interface provides full and partial online help.

You can get help information through the online help commands, which are described below:

1. Enter **?** in any view to get all the commands in that view.
2. Enter a command with a **?** separated by a space. If this position is for parameters, all the parameters and the corresponding brief descriptions will be listed.

```
[5500-EI]interface ?

Aux                    Aux interface
Ethernet               Ethernet interface
GigabitEthernet        GigabitEthernet interface
Loopback               LoopBack interface
NULL                   NULL interface
Vlan-interface         VLAN interface
```

3. Enter a character string followed by a **?**, then all the commands with this character string as their initials will be listed.

```
<SW5500>p?

ping
```

4. Enter a command with a character string and **?**, then all the keywords with this character string as their initials in the command will be listed.

```
<SW5500>display ver?

version
```

5. Enter the first letters of a keyword of a command and press <Tab>. If no other keywords begin with these letters, then this unique keyword will be displayed automatically.
6. To switch to the Chinese display for the above information, perform the **language-mode** command.

Displaying Characteristics of the Command Line

The command line interface provides a pausing function. If the information to be displayed exceeds one screen, users have three choices, as shown in Table 6.

Table 6 Functions of Displaying

Key or Command	Function
Press <Ctrl+C> when the display pauses	Stop displaying and executing command.
Enter a space when the display pauses	Continue to display the next screen of information.
Press <Enter> when the display pauses	Continue to display the next line of information.

History Command

The command line interface provides a function similar to that of the DosKey. Commands entered by users are automatically saved by the command line interface and you can invoke and execute them at any time later. The history command buffer is defaulted as 10. That is, the command line interface stores 10 history commands for each user. The operations are shown in Table 7.

Table 7 Retrieving History Command

Operation	Key	Result
Display history command	**`display history-command`**	Display history command by user inputting
Retrieve the previous history command	Up cursor key <> or <Ctrl+P>	Retrieve the previous history command, if there is any.
Retrieve the next history command	Down cursor key <> or <Ctrl+N>	Retrieve the next history command, if there is any.

*Cursor keys can be used to retrieve the history commands in Windows 3.X Terminal and Telnet. However, in Windows 9X HyperTerminal, the up and down cursor keys and do not work, because Windows 9X HyperTerminal defines the two keys differently. In this case, use the combination keys <**Ctrl+P**> and <**Ctrl+N**> instead for the same purpose.*

Common Command Line Error Messages

Incorrectly entered commands will cause error messages to be reported to users. The common error messages are listed in Table 8.

Table 8 Common Command Line Error Messages

Error messages	Causes
`Unrecognized command`	■ Cannot find the command ■ Cannot find the keyword ■ Wrong parameter type ■ The value of the parameter exceeds the range
`Incomplete command`	The command is incomplete.
`Too many parameters`	Too many parameters have been entered.
`Ambiguous command`	The parameters entered are not specific.

Editing Characteristics of Command Line

The command line interface provides basic command editing and supports the editing of multiple lines. A command cannot be longer than 256 characters. See Table 9.

Table 9 Editing Functions

Key	Function
Common keys	Insert from the cursor position and the cursor moves to the right, if the edition buffer still has free space.
Backspace	Delete the character preceding the cursor and the cursor moves backward.
Leftwards cursor key <> or <Ctrl+B>	Move the cursor a character backward
Rightwards cursor key <> or <Ctrl+F>	Move the cursor a character forward
Up cursor key <> or <Ctrl+P>	Retrieve the history command.
Down cursor key <> or <Ctrl+N>	
<Tab>	Press <Tab> after typing an incomplete keyword and the system will display partial help: If the keyword matching the one entered is unique, the system will replace it with the complete keyword and display it in a new line; if there is no matched keyword or the matched keyword is not unique, the system will do no modification but display the originally typed word in a new line.

User Interface Configuration

User interface configuration is another way provided by the Switch to configure and manage the port data.

Switch 5500 family Switches support the following configuration methods:

- Local configuration through the console port
- Local and remote configuration through Telnet or SSH through an Ethernet port
- Remote configuration through a dial-up modem through the console port.

According to the above-mentioned configuration methods, there are two types of user interfaces:

- AUX user interface

  AUX user interface is used to log in to the Switch through the console port. A fabric can have up to eight AUX user interfaces.

- VTY user interface

  VTY user interface is used to Telnet to the Switch. A Switch can have up to five VTY user interfaces.

For SW5500 family Switches, AUX port, and console port are the same port. There is only the one type of AUX user interface.

The user interface is numbered by absolute number or relative number.

To number the user interface by absolute number:

- The AUX user interface is the first interface—user interface 0. The number ranges from 0 to 7.
- The VTY is numbered after the AUX user interface. The absolute number of the first VTY is the AUX user interface number plus 1. The number ranges from 8 to 12.

To number the user interface by relative number, represented by *interface + number* assigned to each type of user interface:

- AUX user interface = AUX 0.
- The first VTY interface = VTY 0, the second one = VTY 1, and so on.

User Interface Configuration

Tasks for configuring the user interface are described in the following sections:

- Entering User Interface View
- Configuring the User Interface-Supported Protocol
- Configuring the Attributes of AUX (Console) Port
- Configuring the Terminal Attributes
- Managing Users
- Configuring Redirection

Entering User Interface View

Use the **`user-interface`** command to enter a User Interface View. You can enter a single User Interface View or multi User Interface View to configure one or more user interfaces respectively.

Perform the following configuration in System View.

Table 10 Entering User Interface View

Operation	Command
Enter a single User Interface View or multi User Interface Views	**`user-interface`** `[ type ] first-number [ last-number ]`

Configuring the User Interface-Supported Protocol

The following command is used for setting the supported protocol by the current user interface. You can log in to the Switch only through the supported protocol. The configuration becomes effective when you log in again.

Perform the following configurations in User Interface (VTY user interface only) View.

Table 11 Configuring the User Interface-supported Protocol

Operation	Command
Configure the user interface-supported protocol	**`protocol inbound { all`** `|` **`ssh`** `|` **`telnet }`**

By default, the user interface supports Telnet and SSH protocols.

If the Telnet protocol is specified, to ensure a successful login through Telnet, you must configure the password by default.

If SSH protocol is specified, to ensure a successful login, you must configure the local or remote authentication of username and password using the **`authentication-mode scheme`** *command. The* **`protocol inbound ssh`** *configuration fails if you configure* **`authentication-mode password`** *and* **`authentication-mode none`**. *When you configure SSH protocol successfully for the user interface, then you cannot configure* **`authentication-mode password`** *and* **`authentication-mode none`** *any more.*

Configuring the Attributes of AUX (Console) Port

Use the **speed, flow control, parity, stop bit,** and **data bit** commands to configure these attributes of the AUX (console) port.

Perform the following configurations in User Interface (AUX user interface only) View.

Configuring the Transmission Speed on the AUX (Console) Port

Table 12 Configuring the Transmission Speed on the AUX (Console) Port

Operation	Command
Configure the transmission speed on the AUX (console) port	**speed** *speed_value*
Restore the default transmission speed on the AUX (console) port	**undo speed**

By default, the transmission speed on the AUX (console) port is 9600bps.

Configuring the Flow Control on the AUX (Console) Port

Table 13 Configuring the Flow Control on the AUX (Console) Port

Operation	Command
Configure the flow control on the AUX (console) port	**flow-control { hardware** | **none** | **software }**
Restore the default flow control mode on the AUX (console) port	**undo flow-control**

By default, the flow control on the AUX (console) port is none, that is, no flow control will be performed.

Configuring Parity on the AUX (Console) Port

Table 14 Configuring Parity on the AUX (Console) Port

Operation	Command
Configure parity mode on the AUX (console) port	**parity**{**even** | **mark** | **none** | **odd** | **space**}
Restore the default parity mode	**undo parity**

By default, the parity on the AUX (console) port is none, that is, no parity bit.

Configuring the Stop Bit of AUX (Console) Port

Table 15 Configuring the Stop Bit of AUX (Console) Port

Operation	Command
Configure the stop bit of the AUX (console) port	**stopbits** { **1** |**1.5** | **2** }
Restore the default stop bit of the AUX (console) port	**undo stopbits**

By default, the AUX (console) port supports 1 stop bit.

Configuring the Data Bit of the AUX (Console) port

Table 16 Configuring the Data Bit of the AUX (Console) Port

Operation	Command
Configure the data bit of the AUX (console) port	**databits**{**7** | **8**}
Restore the default data bit of the AUX (console) port	**undo databits**

By default, the AUX (console) port supports 8 data bits.

Configuring the Terminal Attributes

The following commands can be used for configuring the terminal attributes, including enabling/disabling terminal service, disconnection upon timeout, lockable user interface, configuring terminal screen length, and history command buffer size.

Perform the following configuration in User Interface View. Perform the **`lock`** command in User View.

Enabling/Disabling Terminal Service After terminal service is disabled on a user interface, you cannot log in to the Switch through the user interface. However, the user logged in through the user interface before disabling the terminal service can continue his operation. After such user logs out, he cannot log in again. In this case, a user can log in to the Switch through the user interface only when the terminal service is enabled again.

Table 17 Enabling/Disabling Terminal Service

Operation	Command
Enable terminal service	**`shell`**
Disable terminal service	**`undo shell`**

By default, terminal service is enabled on all the user interfaces.

Note the following points:

- For security, the **`undo shell`** command can only be used on the user interfaces other than AUX user interface.
- You cannot use this command on the user interface through which you log in.
- You will be asked to confirm before using **`undo shell`** on any legal user interface.

Configuring Idle-timeout

Table 18 Configuring Idle-timeout

Operation	Command
Configure idle-timeout	**`idle-timeout`** *`minutes`* `[` *`seconds`* `]`
Restore the default idle-timeout	**`undo idle-timeout`**

By default, idle-timeout is enabled and set to 10 minutes on all the user interfaces. That is, the user interface will be disconnected automatically after 10 minutes without any operation.

`idle-timeout 0` Disables idle-timeout.

Locking the User Interface This configuration locks the current user interface and prompts the user to enter the password. This makes it impossible for others to operate in the interface after the user leaves.

Table 19 Locking the User Interface

Operation	Command
Lock user interface	**`lock`**

Setting the Screen Length If a command displays more than one screen of information, you can use the following command to set how many lines to be displayed in a screen, so that the information can be separated in different screens and you can view it more conveniently.

Table 20 Setting the Screen Length

Operation	Command
Set the screen length	**screen-length** *screen_length*
Restore the default screen length	**undo screen-length**

By default, the terminal screen length is 24 lines.

screen-length 0 Disables screen display separation function.

Setting the History Command Buffer Size

Table 21 Setting the History Command Buffer Size

Operation	Command
Set the history command buffer size	**history-command max-size** *value*
Restore the default history command buffer size	**undo history-command max-size**

By default, the size of the history command buffer is 10, that is, 10 history commands can be saved.

Managing Users

The management of users includes the setting of user login authentication method, level of command which a user can use after logging in, level of command which a user can use after logging in from a specific user interface, and command level.

Configuring the Authentication Method The following command is used for configuring the user login authentication method to deny the access of an unauthorized user.

Perform the following configuration in User Interface View.

Table 22 Configuring the Authentication Method

Operation	Command
Configure the authentication method	**authentication-mode { password | scheme }**
Configure no authentication	**authentication-mode none**

By default, terminal authentication is not required for users logged in through the console port, whereas the password is required for authenticating the Modem and Telnet users when they log in.

1 Perform local password authentication to the user interface

Using **authentication-mode password** command, you can perform local password authentication. That is, you need use the command below to configure a login password to login successfully.

Perform the following configuration in User Interface View.

Table 23 Configuring the local authentication password

<table>
<tr><th>Operation</th><th>Command</th></tr>
<tr><td>Configure the local authentication password</td><td><b>set authentication password { cipher | simple }</b><i>password</i></td></tr>
<tr><td>Remove the local authentication password</td><td><b>undo set authentication password</b></td></tr>
</table>

Configure for password authentication when a user logs in through a VTY 0 user interface and set the password to 3Com.

```
[SW5500]user-interface vty 0
[SW5500-ui-vty0]authentication-mode password
[SW5500-ui-vty0]set authentication password simple 3Com
```

2 Perform local or remote authentication of the username and the password to the user interface

Using the **authentication-mode scheme** command, you can perform local or remote authentication of username and password. The type of the authentication depends on your configuration.

In the following example, local username and password authentication are configured.

Perform username and password authentication when a user logs in through VTY 0 user interface and set the username and password to zbr and 3Com respectively.

```
[SW5500-ui-vty0]authentication-mode scheme
[SW5500-ui-vty0]quit
[SW5500]local-user zbr
[SW5500-luser-zbr]password simple 3Com
[SW5500-luser-zbr]service-type telnet
```

3 No authentication

```
[SW5500-ui-vty0]authentication-mode none
```

By default, the password is required for authenticating Modem and Telnet users when they log in. If the password has not been set, when a user logs in, he will see the prompt `Login password has not been set!`

If the **authentication-mode none** *command is used, the Modem and Telnet users will not be required to enter a password.*

Setting the command level used after a user has logged on The following command is used for setting the command level used after a user logs in.

Perform the following configuration in Local-User View.

Table 24 Setting the Command Level used after a User Logs In

<table>
<tr><th>Operation</th><th>Command</th></tr>
<tr><td>Set command level used after a user logs in</td><td><b>service-type</b> { <b>ftp</b> [<b>ftp-directory</b> directory | <b>lan-access</b> | { <b>ssh</b> | <b>telnet</b> | <b>terminal</b> }* [<b>level</b> level] }</td></tr>
<tr><td>Restore the default command level used after a user logs in</td><td><b>undo service-type</b> { <b>ftp</b> [<b>ftp-directory</b>] <b>lan-access</b> | { <b>ssh</b> | <b>telnet</b> | <b>terminal</b> }* }</td></tr>
</table>

By default, the specified logged-in user can access the commands at Level 1.

Setting the Command Level used after a User Logs In from a User Interface

You can use the following command to set the command level after a user logs in from a specific user interface, so that a user is able to execute the commands at such command level.

Perform the following configuration in User Interface View.

Table 25 Setting the Command Level used after a User Logs In from a User Interface

Operation	Command
Set command level used after a user logs in from a user interface	**`user privilege level`** *`level`*
Restore the default command level used after a user logs in from a user interface	**`undo user privilege level`**

By default, a user can access the commands at Level 3 after logging in through the AUX user interface, and the commands at Level 0 after logging in through the VTY user interface.

When a user logs in to the Switch, the available command level depends on two points. One is the command level that the user is allowed to access, the other is the set command level of this user interface. If the two levels are different, the former will be taken. For example, the command level of VTY 0 user interface is 1, however, you have the right to access commands of level 3; if you log in from VTY 0 user interface, you can access commands of level 3 and lower.

Setting the command priority The following command is used for setting the priority of a specified command in a certain view. The command levels include visit, monitoring, system, and management, which are identified with 0 through 3 respectively. An administrator assigns authorities as per user requirements.

Perform the following configuration in System View.

Table 26 Setting the Command Priority

Operation	Command
Set the command priority in a specified view.	**`command-privilege level`** *`level`* **`view`** *`view command`*
Restore the default command level in a specified view.	**`command-privilege view`** *`view command`*

Do not change the command level unnecessarily for it may cause inconvenience with maintenance and operation.

Configuring Redirection

send command The following command can be used for sending messages between user interfaces.

Perform the following configuration in User View.

Table 27 Configuring to Send Messages Between Different User Interfaces

Operation	Command
Configuring to send messages between different user interfaces.	**`send`** { **`all`** | *`number`* | *`type number`* }

auto-execute command The following command is used to automatically run a command after you log in. After a command is configured to be run automatically, it will be automatically executed when you log in again.

This command is usually used to automatically execute the **telnet** command on the terminal, which will connect the user to a designated device automatically.

Perform the following configuration in User Interface View.

Table 28 Configuring to Automatically Run the Command

Operation	Command
Configure to automatically run the command	**auto-execute command** *text*
Configure not to automatically run the command	**undo auto-execute command**

Note the following points:

- After executing this command, the user interface can no longer be used to carry out the routine configurations for the local system. Use this command with caution.
- Make sure that you will be able to log in the system in another way and cancel the configuration, before you use the **auto-execute command** command and save the configuration.

Telnet 10.110.100.1 after the user logs in through VTY0 automatically.

```
[SW5500-ui-vty0]auto-execute command telnet 10.110.100.1
```

When a user logs on through VTY 0, the system will run **telnet** 10.110.100.1 automatically.

Displaying and Debugging User Interface

After the above configuration, use the **display** command in any view to display the running of the user interface configuration, and to verify the effect of the configuration.

Use the **free** command in User View to clear a specified user interface.

Table 29 Displaying and Debugging User Interface

Operation	Command
Clear a specified user interface	**free user-interface** [*type*] *number*
Display the user application information of the user interface	**display users** [**all**]
Display the physical attributes and some configurations of the user interface	**display user-interface** [*type number* | *number*] [**summary**]

2 ADDRESS MANAGEMENT CONFIGURATION

Introduction to Address Management

You can easily configure the switch on which the Address Manage (AM) feature is enabled to allow a user with the specified MAC address to gain network access through the specified IP address in a small network, such as a campus network. This facilitates the implementation of user management and accounting.

Configuring Address Management

Address management configuration tasks include:

- Configuring a port-based address management IP address pool
- Binding the MAC address and IP address of a legal user to the specified port

Configuring a Port-Based Address Management IP Address Pool

By setting an address management IP address pool on a port, you can allow a user with the specified IP addresses to access the network. The Ethernet switch allows the packets in the IP address pool whose IP addresses are the source IP addresses to pass the port for layer 3 forwarding. The switch does not forward any packet from any IP address not configured in the IP address pool.

Table 30 Configure a port-based address management IP address pool

Operation	Command	Description
Enter system view	system-view	-
Enable address management	am enable	Required The IP address pool configured on each port to control layer 3 forwarding takes effect only after address management is enabled.
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure an address management IP address pool on a port	**am ip-pool** { *address-list* }	Required By default, the address management IP address pool on each port is null; that is, the switch permits all packets to pass.

When you are configuring an address management IP address pool on a port, if the IP addresses in this IP address pool are those configured in the static ARP on another port, the system will prompt you to delete the corresponding static ARP to ensure that the binding takes effect.

You cannot configure static ARP for the IP address restricted by AM; otherwise, AM fails.

Binding the MAC Address and IP Address of a Legal User to the Specified Port

This configuration binds the specified MAC addresses and IP addresses, only allowing the packets from legal MAC addresses and legal IP addresses to be forwarded by the switch. None of the following combinations enables network access through the switch:

- Illegal MAC address + illegal IP address
- Legal MAC address + illegal IP address
- Illegal MAC address + legal IP address

Perform the following operations to bind the MAC address and IP address of a legal user to the specified port; no other configuration is required.

Table 31 Bind the MAC address and IP address of a legal user to the specified port

Operation	Command	Description
Enter system view	system-view	-
Bind the MAC address and IP address of a legal user to the specified port	**am user-bind mac-addr** *mac-address* **ip-addr** *ip-address* [**interface** *interface-type interface-number*]	Optional
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Bind the MAC address and IP address of a legal user to the specified port	**am user-bind mac-addr** *mac-address* **ip-addr** *ip-address*	Optional

Address Management Configuration Example

This section contains configuration examples.

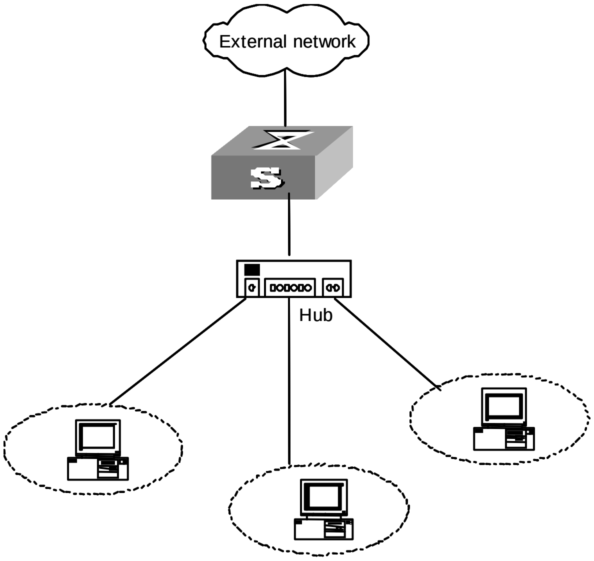
Port-Based Address Management IP Address Pool Configuration Example

Network requirements

The GigabitEthernet1/0/1 port of the switch is connected to multiple PCs.

Network diagram

Figure 12 Network diagram for address management



Configuration procedure

To enable address management, enter the following:

```
<S5500> system-view
[S5500] am enable
```

To configure an address management IP address pool on GigabitEthernet 1/0/1, allowing 20 IP addresses starting from 202.10.20.1 to 202.10.20.20 to access the network, enter the following:

```
[S5500] interface GigabitEthernet 1/0/1
[S5500-GigabitEthernet 1/0/1] am ip-pool 202.10.20.1 20
```

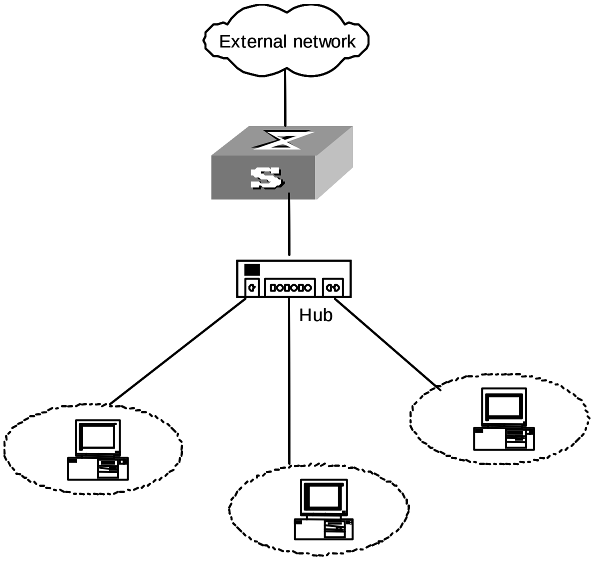
Configuration Example of Binding the MAC Address and IP Address of a Legal User

Network requirements

The GigabitEthernet1/0/1 port of the switch is connected to multiple PCs.

Network diagram

Figure 13 Network diagram for address management



Configuration procedure

To configure to bind MAC addresses and IP addresses to GigabitEthernet 1/0/1, only allowing a PC whose MAC address is 00e0-fc00-3900 to access the network by using the IP address 202.10.20.30, enter the following:

```
<S5500> system-view
[S5500] interface GigabitEthernet 1/0/1
[S5500-GigabitEthernet 1/0/1] am user-bind mac-addr 00e0-fc00-3900
ip-address 202.10.20.30
```

3 PORT OPERATION

This chapter covers the following topics:

- Ethernet Port Configuration Introduction
- Link Aggregation Configuration
- Global Broadcast Suppression Feature
- Configuring VCT
- Global Broadcast Suppression Feature
- Displaying Port Configuration Information in Brief
- Displaying Information About a Specified Optical Port

Ethernet Port Configuration Introduction

The following features are found in the Ethernet ports of the Switch 5500

- 10/100BASE-T Ethernet ports support MDI/MDI-X auto-sensing. They can operate in half-duplex, full-duplex and auto-negotiation modes. They can negotiate with other network devices to determine the operating mode and speed. Thus the appropriate operating mode and speed is automatically configured and the system configuration and management is greatly streamlined.
- Gigabit SFP ports operate in 1000Mbps full duplex mode. The duplex mode can be set to **full** (full-duplex) and **auto** (auto-negotiation) and its speed can be set to **1000** (1000Mbps) and **auto** (auto-negotiation).

Ethernet Port Configuration

Ethernet port configuration is described in the following sections:

- Entering Ethernet Port View
- Enabling/Disabling an Ethernet Port
- Setting the Description Character String for the Ethernet Port
- Setting the Duplex Attribute of the Ethernet Port
- Setting Speed on the Ethernet Port
- Setting the Cable Type for the Ethernet Port
- Enabling/Disabling Flow Control for the Ethernet Port
- Permitting/Forbidding Jumbo Frames to Pass through an Ethernet Port
- Setting the Ethernet Port Suppression Ratio
- Setting the Link Type for an Ethernet Port
- Adding an Ethernet Port to Specified VLANs
- Setting the Default VLAN ID for the Ethernet Port
- Setting Loopback Detection for an Ethernet Port
- Configuring VCT
- VCT Configuration Example
- Copying Port Configuration to Other Ports

Entering Ethernet Port View

Before configuring an Ethernet port, enter Ethernet Port View.

Perform the following configuration in System View.

Table 32 Entering Ethernet Port View

Operation	Command
Enter Ethernet Port View	**interface** { *interface_type interface_num* | *interface_name* }

Enabling/Disabling an Ethernet Port

Use the following command to disable or enable the port. After configuring the related parameters and protocol of the port, you can use the following command to enable the port. If you do not want a port to forward data, use the command to disable it.

Perform the following configuration in Ethernet Port View.

Table 33 Enabling/Disabling an Ethernet Port

Operation	Command
Disable an Ethernet port	**shutdown**
Enable an Ethernet port	**undo shutdown**

By default, the port is enabled.

Setting the Description Character String for the Ethernet Port

To distinguish the Ethernet ports, use the following command to assign a description to each port.

Perform the following configuration in Ethernet Port View.

Table 34 Setting the Description Character String for the Ethernet Port

Operation	Command
Set description character string for Ethernet port.	**description** *text*
Delete the description character string of Ethernet.	**undo description**

By default, the port description is a null character string.

Setting the Duplex Attribute of the Ethernet Port

To configure a port to send and receive data packets at the same time, set it to full-duplex. To configure a port to either send or receive data packets, set it to half-duplex. If the port has been set to auto-negotiation mode, the local and peer ports will automatically negotiate the duplex mode.

Perform the following configuration in Ethernet Port View.

Table 35 Setting the Duplex Attribute for the Ethernet Port

Operation	Command
Set duplex attribute for Ethernet port.	**duplex** { **auto** | **full** | **half** }
Restore the default duplex attribute of Ethernet port.	**undo duplex**

Note that 10/100BASE-T Ethernet ports support full duplex, half duplex and auto-negotiation, which can be set as required. Gigabit Ethernet ports support full duplex and can be configured to operate in **full** (full duplex) or **auto** (auto-negotiation) mode.

The port defaults to **auto** (auto-negotiation) mode.

Setting Speed on the Ethernet Port

Use the following command to set the speed of the Ethernet port. If the speed is set to auto-negotiation mode, the local and peer ports will automatically negotiate the port speed.

Perform the following configuration in Ethernet Port View.

Table 36 Setting Speed on the Ethernet Port

Operation	Command
Set the Ethernet port speed	`speed { 10 | 100 | 1000 | auto }`
Restore the default speed for the Ethernet port	`undo speed`

Note that 10/100BASE-T Ethernet ports support 10Mbps, 100Mbps and auto-negotiation, which can be set as required. Gigabit Ethernet ports support 1000Mbps and can be configured to operate at **1000** (1000Mbps) or **auto** (auto-negotiation) speed.

By default, the speed of the port set to **auto** mode.

Setting the Cable Type for the Ethernet Port

Ethernet ports support straight-through and cross-over network cables. Use the following command to configure the cable type.

Perform the following configuration in Ethernet Port View.

Table 37 Setting the Type of the Cable Connected to an Ethernet Port

Operation	Command
Set the type of the cable connected to an Ethernet port.	`mdi { across | auto | normal }`
Restore the default type of the cable connected to an Ethernet port.	`undo mdi`

By default, the cable type is **auto** (auto-recognized). That is, the system can automatically recognize the type of cable connecting to the port.

Enabling/Disabling Flow Control for the Ethernet Port

After flow control is enabled in both the local and the peer Switch, if congestion occurs in the local Switch, the Switch will inform its peer to pause packet sending. In this way, packet loss is reduced. The flow control function of the Ethernet port can be enabled or disabled using the following command.

Perform the following configuration in Ethernet Port View.

Table 38 Enabling/Disabling Flow Control for an Ethernet Port

Operation	Command
Enable Ethernet port flow control	`flow-control`
Disable Ethernet port flow control	`undo flow-control`

By default, Ethernet port flow control is disabled.

Permitting/Forbidding Jumbo Frames to Pass through an Ethernet Port

An Ethernet port may encounter jumbo frames exceeding the standard frame length, when switching large throughput data like transmitting files. This command can forbid or permit jumbo frames to pass through an Ethernet port.

Perform the following configuration in Ethernet Port View.

Table 39 Permitting/Forbidding Jumbo Frame to Pass through the Ethernet Port

Operation	Command
Permit jumbo frame to pass through the Ethernet port	**`jumboframe enable`**
Forbid jumbo frame to pass through the Ethernet port	**`undo jumboframe enable`**

By default, jumbo frames with lengths between 1518 bytes and 9216 bytes inclusive are permitted to pass through an Ethernet port.

Setting the Ethernet Port Suppression Ratio

Use the following commands to restrict broadcast/multicast/unicast traffic. Once traffic exceeds the value set by the user, the system will maintain an appropriate packet ratio by discarding the overflow traffic, so as to suppress storm, avoid congestion and ensure the normal service.

Perform the following configuration in Ethernet Port View.

Table 40 Setting the Ethernet Port Suppression Ratio

Operation	Command
Set Ethernet port broadcast suppression ratio	**broadcast-suppression** { *ratio* | **pps** *bandwidth* }
Restore the default Ethernet port broadcast suppression ratio	**undo broadcast-suppression**
Set Ethernet port multicast suppression ratio	**multicast-suppression** { *ratio* | **pps** *bandwidth* }
Restore the default Ethernet port multicast suppression ratio	**undo multicast-suppression**
Set Ethernet port unicast suppression ratio	**unicast-suppression** { *ratio* | **pps** *bandwidth* }
Restore the default Ethernet port unicast suppression ratio	**undo unicast-suppression**

By default, all traffic is allowed to pass through, that is, no suppression is performed.

Setting the Link Type for an Ethernet Port

An Ethernet port can operate in four different link types: access, hybrid, trunk and stack. An access port carries one VLAN only, used for connecting to the user's computer. A trunk port can belong to more than one VLAN and receive/send the packets on multiple VLANs, used for connection between the Switches. A hybrid port can also carry more than one VLAN and receive/send the packets on multiple VLANs, used for connecting to both Switches and the user's computers. The difference between a hybrid port and a trunk port is that a hybrid port allows the packets from multiple VLANs to be sent without tags, but a trunk port only allows the packets from the default VLAN to be sent without tags.

Perform the following configuration in Ethernet Port View.

Table 41 Setting the Link Type for the Ethernet Port

Operation	Command
Configure the port as an access port	**port link-type access**
Configure the port as a hybrid port	**port link-type hybrid**
Configure the port as a trunk port	**port link-type trunk**
Configure the port as a stack port	**port link-type xrn-fabric**
Restore the default link type, that is, access port	**undo port link-type**

By default, the port is access port.

Note that:

- You can configure four types of ports concurrently on the same Switch, but you cannot switch port type between trunk port, hybrid port and stack port. You must return it first into access port and the set it as the other type. For example, you cannot configure a trunk port directly as a hybrid port, but first set it as an access port and then as a hybrid port.
- For the Switch 5500-SI 28-Port, Switch 5500-EI 28-Port, and Switch 5500-EI PWR 28-Port, GigabitEthernet1/0/27 and GigabitEthernet1/0/28 ports can be configured as a stack port; For the Switch 5500-SI 52-port, Switch 5500-EI 52-Port, Switch 5500-EI PWR 52-Port, GigabitEthernet1/0/51 and GigabitEthernet1/0/52 ports can be configured as a stack port.

Adding an Ethernet Port to Specified VLANs

Use the following commands to add an Ethernet port to a specified VLAN. An access port can only be added to one VLAN, while hybrid and trunk ports can be added to multiple VLANs.

Perform the following configuration in Ethernet Port View.

Table 42 Adding the Ethernet Port to Specified VLANs

Operation	Command
Add the current access port to a specified VLAN	**port access vlan** *vlan_id*
Add the current hybrid port to specified VLANs	**port hybrid vlan** *vlan_id_list* { **tagged** | **untagged** }
Add the current trunk port to specified VLANs	**port trunk permit vlan** { *vlan_id_list* | **all** }
Remove the current access port from to a specified VLAN.	**undo port access vlan**
Remove the current hybrid port from to specified VLANs.	**undo port hybrid vlan** *vlan_id_list*
Remove the current trunk port from specified VLANs.	**undo port trunk permit vlan** { *vlan_id_list* | **all** }

Note that the access port shall be added to an existing VLAN other than VLAN 1. The VLAN to which a hybrid port is added must have already exist. The one to which a trunk port is added cannot be VLAN 1.

After adding an Ethernet port to specified VLANs, the local port can forward packets of these VLANs. Hybrid and trunk ports can be added to multiple VLANs, thereby implementing the VLAN intercommunication between peers. For a hybrid port, you can configure to tag some VLAN packets, based on which the packets can be processed differently.

Setting the Default VLAN ID for the Ethernet Port

Because the access port can only be included in one VLAN, its default VLAN is the one to which it belongs. Because a hybrid port and a trunk port can be included in several VLANs, you must configure the default VLAN ID. If the default VLAN ID has been configured, the packets without VLAN Tag will be forwarded to the port that belongs to the default VLAN. When sending the packets with VLAN Tag, if the VLAN ID of the packet is identical to the default VLAN ID of the port, the system will remove VLAN Tag before sending this packet.

Perform the following configuration in Ethernet Port View.

Table 43 Setting the Default VLAN ID for an Ethernet Port

Operation	Command
Set the default VLAN ID for a hybrid port.	**port hybrid pvid vlan** *vlan_id*
Set the default VLAN ID for a trunk port	**port trunk pvid vlan** *vlan_id*
Restore the default VLAN ID of a hybrid port to the default value	**undo port hybrid pvid**
Restore the default VLAN ID of a trunk port to the default value	**undo port trunk pvid**

By default, the VLAN of a hybrid port and a trunk port is VLAN 1 and that of the access port is the VLAN to which it belongs.

Note that to guarantee the proper packet transmission, the default VLAN ID of the local hybrid port or trunk port should be identical with that of the hybrid port or trunk port on the peer Switch.

Configuring Loopback Detection for Ethernet Ports

The goal of loopback detection is to check whether the ports of switch have loopback.

After users enable loopback detection for Ethernet ports, the switch will monitor whether the ports have loopback on a regular basis; if the switch detects loopback for a particular port, it will put that port under control.

- For Access port: If system detects loopback for a port, it will shut down that port, send a Trap message to the terminal, and delete the corresponding MAC address forwarding entry.
- For Trunk ports and Hybrid ports: If system detects loopback for a port, it will send a Trap message to the terminal. If the loopback detection and control function for that port is enabled at the same time, the system will then shut down the given port, send a Trap message to the terminal, and delete the corresponding MAC address forwarding entry.

Table 44 Configure loopback detection for Ethernet port

Operation	Command	Description
Enter system view	system-view	-
Enable the global port loopback detection	loopback-detection enable	Optional.By default, the global port loopback detection function is disabled.
Set the time interval for loopback detection function	loopback-detection interval-time time	Optional. Set to 30 seconds by default.

Table 44 Configure loopback detection for Ethernet port (continued)

Operation	Command	Description
Enter the Ethernet port view	interface interface-type interface-number	-
Enable the loopback detection function for a specified port	loopback-detection enable	Optional.By default, the loopback detection function is disabled.
Enable the loopback detection and control function for Trunk ports and Hybrid ports	loopback-detection control enable	Optional.By default, the loopback detection and control function is disabled.
Configure the system to detect loopback in all the VLANs with Trunk ports and Hybrid ports	loopback-detection per-vlan enable	Optional. By default, system only detects loopback for the default VLANs with Trunk ports and Hybrid ports.
Display the loopback detection information	display loopback-detection	Optional. This command can be used under any view

⚠ *Loopback detection function for a port is enabled only when the loopback-detection enable command is enabled under both system view and port view.*

⚠ *When the undo loopback-detection enable command is used under system view, the loopback detection function will be disabled for all ports.*

Setting Loopback Detection for an Ethernet Port

Use the following command to enable port loopback detection and set the detection interval for the external loopback condition of each port. If there is a loopback port found, the Switch will put it under control.

Other correlative configurations function only when port loopback detection is enabled in System View.

Perform the following configuration in the view listed in Table 45.

Table 45 Setting Loopback Detection for the Ethernet Port

Operation	Command
Enable loopback detection on the port (System View/Ethernet Port View)	**`loopback-detection enable`**
Disable loopback detection on the port (System View/Ethernet Port View)	**`undo loopback-detection enable`**
Enable the loopback controlled function of the trunk and hybrid ports (Ethernet Port View)	**`loopback-detection control enable`**
Disable the loopback controlled function of the trunk and hybrid ports (Ethernet Port View)	**`undo loopback-detection control enable`**
Set the external loopback detection interval of the port (System View)	**`loopback-detection interval-time`** *`time`*
Restore the default external loopback detection interval of the port (System View)	**`undo loopback-detection interval-time`**
Configure that the system performs loopback detection to all VLANs on Trunk and Hybrid ports (Ethernet Port View)	**`loopback-detection per-vlan enable`**
Configure that the system only performs loopback detection to the default VLANs on the port (Ethernet Port View)	**`undo loopback-detection per-vlan enable`**

By default, port loopback detection and the loopback detection control function on trunk and hybrid ports are disabled. The detection interval is 30 seconds, and the system detects the default VLAN on the trunk and hybrid ports.

Configuring VCT

You can start the virtual cable test (VCT) to make the system test the cable connected to the current electrical Ethernet port, and the system will return the test results in five seconds. The test items include: whether short or open circuit exists in the Rx/Tx direction of the cable, and what is the length of the cable in normal status or the length from the port to the fault point of the cable.

Table 46 Configure VCT

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	interface interface-type interface-number	-
Start VCT to make the system test the cable connected to the current electrical Ethernet port	virtual-cable-test	Required By default, this test is not started.

VCT Configuration Example

Network requirements

Start VCT to make the system test the cable connected to the following port.

Configuration procedure

1 Enter the system view.

```
<S5500> system-view
```

2 Enter the Ethernet1/0/1 port view.

```
[S5500] interface Ethernet 1/0/1
```

3 Start VCT.

```
[S5500-Ethernet1/0/1] virtual-cable-test
Cable status: abnormal(open), 7 metres
Pair Impedance mismatch: yes
Pair skew: 4294967294 ns
Pair swap: swap
Pair polarity: normal
Insertion loss: 7 db
Return loss: 7 db
Near-end crosstalk: 7 db
```

EthernetPort Security Features

Port security is a security mechanism to control network access. It is an expansion of the current 802.1x and MAC address authentication. This scheme controls the incoming/outgoing packets on port by checking the MAC addresses contained in data frames, and provides multiple security and authentication modes; this greatly improves the security and manageability of the system.

The port security scheme provides the following features:

1 NTK: Need to Know feature. By way of checking the destination MAC addresses of the data frames to be sent from a port, this feature ensures that only successfully authenticated devices can obtain data frames from the port so as to prevent illegal devices from filching network data.

2 Intrusion Protection: By way of checking the source MAC addresses of the data frames received on a port, this feature discovers illegal packets and takes appropriate action (temporarily/permanently disabling the port, or filtering out the packets with these MAC addresses) to guarantee the security on the port.

3 Device Tracking: This feature enables the switch to send trap messages in case special data packets (generated by special actions such as illegal intrusion, and abnormal user logon/logoff) pass through a port, thus helping the network administrator monitor these special actions.

4 Binding of MAC and IP addresses to ports: This feature enables you to bind the MAC and IP addresses of legal users to specific ports on the switch so that only legal user's packets can pass through the corresponding ports, thus improving the security of the system)

Configuring Port Security

Table 47 Configure port security

Operation	Command	Description
Enter system view	system-view	-
Enable port security	port-security enable	Required
Set an OUI value for user authentication	port-security OUI OUI-value index index-value	Optional
Enable the sending of specified type(s) of trap messages	port-security trap { addresslearned | intrusion | dot1xlogon | dot1xlogoff | dot1xlogfailure | ralmlogon | ralmlogoff | ralmlogfailure }*	Optional By default, the system disables the sending of any types of trap messages.
Enter Ethernet port view	interface interface-type interface-number	-
Set the security mode of the port	port-security port-mode mode	Required You can set different security mode accordingly.
Set the maximum number of MAC addresses allowed to access the port	port-security max-mac-count count-value	Optional By default, there is no limit on the number of MAC addresses.
Set the packet transmission mode of the NTK feature on the port	port-security ntk-mode { ntkonly | ntk-withbroadcasts | ntk-withmulticasts }	Required By default, no packet transmission mode of the NTK feature is set on the port.

Table 47 Configure port security (continued)

Bind the MAC and IP addresses of a legal user to a specified port	am user-bind mac-addr mac-address ip-addr ip-address [interface interface-type interface-number]	Optional You need to specify the bound port if you use this command in system view.You do not need to specify the bound port if you use this command in Ethernet port view, because the MAC and IP address will be bound to the current port.
Set the action mode of the Intrusion Protection feature on the port	port-security intrusion-mode { disableport | disableport-temporarily | blockmac }	Required By default, no action mode of the Intrusion Protection feature is set on the port.
Return to the system view	quit	-
Set the time during which the system temporarily disables a port	port-security timer disableport timer	Optional By default, this time is 20 seconds
Display information about port security configuration	display port-security [interface interface-list]	You can execute the display command in any view.

The time set by the port-security timer disableport timer command takes effect when the disableport-temporarily mode is set by the port-security intrusion-mode command.

To avoid confliction, the following limitation on the 802.1x and the MAC address authentication will be taken after port security is enabled:

1. The access control mode (set by the dot1x port-control command) automatically changes to auto.
2. The dot1x port-method command can be successfully executed only when no user is on-line.
3. The dot1x, dot1x port-method, dot1x port-control, and mac-authentication commands cannot be used.

For detailed description of 802.1x authentication, refer to the security module of the 3Com S5500 Series Ethernet Switches Operation Manual.

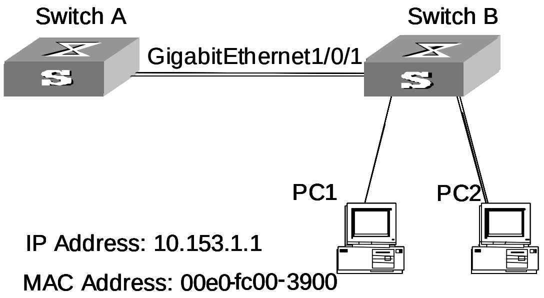
Port Security Configuration Example

Network requirements

- Enable port security on port Ethernet1/0/1 of switch A, and set the maximum number of the MAC addresses that are allowed to access the port to 80.
- Set the packet transmission mode of the NTK feature on the port to ntkonly, and the action mode of the Intrusion Protection feature on the port to disableport.
- Connect PC1 to the port through switch B.
- Bind the MAC and IP addresses of PC1 to the port.

Network diagram

Figure 14 Network diagram for port security configuration



Configuration procedure

Configure switch A as follows:

1 Enter the system view.

```
<S5500> system-view
```

2 Enable port security.

```
[S5500] port-security enable
```

3 Enter Ethernet1/0/1 port view.

```
[S5500] interface Ethernet1/0/1
```

4 Adopt MAC address authentication mode on the port.

```
[S5500-Ethernet1/0/1] port-security port-mode mac-authentication
```

5 Set the maximum number of MAC addresses allowed to access the port to 80.

```
[S5500-Ethernet1/0/1] port-security max-mac-count 80
```

6 Set the packet transmission mode of the NTK feature on the port to ntkonly.

```
[S5500-Ethernet1/0/1] port-security ntk-mode ntkonly
```

7 Set the action mode of the Intrusion Protection feature on the port to disableport.

```
[S5500-Ethernet1/0/1] port-security intrusion-mode disableport
```

8 Return to the system view.

```
[S5500-Ethernet1/0/1] quit
```

9 Enable the sending of intrusion packet discovery trap messages.

```
[S5500] port-security trap intrusion
```

10 Bind the MAC and IP addresses of PC1 to Ethernet1/0/1 port.

```
[S5500] am user-bind mac-address 00e0-fc00-5600 ip-address 10.153.1.1
interface Ethernet1/0/1
```

Copying Port Configuration to Other Ports

To keep the configuration of other ports consistent with a specified port, you can copy the configuration of that specified port to other ports. The configuration may include: STP setting, QoS setting, VLAN setting, port setting, and LACP setting. The STP setting includes STP enabling/disabling, link attribute (point-to-point or not), STP priority, path cost, max transmission speed, loop protection, root protection, edge port or not. The QoS setting includes traffic limiting, priority marking, default 802.1p priority, bandwidth assurance, congestion avoidance, traffic redirection, traffic statistics. The VLAN setting includes permitted VLAN types, and default VLAN ID. The port setting includes port link type, port speed, and duplex mode. LACP setting includes LACP enabling/disabling.

Perform the following configuration in System View.

Table 48 Copying Port Configuration to Other Ports

Operation	Command
Copy port configuration to other ports	**copy configuration source** { *interface_type interface_number* | *interface_name* | **aggregation_group** *agg_id* } **destination** { *interface_list* [**aggregation_group** *agg_id*] | **aggregation_group** *agg_id* }

Note that if the copy source is an aggregation group, take the port with minimum ID as the source; if the copy destination is an aggregation group, make the configurations of all group member ports identical with that of the source.

Displaying and Debugging Ethernet Port

After the above configuration, enter the **display** command in any view to display the running of the Ethernet port configuration, and to verify the effect of the configuration.

Enter the **reset** command in User View to clear the statistics information of the port.

Enter the **loopback** command in Ethernet Port View to check whether the Ethernet port works normally. In the process of the loopback test, the port cannot forward any packets. The loop test will finish automatically after a short time.

Table 49 Displaying and Debugging Ethernet Port

Operation	Command
Perform loopback test on the Ethernet port.	**loopback** { **external** | **internal** }
Display all port information	**display interface** { *interface_type* | *interface_type interface_num* | *interface_nam* }
Display port information of a specific unit	**display unit** *unit_id* **interface**
Display hybrid port or trunk port	**display port** { **hybrid** | **trunk** }
Display the state of loopback detection on the port.	**display loopback-detection**
Clear statistics information of the port	**reset counters interface** [*interface_type* | *interface_type interface_num* | *interface_name*]

Note that:

- The loopback test cannot be performed on a port disabled by the **shutdown** command. During the loopback test, the system will disable **speed**, **duplex**, **mdi** and **shutdown** operation on the port. Some ports do not support the loopback test. If performing this command in these ports, you will see the system prompt.
- After 802.1X is enabled, the port information cannot be reset.

Displaying Port Configuration Information in Brief

This S5500 version has a new command, display brief interface for you to display the port configuration information in brief, including the port type, link state, link rate, duplex attribute, link type and default VLAN ID.

Table 50 Display the port configuration information in brief

Operation	Command	Description
Display the port configuration information in brief	display brief interface [interface-type [interface-number] | interface-name] [| { begin | include | exclude } regular-expression]	You can execute the display command in any view.

Ethernet Port Configuration Example

Networking Requirements

Switch A is connected to Switch B through Trunk port Ethernet1/0/1. Configure the trunk port with a default VLAN ID, so that:

- When receiving packets without a VLAN Tag, the port can forward them to the member ports belonging to the default VLAN
- When it is sending the packets with VLAN Tag and the packet VLAN ID is the default VLAN ID, the trunk port will remove the packet VLAN Tag and forward the packet.

Networking Diagram

Figure 15 Configuring the Default VLAN for a Trunk Port

S
S
Switch A
Switch B

Configuration Procedure

The following configurations are used for Switch A. Configure Switch B in the similar way.

1 Enter the Ethernet Port View of Ethernet1/0/1.

```
[SW5500]interface ethernet1/0/1
```

2 Set the Ethernet1/0/1 as a trunk port and allow VLAN 2, 6 through 50, and 100 to pass through.

```
[SW5500-Ethernet1/0/1]port link-type trunk
[SW5500-Ethernet1/0/1]port trunk permit vlan 2 6 to 50 100
```

3 Create the VLAN 100.

```
[SW5500]vlan 100
```

4 Configure the default VLAN ID of Ethernet1/0/1 as 100.

```
[SW5500-Ethernet1/0/1]port trunk pvid vlan 100
```

Ethernet Port Troubleshooting

Fault: Default VLAN ID configuration failed.

Troubleshooting: Take the following steps.

1 Use the `display interface` or `display port` command to check if the port is a trunk port or a hybrid port. If it is neither, configure it as a trunk port or a hybrid port.

2 Configure the default VLAN ID.

Link Aggregation Configuration

Brief Introduction to Link Aggregation

Link aggregation means aggregating several ports together to implement the outgoing/incoming payload balance among the member ports and enhance the connection reliability. Link aggregation includes manual aggregation, dynamic LACP aggregation, and static LACP aggregation. In terms of load sharing, link aggregation may be load sharing aggregation and non-load sharing aggregation.

For the member ports in an aggregation group, their basic configurations must be the same. That is, if one is a trunk port, the others must also be; when it turns into access port, then others must change to access port.

The basic configuration includes STP setting, QoS setting, VLAN setting, and port setting. The STP setting includes STP enabling/disabling, link attribute (point-to-point or not), STP priority, path cost, max transmission speed, loop protection, root protection, edge port or not. The QoS setting includes traffic limiting, priority marking, default 802.1p priority, bandwidth assurance, congestion avoidance, traffic redirection, traffic statistics. The VLAN setting includes permitted VLAN types, and default VLAN ID. The port setting includes port link type.

The Switch 5500-SI 28-Port can support up to 14 aggregation groups, the Switch 5500-SI 52-Port can support up to 26 aggregation groups, and the Switch 5500-EI Series can support up to 32 aggregation groups. Each group can have a maximum of eight 100 Mbps Ethernet ports or four Gigabit SFP ports. For the Switch 5500-SI series, the ports in an aggregation group must physically belong to the same unit, but for the Switch 5500-EI series, an aggregation group can contain ports which physically belong to different units.

Brief Introduction to LACP

IEEE802.3ad-based Link Aggregation control protocol (LACP) implements dynamic link aggregation and disaggregation and exchanges information with the peer through LACP data unit (LACPADU). When LACP is enabled on it, the port notifies, through sending LACPDU, the peer of its system priority, system MAC, port priority, port number and operation key. On receiving this information, the peer compares the received information with that stored at other ports to determine which ports can be aggregated, so that the two parties can agree on adding/deleting which port into/from a certain dynamic aggregation group.

The operation key is a configuration set generated by LACP based on port setting (speed, duplex mode, basic configuration and management key). When LACP is enabled, the management key of a dynamic aggregation port is 0 by default, but the management key of a static aggregation port consists with the aggregation group ID. For a dynamic aggregation group, all member ports must have the same operation key, while for a manual or static aggregation group, only the active member ports must have the same operation key.

Types of Link Aggregation

The types of link aggregation are described in the following sections:

- Manual Aggregation and Static LACP Aggregation
- Dynamic LACP Aggregation

Manual Aggregation and Static LACP Aggregation Both manual aggregation and static LACP aggregation require manual configuration of aggregation groups and prohibit automatic adding or deleting of member ports by the system. A manual or static LACP aggregation group must contain at least one member port, and you must delete the aggregation group, instead of the port, if the group contains only one port. At a manual aggregation port, LACP is disabled and you are not allowed to enable it. LACP is enabled at a static aggregation port. When a static aggregation group is deleted, its member ports form one or several dynamic LACP aggregation groups and LACP remains enabled on them. You are not allowed to disable LACP protocol at a static aggregation group.

In a manual or static LACP aggregation group, its ports may be in active or inactive state and only the active ports can transceive user service packets. The active port with the minimum port number serves as the master port, while others as sub-ports.

In a manual aggregation group, the system sets the ports to active or inactive state by using these rules:

- The system sets the port with the highest priority to active state, and others to inactive state based on the following descending order of priority levels:
  - full duplex/high speed
  - full duplex/low speed
  - half duplex/high speed
  - half duplex/low speed
- The system sets to inactive state the ports which cannot aggregate with the active port with minimum port number, due to hardware limit, for example, trans-board aggregation unavailable.
- The system sets to inactive state the ports with basic configurations different from that of the active port with minimum port number.

In a static LACP aggregation group, the system sets the ports to active or inactive state by using these rules:

- The system sets the port with the highest priority to active state, and others to inactive state based on the following descending order of priority levels:
  - full duplex/high speed
  - full duplex/low speed
  - half duplex/high speed
  - half duplex/low speed
- The system sets to inactive state the ports which connect to different peer devices from one that the active port with minimum port number connects to, or the ports in different aggregation groups though they are connected to the same peer device.
- The system sets to inactive state the ports which cannot aggregate with the active port with minimum port number, due to hardware limit, for example, trans-board aggregation unavailable.

- The system sets to inactive state the ports with basic configurations different from that of the active port with minimum port number.

Because only a defined number of ports can be supported in an aggregation group, if the active ports in an aggregation group exceed the port quantity threshold for that group, the system shall set some ports with smaller port numbers (in ascending order) as selected ports and others as standby ports. Both selected and standby ports can transceive LACP protocol, but standby ports cannot forward user service packets.

Dynamic LACP Aggregation

The LACP uses peer exchanges across the links to determine, on an ongoing basis, the aggregation capability of the various links, and continuously provides the maximum level of aggregation capability achievable between a given pair of systems as well as under manual control through direct manipulation of the state variables of Link Aggregation (for example, keys) by a network manager.

Dynamic LACP aggregation can be established even for a single port, as is called single port aggregation. LACP is enabled at dynamic aggregation ports. Only the ports with the same speed, duplex mode and basic configuration and connected to the same device can be aggregated dynamically.

Because only a defined number of ports can be supported in an aggregation group, if the ports in an aggregation group exceed the port quantity threshold for that group, the system shall set some ports with smaller system IDs (system priority + system MAC address) and port IDs (port priority + port number) as selected ports and others as standby ports. If not, all member ports are selected ports. Both selected and standby ports can transceive LACP protocol, but standby ports cannot forward user service packets. Among the selected ports of an aggregation group, the one with minimum port number serves as the master port for that group and the others are sub-ports.

In comparing system IDs, the system first compares system priority values; if they are equal, then it compares system MAC addresses. The smaller system ID is given priority. Comparing port IDs follows the same process: the system first compares port priority values and then port numbers and the smaller port ID is given priority. If system ID changes from non-priority to priority, then the selected or standby state is determined by the port priority of the system. You can decide whether the port is selected or standby by setting system priority and port priority.

Load Sharing

In terms of load balancing, link aggregation may be load balancing aggregation and non-load balancing aggregation. In general, the system only provides limited load balancing aggregation resources, so the system needs to rationally allocate these resources among manual aggregation groups, static LACP aggregation groups, dynamic LACP aggregation groups, and the aggregation groups including special ports which require hardware aggregation resources. The system will always allocate hardware aggregation resources to the aggregation groups with higher priority levels. When the load sharing aggregation resources are used up for existing aggregation groups, newly-created aggregation groups will be non-load sharing ones. The priority levels (in descending order) for allocating load sharing aggregation resources are as follows:

- Aggregation groups including special ports which require hardware aggregation resources
- Manual and static LACP aggregation groups
- Aggregation groups that probably reach the maximum rate after the resources are allocated to them

- Aggregation groups with the minimum master port numbers if they reach the equal rate with other groups after the resources are allocated to them

When aggregation groups of higher priority levels appear, the aggregation groups of lower priority levels release their hardware resources. For single-port aggregation groups, if they can transceive packets normally without occupying hardware resources, they shall not occupy the resources.

A load sharing aggregation group may contain several selected ports, but a non-load sharing aggregation group can only have one selected port, while others are standby ports. Selection criteria of selected ports vary for different types of aggregation groups.

Link Aggregation Configuration

Link aggregation configuration is described in the following sections:

- Enabling/Disabling LACP
- Creating/Deleting an Aggregation Group
- Adding/Deleting an Ethernet Port into/from an Aggregation Group
- Setting/Deleting the Aggregation Group Descriptor
- Configuring System Priority
- Configuring Port Priority

Enabling/Disabling LACP

You should first enable LACP at the ports before performing dynamic aggregation, so that both parties can agree on adding/deleting the ports into/from a dynamic LACP aggregation group.

Perform the following configuration in Ethernet Port View.

Table 51 Enabling/Disabling LACP

Operation	Command
Enable LACP at the port	*`lacp enable`*
Disable LACP at the port	**`undo lacp enable`**

By default, LACP is disabled at the port.

Note that:

- You cannot enable LACP at a
  - stack port
  - mirrored port
  - port with a static MAC address configured
  - port with static ARP configured
  - port with 802.1x enabled
  - port in a manual aggregation group
- You can add a port with LACP enabled into a manual aggregation group, but then the LACP will be disabled on it automatically. Or you can add a port with LACP disabled into a static LACP aggregation group, and then the LACP will be enabled automatically.
- The Switch selects the port with the minimum port number as the master port of the aggregation group. This rule applies to all aggregation groups.

Creating/Deleting an Aggregation Group

Use the following command to create a manual aggregation group or static LACP aggregation group, but the dynamic LACP aggregation group is established by the system when LACP is enabled on the ports. You can also delete an existing aggregation group: when you delete a manual aggregation group, all its member ports are disaggregated; when you delete a static or dynamic LACP aggregation group, its member ports form one or several dynamic LACP aggregation groups.

Perform the following configuration in System View.

Table 52 Creating/Deleting an Aggregation Group

Operation	Command
Create an aggregation group	**`link-aggregation group`** *`agg-id`* **`mode`** { **`manual`** | **`static`** }
Delete an aggregation group	**`undo link-aggregation group`** *`agg-id`*

The Switch selects the port with the minimum port number as the master port of the aggregation group. This rule applies to all aggregation groups.

A manual or static aggregation group can have up to eight ports. To change an existing dynamic aggregation group into a manual or static group enter:

```
link-aggregation group agg-id mode
```

If the port number in a group exceeds eight, you will be prompted that a configuration failure has occurred.

If the aggregation group you create already exists but contains no member port, you can overwrite the existing group; if it already exists in the system and contains member ports, then you can only change a dynamic or static LACP aggregation group to a manual one, or a dynamic LACP aggregation group to a static one. In the former case, LACP shall be disabled at the member ports automatically, while in the latter case, LACP shall remain enabled.

Adding/Deleting an Ethernet Port into/from an Aggregation Group

You can add/delete ports into/from a manual or static LACP aggregation group, but member port adding or deleting for a dynamic LACP aggregation group is implemented by the system.

Perform the following configuration in Ethernet Port View.

Table 53 Adding/Deleting an Ethernet Port into/from an Aggregation Group

Operation	Command
Add an Ethernet port into the aggregation group	**`port link-aggregation group`** *`agg_id`*
Delete an Ethernet port from the aggregation port	**`undo port link-aggregation group`**

Note that:

- You cannot enable LACP for a
  - stack port
  - mirrored port
  - port with static MAC address configured

  - port with static ARP configured
  - port with 802.1x enabled.
- You must delete the aggregation group, instead of the port, if the manual or static LACP aggregation group contains only one port.

Setting/Deleting the Aggregation Group Descriptor

Perform the following configuration in System View.

Table 54 Setting/Deleting the Aggregation Group Descriptor

Operation	Command
Set aggregation group descriptor	**link-aggregation group** *agg_id* **description** *alname*
Delete aggregation group descriptor	**undo link-aggregation group** *agg_id* **description**

By default, an aggregation group has no descriptor.

If you have saved the current configuration with the **save** *command, the configured manual aggregation groups, static LACP aggregation groups and corresponding descriptors exist when the system reboots. But the dynamic LACP aggregation groups do not exist, and even the descriptors configured for them will not be restored.*

Configuring System Priority

The LACP refers to system IDs in determining if the member ports are the selected or standby port for a dynamic LACP aggregation group. The system ID consists of two-byte system priority and six-byte system MAC, that is, system ID = system priority + system MAC. In comparing system IDs, the system first compares system priority values; if they are equal, then it compares system MAC addresses. The smaller system ID is given priority.

Changing system priority may affect the priority levels of member ports, and further their selected or standby state.

Perform the following configuration in System View.

Table 55 Configuring System Priority

Operation	Command
Configure system priority	**lacp system-priority** *system_priority_value*
Restore the default system priority	**undo lacp system-priority**

By default, system priority is 32768.

Configuring Port Priority

The LACP compares system IDs first and then port IDs (if system IDs are the same) in determining if the member ports are selected or standby ports for a dynamic LACP aggregation group. If the ports in an aggregation group exceed the port quantity threshold for that group, the system shall set some ports with smaller port IDs as selected ports and others as standby ports. The port ID consists of two-byte port priority and two-byte port number, that is, port ID = port priority + port number. The system first compares port priority values and then port numbers and the small port ID is considered prior.

Perform the following configuration in Ethernet Port View.

Table 56 Configuring Port Priority

Operation	Command
Configure port priority	**lacp port-priority** *port_priority_value*
Restore the default port priority	**undo lacp port-priority**

By default, port priority is 32768.

Displaying and Debugging Link Aggregation

After the above configuration, enter the **display** command in any view to display the running of the link aggregation configuration, and to verify the effect of the configuration.

You can also enter, in User View, the **reset** command to clear LACP statistics of the port and **debugging** commands to debug LACP.

Table 57 Displaying And Debugging Link Aggregation

Operation	Command
Display summary information of all aggregation groups	**display link-aggregation summary**
Display detailed information of a specific aggregation group	**display link-aggregation verbose** [*agg_id*]
Display local system ID	**display lacp system-id**
Display detailed link aggregation information at the port	**display link-aggregation interface** { *interface_type interface_number* | *interface_name* } [**to** { *interface_type interface_num* | *interface_name* }]
Clear LACP statistics at the port	**reset lacp statistics** [**interface** { *interface_type interface_number* | *interface_name* } [**to** { *interface_type interface_num* | *interface_name* }]]
Disable/enable debugging LACP state machine	[**undo**] **debugging lacp state** [**interface** { *interface_type interface_number* | *interface_name* } [**to** { *interface_type interface_num* | *interface_name* }]] { { **actor-churn** | **mux** | **partner-churn** | **ptx** | **rx** }* | **all** }
Disable/enable debugging LACP packets	[**undo**] **debugging lacp packet** [**interface** { *interface_type interface_number* | *interface_name* } [**to** { *interface_type interface_num* | *interface_name* }]]
Disable/enable debugging link aggregation errors	[**undo**] **debugging link-aggregation error**
Disable/enable debugging link aggregation events	[**undo**] **debugging link-aggregation event**

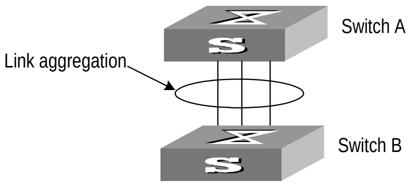
Link Aggregation Configuration Example

Networking Requirement

Switch A connects Switch B with three aggregation ports, numbered as Ethernet1/0/1 to Ethernet1/0/3, so that incoming/outgoing load can be balanced among the member ports.

Networking Diagram

Figure 16 Networking for Link Aggregation



Configuration Procedure

The following only lists the configuration for Switch A; configure Switch B similarly.

1 Manual link aggregation

a Create manual aggregation group 1.

```
[SW5500]link-aggregation group 1 mode manual
```

b Add Ethernet ports Ethernet1/0/1 to Ethernet1/0/3 into aggregation group 1.

```
[SW5500]interface ethernet1/0/1
[SW5500-Ethernet1/0/1]port link-aggregation group 1
[SW5500-Ethernet1/0/1]interface ethernet1/0/2
[SW5500-Ethernet1/0/2]port link-aggregation group 1
[SW5500-Ethernet1/0/2]interface ethernet1/0/3
[SW5500-Ethernet1/0/3]port link-aggregation group 1
```

2 Static LACP aggregation

a Create static LACP aggregation group 1.

```
[SW5500]link-aggregation group 1 mode static
```

b Add Ethernet ports Ethernet1/0/1 to Ethernet1/0/3 into aggregation group 1.

```
[SW5500]interface ethernet1/0/1
[SW5500-Ethernet1/0/1]port link-aggregation group 1
[SW5500-Ethernet1/0/1]interface ethernet1/0/2
[SW5500-Ethernet1/0/2]port link-aggregation group 1
[SW5500-Ethernet1/0/2]interface ethernet1/0/3
[SW5500-Ethernet1/0/3]port link-aggregation group 1
```

3 Dynamic LACP aggregation

a Enable LACP at Ethernet ports Ethernet1/0/1 to Ethernet1/0/3.

```
[SW5500]interface ethernet1/0/1
[SW5500-Ethernet1/0/1]lacp enable
[SW5500-Ethernet1/0/1]interface ethernet1/0/2
[SW5500-Ethernet1/0/2]lacp enable
[SW5500-Ethernet1/0/2]interface ethernet1/0/3
[SW5500-Ethernet1/0/3]lacp enable
```

Only when the three ports are configured with identical basic configuration, rate and duplex mode, can they be added into a same dynamic aggregation group after LACP is enabled on them, for load sharing.

Global Broadcast Suppression Feature

This section describes how to configure the Global Broadcast Suppression feature.

Configuring Global Broadcast Suppression

You can use the following command to globally configure the size of the broadcast traffic allowed to pass through each Ethernet port. Once the broadcast traffic exceeds the threshold you configured, the system discards some broadcast packets to decrease the ratio of the broadcast traffic into a reasonable range. This suppresses broadcast storms and avoids network congestion to guarantee the normal operation of network services.

Table 58 Configure global broadcast suppression

Operation	Command	Description
Enter system view	system-view	-
Globally configure the size of broadcast traffic allowed to pass through each Ethernet port	broadcast-suppression { ratio | pps max-pps }	By default, the system allows the broadcast traffic to occupy 100% network bandwidth. That is, it does not limit broadcast traffic.

The broadcast suppression configured globally with the broadcast-suppression command will take effect on all the Ethernet ports in a stack system.

Global Broadcast Suppression Configuration Example

Network requirements

Configure the global broadcast suppression ratio to 20. That is, allow 20% network bandwidth to be occupied by broadcast traffic.

Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Configure the ratio of global broadcast suppression to 20.

```
[S5500] broadcast-suppression 20
```

3 Display the configuration result.

```
[S5500] display current-configuration
......
#
interface Ethernet1/0/1
 broadcast-suppression 20
#
interface Ethernet1/0/2
 broadcast-suppression 20
#
interface Ethernet1/0/3
 broadcast-suppression 20
#
```

Displaying Information About a Specified Optical Port

You can use the display transceiver-information interface command to display the following information about a specified optical port:

- Hardware type
- Interface type
- Wavelength
- Vender
- Serial number
- Transfer distance

Table 59 Display information about a specified optical port

Operation	Command	Description
Display information about a specified optical port	display transceiver-information interface interface-type interface-number	You can execute the display command in any view.

4 XRN CONFIGURATION

This chapter covers the following topics:

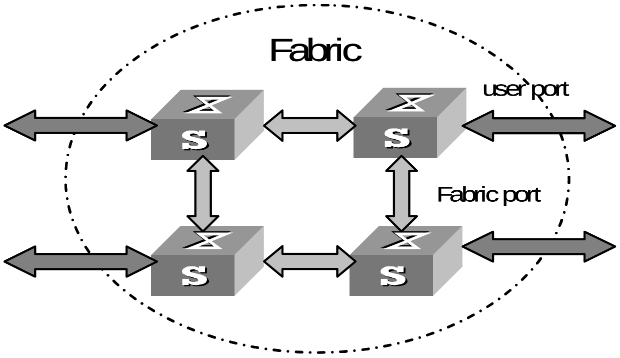
- Introduction to XRN
- Configuring an XRN Fabric
- Fabric Configuration Example

Introduction to XRN

Several XRN Switches of the same model can be interconnected to create a "Fabric", in which each Switch is a unit. The ports used to interconnect all the units are called Fabric ports, while the other ports that are used to connect the Fabric to users are called user ports. In this way, you can increase ports and switching capability by adding devices to the Fabric. In addition, reliability of the system will be improved because the devices within the Fabric can backup each other. This feature brings you many advantages:

- Realizes unified management of multiple devices. Only one connection and one IP address are required to manage the entire Fabric. Therefore, management cost is reduced.
- Enables you to purchase devices on demand and expand network capacity smoothly. Protects your investment to the full extent during network upgrade.
- Ensures high reliability by N+1 redundancy, avoids single point failure, and lessens service interruption.

Figure 17 Fabric Example



Fabric Topology Mapper (FTM) function can manage and maintain Fabric topology. FTM on each unit exchanges information with other units, including unit ID, Fabric name, and the authentication mode between units, by using a special kind of protocol packets. It manages and maintains Fabric topology according to the acquired information. For example, when a new device is connected to a Fabric, FTM will determine whether it should establish a new Fabric with the device according to the information.

Configuring an XRN Fabric

FTM provides user interfaces. You can configure VLAN unit IDs, Fabric name, and the authentication mode between units by using the command.

Table 60 Configuring FTM

Device	Configuration	Default Settings	Comment
Switch	Specify the stacking VLAN of the Switch	The stacking VLAN is VLAN 4093	You should specify the stacking VLAN before the Fabric is established.
	Set unit IDs for the Switches	The unit ID of a Switch is set to 1	Make sure that you have set different unit IDs to different Switches, so that the Fabric can operate normally after all the Switches are interconnected.
	Specify the Fabric port of the Switch	-	For 28-port Switch, the 27th 28th port can be the Fabric port, for 52-port Switch, the 51st, 52nd port can be the Fabric port.
	Set unit names for the Switches	-	-
	Set a name for the Fabric where the Switches belong	The Fabric name of the Switches is 5500	Interconnected the Switches with the same Fabric name to form a Fabric.
	Set the authentication mode for the Fabric	No authentication mode is set on the Switches	Set the same authentication mode on all the devices within the Fabric.

The Switch 5500 Series: the SI units supports basic XRN, that is, Distributed Device Management (DDM) and Distributed Link Aggregation (DLA); the EI units support enhanced XRN, that is DDM, Distributed Resilient Routing (DRR).

Specifying the Stacking VLAN of the Switch

You can use the command in the following table to specify the stacking VLAN of the Switch.

Perform the following configuration in System View.

Table 61 Specifying the Stacking VLAN of the Switch

Operation	Command
Specifying the stacking VLAN of the Switch	**ftm stacking-vlan** *vlan-id*
Setting the stacking VLAN of the Switch to Default Value	**undo ftm stacking-vlan**

By default, the stacking VLAN is VLAN 4093.

You should specify the stacking VLAN before the Fabric is established.

Setting Unit IDs for Switches

You can use the command in the following table to set unit IDs for Switches. Make sure to set different unit IDs for different Switches in a Fabric. On the Switches that support auto numbering, FTM will automatically number the Switches to constitute a Fabric, so that each Switch has a unique unit ID in the Fabric.

Perform the following configuration in System View.

Table 62 Setting unit IDs for Switches

Operation	Command
Set unit IDs for Switches	**change unit-id <1-8> to {<1-8> | auto-numbering }**

n If the modified unit ID does not exist in the Fabric, the Switch sets its priority to 5 and saves it in the unit Flash memory.

- If the modified unit ID is an existing one, the Switch prompts you to confirm if you really want to change the unit ID. If you choose to change, the existing unit ID is replaced and the priority is set to 5. Then you can use the **fabric save-unit-id** command to save the modified unit ID into the unit Flash memory and clear the information about the existing one.
- If **auto-numbering** is selected, the system sets the unit ID priority to 10. You can use the **fabric save-unit-id** command to save the modified unit ID into the unit Flash memory and clear the information about the existing one.

The unit IDs in a Fabric are not necessarily numbered consecutively or in ascending order.

By default, the unit ID of a Switch is set to 1. A unit ID can be set to a value in the range from 1 to the maximum number of devices supported in XRN.

Saving the Unit ID of Each Unit in the Fabric

You can use the commands in the following table to save the unit ID of each unit in the Fabric to the unit Flash memory.

Perform the following configuration in User View.

Table 63 Save the unit ID of each unit in the Fabric

Operation	Command
Save the unit ID of each unit in the fabric	**fabric save-unit-id**
Restore the unit ID of each unit in the fabric	**undo fabric save-unit-id**

Specifying the Fabric Port of the Switch

Perform the following configuration in System View.

Table 64 Specifying the Fabric Port of the Switch

Operation	Command
Specifying the stacking port of the Switch	**fabric-port {** *interface-name* | *interface-type interface-num* **} enable**
cancel the stacking port of the Switch	**undo fabric-port {** *interface-name* | *interface-type interface-num* **} enable**

For 28-port Switch, the ports 27 and 28 can be the Fabric port, for 52-port Switch, the ports 51 and 52 can be the Fabric port.

Setting Unit Names for Switches

You can use the command in the following table to set a unit name for each Switch.

Perform the following configuration in System View.

Table 65 Setting Unit Names for Switches

Operation	Command
Set unit names for Switches	**set unit** *unit-id* **name unit-name**

Setting a Fabric Name for Switches

Only the Switches with the same Fabric name and XRN authentication mode can constitute a Fabric.

You can use the commands in the following table to set a Fabric name for the Switches.

Perform the following configuration in System View.

Table 66 Setting a Fabric Name for Switches

Operation	Command
Set a Fabric name for Switches	**sysname** *sysname*
Restore the default Fabric name	**undo sysname**

By default, the Fabric name is “5500-EI”.

Setting an XRN Authentication Mode for Switches

Only the Switches with the same Fabric name and XRN authentication mode can constitute a Fabric.

You can use the commands in the following table to set an authentication mode for the Switches.

Perform the following configuration in System View.

Table 67 Setting an XRN Authentication Mode for Switches

Operation	Command
Set an XRN authentication mode for Switches	**xrn-fabric authentication-mode {** **simple** *password* | **md5** *key* **}**
Restore the default XRN authentication mode	**undo xrn-fabric authentication-mode**

By default, no authentication mode is set on the Switches.

Displaying and Debugging a Fabric

Following completion of the above configuration, you can execute the **display** command in any view to view device management and verify the settings.

Table 68 Displaying and Debugging FTM

Operation	Command
Display the information of the entire Fabric	**display xrn-fabric [port]**
Display the topology information of Fabric	**display ftm{ information** | **route** | **topology-database }**

Fabric Configuration Example

Networking Requirements

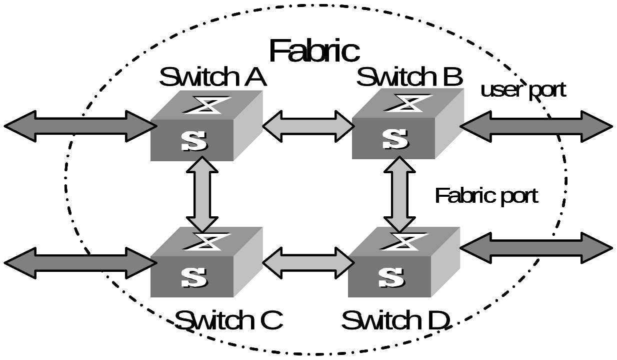
Configure unit ID, unit name, Fabric name, and authentication mode for four Switches, and interconnect them to form a Fabric.

The configuration details are as follows:

- Unit IDs: 1, 2, 3, 4
- Unit names: unit 1, unit 2, unit 3, unit 4
- Fabric name: hello
- Authentication mode: simple password
- Password: welcome

Networking Diagram

Figure 18 Networking Diagram of a Fabric



Configuration Procedure

Configure Switch A:

```
[SW5500]change unit-id 1 to 1
[SW5500]fabric-port gigabitethernet1/0/51 enable
[SW5500]fabric-port gigabitethernet1/0/52 enable
[SW5500]sysname hello
[hello]xrn-fabric authentication-mode simple welcome
```

Configure Switch B:

```
[SW5500]change unit-id 1 to auto-numbering
[SW5500]fabric-port gigabitethernet2/0/51 enable
[SW5500]fabric-port gigabitethernet2/0/52 enable
[SW5500]sysname hello
[hello]xrn-fabric authentication-mode simple welcome
```

Configure Switch C:

```
[SW5500]change unit-id 1 to auto-numbering
[SW5500]fabric-port gigabitethernet3/0/51 enable
[SW5500]fabric-port gigabitethernet3/0/52 enable
[SW5500]sysname hello
[hello]xrn-fabric authentication-mode simple welcome
```

Configure Switch D:

```
[SW5500]change unit-id 1 to auto-numbering
[SW5500]fabric-port gigabitethernet4/0/51 enable
[SW5500]fabric-port gigabitethernet4/0/52 enable
[SW5500]sysname hello
[hello]xrn-fabric authentication-mode simple welcome
```

n *In the example, it is assumed that the system will automatically change the unit IDs of Switch B, Switch C and Switch D to 2, 3 and 4 after you choose auto-numbering for unit-id.*

RMON on XRN

Interconnected switches form a fabric if they all support the XRN function and are all of the same type. The RMON configurations of the devices in a fabric are the same.

The RMON configuration performed on a device of a fabric will be automatically synchronized to all devices in the fabric if the configuration does not conflict with those of other devices in the fabric.

If you configure the same entry in the same ROM group for devices of a fabric to be different values, the entry values of all the conflicting devices will adopt that of the conflicting device with the smallest Unit ID when you synchronize the devices. Such a mechanism eliminates configuration conflicts between the devices in a fabric.

After the device configurations converge, you can collect RMON history and statistics data of any units from any switch in the fabric.

Configuration Commands for RMON on XRN

After the configurations of the switches in a fabric converge, you can use the following commands to collect RMON data of the devices in the fabric.

Table 69 Configuration commands on RMON on XRN

Operation	Command	Description
Collect the RMON statistics data of a specified unit	**display rmon statistics unit** *unit-id*	You can execute the **display** command in any view.
Collect the RMON history data of a specified units	**display rmon history unit** *unit-id*	

Clustering on XRN

Through neighbor topology discovery protocol (NTDP), Clustering can collect the information about the connection relations of the devices in a network and candidate devices, consequently maintaining and managing the cluster topology.

With Clustering employed, the NTDP topology information collecting function is enabled by default on the management device of the cluster. And the timer is set to 1 minute. A management device can also perceive in time any changes of the cluster topology caused by new devices being added to the cluster and determine the candidate switches among the detected devices. By sending joining-request packets to candidate switches, the management device also enables these devices to be plug-and-play.

Peer Fabric Port Detection

As the basis of the XRN function, the fabric topology management (FTM) module manages and maintains the entire topology of a fabric. The FTM module also implements the peer fabric port detection function.

A device can join a fabric only when the following conditions are met.

- The number of the existing devices in the fabric does not reach the maximum number of devices allowed by the fabric.
- The fabric names of the device and the existing devices in the Fabric are the same.
- The software version of the device is the same as that of the existing devices in the fabric.
- The device passes the security authentication if security authentication is enabled in the fabric.

Work Flow of the Peer Fabric Port Detection Function

After a switch is powered on, the FTM module releases device information of the switch through the fabric ports. The device information includes UNIT ID, CPU MAC, device type ID, fabric port information, and all fabric configuration information. The device information is released in the form of discovery packet (DISC). A new device can join a fabric only when its DISC packets pass the authentication performed by the existing devices in the fabric.

- If a fabric port of a switch is connected to a non-fabric port, the switch will not receive DISC packets from the peer. In this case, the switch cannot join the fabric.

- If the switch can receive DISC packets sent by the peer, the FTM module determines whether peer sending ports correspond to local receiving ports according to information in the packet. That is, if a DISC packet received by the left port of the switch is sent by the right port of the peer device, the packet is regarded legal. Otherwise, the packet is regarded illegal and is discarded.
- If the maximum number of devices allowed by the fabric is reached, the devices in the fabric do not send DISC packets and discard the received DISC packets. This prevents new devices from joining the fabric.
- After receiving a DISC packet from a directly connected device, a device in a fabric checks whether the device information (that is, the Fabric name and software version) contained in the packet and those of its own are the same. If not, the received DISC packet is illegal and will be discarded.
- If authentication is enabled in the fabric, the current device in the fabric authenticates received packets sent by new directly connected devices. Packets that fail to pass the authentication will be discarded.

Prompt Information and Solution

normal

If the port displays "normal", it indicates the fabric operates properly.

temporary

If the port displays "temporary", it indicates the port status is changing.

redundance port

If the port displays "redundance port", it indicates the port is the redundant port in fabric ring topology.

The "normal", "temporary" and "redundance port" information do not mean a device or a fabric operates improperly. No measure is needed for any of these three types of information.

connection error

Analysis: The port matching errors (as listed in Table 70) may occur if a switch prompts the "connection error" message.

Solution: Take the measures listed in Table 70 accordingly.

Table 70 Connection error type and solution

Error type	Solution
Two fabric ports of the same device (that is, the right port and the left port) are connected.	Pull out one end of the cable and connect it to a fabric port of another switch.
The left and right fabric ports of two devices are not connected in a crossed way.	Connect the left and right ports of two devices in a crossed way.
A fabric port of the local switch is connected to a non-fabric port.	Check the types of the two interconnected ports on two sides and make sure a fabric port is only connected to ports of the same type.

reached max units

Analysis: The "reached max units" message indicates that the maximum number of units allowed by the current fabric is reached. You will fail to add new devices to the fabric in this case.

Solution: Remove the new device or existing devices in the fabric.

Up to eight devices can be in an XRN fabric at a time.

different system name

Analysis: The "different system name" message indicates the fabric name of the device directly connected to the switch and the existing fabric name of the fabric are not the same. Only the devices with the same fabric name can form a Fabric.

Solution: Configure the fabric name of the new device to be that of the fabric.

different product version

Analysis: The "different product version" message indicates the software version of the directly connected device and that of the current device are not the same. A device can join a fabric only when its software version is identical to that of the fabric.

Solution: Make sure the software version of the new device is the same as that of the fabric.

auth failure

Analysis: The "auth failure" message indicates error occurs when the switch authenticates a directly connected device. The error may occur if the XRN fabric authentication modes configured for the both devices are not the same, or the password configured does not match.

Solution: Make sure the XRN fabric authentication modes and the passwords configured for the both devices are the same.

Multiple Fabric Port Candidates

On a Switch 5500 series switch, four GigabitEthernet ports can operate as fabric ports. The four ports are grouped into two groups. One group comprises of GigabitEthernet1/1/1 and GigabitEthernet1/1/2 ports, the other comprises of GigabitEthernet1/1/3 and GigabitEthernet1/1/4 ports. Only the ports of one group can operate as fabric ports at a time. Of the ports in the two groups, GigabitEthernet1/1/1 and GigabitEthernet1/1/3 ports can operate as UP fabric ports, and GigabitEthernet1/1/2 and GigabitEthernet1/1/4 ports can operates as DOWN fabric ports.

You can configure a port to be a fabric port using the **fabric port** command. Once you configure a port to be a fabric port, the group to which the port belongs becomes a fabric port group, and the other port in the group becomes a fabric port automatically. For example, after you configure the GigabitEthernet1/1/1 port to be a fabric port (a UP fabric port) by executing the **fabric port** GigabitEthernet1/1/1 **enable** command, the port group becomes a fabric port group, and GigabitEthernet1/1/2 port, which belongs to the same port group, becomes a DOWN fabric port.

A port cannot be a fabric port if the jumboframe function is enabled on the port. So make sure the jumboframe function is disabled on a port if you want to configure the port to be a fabric port.

With a port group of a switch being the current fabric port group, you need to invalidate the current fabric port group before configuring the other port group to be a fabric port group.

After a fabric is configured, the master switch synchronizes its configuration file to all the units in the fabric. As the Flashes of the units may differ in size, the synchronizing operation may fail on certain units because of lack of Flash memory space, which makes the fabric fails to be established. So make sure each unit has enough free Flash memory space before configuring a fabric.

5 DLDP CONFIGURATION

This chapter contains DLDP overview, fundamentals, precautions during configuration, and configuration information.

DLDP Overview

You may have encountered unidirectional links in networking. When a unidirectional link occurs, the local device can receive packets from the peer device through the link layer, but the peer device cannot receive packets from the local device. See Figure 20 and Figure 20. Unidirectional links can cause many problems, spanning tree topology loop for example.

Device Link Detection Protocol (DLDP) can detect the link status of the optical fiber cable or copper twisted pair (such as super category 5 twisted pair). If DLDP finds a unidirectional link, it disables the related port automatically or informs users to disable it manually depending on specific configuration, to avoid potential network problems.

Figure 19 Fiber cross-connection

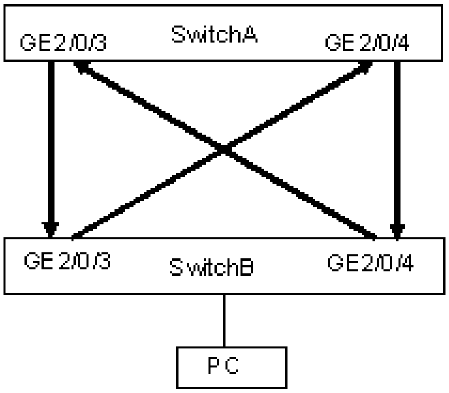
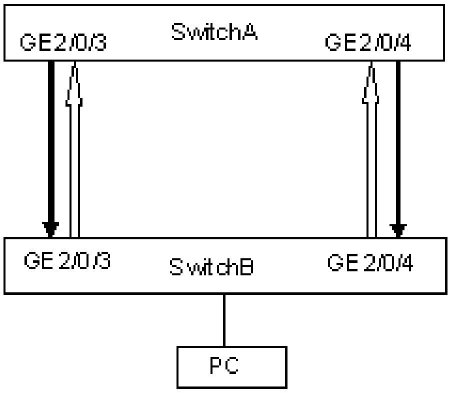


Figure 20 Fiber correct connection/disconnection in one direction



DLDP provides the following features:

- As a link layer protocol, it works together with the physical layer protocol to monitor the link status of a device.
- While the auto-negotiation mechanism on the physical layer detects physical signals and faults; DLDP identifies peer devices and unidirectional links, and disables unreachable ports.
- The auto-negotiation mechanism and DLDP, when enabled, work together to detect and disable physical and logical unidirectional links, and to prevent the failure of other protocols, such as STP (Spanning Tree Protocol).
- Even if the links of both ends can normally operate individually on the physical layer, DLDP can detect (at the link layer) if these links are set up correctly and packets can be exchanged normally between the two ends. This cannot be implemented by the auto-negotiation mechanism.

DLDP Fundamentals

DLDP status

DLDP may be in one of the six states: initial, inactive, active, advertisement, probe and disable.

Table 71 DLDP status

Status	Description
Initial	DLDP is not enabled.
Inactive	DLDP is enabled but the corresponding link is down
Active	DLDP is enabled and the link is up, or an neighbor entry is cleared
Advertisement	All neighbors communicate normally in both direction, or DLDP remains in active status for more than five seconds and enters this status. It is a stable status when no unidirectional link is found
Probe	DHCP sends packets to check if it is a unidirectional link. It enables the probe sending timer and an echo waiting timer for each target neighbor.
Disable	DLDP detects a unidirectional link, or finds (in enhanced mode) that a neighbor disappears. At this time, DLDP does not receive or send DLDP packets.

DLDP timers

DLDP works with the following timers:

Table 72 DLDP timers

Timer	Description
Advertisement sending timer	Time interval for sending advertisement packets, which can be configured with a particular command.By default, the time interval is 10 seconds.
Probe sending timer	The time interval is 1 second. In probe status, DLDP sends two probe packets every second.
Echo waiting timer	It is enabled when DLDP enters probe status. The timeout time is 10 seconds.If no echo packet is received from the neighbor when the Echo waiting timer expires, the local end is set to unidirectional communication status and the state machine turns into disable status. DLDP outputs log and tracking information, sends flush packets. Depending on the user-defined DLDP down mode, DLDP disables the local port automatically or prompt the user to disable the port manually. At the same time, DLDP deletes the neighbor entry.

Table 72 DLDP timers (continued)

Timer	Description
Entry aging timer	When a new neighbor joins, a neighbor entry is created, and the corresponding entry aging timer is enabled.When an advertisement packet is received from a neighbor, the neighbor entry is updated, and the corresponding entry aging timer is reset.In normal mode, if no packet is received from the neighbor when the entry aging timer expires, DLDP sends an advertisement packet with RSY tag, and deletes the neighbor entry.In enhanced mode, if no packet is received from the neighbor when the entry aging timer expires, DLDP enables the enhanced timer.The time interval set for the entry aging timer is three times of that for the advertisement timer.
Enhanced timer	In enhanced mode, if no packet is received from the neighbor when the entry aging timer expires, DLDP enables the enhanced timer for the neighbor. The timeout time for the enhanced timer is 10 seconds.The enhanced timer then sends two probe packets every one second and totally eight packets continuously to the neighbor.If no echo packet is received from the neighbor when the Echo waiting timer expires, the local end is set to unidirectional communication status and the state machine turns into disable status. DLDP outputs log and tracking information, sends flush packets. Depending on the user-defined DLDP down mode, DLDP disables the local port automatically or prompt the user to disable the port manually. DLDP deletes the neighbor entry.

DLDP operating mode

DLDP can operate in two modes: normal and enhanced.

Table 73 DLDP operating mode and neighbor entry aging

DLDP operating mode	Whether DLDP probes neighbor during neighbor entry aging	Whether entry aging timer is enabled during neighbor entry aging	Whether enhanced timer is enabled when entry aging timer expire
Normal mode	No	Yes (the neighbor entry ages after the entry aging timer expires)	No
Enhanced mode	Yes	Yes (the enhancement timer is enabled after the entry aging timer expires)	Yes (When the enhanced timer expires, the local end is set to single pass status, and the neighbor entry ages)

DLDP implementation

1 If the link is up after DLDP is enabled on the port, DLDP sends DLDP packets to the peer device, and analyses and processes DLDP packets received from the peer device. DLDP in different status sends different packets.

.

Table 74 Types of packets sent by DLDP

DLDP status	Packet types
Active	Advertisement packets, including those with or without RSY tags
Advertisement	Advertisement packets
Probe	Probe packets

2 DLDP analyzes and processes received packets as follows:

- In authentication mode, DLDP authenticates the packets on the port, and discards those do not pass the authentication.
- DLDP processes the received DLDP packets as follows:

Table 75 Process received DLDP packets

Packet type	Processing procedure				
Advertisement packet	Extracts neighbor information	If this neighbor entry does not exist on the local device, DLDP creates the neighbor entry, enables the entry aging timer, and turns to probe status.			
		If the neighbor entry already exists on the local device, DLDP resets the entry aging timer.			
Flush packet	Deletes the neighbor entry from the local device				
Probe packet	Sends echo packets containing both neighbor and its own information to the peer	Creates the neighbor entry if this neighbor entry does not exist on the local device.			
		If the neighbor entry already exists on the local device, refreshes the entry aging timer.			
Echo packet	Checks whether the local device is in probe status	No	Discards this echo packet		
		Yes	Checks whether neighbor information in the packet is the same as that on the local device	No	Discards this echo packet
				Yes	Sets the neighbor flag bit to bidirectional
					If all neighbors are in bidirectional communication state, DLDP turns from probe status to advertisement status, and sets the echo waiting timer to 0.

3 If no echo packet is received from the neighbor, DLDP performs the following processing

:Refer to Table 76 to process when no echo packet received from the neighbor.

Table 76 Processing when no echo packet received from the neighbor

No Echo packet received from the neighbor	Processing procedure
In normal mode, no echo packet is received when the echo waiting timer expires	DLDP turns into disable status. It outputs log and tracking information, sends flush packets. Depending on the user-defined DLDP down mode, DLDP disables the local port automatically or prompt the user to disable the port manually. DLDP sends the RSY message and deletes the neighbor entry.
In enhanced mode, no echo packet is received when the enhanced timer expires	

Precautions During DLDP Configuration

It is recommended that the following precautions be taken during DLDP configuration:

- DLDP works only when the link is up.
- To ensure unidirectional links can be detected, you should make sure: DLDP is enabled on both ends, and the time interval for sending advertisement packets, authentication mode and password are set consistent on both ends.
- You can adjust the time interval for sending advertisement packets in different network circumstances, so that DLDP can respond rapidly to link failure. The time interval should be shorter than one-third of the STP convergence time, which is generally 30 seconds. If too long time interval is set, an STP loop may occur before DLDP shut down unidirectional links. On the contrary, if too short time interval is set, network traffic increases, and port bandwidth is reduced.
- DLDP does not process any LACP event, and treats each link in the aggregation group as independent.

For the configuration of distributed products, note that:

- During hot plugging, if the interface board you insert has the same type as that you have removed, DLDP restores working automatically.
- After the SRPU board switchover, the standby board takes over unidirectional link detection. In this case, the DLDP parameters do not change and DLDP checks every port again for unidirectional links.

For the configuration of the products supporting expandable resilient networking (XRN), note that:

- DLDP supports XRN; its processing is fully distributed. In XRN, port management is distributed to each port. Each unit completes only the DLDP tasks for its ports. DLDP commands executed on a port take effect only on the unit where the port is located.
- The global DLDP configuration must be consistent on all units. The global DLDP configuration commands take effect on all the units in the XRN.
- Stack ports do not support DLDP.

DLDP Configuration

Table 77 describes the DLDP basic configuration tasks:

Table 77 DLDP configuration tasks

Operation			Command	Description
Enter system view			**system-view**	-
Enable DLDP	Enable DLDP globally		**dldp enable**	Required, by default, DLDP is disabled
	Enable DLDP on a port	Enter Ethernet port view	**interface** { *interface-type interface-number* | *interface_name* }	
		Enable DLDP on a port	**dldp enable**	
Set the authentication mode and password			**dldp authentication-mode** { **none** | **simple** *password* | **md5** *password* }	Optional, by default, the authentication mode is none
Set the time interval for sending DLDP packets			**dldp interval** *integer*	Optional, by default, the time interval is 10 seconds.

Table 77 DLDP configuration tasks (continued)

Operation	Command	Description
Set the DLDP handling mode when an unidirectional link is detected	**dldp unidirectional-shutdown** { **auto** | **manual** }	Optional, by default, the handling mode is auto.
Set the DLDP operating mode	dldp work-mode { enhance | normal }	Optional; by default, DLDP works in normal mode.
Display the configuration information about the ports on which DLDP is enabled	**display dldp** { *unit-id* | *interface-type interface-number* | *interface-name* }	You can execute this command in any view.

When you use the dldp enable/dldp disable command in system view to enable/disable DLDP globally on all optical ports of the switch, this command is only valid for existing optical ports on the device, it is not valid for those added subsequently.

DLDP can operate normally only when the same authentication mode and password are set for local and peer ports.

Resetting DLDP Status

The command here is only valid for those ports that are DLDP down due to the detection of unidirectional link. You can use the command here to reset the DLDP status of these ports to retrieve DLDP probes.

Table 78 Reset DLDP status

Operation			Command	Description
Reset DLDP status	Enter system view		**system-view**	Optional
	Reset the DLDP status of the system		**dldp reset**	
	Reset the DLDP status of a port	Enter Ethernet port view	**interface** *interface-type interface-number* | *Interface-name }*	
		Reset the DLDP status of a port	**dldp reset**	

This command only applies to the ports in DLDP down status.

DLDP Configuration Example

Network requirements

As shown in Figure 21 and Figure 22, two switches (SwitchA and SwitchB) are connected with each other by fibers.

- The two switches are connected by two pairs of fibers.
- The cross lines in Figure 21 indicates the two fibers are incorrectly cross-connected, and the vacant lines in Figure 22 indicates the two fibers may be either correctly connected or disconnected.
- Both switches support DLDP.
- Unidirectional links due to incorrect fiber connections between the two switches (including disconnection in one direction and cross-connection) are expected to be detected and then automatically shut down by DLDP.
- Suppose a cross-connection exists between SwitchA and SwitchB, which is then corrected by a network administrator after DLDP shuts down the unidirectional links. Now the ports taken down by DLDP need to be restored.

Network diagram

Figure 21 Fiber cross-connection

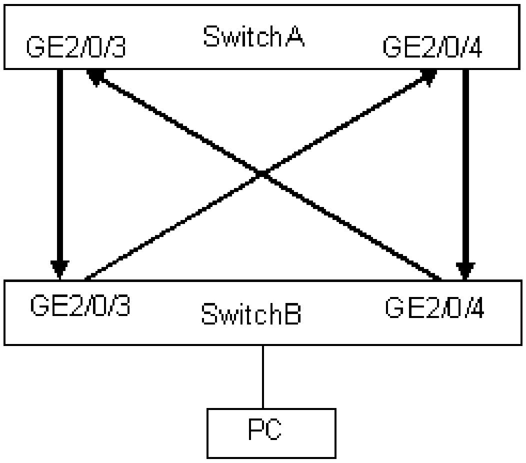
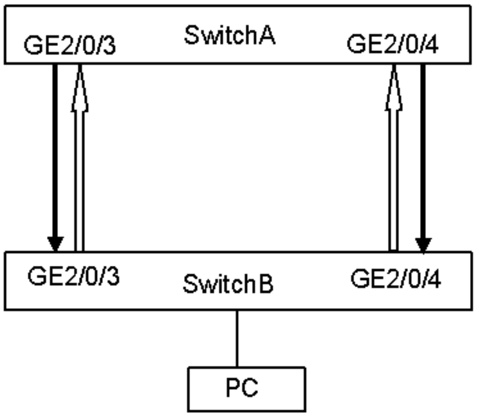


Figure 22 Correct connection/disconnection in one direction



Configuration procedure

1 1Configure SwitchA

a Configure the ports to work in mandatory full duplex mode

```
<S5500A> system-view
[S5500A] interface gigabitethernet 2/0/3
[S5500A-GigabitEthernet2/0/3] duplex full
[S5500A-GigabitEthernet2/0/3] speed 1000
[S5500A-GigabitEthernet2/0/3] quit
[S5500A] interface gigabitethernet 2/0/4
[S5500A-GigabitEthernet2/0/4] duplex full
[S5500A-GigabitEthernet2/0/4] speed 1000
[S5500A-GigabitEthernet2/0/4] quit
```

b Enable DLDP globally

```
[S5500A] dldp enable
```

c Set the time interval for sending DLDP packets to 15 seconds

```
[S5500A] dldp interval 15
```

d Configure DLDP to work in enhanced mode

```
[S5500A] dldp work-mode enhance
```

e Set the DLDP handling mode for unidirectional links to auto

```
[S5500A] dldp unidirectional-shutdown auto
```

f Display the DLDP status on Switch A

```
[S5500A] display dldp 2
```

If the fibers are correctly connected between the two switches, the system displays the connections with the neighbor as bidirectional links, or else, it displays the connections with the neighbor as unidirectional links.

g Restore the ports taken down by DLDP

```
[S5500A] dldp reset
```

2 Configure Switch B

a Configure the ports to work in mandatory full duplex mode

```
<S5500B> system-view
[S5500B] interface gigabitethernet 2/0/3
[S5500B-GigabitEthernet2/0/3] duplex full
[S5500B-GigabitEthernet2/0/3] speed 1000
[S5500B-GigabitEthernet2/0/3] quit
[S5500B] interface gigabitethernet 2/0/4
[S5500B-GigabitEthernet2/0/4] duplex full
[S5500B-GigabitEthernet2/0/4] speed 1000
[S5500B-GigabitEthernet2/0/4] quit
```

b Enable DLDP globally

```
[S5500B] dldp enable
```

c Set the time interval for sending DLDP packets to 15 seconds

```
[S5500B] dldp interval 15
```

d Configure DLDP to work in enhanced mode

```
[S5500B] dldp work-mode enhance
[S5500B] dldp work-mode enhance
```

e Set the DLDP handling mode for unidirectional links to auto

```
[S5500B] dldp unidirectional-shutdown auto
```

f Display the DLDP status on SwitchB

```
[S5500B] display dldp 2
```

If the fibers are correctly connected between the two switches, the system displays the connections with the neighbor as bidirectional links, or else, it displays the connections with the neighbor as unidirectional links.

g Restore the ports taken down by DLDP

```
[S5500B] dldp reset
```

For DLDP to detect fiber disconnection in one direction, you must configure the port to work in mandatory full duplex mode.

When a port works in mandatory full duplex mode and DLDP is enabled, DLDP considers a link as in unidirectional status if fiber in one direction is disconnected.

When a port works in non-mandatory full duplex mode, even if DLDP is enabled, it does not take effect when fiber in one direction is disconnected, in that case, it considers that the port is down.

6 VLAN OPERATION

This chapter covers the following topics:

- VLAN Configuration
- Voice VLAN Configuration

VLAN Configuration

This chapter describes how to configure a VLAN

VLAN Overview

A virtual local area network (VLAN) creates logical groups of LAN devices into segments to implement virtual workgroups. IEEE issued the IEEE 802.1Q in 1999, which was intended to standardize VLAN implementation solutions.

Using VLAN technology, you can logically divide the physical LAN into different broadcast domains. Every VLAN contains a group of workstations with the same demands. However, the workstations of a VLAN do not have to belong to the same physical LAN segment.

Within a VLAN, broadcast and unicast traffic is not forwarded to other VLANs. Therefore, VLAN configurations are very helpful in controlling network traffic, saving device investment, simplifying network management and improving security.

Configuring a VLAN

VLAN configuration is described in the following sections:

- Creating/Deleting a VLAN
- Adding Ethernet Ports to a VLAN
- Setting/Deleting a VLAN or VLAN Interface Description Character String
- Specifying/Removing the VLAN Interface
- Shutting Down/Enabling the VLAN Interface

To configure a VLAN, first create a VLAN according to network requirements.

Creating/Deleting a VLAN

Use the following command to create/delete a VLAN. If the VLAN to be created exists, enter the VLAN View directly. Otherwise, create the VLAN first, and then enter the VLAN View.

Perform the following configurations in System View.

Table 79 Creating/Deleting a VLAN

Operation	Command
Create a VLAN and enter the VLAN View	**vlan** *vlan_id*
Delete the specified VLAN	**undo vlan** { *vlan_id* [**to** *vlan_id*] | **all** }

Note that the default VLAN, namely VLAN 1, cannot be deleted.

Adding Ethernet Ports to a VLAN

Use the following command to add Ethernet ports to a VLAN.

Perform the following configuration in VLAN View.

Table 80 Adding Ethernet Ports to a VLAN

Operation	Command
Add Ethernet ports to a VLAN	**`port`** *`interface_list`*
Remove Ethernet ports from a VLAN	**`undo port`** *`interface_list`*

By default, the system adds all the ports to a default VLAN, whose ID is 1.

Note that you can add/delete a trunk port or a hybrid port to/from VLAN by using the **`port`** and **`undo port`** commands in Ethernet Port View, but not in VLAN View.

Setting/Deleting a VLAN or VLAN Interface Description Character String

Use the following command to set/delete a VLAN or VLAN interface description character string.

Perform the following configuration in VLAN or VLAN Interface View.

Table 81 Setting/Deleting a Vlan or Vlan Interface Description Character String

Operation	Command
Set the description character string for a VLAN or VLAN interface	**`description`** *`string`*
Restore the default description of current VLAN or VLAN interface	**`undo description`**

By default, a VLAN description character string is `No description!`. VLAN interface description character string of VLAN interface is the interface name, for example, `Vlan-interface1 Interface`.

Specifying/Removing the VLAN Interface

Use the following command to specify/remove the VLAN interface. To implement the network layer function on a VLAN interface, the VLAN interface must be configured with an IP address and a subnet mask.

Perform the following configurations in System View.

Table 82 Specifying/Removing the VLAN Interface

Operation	Command
Create a new VLAN interface and enter VLAN Interface View	**`interface vlan-interface`** *`vlan_id`*
Remove the specified VLAN interface	**`undo interface vlan-interface`** *`vlan_id`*

Create a VLAN first before creating an interface for it.

For this configuration task, *`vlan_id`* takes the VLAN ID.

Shutting Down/Enabling the VLAN Interface

Use the following command to shut down/enable a VLAN interface.

Perform the following configuration in VLAN Interface View.

Table 83 Shutting Down/Enabling the VLAN Interface

Operation	Command
Shut down the VLAN interface	**`shutdown`**
Enabling the VLAN interface	**`undo shutdown`**

The operation of shutting down or enabling the VLAN interface has no effect on the UP/DOWN status of the Ethernet ports on the local VLAN.

By default, when all the Ethernet ports belonging to a VLAN are in DOWN status, this VLAN interface is also DOWN, that it, this VLAN interface is shut down. When there is one or more Ethernet ports in UP status, this VLAN interface is also UP, that is, this VLAN interface is enabled.

Displaying and Debugging VLAN

After the above configuration, enter the **`display`** command in any view to display the running of the VLAN configuration, and to verify the effect of the configuration.

Table 84 Displaying and Debugging a VLAN

Operation	Command
Display information about the VLAN interface	**`display interface vlan-interface`** [*`vlan_id`*]
Display information about the VLAN	**`display vlan`** [*`vlan_id`* | **`all`** | **`static`** | **`dynamic`**]

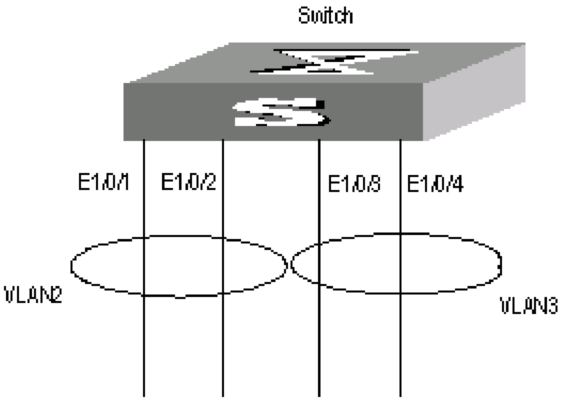
VLAN Configuration Example One

Networking Requirements

Create VLAN2 and VLAN3. Add Ethernet1/0/1 and Ethernet1/0/2 to VLAN2 and add Ethernet1/0/3 and Ethernet1/0/4 to VLAN3.

Networking Diagram

Figure 23 VLAN Configuration Example 1



Configuration Procedure

1 Create VLAN 2 and enter its view.

```
[SW5500]vlan 2
```

2 Add Ethernet1/0/1 and Ethernet1/0/2 to VLAN2.

```
[SW5500-vlan2]port ethernet1/0/1 to ethernet1/0/2
```

3 Create VLAN 3 and enter its view.

```
[SW5500-vlan2]vlan 3
```

4 Add Ethernet1/0/3 and Ethernet1/0/4 to VLAN3.

```
[SW5500-vlan3]port ethernet1/0/3 to ethernet1/0/4
```

VLAN Configuration Example Two

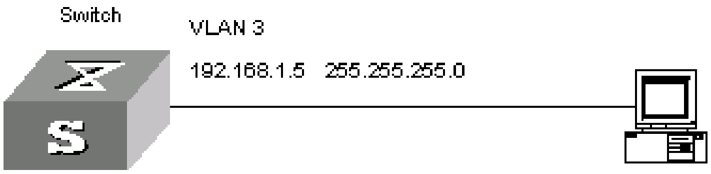
Networking Requirements

Configure an IP address on a VLAN interface.

Networking Diagram

Figure 24 shows an example of a typical VLAN configuration.

Figure 24 VLAN Configuration Example 2



Configuration Procedure

1 If the VLAN does not currently exist, then create it. This example uses VLAN ID 3.

```
[SW5500]vlan 3
[SW5500-vlan3]quit
```

2 Enter the VLAN interface view:

```
[SW5500]interface vlan-interface 3
```

3 Provide the IP address and subnet mask:

```
[SW5500-Vlan-interface3]ip address 192.168.1.5 255.255.255
[SW5500-Vlan-interface3]quit
```

Protocol-Based VLAN Configuration

Comparing with port-based VLANs, protocol-based VLANs operate in a different way. After you configure protocol-based VLANs for a switch, the switch inserts tags automatically in the received untagged packets according to the protocols with which the packets are encapsulated. This enables packets of specific protocols to be transmitted in corresponding VLANs. For ease of network management and maintenance, you can associate services with specific VLANs by configuring protocol-based VLANs.

Configuring Protocol-Based VLANs

The following section describes protocol-based VLAN configuration tasks:

- Creating a VLAN protocol type
- Associating a port with a protocol-based VLAN

I. Creating a VLAN protocol type

Table 85 lists the operations to create a VLAN protocol type.

Table 85 Create a VLAN protocol type

Operation	Command	Description
Enter system view	**system-view**	-
Enter VLAN view	**vlan** *vlan-id*	Required
Create a VLAN protocol type	**protocol-vlan** [*protocol-index*] { **at** | **ip** | **ipx** { **ethernetii** | **llc** | **raw** | **snap** } | **mode** { **ethernetii etype** *etype-id* | **llc** { **dsap** *dsap-id* [**ssap** *ssap-id*] | **ssap** *ssap-id* } | **snap etype** *etype-id* }}	Required

As the mode llc dsap ff ssap ff and ipx raw keywords result in the same packet format, the ipx raw keyword takes precedence over the mode llc dsap ff ssap ff keyword, and the system stops matching the subsequent keywords if the ipx raw keyword does not match, executing the protocol-vlan command in the form of mode llc dsap ff ssap ff does not take effect.

If you set the dsap-id and ssap-id arguments to AA or FF, the packet encapsulation type will be snap instead of llc.

Associating a port with a protocol-based VLAN

Use the following commands to associate ports with protocol VLANs.

Table 86 Associate ports with protocol-based VLANs

Operation	Command	Description
Enter system view	**system-view**	-
Enter port view	**interface** *interface-type interface-number*	Required
Associate the port with a specified protocol-based VLAN	**port hybrid protocol-vlan** *vlan vlan-id { protocol-index* [**to** *protocol-end*] | **all** }	Required

Before associate a port with a protocol-based VLAN, make sure the port is a hybrid port, and the port belongs to the protocol-based VLAN.

Displaying the Information about Protocol-Based VLANs

You can check the information about specified protocol-based VLANs by executing the display command in any view.

Table 87 Display the information about specified protocol-based VLANs

Operation	Command	Description
Display the protocol-related information and protocol indexes configured for specified VLANs	**display protocol-vlan vlan** { *vlan-id* [**to** *vlan-id*] | **all** }	You can execute the **display** command in any view
Display the protocol-related information and protocol indexes configured for specified ports	**display protocol-vlan interface** { *interface-type interface-number* [**to** *interface-type interface-number*] | **all** }	

Voice VLAN Configuration

Voice VLAN is specially designed for users' voice flow, and it distributes different port precedence in different cases.

The system uses the source MAC of the traffic travelling through the port to identify the IP Phone data flow. You can either preset an OUI address or adopt the default OUI address as the standard. Here the OUI address refers to that of a vendor.

Voice VLAN can be configured either manually or automatically. In auto mode, the system learns the source MAC address and automatically adds the ports to a Voice VLAN using the untagged packets sent out when IP Phone is powered on; in manual mode, however, you need to add ports to a Voice VLAN manually. Both of the modes forward the tagged packets sent by IP Phone without learning the address.

Since there are multiple types of IP Phones, you must ensure that the mode on a port matches the IP Phone. See Table 88:

Table 88 The correspondence between Port Mode and IP Phone

Voice VLAN Mode	Type of IP Phone	Port Mode
Auto mode	Tagged IP Phone	Access: Not supported
		Trunk: Supported, but the default VLAN of the connected port must exist and cannot be the voice VLAN. The default VLAN is allowed to pass the connected port.
		Hybrid: Supported, but the default VLAN of the connected port must exist and it is in the tagged VLAN list which is allowed to pass the connected port.
	Untagged IP Phone	Access, Trunk, and Hybrid: Not supported, because the default VLAN of the connected port must be the Voice VLAN, and the connected port belongs to the Voice VLAN, that is, user add the port to the Voice VLAN manually.
Manual Mode	Tagged IP Phone	Access: Not supported
	Untag IP Phone Untagged IP Phone	Trunk: Supported, but the default VLAN of the connected port must exist and cannot be the voice VLAN. The default VLAN is allowed to pass the connected port
		Hybrid: Supported, but the default VLAN of the connected port must exist and it is in the tagged VLAN list which is allowed to pass the connected port.
		Access: Supported, but the default VLAN of the connected port must be the Voice VLAN.

Voice VLAN Configuration

The configuration of Voice VLAN is described in the following sections:

- Enabling/Disabling Voice VLAN Features
- Enabling/Disabling Voice VLAN Features on a Port
- Setting/Removing the OUI Address Learned by Voice VLAN
- Enabling/Disabling Voice VLAN Security Mode
- Enabling/Disabling Voice VLAN Auto Mode
- Setting the Aging Time of Voice VLAN

If you change the status of Voice VLAN security mode, you must first enable Voice VLAN features globally.

Enabling/Disabling Voice VLAN Features

Enable/disable the Voice VLAN in System View.

Table 89 Configuring Voice VLAN Features

Operation	Command
Enable Voice VLAN features	**voice vlan** *vlan_id* **enable**
Disable Voice VLAN features	**undo voice vlan enable**

The VLAN must already exist before you can enable Voice VLAN features. You cannot delete a specified VLAN that has enabled Voice VLAN features and only one VLAN can enable Voice VLAN at one time.

Enabling/Disabling Voice VLAN Features on a Port

Perform the following configuration in Ethernet Port View.

Table 90 Configuring Voice VLAN Features on a Port

Operation	Command
Enable the Voice VLAN features on a port	**voice vlan enable**
Disable the Voice VLAN features on a port	**undo voice vlan enable**

Only when the Voice VLAN features in System View and Port View are all enabled can the Voice VLAN function on the port run normally.

Setting/Removing the OUI Address Learned by Voice VLAN

Configure OUI addresses which can be learned by Voice VLAN using the following command; otherwise the system uses the default OUI addresses as the standard of IP Phone traffic.

The OUI address system can learn 16 MAC addresses at most. Adding the OUI addresses, you need only input the first three-byte values of the MAC address.

Perform the following configuration in System View.

Table 91 Configuring the OUI address Learned by Voice VLAN

Operation	command
Set the OUI address learned by Voice VLAN	**voice vlan mac_address** *oui* **mask** *oui_mask* [**description** *string*]
Remove the OUI address learned by Voice VLAN	**undo voice vlan mac_address** *oui*

There are four default OUI addresses after the system starts.

Table 92 Default OUI Addresses

No.	OUI	Description
1	00:E0:BB	3Com phone
2	00:03:6B	Cisco phone
3	00:E0:75	Polycom phone
4	00:D0:1E	Pingtel phone

Enabling/Disabling Voice VLAN Security Mode

In security mode, the system can filter out the traffic whose source MAC is not OUI within the Voice VLAN, while the other VLANs are not influenced. If security mode is disabled, the system cannot filter anything.

Perform the following configuration in System View.

Table 93 Configuring the Voice VLAN Security Mode

Operation	Command
Enable Voice VLAN security mode	**`voice vlan security enable`**
Disable Voice VLAN security mode	**`undo voice vlan security enable`**

By default, the Voice VLAN security mode is enabled.

Enabling/Disabling Voice VLAN Auto Mode

In auto mode, if you enable Voice VLAN features on a port and there is IP Phone traffic through the port, the system automatically adds the port to the Voice VLAN. But in manual mode, you have to perform the above operation manually.

Perform the following configuration in System View.

Table 94 Configuring Voice VLAN Auto Mode

Operation	Command
Enable Voice VLAN auto mode	**`voice vlan mode auto`**
Disable Voice VLAN auto mode (that is, to enable manual mode)	**`undo voice vlan mode auto`**

By default, Voice VLAN auto mode is enabled.

Setting the Aging Time of Voice VLAN

In auto mode, using the follow command, you can set the aging time of Voice VLAN. After the OUI address, the MAC address of IP Phone, is aged on the port, this port enters the aging phase of Voice VLAN. If OUI address is not learned by a port within the aging time, the port is automatically deleted from Voice VLAN. This command does not operate in manual mode.

Perform the following configuration in System View.

Table 95 Configuring the Aging Time of Voice VLAN

Operation	command
Set the aging time of Voice VLAN	**`voice vlan aging`** *`minutes`*
Restore the default aging time	**`undo voice vlan aging`**

The default aging time is 1440 minutes.

Configuring a voice VLAN to operate in manual mode

Refer to Table 96 to configure a VLAN in manual mode.

Table 96 Configure a voice VLAN to operate in manual mode

Operation			Command	Description
Enter system view			**system-view**	-
Enter port view			**interface** *interface-type interface-number*	Required
Enable the voice VLAN function for the port			**voice vlan enable**	Required By default, the voice VLAN function is disabled.
Set voice VLAN operation mode to manual mode			**undo voice vlan mode auto**	Required The default voice VLAN operation mode is manual mode.
Quit to system view			**quit**	-
Add a portoperating in manual mode to the VLAN	Access port	Enter VLAN view	**vlan** *vlan-id*	Required
		Add the port to the VLAN	**port** *interface-type interface-number*	
	Trunk or hybrid port	Enter port view	**interface** *interface-type interface-number*	
		Add the port to the VLAN	**port trunk permit vlan** *vlan-id* **port hybrid permit vlan** *vlan-id*	
Quit to system view			**quit**	-
Set an OUI address that can be identified by the voice VLAN			**voice vlan mac-address** oui **mask** oui-mask [**description** string]	Optional If you do not set the address, the default OUI address is used.
Enable the voice VLAN security mode			**voice vlan security enable**	Optional By default, the voice VLAN security mode is enabled.
Set aging time for the voice VLAN			**voice vlan aging** minutes	Optional By default, the aging time is 1,440 minutes.
Enable the voice VLAN function globally			**voice vlan** *vlan-id* **enable**	Required

You can enable voice VLAN feature for only one VLAN at a moment.

A port operating in the automatic mode cannot be added to/removed from a voice VLAN.

When a voice VLAN operates in the security mode, the devices in it only permit packets whose source addresses are the voice OUI addresses that can be identified. Packets whose source addresses cannot be identified, including certain authentication packets (such as 802.1x authentication packets), will be dropped. So, do not transmit both voice data and service data in a voice VLAN. If you have to do so, make sure the voice VLAN do not operate in the security mode.

Displaying and Debugging of Voice VLAN

After completing the above configuration, enter the **display** command in any view to view the configuration and running state of Voice VLAN.

Table 97 Displaying Voice VLAN

Operation	Command
Display the status of Voice VLAN	**display voice vlan status**
Display the OUI address supported by the current system	**display voice vlan oui**

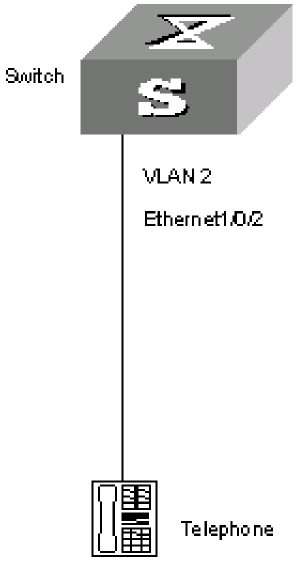
Voice VLAN Configuration Example

Networking Requirements

Create VLAN 2 as the Voice VLAN in manual mode and enable its security mode. It is required to set the aging time to 100 minutes, the OUI address to 0011-2200-0000, and configure the port Ethernet1/0/2 as the IP Phone access port. The type of IP Phone is untagged.

Network Diagram

Figure 25 Voice VLAN Configuration



Configuration Steps

```
[SW5500]vlan 2
[SW5500-vlan2]port ethernet1/0/2
[SW5500-vlan2]interface ethernet1/0/2
[SW5500-Ethernet1/0/2]voice vlan enable
[SW5500 -Ethernet1/0/2]quit
[SW5500]undo voice vlan mode auto
[SW5500]voice vlan mac_address 0011-2200-0000 mask ffff-ff00-0000
description private
[SW5500]voice vlan 2 enable
[SW5500]voice vlan aging 100
```

Creating VLANs in Batches

To improve efficiency, you can create VLANs in batches by performing the operations listed in Table 98.

Table 98 Create VLANs in batches

Operation	Command	Description
Enter system view	**system-view**	-
Create VLANs by specifying a VLAN ID range	**vlan** { vlan-id1 to vlan-id2 | all }	Required

Voice VLAN Configuration

Voice VLANs are VLANs configured specially for voice data stream. By adding the ports with voice devices attached to voice VLANs, you can perform QoS-related configuration for voice data, ensuring the transmission priority of voice data stream and voice quality.

S5500 series Ethernet switches determine whether a received packet is a voice packet by checking its source MAC address. Voice packets can also be identified by organizationally unique identifier (OUI) addresses. You can also configure an OUI address for a voice packet or specify to use the default OUI address.

An OUI address is a globally unique identifier assigned to a vendor by IEEE. It forms the first 24 bits of a MAC address.

A voice VLAN can operate in two modes: automatic mode and manual mode. You can configure the operation mode for a voice VLAN according to data stream passing through the ports of the voice VLAN.

- When a voice VLAN operates in the automatic mode, the switch learns source MAC addresses from untagged packets sent by IP phones (an IP phone sends untagged packets when powered on) and adds the port with the IP phones attached to the voice VLAN. A port in a voice VLAN ages if the corresponding OUI address is not updated when the aging time expires.
- When a voice VLAN operates in the manual mode, you need to execute related commands to add a port to the voice VLAN or remove a port from the voice VLAN.

As for tagged packets sent by IP phones, a switch only forwards them (rather than learns the MAS addresses) regardless of the voice VLAN operation mode.

Voice VLAN packets can be forwarded by trunk ports and hybrid ports. You can enable a trunk port or a hybrid port to forward voice and service packets simultaneously by enabling the voice VLAN function for it.

As multiple types of IP phones exist, you need to match port mode with types of voice stream sent by IP phones, as listed in Table 99T

Table 99 Port modes and types of voice stream types

Port voice VLAN mode	Voice stream type	Port type	Supported or not
Automatic mode	Tagged voice stream	Access	Not supported
		Trunk	Supported Make sure the default VLAN of the port exists and is not a voice VLAN. And the access port permits the packets of the default VLAN.
		Hybrid	Supported Make sure the default VLAN of the port exists and is in the list of the tagged VLANs whose packets are permitted by the access port.
	Untagged voice stream	Access	Not supported, because the default VLAN of the port must be a voice VLAN and the access port is in the voice VLAN. To do so, you can also add the port to the voice VLAN manually.
		Trunk	
		Hybrid	
Manual mode	Tagged voice stream	Access	Not supported
		Trunk	Supported Make sure the default VLAN of the port exists and is not a voice VLAN. And the access port permits the packets of the default VLAN.
		Hybrid	Supported Make sure the default VLAN of the port exists and is in the list of the tagged VLANs whose packets are permitted by the access port.
	Untagged voice stream	Access	Supported Make sure the default VLAN of the port is a voice VLAN.
		Trunk	Supported Make sure the default VLAN of the port is a voice VLAN and the port permits the packets of the VLAN.
		Hybrid	Supported Make sure the default VLAN of the port is a voice VLAN and is in the list of untagged VLANs whose packets are permitted by the port.

Configuring the Voice VLAN Function

Configuration Prerequisites

- Create the corresponding VLAN before configuring a voice VLAN.
- VLAN 1 is the default VLAN and do not need to be created. But VLAN 1 does not support the voice VLAN function.

Configuring a voice VLAN to operate in automatic mode

Table 100 Configure a voice VLAN to operate in automatic mode

Operation	Command	Description
Enter system view	**system-view**	-
Enter port view	**interface** *interface-type interface-number*	Required
Enable the voice VLAN function for the port	**voice vlan enable**	Required By default, the voice VLAN function is disabled.
Set the voice VLAN operation mode to automatic mode	**voice vlan mode auto**	Optional The default voice VLAN operation mode is automatic mode.
Quit to system view	**quit**	-
Set an OUI address that can be identified by the voice VLAN	**voice vlan mac-address** *oui* **mask** *oui-mask* [**description** *string*]	Optional If you do not set the OUI address, the default OUI address is used.
Enable the voice VLAN security mode	**voice vlan security enable**	Optional By default, the voice VLAN security mode is enabled.
Set the aging time for the voice VLAN	**voice vlan aging** minutes	Optional The default aging time is 1,440 minutes.
Enable the voice VLAN function globally	**voice vlan** *vlan-id* **enable**	Required

Voice VLAN Displaying and Debugging

Refer to Table 101 to display or debug a voice VLAN.

Table 101 Display and debug a voice VLAN

Operation	Command	Description
Display voice VLAN configuration	**display voice vlan status**	You can execute the display command in any view.
Display the currently valid OUI addresses	**display voice vlan oui**	
Display ports operating in the current voice VLAN	**display vlan** *vlan-id*	

Voice VLAN Configuration Example

Network requirements

- Create VLAN 3 as a voice VLAN.
- Add/remove Ethernet1/0/3 port to/from the voice VLAN manually.
- Configure the OUI address to be 0011-2200-0000, with the description set to "test".

Configuration procedure

1 Create VLAN 3.

```
[S5500] vlan 3
```

2 Add Ethernet1/0/3 port to VLAN 3.

```
[S5500-vlan3] port Ethernet1/0/3
```

3 Enable the voice VLAN function for the port and configure the port to operate in manual mode.

```
[S5500-vlan3] quit
[S5500] interface Ethernet1/0/3
[S5500-Ethernet1/0/3] voice vlan enable
[S5500-Ethernet1/0/3] undo voice vlan mode auto
[S5500-Ethernet1/0/3] quit
```

4 Specify the OUI address.

```
[S5500] voice vlan mac-address 0011-2200-0000 mask ffff-ff00-0000
description test
```

5 Enable the voice VLAN function globally.

```
[S5500] voice vlan 3 enable
```

6 Display the configuration.

```
[S5500] display voice vlan status
Voice Vlan status: ENABLE
Voice Vlan ID: 3
Voice Vlan security mode: Security
Voice Vlan aging time: 1440 minutes
Current voice vlan enabled port mode:
PORT                     MODE
----------------------------------------
Ethernet1/0/3            MANUAL
```

7 Remove Ethernet 1/0/3 port from the voice VLAN.

```
[S5500] vlan 3
[S5500-vlan3] undo port Ethernet1/0/3
```

7 GVRP CONFIGURATION

This chapter contains GVRP configuration information.

Introduction to GVRP

GVRP (GARP VLAN Registration Protocol) is an application of GARP (Generic Attribute Registration Protocol). GVRP is based on the work scheme of GARP; it maintains dynamic VLAN registration information and propagates the information to other switches.

GARP is a generic attribute registration protocol. This protocol provides a scheme to register, distribute and propagate the information about VLANs, multicast addresses, and so on, between the switching members in a switching network

After the GVRP feature is enabled on a switch, the switch can receive the VLAN registration information from other switches to dynamically update the local VLAN registration information (including current VLAN members, which ports these VLAN members get to), and propagate the local VLAN registration information to other switches so that all the switching devices in the same switching network can have the same VLAN information. The VLAN registration information not only includes the static registration information configured locally, but also includes the dynamic registration information from other switches.

GVRP Working Scheme

GARP Timers

The information exchange between GARP members is completed by messages. The messages performing important functions for GARP fall into three types: Join, Leave and LeaveAll.

- When a GARP entity expects other switches to register certain attribute information of its own, it sends out a Join message.
- When a GARP entity expects other switches to unregister certain attribute information of its own, it sends out a Leave message.
- Once a GARP entity starts up, it starts the LeaveAll timer. After the timer times out, the GARP entity sends out a LeaveAll message.

The join message and the Leave message are used together to complete the unregistration and re-registration of information. Through message exchange, all the attribute information to be registered can be propagated to all the switches in the same switching network.

GARP has the following timers:

- Hold: When a GARP entity receives a piece of registration information, it does not send out a Join message immediately. Instead, it starts the Hold timer, and sends out a Join message after the timer times out, so that all the registration information received before the timer times out can be put into the same frame that will be sent to save the bandwidth resources.
- Join: After the Join timer times out, the GARP entity sends out a Join message to indicate other GARP entities to register the information of its own.

- Leave: When a GARP entity expects to unregister a piece of attribute information, it sends out a Leave message. Any GARP entity receives this message starts its Leave timer, and unregister the attribute information after the timer times out if it does not receives a Join message again before the timeout.
- LeaveAll: Once a GARP entity starts up, it starts the LeaveAll timer, and sends out a LeaveALL message after the timer times out, so that other GARP entities can re-register all the attribute information on this entity. After that, the entity restarts the LeaveAll timer to begin a new cycle.

GVRP port registration mode

GVRP has the following port registration modes:

- Normal: In this mode, both dynamic and manual creation, registration and unregistration of VLAN are allowed.
- Fixed: In this mode, when you created a static VLAN on a switch and the packets of this VLAN are allowed to pass through the current port, the switch joins the current port to this VLAN and add a VLAN entry to the local GVRP database (a table maintained by GVRP); but GVRP cannot learn dynamic VLAN through this port, and the dynamic VLANs learned through other ports on this switch cannot be pronounced through this port.
- Forbidden: In this mode, all the VLANs except VLAN 1 are unregistered on the port, and no other VLANs can be created or registered on the port.

GARP operation procedure

Through the working scheme of GARP, the configuration information on a GARP member will be propagate to the whole switching network. A GARP can be a terminal workstation or a bridge; it informs other GARP member to register/unregister its attribute information by declaration/recant, and register/unregister other GARP member's attribute information according to other member's declaration/recant.

The protocol packets of GARP entity use specific multicast MAC addresses as their destination MAC addresses. When receiving these packets, the switch distinguishes them packet by their destination MAC addressed and delivers them to different GARP application (for example, GVRP) for further processing.

GVRP Packet Format

The GVRP packets are in the following format:

Figure 26 Format of GVRP packets

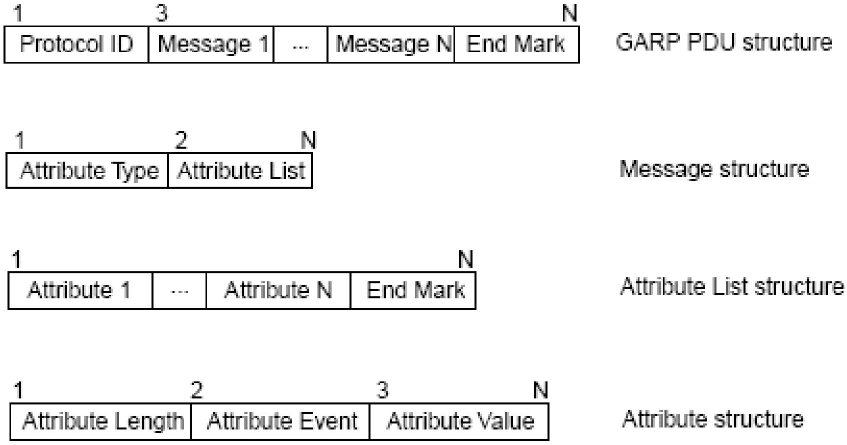


Table 102 describes the packet fields in Figure 26.

Table 102 Description of the packet fields

Field	Description	Value
Protocol ID	Protocol ID	1
Message	Each message consists of two parts: Attribute Type and Attribute List.	-
Attribute Type	It is defined by specific GARP application.	The attribute type of GVRP is 0x01.
Attribute List	It contains multiple attributes.	-
Attribute	Each general attribute consists of three parts: Attribute Length, Attribute Event, and Attribute Value. Each LeaveAll attribute consists of two parts: Attribute Length and LeaveAll Event.	-
Attribute Length	The length of the attribute	2 to 255
Attribute Event	The event described by the attribute	0: LeaveAll Event1: JoinEmpty 2: JoinIn3: LeaveEmpty4: LeaveIn5: Empty
Attribute Value	The value of the attribute	The attribute value of GVRP is the VID.
End Mark	End mark of the GVRP PDU.	-

Protocol Specifications

GVRP is defined in IEEE 802.1Q standard.

GVRP Configuration

The GVRP configuration tasks include configuring the timers, enabling GVRP, and configuring the GVRP port registration mode.

Configuration Prerequisite

The port on which GVRP will be enabled must be configured to the Trunk port.

Configuration Procedure

Refer to Table 103 for configuration procedures

Table 103 Configuration procedure

Operation	Command	Description
Enter system view	system-view	-
Enable GVRP globally.	gvrp	Required By default, GVRP is disabled globally.
Configure the LeaveAll timer	garp timer leaveall timer-value	Optional By default, the LeaveAll timer is set to 1,000 centiseconds.
Enter Ethernet port view	interface interface-type interface-number	This port must be a Trunk port.
Enable GVRP on the port	gvrp	Required By default, GVRP is disabled on port.After enabling GVRP on the Trunk port, you are not allowed to change the port type from Trunk to another.
Configure the Hold, Join, and Leave timers	garp timer { hold | join | leave } timer-value	Optional By default, the Hold, Join, and Leave timers are set to 10, 20, and 60 centiseconds respectively.
Configure GVRP port registration mode	gvrp registration { normal | fixed | forbidden }	Optional You can choose one of the three modes.By default, GVRP port registration mode is normal.
Display the GARP statistics	display garp statistics [interface interface-list]	You can execute the display commands in any view.
Display the values of the GARP timers	display garp timer [interface interface-list]	
Display the GVRP statistics	display gvrp statistics [interface interface-list]	
Display global GVRP status	display gvrp status	

You can use the reset garp statistics [interface interface-list] command to clear the GARP statistics.

The ranges of the timers vary depending on the values of other timers. You can set a timer to a value out of the current range by set the associated timer to another value.

Table 104 describes the relations between the timers:

Table 104 **Relations between the timers**

Timer	Lower threshold	Upper threshold
Hold	10 centiseconds	This upper threshold is less than or equal to one-half of the value of the Join timer. You can change the threshold by changing the value of the Join timer.
Join	This lower threshold is greater than or equal to twice the value of the Hold timer. You can change the threshold by changing the value of the Hold timer.	This upper threshold is less than one-half of the value of the Leave timer. You can change the threshold by changing the value of the Leave timer.
Leave	This lower threshold is greater than twice the value of the Join timer. You can change the threshold by changing the value of the Join timer.	This upper threshold is less than the value of the LeaveAll timer. You can change the threshold by changing the value of the LeaveAll timer.
LeaveAll	This lower threshold is greater than the value of the Leave timer. You can change threshold by changing the value of the Leave timer.	32,765 centiseconds

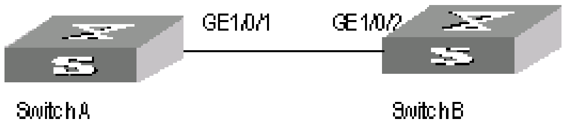
Configuration Example

Network requirements

You should enable GVRP on the switches to implement the dynamic registration and update of VLAN information between the switches.

Network diagram

Figure 27 Network diagram for GVRP configuration



Configuration procedure

1 Configure switch A:

a Enable GVRP globally.

```
<S5500> system-view
[S5500] gvrp
```

b Configure the port Ethernet1/0/1 to the Trunk port, and allow all VLAN packets to pass through the port.

```
[S5500] interface Ethernet1/0/1
[S5500-Ethernet1/0/1] port link-type trunk
[S5500-Ethernet1/0/1] port trunk permit vlan all
```

c Enable GVRP on the Trunk port.

```
[S5500-Ethernet1/0/1] gvrp
```

2 Configure switch B:

a Enable GVRP globally.

```
<S5500> system-view
[S5500] gvrp
```

b Configure the port Ethernet1/0/2 to the Trunk port, and allow all VLAN packets to pass

```
[S5500] interface Ethernet1/0/2
[S5500-Ethernet1/0/2] port link-type trunk
[S5500-Ethernet1/0/2] port trunk permit vlan all
```

c Enable GVRP on the Trunk port.

```
[S5500-Ethernet1/0/2] gvrp
```

Displaying GVRP

You can use the display commands here to display the GVRP configuration. You can execute the display commands in any view.

Table 105 Displaying GVRP

Operation	Command
Display the GARP statistics	display garp statistics [interface interface-list]
Display the values of GARP timers	display garp timer [interface interface-list]
Display the GVRP statistics	display gvrp statistics [interface interface-list]
Display the global GVRP status	display gvrp status
Clear the GARP statistics (in user view).	reset garp statistics [interface interface-list]

8 VLAN-VPN CONFIGURATION

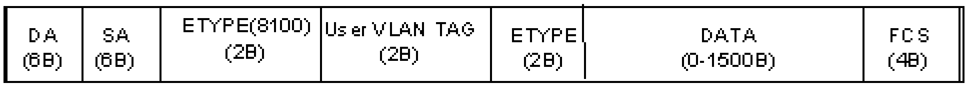
This chapter contains configuration information to create VLAN-VPNs.

VLAN-VPN Overview

The VLAN-VPN function enables packets to be transmitted across the operators' backbone networks with VLAN tags of private networks nested in those of public networks. In public networks, packets of this type are transmitted by their outer VLAN tags (that is, the VLAN tags of public networks). And those of private networks, which are nested in the VLAN tags of public networks, remain intact.

Figure 28 describes the structure of the packets with single VLAN tags.

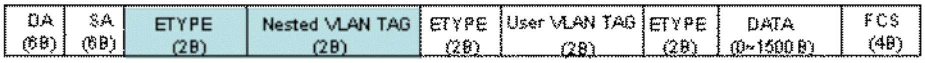
Figure 28 Structure of packets with private network VLAN tags only



DA (6B)	SA (6B)	ETYPE(8100) (2B)	User VLAN TAG (2B)	ETYPE (2B)	DATA (0-1500B)	FCS (4B)

Figure 29 describes the structure of the packets with nested VLAN tags.

Figure 29 Structure of packets with nested VLAN tags



DA (6B)	SA (6B)	ETYPE (2B)	Nested VLAN TAG (2B)	ETYPE (2B)	User VLAN TAG (2B)	ETYPE (2B)	DATA (0~1500 B)	FCS (4B)

Compared with MPLS-based L2VPN, VLAN-VPN has the following features:

- It allows Layer 2 VPN tunnels that are simpler.
- VLAN-VPN can be implemented without the support of signalling protocols. You can enable VLAN-VPN by static configuring.

The VLAN-VPN function provides you with the following benefits:

- Saves public network VLAN ID resource.
- You can have VLAN IDs of your own, which is independent of public network VLAN IDs.
- Provides simple Layer 2 VPN solutions for small-sized MANs or intranets.

Implementation of VLAN-VPN

VLAN-VPN can be implemented by enabling the VLAN-VPN function on ports.

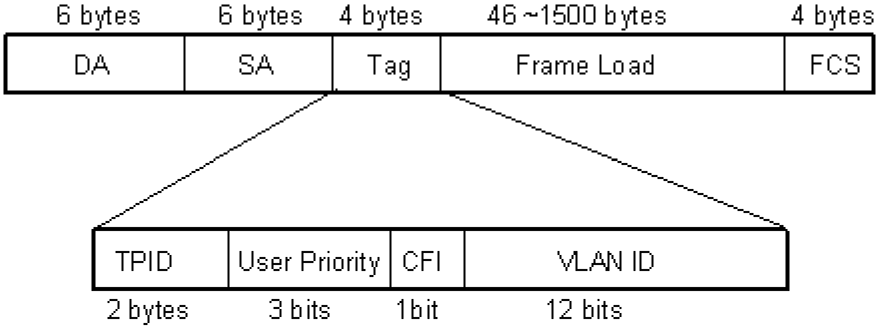
With the VLAN-VPN function enabled, a received packet is tagged with the default VLAN tag of the receiving port no matter whether or not the packet already carries a VLAN tag. If the packet already carries a VLAN tag, the inserted VLAN tag becomes a nested VLAN tag in the packet. Otherwise, the packet is then transmitted with the default VLAN tag of the port carried.

Adjusting the TPID Values of VLAN-VPN Packet

Tag protocol identifier (TPID) is a portion of the VLAN tag field. IEEE 802.1Q specifies the value of TPID to be 0x8100.

Figure 30 illustrates the structure of the Tag field of an Ethernet frame defined by IEEE 802.1Q.

Figure 30 The structure of the Tag field of an Ethernet frame



As for S5600 series switches, the value of the TPID field is 0x8100, which is defined by IEEE 802.1Q. Other vendors use other TPID values (such as 0x9100 or 0x9200) in the outer tags of VLAN-VPN packets.

To be compatible with devices coming from other vendors, S5600 series switches can adjust the TPID values of VLAN-VPN packets. You can configure TPID value for ports connecting to the public networks to enable these ports to forward received packets after replacing the TPID values carried in the outer VLAN tags of the received packets with the user-defined TPID value, through which the VLAN-VPN packets sent to public networks can be recognized by devices of other vendors.

VLAN-VPN Configuration

This section contains configuration information for VLAN-VPN.

Configuration Prerequisites

- GARP VLAN registration protocol (GVRP), GARP multicast registration protocol (GMRP), expandable resilient networking (XRN), neighbor topology discovery protocol (NTDP), spanning tree protocol (STP) and 802.1x protocol are disabled on the port.
- The port is not a VLAN-VPN uplink port.

CAUTION: By default, STP and NTDP are enabled on a device. You can disable these two protocols using the stp disable and undo ntdp enable commands.

Configuration procedure

Table 106 Configure the VLAN-VPN function for a port

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	interface interface-type interface-number	-
Enable the VLAN-VPN function	vlan-vpn enable	Required By default, the VLAN-VPN function is disabled on a port.The VLAN-VPN function is applicable to access ports only.

Table 106 Configure the VLAN-VPN function for a port (continued)

Operation	Command	Description
Display VLAN VPN configuration information about all ports	display port vlan-vpn	You can execute the display command in any view.

The VLAN-VPN function is unavailable if the port has any of the protocols among GVRP, GMRP, XRN, NTDP, STP and 802.1x enabled.

Inner VLAN Tag Priority Replication Configuration

You can configure to replicate the tag priority of the inner VLAN tag of a VLAN-VPN packet to the outer VLAN tag to remain the original tag priority after the packet is inserted an outer VLAN tag.

Configuration Prerequisites

The VLAN-VPN function is enabled.

Configuration procedure

Table 107 Configure to replicate the tag priority of the inner VLAN tag

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	interface interface-type interface-number	-
Enable the inner VLAN Tag priority replication function	vlan-vpn inner-cos-trust enable	Required By default, the inner VLAN tag priority replicating function is disabled. And the priority of a outer VLAN tag is that of the default priority of the current port.
Display the VLAN-VPN configuration information about all ports	display port vlan-vpn	You can execute the display command in any view.

TPID Adjusting Configuration

This Section describes how to configure TPID Adjusting.

Configuration Prerequisites

Before you configure a VLAN-VPN uplink port, make sure that:

- The VLAN-VPN function is not enabled.

Configuration Procedure

Table 108 Adjust TPID values for VLAN-VPN packets

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	interface interface-type interface-number	-
Set a TPID value for the port	vlan-vpn tpid value	Required Do not set the TPID value to a value that conflicts with known protocol type values.
Set the port to be a VLAN-VPN uplink port	vlan-vpn uplink enable	Optional By default, the VLAN-VPN uplink function is disabled.

Table 108 Adjust TPID values for VLAN-VPN packets (continued)

Operation	Command	Description
Display VLAN-VPN configuration information about all ports	display port vlan-vpn	You can execute the display command in any view.

You can execute the vlan-vpn enable or vlan-vpn uplink enable command for a port, but do not execute both of the two commands for a port.

When the TPID field is set to the default value (that is, 0x8100), a port can serve as an uplink port no matter whether or not you enable the VLAN-VPN uplink function for the port. However, if the TPID field is not set to 0x8100, you need to enable the VLAN-VPN uplink function for the port if you want to make the port an uplink port.

VLAN-VPN Configuration Example

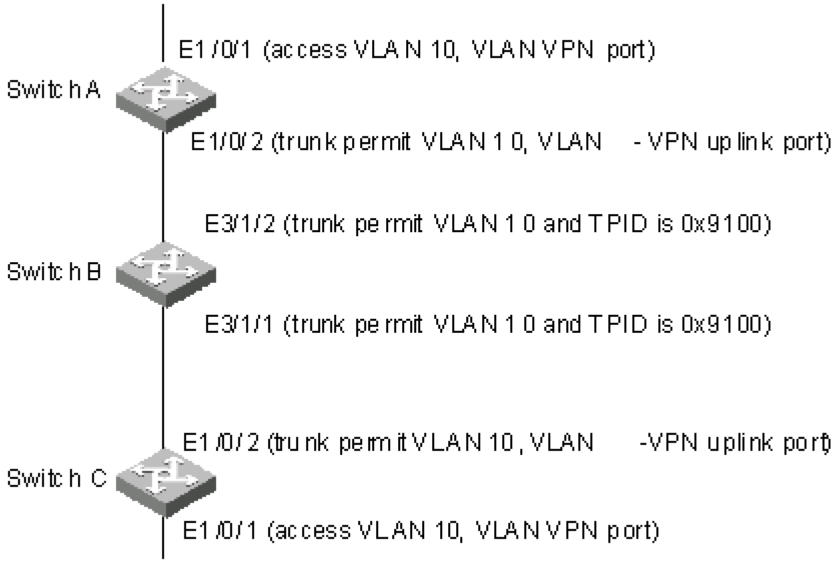
This Section contains a VLAN-VPN configuration example.

Network requirements

- Switch A and Switch C are S5500 series switches. Switch B is a switch comes from another vendor, which uses a TPID value of 0x9100.
- Two networks are connected to the Ethernet1/0/1 ports of Switch A and Switch C respectively.
- Switch B only permits packets of VLAN 10.
- It is desired that packets of VLANs other than VLAN 10 can be exchanged between the networks connected to Switch A and Switch C.

Network diagram

Figure 31 Network diagram for adjusting TPID values


E1/0/1 (access VLAN 10, VLAN VPN port)
Switch A
E1/0/2 (trunk permit VLAN 10, VLAN -VPN uplink port)
E3/1/2 (trunk permit VLAN 10 and TPID is 0x9100)
Switch B
E3/1/1 (trunk permit VLAN 10 and TPID is 0x9100)
E1/0/2 (trunk permit VLAN 10, VLAN -VPN uplink port)
Switch C
E1/0/1 (access VLAN 10, VLAN VPN port)

Configuration Procedure

Perform the following procedure to configure switches A and C.

1 Configure Switch A and Switch C.

As the configuration performed on Switch A and Switch C is the same, configuration on Switch C is omitted.

a Configure Ethernet1/0/2 port of Switch A to be a VLAN-VPN uplink port and add it to VLAN 10. Set the TPID value of the port to 0x9100.

```
<SwitchA> system-view
System View: return to User View with Ctrl+Z.
[SwitchA] vlan 10
[SwitchA-vlan10] quit
[SwitchA] interface GigabitEthernet1/0/2
[SwitchA-Ethernet1/0/2] vlan-vpn tpid 9100
[SwitchA-Ethernet1/0/2] port link-type trunk
[SwitchA-Ethernet1/0/2] port trunk permit vlan 10
[SwitchA-Ethernet1/0/2] vlan-vpn uplink enable
```

b Configure GigabitEthernet1/0/1 port of Switch A to be a VLAN-VPN port and add it to VLAN 10.

```
[SwitchA] interface GigabitEthernet1/0/1
[SwitchA-Ethernet1/0/1] port access vlan 10
[SwitchA-Ethernet1/0/1] vlan-vpn enable
[SwitchA-Ethernet1/0/1] quit
```

2 Configure Switch B

Because Switch B comes from another vendor, the commands involved may differ from those for S5500 switches. So only the operations are listed, as shown below:

- Configure Ethernet3/1/1 and Ethernet3/1/2 ports of Switch B to be trunk ports.
- Add the two ports to VLAN 10.

The following describes how a packet is forwarded from Switch A to Switch C.

- As the Ethernet1/0/1 port of Switch A is a VLAN-VPN port, when a packet reaches Ethernet1/0/1 port of Switch A, it is tagged with the default VLAN tag of the port (VLAN 10, the outer tag) and is then forwarded to Ethernet1/0/2 port.
- Because Ethernet1/0/2 port is a VLAN-VPN uplink port with a TPID of 0x9100, Switch A changes the TPID value in the outer VLAN Tag of the packet to 0x9100 and forwards the packet to the public network.
- The packet reaches Ethernet3/1/2 port of Switch B. Switch B sends the packet to its Ethernet3/1/1 port to enable the packet being forwarded in VLAN 10.
- The packet is forwarded from Ethernet3/1/1 port of Switch B to the network on the other side and enters Ethernet1/0/2 port of Switch C, Switch C sends the packet to its Ethernet1/0/1 port by forwarding the packet in VLAN 10. As Ethernet1/0/1 port is an access port, Switch C strips off the outer VLAN tag of the packet and restores the original packet.

It is the same case when a packet travel from Switch C to Switch A.

After the configuration, the networks connecting Switch A and Switch C can receive data packets from each other.

9

DHCP OVERVIEW

Introduction to DHCP

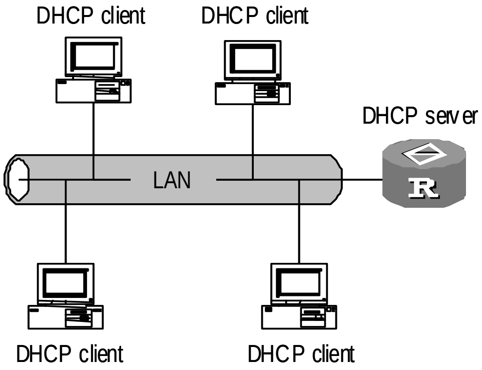
With networks getting larger in size and more complicated in structure, lack of available IP addresses becomes the common situation the network administrators have to face, and network configuration becomes a tough task for the network administrators. With the emerging of wireless networks and the using of laptops, the position change of hosts also requires new technology. Dynamic host configuration protocol (DHCP) is developed in this background.

Similar to BOOTP, DHCP adopts a client/server model, where DHCP clients send requests to DHCP servers for configuration parameters such as IP addresses, subnet masks, and default gateway IP addresses; and the DHCP servers returns the corresponding configuration information. Both BOOTP and DHCP are encapsulated with UDP. They adopt almost the same packet format.

BOOTP is suitable for relatively stable networks where hosts have fixed positions. When using BOOTP, the administrators need to configure a BOOTP parameter file for each host and will not change the file frequently. In comparison with BOOTP, DHCP assigns IP addresses to hosts dynamically and quickly; that is, IP addresses are not statically assigned.

A typical DHCP application includes one DHCP server and multiple clients (such as PCs and laptops), as shown in Figure 32.

Figure 32 Typical DHCP application



DHCP IP Address Assignment

This section contains information on DHCP IP Address Assignments.

IP Address Assignment Policy

Currently, DHCP provides the following three IP address assignment policies to meet the requirements of different clients:

- Manual assignment. The administrator statically binds IP addresses to the few clients with special uses (such as WWW server). Then the DHCP server assigns these fixed IP addresses to the clients.
- Automatic assignment. The DHCP server assigns IP addresses to DHCP clients when they first connect to the network. The IP addresses will be occupied by the DHCP clients permanently.
- Dynamic assignment. The DHCP server leases IP addresses for predetermined period of time and reclaims them at the expiration of the period. In this case, a DHCP client must apply for an IP address regularly. This policy is suitable for temporarily IP address requests and is applied to most clients.

DHCP IP Address Preferences

The order in which a DHCP server assigns IP addresses to DHCP clients are as follows:

- IP addresses that are statically bound to the MAC addresses of DHCP clients
- IP addresses that are reclaimed by DHCP servers. That is, those in the Option fields of DHCP-REQUEST packets sent by DHCP clients
- The IP addresses in the DHCP address pool
- IP addresses that are expired or conflict

Sending Device Information through DHCP Option60

As a DHCP extended option defined in RFC2132, Option60 is used to send the device information of a client through a DHCP request packet. When requesting for an IP address, a DHCP client adds the manufacturer name, product type, and other information of this device to the Option60 field of a DHCP request packet and sends the packet to the DHCP server. You cannot change this device information, which is controlled by host software.

Table 109 lists the device information provided by 5500 series Ethernet switches through DHCP requests.

Table 109 Device information that 5500 series Ethernet switches add to DHCP Option60

Model	Device information in Option60
5500-SI 28-Port	3Com-Switch-5500-SI
5500-SI 52-Port	3Com-Switch-5500-SI
5500-EI 28-Port	3Com-Switch-5500-EI
5500-EI 52-Port	3Com-Switch-5500-EI
5500-EI PWR 28-Port	3Com-Switch-5500-EI
5500-EI PWR 52-Port	3Com-Switch-5500-EI
5500-EI 28-Port FX	3Com-Switch-5500-EI
5500G-EI 24-Port	3Com-Switch-5500G-EI
5500G-EI 48-Port	3Com-Switch-5500G-EI
5500G-EI PWR 24-Port	3Com-Switch-5500G-EI
5500G-EI PWR 48-Port	3Com-Switch-5500G-EI
5500G-EI SFP 24-Port	3Com-Switch-5500G-EI

10 DHCP SERVER CONFIGURATION

Introduction to DHCP Server

This section contains configuration introduction on DHCP Server.

Usage of DHCP Server

Generally, DHCP servers are used in the following networks to assign IP addresses:

- Large-sized networks, where manual configuration method bears heavy load and is difficult to manage the whole network in centralized way.
- Networks where the number of available IP addresses is less than that of the hosts. In this type of networks, IP addresses are not enough for all the hosts to obtain a fixed IP address, and the number of on-line users is limited (such is the case in an ISP network). In these networks, a great number of hosts must dynamically obtain IP addresses through DHCP.
- Networks where only a few hosts need fixed IP addresses and most hosts do not need fixed IP addresses.

DHCP Fundamentals

Obtain IP address dynamically

A DHCP client undergoes the following four phases to dynamically obtain an IP address from a DHCP server.

- Discover: The DHCP client tries to find a DHCP server by broadcasting a DHCP-DISCOVER packet.
- Offer: Each DHCP server that receives the DHCP-DISCOVER packet chooses an unassigned IP address from the address pool and sends a DHCP-OFFER packet (which carries the IP address and other configuration information) to the DHCP client.
- Select: If more than one DHCP server sends a DHCP-OFFER packet to the DHCP client, the DHCP client only accepts the DHCP-OFFER packet that first arrives, and then broadcasts a DHCP-REQUEST packet containing the assigned IP address carried in the DHCP-OFFER packet.
- Acknowledge: Upon receiving the DHCP-REQUEST packet, the DHCP server returns a DHCP-ACK packet to the DHCP client to confirm the assignment of the IP address to the client, or returns a DHCP-NAK packet to refuse the assignment of the IP address to the client. When the client receives the DHCP-ACK packet, it broadcasts an ARP packet with the assigned IP address as the destination address to detect the assigned IP address, and uses the IP address only if it does not receive any response within a specified period.

The IP addresses offered by other DHCP servers (if any) are not used by the DHCP client and are still available to other clients.

IP address lease update

After a DHCP server dynamically assigns an IP address to a DHCP client, the IP address keeps valid only within a specified lease time and will be reclaimed by the DHCP server when the lease expires. If the DHCP client wants to use the IP address for a longer time, it must update the IP lease.

By default, a DHCP client updates its IP address lease automatically by sending a DHCP-REQUEST packet to the DHCP server when half of the lease time elapses. The DHCP server, in turn, responds with a DHCP-ACK packet to notify the DHCP client of a new IP lease if the server can assign the same IP address to the client. Otherwise, the DHCP server responds with a DHCP-NAK packet to notify the DHCP client that the IP address will be reclaimed when the lease time expires.

XRN support

In an XRN (expandable resilient networking) system, DHCP servers operate in a centralized way to fit the XRN environment.

- DHCP servers run (as tasks) on all the units (including the master unit and the slave units) in a Fabric system. But only the one running on the master unit receives/sends packets and carries out all functions of a DHCP server. Those running on the slave units only operate as the backup tasks of the one running on the master unit.
- When a slave unit receives a DHCP-REQUEST packet, it redirects the packet to the DHCP server on the master unit, which returns a DHCP-ACK/DHCP-NAK packet to the DHCP client and at the same time backs up the related information to the slave units. In this way, when the current master unit fails, one of the slaves can change to the master and operates as the DHCP server immediately.
- DHCP is an UDP-based protocol operating at the application layer. When a DHCP server in a fabric system runs on a Layer 2 network device, DHCP packets are directly forwarded by hardware instead of being delivered to the DHCP server, or being redirected to the master unit by UDP HELPER. This idles the DHCP server. DHCP packets can be redirected to the DHCP server on the master unit by UDP HELPER only when the Layer 2 device is upgraded to a Layer 3 device.

When you merge two or more XRN systems into one XRN system, a new master unit is elected, and the new XRN system adopts new configurations accordingly. This may result in the existing system configurations (including the address pools configured for the DHCP servers) being lost. As the new XRN system cannot inherit the original DHCP server configurations, you need to perform DHCP server configurations for it.

When an XRN system is split into multiple new XRN systems, some of the new XRN systems may be degraded to Layer 2 devices. For a new XRN system degraded to Layer 2 device, although the original DHCP server still exists in the new system, it run idle for being unable to receive any packets. When the XRN system restores to a Layer 3 device due to being merged into a new XRN system, it adopts the configurations on the new XRN system. And you need to perform DHCP server configurations if the new XRN system does not have DHCP server-related configurations.

In an XRN system, the UDP HELPER function must be enabled on the DHCP servers that are in fabric state.

After DHCP server is enabled on a device, the device processes the DHCP packet received from a DHCP client in one of the following three modes depending on your configuration.

DHCP Packet Processing Modes

- Global address pool: In response to the DHCP packets received from DHCP clients, the DHCP server picks IP addresses from its global address pools and assigns them to the DHCP clients.
- Interface address pool: In response to the DHCP packets received from DHCP clients, the DHCP server picks IP addresses from the interface-based address pools and assigns them to the DHCP clients.
- Trunk: DHCP packets received from DHCP clients are forwarded to an external DHCP server, which in turn assigns IP addresses to the DHCP clients.

You can specify the mode to process DHCP packets. Note that an interface can operate in only one mode at a given time; and a newly configured mode overwrites the existing mode.

This chapter covers the configuration of the first two modes. The configuration of the trunk mode is covered in Chapter 3 "DHCP Relay Configuration".

DHCP Address Pool

A DHCP address pool holds the IP addresses to be assigned to DHCP clients. When a DHCP server receives a DHCP request from a DHCP client, it selects an address pool depending on the configuration, picks an IP address from the pool and sends the IP address and other related parameters (such as the IP address of the DNS server, and the lease time of the IP address) to the DHCP client. You can configure multiple address pools for one DHCP server. Currently, a DHCP server supports up to 128 global address pools.

Types of address pool

The address pools of a DHCP server fall into two types: global address pool and interface address pool.

- A global address pool is created by executing the dhcp server ip-pool command in system view. It is valid on the current device.
- If an interface is configured with a valid unicast IP address, you can create an interface-based address pool for the interface by executing the dhcp select interface command in interface view. The IP addresses an interface address pool holds belong to the network segment the interface resides in and are available to the interface only.

The structure of an address pool

The address pools of a DHCP server are hierarchically organized in a tree-like structure. The root holds the IP address of the network segment, the branches hold the subnet IP addresses, and the leaves holds the IP addresses that are manually bound to specific clients. The address pools that are of the same level are sorted by their configuration precedence order. Such a structure enables configurations to be inherited. That is, the configurations of the network segment can be inherited by its subnets, whose configurations in turn can be inherited by their client address. So, for the parameters that are common to the whole network segment or some subnets (such as domain name), you just need to configure them on the network segment or the corresponding subnets. The following is the details of configuration inheritance.

- A newly created child address pool inherits the configurations of its parent address pool.
- For an existing parent-child address pool pair, when you performs a new configuration on the parent address pool:

a The child address pool inherits the new configuration if there is no corresponding configuration on the child address pool.

b The child address pool does not inherit the new configuration if there is already a corresponding configuration on the child address pool.

Global Address Pool-Based DHCP Server Configuration

This section contains configuration information for Pool-Based DHCP Server.

Configuration Overview

Table 110 Global address pool-based DHCP server configuration

Operation		Description	Related section
Enable DHCP		Required	Enabling DHCP
Configure global address pool mode on interface(s)		Optional	Configuring Global Address Pool Mode on Interface(s)
Configure the interface(s) to operate in global address pool mode	Configure to bind IP address statically to a DHCP client	One among these two options is required.	Configuring How to Assign IP Addresses in a Global Address Pool
	Configure to assign IP addresses dynamically		
Configure DNS services for DHCP clients		Optional	Configuring DNS Services for DHCP Clients
Configure NetBIOS services for DHCP clients		Optional	Configuring NetBIOS Services for DHCP Clients
Customize DHCP service		Optional	Customizing DHCP Service
Configure the gateway IP address for DHCP clients		Optional	Configuring Gateway Addresses for DHCP Clients

Enabling DHCP

You need to enable DHCP before performing other DHCP-related configurations, which take effect only when DHCP is enabled.

Table 111 2-2 Enable DHCP

Operation	Command	Description
Enter system view	**system-view**	-
Enable DHCP	**dhcp enable**	Required By default, DHCP is enabled.

Configuring Global Address Pool Mode on Interface(s)

You can configure the global address pool mode on the specified or all interfaces of a DHCP server. After that, when the DHCP server receives DHCP packets from DHCP clients through these interfaces, it assigns IP addresses in local global address pools to the DHCP clients.

Table 112 Configure the global address pool mode on interface(s)

Operation		Command	Description
Enter system view		system-view	-
Configure the specified interface(s) or all interfaces to operate in global address pool mode	On one specified interface	**interface** interface-type interface-number	Optional By default, a DHCP server assigns the IP addresses of the local global address pool to DHCP clients in response to DHCP packets received from DHCP clients.
		dhcp select global	
		quit	
	On multiple specified interfaces or all interfaces	**dhcp select global** { **interface** interface-type interface-number [**to** interface-type interface-number] | all }	

Configuring How to Assign IP Addresses in a Global Address Pool

You can specify to bind an IP address in a global address pool statically to a DHCP client or assign IP addresses in the pool dynamically to DHCP clients as needed. But the two address assignment ways cannot coexist in one DHCP address pool.

For dynamic IP address assigning, you need to specify the range of the IP addresses to be dynamically assigned. But for static IP address binding, you can consider an IP address statically bound to a DHCP client coming from a special DHCP address pool that contains only one IP address.

Configuring to assign IP addresses by static binding

Some DHCP clients, such as WWW servers, need fixed IP addresses. This can be achieved by binding IP addresses to the MAC addresses of these DHCP clients. When such a DHCP client applies for an IP address, the DHCP server searches for the IP address corresponding to the MAC address of the DHCP client and assigns the IP address to the DHCP client. Currently, only one IP address in a global DHCP address pool can be statically bound to a MAC address.

Table 113 Configure to assign IP addresses by static binding

Operation		Command	Description
Enter system view		**System-view**	-
Create a DHCP address pool and enter DHCP address pool view		**dhcp server ip-pool** *pool-name*	Required By default, no global DHCP address pool is created.
Bind an IP address to the MAC address of a DHCP client statically	Configure the IP address to be statically bound	**static-bind ip-address** *ip-address [mask-length* | **mask** *mask*]	Required By default, no IP address is statically bound to a MAC address.
	Configure the MAC address to which the MAC address is to be bound	static-bind mac-address mac-address	

The static-bind ip-address command and the static-bind mac-address command must be coupled.

The static-bind ip-address command and the static-bind mac-address command can be executed repeatedly. In this case, the new configuration overwrites the previous one.

Configuring to assign IP addresses dynamically

IP addresses dynamically assigned to DHCP clients (including those that are permanently leased and those that are temporarily leased) belong to addresses segments that are previously specified. Currently, an address pool can contain only one address segment, whose ranges are determined by the subnet mask.

To avoid IP address conflicts, the IP addresses to be dynamically assigned to DHCP clients are those that are not occupied by specific network devices (such as gateways and FTP servers).

The lease time can differ with address pools. But that of the IP addresses of the same address pool are the same. Lease time is not inherited.

Table 114 Configure to assign IP addresses dynamically

Operation	Command	Description
Enter system view	**system-view**	-
Create a DHCP address pool and enter DHCP address pool view	**dhcp server ip-pool** *pool-name*	Required By default, no DHCP address pool is created.
Set the IP address segment whose IP address are to be assigned dynamically	**network** *ip-address [mask-length* | **mask** *mask*]	Required By default, no IP address segment is set. That is, no IP address is available for being assigned.
Configure the lease time	**expired** { **day** *day* [**hour** *hour* [**minute** *minute*]] | **unlimited** }	Optional The default lease time is one day.
Return to system view	**Quit**	-
Specify the IP addresses that are not dynamically assigned	**dhcp server forbidden-ip** *low-ip-address [high-ip-address*]	Optional By default, all IP addresses in a DHCP address pool are available for being dynamically assigned.

The network command can be executed repeatedly. In this case, the new configuration overwrites the previous one.

The dhcp server forbidden-ip command can be executed repeatedly. That is, you can repeatedly configure IP addresses that are not dynamically assigned to DHCP clients.

Configuring DNS Services for DHCP Clients

If a host accesses the Internet through domain names, DNS (domain name system) is needed to translate the domain names into the corresponding IP addresses. To enable DHCP clients to access the Internet through domain names, a DHCP server is required to provide DNS server addresses while assigning IP addresses to DHCP clients. Currently, you can configure up to eight DNS server addresses for a DHCP address pool.

You can configure domain names to be used by DHCP clients for address pools. After you do this, the DHCP server provides the domain names to the DHCP clients as well while the former assigns IP addresses to the DHCP clients.

Table 115 Configure DNS services for DHCP clients

Operation	Command	Description
Enter system view	**system-view**	-
Create a DHCP address pool and enter DHCP address pool view	**dhcp server ip-pool** *pool-name*	Required By default, no global DHCP address pool is created.
Configure a domain name for DHCP clients	**domain-name** *domain-name*	Required By default, no domain name is configured for DHCP clients.
Configure DNS server addresses for DHCP clients	**dns-list** *ip-address&<1-8>*	Required By default, no DNS server address is configured.

Configuring NetBIOS Services for DHCP Clients

For Microsoft Windows-based DHCP clients that communicate through NetBIOS protocol, the host name-to-IP address translation is carried out by WINS (Windows internet naming service) servers. So you need to perform WINS-related configuration for most Windows-based hosts. Currently, you can configure up to eight NetBIOS addresses for a DHCP address pool.

Host name-to-IP address mappings are needed for DHCP clients communicating through NetBIOS protocol. According to the way to establish the mapping, NetBIOS nodes fall into the following four categories:

- B-node. Nodes of this type establish their mappings through broadcasting. (The character b stands for the word broadcast.)
- P-node. Nodes of this type establish their mappings by communicating with NetBIOS servers. (The character p stands for peer-to-peer.)
- M-node. Nodes of this type are p-nodes mixed with broadcasting features. (The character m stands for the word mixed.)
- H-node. Nodes of this type are b-nodes mixed with peer-to-peer features. (The character h stands for the word hybrid.)

Table 116 Configure NetBIOS services for DHCP clients

Operation	Command	Description
Enter system view	system-view	-
Create a DHCP address pool and enter DHCP address pool view	dhcp server ip-pool pool-name	Required By default, no global DHCP address pool is created.
Configure NetBIOS server addresses for DHCP clients	nbns-list ip-address&<1-8>	Required By default, no NetBIOS server address is configured.
Configure DHCP clients to be of a specific NetBIOS node type	netbios-type { b-node | h-node | m-node | p-node }	Optional By default, a DHCP client is an h-node.

Customizing DHCP Service

With the evolution of DHCP, new options are constantly coming into being. You can add the new options as the properties of DHCP servers by performing the following configuration.

Table 117 Customize DHCP service

Operation	Command	Description
Enter system view	**System-view**	-
Create a DHCP address pool and enter DHCP address pool view	**dhcp server ip-pool** *pool-name*	Required By default, no global DHCP address pool is created.
Configure customized options	**option** *code* { **ascii** *ascii-string* | **hex** *hex-string&<1-10>* | **ip-address** *ip-address&<1-8>* }	Required By default, no customized option is configured.

Configuring Gateway Addresses for DHCP Clients

Gateways are necessary for DHCP clients to access servers/hosts outside the current network segment. After you configure gateway addresses on a DHCP server, the DHPC server provides the gateway addresses to DHCP clients as well while assigning IP addresses to them.

You can configure gateway addresses for address pools on a DHCP server. Currently, you can configure up to eight gateway addresses for a DHCP address pool.

Table 118 Configure gateway addresses for DHCP clients

Operation	Command	Description
Enter system view	**system-view**	-
Create a DHCP address pool and enter DHCP address pool view	**dhcp server ip-pool** *pool-name*	Required By default, no global DHCP address pool is created.
Configure gateway addresses for DHCP clients	**gateway-list** *ip-address&<1-8>*	Required By default, no gateway address is configured.

Interface Address Pool-based DHCP Server Configuration

This section contains configuration information for Interface Address Pool-Based DHCP Server

Configuration Overview

An interface address pool is created when the interface is assigned a valid unicast IP address and you execute the dhcp select interface command in interface view. The IP addresses contained in it belong to the network segment where the interface resides in and are available to the interface only.

You can perform certain configurations for DHCP address pools of an interface or multiple interfaces within specified interface ranges. Configuring for multiple interfaces eases configuration work load and makes you to configure in a more convenient way.

Table 119 Overview of interface address pool-based DHCP server configuration

Operation		Description	Related section
Enable DHCP		Required	Enabling DHCP
Configure to assign the IP addresses of the local interface-based address pools to DHCP clients		Required	Configuring to Assign the IP addresses of Local Interface-based address pools to DHCP Clients
Configure to assign IP addresses of interface DHCP address pool to DHCP clients	Configure to bind IP address statically to DHCP clients	One among these two options is required.	Configuring to Assign IP Addresses of Interface-based Address Pools to DHCP Clients
	Configure to assign IP addresses dynamically		
Configure DNS service for DHCP clients		Optional	Configuring DNS Services for DHCP Clients
Configure NetBIOS service for DHCP clients		Optional	Configuring NetBIOS Services for DHCP Clients
Customize DHCP service		Optional	Customizing DHCP Service

Enabling DHCP

You need to enable DHCP before performing DHCP configurations. DHCP-related configurations are valid only when DHCP is enabled.

Table 120 Enable DHCP

Operation	Command	Description
Enter system view	**system-view**	-
Enable DHCP	**dhcp enable**	Required By default, DHCP is disabled.

Configuring to Assign the IP addresses of Local Interface-based address pools to DHCP Clients

You can configure a DHCP server to assign the IP addresses of local interface-based address pools to DHCP clients when it receives DHCP packets from DHCP clients.

Table 121 Configure to assign the IP addresses of local interface-based address pools to DHCP clients

Operation		Command	Description
Enter system view		**system-view**	-
Configure to assign the IP addresses of local interface-based address pools to DHCP clients	Configure the current interface	**interface** *interface-type interface-number*	Required By default, a DHCP server assigns the IP addresses of the local global address pool to DHCP clients in response to DHCP packets received from DHCP clients.
		dhcp select interface	
		quit	
	Configure multiple interfaces	**dhcp select interface** { **interface** *interface-type interface-number* [**to** *interface-type interface-number*] | **all** }	

Configuring to Assign IP Addresses of Interface-based Address Pools to DHCP Clients

You can specify to bind IP addresses statically to DHCP clients or assign IP addresses dynamically to DHCP clients as needed. But the IP addresses of a DHCP address pool can only be assigned in one of these two ways at the same time.

As for dynamic IP address assigning, you need to specify the ranges of IP addresses to be assigned. But for static IP address binding, you can consider an IP address statically bound to a DHCP client to come from a special DHCP address pool that contains only the IP address.

Configuring to assign IP addresses by static binding

Some DHCP clients, such as WWW servers, need to be assigned fixed IP addresses. This is achieved by binding IP addresses to the MAC addresses of these DHCP clients. When a DHCP client that is of this kind applies for an IP address, the DHCP server searches for the IP address corresponding to the MAC address of the DHCP client and then assign the IP address to the DHCP client.

Table 122 Configure to assign IP addresses by static binding

Operation	Command	Description
Enter system view	**system-view**	-
Enter interface view	**interface** *interface-type interface-number*	-
Bind an IP address to the MAC address of a DHCP client statically	**dhcp server static-bind ip-address** *ip-address mac-address mac-address*	Required By default, no IP address is statically bound to a MAC address.

Configuring to assign IP addresses dynamically

As an interface-based address pool is created after the interface is assigned a valid unicast IP address, the IP addresses contained in the address pool belong to the network segment where the interface resides in and are available to the interface only. So specifying the range of the IP addresses to be dynamically assigned is unnecessary.

To avoid IP address conflicts, the IP addresses to be dynamically assigned to DHCP clients are those that are not occupied by specific network devices (such as gateways and FTP servers).

The lease time can differ with address pools. But that of the IP addresses of the same address pool are the same. Lease time is not inherited.

Table 123 Configure to assign IP addresses dynamically

Operation		Command	Description
Enter system view		system-view	-
Configure the lease time	Configure for the current interface	interface interface-type interface-number	Optional The default lease time is one day.
		dhcp server expired { day day [hour hour [minute minute]] | unlimited }	
		quit	
	Configure multiple interfaces	dhcp server expired { day day [hour hour [minute minute]] | unlimited } { interface interface-type interface-number [to interface-type interface-number] | all }	

Table 123 Configure to assign IP addresses dynamically (continued)

Operation	Command	Description
Specify the IP addresses that are not dynamically assigned	dhcp server forbidden-ip low-ip-address [high-ip-address]	Optional By default, all IP addresses in a DHCP address pool are available for being dynamically assigned.

The dhcp server forbidden-ip command can be executed repeatedly. That is, you can repeatedly configure IP addresses that are not dynamically assigned to DHCP clients.

Configuring DNS Services for DHCP Clients

If a host accesses the Internet through domain names, DNS is needed to translate the domain names into the corresponding IP addresses. To enable DHCP clients to access the Internet through domain names, a DHCP server is required to provide DNS server addresses while assigning IP addresses to DHCP clients. Currently, you can configure up to eight DNS server addresses for a DHCP address pool.

You can configure domain names to be used by DHCP clients for address pools. After you do this, the DHCP server provides the domain names to the DHCP clients as well while the former assigns IP addresses to the DHCP clients.

Table 124 Configure DNS services for DHCP clients

Operation		Command	Description
Enter system view		system-view	-
Configure a domain name for DHCP clients	Configure for the current interface	interface interface-type interface-number	Required By default, no domain name is configured for DHCP clients
		dhcp server domain-name domain-name	
		quit	
	Configure for multiple interfaces	dhcp server domain-name domain-name { interface interface-type interface-number [to interface-type interface-number] | all }	
Configure DNS server addresses for DHCP clients	Configure for the current interface	interface interface-type interface-number	Required By default, no DNS server address is configured.
		dhcp server dns-list ip-address&<1-8>	
		quit	
	Configure for multiple interfaces	dhcp server dns-list ip-address&<1-8> { interface interface-type interface-number [to interface-type interface-number] | all }	

Configuring NetBIOS Services for DHCP Clients

For Microsoft Windows-based DHCP clients that communicate through NetBIOS protocol, the host name-to-IP address translation is carried out by WINS servers. So you need to perform WINS-related configuration for most Windows-based hosts. Currently, you can configure up to eight NetBIOS addresses for a DHCP address pool.

Host name-to-IP address mappings are needed for DHCP clients communicating through NetBIOS protocol. According to the way to establish the mapping, NetBIOS nodes fall into the following four categories:

- B-node. Nodes of this type establish their mappings through broadcasting. (The character b stands for the word broadcast.)
- P-node. Nodes of this type establish their mappings by communicating with NetBIOS servers. (The character p stands for peer-to-peer.)
- M-node. Nodes of this type are p-nodes mixed with broadcasting features. (The character m stands for the word mixed.)
- H-node. Nodes of this type are b-nodes mixed with peer-to-peer features. (The character h stands for the word hybrid.)

Table 125 Configure NetBIOS services for DHCP clients

Operation		Command	Description
Enter system view		system-view	-
Configure NetBIOS server addresses for DHCP clients	Configure for the current interface	interface interface-type interface-number	Required By default, no NetBIOS server address is configured.
		dhcp server nbns-list ip-address&<1-8>	
		quit	
	Configure for multiple interfaces	dhcp server nbns-list ip-address&<1-8> { interface interface-type interface-number [to interface-type interface-number] | all }	
Configure DHCP clients to be of a specific NetBIOS node type	Configure for the current interface	interface interface-type interface-number	Required By default, a DHCP client is an h-node.
		dhcp server netbios-type { b-node | h-node | m-node | p-node }	
		quit	
	Configure for multiple interfaces	dhcp server netbios-type { b-node | h-node | m-node | p-node } { interface interface-type interface-number [to interface-type interface-number] | all }	

Customizing DHCP Service

With the evolution of DHCP, new options are constantly coming into being. You can add the new options as the properties of DHCP servers by performing the following configuration.

Table 126 Customize DHCP service

Operation		Command	Description
Enter system view		system-view	-
Configure customized options	Configure for the current interface	interface interface-type interface-number	Required By default, no customized option is configured.
		dhcp server option code { ascii ascii-string | hex hex-string&<1-10> | ip-address ip-address&<1-8> }	
		quit	
	Configure for multiple interfaces	dhcp server option code { ascii ascii-string | hex hex-string&<1-10> | ip-address ip-address&<1-8> } { interface interface-type interface-number [to interface-type interface-number] | all }	

DHCP Security Configuration

DHCP security configuration is needed to ensure the security of DHCP service.

Prerequisites

Before configuring DHCP security, you should first complete the DHCP server configuration (either global address pool-based or interface address pool-based DHCP server configuration).

Configuring Private DHCP Server Detecting

A private DHCP server on a network also answers IP address request packets and assigns IP addresses to DHCP clients. However, the IP addresses they assigned may conflict with those of other hosts and cause users cannot normally access networks. This kind of DHCP servers are known as private DHCP servers.

With the private DHCP server detecting function enabled, a DHCP server tracks the information (such as the IP addresses and interfaces) of DHCP servers to enable the administrator to detect private DHCP servers in time and take proper measures.

Table 127 Enable private DHCP server detecting

Operation	Command	Description
Enter system view	system-view	-
Enable the private DHCP server detecting function	dhcp server detect	Required By default, the private DHCP server detecting function is disabled.

Configuring IP Address Detecting

To avoid IP address conflicts caused by assigning the same IP address to multiple DHCP clients simultaneously, you can configure a DHCP server to detect an IP address before it assigns the address to a DHCP client.

IP address detecting is achieved by performing ping operations. To detect whether or not an IP address is currently in use, the DHCP server sends an ICMP (Internet Control Message Protocol) packet with the IP address to be assigned as the destination and waits for a response. If the DHCP server receives no response within a specified time, it resends an ICMP packet. This procedure repeats on and on until the DHCP server receives a response or the number of the sent ICMP packets reaches the specified maximum number. The DHCP server assigns the IP address to the DHCP client only when no response is received during the whole course. Such a mechanism ensures an IP address is assigned to one DHCP client exclusively.

A DHCP server performs ping tests to detect potential IP address conflicts, while a DHCP client uses ARP packets to detect IP address conflicts

Table 128 Configure IP address detecting

Operation	Command	Description
Enter system view	**system-view**	-
Set the maximum number of ICMP packets a DHCP server sends in a ping test	**dhcp server ping packets** *number*	Optional By default, a DHCP server performs the ping operation twice to test an IP address.
Set the response timeout time of each ICMP packet	**dhcp server ping timeout** *milliseconds*	Optional The default timeout time is 500 milliseconds.

Option 184 Supporting Configuration

Option 184 is an RFC reserved option, and the information it carries can be customized. 3Com defines four proprietary sub-options for this option, enabling the DHCP server to put the information required by a DHCP client in the response packet to the client. The four sub-options of option 184 mainly carry information about voice. The following lists the sub-options and the carried information:

- Sub-option 1: IP address of the network call processor (NCP-IP).
- Sub-option 2: IP address of the alternate server (AS-IP).
- Sub-option 3: Voice VLAN configuration.
- Sub-option 4: Fail-over call routing.

Meanings of the sub-options for option 184

- NCP-IP

  The NCP-IP sub-option carries the IP address of the network call processor (NCP). When used in option 184, this sub-option must be the first sub-option, that is, sub-option 1.

  The IP address of the NCP server carried by sub-option 1 of option 184 is intended for identifying the server acting as the network call controller and the server used for application downloading.

- AS-IP

  The AS-IP sub-option carries the IP address of the alternate server (AS), and is the second sub-option of option 184, that is, sub-option 2. The AS-IP sub-option takes effect only when sub-option 1 (that is, the NCP-IP sub-option) is defined.

  The alternate NCP server identified by sub-option 2 of option 184 acts as the backup of the NCP server and is used only when the IP address carried by the NCP-IP sub-option is unreachable or invalid.

- Voice VLAN Configuration

  The voice VLAN configuration sub-option carries the ID of the voice VLAN and the flag indicating whether the voice VLAN identification function is enabled. This sub-option is the third sub-option of option 184, that is, sub-option 3.

The sub-option 3 of option 184 comprises two parts, which carry the previously mentioned two items respectively. A flag value of 0 indicates that the voice VLAN identification function is not enabled, in which case the information carried by the VLAN ID part will be neglected. A flag value of 1 indicates that the voice VLAN identification function is enabled.

Fail-Over Call Routing

The fail-over call routing sub-option carries the IP address for fail-over call routing and the associated dial number. This sub-option is the fourth sub-option of option 184, that is, sub-option 4.

The IP address for fail-over call routing and the dial number in sub-option 4 of option 184 refer to the IP address and dial number of the session initiation protocol (SIP) peer. When the NCP server and alternate NCP server (if configured) are unreachable, a SIP user can use the configured IP address and dial number of the peer to establish a connection and communicates with the peer SIP user.

For the configurations specifying to add sub-option 2, sub-option 3, and sub-option 4 in the response packets to take effect, you must configure the DHCP server to add sub-option 1.

Mechanism of using option 184 on DHCP server

The DHCP server encapsulates the information for option 184 to carry in the response packets sent to the DHCP clients. Supposing that the DHCP clients are on the same segment as the DHCP server, the mechanism of option 184 support on DHCP server is as follows:

1. A DHCP client sends to the DHCP server a request packet carrying option 55, which indicates the client requests the configuration parameters of option 184.
2. The DHCP server checks the request list in option 55 carried by the request packet, and then adds the sub-options of option 184 in the Options field of the response packet sent to the DHCP client.

Only when the DHCP client specifies in option 55 of the request packet that it requires option 184, does the DHCP server add option 184 in the response packet sent to the client.

Prerequisites

The following are required before you configuring the option 184 supporting function.

- The network parameters, address pools, and lease time are configured.
- The DHCP server and the DHCP clients can communicate properly with each other.

Configuring the Option 184 Supporting Function

You can configure the sub-options of option 184 in system view, interface view, and DHCP address pool view. Note that an interface-based address pool is needed for the first two methods.

Configuring the option 184 supporting function in system view

Table 129 Configure the option 184 supporting function in system view

Operation	Command	Description
Enter system view	system-view	-
Configure the interface to operate in DHCP server mode and assign the IP addresses of a specified interface-based address pool to DHCP clients	**dhcp select interface { all | interface** *interface-type interface-number* [to *interface-type interface-number] }*	Required
Configure the NCP-IP sub-option	**dhcp server voice-config ncp-ip** *ip-address* { **all** | **interface** *interface-type interface-number* [**to** *interface-type interface-number] }*	Required
Configure the AS-IP sub-option	**dhcp server voice-config as-ip** *ip-address* { **all** | **interface** *interface-type interface-number* [**to** *interface-type interface-number*] }	Optional You can configure these three sub-options only after you configure the NCP-IP sub-option.
Configure the voice VLAN configuration sub-option	**dhcp server voice-config voice-vlan** *vlan-id* { **enable** | **disable** } { **all** | **interface** *interface-type interface-number* [**to** *interface-type interface-number*] }	
Configure the Fail-over routing sub-option	**dhcp server voice-config fail-over** *ip-address dialer-string* { **all** | **interface** *interface-type interface-number* [**to** *interface-type interface-number*] }	
Enter the corresponding interface view	**interface** *interface-type interface-number*	To create an interface-based address pool, you need to configure an IP address for the interface.
Configure an IP address for the interface	**ip address** *ip-address net-mask*	

Perform the operations listed in Table 129 if you specify to assign IP addresses of an interface-based address pool to DHCP clients.

This method allows you to configure the option 184 supporting function for multiple interfaces.

Configuring the option 184 supporting function in interface view

Table 130 Configure the option 184 supporting function in interface view

Operation	Command	Description
Enter system view	System-view	-
Enter interface view	interface interface-type interface-number	-
Configure an IP address for the interface	ip address ip-address net-mask	-
Configure the interface to operate in DHCP server mode and assign the IP addresses of an interface-based address pool to DHCP clients	dhcp select interface	Required
Configure the NCP-IP sub-option	dhcp server voice-config ncp-ip ip-address	Required
Configure the AS-IP sub-option	dhcp server voice-config as-ip ip-address	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.
Configure the voice VLAN configuration sub-option	dhcp server voice-config voice-vlan vlan-id { enable | disable }	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.
Configure the Fail-over routing sub-option	dhcp server voice-config fail-over ip-address dialer-string	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.

Perform the operations listed in Table 130 if you specify to assign IP addresses of an interface-based address pool to DHCP clients.

This method allows you to configure the option 184 supporting function for a specific interface.

Configuring the option 184 supporting function in global DHCP address pool view

Table 131 Configure the option 184 supporting function in global DHCP address pool view

Operation	Command	Description
Enter system view	system-view	-
Configure the interface to operate in DHCP server mode and assign the IP addresses of an interface-based address pool to DHCP clients	**dhcp select global** [**subaddress**] { **all** | **interface** *interface-type interface-number* [**to** *interface-type interface-number*] }	Required
Enter DHCP address pool view	**dhcp server ip pool** *pool-name*	-
Configure an IP address range IP addresses in which are dynamically assigned	**network** *ip-address* [**mask** *netmask*]	-
Configure the NCP-IP sub-option	voice-config ncp-ip ip-address	Required
Configure the AS-IP sub-option	voice-config as-ip ip-address	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.
Configure the voice VLAN configuration sub-option	voice-config voice-vlan vlan-id { enable | disable }	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.
Configure the Fail-over routing sub-option	voice-config fail-over ip-address dialer-string	Optional You can configure this sub-option only after you configure the NCP-IP sub-option.

Perform the operations listed in Table 131 if you specify to assign IP addresses of a global DHCP address pool to DHCP clients.

Configuration Example

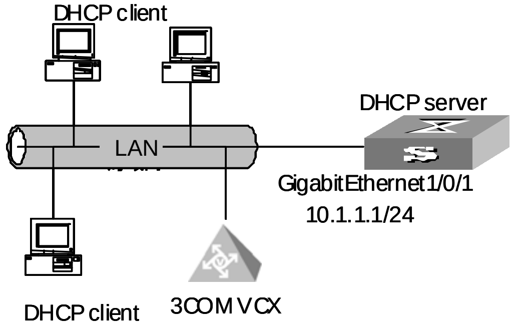
Network requirements

A 3COM VCX device operating as a DHCP client requests the DHCP server for all sub-options of option 184. A S5500 series switch operates as the DHCP server. The option 184 supporting function is configured for a global DHCP address pool. The sub-options of option 184 are as follows:

- NCP-IP: 3.3.3.3
- AS-IP: 2.2.2.2
- Voice VLAN: enabled
- Voice VLAN ID: 1
- Fail-over routing IP: 1.1.1.1
- Dialer string: 99*

Network diagram

Figure 33 Network diagram for option 184 supporting configuration



Configuration procedure

1 Configure the DHCP client

Configure the 3COM VCX device to operate as a DHCP client and to request for all sub-options of option 184. (Omitted)

2 Configure the DHCP server.

a Enter system view.

```
<S5500> system-view
```

b Add Ethernet1/0/1 port to VLAN 2 and and configure the IP address of VLAN 2 interface to be 10.1.1.1/24.

```
[S5500] vlan 2
[S5500-vlan2] port Ethernet1/0/1
[S5500-vlan2] quit
[S5500] interface vlan-interface 2
[S5500-Vlan-interface2] ip address 10.1.1.1 255.255.255.0
[S5500-Vlan-interface2] quit
```

c Configure VLAN 2 interface to operate in the DHCP server mode.

```
[S5500] dhcp select global interface vlan-interface 2
```

d Enter DHCP address pool view.

```
[S5500] dhcp server ip-pool 123
```

e Configure sub-options of option 184 in global DHCP address pool view.

```
[S5500-dhcp-pool-123] network 10.1.1.1 mask 255.255.255.0
[S5500-dhcp-pool-123] voice-config as-ip 2.2.2.2
[S5500-dhcp-pool-123] voice-config ncp-ip 3.3.3.3
[S5500-dhcp-pool-123] voice-config voice-vlan 1 enable
[S5500-dhcp-pool-123] voice-config fail-over 1.1.1.1 99*
```

DHCP Server Displaying and Debugging

You can verify your DHCP-related configuration by executing the display command in any view.

To clear the information about DHCP servers, execute the reset command in user view.

Table 132 Display and debug a DHCP server

Operation	Command
Display the statistics on IP address conflicts	**display dhcp server conflict** { **all** | **ip** *ip-address* }
Display lease expiration information	**display dhcp server expired** { **ip** *ip-address* | **pool** [*pool-name*] | **interface** [*interface-type interface-number*] **all** }
Display the free IP addresses	**display dhcp server free-ip**
Display information about address binding	**display dhcp server ip-in-use** { **ip** *ip-address* | **pool** [*pool-name*] | **interface** [*interface-type interface-number*] **all** }
Display the statistics on a DHCP server	**display dhcp server statistics**
Display information about DHCP address pool tree	**display dhcp server tree** { **pool** [*pool-name*] | **interface** [*interface-type interface-number*] | **all** }
Clear IP address conflict statistics	**reset dhcp server conflict** { **all** | **ip** *ip-address* }
Clear dynamic address binding information	**reset dhcp server ip-in-use** { **ip** *ip-address* | **pool** [*pool-name*] | **interface** [*interface-type interface-number*] | **all** }
Clear the statistics on a DHCP server	**reset dhcp server statistics**

Executing the save command will not save the lease information on a DHCP server to the flash memory. Therefore, the configuration file contains no lease information after the DHCP server restarts or you clear the lease information by executing the reset dhcp server ip-in-use command. In this case, any lease-update requests will be denied, and the clients must apply for IP addresses again.

DHCP Server Configuration Example

Currently, DHCP networking can be implemented in two ways. One is to deploy the DHCP server and DHCP clients in the same network segment. This enables the clients to communicate with the server directly. The other is to deploy the DHCP server and DHCP clients in different network segments. In this case, IP address assigning is carried out through DHCP relay. Note that DHCP configuration is the same in both scenarios.

Network requirements

The DHCP server assigns IP addresses dynamically to the DHCP clients on the same network segment. The network segment 10.1.1.0/24, to which the IP addresses of the address pool belong, is divided into two sub-network segment: 10.1.1.0/25 and 10.1.1.128/25. The switch operating as the DHCP server hosts two VLANs, whose interface IP addresses are 10.1.1.1/25 and 10.1.1.129/25 respectively.

The DHCP settings of the 10.1.1.0/25 network segment are as follows:

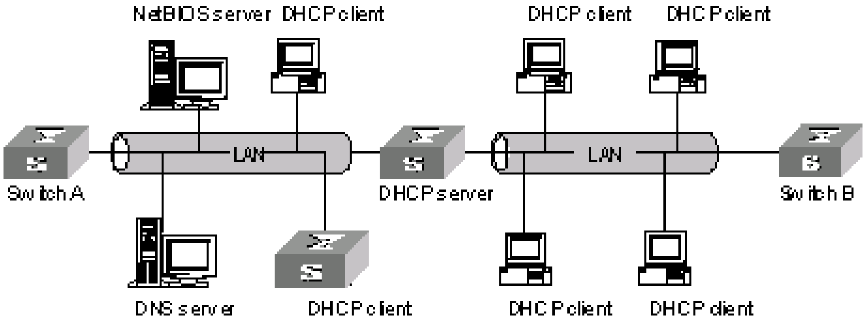
- Lease time: 10 days plus 12 hours
- Domain name: aabbcc.com
- DNS server: 10.1.1.2
- NetBIOS server: none
- Gateway: 10.1.1.126

The DHCP settings of the 10.1.1.128/25 network segment are as follows:

- Lease time: 5 days
- Domain name: aabbcc.com
- DNS server: 10.1.1.2
- NetBIOS server: 10.1.1.4
- Gateway: 10.1.1.254

Network diagram

Figure 34 Network diagram for DHCP configuration



Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Enable DHCP.

```
[S5500] dhcp enable
```

3 Configure the IP addresses that are not dynamically assigned. (That is, the IP addresses of the DNS server, NetBIOS server, and gateways.)

```
[S5500] dhcp server forbidden-ip 10.1.1.2
[S5500] dhcp server forbidden-ip 10.1.1.4
[S5500] dhcp server forbidden-ip 10.1.1.126
[S5500] dhcp server forbidden-ip 10.1.1.254
```

4 Configure DHCP address pool 1, including address range, domain name, DNS server address, gateway address, and lease time.

```
[S5500] dhcp server ip-pool 1
[S5500-dhcp-pool-1] network 10.1.1.0 mask 255.255.255.128
[S5500-dhcp-pool-1] domain-name aabbcc.com
[S5500-dhcp-pool-1] dns-list 10.1.1.2
[S5500-dhcp-pool-1] gateway-list 10.1.1.126
[S5500-dhcp-pool-1] expired day 10 hour 12
```

5 Return to system view.

```
[S5500-dhcp-pool-1] quit
```

6 Configure DHCP address pool 2, including address range, domain name, DNS server address, lease time, NetBIOS server address, and gateway address.

```
[S5500] dhcp server ip-pool 2
[S5500-dhcp-pool-2] network 10.1.1.128 mask 255.255.255.128
[S5500-dhcp-pool-2] domain-name aabbcc.com
[S5500-dhcp-pool-2] dns-list 10.1.1.2
[S5500-dhcp-pool-2] expired day 5
[S5500-dhcp-pool-2] nbns-list 10.1.1.4
[S5500-dhcp-pool-2] gateway-list 10.1.1.254
```

Troubleshooting DHCP Server

Symptom

The IP address dynamically assigned by a DHCP server to a client conflicts with the IP address of another host.

Analysis

With DHCP enabled, IP address conflicts are usually caused by IP addresses that are manually configured on hosts.

Solution

- Disconnect the DHCP client from the network and then check whether there is a host using the conflicting IP address by performing ping operation on another host on the network, with the conflicting IP address as the destination and an enough timeout time.
- The IP address is manually configured on a host if you receive a response packet of the ping operation. You can then disable the IP address from being dynamically assigned by using the dhcp server forbidden-ip command.
- Attach the DHCP client to the network, release the dynamically assigned IP address and apply an IP address again. (You can release a dynamically assigned IP address by executing the winipcfg command in Windows 98 or by executing the ipconfig/release command in Windows 2000/XP. You can refresh the IP address by using the ipconfig/release_all and ipconfig/renew_all commands in DOS.)

11 DHCP RELAY CONFIGURATION

Introduction to DHCP Relay

This section contains an introduction to DHCP Relay

Usage of DHCP Relay

Early DHCP implementations assumes that DHCP clients and DHCP servers are on the same network segment, that is, you need to deploy at least one DHCP server for each network segment, which is far from economical.

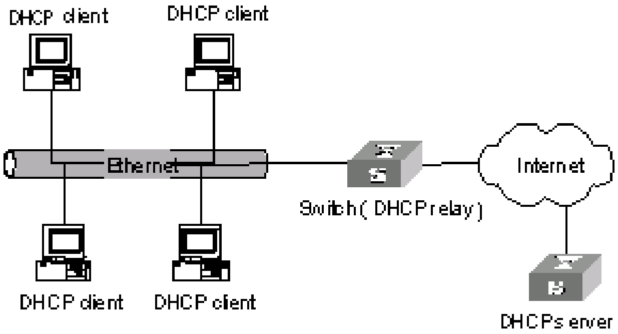
DHCP Relay is designed to address this problem. It enables DHCP clients of multiple networks to share a common DHCP server, through which DHCP clients in a LAN can acquire IP addresses by negotiating with DHCP servers of other networks. It decreases your cost and provides a centralized administration.

A DHCP relay can be a host or a switch that has DHCP relay service enabled.

DHCP Relay Fundamentals

Figure 35 illustrates a typical DHCP relay application.

Figure 35 Typical DHCP relay application



A DHCP relay works as follows:

- A DHCP client broadcasts a configuration request packet in the local network when it starts and initiates.
- If a DHCP server exists in the local network, it processes the configuration request packet directly without the help of a DHCP relay.
- If no DHCP server exists in the local network, the network device serving as a DHCP relay on this network appropriately processes the configuration request packet and forwards it to a specified DHCP server located on another network.
- When the DHCP server receives the packet, it generates configuration information accordingly and sends it to the DHCP client through the DHCP relay to complete the dynamic configuration of the DHCP client.

Note that such an interacting process may be repeated several times for a DHCP client to be successfully configured.

Actually, a DHCP relay enables DHCP clients and DHCP servers on different networks to communicate with each other by forwarding the DHCP broadcasting packets transparently between them.

DHCP Relay Configuration

If a switch belongs to a fabric, you need to enable the UDP-helper function on it before configure it to be a DHCP relay.

DHCP Relay Configuration Tasks

Table 133 DHCP relay configuration tasks

Operation	Description	Related section
Enable DHCP	Required	Enabling DHCP
Configure an interface to operate in DHCP relay mode	Required	Configuring an Interface to Operate in DHCP Relay Mode
Configure DHCP relay security	Required	Configuring an Interface to Operate in DHCP Relay Mode

Enabling DHCP

Be sure to enable DHCP before you perform other DHCP relay-related configuration, for other DHCP-related configurations cannot take effect with DHCP disabled.

Table 134 Enable DHCP

Operation	Command	Description
Enter system view	system-view	-
Enable DHCP	dhcp enable	Required By default, DHCP is disabled.

Configuring an Interface to Operate in DHCP Relay Mode

There may be multiple DHCP servers deployed in one network. This increases the reliability. Here, you can configure a DHCP server group containing one or multiple DHCP servers.

You can configure an interface to forward DHCP packets received from DHCP clients to a group of external DHCP server(s), so that the DHCP server(s) in this group can assign IP addresses to the DHCP clients under this interface.

Table 135 Configure an interface to operate in DHCP relay mode

Operation	Command	Description
Enter system view	**system-view**	-
Configure the DHCP server IP address(es) in a specified DHCP server group	**dhcp-server groupNo ip** *ip-address1* [*ipaddress-list*]	Required By default, no DHCP server IP address is configured in a DHCP server group.
Map an interface to a DHCP server group	**interface** *interface-type interface-number*	Required By default, a VLAN interface is not mapped to any DHCP server group.
	dhcp-server *groupNo*	

You can configure up to eight external DHCP IP addresses in a DHCP server group.

You can map multiple VLAN interfaces to one DHCP server group. But one VLAN interface can be mapped to only one DHCP server group. If you execute the dhcp-server groupNo command repeatedly, the new configuration overwrites the previous one.

The group number referenced in the dhcp-server groupNo command must has already been configured by using the dhcp-server groupNo ip ipaddress1 [ipaddress-list] command.

DHCP Relay Displaying

You can verify your DHCP relay-related configuration by executing the following display commands in any view.

Table 136 Display DHCP relay information

Operation	Command
Display information about a specified DHCP server group	display dhcp-server groupNo
Display information about the DHCP server group to which a specified VLAN interface is mapped	display dhcp-server interface vlan-interface vlan-id
Display one or all user address entries, or a specified type of entries in the valid user address table of the DHCP server group	display dhcp-security [ip-address | dynamic | static | tracker]

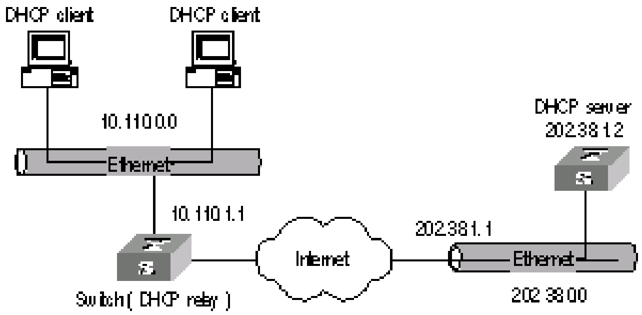
DHCP Relay Configuration Example

Network requirements

The DHCP clients on the network segment 10.110.0.0 (255.255.255.0) are connected to a port of VLAN 2, which has been created on the switch acting as a DHCP relay. The IP address of the DHCP server is 202.38.1.2. DHCP packets between the DHCP clients and the DHCP server are forwarded by the DHCP relay, through which the DHCP clients can obtain IP addresses and related configuration information from the DHCP server.

Network diagram

Figure 36 Network diagram for DHCP relay



Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Enable DHCP.

```
[S5500] dhcp enable
```

3 Create DHCP server group 1 and configure an IP address of 202.38.1.2 for it.

```
[S5500] dhcp-server 1 ip 202.38.1.2
```

4 Map VLAN 2 interface to DHCP server group 1.

```
[S5500] interface vlan-interface 2
[S5500-Vlan-interface2] dhcp-server 1
```

5 Configure an IP address for VLAN 2 interface, so that this interface is on the same network segment with the DHCP clients.)

```
[S5500-Vlan-interface2] ip address 10.110.1.1 255.255.0.0
```

You need to perform corresponding configurations on the DHCP server to enable the DHCP clients to obtain IP addresses from the DHCP server. The DHCP server configurations differ depending on different DHCP server devices and are thus omitted.

Troubleshooting DHCP Relay

Symptom

A client fails to obtain configuration information through a DHCP relay.

Analyse

This problem may be caused by improper DHCP relay configuration. When a DHCP relay operates improperly, you can locate the problem by enabling debugging and checking the information about debugging and interface state (You can display the information by executing the corresponding display command.)

Solution

- Check if an address pool that is on the same network segment with the DHCP clients is configured on the DHCP server.
- Check if a reachable route is configured between the DHCP relay and the DHCP server.
- Check if the DHCP relay has proper relay IP addresses configured on the VLAN interface to which the network segment containing the DHCP clients is connected, and if the configured relay IP addresses conflict.

12 VRRP CONFIGURATION

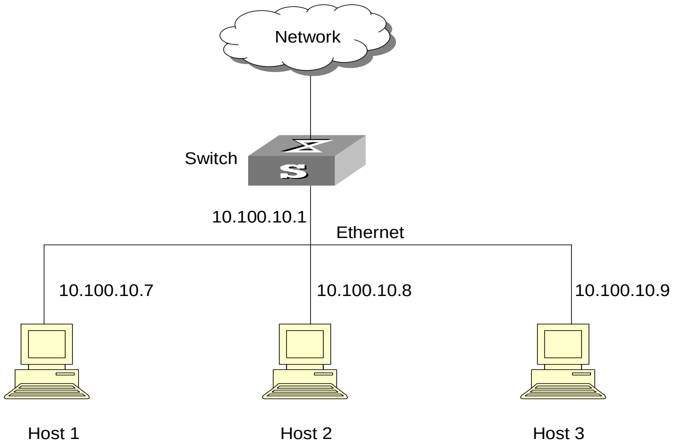
VRRP Overview

Virtual router redundancy protocol (VRRP) is a fault-tolerant protocol.

As shown in Figure 37, in general,

- A default route (for example, the next hop address of the default route is 10.100.10.1, as shown in Figure 37) is configured for every host on a network.
- The packets destined to the external network segments and sourced from these hosts go through the default routes to the Layer 3 Switch, implementing communication between these hosts and the external network.
- If Switch fails, all the hosts on this segment taking Switch as the next-hop through the default routes are cut off from the external network.

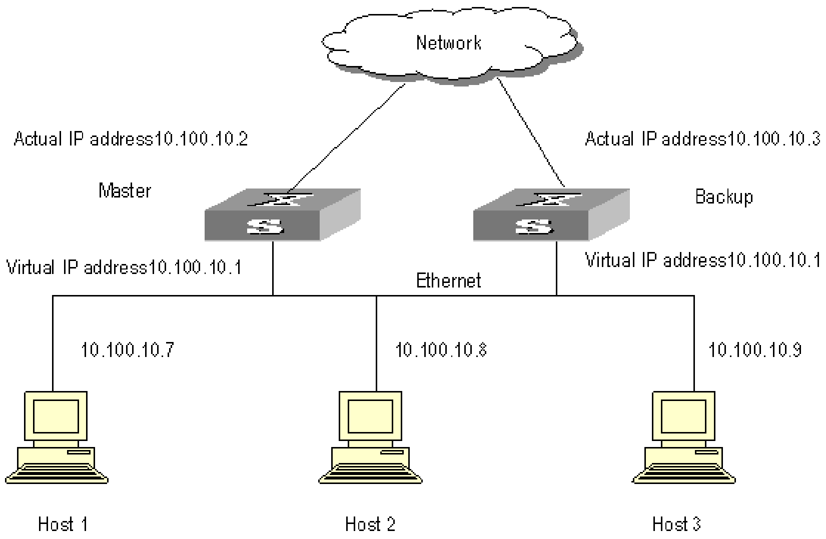
Figure 37 LAN Networking



VRRP, which is designed for LANs with multicast and broadcast capabilities (such as Ethernet) settles the problem caused by switch failures.

VRRP combines a group of LAN switches, including a master switch and several backup switches, into a virtual router, or a backup group.

Figure 38 Virtual router


Network
Actual IP address10.100.10.2
Master
Actual IP address10.100.10.3
Backup
Virtual IP address10.100.10.1
Ethernet
Virtual IP address10.100.10.1
10.100.10.7
10.100.10.8
10.100.10.9
Host 1
Host 2
Host 3

The switches in the backup group have the following features:

- This virtual router has its own IP address: 10.100.10.1 (which can be the interface address of a switch within the backup group).
- The switches within the backup group have their own IP addresses (such as 10.100.10.2 for the master switch and 10.100.10.3 for the backup switch).
- Hosts on the LAN only know the IP address of this virtual router, that is, 10.100.10.1, but not the specific IP addresses 10.100.10.2 of the master switch and 10.100.10.3 of the backup switch.
- Hosts in the LAN use the IP address of the virtual router (that is, 10.100.10.1) as their default next-hop IP addresses.

Therefore, hosts within the network will communicate with the other networks through this virtual router.

If the master switch in the backup group goes down, the backup switch with the highest priority will function as the new master switch to guarantee normal communication between the hosts and the external networks. This ensures the communications between the hosts and the external networks.

Virtual Router Overview

After you enable VRRP on the switches of a backup group, a virtual router is formed. You can perform related configuration on the virtual router.

Configuring a virtual router IP address

The IP address of the virtual router can be an unassigned IP address of the network segment where the backup group is located or the interface IP address of a member switch in the backup group. The virtual router IP address has the following features:

- You can specify the virtual router IP address as the IP address used by a member switch in the backup group. In this case, the switch is called an IP address owner.
- A backup group is established if it is assigned an IP address for the first time. If you then add other IP addresses to the backup group, the IP addresses are added to the virtual router IP address list of the backup group.

- The virtual router IP addresses and the real IP addresses used by the member switches in the backup group must belong to the same network segment. If they are not in the same network segment, the backup group will be in initial state.
- A backup group is removed if its last virtual router IP address is removed from the backup group. If a backup group is removed, all its configurations get ruined.

According to the standard VRRP, you will fail to use the **ping** command to ping the IP address of a virtual router. So the hosts connected to a switch in a backup group cannot judge with **ping** command whether an IP address is used by the backup group. In this case, if the IP address of a host is also used by the virtual router, all packets destined for the network segment will be forwarded to the host.

Before enabling VRRP feature on an SWITCH 5500 series switch, you can enable the switches in a backup group to respond the **ping** operations destined for the virtual router IP addresses. Therefore the above incident can be avoided. If VRRP is already enabled, the system does not support this configuration.

Mapping Virtual IP Addresses to MAC Addresses

You can map MAC addresses to virtual router IP addresses as needed. The MAC address can be a virtual MAC address or the real MAC address of a Layer 3 switch routing interface.

You need to map the IP addresses of the backup group to the MAC addresses before enabling VRRP feature on an SWITCH 5500 series switch. If VRRP is already enabled, the system does not support this configuration.

By default, virtual router IP addresses are mapped to the virtual MAC address of a backup group.

Due to the chips installed, you can configure only one backup group on a VLAN interface of some switches when mapping the virtual IP addresses to the virtual MAC addresses.

Due to the chips installed, you can configure up to 14 backup groups on a VLAN interface of some switches if you map the virtual IP addresses to the real MAC address of a switch.

You can configure on some switches 14 backup groups under both of the above mentioned circumstances.

Introduction to Backup Group

VRRP can group switches in a LAN into a virtual router, which is also known as a backup group.

You can perform the following configuration on an SWITCH 5500 series switch that belongs to a backup group.

- Configuring switch priority
- Configuring preemptive mode for a switch in a backup group
- Configuring authentication type and authentication key for a switch in a backup group
- Configuring VRRP timer
- Configuring the VLAN interfaces to be tracked for a backup group

Configuring switch priority

The status of each switch in a backup group is determined by its priority. The master switch in a backup group is the one currently with the highest priority.

Switch priority ranges from 0 to 255 (a larger number indicates a higher switch priority) and defaults to 100. Note that only 1 through 254 are available to users. Switch priority of 255 is reserved for IP address owners.

The switch priority of an IP address owner is fixed to 255.

Configuring preemptive mode for a switch in a backup group

As long as a switch in the backup group becomes the master switch, other switches, even if they are configured with a higher priority later, do not preempt the master switch unless they operate in preemptive mode. The switch operating in preemptive mode will become the master switch when it finds its priority is higher than that of the current master switch, and the former master switch becomes a backup switch accordingly.

You can configure an SWITCH 5500 series switch to operate in preemptive mode. You can also set the delay period. A backup switch waits for a period of time (the delay period) before becoming a master switch. Setting a delay period aims at:

- In an unstable network, backup switches in a backup group possibly cannot receive packets from the master in time due to network congestions even if the master operates properly. This causes the master of the backup group being determined frequently.
- With the configuration of delay period, the backup switch will wait for a while if it does not receive packets from the master switch in time. The master is redetermined only after the backup switches do not receive packets from the master switch after the specified delay time.

Configuring authentication type and authentication key for a switch in a backup group

VRRP provides following authentication types:

- **simple**: Simple character authentication
- **md5**: MD5 authentication

In a network under possible security threat, the authentication type can be set to **simple**. Then the switch adds the authentication key into the VRRP packets before transmitting them. The receiver will compare the authentication key of the packet with the locally configured one. If they are the same, the packet will be taken as a true and legal one. Otherwise it will be regarded as an illegal packet and be discarded. In this case, a simple authentication key should not exceed eight characters.

In a vulnerable network, the authentication type can be set to **md5**. The switch will use the authentication type and MD5 algorithm provided by the Authentication Header to authenticate the VRRP packets. In this case, you need to set an authentication key comprising up to eight characters or a 24-character encrypted string.

A switch discards the packets that fail to pass the authentication and then sends trap packets to the network management system.

Configuring VRRP timer

The master switch advertises its normal operation state to the switches within the VRRP backup group by sending VRRP packets once in each specified interval (determined by the *adver-interval* argument). If the backup switches do not receive VRRP packets from the master after a specific period (determined by the *master-down-interval* argument), they consider the master is down and initiates the process to determine the master switch.

You can adjust the frequency in which a master sends VRRP packets by setting the corresponding VRRP timers (that is, the *adver-interval* argument). The *master-down-interval* argument is usually three times of the *adver-interval* argument. Excessive network traffic or differences between the timers of different switches will result in *master-down-interval* timing out and state changing abnormally. Such problems can be solved through prolonging the *adver-interval* and setting delay time. If you configure the preemption delay for a backup switch, the switch preempts the master after the period specified by the preemption delay if it does not receive a VRRP packet from the master for the period specified by the *master-down-interval* argument.

Configuring the VLAN interfaces to be tracked for a backup group

The VLAN interface tracking function expands the backup group function. With this function enabled, the backup group function is provided not only when the interface where the backup group resides fails, but also when other interfaces are unavailable. By executing the related command you can track an interface.

When a tracked VLAN interface goes down, the priority of the switch owning the interface will reduce automatically by a specified value (the *value-reduced* argument). If the switches with their priorities higher than that of the current master switch exist in the backup group, a new master switch will be then determined.

VRRP Configuration

The following sections describe the VRRP configuration tasks:

- Configuring a Virtual Router IP address
- Configuring Backup Group-Related Parameters

Configuring a Virtual Router IP address

Table 137 lists the operations to configure a virtual router IP address (suppose you have correctly configured the relation between the port and VLAN):

Table 137 Configure a virtual router IP address

Operation	Command	Description
Enter system view	**system-view**	-
Configure that the virtual IP address can be pinged	Vrrp ping-enable	Optional By default, the virtual IP address cannot be pinged.
Map the virtual router IP address to a MAC address	**Vrrp method** { **real-mac** | **virtual-mac** }	Optional By default, the virtual IP address of a backup group is mapped to a virtual router IP address.
Create a VLAN	**vlan** *vlan-id*	-
Quit to system view	quit	-
Enter VLAN interface view	**interface vlan-interface** *vlan-id*	-

Table 137 Configure a virtual router IP address (continued)

Operation	Command	Description
Configure a virtual router IP address	**vrrp vrid** *virtual-router-ID* **virtual-ip** *virtual-address*	Optional *virtual-router-ID*: VRRP backup group ID. *virtual-address*: Virtual router IP address to be configured.

Configuring Backup Group-Related Parameters

Table 138 lists the operations to configure a switch in a backup group.

Table 138 Configure backup group-related parameters

Operation	Command	Description
Enter system view	**system**-**view**	-
Create a VLAN	**vlan** *vlan-id*	-
Quit to system view	quit	-
Enter VLAN interface view	**interface vlan-interface** *valn-id*	-
Configure the priority of the backup group	**vrrp vrid** *virtual-router-ID* **priority** *priority*	Optional *virtual-router-ID*: Backup group ID *priority*: Priority value
Configure the preemptive mode and delay period for the backup group	**vrrp vrid** *virtual-router-ID* **preempt-mode** [**timer delay** *delay-value*]	Optional *virtual-router-ID*: Backup group ID *delay-value*: Delay value (in seconds) By default, a backup group operates in the preemptive mode.
Configure the authentication type and authentication key	**vrrp authentication-mode** *authentication-type authentication-key*	Optional The value of the *authentication-type* argument can be: n **simple**: Specifies to authenticate using plain text. n **md5**: Performs AH authentication using MD5 algorithm. *authentication-key*: Authentication key. A string comprising of up to 8 characters or a 24-character encrypted string.
Configure the VRRP timer	**vrrp vrid** *virtual-router-ID* **timer advertise** *adver-interval*	Optional *adver-interval*: Interval (in seconds) for the master switch in a backup group to send VRRP packets.
Specify the interface to be tracked	**vrrp vrid** *virtual-router-ID* **track vlan-interface** vlan-id [**reduced** *value-reduced*]	Optional *value-reduced*: Value by which the priority is to be reduced.

Displaying and Clearing VRRP Information

You can execute the **display** command in any view to view VRRP configuration.

Table 139 Display and Clear VRRP Information

Operation	Command	Description
Display VRRP state information and statistics information	**display vrrp** [**interface vlan-interface** *vlan-id* | **statistics** [**vlan-interface** *vlan-id*]] [*virtual-router-ID*]	You can execute the **display vrrp** command in any view
Clear VRRP statistics	**reset vrrp statistics** [**vlan-interface** *vlan-id*] [*virtual-router-ID*]	Execute the **reset** command in user view

VRRP Configuration Example

This section contains examples of VRRP configurations.

Single-VRRP Backup Group Configuration Example

Network requirements

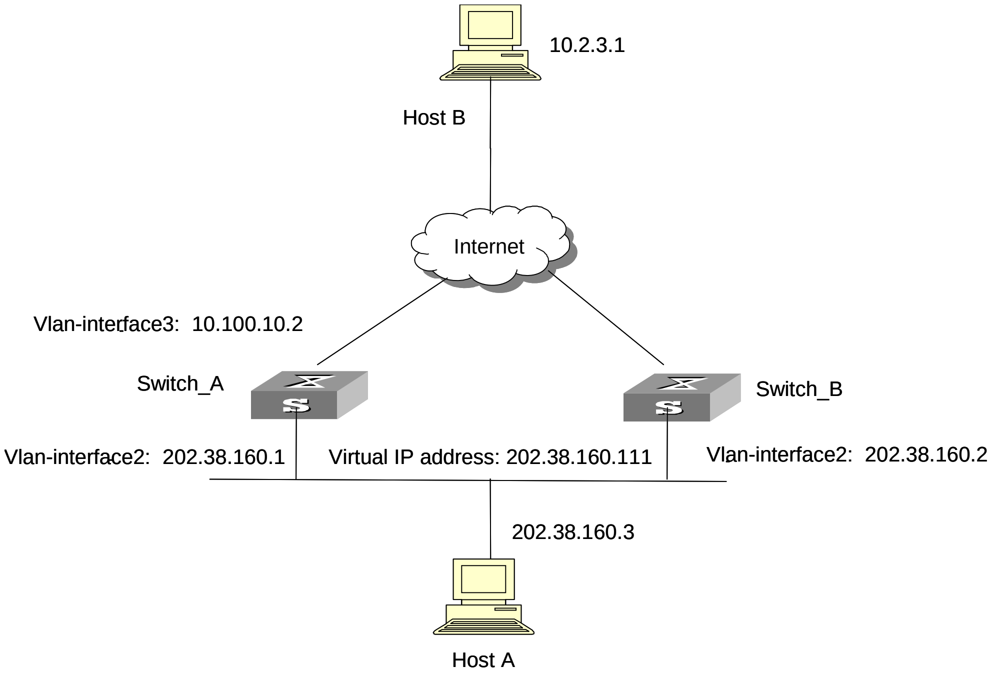
Host A uses the VRRP virtual router comprising switch A and switch B as its default gateway to visit host B on the Internet.

The information about the VRRP backup group is as follows:

- VRRP backup group ID: 1
- Virtual router IP address: 202.38.160.111
- Master switch: Switch A
- Backup switch: Switch B
- Preemptive mode: enabled

Network diagram

Figure 39 Network diagram for single-VRRP backup group configuration


10.2.3.1
Host B
Internet
Vlan-interface3: 10.100.10.2
Switch_A
Switch_B
Vlan-interface2: 202.38.160.1
Virtual IP address: 202.38.160.111
Vlan-interface2: 202.38.160.2
202.38.160.3
Host A

Configuration procedure

1 Configure Switch A.

a Configure VLAN 2.

```
<LSW-A> system-view
System View: return to User View with Ctrl+Z.
[LSW-A] vlan 2
[LSW-A-vlan2] port Ethernet 1/0/6
[LSW-A-vlan2] quit
[LSW-A] interface vlan-interface 2
[LSW-A-Vlan-interface2] ip address 202.38.160.1 255.255.255.0
[LSW-A-Vlan-interface2] quit
```

b Configure VRRP.

```
[LSW-A] vrrp ping-enable
[LSW-A] interface vlan 2
[LSW-A-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
[LSW-A-Vlan-interface2] vrrp vrid 1 priority 110
[LSW-A-Vlan-interface2] vrrp vrid 1 preempt-mode
```

2 Configure Switch B.

a Configure VLAN 2.

```
<LSW-B> system-view
System View: return to User View with Ctrl+Z.
[LSW-B] vlan 2
[LSW-B-Vlan2] port Ethernet 1/0/5
[LSW-B-vlan2] quit
[LSW-B] interface vlan-interface 2
[LSW-B-Vlan-interface2] ip address 202.38.160.2 255.255.255.0
[LSW-B-Vlan-interface2] quit
```

b Configure VRRP.

```
[LSW-B] vrrp ping-enable
[LSW-B] interface vlan 2
[LSW-B-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
[LSW-B-Vlan-interface2] vrrp vrid 1 preempt-mode
```

The IP address of the default gateway of Host A can be configured to be 202.38.160.111.

Normally, Switch A functions as the gateway, but when Switch A is turned off or malfunctions, Switch B will function as the gateway instead.

Configure Switch A to operate in preemptive mode, so that it can resume its gateway function as the master switch after recovery.

VRRP Tracking Interface Example

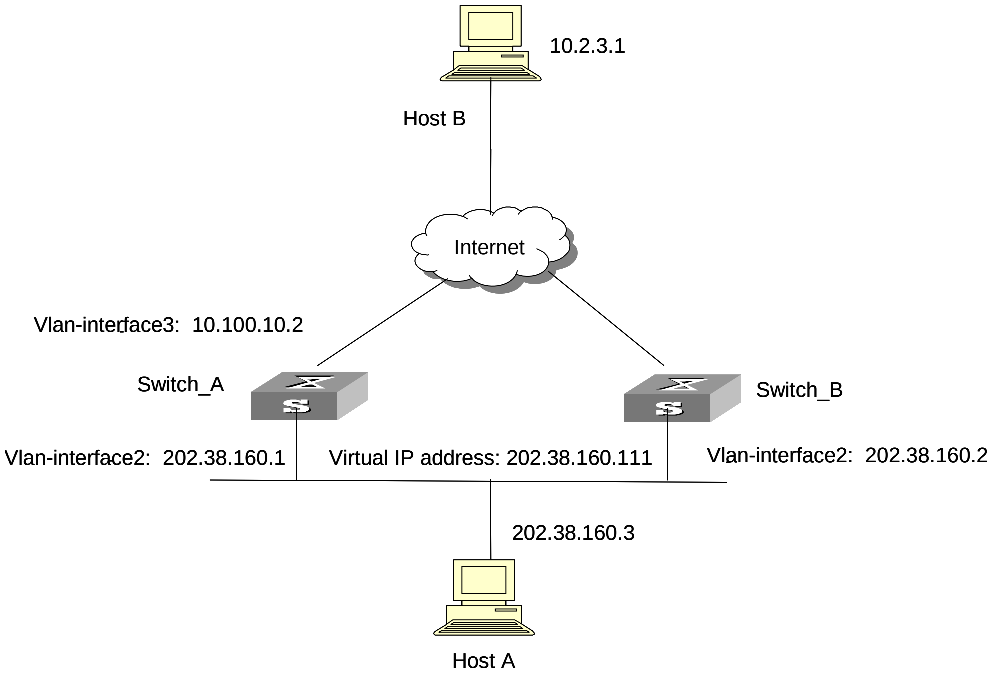
Network requirements

Even when Switch A is still functioning, Switch B can function as a gateway when the interface on Switch A and connecting to Internet does not function properly. This can be implemented by enabling the VLAN interface tracking function.

The VRRP backup group ID is set to 1, with additional configurations of authorization key and timer.

Network diagram

Figure 40 Network diagram for interface tracking configuration


10.2.3.1
Host B
Internet
Vlan-interface3: 10.100.10.2
Switch_A
Switch_B
Vlan-interface2: 202.38.160.1
Virtual IP address: 202.38.160.111
Vlan-interface2: 202.38.160.2
202.38.160.3
Host A

Configuration procedure

1 Configure Switch A.

a Configure VLAN 2.

```
<LSW-A> system-view
System View: return to User View with Ctrl+Z.
[LSW-A] vlan 2
[LSW-A-vlan2] port Ethernet 1/0/6
[LSW-A-vlan2] quit
[LSW-A] interface vlan-interface 2
[LSW-A-Vlan-interface2] ip address 202.38.160.1 255.255.255.0
[LSW-A-Vlan-interface2] quit
```

b Configure that the virtual router can be pinged.

```
[LSW-A ] vrrp ping-enable
```

c Create a backup group.

```
[LSW-A] interface vlan-interface 2
[LSW-A-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
```

d Set the priority for the backup group.

```
[LSW-A-Vlan-interface2] vrrp vrid 1 priority 110
```

e Set the authentication key for the backup group.

```
[LSW-A-Vlan-interface2] vrrp authentication-mode md5 switch
```

f Configure that the master switch to send VRRP packets once in every 5 seconds.

```
[LSW-A-Vlan-interface2] vrrp vrid 1 timer advertise 5
```

g Set the tracked VLAN interface.

```
[LSW-A-Vlan-interface2] vrrp vrid 1 track vlan-interface 3 reduced 
30
```

2 Configure switch B.

a Configure VLAN 2.

```
<LSW-B> system-view
System View: return to User View with Ctrl+Z.
[LSW-B] vlan 2
[LSW-B-vlan2] port Ethernet 1/0/5
[LSW-B-vlan2] quit
[LSW-B] interface vlan-interface 2
[LSW-B-Vlan-interface2] ip address 202.38.160.2 255.255.255.0
[LSW-B-Vlan-interface2] quit
```

b Configure that the virtual router can be pinged.

```
[LSW-B] vrrp ping-enable
```

c Create a backup group.

```
[LSW-B] interface vlan-interface 2
[LSW-B-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
```

d Set the authentication key for the backup group.

```
[LSW-B-Vlan-interface2] vrrp authentication-mode md5 switch
```

e Set the master to send VRRP packets once in every 5 seconds.

```
[LSW-B-Vlan-interface2] vrrp vrid 1 timer advertise 5
```

Normally, Switch A functions as the gateway, but when VLAN 3 interface on Switch A goes down, its priority will be reduced by 30, lower than that of Switch B so that Switch B will preempt the master for gateway services instead.

When VLAN 3 interface recovers, switch A will resume its gateway function as the master.

Multiple-VRRP Backup Group Configuration Example

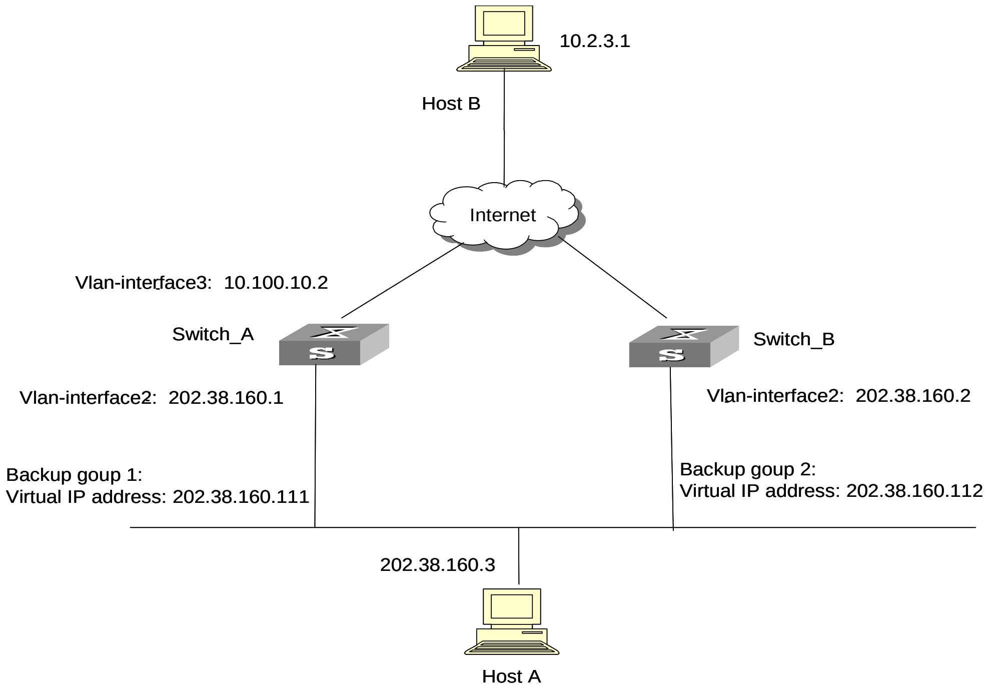
Network requirements

A switch can function as backup switches of multiple backup groups.

Multiple-backup group configuration can implement load balancing. For example, Switch A operates as the master switch of backup group 1 and a backup switch in backup group 2. Similarly, Switch B operates as the master switch of backup group 2 and a backup switch in backup group 1. Some hosts in the network take virtual router 1 as the gateway, while others take virtual router 2 as the gateway. In this way, both load balancing and mutual backup are implemented.

Network diagram

Figure 41 Network diagram for multiple-VRRP backup group configuration


10.2.3.1
Host B
Internet
Vlan-interface3: 10.100.10.2
Switch_A
Switch_B
Vlan-interface2: 202.38.160.1
Vlan-interface2: 202.38.160.2
Backup goup 1:
Virtual IP address: 202.38.160.111
Backup goup 2:
Virtual IP address: 202.38.160.112
202.38.160.3
Host A

Configuration procedure

1 Configure Switch A.

a Configure VLAN 2.

```
<LSW-A> system-view
System View: return to User View with Ctrl+Z.
[LSW-A] vlan 2
[LSW-A-vlan2] port Ethernet 1/0/6
[LSW-A-vlan2] quit
[LSW-A] interface vlan-interface 2
[LSW-A-Vlan-interface2] ip address 202.38.160.1 255.255.255.0
```

b Create backup group 1.

```
[LSW-A-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
```

c Set the priority for backup group 1.

```
[LSW-A-Vlan-interface2] vrrp vrid 1 priority 150
```

d Create backup group 2.

```
[LSW-A-Vlan-interface2] vrrp vrid 2 virtual-ip 202.38.160.112
```

2 Configure Switch B.

a Configure VLAN 2.

```
<LSW-B> system-view
System View: return to User View with Ctrl+Z.
[LSW-B] vlan 2
[LSW-B-vlan2] port Ethernet 1/0/6
[LSW-B-vlan2] quit
[LSW-B] interface vlan-interface 2
[LSW-B-Vlan-interface2] ip address 202.38.160.2 255.255.255.0
```

b Create backup group 1.

```
[LSW-B-Vlan-interface2] vrrp vrid 1 virtual-ip 202.38.160.111
```

c Create backup group 2.

```
[LSW-B-Vlan-interface2] vrrp vrid 2 virtual-ip 202.38.160.112
```

d Set the priority for backup group 2.

```
[LSW-B-Vlan-interface2] vrrp vrid 2 priority 110
```

Normally, multiple backup groups are used in actual use.

Troubleshooting VRRP

As the configuration of VRRP is not very complicated, almost all the malfunctions can be located through viewing the configuration and debugging information. Here are some possible failures you might meet and the corresponding troubleshooting methods.

Symptom 1: Frequent prompts of configuration errors on the console

This indicates that incorrect VRRP packets are received. It may be because of the inconsistent configuration of the switches within the backup group, or the attempt of other devices sending out illegal VRRP packets. The first possible fault can be solved through modifying the configuration. And as the second possibility is caused by the malicious attempt of some devices, non-technical measures should be resorted to.

Symptom 2: More than one master existing within a backup group

There are also 2 reasons. One is short time coexistence of many master switches, which is normal and needs no manual intervention. Another is the long time coexistence of many master switches, which may be because the original master switch and other member switches in a backup group cannot receive VRRP packets from each other, or receive some illegal packets.

To solve such a problem, an attempt should be made to ping among these masters and if such an attempt fails, check the connectivity between related devices. If they can be pinged through, check VRRP configuration. For the configuration of a VRRP backup group, complete consistency for the number of virtual IP addresses, each virtual IP address, timer duration and authentication type configured on each member switch must be guaranteed.

Symptom 3: Frequent switchover of VRRP state

Such a problem occurs when the backup group timer duration is too short. So the problem can be solved through prolonging this duration or configuring the preemption delay period.

13

MSTP CONFIGURATION

MSTP Overview

Spanning tree protocol (STP) cannot enable Ethernet ports to transit their states rapidly. It costs two times of the forward delay for a port to transit to the forwarding state even if the port is on a point-to-point link or is an edge port.

Rapid spanning tree protocol (RSTP) supports rapid convergence. However, it suffers from the same drawback as STP does: all bridges in a LAN share a same spanning tree and redundant links cannot be blocked in terms of VLANs, making packets of all VLANs be forwarded along one spanning tree.

Multiple spanning tree protocol (MSTP) can disbranch a looped network to create a loop-free network of tree topology, and therefore can prevent packets from being propagated and forwarded endlessly. It also provides multiple redundant paths for packet forwarding, implementing the forwarding load balancing of VLAN packets.

MSTP is compatible with both STP and RSTP. Moreover, it overcomes the drawbacks that STP and RSTP suffer from. It allows rapid convergence, and enables packets of different VLANs to be forwarded along the corresponding paths, and thus provides a better load balancing mechanism using redundant links.

MSTP Protocol Data Unit

Bridge protocol data unit (BPDU), also known as configuration message, is the protocol data unit (PDU) that STP uses to determine the topology of a network and to figure out the spanning trees.

BPDUs fall into the following two categories:

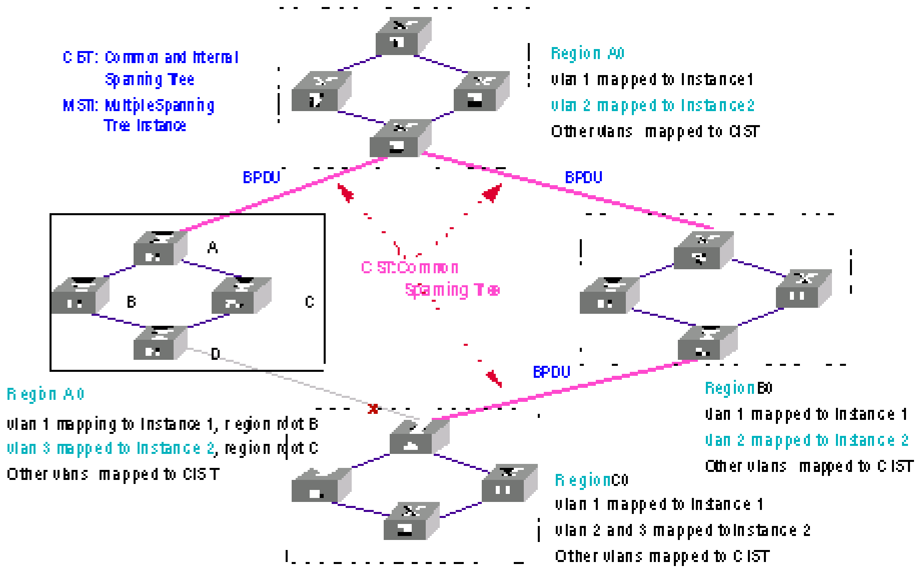
- Configuration BPDUs: BPDUs of this type are used to maintain the spanning tree topology.
- Topology change notification BPDU (TCN BPDN): BPDUs of this type are used to notify the switches of network changes.

Similar to STP and RSTP, MSTP uses BPDUs to figure out spanning trees. The only difference is that MSTP BPDUs carry MSTP configuration information of the switches.

Basic MSTP Terminologies

Figure 42 illustrates primary MSTP terms (assuming that each switch in it has MSTP employed).

Figure 42 Basic MSTP terminologies


CIST: Common and Internal Spanning Tree
MSTI: Multiple Spanning Tree Instance
Region A0
vlan 1 mapped to Instance1
vlan 2 mapped to Instance2
Other vlans mapped to CIST
BPDU
BPDU
A
B
C
D
CST:Common Spanning Tree
Region A0
vlan 1 mapping to Instance 1, region not B
vlan 3 mapped to Instance 2, region not C
Other vlans mapped to CIST
BPDU
Region B0
vlan 1 mapped to Instance 1
vlan 2 mapped to Instance 2
Other vlans mapped to CIST
Region C0
vlan 1 mapped to Instance 1
vlan 2 and 3 mapped to Instance 2
Other vlans mapped to CIST

MST region

A multiple spanning tree (MST) region comprises multiple switches and the connected network segments. The switches are all MSTP-enabled and physically connected. They have the same region name, the same VLAN-to-spanning tree mapping configuration, and the same MSTP revision level configuration.

A switched network can contain multiple MST regions. You can group multiple switches into one MST region by using the corresponding MSTP configuration commands. For example, as shown in Figure 42, all switches in region A0 have the same MST region configuration: the same region name, the same VLAN-to-spanning tree mapping (that is, VLAN 1 is mapped to spanning tree instance 1, VLAN 2 is mapped to spanning tree 2, and the other VLANs are mapped to CIST), the same MSTP revision level (not shown in Figure 42).

MSTI

A multiple spanning tree instance (MSTI) refers to a spanning tree in a MST region.

In a MST region, multiple spanning trees can be established independent of each other. For example, each region in Figure 42 can contain multiple spanning trees, known as MSTIs. Each of these spanning trees corresponds to a VLAN.

VLAN mapping table

VLAN mapping table is a MST region attribute for describing how VLANs are mapped to MSTIs. For example, the VLAN mapping table of region A0 in Figure 42says: VLAN 1 is mapped to MSTI 1; VLAN 2 is mapped to MSTI 2; and the other VLANs are mapped to CIST. In an MST region, load balancing is achieved according to the VLAN mapping table.

IST

An internal spanning tree (IST) is a spanning tree in an MST region.

ISTs, along with the common spanning tree (CST), form the common and internal spanning tree (CIST) of the entire switched network. An IST is a branch of CIST and is a special MSTI. In Figure 42, CIST has a branch in each MST region, which is the IST in the region.

CST

A CST is the spanning tree connecting all the MST regions in a switched network. If you consider each MST region a “switch”, the CST is the spanning tree calculated by STP or RSTP with these “switches” as the nodes. In Figure 42 , the lines in red depict the CST.

CIST

A common and internal spanning tree (CIST) is the spanning tree in a switched network that connects all switches in the network. It comprises the ISTs and the CST. In Figure 42, the IST of each MST region and the CST form the CIST.

Region root

A region root is the root of an IST or MSTI in a MST region. Since the spanning trees in a MST region have different topologies, they may hold different region roots. For region D0 in Figure 42, the region root of MSTI 1 is switch B, and the region root of MSTI 2 is switch C.

Common root bridge

A common root bridge is the root of a CIST. The common root bridge of the network shown in Figure 42 is a switch in region A0.

Port role

In MSTP, the following port roles exist: root port, designated port, master port, region edge port, alternate port, and backup port.

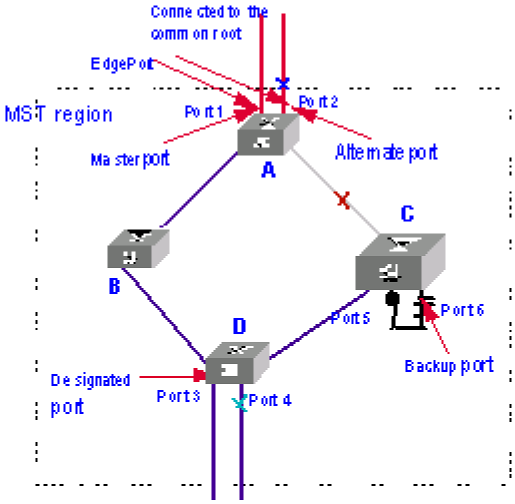
- A root port is in charge of forwarding packets in the direction of the root.
- A designated port is in charge of forwarding packets to downstream network segments or switches.
- A master port connects a MST region to the common root bridge. It is located along the shortest path from the MST region to the common root bridge.
- A region edge port is located on the edge of an MST region and is used to connect the MST region to another MST region, a region running STP, or a region running RSTP.
- An alternate port serves as the backup of a mater port. Once the master port is blocked, it becomes the new master port.
- A loop occurs when two ports of a switch are connected. In this case, the switch blocks one of the two ports. The blocked one is the backup port.

In Figure 43, switches A, B, C, and D form a MST region. Port 1 and port 2 on switch A connect upstream to the common root bridge. Port 5 and port 6 on switch C form a loop. Port 3 and port 4 on switch D connect downstream to other MST regions. Figure 43 shows the roles of the ports.

A port can play different roles in different MSTIs.

The role of a region edge port is consistent with that of the port in the CIST. For example, port 1 on switch A shown in Figure 43 is a region edge port, and it is a master port in the CIST. Therefore, it is a master port in all MSTIs in the region.

Figure 43 Port roles



Port state

In MSTP, depending on whether it forwards user packets and receives/sends BPDU packets, a port can be in one of the following three states:

- Forwarding state: A port in this state forwards user packets and receives/sends BPDU packets.
- Learning state: A port in this state receives/sends BPDU packets.
- Discarding state: A port in this state receives only BPDU packets.

The port states and port roles are not correlated. Table 140 lists all possible combinations of port states and port roles.

Table 140 Combinations of port states and port roles

	Port role				
Port state	**Root port/Master port**	**Designated port**	**Region edge port**	**Alternate port**	**Backup port**
Forwarding	x	x	x	-	-
Learning	x	x	x	-	-
Discarding	x	x	x	x	x

Fundamentals of MSTP

MSTP divides a network into multiple MST regions at Layer 2 and calculates the CST of these MST regions. In each MST region, it generates multiple spanning trees, each of which is called an MSTI. Similar to RSTP, MSTP calculates spanning trees based on BPDUs. The only difference is that MSTP BPDUs carry MSTP configuration information of the switches.

Determining the CIST

By comparing BPDUs, MSTP selects the switch of the highest priority across the network as the root of the CIST. In each MST region, MSTP calculates the ISTs. Then, considering each MST region a single switch, MSTP calculates the CST of the MST regions. The CST, along with the ISTs, forms the CIST of the network.

Determining an MSTI

In an MST region, MSTP generates different MSTIs for different VLANs according to VLAN-to-spanning tree mappings. MSTP calculates each spanning tree independently in the same way as STP/RSTP does.

Implementation of STP algorithm

In the beginning, each of the ports on each switch generate its own BPDU, taking the switch as the root, setting the root path cost to 0, the ID of the designated bridge to that of the switch, and the designated port to itself.

1. Each switch releases its BPDUs and operates as follows when receiving BPDUs of other switches.
   - Discards the received BPDUs whose priorities are lower than that of its BPDU. That is, the received messages of this type are not processed.
   - If the priority of a received BPDU is higher than that of the BPDU released by one of its ports, the switch replaces the BPDU of the port with the received one and compares the resulted BPDU with those of its other ports to obtain the one with the highest priority.
2. BPDUs are compared based on the following principles:
   - The BPDU with a smaller root ID has a higher priority.
   - For BPDUs with the same root ID, the BPDU with a smaller sum of the root path cost (in the BPDU) and the path cost of the port has a higher priority.
   - For BPDUs with the same root ID and root path cost, the designated bridge ID, designated port ID, the ID of the port from which the BPDU is received are compared in turn.
3. A spanning tree is figured out in the following steps:
   - Determine the root bridge
   - The root bridge is determined through BPDU comparing. The switch with the smallest root ID is the root bridge.
   - Determine the root port
   - For each switch in a network, the port from which the BPDU with the highest priority is received is set to be the root port of the switch.
   - Determine the designated port

First, a switch generates a designated port BPDU for each of its port based on the root port BPDU and the root port path cost, setting the root ID to that of the root port BPDU, the root path cost to the sum of the path cost of the root port BPDU and the path cost of the root port, the ID of the designated bridge to that of the switch, and the ID of the designated port to that of the port.

Then, the switch compares the resulted BPDUs with the original BPDUs of its ports. For ports whose original BPDUs are better, the switch blocks them and remains their original BPDUs, allowing them to receive BPDUs and forbidding them from forwarding data. For a port whose original BPDU is not as good, the switch sets it to the designated port, replaces the original BPDU with the calculated one, and releases the new BPDU regularly.

MSTP Implementation on Switches

MSTP is compatible with both STP and RSTP. That is, switches running MSTP can recognize STP and RSTP packets and use them to calculate spanning trees. In addition to the basic MSTP functions, a S5500 series switch also provides many special functions for ease of management to further meet the needs of users, as listed in the following.

- Root bridge retaining
- Root bridge backup
- Root protection
- BPDU protection
- Loop prevention

Root Bridge Configuration

Table 141 lists the MSTP configuration tasks for root bridges.

Table 141 Root bridge configuration

Operation	Description	Related section
Enable MSTP	Required Normally, to reduce network topology jitters caused by configuration, you are recommended to enable MSTP after completing other related configurations.	Enabling MSTP
Configure an MST region	Required	Configuring an MST Region
Set the switch as the root/secondary root bridge	Required	Setting a switch as the root bridge of a spanning tree
Configure the bridge priority of the switch	Optional The priority of a switch cannot be changed after the switch is specified as the root bridge or a secondary root bridge.	Setting a switch as a secondary root bridge of a spanning tree
Configure MSTP operation mode	Optional	Configuring MSTP Operation Mode
Configure the maximum hop count of an MST region	Optional	Configuring the Maximum Hop Count of an MST Region
Configure the diameter of a switched network	Optional The default is recommended.	Configuring the Diameter of a Switched Network
Configure MSTP time parameters	Optional The defaults are recommended.	Configuring MSTP Time Parameters
Configure the timeout time factor	Optional	Configuring the Timeout Time Factor
Configure the maximum transmission speed of a port	Optional The default is recommended.	Configuring the Maximum Transmission Speed of a Port
Set a port as an edge port	Optional	Setting a Port as an Edge Port
Specify whether a port connect to point-to-point link	Optional	Specifying whether a Port Connect to Point-to-Point Link

With both GVRP and MSTP enabled on switches, GVRP packets will be forwarded along the CIST. If you want to broadcast packets of a specific VLAN through GVRP, be sure to map the VLAN to the CIST when configuring the MSTP VLAN mapping table. The CIST of a network is the spanning tree instance numbered 0.

Prerequisites

Before configuration, determine what roles the switches will play in the spanning trees, that is, whether a switch will be the root, a branch, or a leaf in a spanning tree.

Configuring an MST Region

Configuration procedure

Table 142 Configure an MST region

Operation	Command	Description
Enter system view	system-view	—
Enter MST region view	stp region-configuration	—
Configure a name for the MST region	**region-name** *name*	Required By default, the name of an MST region is the MAC address of the switch.
Configure the VALN mapping table	**instance** *instance-id* **vlan** *vlan-list*	Required Both commands can be used to configure a VLAN mapping table. By default, all VLANs in an MST region are mapped to MSTI 0.
	vlan-mapping modulo *modulo*	—
Configure the MSTP revision level of the MST region	**revision-level** *level*	Required The default revision level of an MST region is level 0.
Activate the configuration of the MST region manually	**active region-configuration**	Required
Display the configuration of the MST region	**check region-configuration**	Optional
Display the effective configuration of the MST region	**display stp region-configuration**	You can execute this command in any view.

Changes of MST region parameters, especially those of the VLAN mapping tables, can cause MSTP to recalculate the spanning trees, creating network topology jitters across the network. To reduce network topology jitters caused by configuration changes, MSTP does not recalculate the spanning trees immediately in response to region configuration changes. In fact, region configurations take effect only when you perform any of the following operations:

- Activate the new MST region settings by using the **active region-configuration** command.
- Enable MSTP by using the **stp enable** command.

Switches belong to the same MST region only when they have the same MST region name, the same VLAN mapping table, and the same MST region revision level.

Configuration example

1 Configure an MST region, with the name being info, the MSTP revision level being level 1, VLAN 2 through VLAN 10 being mapped to MSTI 1, and VLAN 20 through VLAN 30 being mapped to MSTI 2.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp region-configuration
[S5500-mst-region] region-name info
[S5500-mst-region] instance 1 vlan 2 to 10
[S5500-mst-region] instance 2 vlan 20 to 30
[S5500-mst-region] revision-level 1
[S5500-mst-region] active region-configuration
```

2 Verify the above configuration.

```
[S5500-mst-region] check region-configuration
Admin configuration
   Format selector    :0
   Region name        :info
   Revision level     :1

   Instance   Vlans Mapped
      0       11 to 19, 31 to 4094
      1       1 to 10
      2       20 to 30
```

Setting the Switch as the Root/Secondary Root Bridge

MSTP can determine the root bridge of a spanning tree by calculating. In addition, you can specify a switch to be the root bridge by using the corresponding commands.

Setting a switch as the root bridge of a spanning tree

Table 143 Set a switch as the root bridge of a specified spanning tree

Operation	Command	Description
Enter system view	**system-view**	-
Set the switch as the root bridge of a specified spanning tree	**stp** [**instance** *instance-id*] **root primary** [**bridge-diameter** *bridgenum*] [**hello-time** *centi-seconds*]	Required

Setting a switch as a secondary root bridge of a spanning tree

Table 144 Set a switch as a secondary root bridge of a spanning tree

Operation	Command	Description
Enter system view	system-view	-
Set the current switch as a secondary root bridge of a specified spanning tree	**stp** [**instance** *instance-id*] **root secondary** [**bridge-diameter** *bridgenum*] [**hello-time** *centi-seconds*]	Required

Using the **stp root primary/stp root secondary** command, you can specify a switch to be the root bridge or a secondary root bridge of the spanning tree instance identified by the *instance-id* argument. If the value of the *instance-id* argument is 0, the two commands specify the current switch to be the root bridge or a secondary root bridge of the CIST.

A switch can play different roles in different spanning tree instances independently at the same time. However, in one spanning tree instance, a switch cannot be the root bridge and a secondary root bridge simultaneously.

A secondary root bridge becomes a root bridge if the original root bridge fails or is turned off. A secondary root bridge remains unchanged if a new root bridge is configured. If you configure multiple secondary root bridges for a spanning tree instance, the one with the least MAC address replaces the root bridge if the latter goes down.

You can specify the network diameter and the Hello time parameters while configuring a root bridge/secondary root bridge. Refer to "Configuring the Diameter of a Switched Network" and "Configuring MSTP Time Parameters" for information about the network diameter argument and the Hello time argument.

*You can configure a switch to be the root bridges of multiple spanning tree instances. But a spanning tree instance cannot be configured with two or more root bridges. That is, you cannot set root bridges for the same spanning tree instance by configuring the **stp root primary** command on two or more switches.*

*You can configure multiple secondary root bridges for one spanning tree. That is, you can set secondary root bridges for the same spanning tree instance by configuring the **stp root secondary** command on two or more switches.*

You can also configure the current switch to be the root bridge by setting the priority of the switch to 0. Note that once a switch is configured to be the root bridge or secondary root bridge, its priority cannot be modified.

Configuration example

Configure the current switch to be the root bridge of spanning tree instance 1 and a secondary root bridge of spanning tree instance 2.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp instance 1 root primary
[S5500] stp instance 2 root secondary
```

Setting the Bridge Priority of a Switch

The bridge priorities of switches determine which switch will be elected as the root of the spanning tree. You can make a switch elected as the root bridge by assigning a higher bridge priority to it (note that a smaller bridge priority value indicates a higher bridge priority). An MSTP-enabled switch can have different bridge priorities in different spanning tree instances.

Configuration procedure

Table 145 Assign a bridge priority to a switch

Operation	Command	Description
Enter system view	system-view	-
Assign a bridge priority to a switch	**stp** [**instance** *instance-id*] **priority** *priority*	Required The default bridge priority of a switch is 32,768.

Once you specify a switch to be the root bridge or a secondary root bridge, you cannot change its bridge priority any more.

During root bridge election process, if multiple switches share the same bridge priority, the one with the smallest MAC address becomes the root bridge.

Configuration example

Configure the bridge priority of the current switch to be 4,096 in spanning tree instance 1.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp instance 1 priority 4096
```

Configuring MSTP Operation Mode

A switch running MSTP can operate in one of these three modes:

- STP mode: In this mode, ports of the switch send STP packets. If the switched network contains STP-enabled switches, you can configure the current MSTP-enabled switch to operate in this mode by using the **stp mode stp** command.
- RSTP mode: In this mode, ports of the switch send RSTP packets. If the switched network contains RSTP-enabled switches, you can configure the current MSTP-enabled switch to operate in this mode by using the **stp mode rstp** command.
- MSTP mode: In this mode, ports of the switch send MSTP packets or STP packets (if the ports have STP-enabled switches connected). In this case, the multiple spanning tree function is enabled as well.

Configuration procedure

Table 146 Configure MSTP operation mode

Operation	Command	Description
Enter system view	system-view	-
Configure the MSTP operation mode of the switch	**stp mode** { **stp** | **rstp** | **mstp** }	Required An MSTP-enabled switch operates in MSTP mode by default.

Configuration example

Configure the current switch to operate in STP mode.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp mode stp
```

Configuring the Maximum Hop Count of an MST Region

The maximum hop count of an MST region is used to limit the size of the MST region. Normally, it is configured on the region roots.

A BPDU contains a hop counter field. In a MST region, after a BPDU leaves the root bridge, its hop counter decreases by 1 whenever it is forwarded by a switch; once its hop counter reaches 0, it is dropped. Such a mechanism disables the switches that are beyond the maximum hop count from participating in spanning tree calculation, and thus limits the size of an MST region.

With such a mechanism, once a switch becomes the root bridge of a CIST or MSTI, the maximum hop count configured on it determines the network diameter of the spanning tree and limits the size of the spanning tree. The switches that are not the root bridge in an MST region adopts the maximum hop count configured on the root bridge.

Configuration procedure

Table 147 Configure the maximum hop count of an MST region

Operation	Command	Description
Enter system view	system-view	—
Configure the maximum hop count of an MST region	**stp max-hops** *hops*	Required By default, the maximum hop count of an MST region is 20.

Note that only the maximum hop count setting configured on a switch acting as the region root limits the size of the MST region.

Configuration example

Set the maximum hop count of the MST region to 30 on the future region root.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp max-hops 30
```

Configuring the Diameter of a Switched Network

In a switched network, any two switches can communicate with each other through paths formed by some other switches in the network. The diameter of a network refers to the path that contains the maximum number of switches, and is measured in the number of the switches along the path.

Configuration procedure

Table 148 Configure the diameter of a network

Operation	Command	Description
Enter system view	system-view	—
Configure the diameter of a switched network	**stp bridge-diameter** *bridgenum*	Required The default diameter of a switched network is 7.

Network diameter is an argument intended to indicate the size of a network. A greater network diameter indicates a larger network.

After you configure the network diameter on a switch, MSTP will automatically adjust the Hello time, Forward delay, and Max age settings accordingly.

The network diameter setting only applies to CISTs.

Configuration example

Configure the diameter of the switched network to 6.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp bridge-diameter 6
```

Configuring MSTP Time Parameters

In MSTP, a switch has three time parameters: Forward delay, Hello time, and Max age.

- Forward delay: Indicates the state transition delay.

Link problems occurred in a network can cause MSTP to recalculate the spanning trees to reflect the changes of links. As it takes some time for newly generated BPDUs to be propagated across the network, loops may occur temporarily if the new root ports and designated ports begin to forward packets immediately.

To solve this problem, MSTP adopts the state transition mechanism. With this mechanism, new root ports and designated ports must go through an intermediate state to the forwarding state, so that the new BPDUs can be advertised throughout the network. The introduced delay is dictated by the Forward delay argument.

- Hello time: Indicates the interval in which the switch checks the connectivity of links.

A switch sends Hello packets to its neighboring switches in the specified Hello time interval to check the connectivity of links.

- Max age: Indicates the timeout time of BPDUs. Obsolete BPDUs will be discarded.

Configuration procedure

Table 149 Configure MSTP time parameters

Operation	Command	Description
Enter system view	system-view	—
Configure the Forward delay	**stp timer forward-delay** *centi-seconds*	Required The Forward delay defaults to 1,500 centiseconds (15 seconds).
Configure the Hello time	**stp timer hello** *centi-seconds*	Required The Hello time defaults to 200 centiseconds (2 seconds).
Configure the Max age	**stp timer max-age** *centi-seconds*	Required The Max age defaults to 2,000 centiseconds (20 seconds).

All switches in a switched network adopt the settings of the three time parameters configured on the CIST root bridge.

The value of the Forward delay argument depends on the network diameter. Normally, a greater network diameter requires a greater Forward delay. A too small Forward delay may result in temporary redundant paths. And a too great Forward delay may cause a network unable to resume connectivity in a relatively long time. The default is recommended.

An adequate Hello time enables a switch to detect link problems in time without consuming too many network resources. A too great Hello time may cause normal links to be regarded as failed when only some packets get lost, which in turn causes spanning trees to be recalculated. And a too small Hello time causes duplicated BPDUs to be sent frequently, which increases the load of the switches and wastes network resources. The default is recommended.

As for the Max age argument, if it is too small, network congestions may be falsely regarded as link problems, which causes the spanning trees to be frequently regenerated. If it is too large, link problems may not be found in time, which causes spanning trees unable to be regenerated in time, making the network less adaptive. The default is recommended.

The settings of the three MSTP time parameters must satisfy the following expressions to prevent frequent network jitters:

2 * (Forward delay 1 second) >= Max age

Max age >= 2 * (Hello time + 1 second)

It is recommended that you specify the network diameter and the Hello time by using the **stp root primary** or **stp root secondary** command. MSTP will then automatically calculate the optimal values of the three parameters.

Configuration example

Set the Forward delay to 1,600 centiseconds, the Hello time to 300 centiseconds, and the Max age to 2,100 centiseconds on the future CIST root bridge.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp timer forward-delay 1600
[S5500] stp timer hello 300
[S5500] stp timer max-age 2100
```

Configuring the Timeout Time Factor

A switch sends protocol packets to its neighboring devices in the specified Hello time interval to test the connectivity of links. Normally, if a switch does not receive any protocol packets from its upstream switch in a period three times of the Hello time, it assumes that the upstream switch is down and recalculates the spanning trees.

Spanning tree recalculation may also occur in a very stable network where certain upstream switches are busy. In this case, you can increase the timeout time to four or more times of the Hello time. For stable networks, a timeout time of five to seven times of the Hello time is recommended.

Configuration procedure

Table 150 Configure the timeout time factor

Operation	Command	Description
Enter system view	system-view	—
Configure the timeout time factor of a switch	**stp timer-factor** *number*	Required The timeout time of a switch defaults to 3.

Configuration example

Set the timeout time factor to 6.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp timer-factor 6
```

Configuring the Maximum Transmission Speed of a Port

The maximum transmission speed of a port indicates the maximum number of BPDUs a port can transmit in a Hello time interval. It depends on the physical status of the port and the network structure. You can configure this argument as required in system view or Ethernet port view.

Configuration procedure in system view

Table 151 Configure the maximum transmission speed of specified ports in system view

Operation	Command	Description
Enter system view	system-view	-
Configure the maximum transmission speed of specified ports	**stp interface** *interface-list* **transmit-limit** *packetnum*	Required The maximum transmission speed of all Ethernet ports on a switch defaults to 3.

Configuration procedure in Ethernet port view

Table 152 Configure the maximum transmission speed in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure the maximum transmission speed of the port	**stp transmit-limit** *packetnum*	Required The maximum transmission speed of all Ethernet ports on a switch defaults to 3.

You can configure the maximum transmission speed of ports with either of the above two methods.

A too high maximum transmission speed can cause too many MSTP BPDUs transmitted in each Hello time interval, resulting in waste of network resources. The default is recommended.

Configuration example

Set the maximum transmission speed of interface Ethernet1/0/1 to 5.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 transmit-limit 5
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp transmit-l
```

Setting a Port as an Edge Port

Edge ports are ports that do not have any switches connected to them directly or through networks. After a port is configured to be an edge port, the port can perform rapid transition, that is, it can move from the blocking state to the forwarding state without waiting for the delay timer to time out.

You can configure a port to be an edge port or non-edge port in either system view or Ethernet port view.

Configuration procedure in system view

Table 153 Set a port as an edge port in system view

Operation	Command	Description
Enter system view	system-view	-
Configure the specified ports to be edge ports	**stp interface** *interface-list* **edged-port enable**	Required By default, all Ethernet ports of a switch are non-edge ports.

Configuration procedure in Ethernet port view

Table 154 Set a port as an edge port in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure the port to be an edge port	**stp edged-port enable**	Required By default, all Ethernet ports of a switch are non-edge ports.

On a switch with BPDU protection not enabled, an edge port becomes a non-edge port again once it receives a BPDU from another port.

It is recommended that you configure Ethernet ports with terminals directly connected to be edge ports and enable BPDU protection on them. This not only allows the ports to transit to the forwarding state rapidly, but also secures the network.

Configuration example

Configure Ethernet1/0/1 port to be an edge port.

- Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 edged-port enable
```

- Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp edged-port enable
```

Specifying whether a Port Connect to Point-to-Point Link

A point-to-point link directly connects two switches. If the two ports at the two ends of a point-to-point link meet certain role criteria, they can transit to the forwarding state rapidly by exchanging and processing synchronization packets, eliminating the forwarding delay.

You can configure a port to connect to a point-to-point link in either system view or Ethernet port view.

Configuration procedure in system view

Table 155 Configure a port to connect to a point-to-point link in system view

Operation	Command	Description
Enter system view	system-view	-
Specify whether the specified ports connect to point-to-point links or not	**stp interface** *interface-list* **point-to-point** { **force-true** | **force-false** | **auto** }	Required The **auto** keyword is specified by default. The **force-true** keyword specifies that the specified ports connect to point-to-point links. The **force-false** keyword specifies that the specified ports connect to links that are not point-to-point. The **auto** keyword specifies that MSTP automatically determines whether the specified Ethernet ports connect to point-to-point links.

Configuration procedure in Ethernet port view

Table 156 Configure a port to connect to a point-to-point link in Ethernet port view

Operation	Command	Description
Enter system view	**system-view**	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure the port to connect to a point-to-point link	**stp point-to-point** { **force-true** | **force-false** | **auto** }	Required The **auto** keyword is specified by default. The **force-true** keyword specifies that the port connect to a point-to-point link. The **force-false** keyword specifies that the port connect to a link that is not point-to-point. The **auto** keyword specifies that MSTP automatically determines whether the Ethernet port connects to a point-to-point link.

Only the master ports of aggregation ports can be configured to connect to point-to-point link.

You can configure a port to connect to point-to-point link if the port operates in auto-negotiation mode and the negotiated operation mode is full duplex.

If you configure a port to connect to a point-to-point link, the port will connect to point-to-point links in all spanning tree instances. If the actual physical link is not a point-to-point link, loops may temporarily appear.

Configuration example

Configure Ethernet1/0/1 port to connect to point-to-point link.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 point-to-point force-true
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp point-to-point force-true
```

Enabling MSTP

Configuration procedure

You can enable MSTP in system view or Ethernet port view.

Table 157 Enable MSTP in system view

Operation	Command	Description
Enter system view	**system-view**	-
Enable MSTP	**stp enable**	Required MSTP is disabled by default.
Disable MSTP on some ports	**stp interface** *interface-list* **disable**	Optional By default, MSTP is enabled on all ports after you enable MSTP in system view. You can disable MSTP on certain Ethernet ports to prevent them from participating in spanning tree calculation, saving switch CPU utilization.

Table 158 Enable MSTP in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enable MSTP	stp enable	Required MSTP is disabled by default.
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Disable MSTP on the port	stp disable	Optional By default, MSTP is enabled on all ports after you enable MSTP in system view. You can disable MSTP on certain Ethernet ports to prevent them from participating in spanning tree calculation, saving switch CPU utilization.

Only when you enable MSTP on a switch, can MSTP configurations take effect.

Configuration example

Enable MSTP on the switch and disable MSTP on port Ethernet1/0/1.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
[S5500] stp interface ethernet1/0/1 disable
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp disable
```

Leaf Node Configuration

Table 159 lists the MSTP configuration tasks for leaf nodes.

Table 159 Leaf node configuration

Operation	Description	Related section
Enable MSTP	Required Normally, to reduce network topology jitters caused by configuration, you are recommended to enable MSTP after completing other related configurations.	Enabling MSTP
Configure an MST region	Required	Configuring an MST Region
Configure MSTP operation mode	Optional	Configuring MSTP Operation Mode
Configure the timeout time factor	Optional	Configuring the Timeout Time Factor
Configure the maximum transmission speed of a port	Optional The default is recommended.	Configuring the Maximum Transmission Speed of a Port
Set a port as an edge port	Optional	Setting a Port as an Edge Port
Configure the path cost of a port	Optional	Configuring the Path Cost of a Port
Configure the priority of a port	Optional	Configuring the Priority of a Port
Configure a port to connect to point-to-point link	Optional	Configuring a Port to Connect to Point-to-Point Link

With both GVRP and MSTP enabled on switches, GVRP packets will be forwarded along the CIST. If you want to broadcast packets of a specific VLAN through GVRP, be sure to map the VLAN to the CIST when configuring the MSTP VLAN mapping table. The CIST of a network is the spanning tree instance numbered 0.

Prerequisites

Before configuration, determine what roles the switches will play in the spanning trees, that is, whether a switch will be the root, a branch, or a leaf in a spanning tree

Configuring an MST Region

Refer to "Configuring an MST Region".

Configuring MSTP Operation Mode

Refer to "Configuring MSTP Operation Mode".

Configuring the Timeout Time Factor

Refer to "Configuring the Timeout Time Factor".

Configuring the Maximum Transmission Speed of a Port

Refer to "Configuring the Maximum Transmission Speed of a Port".

Setting a Port as an Edge Port

Refer to "Setting a Port as an Edge Port".

Configuring the Path Cost of a Port

The path cost of a port is related with the speed of the connected link. A port of an MSTP-enabled switch can have different path costs for different spanning tree instances. By configuring proper path costs, you can enable flows of different VLANs to travel along different physical links to implement VLAN-based load balancing.

Path cost can be configured manually or be determined by the switch.

Specifying the standard for calculating path costs of ports

Currently, the following standards are available for calculating path costs of ports on a switch:

- **dot1d-1998**: Adopts the IEEE 802.1D-1998 standard to calculate the default path costs of ports.
- **dot1t**: Adopts the IEEE 802.1t standard to calculate the default path costs of ports.
- **legacy**: Adopts the standard defined by 3Com-3Com Technology Co., Ltd to calculate the default path costs of ports.

Table 160 Specify the standard for calculating path costs

Operation	Command	Description
Enter system view	system-view	-
Specify the standard for calculating the default path costs of links connecting to the switch	**stp pathcost-standard** { **dot1d-1998** | **dot1t** | **legacy** }	Optional By default, the IEEE 802.1t standard is used to calculate the default path costs of ports.

Table 161 Transmission speeds and the corresponding path costs

Transmission speed	Operation mode (half-/full-duplex)	802.1D-1998	IEEE 802.1t	3Com-3Com standard
0	—	65,535	200,000,000	200,000
10 Mbps	Half-Duplex	100	2,000,000	2,000
	Full-Duplex	99	1,999,999	2,000
	Aggregated Link 2 Ports	95	1,000,000	1,800
	Aggregated Link 3 Ports	95	666,666	1,600
	Aggregated Link 4 Ports	95	500,000	1,400

Table 161 Transmission speeds and the corresponding path costs (continued)

Transmission speed	Operation mode (half-/full-duplex)	802.1D-1998	IEEE 802.1t	3Com-3Com standard
100 Mbps	Half-Duplex	19	200,000	200
	Full-Duplex	18	199,999	200
	Aggregated Link 2 Ports	15	100,000	180
	Aggregated Link 3 Ports	15	66,666	160
	Aggregated Link 4 Ports	15	50,000	140
1,000 Mbps	Full-Duplex	4	20,000	20
	Aggregated Link 2 Ports	3	10,000	18
	Aggregated Link 3 Ports	3	6,666	16
	Aggregated Link 4 Ports	3	5,000	14
10 Gbps	Full-Duplex	2	2,000	2
	Aggregated Link 2 Ports	1	1,000	1
	Aggregated Link 3 Ports	1	666	1
	Aggregated Link 4 Ports	1	500	1

Normally, the path cost of a port in full-duplex mode is slightly less than that of the port in half-duplex mode.

When calculating the path cost of an aggregate link, the 802.1D-1998 standard does not take the number of the aggregated links into account, whereas the 802.1T standard does so by using the following equation:

Path cost = 200,000,000/link transmission speed

Where, the link transmission speed is the sum of the speeds of the unblocked ports for the aggregate link measured in 100 kbps units.

Configuring the path cost of a port

Table 162 Configure the path costs of specified ports in system view

Operation	Command	Description
Enter system view	system-view	-
Configure the path costs of specified ports	**stp interface** *interface-list* [**instance** *instance-id*] **cost** *cost*	Required By default, an MSTP-enabled switch calculates path costs of its ports automatically.

Table 163 Configure the path cost of a port in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure the path cost of the port	**stp** [**instance** *instance-id*] **cost** *cost*	Required By default, an MSTP-enabled switch calculates path costs of its ports automatically.

Changes of path costs can cause MSTP to redetermine the roles of ports, resulting in state transition of ports. If you provide 0 for the *instance-id* argument when executing the **stp cost** command, the command sets the path cost of the CIST.

Configuration example (A)

Configure the path cost of port Ethernet1/0/1 in spanning tree instance 1 to be 2,000.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 instance 1 cost 2000
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp instance 1 cost 2000
```

Configuration example (B)

Configure to make MSTP automatically calculate the path cost of port Ethernet1/0/1 in spanning tree instance 1 by using the IEEE 802.1D-1998 standard.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] undo stp interface ethernet1/0/1 instance 1 cost
[S5500] stp pathcost-standard dot1d-1998
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] undo stp instance 1 cost
[S5500-Ethernet1/0/1] quit
[S5500] stp pathcost-standard dot1d-1998
```

Configuring the Priority of a Port

Port priority is an important criterion for determining the root port. With other parameters being the same, the port with the highest priority becomes the root port.

A port on an MSTP-enabled switch can have different port priorities and play different roles in different spanning tree instances. This enables packets of different VLANs to be forwarded along different physical paths, implementing VLAN-based load balancing.

You can configure port priorities in the following two ways.

Configuring the priorities of ports in system view

Table 164 Configure the priorities of specified ports in system view

Operation	Command	Description
Enter system view	system-view	-
Configure the port priorities of specified ports	**stp interface** *interface-list* **instance** *instance-id* **port priority** *priority*	Required By default, all Ethernet ports of a switch have the same priority, namely 128.

Configuring the priority of a port in Ethernet port view

Table 165 Configure the priority of a port in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Configure the port priority of the port	**stp** [**instance** *instance-id*] **port priority** *priority*	Required. By default, all Ethernet ports of a switch have the same priority, namely 128.

Changes of port priorities can cause MSTP to redetermine the roles of ports, resulting in state transition of ports.

A lower port priority value indicates a higher port priority. If all ports of a switch have the same port priority setting, the actual port priorities are determined by the port indexes.

You can configure port priorities based on the specific networking requirements.

Configuration example

Configure the priority of port Ethernet1/0/1 in spanning tree instance 1 to be 16.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 instance 1 port priority 16
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp instance 1 port priority 16
```

Configuring a Port to Connect to Point-to-Point Link

Refer to “Configuring a Port to Connect to Point-to-Point Link”.

Enabling MSTP

Refer to “Enabling MSTP”.

mCheck Configuration

As mentioned previously, ports on an MSTP-enabled switch can operate in three modes: STP mode, RSTP mode, and MSTP mode. On a switched network, if a port on a switch running MSTP is connected to a switch running STP or RSTP, it automatically transits to STP or RSTP mode. But when the switch running STP or RSTP is disconnected, the port cannot transit back to MSTP mode automatically; it remains in STP or RSTP mode.

In this case, you can force the port to operate in MSTP mode by performing the mCheck operation.

Prerequisites

Configure MSTP on the switch properly.

Configuration Procedure

You can perform the mCheck operation in the following two ways.

Performing the mCheck operation in system view

Table 166 Perform the mCheck operation in system view

Operation	Command	Description
Enter system view	system-view	-
Perform the mCheck operation	**stp** [**interface** *interface-list*] **mcheck**	Required

Performing the mCheck operation in Ethernet port view

Table 167 Perform the mCheck operation in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Perform the mCheck operation	stp mcheck	Required

***CAUTION:** Execute the **stp mcheck** command on switches configured to operate in MSTP mode only. If a switch is configured to operate in STP or RSTP mode, the **stp mcheck** command does not take effect.*

Configuration Example

Perform the mCheck operation for port Ethernet1/0/1.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 mcheck
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp mcheck
```

Protection Functions Configuration

This section contains configuration information for Protection Functions.

Introduction to the Protection Functions

On an MSTP-enabled switch, four protection functions are available: BPDU protection, root protection, loop prevention, and TC-BPDU attack prevention.

BPDU protection

Typically, access ports of access layer devices have terminals (such as PCs) or file servers directly connected to them. These ports are usually configured to be edge ports to achieve rapid transition. When they receive BPDUs, however, they are set as non-edge ports automatically, which causes MSTP to recalculate the spanning trees, resulting in network topology jitters.

In normal cases, edge ports are free of BPDUs. But malicious users may attack the switches by sending forged BPDUs to the edge ports to create network jitters. You can prevent this type of attack by utilizing the BPDU protection function. With this function enabled on a switch, once an edge port receives a BPDU, the system automatically shut it down and notifies the network administrator of the situation. Only the administrator can restore edge ports that are shut down.

Root protection

A root bridge and its secondary root bridges must reside in the same region. Particularly, a CIST and its secondary root bridges are usually located in the core region, which is equipped with high bandwidth. But errors may exist in configurations and malicious attacks may occur, making legal root bridges receive BPDUs of higher priorities and give up their roles as root bridges, which means network topology jitters. In this case, flows that should travel along high-speed links may be led to low-speed links, and network congestions may occur.

You can avoid this problem by utilizing the root protection function. Ports with this function enabled can retain their roles in all spanning tree instances. When such a port receives BPDUs of higher priorities, its state is set to discarding and it stops forwarding any packets as if the connected link were down. Only when it receives no BPDUs of higher priorities in a specified period, does it resumes its normal state.

Loop prevention

A switch maintains the states of the root port and blocked ports by receiving and processing BPDUs from the upstream switch. However, the switch may not receive the BPDUs due to network congestions or unidirectional link failures. In this case, the switch reelects a root port, sets the original root port to a designated port, and places the blocked ports to the forwarding state, all of which may bring about loops in the network.

The loop prevention function can suppress loops of this type. With this function enabled, the root port does not give up its role and the blocked ports remain in the discarding state, eliminating the possibilities of loops in the network.

TC-BPDU attack prevention

A switch removes MAC address entries and ARP entries upon receiving TC-BPDUs. If a malicious user sends large amounts of TC-BPDUs to a switch in a short period, the switch may be busy removing MAC address entries and ARP entries, which may decrease the performance of the switch and introduce potential stability risks.

With the TC-BPDU attack prevention function enabled, a switch performs removing operation only once in a specified period (10 seconds by default) after it receives a TC-BPDU. The switch also checks to see if other TC-BPDUs arrive and performs another removing operation in the next period if a TC-BPDU is received. Such a mechanism prevents a switch from being busy removing address entries and ARP entries.

⚠ *Only one function among loop prevention, root protection, and edge port can be valid at a time.*

Prerequisites Configure MSTP on the switch properly.

Configuring BPDU Protection

Configuration procedure

Table 168 Enable the BPDU protection function

Operation	Command	Description
Enter system view	system-view	-
Enable the BPDU protection function	stp bpdu-protection	Required The BPDU protection function is disabled by default.

Configuration example

Enable the BPDU protection function.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp bpdu-protection
```

As 1000 Mbps ports of an Switch 5500 cannot be shut down, the BPDU protection function is not applicable to these ports even you enable the BPDU protection function and specify these ports to be MSTP edge ports.

Configuring Root Protection

Configuration procedure

Table 169 Enable the root protection function in system view

Operation	Command	Description
Enter system view	system-view	-
Enable the root protection function	**stp interface** *interface-list* **root-protection**	Required The root protection function is disabled by default.

Table 170 Enable the root protection function in Ethernet port view

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Enable the root protection function	stp root-protection	Required The root protection function is disabled by default.

Configuration example

Enable the root protection function for port Ethernet1/0/1.

1 Configure in system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp interface ethernet1/0/1 root-protection
```

2 Configure in Ethernet port view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp root-protection
```

Configuring Loop Prevention

Configuration procedure

Table 171 Enable the loop prevention function

Operation	Command	Description
Enter system view	system-view	-
Enter Ethernet port view	**interface** *interface-type interface-number*	-
Enable the loop prevention function	stp loop-protection	Required The loop prevention function is disabled by default.

Configuration example

Enable the loop prevention function on port Ethernet1/0/1.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] stp loop-protection
```

Configuring TC-BPDU Attack Prevention

Configuration procedure

Table 172 Enable the TC-BPDU attack prevention function

Operation	Command	Description
Enter system view	system-view	-
Enable the TC-BPDU attack prevention function	stp tc-protection enable	Required The TC-BPDU attack prevention function is disabled by default.

Configuration example

Enable the TC-BPDU attack prevention function.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp tc-protection enable
```

BPDU Tunnel Configuration

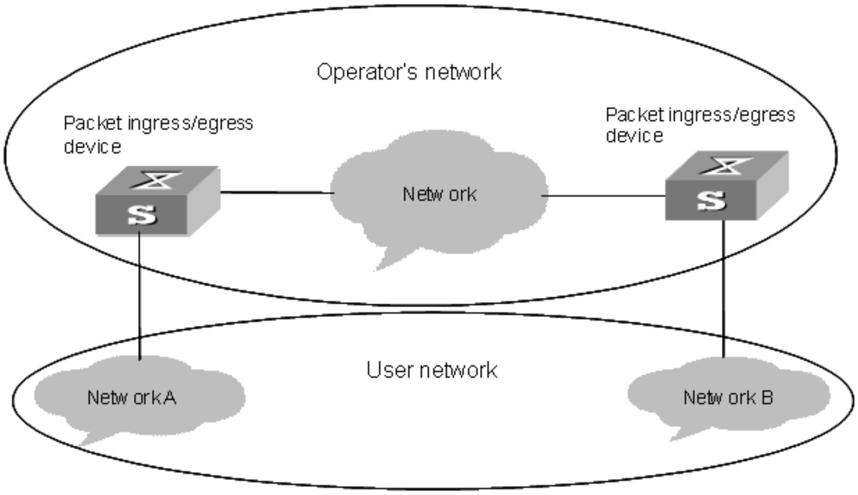
This section contains configuration information for BPDU Tunnel.

Introduction to BPDU Tunnel

The BPDU tunnel function enables BPDUs to be transparently transmitted between geographically dispersed user networks through specified VLAN VPNs in operator's networks, allowing spanning trees to be generated across these user networks and keep independent of those of the operator's networks.

As shown in Figure 44, the upper part is the operator's network, and the lower part is the user network. The operator's network comprises packet ingress/egress devices, and the user network consists of networks A and B. On the operator's network, configure the arriving BPDU packets at the ingress to have MAC addresses in a special format, and reconvert them back to their original formats at the egress. This is how transparent transmission is implemented on the operator's network.

Figure 44 BPDU Tunnel network hierarchy



Configuring BPDU Tunnel

Table 173 Configure the BPDU tunnel function

Operation	Command	Description
Enter system view	system-view	-
Enable MSTP	stp enable	-
Enable the BPDU tunnel function	vlan-vpn tunnel	Required
Enter Ethernet port view	**Interface** *interface-type interface-number*	Make sure that you enter the Ethernet port view of the port on which you want to enable the BPDU tunnel function.
Disable MSTP	stp disable	-
Enable the VLAN VPN function	vlan-vpn enable	Required By default, the VLAN VPN function is disabled on all ports.

Notes:

- You must enable STP on a device before enabling the BPDU tunnel function on it.
- The BPDU tunnel function is only available to access ports.
- To implement the BPDU tunnel function, the links between operator networks must be trunk links.
- As the VLAN VPN function is unavailable to the ports with 802.1x, GVRP, GMRP, STP, or NTDP employed, the BPDU tunnel function is unavailable to these ports.

Displaying and Debugging MSTP

After completing the above configurations, you can display MSTP operation and verify your configuration by executing the **display** command in any view.

You can also clear MSTP-related statistics by executing the **reset** command in user view or debug the MSTP module by executing the **debugging** command in user view.

Table 174 Display and debug MSTP

Operation	Command
Display the spanning tree status information and statistics about the current switch	**display stp** [**instance** *instance-id*] [**interface** *interface-list* | **slot** *slot-number*] [**brief**]
Display region configuration	display stp region-configuration
Clear MSTP-related statistics	**reset stp** [**interface** *interface-list*]

MSTP Configuration Example

Network requirements

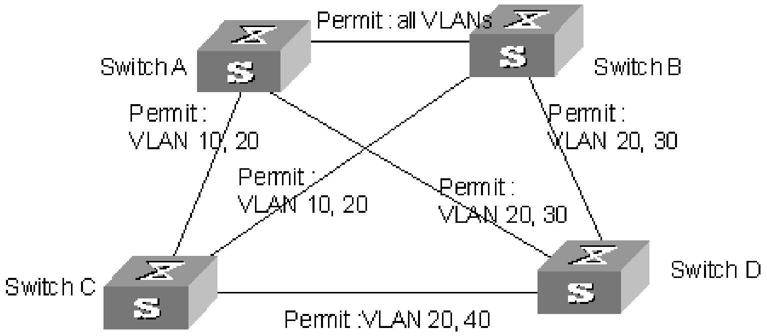
Perform MSTP configuration in the network shown in Figure 45 to enable packets of different VLANs to be forwarded along different spanning tree instances. The detailed requirements are as follows:

- All switches in the network belong to the same MST region.
- Packets of VLAN 10 are forwarded along spanning tree instance 1; those of VLAN 30 are forwarded along spanning tree instance 3; those of VLAN 40 are forwarded along spanning tree instance 4; and those of VLAN 20 are forwarded along spanning tree instance 0.

In this network, Switch A and Switch B operate at the distribution layer, Switch C and Switch D operate at the access layer. VLAN 10 and VLAN 30 are limited in the distribution layer and VLAN 40 is limited in the access layer. Switch A and Switch B are the root bridges of spanning tree instance 1 and spanning tree instance 3 respectively. Switch C is the root bridge of spanning tree instance 4.

Network diagram

Figure 45 Network diagram for MSTP configuration



The Permit: shown in Figure 45, means the corresponding link permits packets of specific VLANs.

Configuration procedure

1 Configure Switch A.

a Enter MST region view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp region-configuration
```

b Configure the MST region.

```
[S5500-mst-region] region-name example
[S5500-mst-region] instance 1 vlan 10
[S5500-mst-region] instance 3 vlan 30
[S5500-mst-region] instance 4 vlan 40
[S5500-mst-region] revision-level 0
```

c Activate the settings of the MST region.

```
[S5500-mst-region] active region-configuration
```

d Specify Switch A to be the root bridge of spanning tree instance 1.

```
[S5500] stp instance 1 root primary
```

2 Configure Switch B.

a Enter MST region view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp region-configuration
```

b Configure the MST region.

```
[S5500-mst-region] region-name example
[S5500-mst-region] instance 1 vlan 10
[S5500-mst-region] instance 3 vlan 30
[S5500-mst-region] instance 4 vlan 40
[S5500-mst-region] revision-level 0
```

c Activate the settings of the MST region.

```
[S5500-mst-region] active region-configuration
```

d Specify Switch B to be the root bridge of spanning tree instance 3.

```
[S5500] stp instance 3 root primary
```

3 Configure Switch C.

a Enter MST region view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp region-configuration
```

b Configure the MST region.

```
[S5500-mst-region] region-name example
[S5500-mst-region] instance 1 vlan 10
[S5500-mst-region] instance 3 vlan 30
[S5500-mst-region] instance 4 vlan 40
[S5500-mst-region] revision-level 0
```

c Activate the settings of the MST region.

```
[S5500-mst-region] active region-configuration
```

d Specify Switch C to be the root bridge of spanning tree instance 4.

```
[S5500] stp instance 4 root primary
```

4 Configure Switch D.

a Enter MST region view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp region-configuration
```

b Configure the MST region.

```
[S5500-mst-region] region-name example
[S5500-mst-region] instance 1 vlan 10
[S5500-mst-region] instance 3 vlan 30
[S5500-mst-region] instance 4 vlan 40
[S5500-mst-region] revision-level 0
```

c Activate the settings of the MST region.

```
[S5500-mst-region] active region-configuration
```

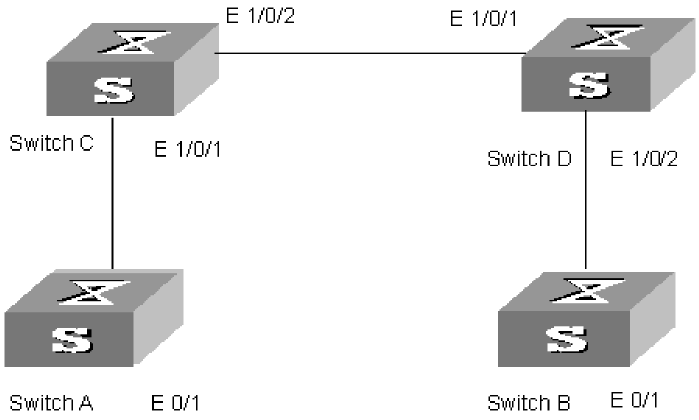
BPDU Tunnel Configuration Example

Network requirements

- Two Switch 5500 switches, Switch C and Switch D shown in Figure 46, operate as the access devices of the operator's network.
- Two S2000 series switches, Switch A and Switch B shown in Figure 46, are used as the access devices of the user network.
- Switch C and Switch D are connected to each other through two ports that are configured as trunk ports. The BPDU tunnel function is enabled in system view to allow transparent transmission of BPDUs over the operator's network.

Network diagram

Figure 46 Network diagram for BPDU tunnel configuration



Configuration procedure

1 Configure Switch A.

a Enable RSTP.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
```

b Add Ethernet0/1 port to VLAN 10.

```
[S5500] vlan 10
[S5500-Vlan10] port Ethernet 0/1
```

2 Configure Switch B.

a Enable RSTP.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
```

b Add Ethernet0/1 port to VLAN 10.

```
[S5500] vlan 10
[S5500-Vlan10] port Ethernet 0/1
```

3 Configure Switch C.

a Enable MSTP.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
```

b Enable the BPDU tunnel function.

```
[S5500] vlan-vpn tunnel
```

c Add Ethernet1/0/1 port to VLAN 10.

```
[S5500] vlan 10
[S5500-Vlan10] port Ethernet 1/0/1
[S5500-Vlan10] quit
```

d Disable STP and enable VLAN VPN on port Ethernet1/0/1 port.

```
[S5500] interface Ethernet 1/0/1
[S5500-Ethernet1/0/1] stp disable
[S5500-Ethernet1/0/1] vlan-vpn enable
[S5500-Ethernet1/0/1] quit
```

e Configure Ethernet1/0/2 port to be a trunk port.

```
[S5500] interface Ethernet 1/0/2
[S5500-Ethernet1/0/2] port link-type trunk
```

f Add the trunk port to all VLANs.

```
[S5500-Ethernet1/0/2] port trunk permit vlan all
```

4 Configure Switch D.

a Enable MSTP.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] stp enable
```

b Enable the BPDU tunnel function.

```
[S5500] vlan-vpn tunnel
```

c Add Ethernet1/0/2 port to VLAN 10.

```
[S5500] vlan 10
[S5500-Vlan10] port Ethernet 1/0/2
```

d Disable STP and enable VLAN VPN on port Ethernet1/0/2 port.

```
[S5500] interface Ethernet 1/0/2
[S5500-Ethernet1/0/2] stp disable
[S5500-Ethernet1/0/2] vlan-vpn enable
[S5500-Ethernet1/0/2] quit
```

e Configure Ethernet1/0/1 port to be a trunk port.

```
[S5500] interface Ethernet 1/0/1
[S5500-Ethernet1/0/1] port link-type trunk
```

f Add the trunk port to all VLANs.

```
[S5500-Ethernet1/0/1] port trunk permit vlan all
```

Notes:

- You must enable STP on a device before enabling the BPDU tunnel function on it.
- The BPDU tunnel function is only available to access ports.
- To implement the BPDU tunnel function, the links between operator networks must be trunk links.
- As the VLAN VPN function is unavailable to the ports with 802.1x, GVRP, GMRP, STP, or NTDP employed, the BPDU tunnel function is unavailable to these ports.

This chapter contains configuration information to create VLANs in batches, protocol-based VLANs and voice VLANs.

14 CENTRALIZED MAC ADDRESS AUTHENTICATION CONFIGURATION

Introduction to Centralized MAC Address Authentication

Centralized MAC address authentication controls accesses to a network through ports and MAC addresses. This kind of authentication requires no client software. When operating in centralized MAC address authentication mode, a switch begins to authenticate the user if it detects a new user MAC address.

Centralized MAC address authentication is implemented in the following two modes:

- MAC address mode. In this mode, user MAC address is used as both the user name and the password.
- Fixed mode. In this mode, user names and passwords are configured on the switch in advance. And users log on using the user names and passwords configured on the switch.

SWITCH 5500 series Ethernet switches support local authentication and RADIUS server authentication.

1. When a RADIUS server is used for authentication, the switch serves as a RADIUS client. In this case, centralized MAC address authentications are carried out as follows.
   - In MAC address mode, a switch sends newly detected MAC addresses to the RADIUS server as both the user names and passwords. The rest handling procedures are the same as that of 802.1x.
   - In fixed mode, a switch sends the user names and passwords configured for fixed mode on it to the RADIUS server. It also inserts user MAC addresses into the calling-station-id fields of the RADIUS packets sent to the RADIUS server. The rest handling procedures are the same as that of 802.1x.
   - The RADIUS server authenticates the user and grants the user the permission to access the network if the user passes the authentication.
2. When local authentication is used, users are authenticated by the switch. When configuring local authentication, note that:
   - For MAC address authentication mode, you need to provide MAC addresses as the user names and passwords. (The MAC addresses provided here need to be in the format of xx-xx-xx-xx-xx-xx, where the character x stands for a hexadecimal number ranging from 0 to f.)
   - For fixed mode, configure the user name and password as those for fixed mode.
   - Set local service type as LAN-access.

Centralized MAC Address Authentication Configuration

The following sections describe centralized MAC address authentication configuration tasks:

- Enabling Global/Port-based Centralized MAC Address Authentication
- Setting Centralized MAC Address Authentication Timers
- Setting Centralized MAC Address Authentication Timers
- Displaying and Debugging Centralized MAC Address Authentication
- Centralized MAC Address Authentication Configuration Example

For a port, the centralized MAC address authentication configuration and the maximum number of learned MAC addresses configuration are mutually exclusive. That is, if you enable the centralized MAC address authentication function for a port, the maximum number of learned MAC addresses configuration (see the ***mac-address max-mac-count*** *command) is unavailable. And if you set the maximum number of learned MAC addresses, the centralized MAC address authentication configuration is unavailable.*

Enabling Global/Port-based Centralized MAC Address Authentication

Table 175 lists the operations to enable centralized MAC address authentication on specified ports.

Table 175 Enable/disable centralized MAC address authentication

Operation	Command	Description
Enter system view	system-view	—
Enable centralized MAC address authentication	**mac-authentication interface** *interface-list*	Required By default, global and port-based centralized MAC address authentications are disabled.

Port-based centralized MAC address authentication configurations take effect only when global centralized MAC address authentication is also enabled.

Configuring an ISP Domain for MAC Address Authentication Users

Table 176 lists the operations to configure an ISP domain for centralized MAC address authentication users.

Table 176 Configure an ISP domain for MAC address authentication users

Operation	Command	Description
Enter system view	system-view	—
Configure an ISP domain for MAC address authentication users	**mac-authentication domain** *isp-name*	Required By default, the ISP domain is not configured for MAC address authentication users.

Setting Centralized MAC Address Authentication Timers

Following timers are used in centralized MAC address authentication.

- Offline-detect timer. This timer sets the interval for a switch to test whether or not a user goes offline. Upon determining a user is offline, a switch notifies the RADIUS server of the state of the user, and the RADIUS server in turn stops perform accounting operation on the user.
- Quiet timer. If a user fails to pass the authentication performed by a switch, the switch stops authenticating users for a specified period before it authenticates users again. You can use the quiet timer to set the period.

- Server-timeout timer. If the connection between a switch and a RADIUS server times out when the switch authenticates a user on one of its ports, the switch turns down the user. You can use the server-timeout timer to set the time out time.
- Table 177 lists the operations to set centralized MAC address authentication timers.

Table 177 Set a centralized MAC address authentication timer

Operation	Command	Description
Enter system view	system-view	
Set a centralized MAC address authentication timer	**mac-authentication timer** { **offline-detect** *offline-detect-value* | **quiet** *quiet-value* | **server-timeout** *server-timeout-value* }	Optional By default, the three MAC address authentication timers are set as follows: Offline-detect timer: 300 seconds Quiet timer: 1 minute Server-timeout timer: 100 seconds

Displaying and Debugging Centralized MAC Address Authentication

You can display and verify centralized MAC address authentication-related configuration by executing the **display** command in any view.

Table 178 Display and debug centralized MAC address authentication

Operation	Command	Description
Display global information about centralized MAC address authentication	**display mac-authentication** [**interface** *interface-list*]	Optional You can execute the **display** command in any view.

Centralized MAC Address Authentication Configuration Example

The configuration of centralized MAC address authentication is the same as that of 802.1x in this example except that:

- Centralized MAC address authentication is enabled both globally and for the ports.
- For MAC address mode, the user name and password of a user to be authenticated locally need to be configured as the MAC address of the user.
- For MAC address mode, the user name and password of a user to be authenticated by a RADIUS server need to be configured as the MAC address of the user on the RADIUS server.

The following example describes how to enable port-based and global centralized MAC address authentication, and local user configuration.

1 Enable centralized MAC address authentication on GigabitEthernet1/0/2 port.

```
<S5500> system-view
[S5500] mac-authentication interface GigabitEthernet 1/0/2
```

2 Configure centralized MAC address authentication mode to be MAC address mode.

```
[S5500] mac-authentication authmode usernameasmacaddress
```

3 Add a local access user.

a Configure the user name and password for the local user.

```
[S5500] local-user 00-e0-fc-01-01-01
[S5500-luser-00-e0-fc-01-01-01] password simple 00-e0-fc-01-01-01
```

b Set service type to LAN-access for the local user.

```
[S5500-luser-00-e0-fc-01-01-01] service-type lan-access
```

4 Enable global centralized MAC address authentication.

```
[S5500] mac-authentication
```

5 Configure the domain name for centralized MAC address authentication user to be aabbcc163.net.

```
[S5500] mac-authentication domain aabbcc163.net
```

15 SSH TERMINAL SERVICES

SSH Terminal Services

This section contains information for SSH Terminal Services.

Introduction to SSH

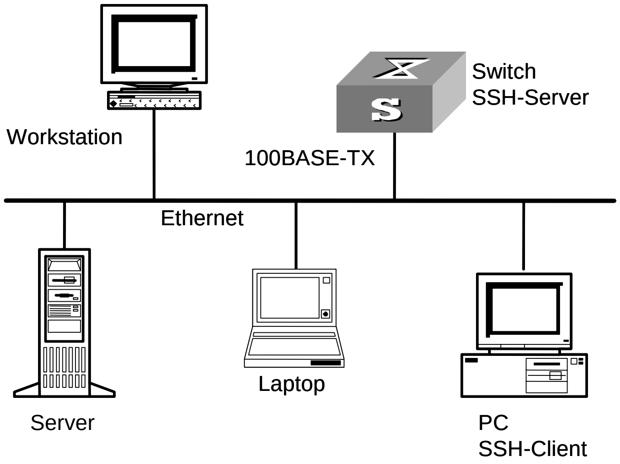
Secure Shell (SSH) can provide information security and powerful authentication to prevent such assaults as IP address spoofing, plain-text password interception when users log on to the Switch remotely using an insecure network environment.

- A Switch can connect to multiple SSH clients. SSH 2.0 and SSH1.x are currently available.
- SSH client functions to enable SSH connections between users and the Switch or UNIX host that support SSH server.

Figure 47 and Figure 48 show respectively SSH connection establishment for client and server.

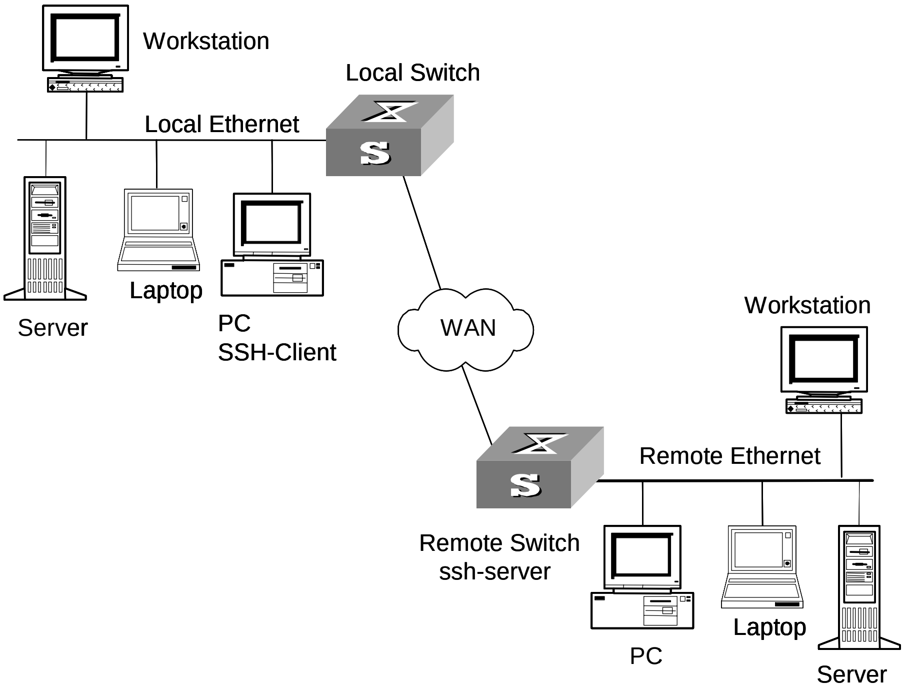
- SSH connections through LAN

Figure 47 Establish SSH channels through LAN



- SSH connections through WAN

Figure 48 Establish SSH channels through WAN



The communication process between the server and client includes these five stages:

1 Version negotiation stage. These operations are completed at this stage:

- The client sends TCP connection requirement to the server.
- When TCP connection is established, both ends begin to negotiate the SSH version.
- If they can work together in harmony, they enter the key algorithm negotiation stage. Otherwise the server clears the TCP connection.

2 Key algorithm negotiation stage. These operations are completed at this stage:

- The server randomly generates its RSA key and sends the public key to the client.
- The client figures out session key based on the public key from the server and the random number generated locally.
- The client encrypts the random number with the public key from the server and sends the result back to the server.
- The server then decrypts the received data with the server private key to get the client random number.
- The server then uses the same algorithm to work out the session key based on server public key and the returned random number.

Then both ends get the same session key without data transfer over the network, while the key is used at both ends for encryption and decryption.

3 Authentication method negotiation stage. These operations are completed at this stage:

- The client sends its username information to the server.
- The server authenticates the username information from the client. If the user is configured as no authentication on the server, authentication stage is skipped and session request stage starts directly.

- The client authenticates information from the user at the server till the authentication succeeds or the connection is turned off due to authentication timeout.

SSH supports two authentication types: password authentication and RSA authentication.

1 Password authentication works as follows:

- The client sends its username and password to the server.
- The server compares the username and password received with those configured locally. The user is allowed to log on to the Switch if the usernames and passwords match exactly.

2 RSA authentication works in this way:

- Configure the RSA public key of the client user at the server.
- The client sends the member modules of its RSA public key to the server.
- The server checks the validity of the member module. If it is valid, the server generates a random number, which is sent to the client after being encrypted with RSA public key of the client.
- Both ends calculate authentication data based on the random number and session ID.
- The client sends the authentication data calculated back to the server.
- The server compares it with its authentication data obtained locally. If they match exactly, the user is allowed to access the switch.

3 Session request stage. The client sends session request messages to the server which processes the request messages.

4 Interactive session stage. Both ends exchange data till the session ends.

SSH Server Configuration

Table 179 describes SSH server configuration tasks.

Table 179 Configure SSH 2.0 server

Serial No	Operation	Command	Description
1	Configure supported protocols	protocol inbound	Refer to "Configuring supported protocols"
2	Generate a local RSA key pair	**rsa local-key-pair create**	Refer to "Generating or destroying RSA key pairs"
	Destroy the local RSA key pair	**rsa local-key-pair destroy**	
3	Configure authentication mode for SSH users	ssh user username authentication-type	Refer to "Configuring authentication type"
4	Set SSH authentication timeout time	ssh server timeout	Refer to "Configuring server SSH attributes"
	Set SSH authentication retry number	ssh server authentication-retries	
5	Allocate public keys for SSH users	ssh user username assign rsa-key keyname	Refer to "Configuring client public keys"

Configuring supported protocols

Table 180 Configure supported protocols

Operation	Command	Description
Enter system view	system-view	-
Enter one or multiple user interface views	**user-interface** [type-keyword] number [ending-number]	Required
Configure the protocols supported in the user interface view(s)	protocol inbound { all |ssh | telnet }	Optional By default, the system supports both Telnet and SSH.

When SSH protocol is specified, to ensure a successful login, you must configure the AAA authentication using the ***authentication-mode scheme*** *command.*

The ***protocol inbound ssh*** *configuration fails if you configured* ***authentication-mode password*** *and* ***authentication-mode none****. When you configured SSH protocol successfully for the user interface, then you cannot configure authentication-mode password and authentication-mode none any more.*

Generating or destroying RSA key pairs

The name of the server RSA key pair is in the format of switch name plus _host, S5500_host for example.

After you use the command, the system prompts you to define the key length.

- In SSH1.x, the key length is in the range of 512 to 2,048 (bits).
- In SSH 2.0, the key length is in the range of 1,024 to 2,048 (bits). To make SSH 1.x compatible, 512 to 2,048-bit keys are allowed on clients, but the length of server keys must be more than 1,024 bits. Otherwise, clients cannot be authenticated.

Table 181 Generate or destroy RSA key pairs

Operation	Command	Description
Enter system view	system-view	-
Generate a local RSA key pair	rsa local-key-pair create	Required
Destroy a local RSA key pair	rsa local-key-pair destroy	Required

For a successful SSH login, you must generate the local RSA key pairs first.

You just need to execute the command once, with no further action required even after the system is rebooted.

If you use this command to generate an RSA key provided an old one exits, the system will prompt you to replace the previous one or not.

As a fabric contains multiple devices, you need to execute the ***rsa local-key-pair create*** *command first to make sure all the devices in the fabric share one RSA local-key pair.*

Configuring authentication type

New users must specify authentication type. Otherwise, they cannot access the switch.

Table 182 Configure authentication type

Operation	Command	Description
Enter system view	system-view	-
Configure authentication type for SSH users	**ssh user** *username* **authentication-type** { **password** | **password-publickey** | **rsa** | **all** }	Required

If RSA authentication type is defined, then the RSA public key of the client user must be configured on the switch.

By default, no authentication type is specified for a new user, so they cannot access the switch.

*If you specify the **password-publickey** keyword when execute the **ssh user** username **authentication-type** command, users using SSHv1 can log onto a switch if they pass one of the authentications, whereas those using SSHv2 need to pass both of the authentications to log onto a switch.*

Configuring server SSH attributes

Configuring server SSH authentication timeout time and retry number can effectively assure security of SSH connections and avoid illegal actions.

Configure server SSH attributes

Table 183 Configure server SSH attributes

Operation	Command	Description
Enter system view	**system-view**	-
Set SSH authentication timeout time	ssh server timeout *seconds*	Optional The timeout time defaults to 60 seconds.
Set SSH authentication retry number	ssh server authentication-retries *times*	Optional The retry number defaults to 3.

Configuring client public keys

This operation is not required for password authentication type.

You can configure RSA public keys for client users on the server in two ways:

1 Manual mode

- Operations on the client include:
- SSH1.5/2.0-supported client software generates randomly RSA key pairs.
- SSHKEY.EXE software converts the public part of the RSA key into PKCS code format.

Operations on the server are described in Table 184.

Table 184 Configure client public keys

Operation	Command	Description
Enter system view	system-view	-
Enter public key view	rsa peer-public-key *key-name*	Required
Enter public key edit view	public-key-code begin	Required You can key in a blank space between characters, since the system can remove the blank space automatically. But the public key should be composed of hexadecimal characters.
Return to public key view and save the public keys	public-key-code end	Required The system saves public key data when exiting from public key edit view
Return to system view	peer-public-key end	-
Allocate public keys to SSH users	ssh user *username* assign rsa-key *keyname*	Required *Keyname* is the name of an existing public key. If the user already has a public key, the new public key overrides the old one.

The manual mode is rather complex since it requires format conversation with the specific software first and then manual configuration.

2 Automatic mode with the command

Operations on the client include:

- SSH1.5/2.0-supported client software generates randomly RSA key pairs.
- Send the public key file to the Flash memory of the server using FTP/TFTP.

Operations on the server are described in Table 185.

Table 185 Configure client public keys

Operation	Command	Description
Enter system view	system-view	-
Convert the format and automatically configure the client public keys	rsa peer-public-key *key-name* import sshkey *filename*	Required The *filename* in the command must be consistent with the public key file name to be sent to the server Flash memory.

The automatic mode is recommended for its simplicity.

SSH Client Configuration

Table 186 describes SSH configuration tasks.

Table 186 Configure SSH client

Operation	Command	Description
Enter system view	system-view	-
Enable the connection between SSH client and server	ssh2 *host-ipaddr* [port] [prefer_kex { dh_group1 | dh_exchange_group }] [prefer_ctos_cipher { des | aes128 }] [prefer_stoc_cipher { des | aes128 }] [prefer_ctos_hmac { sha1 | sha1_96 | md5 | md5_96 }] [prefer_stoc_hmac { sha1 | sha1_96 | md5 | md5_96 }]	Required You can use this command to enable the connection between SSH client and server, define key exchange algorithm preference, encryption algorithm preference and HMAC algorithm preference between the server and client.
Allocate a public key to the server	ssh client *server-ip* assign rsa-key *keyname*	Required You can specify on the client the public key for the server to be connected to guarantee the client can be connected to a reliable server.
Configure the client to run the initial authentication	ssh client first-time enable	Optional By default, the client runs the initial authentication.

In the initial authentication, if the SSH client does not have the public key for the server which it accesses for the first time, the client continues to access the server and save locally the public key of the server. Then at the next access, the client can authenticate the server using the public key saved locally.

Displaying SSH Configuration

Use the **display** commands in any view to view the running of SSH and further to check the configuration result.

Table 187 Display SSH configuration

Operation	Command
Display host and server public keys	display rsa local-key-pair public
Display client RSA public key	display rsa peer-public-key [brief | name *keyname*]
Display SSH status and session information	display ssh server { status | session }
Display SSH user information	display ssh user-information [*username*]

Users using SecureCRT as the client side software will fail to log onto a switch if they check the Enable OpenSSH agent forwarding option.

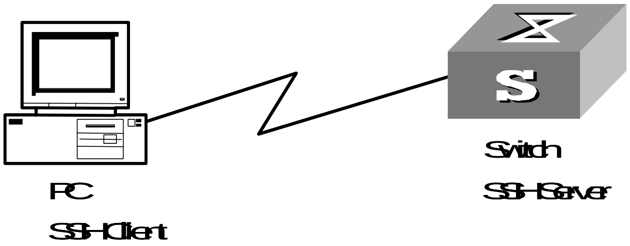
SSH Server Configuration Example

Network requirements

As shown in Figure 49, configure a local connection from the SSH client to the switch. The PC runs the SSH 2.0-supported client software.

Network diagram

Figure 49 Network diagram for SSH server configuration



Configuration procedure

1 Generate a local RSA key pair.

```
<S5500>system-view
[S5500] rsa local-key-pair create
```

If the local RSA key pair has been generated in previous operations, skip step 2.

2 Set authentication type.

Settings for the two authentication types are described respectively in :

- Password authentication
- RSA public key authentication

Password authentication

1 Set AAA authentication on the user interfaces.

```
[S5500] user-interface vty 0 4
[S5500-ui-vty0-4] authentication-mode scheme
```

2 Set the user interfaces to support SSH.

```
[S5500-ui-vty0-4] protocol inbound ssh
```

3 Configure the login protocol for the clinet001 user as SSH and authentication type as password.

```
[S5500] local-user client001
[S5500-luser-client001] password simple aabbcc
[S5500-luser-client001] service-type ssh
[S5500] ssh user client001 authentication-type password
```

Select the default SSH authentication timeout time and authentication retry number. After these settings, run the SSN2.0-supported client software on other hosts connected to the switch. Log in to the switch using user name client001 and password aabbcc.

RSA public key authentication

1 Set AAA authentication on the user interfaces.

```
[S5500] user-interface vty 0 4
[S5500-ui-vty0-4] authentication-mode scheme
```

2 Set the user interfaces to support SSH.

```
[S5500-ui-vty0-4] protocol inbound ssh
```

3 Configure the login protocol for the client002 user as SSH and authentication type as RSA public key.

```
[S5500] ssh user client002 authentication-type rsa
```

4 Generate randomly RSA key pairs on the SSH 2.0 client and send the corresponding public keys to the server.

5 Configure client public keys on the server, with their name as S5500002.

```
[S5500] rsa peer-public-key S5500002
[S5500-rsa-public-key] public-key-code begin
[S5500-rsa-key-code] 308186028180739A291ABDA704F5D93DC8FDF84C427463
[S5500-rsa-key-code] 1991C164B0DF178C55FA833591C7D47D5381D09CE82913
[S5500-rsa-key-code] D7EDF9C08511D83CA4ED2B30B809808EB0D1F52D045DE4
[S5500-rsa-key-code] 0861B74A0E135523CCD74CAC61F8E58C452B2F3F2DA0DC
[S5500-rsa-key-code] C48E3306367FE187BDD944018B3B69F3CBB0A573202C16
[S5500-rsa-key-code] BB2FC1ACF3EC8F828D55A36F1CDDC4BB45504F020125
[S5500-rsa-key-code] public-key-code end
[S5500-rsa-public-key] peer-public-key end
[S5500] ssh user client002 assign rsa-key S5500002
```

6 Start the SSH client software on the host which stores the RSA private keys and make corresponding configuration to establish an SSH connection.

SSH Client Configuration Example

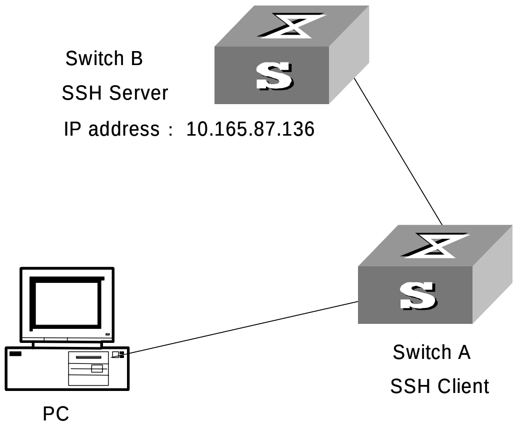
Network Requirements

As shown in Figure 50,

- Switch A serves as an SSH client with user name as client003.
- Switch B serves as an SSH server, with its IP address 10.165.87.136.

Network diagram

Figure 50 Network diagram for SSH client configuration



Configuration procedure

1 Configure the client to run the initial authentication.

```
[S5500] ssh client first-time enable
```

2 Configure server public keys on the client.

```
[S5500] rsa peer-public-key public
[S5500-rsa-public-key] public-key-code begin
[S5500-rsa-key-code] 308186028180739A291ABDA704F5D93DC8FDF84C427463
[S5500-rsa-key-code] 1991C164B0DF178C55FA833591C7D47D5381D09CE82913
[S5500-rsa-key-code] D7EDF9C08511D83CA4ED2B30B809808EB0D1F52D045DE4
[S5500-rsa-key-code] 0861B74A0E135523CCD74CAC61F8E58C452B2F3F2DA0DC
[S5500-rsa-key-code] C48E3306367FE187BDD944018B3B69F3CBB0A573202C16
[S5500-rsa-key-code] BB2FC1ACF3EC8F828D55A36F1CDDC4BB45504F020125
[S5500-rsa-key-code] public-key-code end
[S5500-rsa-public-key] peer-public-key end
[S5500] ssh client 10.165.87.136 assign rsa-key public
```

3 Start SSH client.

Settings for the two authentication types are described respectively in the following:

a Use the password authentication and start the client using the default encryption algorithm.

```
[S5500] ssh2 10.165.87.136
username: client003
Trying 10.165.87.136
Press CTRL+K to abort
Connected to 10.165.87.136...
The Server is not autherncated.Do you continue access it?(Y/N):y
Do you want to save the server's public key?(Y/N):y
Enter password:
*********************************************************
*          All rights reserved (1997-2005)              *
*      Without the owner's prior written consent,       *
*no decompiling or reverse-engineering shall be allowed.*
*********************************************************
<S5500>
```

b Start the client and use the RSA public key authentication according to the encryption algorithm defined.

```
[S5500] ssh2 10.165.87.136 22 perfer_kex dh_group1
perfer_ctos_cipher des perfer_ctos_hmac md5 perfer_stoc_hmac md5
username: client003
Trying 10.165.87.136...
Press CTRL+K to abort
Connected to 10.165.87.136...
The Server is not autherncated.Do you continue access it?(Y/N):y
Do you want to save the server's public key?(Y/N):y
*********************************************************
*          All rights reserved (1997-2005)              *
*      Without the owner's prior written consent,       *
*no decompiling or reverse-engineering shall be allowed.*
*********************************************************
<S5500>
```

SSH Keygen Program

This procedure details how to create an SSH Keygen

- OpenSSH (Linux/Unix)
- OpenSSH requires several additional configuration steps to work properly with the Switch 5500. This example will show how to create and modify an SSH key for use on the Switch 5500.

1 Create the local-key on linux/unix using the command:

```
./ssh-keygen -b 1024 -f ssh_rsa_key -t rsa
```

This will create two files "ssh_rsa_key" which is the Private key, and "ssh_rsa_key.pub" which is the Public key.

2 Copy the public key file ssh_rsa_key.pub to a windows pc from the linux/unix system. Open it with Notepad, the file will look like this:

```
ssh-rsa
AAAAB3NzaC1yc2EAAAABIwAAAIEA0Fa37P74lMp8STHs8enDBMDwTM1twvtnwanrFdY+ri
oHzXMnp8+S2c2jd30qzLV7t/cR25GeX/SwiIpcmlG107Fge20jVKqAGfnZkdEAChbJcbU7
OPK+av5Hq6e59Mgys1pDfhfwWNPrtxcM3BgoSo5Hj5EUtR2E4dbSS3jnR/E= localhost
```

3 Add these lines to the beginning of ssh_rsa_key.pub. Also, remove the old beginning "ssh-rsa" and the old ending "localhost".

```
---- BEGIN SSH2 PUBLIC KEY ----
Comment: "rsa-key-20051118"
AAAAB3NzaC1yc2EAAAABIwAAAIEA0Fa37P74lMp8STHs8enDBMDwTM1twvtnwanrFdY+ri
oHzXMnp8+S2c2jd30qzLV7t/cR25GeX/SwiIpcmlG107Fge20jVKqAGfnZkdEAChbJcbU7
OPK+av5Hq6e59Mgys1pDfhfwWNPrtxcM3BgoSo5Hj5EUtR2E4dbSS3jnR/E=
<<<<<The key is the same as in step 2.
---- END SSH2 PUBLIC KEY ----
```

4 Using sshkey.exe convert the key into the 3Com hex format and copy it into your switch.

5 Configure the switch and execute the command to log on

```
./ssh -2 -l usrname -i /home/user/ssh_rsa_key xx.xx.xx.xx (ip address of
switch)
```

BOTH the private AND public key MUST be in /home/user/ for OpenSSH to work. result:

```
[root@localhost openssh-4.2p1]# ./ssh -2 -l 1 -i /home/user/ssh_rsa_key
192.168.0.131
```

SFTP Service

The following sections describe SFTP service.

SFTP Overview

Secure FTP (SFTP) is a new feature introduced in SSH 2.0.

SFTP is established on SSH connections to secure remote users' login to the switch, perform file management and file transfer (such as upgrade the system), and provide secured data transfer. As an SFTP client, it allows you to securely log onto another device to transfer files.

SFTP Server Configuration

The following sections describe SFTP server configuration tasks:

- Configuring service type for an SSH user
- Enabling the SFTP server
- Setting connection timeout time

Configuring service type for an SSH user

Table 188 Configure service type for an SSH user

Operation	Command	Description
Enter system view	system-view	
Configure service type for an SSH user	ssh user *username* service-type { telnet | sftp | all }	Optional By default, the SSH service type is **telnet**.

Enabling the SFTP server

Table 189 Enable the SFTP server

Operation	Command	Description
Enter system view	system-view	-
Enable the SFTP server	sftp server enable	Required By default, the SFTP server is not enabled.

Setting connection timeout time

After you set the timeout time for the SFTP user connection, the system will automatically release the connection when the time is up.

Table 190 Set connection timeout time

Operation	Command	Description
Enter system view	system-view	
Set timeout time for the SFTP user connection	sftp time-out time-out-value	Required By default, the connection timeout time is 10 minutes.

SFTP Client Configuration

The following sections describe SFTP client configuration tasks:

- Configuring SFTP client
- Enabling the SFTP client
- Disabling the SFTP client
- Operating with SFTP directories
- Operating with SFTP files

Configuring SFTP client

Table 191 Configuring SFTP client

Serial No	Operation		Command	View	Description
1	Enable the SFTP client		sftp	System view	Required
2	Disable the SFTP client		bye	SFTP client view	Optional
			exit		
			quit		
3	SFTP directory -related operations	Change the current directory	cd	SFTP client view	Optional
		Return to the upper directory	cdup		
		Display the current directory	pwd		
		Display the list of the files in a directory	dir		
			ls		
		Create a new directory	mkdir		
		Delete a directory	rmdir		
4	SFTP file-related operations	Rename a file on the SFTP server	rename	SFTP client view	Optional
		Download a file from the remote SFTP server	get		
		Upload a local file to the remote SFTP server	put		
		Display the list of the files in a directory	dir		
			ls		
		Delete a file from the SFTP server	delete		
			remove		
5	Get help information about SFTP client commands		help	SFTP client view	Optional

Enabling the SFTP client

You can enable the SFTP client, establish a connection to the remote SFTP server and enter STP client view.

Table 192 Enable the SFTP client

Operation	Command	Description
Enter system view	**system-view**	-
Enable the SFTP client	**`sftp`** *ipaddr* [prefer_kex { dh_group1 | dh_exchange_group }] [prefer_ctos_cipher { des | aes128 }] [prefer_stoc_cipher { des | aes128 }] [prefer_ctos_hmac { sha1 | sha1_96 | md5 | md5_96 }] [prefer_stoc_hmac { sha1 | sha1_96 | md5 | md5_96 }]	Required

Disabling the SFTP client

Table 193 Disable the SFTP client

Operation	Command	Description
Enter system view	**system-view**	-
Enter SFTP client view	**sftp** { *host-ip* | *host-name* }	-
Disable the SFTP client	**bye**	The three commands have the same function.
	exit	
	quit	

Operating with SFTP directories

SFTP directory-related operations include: changing or displaying the current directory, creating or deleting a directory, displaying files or information of a specific directory.

Table 194 Operate with SFTP directories

Operation	Command	Description
Enter system view	system-view	Optional
Enter SFTP client view	**sftp** { *host-ip* | *host-name* }	
Change the current directory	**cd** *remote-path*	
Return to the upper directory	cdup	
Display the current directory	pwd	
Display the list of the files in a directory	**dir** [*remote-path*]	Optional The **dir** and **ls** commands have the same function.
	ls [*remote-path*]	
Create a directory on the SFTP server	**mkdir** *remote-path*	Optional
Delete a directory from the SFTP server	**rmdir** remote-path	

Operating with SFTP files

SFTP file-related operations include: changing file name, downloading files, uploading files, displaying the list of the files, deleting files.

Table 195 Operate with SFTP files

Operation	Command	Description
Enter system view	system-view	Optional
Enter SFTP client view	**sftp** { *host-ip* | *host-name* }	
Change the name of a file on the remote SFTP server	**rename** old-name new-name	
Download a file from the remote SFTP server	**get** remote-file [local-file]	
Upload a file to the remote SFTP server	**put** local-file [remote-file]	
Display the list of the files in a directory	**dir** [remote-path]	Optional The **dir** and **ls** commands have the same function.
	ls [remote-path]	
Delete a file from the SFTP server	**delete** remote-file	Optional The **delete** and **remove** commands have the same function.
	remove remote-file	

Displaying help information

You can display help information about a command, such as syntax and parameters.

Table 196 Display help information about SFTP client commands

Operation	Command	Description
Enter system view	system-view	-
Enter SFTP client view	**sftp** { *host-ip* | *host-name* }	-
Display help information about SFTP client commands	**help** [command-name]	Optional

SFTP Configuration Example

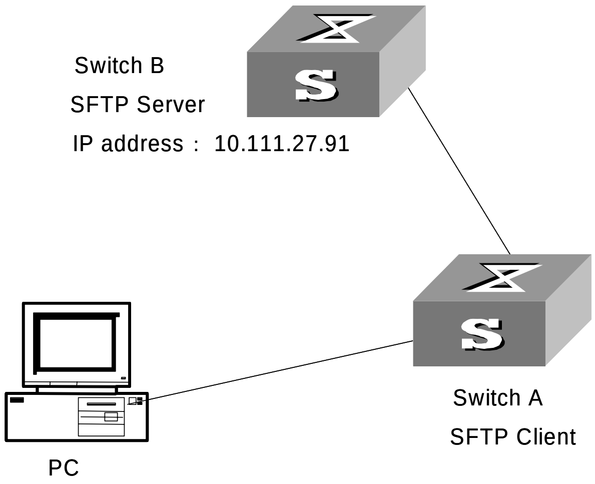
Network requirements

As shown in Figure 51,

- An SSH connection is present between Switch A and Switch B.
- Switch B serves as an SFTP server, with IP address 10.111.27.91.
- Switch A serves as an SFTP client.
- An SSH user name 8040 with password S5500 is created.

Network diagram

Figure 51 Network diagram for SFTP configuration



Configuration procedure

1 Configure Switch B (SFTP server)

a Enable the SFTP server.

```
[S5500] sftp server enable
```

b Specify SFTP service for SSH user 8040.

```
[S5500] ssh user 8040 service-type sftp
```

2 Configure Switch A (SFTP client)

a Establish a connection to the remote SFTP server and enter SFTP client view.

```
[S5500] sftp 10.111.27.91
```

b Display the current directory on the SFTP server, delete file z and verify the operation.

```
sftp-client> dir
-rwxrwxrwx   1 noone    nogroup      1759 Aug 23 06:52 vrpcfg.cfg
-rwxrwxrwx   1 noone    nogroup       225 Aug 24 08:01 pubkey2
-rwxrwxrwx   1 noone    nogroup       283 Aug 24 07:39 pubkey1
drwxrwxrwx   1 noone    nogroup         0 Sep 01 06:22 new
-rwxrwxrwx   1 noone    nogroup       225 Sep 01 06:55 pub
-rwxrwxrwx   1 noone    nogroup         0 Sep 01 08:00 z
sftp-client> delete z
The following File will be deleted:
flash:/z
Are you sure to delete it?(Y/N):y
This operation may take a long time.Please wait...

File successfully Removed
sftp-client> dir
-rwxrwxrwx   1 noone    nogroup      1759 Aug 23 06:52 vrpcfg.cfg
-rwxrwxrwx   1 noone    nogroup       225 Aug 24 08:01 pubkey2
-rwxrwxrwx   1 noone    nogroup       283 Aug 24 07:39 pubkey1
drwxrwxrwx   1 noone    nogroup         0 Sep 01 06:22 new
-rwxrwxrwx   1 noone    nogroup       225 Sep 01 06:55 pub
```

c Create directory new1 and verify the operation.

```
sftp-client> mkdir new1
New directory created
sftp-client> dir
-rwxrwxrwx   1 noone    nogroup      1759 Aug 23 06:52 vrpcfg.cfg
-rwxrwxrwx   1 noone    nogroup       225 Aug 24 08:01 pubkey2
-rwxrwxrwx   1 noone    nogroup       283 Aug 24 07:39 pubkey1
drwxrwxrwx   1 noone    nogroup         0 Sep 01 06:22 new
-rwxrwxrwx   1 noone    nogroup       225 Sep 01 06:55 pub
drwxrwxrwx   1 noone    nogroup         0 Sep 02 06:30 new1
```

d Change the name of directory new1 to new2 and verify the operation.

```
sftp-client> rename new1 new2
File successfully renamed
sftp-client> dir
-rwxrwxrwx   1 noone    nogroup      1759 Aug 23 06:52 vrpcfg.cfg
-rwxrwxrwx   1 noone    nogroup       225 Aug 24 08:01 pubkey2
-rwxrwxrwx   1 noone    nogroup       283 Aug 24 07:39 pubkey1
drwxrwxrwx   1 noone    nogroup         0 Sep 01 06:22 new
-rwxrwxrwx   1 noone    nogroup       225 Sep 01 06:55 pub
drwxrwxrwx   1 noone    nogroup         0 Sep 02 06:33 new2
```

e Download file pubkey2 and rename it to public.

```
sftp-client> get pubkey2 public
Remote  file:flash:/pubkey2 --->  Local file: public..
Downloading file successfully ended
```

f Upload file pu to the SFTP server and rename it to puk. Verify the operations.

```
sftp-client> put pu puk
Local file: pu --->  Remote file: flash:/puk
Uploading file successfully ended
sftp-client> dir
-rwxrwxrwx   1 noone    nogroup      1759 Aug 23 06:52 vrpcfg.cfg
-rwxrwxrwx   1 noone    nogroup       225 Aug 24 08:01 pubkey2
-rwxrwxrwx   1 noone    nogroup       283 Aug 24 07:39 pubkey1
drwxrwxrwx   1 noone    nogroup         0 Sep 01 06:22 new
drwxrwxrwx   1 noone    nogroup         0 Sep 02 06:33 new2
-rwxrwxrwx   1 noone    nogroup       283 Sep 02 06:35 pub
-rwxrwxrwx   1 noone    nogroup       283 Sep 02 06:36 puk
sftp-client>
```

g Exit from SFTP.

```
sftp-client> quit
Bye
[S5500]
```

16

IP ROUTING PROTOCOL OPERATION

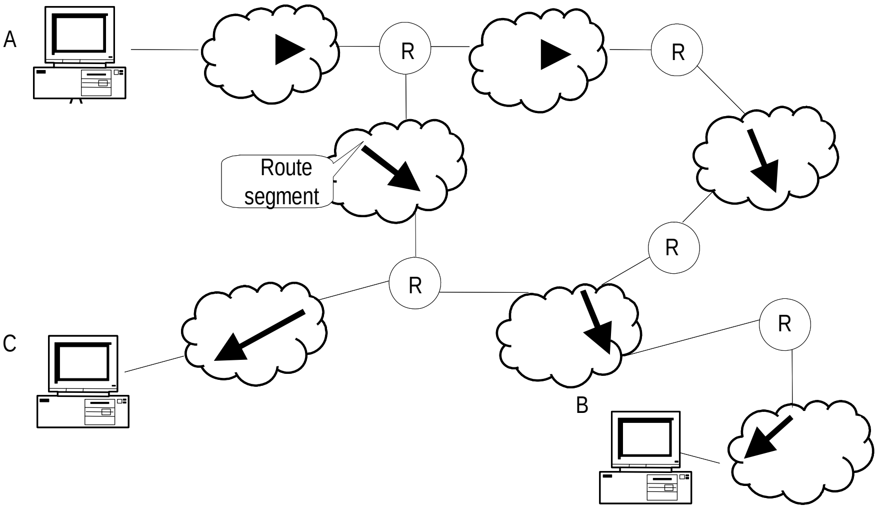
IP Routing Protocol Overview

Routers select an appropriate path through a network for an IP packet according to the destination address of the packet. Each router on the path receives the packet and forwards it to the next router. The last router in the path submits the packet to the destination host.

In a network, the router regards a path for sending a packet as a logical route unit, and calls it a hop. For example, in Figure 52, a packet sent from Host A to Host C goes through 3 networks and 2 routers and the packet is transmitted through two hops (represented by the bold arrows) and route segments. Therefore, when a node is connected to another node across a network, there is a hop between these two nodes and these two nodes are considered adjacent in the Internet. Adjacent routers are two routers connected to the same network. The number of route segments between a router and hosts in the same network is zero. A router can be connected to any physical link that constitutes a route segment for routing packets through the network.

When the Switch 5500 runs a routing protocol, it can perform router functions. In this guide, a router and its icon represent either a generic router or a Switch 5500 running routing protocols.

Figure 52 About hops



Networks can be different sizes, so the segment lengths between two different pairs of routers can also be different.

If a router in a network is regarded as a node and a route segment in the Internet is regarded as a link, message routing in the Internet works in a similar way as the message routing in a conventional network. The shortest route may not always be the optimal route. For example, routing through three LAN route segments may be much faster than routing through two WAN route segments.

Configuring the IP Routing Protocol is described in the following sections:

- Selecting Routes Through the Routing Table
- Routing Management Policy

Selecting Routes Through the Routing Table

For a router, the routing table is the key to forwarding packets. Each router saves a routing table in its memory, and each entry in this table specifies the physical port of the router through which a packet is sent to a subnet or a host. The packet can reach the next router over a particular path or reach a destination host through a directly connected network.

A routing table has the following key entries:

- A destination address—Identifies the destination IP address or the destination network of the IP packet, which is 32 bits in length.
- A network mask—Made up of several consecutive 1s, which can be expressed either in the dotted decimal format, or by the number of the consecutive 1s in the mask. Combined with the destination address, the network mask identifies the network address of the destination host or router. With the destination address and the network mask, you have the address of the network segment where the destination host or router is located. For example, if the destination address is 129.102.8.10, the address of the network where the host or the router with the mask 255.255.0.0 is located is 129.102.0.0.
- The output interface—Indicates an interface through which an IP packet should be forwarded.
- The next hop address—Indicates the next router that an IP packet will pass through.
- The priority added to the IP routing table for a route—Indicates the type of route that is selected. There may be multiple routes with different next hops to the same destination. These routes can be discovered by different routing protocols, or they can be the static routes that are configured manually. The route with the highest priority (the smallest numerical value) is selected as the current optimal route.

Routes are divided into the following types: subnet routes, in which the destination is a subnet, or host routes, in which the destination is a host.

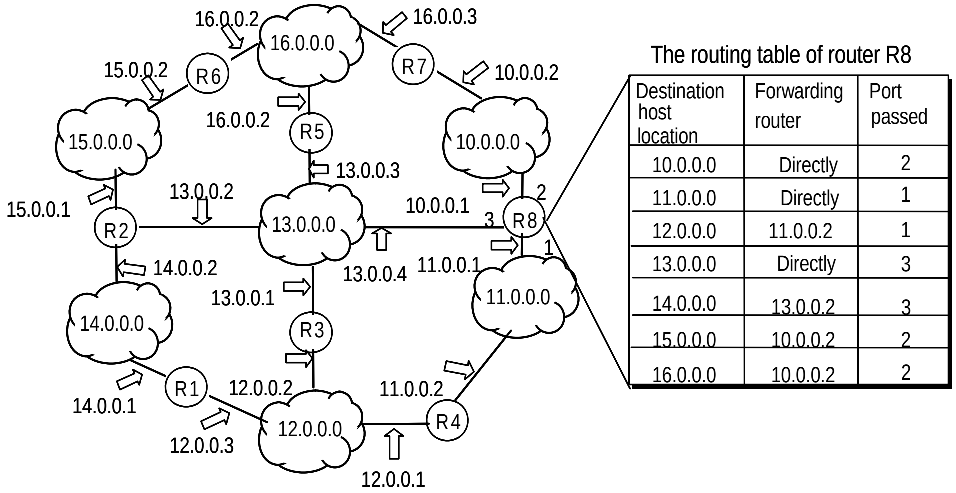
In addition, depending on whether the network of the destination host is directly connected to the router, there are the following types of routes:

- Direct route—The router is directly connected to the network where the destination is located.
- Indirect route—The router is not directly connected to the network where the destination is located.

To limit the size of the routing table, an option is available to set a default route. All the packets that fail to find a suitable table entry are forwarded through this default route.

In a complicated Internet configuration, as shown in Figure 53, the number in each network is the network address. The router R8 is connected to three networks, so it has three IP addresses and three physical ports. Its routing table is shown in Figure 53.

Figure 53 The routing table



The routing table of router R8

Destination host location	Forwarding router	Port passed
10.0.0.0	Directly	2
11.0.0.0	Directly	1
12.0.0.0	11.0.0.2	1
13.0.0.0	Directly	3
14.0.0.0	13.0.0.2	3
15.0.0.0	10.0.0.2	2
16.0.0.0	10.0.0.2	2

Routing Management Policy

The Switch 5500 supports the configuration of a series of dynamic routing protocols such as RIP and OSPF, as well as static routes. The static routes configured by the user are managed together with the dynamic routes as detected by the routing protocol. The static routes and the routes learned or configured by routing protocols can be shared with each other.

Routing Protocols and Route Preferences

Routing protocols (including static configurations) can generate different routes to the same destination, but not all these routes are optimal. In fact, at a certain moment, only one routing protocol can determine a current route to a single destination. Thus, each routing protocol (including static configurations) has a set preference, and when there are multiple routing information sources, the route with the highest preference becomes the current route. Routing protocols and the default preferences of the routes that they learn are shown in Table 197. The smaller the value, the higher the preference).

Table 197 Routing Protocols and the Default Preferences for Routes

Routing protocol or route type	The preference of the corresponding route
DIRECT	0
OSPF	10
ISIS	15
STATIC	60
RIP	100
OSPF ASE	150
OSPF NSSA	150
IBGP	256
EBGP	256
UNKNOWN	255

In Table 197, 0 indicates a direct route, and 255 indicates any route from an unreliable source.

Except for direct routing and BGP (IBGP and EBGP), the preferences of various dynamic routing protocols can be manually configured to meet the user requirements. The preferences for individual static routes can be different.

Supporting Load Sharing and Route Backup

I. Load sharing

Supports multi-route mode, allowing the user to configure multiple routes that reach the same destination and use the same precedence. The same destination can be reached using multiple different paths, whose precedences are equal. When there is no route that can reach the same destination with a higher precedence, the multiple routes will be adopted by IP, which will forward the packets to the destination using these paths so as to implement load sharing.

For the same destination, a specified routing protocol may find multiple different routes. If the routing protocol has the highest precedence among all active routing protocols, these multiple routes will be regarded as currently valid routes. Thus, load sharing of IP traffic is ensured in terms of routing protocols.

The Switch 5500 supports three routes to implement load sharing.

II. Route backup

Supports route backup. If the main route is in failure, the unit will automatically switch to a backup route to improve the network reliability.

To achieve route backup, the user can configure multiple routes to the same destination according to actual situation. One of the routes has the highest precedence and is called the main route. The other routes have descending precedences and are called backup routes. Normally, the router sends data using the main route. When the line fails, the main route will hide itself and the router will choose from one of the remaining routes as a backup route whose precedence is higher than the others to send data. This process is the switchover from the main route to the backup route. When the main route recovers, the router will restore it by re-selecting the main route. As the main route has the highest precedence, the router will select the main route again to send data. This process is the automatic switchover from the backup route to the main route.

Routes Shared between Routing Protocols

As the algorithms of various routing protocols are different, different protocols can generate different routes. This situation creates the problem of how to resolve the different routes being generated by different routing protocols. The Switch 5500 can import the information of another routing protocol. Each protocol has its own route redistribution mechanism. For details, refer to “Enabling RIP to Import Routes of Other Protocols” on page 230, “Configuring OSPF to Import the Default Route” on page 250 and “Importing Routing Information Discovered by Other Routing Protocols” on page 261.

Static Routes

A static route is a route that is manually configured by the network administrator. You can set up an interconnected network using static routes. However, if a fault occurs in the network, the static route cannot change automatically to steer packets away from the fault without the help of the administrator.

In a relatively simple network, you only need to configure static routes to make the router work normally. Proper configuration and usage of the static route can improve network performance and ensure bandwidth for important applications.

The following routes are static routes:

- Reachable route—The IP packet is sent to the next hop towards the destination. This is a common type of static route.
- Unreachable route—When a static route to a destination has the *reject* attribute, all the IP packets to this destination are discarded, and the originating host is informed that the destination is unreachable.
- Blackhole route—If a static route to a destination has the *blackhole* attribute, all the IP packets to this destination are discarded, and the originating host is not informed.

The attributes *reject* and *blackhole* are usually used to control the range of reachable destinations for the router, and to help troubleshoot the network.

Default Route

The default route is also a static route. The default route is used only when no suitable routing table entry is found. In a routing table, the default route is in the form of the route to the network 0.0.0.0 (with the mask 0.0.0.0). You can determine whether a default route has been set by viewing the output of the **`display ip routing-table`** command. If the destination address of a packet fails to match any entry of the routing table, the router selects the default route to forward this packet. If there is no default route and the destination address of the packet fails to match any entry in the routing table, the packet is discarded, and an Internet Control Message Protocol (ICMP) packet is sent to the originating host to indicate that the destination host or network is unreachable.

In a typical network that consists of hundreds of routers, if you used multiple dynamic routing protocols without configuring a default route then significant bandwidth is consumed. Using the default route can provide appropriate bandwidth for communications between large numbers of users.

Static Routes configuration is described in the following sections:

- Configuring Static Routes
- Troubleshooting Static Routes

Configuring Static Routes

Static route configuration tasks are described in the following sections:

- Configuring a Static Route
- Configuring a Default Route
- Deleting All The Static Routes
- Displaying and Debugging Static Routes

Configuring a Static Route

Perform the following configurations in System View.

Table 198 Configuring a static route

Operation	Command
Add a static route	**`ip route-static`** *`ip_address`* `{` *`mask`* `|` *`mask_length`* `} {` *`interface_type interface_number`* `|` *`gateway_address`* `} [` **`preference`** *`value`* `] [` **`reject`** `|` **`blackhole`** `]`
Delete a static route	**`undo ip route-static`** *`ip_address`* `{` *`mask`* `|` *`mask_length`* `} [` *`interface_type interface_number`* `|` *`gateway_address`* `] [` **`preference`** *`value`* `] [` **`reject`** `|` **`blackhole`** `]`

The parameters are explained as follows:

- IP address and mask

  The IP address and mask use a decimal format. Because the 1s in the 32-bit mask must be consecutive, the dotted decimal mask can also be replaced by the mask-length which refers to the digits of the consecutive 1s in the mask.

- Next hop address and NULL interface

  When configuring a static route, you can specify the *gateway_address* to decide the next hop address, depending on the actual conditions.

  For all the routing items, the next hop address must be specified. When the IP layer transmits a packet, it first searches the matching route in the routing table, depending on the destination address of the packet. Only when the next hop address of the route is specified can the link layer find the corresponding link layer address, and then forward the packet.

  The packets sent to the NULL interface, which is a virtual interface, are discarded at once. This can decrease system load.

  You cannot specify an interface address of the local Switch as the next hop address of an static route.

- Preference

  For different configurations of *preference_value*, you can flexibly apply the routing management policy.

- Other parameters

  The attributes **reject** and **blackhole** indicate the unreachable route and the blackhole route, respectively.

Configuring a Default Route

Perform the following configurations in System View.

Table 199 Configuring a default route

Operation	Command
Configure a default route	**ip route-static** 0.0.0.0 { 0.0.0.0 | 0 } { *interface_type interface_number* | *gateway_address* } [**preference** *value*] [**reject** | **blackhole**]
Delete a default route	**undo ip route-static** 0.0.0.0 { 0.0.0.0 | 0 } [*interface_type interface_number* | *gateway_address*] [**preference** *value*] [**reject** | **blackhole**]

The parameters for the default route are the same as those for the static route.

Deleting All The Static Routes

You can use the **undo ip route-static** command to delete a static route. The Switch 5500 also provides the **delete static-routes all** command for you to delete all static routes at one time, including the default routes.

Perform the following configuration in System View.

Table 200 Deleting all static routes

Operation	Command
Delete all static routes	**delete static-routes all**

Displaying and Debugging Static Routes

After you configure static and default routes, execute the **`display`** command in any view to display the static route configuration, and to verify the effect of the configuration.

Table 201 Displaying and debugging the routing table

Operation	Command
View routing table summary	**`display ip routing-table`**
View routing table details	**`display ip routing-table verbose`**
View the detailed information of a specific route	**`display ip routing-table`** *`ip_address`* `[` *`mask`* `]` `[` **`longer-match`** `]` `[` **`verbose`** `]`
View the route information in the specified address range	**`display ip routing-table`** *`ip_address1 mask1 ip_address2 mask2`* `[` **`verbose`** `]`
View the route filtered through specified basic access control list (ACL)	**`display ip routing-table acl`** *`acl_number`* `[` **`verbose`** `]`
View the route information that through specified ip prefix list	**`display ip routing-table ip-prefix`** *`ip_prefix_name`* `[` **`verbose`** `]`
View the routing information found by the specified protocol	**`display ip routing-table protocol`** *`protocol`* `[` **`inactive`** `|` **`verbose`** `]`
View the tree routing table	**`display ip routing-table radix`**
View the statistics of the routing table	**`display ip routing-table statistics`**

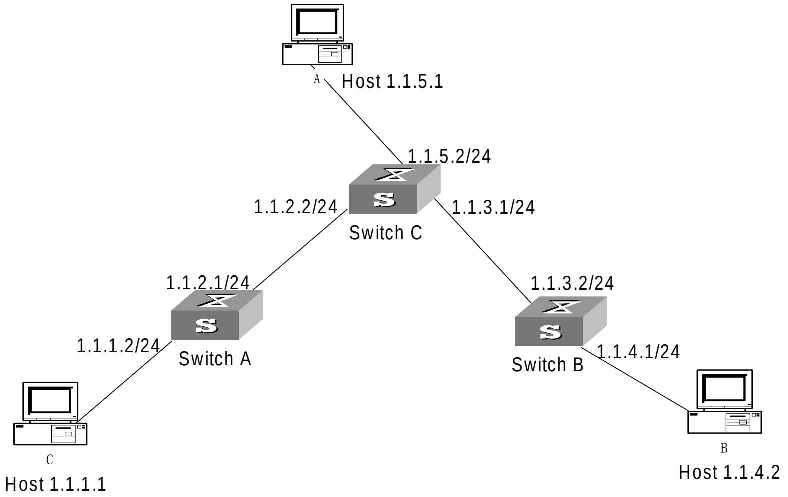
Example: Typical Static Route Configuration

Networking Requirements

The masks of all the IP addresses shown in Figure 54 are 255.255.255.0. All the hosts or switches must be interconnected in pairs by configuring static routes.

Networking Diagram

Figure 54 Networking diagram of the static route configuration example



Configuration procedure

1 Configure the static route for Ethernet Switch A

```
[Switch A]ip route-static 1.1.3.0 255.255.255.0 1.1.2.2
[Switch A]ip route-static 1.1.4.0 255.255.255.0 1.1.2.2
[Switch A]ip route-static 1.1.5.0 255.255.255.0 1.1.2.2
```

2 Configure the static route for Ethernet Switch B

```
[Switch B]ip route-static 1.1.2.0 255.255.255.0 1.1.3.1
[Switch B]ip route-static 1.1.5.0 255.255.255.0 1.1.3.1
[Switch B]ip route-static 1.1.1.0 255.255.255.0 1.1.3.1
```

3 Configure the static route for Ethernet Switch C

```
[Switch C]ip route-static 1.1.1.0 255.255.255.0 1.1.2.1
[Switch C]ip route-static 1.1.4.0 255.255.255.0 1.1.3.2
```

4 Configure the default gateway of the Host A to be 1.1.5.2

5 Configure the default gateway of the Host B to be 1.1.4.1

6 Configure the default gateway of the Host C to be 1.1.1.2

Using this procedure, all the hosts or switches in Figure 54 can be interconnected in pairs.

Troubleshooting Static Routes

The Switch 5500 is not configured with the dynamic routing protocol enabled. Both the physical status and the link layer protocol status of the interface are enabled, but the IP packets cannot be forwarded normally.

Troubleshooting:

- Use the **`display ip routing-table protocol static`** command to view whether the corresponding static route is correctly configured.
- Use the **`display ip routing-table`** command to view whether the corresponding route is valid.

RIP

Routing Information Protocol (RIP) is a simple dynamic routing protocol, that is Distance-Vector (D-V) algorithm based. It uses hop counts to measure the distance to the destination host. This is called the routing cost. In RIP, the hop count from a router to its directly connected network is 0; the hop count to a network which can be reached through another router is 1; and so on. To restrict the time to converge, RIP prescribes that the cost value is an integer ranging from 0 and 15. A hop count equal to or exceeding 16 is defined as infinite, which indicates that the destination network or the host is unreachable.

RIP sends a routing refresh message every 30 seconds. If no routing refresh message is received from a network neighbor in 180 seconds, RIP tags all routes of the network neighbor as unreachable. If no routing refresh message is received from a network neighbor in 300 seconds, RIP removes the routes of the network neighbor from the routing table.

To improve network performances and avoid routing loops, RIP supports split horizon, poison reverse, and allows importing of routes discovered by other routing protocols.

Each router that is running RIP manages a route database, which contains routing entries to all the reachable destinations in the network. These routing entries contain the following information:

- Destination address—The IP address of a host or network.
- Next hop address—The address of the next router that an IP packet will pass through for reaching the destination.
- Output interface—The interface through which the IP packet should be forwarded.

- Cost—The cost for the router to reach the destination, which should be an integer in the range of 0 to 16.
- Timer—The length of time from the last time that the routing entry was modified until now. The timer is reset to 0 whenever a routing entry is modified.
- Route tag—The indication whether the route is generated by an interior routing protocol or by an exterior routing protocol.

The process of RIP startup and operation is as follows:

1. If RIP is enabled on a router for the first time, the router broadcasts or multicasts a request packet to the adjacent routers. When they receive the request packet, adjacent routers (on which RIP is also enabled) respond to the request by returning response packets containing information about their local routing tables.
2. After receiving the response packets, the router that sent the request modifies its own routing table.
3. RIP broadcasts its routing table to the adjacent routers every 30 seconds. The adjacent routers maintain their own routing table after receiving the packets and elect an optimal route. They then advertise the modification information to their adjacent network to make the updated route globally available. RIP uses the timeout mechanism to handle timed out routes to ensure the timeliness and validity of the routes. With these mechanisms, RIP, an interior routing protocol, enables the router to learn the routing information of the entire network.

RIP has become one of the most popular standards of transmitting router and host routes. It can be used in most campus networks and regional networks that are simple yet extensive. RIP is not recommended for larger and more complicated networks.

RIP configuration is described in the following sections:

- Configuring RIP
- Troubleshooting RIP

Configuring RIP

Only after RIP is enabled can other functional features be configured. But the configuration of the interface-related functional features is not dependent on whether RIP has been enabled.

After RIP is disabled, the interface-related features also become invalid.

The RIP configuration tasks are described in the following sections:

- Enabling RIP and Entering the RIP View
- Enabling RIP on a Specified Network
- Configuring Unicast RIP Messages
- Specifying the RIP Version
- Configuring RIP Timers
- Configuring RIP-1 Zero Field Check of the Interface Packet
- Specifying the Operating State of the Interface
- Disabling Host Route
- Enabling RIP-2 Route Aggregation
- Setting RIP-2 Packet Authentication
- Configuring Split Horizon

- Enabling RIP to Import Routes of Other Protocols
- Configuring the Default Cost for the Imported Route
- Setting the RIP Preference
- Setting Additional Routing Metrics
- Configuring Route Filtering

Enabling RIP and Entering the RIP View

Perform the following configurations in System View

Table 202 Enabling RIP and Entering the RIP View

Operation	Command
Enable RIP and enter RIP view	**`rip`**
Disable RIP	**`undo rip`**

By default, RIP is not enabled.

Enabling RIP on a Specified Network

For flexible control of RIP operation, you can specify the interface and configure the network on which the interface is located to the RIP network, so that these interfaces can send and receive RIP packets.

Perform the following configurations in RIP View.

Table 203 Enabling RIP Interface

Operation	Command
Enable RIP on the specified network	**`network`** *`network_address`*
Disable RIP on the specified network	**`undo network`** *`network_address`*

After the RIP interface is enabled, you should also specify its operating network segment, because RIP only operates on the interface when the network segment has been specified. RIP does not receive or send routes for an interface that is not on the specified network, and does not forward its interface route.

When the **`network`** command is used for an address, the effect is to enable the interface of the network with this address. For example, for network 129.102.1.1, you can see network 129.102.0.0 either using the **`display current-configuration`** command, or using the **`display rip`** command.

By default, RIP is disabled on all interfaces.

Configuring Unicast RIP Messages

RIP is a broadcast protocol. To exchange routing information with a non-broadcast network, unicast transmission mode must be used.

Perform the following configuration in the RIP View.

Table 204 Configuring unicast RIP messages

Operation	Command
Configure unicast RIP message	**`peer`** *`ip_address`*
Cancel unicast RIP message	**`undo peer`** *`ip_address`*

By default, RIP does not send messages to unicast addresses.

3Com does not recommend the use of this command, because the destination address does not need to receive two copies of the same message at the same time. Note that **peer** should be restricted using the following commands: **rip work**, **rip output**, **rip input** and **network**.

Specifying the RIP Version

RIP has two versions, RIP-1 and RIP-2. You can specify the version of the RIP packet used by the interface.

RIP-1 broadcasts the packets. RIP-2 can transmit packets by both broadcast and multicast. By default, multicast is adopted for transmitting packets. In RIP-2, the default multicast address is 224.0.0.9. The advantage of transmitting packets in multicast mode is that the hosts in the same network that do not run RIP, do not receive RIP broadcast packets. In addition, this mode prevents the hosts that are running RIP-1 from incorrectly receiving and processing the routes with subnet masks in RIP-2. When an interface is running RIP-2, it can also receive RIP-1 packets.

Perform the following configuration in Interface View.

Table 205 Specifying RIP Version of the Interface

Operation	Command
Specify the interface version as RIP-1	**rip version 1**
Specify the interface version as RIP-2	**rip version 2** [**broadcast** | **multicast**]
Restore the default RIP version running on the interface	**undo rip version**

By default, the interface receives and sends the RIP-1 packets. It transmits packets in multicast mode when the interface RIP version is set to RIP-2.

Configuring RIP Timers

As stipulated in RFC1058, RIP is controlled by three timers: period update, timeout, and garbage-collection:

- Period update is triggered periodically to send all RIP routes to all neighbors.
- If an RIP route has not been updated when the timeout timer expires, the route is considered unreachable.
- If the garbage-collection timer expires before the unreachable route is updated by the update packets from the neighbors, the route will be deleted completely from the routing table.

Modification of these timers can affect the convergence speed of RIP.

Perform the following configuration in RIP View.

Table 206 Configuring RIP timers

Operation	Command
Configure RIP timers	**timers** { **update** *update_timer_length* | **timeout** *timeout_timer_length* } *
Restore the default settings of RIP	**undo timers** { **update** | **timeout** } *

The modification of RIP timers is validated immediately.

By default, the values of the period update and timeout timers are 30 seconds and 180 seconds respectively. The value of the garbage-collection timer is four times of that of Period Update timer: 120 seconds.

In fact, you may find that the timeout time of the garbage-collection timer is not fixed. If the period update timer is set to 30 seconds, the garbage-collection timer might range from 90 to 120 seconds.

Before RIP completely deletes an unreachable route from the routing table, it advertises the route by sending four update packets with a route metric of 16, to let all the neighbors know that the route is unreachable. Routes do not always become unreachable when a new period starts so the actual value of the garbage-collection timer is 3 to 4 times of that of the period update timer.

You must consider network performance when adjusting RIP timers, and configure all the routes that are running RIP, so as to avoid unnecessary traffic or network oscillation.

Configuring RIP-1 Zero Field Check of the Interface Packet

According to the RFC1058, some fields in the RIP-1 packet must be 0. When an interface version is set to RIP-1, the zero field check must be performed on the packet. If the value in the zero field is not zero, processing is refused. There are no zero fields in RIP-2 packets so configuring a zero field check is invalid for RIP-2.

Perform the following configurations in RIP View.

Table 207 Configuring Zero Field Check of the Interface Packets

Operation	Command
Configure zero field check on the RIP-1 packet	**`checkzero`**
Disable zero field check on the RIP-1 packet	**`undo checkzero`**

Specifying the Operating State of the Interface

In the Interface View, you can specify whether RIP update packets are sent and received on the interface. In addition, you can specify whether an interface sends or receives RIP update packets.

Perform the following configuration in Interface View:

Table 208 Specifying the Operating State of the Interface

Operation	Command
Enable the interface to run RIP	**`rip work`**
Disable the interface from running RIP	**`undo rip work`**
Enable the interface to receive RIP update packets	**`rip input`**
Disable the interface from receiving RIP update packets	**`undo rip input`**
Enable the interface to send RIP update packets	**`rip output`**
Disable the interface from sending RIP update packets	**`undo rip output`**

The **`undo rip work`** command and the **`undo network`** command have similar but not the same functions. The **`undo rip work`** command allows other interfaces to forward the route of the interface applying this command. The **`undo network`** command prevents other interfaces from forwarding the route of the interface applying this command, and it appears that this interface has been removed.

In addition, the **rip work** command is functionally equivalent to both the **rip input** and **rip output** commands.

By default, all interfaces except loopback interfaces both receive and transmit RIP update packets.

Disabling Host Route

In some cases, the router can receive many host routes from the same segment, and these routes are of little help in route addressing but consume a lot of network resources. Routers can be configured to reject host routes by using the **undo host-route** command.

Perform the following configurations in RIP View.

Table 209 Disabling Host Route

Operation	Command
Enable receiving host route	**host-route**
Disable receiving host route	**undo host-route**

By default, the router receives the host route.

Enabling RIP-2 Route Aggregation

Route aggregation means that different subnet routes in the same natural network can be aggregated into one natural mask route for transmission when they are sent to other networks. Route aggregation can be performed to reduce the routing traffic on the network as well as to reduce the size of the routing table.

RIP-1 only sends the routes with natural mask, that is, it always sends routes in the route aggregation form.

RIP-2 supports subnet mask and classless inter-domain routing. To advertise all the subnet routes, the route aggregation function of RIP-2 can be disabled.

Perform the following configurations in RIP View.

Table 210 Enabling Route Aggregation

Operation	Command
Activate the automatic aggregation function of RIP-2	**summary**
Disable the automatic aggregation function of RIP-2	**undo summary**

By default, RIP-2 uses the route aggregation function.

Setting RIP-2 Packet Authentication

RIP-1 does not support packet authentication. However, you can configure packet authentication on RIP-2 interfaces.

RIP-2 supports two authentication modes:

- Simple authentication—This mode does not ensure security. The key is not encrypted and can be seen in a network trace, so simple authentication should not be applied when there are high security requirements.
- MD5 authentication—This mode uses two packet formats. One format follows RFC1723, and the other follows RFC2082.

Perform the following configuration in Interface View:

Table 211 Setting RIP-2 Packet Authentication

Operation	Command
Configure RIP-2 simple authentication key	**rip authentication-mode simple** *password_string*
Configure RIP-2 MD5 authentication with packet type following RFC 1723	**rip authentication-mode md5 usual** *key_string*
Configure RIP-2 MD5 authentication with packet type following RFC 2082	**rip authentication-mode md5 nonstandard** *key_string key_id*
Cancel authentication of RIP-2 packet	**undo rip authentication-mode**

The **usual** packet format follows RFC1723 and **nonstandard** follows RFC2082.

Configuring Split Horizon

Split horizon means that the route received through an interface will not be sent through this interface again. The split horizon algorithm can reduce the generation of routing loops, but in some special cases, split horizon must be disabled to obtain correct advertising at the cost of efficiency. Disabling split horizon has no effect on P2P connected links but is applicable on the Ethernet.

Perform the following configuration in Interface View:

Table 212 Configuring Split Horizon

Operation	Command
Enable split horizon	**rip split-horizon**
Disable split horizon	**undo rip split-horizon**

By default, split horizon is enabled.

Enabling RIP to Import Routes of Other Protocols

RIP allows users to import the route information of other protocols into the routing table.

RIP can import routes from protocols including direct, static and OSPF.

Perform the following configurations in RIP View.

Table 213 Enabling RIP to Import Routes of Other Protocols

Operation	Command
Enable RIP to import routes of other protocols	**import-route** *protocol* [**cost** *value*] [**route-policy** *route_policy_name*]
Disable route imports from other protocols	**undo import-route** *protocol*

By default, RIP does not import the route information of other protocols.

Configuring the Default Cost for the Imported Route

When you use the **import-route** command to import the routes of other protocols, you can specify their cost. If you do not specify the cost of the imported route, RIP will set the cost to the default cost, specified by the **default cost** parameter.

Perform the following configurations in RIP View.

Table 214 Configuring the Default Cost for the Imported Route

Operation	Command
Configure default cost for the imported route	**`default cost`** *`value`*
Restore the default cost of the imported route	**`undo default cost`**

By default, the cost *`value`* for the RIP imported route is 1.

Setting the RIP Preference

Each routing protocol has its own preference by which the routing policy selects the optimal route from the routes of different protocols. The greater the preference value, the lower the preference. The preference of RIP can be set manually.

Perform the following configurations in RIP View.

Table 215 Setting the RIP Preference

Operation	Command
Set the RIP Preference	**`preference`** *`value`*
Restore the default value of RIP preference	**`undo preference`**

By default, the preference of RIP is 100.

Setting Additional Routing Metrics

The additional routing metric is the input or output routing metric added to an RIP route. It does not change the metric value of the route in the routing table, but adds a specified metric value when the interface receives or sends a route.

Perform the following configuration in Interface View:

Table 216 Setting Additional Routing Metrics

Operation	Command
Set the additional routing metric of the route when the interface receives an RIP packet	**`rip metricin`** *`value`*
Disable the additional routing metric of the route when the interface receives an RIP packet	**`undo rip metricin`**
Set the additional routing metric of the route when the interface sends an RIP packet	**`ip metricout`** *`value`*
Disable the additional routing metric of the route when the interface sends an RIP packet	**`undo rip metricout`**

By default, the additional routing metric added to the route when RIP sends the packet is 1. The additional routing metric when RIP receives the packet is 0.

The metricout configuration takes effect only on the RIP routes learnt by the router and RIP routes generated by the router itself, which means that it has no effect on the routes imported to RIP by other routing protocols.

Configuring Route Filtering

The Router provides a route filtering function. You can configure the filter policy rules by specifying the ACL and ip-prefix for route redistribution and distribution. To import a route, the RIP packet of a specific router can also be received by designating a neighbor router.

Perform the following configurations in RIP View.

Configuring RIP to Filter the Received Routes

Table 217 Configuring RIP to Filter the Received Routes

Operation	Command
Filter the received routing information distributed by the specified address	**filter-policy gateway** *ip_prefix_name* **import**
Cancel filtering of the received routing information distributed by the specified address	**undo filter-policy gateway** *ip_prefix_name* **[gateway** *ip-prefix-name* **] | route-policy** *route-policy-name* **} import**
Filter the received global routing information	**filter-policy** {*acl_number* | **ip-prefix** *ip_prefix_name* **[gateway** *ip-prefix-name* **] | route-policy** *route-policy-name* **} import**
Cancel filtering of the received global routing information	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } **import**

Configuring RIP to Filter the Distributed Routes

Table 218 Configuring RIP to Filter the Distributed Routes

Operation	Command
Configure RIP to filter the distributed routing information	**filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* | **route-policy** *route_policy_name* } **export** [*routing_protocol*]
Cancel the filtering of the routing information	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix-name* | **route-policy** *route_policy_name* } **export** [*routing_protocol*]

By default, RIP will not filter the received and distributed routing information.

- *The* `filter-policy import` *command filters the RIP routes received from its neighbors, and the routes that cannot pass the filter will not be added to the routing table, and will not be advertised to the neighbors.*
- *The* `filter-policy export` *command filters all the advertised routes, including routes imported by using the* `import-route` *command, and RIP routes learned from the neighbors.*
- *If the* `filter-policy export` *command does not specify which route is to be filtered, then all the routes imported by the* `import-route` *command and the transmitted RIP routes will be filtered.*

Traffic Sharing Across RIP Interfaces

Equal-cost routes are routes with the same destination but different next hop addresses in a routing table. After traffic sharing across RIP interfaces is enabled, the system averagely distributes the traffic to its RIP interfaces through equal-cost routes.

Configuration Procedure

You can perform the following operations to configure traffic sharing across RIP interfaces.

Table 219 Configure traffic sharing across RIP interfaces

Operation	Command	Description
Enter system view	system-view	-
Enter RIP view	rip	-
Enable traffic sharing across RIP interfaces	traffic-share-across-interface	Required By default, traffic sharing across RIP interfaces is disabled.
Display the current running state and configuration information of the RIP protocol	display rip	You can execute this command in any view.

Displaying and Debugging RIP

After configuring RIP, enter the `display` command in any view to display the RIP configuration, and to verify the effect of the configuration. Enter the `debugging` command in User View to debug the RIP module. Enter the `reset` command in RIP View to reset the system configuration parameters of RIP.

Table 220 Displaying and Debugging RIP

Operation	Command
Display the current RIP running state and configuration information	**display rip**
Enable the RIP debugging information	**debugging rip packet**
Disable the RIP debugging information	**undo debugging rip packet**
Enable the debugging of RIP receiving packet	**debugging rip receive**
Disable the debugging of RIP receiving packet	**undo debugging rip receive**
Enable the debugging of RIP sending packet	**debugging rip send**
Disable the debugging of RIP sending packet	**undo debugging rip send**
Reset the system configuration parameters of RIP	**reset**

Display Command for RIP Interfaces

Use the command **display rip interface** to display information about RIP interfaces.

Example: Typical RIP Configuration

Networking Requirements

As shown in Figure 55, Switch C connects to the subnet 117.102.0.0 through the Ethernet port. The Ethernet ports of Switch A and Switch B are connected to the networks 155.10.1.0 and 196.38.165.0 respectively. Switch C, Switch A and Switch B are connected using Ethernet 110.11.2.0. Correctly configure RIP to ensure that Switch C, Switch A and Switch B can interconnect.

Networking Diagram

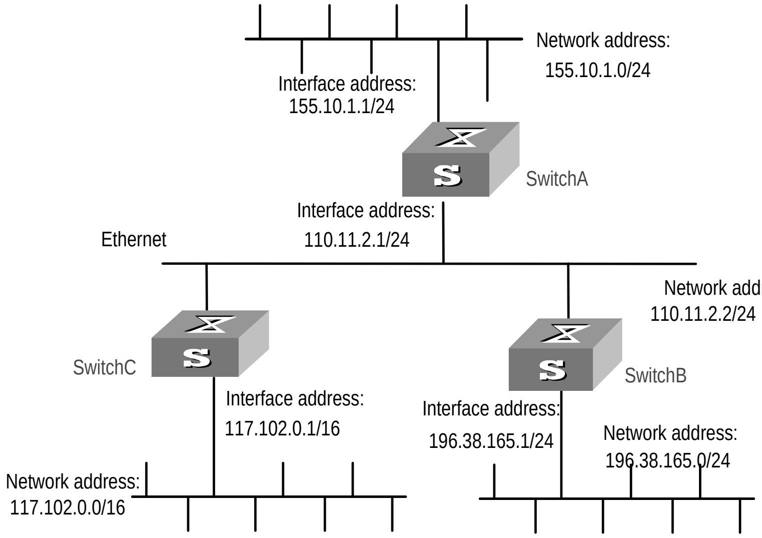


Figure 55 RIP configuration networking

Configuration Procedure

The following configuration only shows the operations related to RIP. Before performing the following configuration, please make sure the Ethernet link layer can work normally.

1 Configure RIP on Switch A

```
[Switch A]rip
[Switch A-rip]network 110.11.2.0
[Switch A-rip]network 155.10.1.0
```

2 Configure RIP on Switch B

```
[Switch B]rip
[Switch B-rip]network 196.38.165.0
[Switch B-rip]network 110.11.2.0
```

3 Configure RIP on Switch C

```
[Switch C]rip
[Switch C-rip]network 117.102.0.0
[Switch C-rip]network 110.11.2.0
```

Troubleshooting RIP

The Switch 5500 cannot receive the update packets when the physical connection to the peer routing device is normal.

- RIP does not operate on the corresponding interface (for example, the **`undo rip work`** command is executed) or this interface is not enabled through the **`network`** command.
- The peer routing device is configured to be in the multicast mode (for example, the **`rip version 2 multicast`** command is executed) but the multicast mode has not been configured on the corresponding interface of the local Ethernet Switch.

OSPF Configuration

Open Shortest Path First (OSPF) is an Interior Gateway Protocol based on the link state developed by IETF.

Only the Switch 5500-EI supports the OSPF protocol.

The Switch 5500 uses OSPF version 2 (RFC2328), which has the following features:

- Scope—Supports networks of various sizes and can support several hundred routers.
- Fast convergence—Transmits the update packets instantly after the network topology changes so that the change is synchronized in the AS.
- Loop-free—Calculates routes with the shortest path tree algorithm, according to the collected link states, so that no loop routes are generated from the algorithm itself.
- Area partition—Allows the network of AS to be divided into different areas for management convenience, so that the routing information that is transmitted between the areas is further abstracted to reduce network bandwidth consumption.
- Equal-cost multi-route—Supports multiple equal-cost routes to a destination.
- Routing hierarchy—Supports a four-level routing hierarchy that prioritizes the routes into intra-area, inter-area, external type-1, and external type-2 routes.
- Authentication—Supports interface-based packet authentication to guarantee the security of the route calculation.
- Multicast transmission—Uses multicast address to receive and send packets.

Calculating OSPF Routes

The OSPF protocol calculates routes as follows:

- Each OSPF-capable router maintains a Link State Database (LSDB), which describes the topology of the entire AS. Depending on the surrounding network topology, each router generates a Link State Advertisement (LSA). The routers on the network transmit the LSAs among themselves by transmitting the protocol packets to each other. In this way, each router receives the LSAs of other routers and all these LSAs constitute its LSDB.
- LSA describes the network topology around a router, so the LSDB describes the network topology of the entire network. Routers can easily transform the LSDB to a weighted directed graph, which actually reflects the topology of the whole network. All routers have the same graph.
- A router uses the SPF algorithm to calculate the shortest path tree which shows the routes to the nodes in the autonomous system. The external routing information is a leaf node. A router that advertises the routes, also tags them and records the additional information of the autonomous system. Therefore, the routing tables obtained from different routers are different.

OSPF supports interface-based packet authentication to guarantee the security of route calculation. OSPF also transmits and receives packets by IP multicast.

OSPF Packets

OSPF uses five types of packets:

- Hello Packet.

  The Hello Packet is the most common packet sent by the OSPF protocol. A router periodically sends it to its neighbor. It contains the values of some timers, DR, BDR and the known neighbor.

- Database Description (DD) Packet.

  When two routers synchronize their databases, they use DD packets to describe their own LSDBs, including the digest of each LSA. The digest refers to the HEAD of an LSA, which can be used to uniquely identify the LSA. Synchronizing databases with DD packets reduces the traffic size transmitted between the routers, since the HEAD of a LSA only occupies a small portion of the overall LSA traffic. With the HEAD, the peer router can judge whether it already has had the LSA.

- Link State Request (LSR) Packet.

  After exchanging the DD packets, the two routers know which LSAs of the peer routers are missing from the local LSDBs. In this case, they send LSR packets to the peers, requesting the missing LSAs. The packets contain the digests of the missing LSAs.

- Link State Update (LSU) Packet.

  The LSU packet is used to transmit the needed LSAs to the peer router. It contains a collection of multiple LSAs (complete contents).

- Link State Acknowledgment (LSAck) Packet.

  The packet is used for acknowledging the received LSU packets. It contains the HEAD(s) of LSA(s) requiring acknowledgement.

Basic Concepts Related to OSPF

- Router ID

  To run OSPF, a router must have a router ID. If no ID is configured, the system automatically selects an IP address from the IP addresses of the current interface as the Router ID. How a router ID is chosen: if the LoopBack interface address exists, the system chooses the LoopBack address with the greatest IP address value as the router ID; if no LoopBack interface configured, then the address of the physical interface with the greatest IP address value will be the router ID.

- Designated Router (DR)

  In multi-access networks, if any two routers establish adjacencies, the same LSA will be transmitted repeatedly, wasting bandwidth resources. To solve this problem, the OSPF protocol regulates that a DR must be elected in a multi-access network and only the DR (and the BDR) can establish adjacencies with other routers in this network. Two non-DR routers or non-BDR routers cannot establish adjacencies and exchange routing information.

  When the DR is not manually specified, the DR is elected by all the routers in the segment. See "Setting the Interface Priority for DR Election" on page 241.

- Backup Designated Router (BDR)

  If the DR fails, a new DR must be elected and synchronized with the other routers on the segment. This process will take a relatively long time, during which the route calculation is incorrect. To shorten the process, OSPF creates a BDR as backup for the DR. A new DR and BDR are elected in the meantime. The adjacencies are also established between the BDR and all the routers on the segment, and routing information is also exchanged between them. After the existing DR fails, the BDR will immediately becomes a DR.

- Area

  If all routers on a large network are running OSPF, the large number of routers results in an enormous LSD, which consumes storage space, complicates the SPF algorithm, and adds CPU load. Furthermore, as a network grows larger, the topology becomes more likely to change. Hence, the network is always in "turbulence", and a large number of OSPF packets are generated and transmitted in the network. This shrinks network bandwidth. In addition, each change causes all the routers on the network to recalculate the routes.

  OSPF solves this problem by dividing an AS into different areas. Areas logically group the routers, which form the borders of each area. Thus, some routers may belong to different areas. A router that connects the backbone area and a non-backbone area is called an area border router (ABR). An ABR can connect to the backbone area physically or logically.

- Backbone Area

  After the area division of OSPF, one area is different from all the other areas. Its area-id is 0 and it is usually called the backbone area.

- Virtual link

  As all the areas should be connected to the backbone area, virtual link is adopted so that the physically separated areas can still maintain logical connectivity to the backbone area.

- Route Summary

  An AS is divided into different areas that are interconnected using OSPF ABRs. The routing information between areas can be reduced by use of a route summary. Thus, the size of routing table can be reduced and the calculation speed of the router can be improved. After calculating an intra-area route of an area, the ABR summarizes multiple OSPF routes into an LSA and sends it outside the area according to the configuration of the summary.

Configuring OSPF

You must first enable OSPF then specify the interface and area ID before configuring other functions. However, the configuration of functions that are related to the interface does not depend on whether OSPF is enabled. If OSPF is disabled, the OSPF-related interface parameters become invalid.

OSPF configuration includes tasks that are described in the following sections:

- Enabling OSPF and Entering OSPF View
- Entering OSPF Area View
- Specifying the Interface
- Configuring a Router ID
- Configuring the Network Type on the OSPF Interface
- Configuring the Cost for Sending Packets on an Interface

- Setting the Interface Priority for DR Election
- Configuring the Peer
- Setting the Interval of Hello Packet Transmission
- Setting a Dead Timer for the Neighboring Routers
- Configuring an Interval Required for Sending LSU Packets
- Setting an Interval for LSA Retransmission between Neighboring Routers
- Setting a Shortest Path First (SPF) Calculation Interval for OSPF
- Configuring STUB Area of OSPF
- Configuring the NSSA of OSPF
- Configuring the Route Summarization of OSPF Area
- Configuring Summarization of Imported Routes by OSPF
- Configuring OSPF Virtual Link
- Configuring the OSPF Area to Support Packet Authentication
- Configuring OSPF Packet Authentication
- Configuring OSPF to Import Routes of Other Protocols
- Configuring Parameters for OSPF to Import External routes
- Configuring OSPF to Import the Default Route
- Setting OSPF Route Preference
- Configuring OSPF Route Filtering
- Configuring the Filling of the MTU Field When an Interface Transmits DD Packets
- Disabling the Interface to Send OSPF Packets
- Configuring OSPF and Network Management System (NMS)
- Resetting the OSPF Process

Enabling OSPF and Entering OSPF View

Perform the following configurations in System View.

Table 221 Enabling the OSPF process

Operation	Command
Enable the OSPF process	**ospf** [*process_id* [**router-id** *router_id*]]
Disable the OSPF process	**undo ospf** [*process_id*]

By default, OSPF is not enabled.

When enabling OSPF, note the following:

- By default, the OSPF process ID is 1.
- If a router is running multiple OSPF processes, 3Com recommends that you to use **router-id** in the command to specify different Router IDs for different processes.

Entering OSPF Area View

Perform the following configurations in OSPF View.

Table 222 Entering OSPF Area View

Operation	Command
Enter an OSPF Area View	**area** *area_id*
Delete a designated OSPF area	**undo area** *area_id*

area_id is the ID of the OSPF area, which can be a decimal integer or in IP address format.

Specifying the Interface

OSPF divides the AS into different areas. You must configure each OSPF interface to belong to a particular area, identified by an area ID. The areas transfer routing information between them through the ABRs.

In addition, parameters of all the routers in the same area should be identical. Therefore, when configuring the routers in the same area, please note that most configurations should be based on the area. An incorrect configuration can disable the neighboring routers from transmitting information, and lead to congestion or self-loop of the routing information.

Perform the following configuration in OSPF Area View.

Table 223 Specifying interface

Operation	Command
Specify an interface to run OSPF	**network** *ip_address ip_mask*
Disable OSPF on the interface	**undo network** *ip_address ip_mask*

You must specify the segment to which the OSPF will be applied after enabling OSPF.

ip-mask can be IP address mask or IP address wildcard shielded text (similar to the complement of the IP address mask).

Configuring a Router ID

A Router ID is a 32-bit unsigned integer that uniquely identifies a router within an AS. A Router ID can be configured manually. If a Router ID is not configured, the system selects the IP address of an interface automatically. When you set a Router ID manually, you must guarantee that the IDs of any two routers in the AS are unique. It is usual to set the router ID to be the IP address of an interface on the router.

Perform the following configurations in System View.

Table 224 Configuring a router ID

Operation	Command
Configure a Router ID	**router id** *router_id*
Remove the router ID	**undo router id**

To ensure the stability of OSPF, you must determine the division of router IDs and manually configure them when implementing network planning.

Configuring the Network Type on the OSPF Interface

The route calculation of OSPF is based upon the topology of the adjacent network of the local router. Each router describes the topology of its adjacent network and transmits it to all the other routers.

OSPF divides networks into four types by link layer protocol:

- Broadcast—If Ethernet or FDDI is adopted, OSPF defaults the network type to broadcast.
- Non-Broadcast Multi-access (NBMA)—If Frame Relay, ATM, HDLC or X.25 is adopted, OSPF defaults the network type to NBMA.
- Point-to-Multipoint (P2MP)—OSPF will not default the network type of any link layer protocol to P2MP. The usual policy is to change a partially connected NBMA network to a P2MP network, if the NBMA network is not fully connected.
- Point-to-point (P2P)—If PPP, LAPB or POS is adopted, OSPF defaults the network type to P2P.

As you configure the network type, consider the following points:

- NBMA means that a network is non-broadcast and multi-accessible. ATM is a typical example. You can configure the polling interval for hello packets before the adjacency of the neighboring routers is formed.
- Configure the interface type to nonbroadcast on a broadcast network without multi-access capability.
- Configure the interface type to P2MP if not all the routers are directly accessible on an NBMA network.
- Change the interface type to P2P if the router has only one peer on the NBMA network.

The differences between NBMA and P2MP are listed below:

- In OSPF, NBMA refers to the networks that are fully connected, non-broadcast and multi-accessible. However, a P2MP network is not required to be fully connected.
- DR and BDR are required on a NBMA network but not on a P2MP network.
- NBMA is the default network type. For example, if ATM is adopted as the link layer protocol, OSPF defaults the network type on the interface to NBMA, regardless of whether the network is fully connected. P2MP is not the default network type. No link layer protocols will be regarded as P2MP. You must change the network type to P2MP manually. The most common method is to change a partially connected NBMA network to a P2MP network.
- NBMA forwards packets by unicast and requires neighbors to be configured manually. P2MP forwards packets by multicast.

Perform the following configuration in Interface View:

Table 225 Configuring a Network Type on the Interface That Starts OSPF

Operation	Command
Configure network type on the interface	**`ospf network-type`** `{` **`broadcast`** `|` **`nbma`** `|` **`p2mp`** `|` **`p2p`** `}`

After the interface has been configured with a new network type, the original network type of the interface is removed automatically.

Configuring the Cost for Sending Packets on an Interface

You can control network traffic by configuring different message sending costs for different interfaces. Otherwise, OSPF automatically calculates the cost according to the baud rate on the current interface.

Perform the following configuration in Interface View:

Table 226 Configuring the cost for sending packets on the Interface

Operation	Command
Configure the cost for sending packets on Interface	**`ospf cost`** *`value`*
Restore the default cost for packet transmission on the Interface	**`undo ospf cost`**

For the Switch 5500 the default cost for running OSPF protocol on the VLAN interface is 10.

Setting the Interface Priority for DR Election

The priority of the router interface determines the qualification of the interface for DR election. A router of higher priority will be considered first if there is a collision in the election.

DR is not designated manually; instead, it is elected by all the routers on the segment. Routers with the priorities greater than 0 in the network are eligible candidates. Among all the routers self-declared to be the DR, the one with the highest priority is elected. If two routers have the same priority, the one with the highest router ID will be elected as the DR. Each router writes the expected DR in the packet and sends it to all the other routers on the segment. If two routers attached to the same segment concurrently declare themselves to be the DR, the one with higher priority is elected DR. If the priorities are the same, the router with the higher router ID is elected DR. If the priority of a router is 0, it will not be elected as DR or BDR.

If DR fails, the routers on the network must elect a new DR and synchronize with the new DR. The process takes a relatively long time, during which route calculation can be incorrect. To speed up this DR replacement process, OSPF implements the BDR as backup for DR. The DR and BDR are elected at the same time. The adjacencies are also established between the BDR and all the routers on the segment, and routing information is exchanged between them. When the DR fails, the BDR becomes the DR. Since no re-election is needed and the adjacencies have already been established, the process is very quick. But in this case, a new BDR should be elected. Although it also takes a long time, it does not influence route calculation.

Note that:

- The DR on the network is not necessarily the router with the highest priority. Likewise, the BDR is not necessarily the router with the second highest priority. If a new router is added after DR and BDR election, it is impossible for the router to become the DR even if it has the highest priority.
- The DR is based on the router interface in a certain segment. A router can be a DR on one interface, and a BDR or DROther on another interface.
- DR election is only required for the broadcast or NBMA interfaces. For P2P or P2MP interfaces, DR election is not required.

Perform the following configuration in Interface View:

Table 227 Setting the Interface Priority for DR Election

Operation	Command
Configure the interface with a priority for DR election	**ospf dr-priority** *priority_num*
Restore the default interface priority	**undo ospf dr-priority**

By default, the priority of the Interface is 1 in the DR election. The value can be taken from 0 to 255.

Configuring the Peer

In an NBMA network, some special configurations are required. Since an NBMA interface on the network cannot discover the adjacent router through broadcasting Hello packets, you must manually specify an IP address for the adjacent router for the interface, and whether the adjacent router is eligible for election. This can be done by configuring the **peer** *ip_address* command.

Perform the following configuration in OSPF View.

Table 228 Configuring the peer

Operation	Command
Configure a peer for the NBMA interface	**peer** *ip_address* [**dr-priority** *dr_priority_number*]
Remove the configured peer for the NBMA interface	**undo peer** *ip_address*

By default, the preference for the neighbor of NBMA interface is 1.

Setting the Interval of Hello Packet Transmission

Hello packets are the most frequently sent packets. They are periodically sent to the adjacent router for discovering and maintaining adjacency, and for electing a DR and BDR. The user can set the hello timer.

According to RFC2328, the consistency of hello intervals between network neighbors should be kept. The hello interval value is in inverse proportion to the route convergence rate and network load.

Perform the following configuration in Interface View

Table 229 Setting Hello Timer and Poll Interval

Operation	Command
Set the hello interval of the interface	**ospf timer hello** *seconds*
Restore the default hello of the interface	**undo ospf timer hello**
Set the poll interval on the NBMA interface	**ospf timer poll** *seconds*
Restore the default poll interval	**undo ospf timer poll**

By default, P2P and broadcast interfaces send Hello packets every 10 seconds, and P2MP and NBMA interfaces send Hello packets every 30 seconds.

Setting a Dead Timer for the Neighboring Routers

If hello packets are not received from a neighboring router, that router is considered dead. The dead timer of neighboring routers refers to the interval after which a router considers a neighboring router dead. You can set a dead timer for the neighboring routers.

Perform the following configuration in Interface View:

Table 230 Setting a Dead Timer for the Neighboring Routers

Operation	Command
Configure a dead timer for the neighboring routers	**`ospf timer dead`** *`seconds`*
Restore the default dead interval of the neighboring routers	**`undo ospf timer dead`**

By default, the dead interval for the neighboring routers of P2P or broadcast interfaces is 40 seconds, and for the neighboring routers of P2MP or NBMA interfaces is 120 seconds.

Both hello and dead timers restore to the default values if you modify the network type.

Configuring an Interval Required for Sending LSU Packets

Trans-delay seconds should be added to the aging time of the LSA in an LSU packet. This parameter affects the time duration that the interface requires to transmit the packet.

You can configure the interval for sending LSU messages. This is more important on low speed networks.

Perform the following configuration in Interface View

Table 231 Configuring an Interval for LSU packets

Operation	Command
Configure an interval for sending LSU packets	**`ospf trans-delay`** *`seconds`*
Restore the default interval of sending LSU packets	**`undo ospf trans-delay`**

By default, the LSU packets are transmitted every second.

Setting an Interval for LSA Retransmission between Neighboring Routers

If a router transmits an LSA (Link State Advertisements) to the peer, it requires an acknowledgement packet from the peer. If it does not receive the acknowledgement packet within the retransmit time, it retransmits this LSA to the neighbor. You can configure the value of the retransmission interval.

Perform the following configuration in Interface View

Table 232 Setting an Interval for LSA Retransmission between Neighboring Routers

Operation	Command
Configure the interval of LSA retransmission for the neighboring routers	**`ospf timer retransmit`** *`interval`*
Restore the default LSA retransmission interval for the neighboring routers	**`undo ospf timer retransmit`**

By default, the interval for neighboring routers to retransmit LSAs is five seconds.

The value of *interval* should be bigger than the interval in which a packet can be transmitted and returned between two routers.

An LSA retransmission interval that is too small will cause unnecessary retransmission.

Setting a Shortest Path First (SPF) Calculation Interval for OSPF

Whenever the OSPF LSDB changes, the shortest path requires recalculation. Calculating the shortest path after the change consumes enormous resources and affects the operating efficiency of the router. Adjusting the SPF calculation interval, however, can restrain the resource consumption due to frequent network changes.

Perform the following configuration in OSPF View.

Table 233 Setting the SPF calculation interval

Operation	Command
Set the SPF calculation interval	**spf-schedule-interval** *seconds*
Restore the SPF calculation interval	**undo spf-schedule-interval** *seconds*

By default, the interval for SPF recalculation is 5 seconds.

Configuring STUB Area of OSPF

STUB areas are special LSA areas in which the ABRs do not propagate the learned external routes of the AS. In these areas, the routing table sizes of routers and the routing traffic are significantly reduced.

The STUB area is an optional configuration attribute, but not every area conforms to the configuration condition. Generally, STUB areas, located at the AS boundaries, are those non-backbone areas with only one ABR. Even if this area has multiple ABRs, no virtual links are established between these ABRs.

To ensure that the routes to destinations outside the AS are still reachable, the ABR in this area will generate a default route (0.0.0.0) and advertise it to the non-ABR routers in the area.

Note the following items when you configure a STUB area:

- The backbone area cannot be configured as a STUB area, and virtual links cannot pass through the STUB area.
- If you want to configure an area as a STUB area, all the routers in this area should be configured with the **stub** command.
- No ASBR can exist in a STUB area, and the external routes of the AS cannot be propagated in the STUB area.

Perform the following configuration in OSPF Area View.

Table 234 Configuring and OSPF STUB area

Operation	Command
Configure an area to be the STUB area	**stub** [**no-summary**]
Remove the configured STUB area	**undo stub**
Configure the cost of the default route transmitted by OSPF to the STUB area	**default-cost** *value*
Remove the cost of the default route to the STUB area	**undo default-cost**

By default, the STUB area is not configured, and the cost of the default route to the STUB area is 1.

Configuring the NSSA of OSPF

To keep the advantages of stub areas and simultaneously improve the networking flexibility, RFC1587 (OSPF NSSA Option) defines a new type of area, namely NSSA, which has the capability of importing external routes in a limited way.

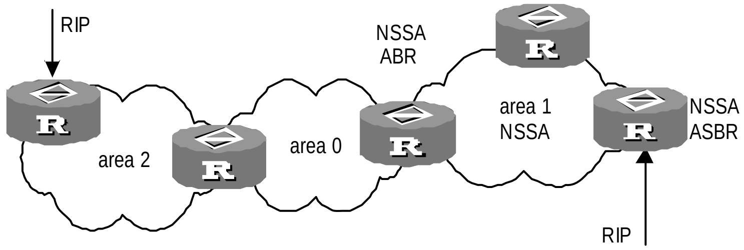
An NSSA is similar to a Stub area. Neither of them generates or imports AS-External-LSA (namely Type-5 LSA), and both of them can generate and import Type-7 LSAs. Type-7 LSAs are generated by the ASBR of the NSSA area, which can only advertise in the NSSA area. When a Type-7 LSA reaches the ABR of the NSSA, the ABR decides whether to transform the Type-7 LSA into an AS-External-LSA so as to advertise it to other areas.

For example, in Figure 56, the AS running OSPF comprises three areas: Area 1, Area 2 and Area 0. Area 0 is the backbone area. There are another two ASs running RIP. Area 1 is defined as an NSSA. After the RIP routes of the Area 1 are propagated to the NSSA, ASBR generates type-7 LSAs which are propagated in Area 1. When a type-7 LSA reaches the NSSA ABR, the NSSA ABR transforms it into a type-5 LSA, which is propagated to Area 0 and Area 2.

RIP routes of the AS running RIP are translated into type-5 LSAs that are propagated in the OSPF AS. However, type-5 LSAs do not reach Area 1 because Area 1 is an NSSA. NSSA and STUB areas use the same policy in this respect.

The NSSA cannot be configured with virtual links.

Figure 56 NSSA area



Perform the following configuration in OSPF Area View.

Table 235 Configuring the NSSA of OSPF

Operation	Command
Configure an area to be the NSSA area	**nssa** [**default-route-advertise** | **no-import-route** | **no-summary**]*
Cancel the configured NSSA	**undo nssa**
Configure the default cost value of the route to the NSSA	**default-cost** *cost*
Restore the default cost value of the route to the NSSA area	**undo default-cost**

All the routers connected to the NSSA should use the **nssa** command to configure the area with the NSSA attributes.

The **default-route-advertise** parameter is used to generate the default type-7 LSAs. When **default-route-advertise** is configured, the default type-7 LSA route is generated on the ABR, even though the default route 0.0.0.0 is not in the routing table. On an ASBR, however, the default type-7 LSA route can be generated only if the default route 0.0.0.0 is in the routing table.

Executing the **no-import-route** command on the ASBR prevents the external routes that OSPF imported through the **import-route** command from advertising to the NSSA. Generally, if an NSSA router is both ASBR and ABR, this argument is used.

The **default-cost** command is used on the ABR attached to the NSSA. Using this command, you can configure the default route cost on the ABR to NSSA.

By default, the NSSA is not configured, and the cost of the default route to the NSSA is 1.

Configuring the Route Summarization of OSPF Area

Route summary means that ABR can aggregate information of routes of the same prefix and advertise only one route to other areas. An area can be configured with multiple aggregate segments allowing OSPF can summarize them. When the ABR transmits routing information to other areas, it will generate Sum_net_Lsa (type-3 LSA) per network. If continuous networks exist in this area, you can use the **abr-summary** command to summarize these segments into one segment. Thus, the ABR only needs to send an aggregate LSA, and all the LSAs in the range of the aggregate segment specified by the command are not transmitted separately.

Once the aggregate segment of a certain network is added to the area, all the internal routes of the IP addresses in the range of the aggregate segment will no longer be separately advertised to other areas. Only the route summary of the whole aggregate network will be advertised. But if the range of the segment is restricted by the parameter **not-advertise**, the route summary of this segment is not advertised. This segment is represented by IP address and mask.

Route summarization can take effect only when it is configured on ABRs.

Perform the following configuration in OSPF Area View.

Table 236 Configuring the route summarization of OSPF area

Operation	Command
Configure the Route Summarization of OSPF Area	**abr-summary** *ip_address mask* [**advertise** | **not-advertise**]
Cancel the route summarization of OSPF Area	**undo abr-summary** *ip_address mask*

By default, the inter-area routes will not be summarized.

Configuring Summarization of Imported Routes by OSPF

Perform the following configurations in OSPF View.

Table 237 Configuring summarization of imported routes by OSPF

Operation	Command
Configure summarization of imported routes by OSPF	**asbr-summary** *ip_address mask* [**not-advertise** | **tag** *value*]
Remove summarization of routes imported into OSPF	**undo asbr-summary** *ip_address mask*

By default, summarization of imported routes is disabled.

After the summarization of imported routes is configured, if the local router is an autonomous system border router (ASBR), this command summarizes the imported Type-5 LSAs in the summary address range. When NSSA is configured, this command will also summarize the imported Type-7 LSA in the summary address range.

If the local router works as an area border router (ABR) and a router in the NSSA, this command summarizes Type-5 LSAs translated from Type-7 LSAs. If the router is not the router in the NSSA, this summarization is disabled.

Configuring OSPF Virtual Link

According to RFC2328, after the area division of OSPF, the backbone is established with an area-id of 0.0.0.0. The OSPF routes between non-backbone areas are updated with the help of the backbone area. OSPF stipulates that all the non-backbone areas should maintain the connectivity with the backbone area, and at least one interface on the ABR should fall into the area 0.0.0.0. If an area does not have a direct physical link with the backbone area 0.0.0.0, a virtual link must be created.

If physical connectivity cannot be ensured due to the network topology restrictions, a virtual link can be used to meet the requirements of RFC2328. The virtual link refers to a logic channel set up through the area of a non-backbone internal route between two ABRs. Both ends of the logic channel should be ABRs and the connection can take effect only when both ends are configured. The virtual link is identified by the ID of the remote router. The area, which provides the ends of the virtual link with a non-backbone area internal route, is called the transit area. The ID of the transit area should be specified during configuration.

The virtual link is activated after the route passing through the transit area is calculated, which is equivalent to a P2P connection between two ends. Therefore, similar to the physical interfaces, you can also configure various interface parameters on this link, such as an hello timer.

The "logic channel" means that the multiple routers running OSPF between two ABRs only take the role of packet forwarding (the destination addresses of the protocol packets are not these routers, so these packets are transparent to them and the routers forward them as common IP packets). The routing information is directly transmitted between the two ABRs. The routing information refers to the type-3 LSAs generated by the ABRs, for which the synchronization mode of the routers in the area will not be changed.

Perform the following configuration in OSPF Area View.

Table 238 Configuring OSPF Virtual Link

Operation	Command
Create and configure a virtual link	**vlink-peer** *router_id* [**hello** *seconds* | **retransmit** *seconds* | **trans-delay** *seconds* | **dead** *seconds* | **simple** *password* | **md5** *keyid key*]*
Remove the created virtual link	**undo vlink-peer** *router_id*

The *area_id* and *router_id* have no default value.

By default, hello timer is 10 seconds, retransmit 5 seconds, trans-delay 1 second, and the dead timer is 40 seconds.

Configuring the OSPF Area to Support Packet Authentication

All the routers in an area must use the same authentication mode. In addition, all routers on the same segment must use the same authentication key password. Use the **`authentication-mode simple`** command to configure a simple authentication password for the area, and the **`authentication-mode md5`** command to configure the MD5 authentication password.

Perform the following configuration in OSPF Area View.

Table 239 Configuring the OSPF Area to Support Packet Authentication

Operation	Command
Configure the area to support authentication type	**`authentication-mode { simple | md5 }`**
Cancel the authentication attribute of this area	**`undo authentication-mode`**

By default, the area does not support packet authentication.

Configuring OSPF Packet Authentication

OSPF supports simple authentication or MD5 authentication between neighboring routers.

Perform the following configuration in Interface View:

Table 240 Configuring OSPF Packet Authentication

Operation	Command
Specify a password for OSPF simple text authentication	**`ospf authentication-mode simple`** *`password`*
Cancel simple authentication on the interface	**`undo ospf authentication-mode simple`**
Specify the key-id and key for OSPF MD5 authentication	**`ospf authentication-mode md5`** *`key_id key`*
Disable the interface to use MD5 authentication	**`undo ospf authentication-mode md5`**

By default, the interface is not configured with either simple authentication or MD5 authentication.

Configuring OSPF to Import Routes of Other Protocols

The dynamic routing protocols on the router can share routing information. As far as OSPF is concerned, the routes discovered by other routing protocols are always processed as the external routes of AS. In the **`import-route`** commands, you can specify the route cost type, cost value and tag to overwrite the default route receipt parameters (refer to "Configuring Parameters for OSPF to Import External routes" on page 249).

The OSPF uses the following four types of routes (in priority):

- Intra-area route
- Inter-area route
- External route type 1
- External route type 2

Intra-area and inter-area routes describe the internal AS topology whereas the external routes describes how to select the route to the destinations beyond the AS.

The external type-1 routes refer to imported IGP routes (such as static route and RIP). Since these routes are more reliable, the calculated cost of the external routes is the same as the cost of routes within the AS. Also, this route cost and the route cost of the OSPF itself are comparable. That is, the cost to reach the external route type 1 equals the cost to reach the corresponding ASBR from the local router plus the cost to reach the destination address of the route from the ASBR

The external routes type-2 refer to the imported EGP routes. Since these routes typically have higher cost, OSPF assumes that the cost from the ASBR to reach the destinations beyond the AS is higher than the cost from within the AS to ASBR. So in route cost calculation, the cost from the ASBR to the destination is considered and the cost between the router and the ASBR is ignored. If the cost from the router to the ASBR and the cost from the ASBR to the destination are of the same size, then the cost of the router to the ASBR will also be included.

Perform the following configuration in OSPF View.

Table 241 Configuring OSPF to Import Routes of Other Protocols

Operation	Command
Configure OSPF to import routes of other protocols	**`import-route`** *`protocol`* `[` **`cost`** *`value`* `|` **`type`** *`value`* `|` **`tag`** *`value`* `|` **`route-policy`** *`route_policy_name`* `]*`
Cancel importing routing information of other protocols	**`undo import-route`** *`protocol`*

By default, OSPF does not import the routing information of other protocols. The default type of the imported route is 2, cost is 1 and the tag is 1.

The *`protocol`* variable specifies a source routing protocol that can be imported. This can be Direct, Static or RIP.

3Com recommends that you configure the route **`type`**, **`cost`** *and* **`tag`** *together in one command. If you do not, note that a new configuration overwrites the previous configuration.*

Configuring Parameters for OSPF to Import External routes

When the OSPF imports the routing information discovered by other routing protocols in the autonomous system, some additional parameters need to be configured, such as default route cost and default tag of route distribution. Route ID can be used to identify the protocol-related information.

Perform the following configuration in OSPF View.

Table 242 Configuring Parameters for OSPF to Import External routes

Operation	Command
Configure the minimum interval for OSPF to import the external routes	**`default interval`** *`seconds`*
Restore the default value of the minimum interval for OSPF to import the external routes	**`undo default interval`**
Configure the upper limit to the routes that OSPF import each time	**`default limit`** *`routes`*

Table 242 Configuring Parameters for OSPF to Import External routes (continued)

Operation	Command
Restore the default upper limit to the external routes that can be imported at a time	**undo default limit**
Configure the default cost for the OSPF to import external routes	**default cost** *value*
Restore the default cost for the OSPF to import external routes	**undo default cost**
Configure the default tag for the OSPF to import external routes	**default tag** *tag*
Restore the default tag for the OSPF to import external routes	**undo default tag**
Configure the default type of external routes that OSPF will import	**default type** { **1** | **2** }
Restore the default type of the external routes imported by OSPF	**undo default type**

By default, when importing external routes, the type of imported route is type-2, the cost is 1 and the tag is 1. The interval of importing the external route is 1 second. The upper limit to the external routes imported is 1000 per second.

Configuring OSPF to Import the Default Route

The **import-route** command cannot be used to import the default route. Using the **default-route-advertise** command, you can import the default route into the routing table.

Perform the following configuration in OSPF View.

Table 243 Configuring OSPF to Import the Default Route

Operation	Command
Import the default route to OSPF	**default-route-advertise** [**always** | **cost** *value* | **type** *type_value* | **route-policy** *route_policy_name*]*
Remove the imported default route	**undo default-route-advertise** [**always** | **cost** | **type** | **route-policy**]*

By default, OSPF does not import the default route.

Setting OSPF Route Preference

Since it is possible for multiple dynamic routing protocols to run concurrently on one router, problems of route sharing and selection between various routing protocols can occur. The system sets a priority for each routing protocol, which will be used in tie-breaking in the case that different protocols discover the same route.

Perform the following configuration in OSPF View.

Table 244 Setting OSPF Route Preference

Operation	Command
Configure a priority for OSPF for comparing with the other routing protocols	**preference** [**ase**] *preference*
Restore the default protocol priority	**undo preference** [**ase**]

By default, the OSPF preference is 10, and the imported external routing protocol is 150.

Configuring OSPF Route Filtering

Perform the following configuration in OSPF View.

Configuring OSPF to Filter the Received Routes

Table 245 Enabling OSPF to filter the received routes

Operation	Command
Disable to filter the received global routing information	**filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* | **gateway** *ip_prefix_name* } **import**
Cancel to filter the received global routing information	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* | **gateway** *ip_prefix_name* } **import**

Configuring OSPF to filter the distributed routes

Table 246 Enabling OSPF to filter the distributed routes

Operation	Command
Enable OSPF to filter the distributed routes	**filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } **export** [*routing_ process*]
Disable OSPF to filter the distributed routes	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } **export** [*routing_process*]

By default, OSPF will not filter the imported and distributed routing information.

- *The* **filter-policy import** *command only filters the OSPF routes of this process received from the neighbors, and routes that cannot pass the filter will not be added to the routing table. This command only takes effect on ABR.*
- *The* **filter-policy export** *command only takes effect to the routes imported by the* **import-route** *command. If you configure the Switch with only the* **filter-policy export** *command, but without configuring the* **import-route** *command to import other external routes (including OSPF routes of different process), then the* **filter-policy export** *command does not take effect.*

Configuring the Filling of the MTU Field When an Interface Transmits DD Packets

OSPF-running routers use the DD (Database Description) packets to describe their own LSDBs when synchronizing the databases.

You can manually specify an interface to fill in the MTU field in a DD packet when it transmits the packet. The MTU should be set to the real MTU on the interface.

Perform the following configuration in Interface View:

Table 247 Configuring the Filling of the MTU Field when an Interface Transmits DD Packets

Operation	Command
Enable an interface to fill in the MTU field when transmitting DD packets	**ospf mtu-enable**
Disable the interface to fill MTU when transmitting DD packets	**undo ospf mtu-enable**

By default, the interface does not fill in the MTU field when transmitting DD packets, and the MTU in the DD packets is 0.

Disabling the Interface to Send OSPF Packets

Use the **silent-interface** command to prevent the interface from transmitting OSPF packets.

Perform the following configuration in OSPF View.

Table 248 Disabling the interface to send OSPF packets

Operation	Command
Prevent the interface from sending OSPF packets	**silent-interface** *silent_interface_type silent_interface_number*
Allow the interface to send OSPF packets	**undo silent-interface** *silent_interface_type silent_interface_number*

By default, all the interfaces are allowed to transmit and receive OSPF packets.

After an OSPF interface is set to silent status, the interface can still advertise its direct route. However, the OSPF hello packets of the interface are blocked, and no neighboring relationship can be established on the interface. This enhances the ability of OSPF to adapt to the network, which can reduce the consumption of system resources. On a Switch, this command can disable/enable the specified VLAN interface to send OSPF packets.

Configuring OSPF and Network Management System (NMS)

Configuring OSPF MIB binding After multiple OSPF processes are enabled, you can configure to which OSPF process MIB is bound.

Perform the following configuration in System View.

Table 249 Configure OSPF MIB binding

Operation	Command
Configure OSPF MIB binding	**ospf mib-binding** *process_id*
Restore the default OSPF MIB binding	**undo ospf mib-binding**

By default, MIB is bound to the first enabled OSPF process.

Configuring OSPF TRAP You can configure the switch to send multiple types of SNMP TRAP packets in case of OSPF anomalies. In addition, you can configure the switch to send SNMP TRAP packets when a specific process is abnormal by specifying the process ID.

Perform the following configuration in System View.

Table 250 Enabling/disabling OSPF TRAP function

Operation	Command
Enable OSPF TRAP function	**snmp-agent trap enable ospf** [*process_id*] [**ifstatechange** | **virifstatechange** | **nbrstatechange** | **virnbrstatechange** | **ifcfgerror** | **virifcfgerror** | **ifauthfail** | **virifauthfail** | **ifrxbadpkt** | **virifrxbadpkt** | **txretransmit** | **viriftxretransmit** | **originatelsa** | **maxagelsa** | **lsdboverflow** | **lsdbapproachoverflow**]
Disable OSPF TRAP function	**undo snmp-agent trap enable ospf** [*process_id*] [**ifstatechange** | **virifstatechange** | **nbrstatechange** | **virnbrstatechange** | **ifcfgerror** | **virifcfgerror** | **ifauthfail** | **virifauthfail** | **ifrxbadpkt** | **virifrxbadpkt** | **txretransmit** | **viriftxretransmit** | **originatelsa** | **maxagelsa** | **lsdboverflow** | **lsdbapproachoverflow**]

By default, OSPF TRAP function is disabled, so the switch does not send TRAP packets when any OSPF process is abnormal. The configuration is valid to all OSPF processes if you do not specify a process ID.

For detailed configuration of SNMP TRAP, refer to “System Management" on .

Resetting the OSPF Process

If the **undo ospf** command is executed on a router and then the **ospf** command is used to restart the OSPF process, the previous OSPF configuration is lost. With the **reset ospf** command, you can restart the OSPF process without losing the previous OSPF configuration.

Perform the following configuration in User View.

Table 251 Resetting the OSPF process

Operation	Command
Reset the OSPF process	**reset ospf** [statistics] { all | *process_id* }

Resetting the OSPF process can immediately clear the invalid LSAs, make the modified Router ID effective or re-elect the DR and BDR.

Displaying and Debugging OSPF

After the above configuration, execute **display** command in any view to display the operation of the OSPF configuration, and to verify the effect of the configuration. Execute the **debugging** command in User View to debug the OSPF module.

Table 252 Displaying and debugging OSPF

Operation	Command
Display the brief information of the OSPF routing process	**display ospf** [*process_id*] **brief**
Display OSPF statistics	**display ospf** [*process_id*] **cumulative**
Display LSDB information of OSPF	**display ospf** [*process_id*] [*area_id*] **lsdb** [**brief** | [**asbr** | **ase** | **network** | **nssa** | **router** | **summary**] [*ip_address*] [**originate-router** *ip_address* | **self-originate**]]
Display OSPF peer information	**display ospf** [*process_id*] **peer** [**brief**]
Display OSPF next hop information	**display ospf** [*process_id*] **nexthop**

Table 252 Displaying and debugging OSPF

Operation	Command
Display OSPF routing table	**display ospf** [*process_id*] **routing**
Display OSPF virtual links	**display ospf** [*process_id*] **vlink**
Display OSPF request list	**display ospf** [*process_id*] **request-queue**
Display OSPF retransmission list	**display ospf** [*process_id*] **retrans-queue**
Display the information of OSPF ABR and ASBR	**display ospf** [*process_id*] **abr-asbr**
Display the summary information of OSPF imported route	**display ospf** [*process_id*] **asbr-summary** [*ip_address mask*]
Display OSPF interface information	**display ospf** [*process_id*] **interface**
Display OSPF errors	**display ospf** [*process_id*] **error**

Display Command for OSPF Neighbor Information

Use the command **display ospf peer statistics**, which has the same display output as that of **display ospf peer brief** command.

The **display ospf peer brief** command has the following fields in its display output:

- Router ID
- Address (IP address of the neighbor)
- Pri (priority of the neighbor)
- DeadTime(s)
- Interface
- State

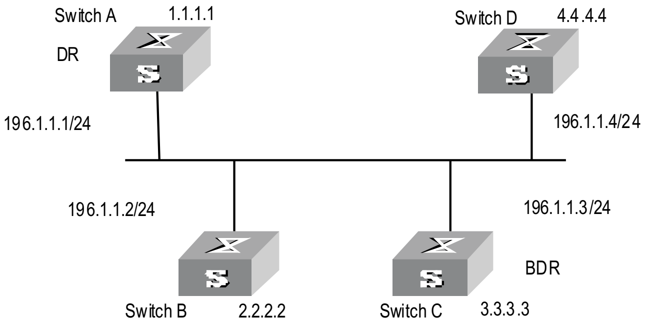
Example: Configuring DR Election Based on OSPF Priority

Networking Requirements

In this example, four Switch 5500s, Switch A, Switch B, Switch C and Switch D, which can perform the router functions and run OSPF, are located on the same segment, as shown Figure 57

Networking Diagram

Figure 57 Networking for configuring DR election based on OSPF priority



The commands listed in the following examples enable Switch A and Switch C to be DR and BDR, respectively. The priority of Switch A is 100, which is the highest on the network, so it is elected as the DR. Switch C has the second highest priority, so it is elected as the BDR. The priority of Switch B is 0, which means that it cannot be elected as the DR, and Switch D does not have a priority, and therefore takes priority 1 by default.

Configuration Procedure

1 Configure Switch A:

```
[Switch A]interface Vlan-interface 1
[Switch A-Vlan-interface1]ip address 196.1.1.1 255.255.255.0
[Switch A-Vlan-interface1]ospf dr-priority 100
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf-1]area 0
[Switch A-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

2 Configure Switch B:

```
[Switch B]interface Vlan-interface 1
[Switch B-Vlan-interface1]ip address 196.1.1.2 255.255.255.0
[Switch B-Vlan-interface1]ospf dr-priority 0
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf-1]area 0
[Switch B-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

3 Configure Switch C:

```
[Switch C]interface Vlan-interface 1
[Switch C-Vlan-interface1]ip address 196.1.1.3 255.255.255.0
[Switch C-Vlan-interface1]ospf dr-priority 2
[Switch C]router id 3.3.3.3
[Switch C]ospf
[Switch C-ospf-1]area 0
[Switch C-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

4 Configure Switch D:

```
[Switch D]interface Vlan-interface 1
[Switch D-Vlan-interface1]ip address 196.1.1.4 255.255.255.0
[Switch D]router id 4.4.4.4
[Switch D]ospf
[Switch D-ospf-1]area 0
[Switch D-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

On Switch A, run the **display ospf peer** command to show the Switch's OSPF neighbors. Note that Switch A has three neighbors.

The status of each neighbor is full, which means that adjacency is set up between Switch A and each neighbor. Switch A and Switch C should be set up with adjacencies to all the routers on the network so that they can serve as the DR and BDR on the network. Switch A is DR, while Switch C is BDR on the network. All the other neighbors are DROthers (which means that they are neither DRs nor BDRs).

5 Modify the priority of Switch B to 200:

```
[Switch B-Vlan-interface2000]ospf dr-priority 200
```

Execute the **display ospf peer** command on Switch A to show its OSPF neighbors. Please note the priority of Switch B has been modified to 200, but it is still not the DR.

Only when the current DR is offline does the DR change. Shut down Switch A, and run **display ospf peer** command on Switch D to display its neighbors. Note that the original BDR (Switch C) becomes the DR, and Switch B is the new BDR.

If all Ethernet Switches on the network are removed and added again, Switch B is elected as the DR (with a priority of 200), and Switch A becomes the BDR (with a priority of 100). Switching off and restarting all the switches initiates a new round of DR and BDR selection.

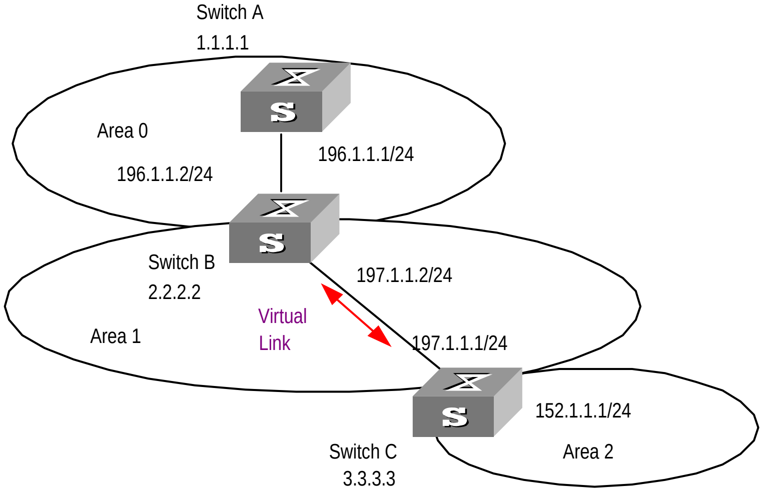
Example: Configuring OSPF Virtual Link

Networking requirements

In Figure 58, Area 2 and Area 0 are not directly connected. Area 1 is used as the transit area for connecting Area 2 and Area 0.

Networking diagram

Figure 58 OSPF virtual link configuration networking



The following commands configure a virtual link between Switch B and Switch C in Area 1.

Configuration procedure

1 Configure Switch A:

```
[Switch A]interface Vlan-interface 1
[Switch A-Vlan-interface1]ip address 196.1.1.1 255.255.255.0
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf-1]area 0
[Switch A-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
```

2 Configure Switch B:

```
[Switch B]interface vlan-interface 7
[Switch B-Vlan-interface7]ip address 196.1.1.2 255.255.255.0
[Switch B]interface vlan-interface 8
[Switch B-Vlan-interface8]ip address 197.1.1.2 255.255.255.0
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf-1]area 0
[Switch B-ospf-1-area-0.0.0.0]network 196.1.1.0 0.0.0.255
[Switch B-ospf-1-area-0.0.0.0]quit
```

```
[Switch B-ospf-1]area 1
[Switch B-ospf-1-area-0.0.0.1]network 197.1.1.0 0.0.0.255
[Switch B-ospf-1-area-0.0.0.1]vlink-peer 3.3.3.3
```

3 Configure Switch C:

```
[Switch C]interface Vlan-interface 1
[Switch C-Vlan-interface1]ip address 152.1.1.1 255.255.255.0
[Switch C]interface Vlan-interface 2
[Switch C-Vlan-interface2]ip address 197.1.1.1 255.255.255.0
[Switch C]router id 3.3.3.3
[Switch C]ospf
[Switch C-ospf-1]area 1
[Switch C-ospf-1-area-0.0.0.1]network 197.1.1.0 0.0.0.255
[Switch C-ospf-1-area-0.0.0.1]vlink-peer 2.2.2.2
[Switch C-ospf-1-area-0.0.0.1]quit
[Switch C-ospf-1]area 2
[Switch C-ospf-1-area-0.0.0.2]network 152.1.1.0 0.0.0.255
```

Troubleshooting OSPF

OSPF has been configured in accordance with the above-mentioned steps, but OSPF does not run normally on the router

Troubleshooting locally: Check whether the protocol between two directly connected routers is operating normally. The normal sign is the peer state machine between the two routers reaching the FULL state.

On a broadcast or NBMA network, if the interfaces for two routers are in DROther state, the peer state machine for the two routers are in 2-way state, instead of FULL state. The peer state machine between DR/BDR and all the other routers is in FULL state.

- Execute the **`display ospf peer`** command to view neighbors.
- Execute the **`display ospf interface`** command to view OSPF information in the interface.
- Use the **`ping`** command to check whether the physical link and the lower level protocol are normal. If the local router cannot ping the peer router, this indicates that faults have occurred on the physical link and the lower level protocol.
- If the physical link and the lower level protocol are normal, please check the OSPF parameters configured on the interface. The parameters should be the same parameters configured on the router adjacent to the interface. The same area ID should be used, and the networks and the masks should also be consistent. (The P2P or virtually linked segment can have different segments and masks.)
- Ensure that the dead timer on the same interface is at least four times the value of the hello timer.
- If the network type is NBMA, the peer must be manually specified, using the **`peer ip-address`** command.
- If the network type is broadcast or NBMA, there must be at least one interface with a priority greater than zero.
- If an area is set as the STUB area to which the routers are connected, the area on these routers must be also set as the STUB area.
- The same interface type must be adopted for neighboring routers.
- If more than two areas are configured, at least one area should be configured as the backbone area with an ID of 0.

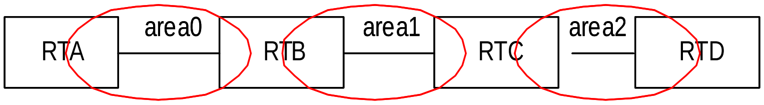
- Ensure the backbone area connects with all other areas.
- The virtual links cannot pass through the STUB area.

Troubleshooting globally: If OSPF cannot discover the remote routes and you have checked all troubleshooting items listed above, check the following configurations:

- If more than two areas are configured on a router, at least one area should be configured as the backbone area.

  As shown in Figure 59, RTA and RTD are each configured to belong to only one area, whereas RTB and RTC are both configured to belong to two areas. RTB belongs to area0, which is compliant with the requirement. However, RTC does not belong to area0. Therefore, a virtual link must be set up between RTC and RTB to ensure that area2 and area0 (the backbone area) are connected.

Figure 59 OSPF areas



- The backbone area (area 0) cannot be configured as a STUB area and the virtual link cannot pass through the STUB area. So if a virtual link has been set up between RTB and RTC, neither area1 nor area0 can be configured as a STUB area. In Figure 59, only area 2 can be configured as stub area.
- Routers in the STUB area cannot redistribute the external routes.
- The backbone area must guarantee the connectivity of all nodes.

IP Routing Policy

When a router distributes or receives routing information, it must implement policies to filter the routing information so that it can receive or distribute only the routing information that meets specified conditions. A routing protocol, such as RIP, may need to import routing information discovered by other protocols to enrich its routing knowledge. While importing the routing information, it must import only the information that meets its conditions.

To implement a routing policy, you must define a set of rules by specifying the characteristics of the routing information to be filtered. You can set the rules based on such attributes as the destination address and source address of the information. The rules can be set in advance and then used in the routing policy to advertise, receive and import the route information.

The Switch 5500 supports three kinds of filters. The following sections introduce these filters:

- Route Policy
- ACL
- IP Prefix

Route Policy

A route policy is used to match some attributes with given routing information and the attributes of the information will be set if the conditions are satisfied.

A route policy can comprise multiple nodes. Each node is a unit for match testing, and the nodes will be matched in a sequence-number-based order. Each node comprises a set of **if-match** and **apply** clauses. The **if-match** clauses define the matching rules and the matching objects are attributes of routing information. The relationship of **if-match** clauses for a node uses a series of Boolean "AND" statements. As a result, a match is found unless all the matching conditions specified by the **if-match** clauses are satisfied. The **apply** clause specifies the actions that are performed after the node match test concerning the attribute settings of the route information.

The comparisons of different nodes in a route policy uses a Boolean "OR" statement. The system examines the nodes in the route policy in sequence. Once the route is permitted by a single node in the route-policy, the route passes the matching test of the route policy without attempting the test of the next node.

ACL

The access control list (ACL) used by the route policy can be divided into three types: advanced ACL, basic ACL and interface ACL.

A basic ACL is usually used for routing information filtering. When the user defines the ACL, the user must define the range of an IP address or subnet for the destination network segment address, or the next-hop address of the routing information. If an advanced ACL is used, perform the matching operation by the specified source address range.

For details of ACL configuration, refer to Chapter 7, Using QoS/ACL Commands.

IP Prefix

The function of the IP Prefix is similar to that of the ACL, but it is more flexible and easier for users to understand. When the IP Prefix is applied to routing information filtering, its matching objects are the destination address information and the domain of the routing information. In addition, in the IP Prefix, you can specify the **gateway** options and require it to receive only the routing information distributed by some certain routers.

An IP Prefix is identified by the ip-prefix name. Each IP Prefix can include multiple list items, and each list item can specify the match range of the network prefix forms, and is identified with an index-number. The index-number designates the matching check sequence in the IP Prefix.

During the matching, the router checks list items identified by the sequence-number in ascending order. Once a single list item meets the condition, it means that it has passed the ip-prefix filtering and does not enter the testing of the next list item.

Configuring an IP Routing Policy

Configuring a routing policy includes tasks described in the following sections:

- Defining a Route Policy
- Defining If-match Clauses for a Route-policy
- Defining Apply Clauses for a Route Policy
- Importing Routing Information Discovered by Other Routing Protocols
- Defining IP Prefix
- Configuring the Filtering of Received Routes
- Configuring the Filtering of Distributed Routes

Defining a Route Policy

A route policy can include multiple nodes. Each node is a unit for the matching operation. The nodes are tested against the *node_number*.

Perform the following configurations in System View.

Table 253 Defining a route-policy

Operation	Command
Enter Route Policy View	**route-policy** *route_policy_name* { **permit** | **deny** } **node** { *node_number* }
Remove the specified route-policy	**undo route-policy** *route_policy_name* [**permit** | **deny** | **node** *node_number*]

The **permit** parameter specifies that if a route satisfies all the **if-match** clauses of a node, the route passes the filtering of the node, and the **apply** clauses for the node are executed without taking the test of the next node. If a route does not satisfy all the **if-match** clauses of a node, however, the route takes the test of the next node.

The **deny** parameter specifies that the **apply** clauses are not executed. If a route satisfies all the **if-match** clauses of the node, the node denies the route and the route does not take the test of the next node. If a route does not satisfy all the **if-match** clauses of the node, however, the route takes the test of the next node.

The router tests the route against the nodes in the route policy in sequence, once a node is matched, the route policy filtering will be passed.

By default, the route policy is not defined.

If multiple nodes are defined in a route-policy, at least one of them should be in **permit** *mode. Apply the route policy to filter routing information. If the routing information does not match any node, the routing policy denies the routing information. If all the nodes in the route policy are in deny mode, all routing information is denied by the route policy.*

Defining If-match Clauses for a Route-policy

The **if-match** clauses define the matching rules that the routing information must satisfy to pass the route policy. The matching objects are attributes of the routing information.

Perform the following configurations in Route Policy View.

Table 254 Defining if-match Conditions

Operation	Command
Match the destination address of the routing information	**if-match** { **acl** *acl_number* | **ip-prefix** *ip_prefix_name* }
Cancel the matched destination address of the routing information	**undo if-match** { **acl** | **ip-prefix** }
Match the next-hop interface of the routing information	**if-match interface**{ *interface_type_ interface_number* }
Cancel the matched next-hop interface of the routing information	**undo if-match interface**
Match the next-hop of the routing information	**if-match ip next-hop { acl** *acl_number* **| ip-prefix** *ip_prefix_name* **}**

Table 254 Defining if-match Conditions (continued)

Operation	Command
Cancel the matched next-hop of the routing information set by ACL	**undo if-match ip next-hop**
Cancel the matched next-hop of the routing information set by the address prefix list	**undo if-match ip next-hop ip-prefix**
Match the routing cost of the routing information	**if-match cost** *cost*
Cancel the matched routing cost of the routing information	**undo if-match cost**
Match the tag domain of the OSPF routing information	**if-match tag** *value*
Cancel the tag domain of the matched OSPF routing information	**undo if-match tag**

By default, no matching is performed.

*The **if-match** clauses for a node in the route policy require that the route satisfy all the clauses to match the node before the actions specified by the **apply** clauses can be executed.*

*If no **if-match** clauses are specified, all the routes will pass the filtering on the node.*

Defining Apply Clauses for a Route Policy

The **apply** clauses specify actions, which are the configuration commands executed after a route satisfies the filtering conditions that are specified in the **if-match** clauses. In this way, some attributes of the route can be modified.

Perform the following configurations in Route Policy View.

Table 255 Defining Apply Clauses

Operation	Command
Set the routing cost of the routing information	**apply cost** *value*
Cancel the routing cost of the routing information	**undo apply cost**
Set the tag domain of the OSPF routing information	**apply tag** *value*
Cancel the tag domain of the OSPF routing information	**undo apply tag**

By default, no apply clauses are defined.

Importing Routing Information Discovered by Other Routing Protocols

A routing protocol can import the routes that are discovered by other routing protocols to enrich its route information. The route policy can filter route information to implement the redistribution. If the destination routing protocol that imports the routes cannot directly reference the route costs of the source routing protocol, you should satisfy the requirement of the destination protocol by specifying a route cost for the imported route.

Perform the following configuration in Routing Protocol View.

Table 256 Configuring to import the routes of other protocols

Operation	Command
Import routes of other protocols	**import-route** *protocol* [**cost** *cost*] [**tag** *value*] **type** { **1** | **2** } [**route-policy** *route_policy_name*]
Do not import routes of other protocols	**undo import-route** *protocol*

By default, the routes discovered by other protocols will not be distributed.

In different routing protocol views, the parameter options are different. For details, refer to the description of the **import-route** *command for each protocol.*

Defining IP Prefix

A prefix list is identified by the IP Prefix name. Each IP Prefix can include multiple items, and each item can specify the matching range of the network prefix forms. The *index_number* specifies the matching sequence in the prefix list.

Perform the following configurations in System View.

Table 257 Defining Prefix-list

Operation	Command
Define a Prefix-list	**ip ip-prefix** *ip_prefix_name* [**index** *index_number*] { **permit** | **deny** } *network len* [**greater-equal** *greater_equal*] [**less-equal** *less_equal*]
Remove a Prefix-list	**undo ip ip-prefix** *ip_prefix_name* [**index** *index_number* | **permit** | **deny**]

During the matching, the router checks list items identified by the *index_number* in ascending order. If only one list item meets the condition, it means that it has passed the **ip-prefix** filtering (and does not enter the testing of the next list item).

If more than one IP prefix item is defined, then the match mode of at least one list item should be the **permit** mode. The list items of the **deny** mode can be defined to rapidly filter the routing information not satisfying the requirement, but if all the items are in the **deny** mode, no route will pass the **ip-prefix** filtering. You can define an item of **permit** 0.0.0.0/0 **greater-equal** 0 **less-equal** 32 after the multiple list items in the **deny** mode to let all the other routes pass.

Configuring the Filtering of Received Routes

Perform the following configuration in Routing Protocol View.

Define a policy that filters the routing information that does not satisfy the conditions and receives routes with the help of an ACL or address prefix-list. The **filter-policy gateway** command specifies that only the update packets from a specific neighboring router will be received.

Table 258 Configuring the Filtering of Received Routes

Operation	Command
Configure to filter the received routing information distributed by the specified address	**filter-policy gateway** *ip_prefix_name* **import**
Cancel the filtering of the received routing information distributed by the specified address	**undo filter-policy gateway** *ip_prefix_name* **import**
Configure to filter the received global routing information	**filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } [**gateway**] **import**
Cancel the filtering of the received global routing information	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } [**gateway**] **import**

By default, the filtering of received routes is not performed.

Configuring the Filtering of Distributed Routes

Define a policy concerning route distribution that filters the routing information that does not satisfy the conditions, and distributes routes with the help of an ACL or address ip-prefix.

Perform the following configuration in Routing Protocol View.

Table 259 Configuring to filter the distributed routes

Operation	Command
Configure to filter the routes distributed by the protocol	**filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } **export** [*routing_process*
Cancel the filtering of the routes distributed by the protocol	**undo filter-policy** { *acl_number* | **ip-prefix** *ip_prefix_name* } **export** [*routing_process*]

The route policy supports importing the routes discovered by the following protocols into the routing table:

- Direct—The hop (or host) to which the local interface is directly connected.
- Static—Static Route Configuration
- RIP—Route discovered by RIP
- OSPF—Route discovered by OSPF
- OSPF-ASE—External route discovered by OSPF
- OSPF-NSSA—NSSA route discovered by OSPF

By default, the filtering of distributed routes is not performed.

Forwarding Layer 3 Broadcast Packets

Broadcast packets include full-net broadcast packets and directly connected broadcast packets. The destination IP address of a full-net broadcast packet is all 1s (255.255.255.255) or all 0s. A directly-connected broadcast packet is a packet whose destination IP address is the network broadcast address of a subnet, but the source IP address is not in the subnet segment. When a switch forwards this kind of packet, the switch cannot tell whether the packet is a broadcast packet if the switch is not connected with the subnet.

If a broadcast packet reaches the destination network after being forwarded by the switch, the switch will receive the broadcast packet, for the switch also belongs to the subnet. Since the VLAN of the switch isolates the broadcast domain, the switch will stop forwarding the packet to the network. Using the following configuration tasks, you can choose to forward the broadcast packet to the network for broadcast.

Perform the following configuration in system view.

Table 260 Configuring to forward layer 3 broadcast packets

Operation	Command	Description
Enter system view	**system-view**	—
Configure to forward layer 3 broadcast packets	**ip forward-broadcast**	Required By default, the switch does not forward layer 3 broadcast packets

Displaying and Debugging the Routing Policy

Enter the **display** command in any view to display the operation of the routing policy configuration, and to verify the effect of the configuration.

Table 261 Displaying and Debugging the Routing Policy

Operation	Command
Display the routing policy	**display route-policy** [*route_policy_name*]
Display the address prefix list information	**display ip ip-prefix** [*ip_prefix_name*]

Typical IP Routing Policy Configuration Example

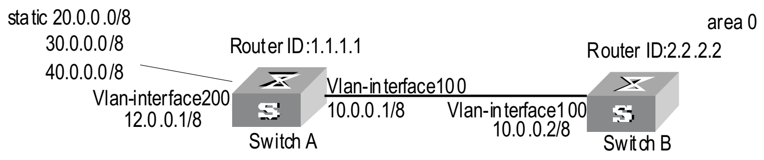
Configuring the Filtering of the Received Routing Information

Networking Requirements

- Switch A communicates with Switch B, running OSPF protocol.
- Import three static routes by enabling the OSPF protocol on Switch A.
- The route filtering rules can be configured on Switch B to make the received three static routes partially visible and partially shielded. This means that routes in the network segments 20.0.0.0 and 40.0.0.0 are visible while those in the network segment 30.0.0.0 are shielded.

Networking diagram

Figure 60 Filtering the received routing information



Configuration procedure

1 Configure Switch A:

a Configure the IP address of VLAN interface.

```
[Switch A]interface vlan-interface 100
[Switch A-Vlan-interface100]ip address 10.0.0.1 255.0.0.0
[Switch A]interface vlan-interface 200
[Switch A-Vlan-interface200]ip address 12.0.0.1 255.0.0.0
```

b Configure three static routes.

```
[Switch A]ip route-static 20.0.0.1 255.0.0.0 12.0.0.2
[Switch A]ip route-static 30.0.0.1 255.0.0.0 12.0.0.2
[Switch A]ip route-static 40.0.0.1 255.0.0.0 12.0.0.2
```

c Enable OSPF protocol and specifies the number of the area to which the interface belongs.

```
[Switch A]router id 1.1.1.1
[Switch A]ospf
[Switch A-ospf-1]area 0
[Switch A-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

d Import the static routes

```
[Switch A-ospf-1]import-route static
```

2 Configure Switch B:

a Configure the IP address of VLAN interface.

```
[Switch B]interface vlan-interface 100
[Switch B-Vlan-interface100]ip address 10.0.0.2 255.0.0.0
```

b Configure the access control list.

```
[Switch B]acl number 2000
[Switch B-acl-basic-2000]rule deny source 30.0.0.0 0.255.255.255
[Switch B-acl-basic-2000]rule permit source any
```

c Enable OSPF protocol and specifies the number of the area to which the interface belongs.

```
[Switch B]router id 2.2.2.2
[Switch B]ospf
[Switch B-ospf-1]area 0
[Switch B-ospf-1-area-0.0.0.0]network 10.0.0.0 0.255.255.255
```

d Configure OSPF to filter the external routes received.

```
[Switch B-ospf-1]filter-policy 2000 import
```

Troubleshooting Routing Protocols

Routing information filtering cannot be implemented in normal operation of the routing protocol

Check for the following faults:

- The if-match mode of at least one node of the Route Policy should be the **permit** mode. When a Route Policy is used for the routing information filtering, if a piece of routing information does not pass the filtering of any node, then it means that the route information does not pass the filtering of the Route Policy. When all the nodes of the Route Policy are in the **deny** mode, then all the routing information cannot pass the filtering of the Route Policy.
- The if-match mode of at least one list item of the ip-prefix should be the **permit** mode. The list items of the **deny** mode can be firstly defined to rapidly filter the routing information not satisfying the requirement, but if all the items are in the deny mode, no routes will not pass the **ip-prefix** filtering. You can define an item of permit 0.0.0.0/0 **less-equal** 32 after the multiple list items in the **deny** mode so as to let all the other routes pass the filtering (If **less-equal** 32 is not specified, only the default route will be matched).

Route Capacity Configuration

In practical networking applications, there is always a large number of routes in the routing table, especially OSPF routes. The routing information is usually stored in the memory of the Ethernet switch. When the size of the routing table increases, it can consume a significant amount of the switch memory.

To solve this problem, the Switch 5500 provides a mechanism to control the size of the routing table. This monitors the free memory in the system to determine whether to add new routes to the routing table and whether or not to keep connection with a routing protocol.

The default value normally meets the network requirements. You must be careful when modifying the configuration to avoid reducing the stability of the network.

Limiting Route Capacity

The size of the routing table is determined by OSPF routes. Therefore, the route capacity limitation of the Switch 5500 is only effective for these two types of routes and has no impact on static routes and other dynamic routing protocols.

When the free memory of the Switch 5500 reduces to the lower limit value, the system will disconnect OSPF and remove the routes from the routing table to release memory. The system checks the free memory periodically. When enough free memory is detected the OSPF connection is restored.

Route Capacity Configuration

Route capacity configuration includes tasks described in the following sections:

- Setting the Lower Limit and the Safety Value of the Switch Memory
- Enabling and Disabling Automatic Recovery of Disconnected Routing Protocols

Setting the Lower Limit and the Safety Value of the Switch Memory

When the Switch memory is equal to or lower than the lower limit, OSPF is disconnected and OSPF routes are removed from the routing table.

Perform the following configuration in the System View.

Table 262 Setting the Lower Limit and the Safety Value of the Switch Memory

Operation	Command
Set the lower limit and the safety value of the Switch	**memory** { **safety** *safety_value* | **limit** *limit_value* }*
Restore the lower limit and the safety value of the Switch to the default value	**undo memory** [**safety** | **limit**]

The lower limit value set for the memory must be smaller than the safety value.

Enabling and Disabling Automatic Recovery of Disconnected Routing Protocols

If the Automatic Recovery function of the Switch 5500 is disabled, connection to routing protocols is not restored even if the free memory returns to the safety value. Therefore, disabling automatic recovery must be performed cautiously.

Perform the following configurations in System View.

Table 263 Enabling/Disabling the Switch to Recover the Disconnected Routing Protocol Automatically

Operation	Command
Enable memory automatic restoration function	**memory auto-establish enable**
Disable memory automatic restoration function of a Ethernet switch	**memory auto-establish disable**

By default, automatic recovery of disconnected routing protocols is enabled.

Displaying and Debugging Route Capacity

Enter the `display` command in any view to display the operation of the Route Capacity configuration.

Table 264 Displaying and debugging route capacity

Operation	Command
Display the route capacity memory information	**display memory** [**unit** *unit_id*]
Display the route capacity memory setting and state information	**display memory limit**

17 NETWORK PROTOCOL OPERATION

This chapter covers the following topics:

- IP Address Configuration
- ARP Configuration
- Resilient ARP Configuration
- BOOTP Client Configuration
- DHCP Configuration
- Access Management Configuration
- UDP Helper Configuration
- IP Performance Configuration

IP Address Configuration

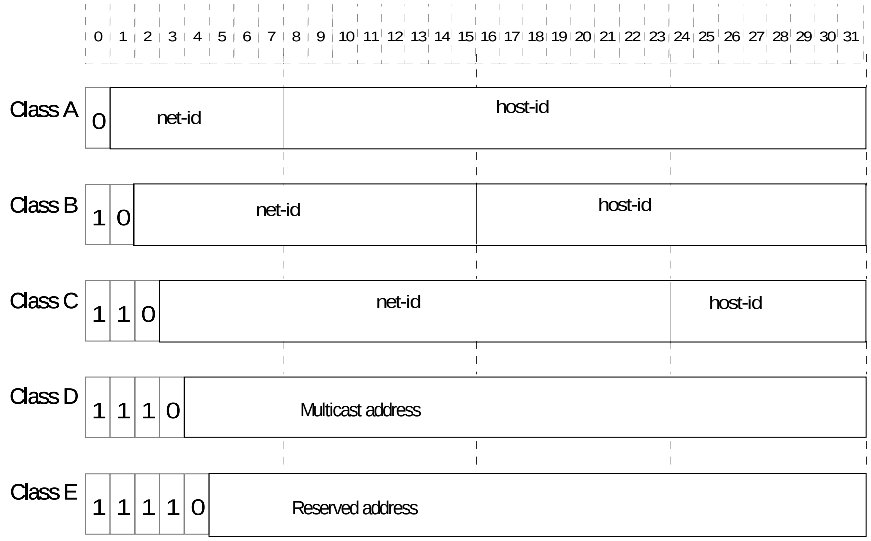
This section contains IP Address Configuration information.

IP Address Overview

IP Address Classification and Indications

An IP address is a 32-bit address allocated to the devices which access the Internet. It consists of two fields: net-id field and host-id field. There are five types of IP address. See Figure 61.

Figure 61 Five Classes of IP Address



Class A, Class B and Class C are unicast addresses, while Class D addresses are multicast addresses and Class E addresses are reserved for special applications. The first three types are commonly used.

The IP address is in dotted decimal format. Each IP address contains 4 integers in dotted decimal notation. Each integer corresponds to one byte, for example, 10.110.50.101.

When using IP addresses, note that some of them are reserved for special uses, and are seldom used. The IP addresses you can use are listed in Table 265.

Table 265 IP Address Classes and Ranges

Network class	Address range	IP network range	Note
A	0.0.0.0 to 127.255.255.255	1.0.0.0 to 126.0.0.0	Host ID with all the digits being 0 indicates that the IP address is the network address, and is used for network routing. Host ID with all the digits being 1 indicates the broadcast address, that is, broadcast to all hosts on the network. IP address 0.0.0.0 is used for the host that is not put into use after starting up. The IP address with network number as 0 indicates the current network and its network can be cited by the router without knowing its network number. Network ID with the format of 127.X.Y.Z is reserved for self-loop test and the packets sent to this address will not be output to the line. The packets are processed internally and regarded as input packets.
B	128.0.0.0 to 191.255.255.255	128.0.0.0 to 191.254.0.0	Host ID with all the digits being 0 indicates that the IP address is the network address, and is used for network routing. Host ID with all the digits being 1 indicates the broadcast address, that is, broadcast to all hosts on the network.
C	192.0.0.0 to 223.255.255.255	192.0.0.0 to 223.255.254.0	Host ID with all the digits being 0 indicates that the IP address is the network address, and is used for network routing. Host ID with all the digits being 1 indicates the broadcast address, that is, broadcast to all hosts on the network.
D	224.0.0.0 to 239.255.255.255	None	Addresses of class D are multicast addresses.
E	240.0.0.0 to 255.255.255.254	None	The addresses are reserved for future use.
Other addresses	255.255.255.255	255.255.255.255	255.255.255.255 is used as LAN broadcast address.

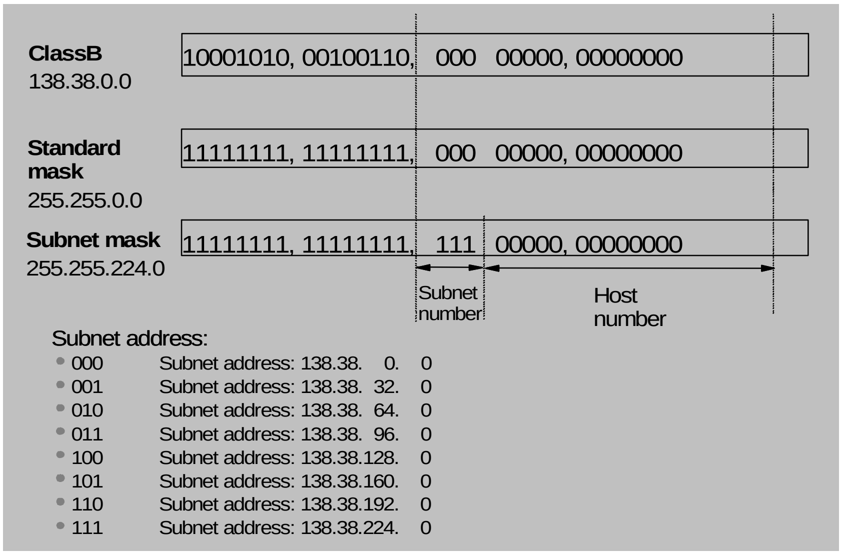
Subnet and Mask

With the rapid development of the Internet, available IP addresses are depleting very fast. The traditional IP address allocation method wastes IP addresses. In order to make full use of the available IP addresses, the mask and subnet are used.

A mask is a 32-bit number corresponding to an IP address. The number consists of 1s and 0s. Principally, these 1s and 0s can be combined randomly. However, the first consecutive bits are set to 1s when designing the mask. The mask divides the IP address into two parts: subnet address and host address. The bits 1s in the address and the mask indicate the subnet address and the other bits indicate the host address. If there is no subnet division, then its subnet mask is the default value and the length of "1" indicates the net-id length. Therefore, for IP addresses of classes A, B and C, the default values of corresponding subnet mask are 255.0.0.0, 255.255.0.0 and 255.255.255.0 respectively.

The mask can be used to divide a Class A network containing more than 16,000,000 hosts or a Class B network containing more than 60,000 hosts into multiple small networks. Each small network is called a subnet. For example, for the Class B network address 138.38.0.0, the mask 255.255.224.0 can be used to divide the network into 8 subnets: 138.38.0.0, 202.38.32.0, 138.38.64.0, 138.38.96.0, 138.38.128.0, 138.38.160.0, 138.38.192.0 and 138.38.224.0 (Refer to the Figure 62). Each subnet can contain more than 8000 hosts.

Figure 62 Subnet Division of IP Address



Subnet address:
- 000 Subnet address: 138.38. 0. 0
- 001 Subnet address: 138.38. 32. 0
- 010 Subnet address: 138.38. 64. 0
- 011 Subnet address: 138.38. 96. 0
- 100 Subnet address: 138.38.128. 0
- 101 Subnet address: 138.38.160. 0
- 110 Subnet address: 138.38.192. 0
- 111 Subnet address: 138.38.224. 0

Configuring IP Address

Configure an IP address for a VLAN interface in one of three ways:

- Using the IP address configuration command
- Allocated by BOOTP server
- Allocated by DHCP server

These three methods are mutually exclusive and a new configuration will replace the current IP address. For example, if you apply for an IP address using the **`ip address bootp-alloc`** command, the address allocated by BOOTP shall replace the currently-configured IP address.

This section introduces how to configure an IP address with the IP address configuration command. The other two methods are described in subsequent chapters.

The IP address configuration is described in the following sections:

- Configuring the Hostname and Host IP Address
- Configuring the IP Address of the VLAN Interface

Configuring the Hostname and Host IP Address

The host name is corresponded to the IP address by using this command. When you use applications like Telnet, you can use the host name without having to memorize the IP address since the system translates it to the IP address automatically.

Perform the following configuration in System View.

Table 266 Configuring the Host Name and the Corresponding IP Address

Operation	Command
Configure the hostname and the corresponding IP address	**ip host** *hostname ip_address*
Delete the hostname and the corresponding IP address	**undo ip host** *hostname* [*ip_address*]

By default, there is no host name associated to any host IP address.

For further information on IP Address configuration, please refer to the Getting Started Guide that accompanies your Switch.

Configuring the IP Address of the VLAN Interface

You can configure an IP address for every VLAN interface of the Switch. Generally, it is enough to configure one IP address for an interface. You can also configure up to five IP addresses for an interface, so that it can be connected to several subnets. Among these IP addresses, one is the primary IP address and all others are secondary.

Perform the following configuration in VLAN Interface View.

Table 267 Configuring the IP Address for a VLAN Interface

Operation	Command
Configure IP address for a VLAN interface	**ip address** *ip_address* { *mask* | *mask_length* } [**sub**]
Delete the IP address of a VLAN interface	**undo ip address** *ip-address* { *mask* | *mask_length* } [**sub**]

By default, the IP address of a VLAN interface is null.

Note that the VLAN interface cannot be configured with the secondary IP address if its IP address is set to be allocated by BOOTP or DHCP.

Displaying and Debugging IP Address

After the above configuration, enter the **display** command in any view to display the IP addresses configured on interfaces of the network device, and to verify the effect of the configuration.

Table 268 Displaying and Debugging IP Address

Operation	Command
Display all hosts on the network and the corresponding IP addresses	**display ip host**
Display the configurations of each interface	**display ip interface vlan-interface** *vlan_id*

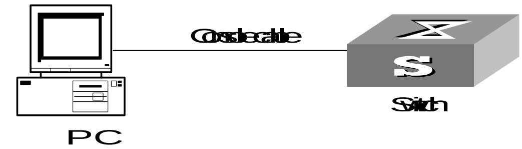
IP Address Configuration Example

Networking Requirements

Configure the IP address as 129.2.2.1 and subnet mask as 255.255.255.0 for VLAN interface 1 of the Switch.

Networking Diagram

Figure 63 IP Address Configuration Networking



Configuration Procedure

1 Enter VLAN interface 1.

```
[SW5500]interface vlan-interface 1
```

2 Configure the IP address for VLAN interface 1.

```
[SW5500-vlan-interface1]ip address 129.2.2.1 255.255.255.0
```

Troubleshooting IP Address Configuration

Fault 1: The Switch cannot ping through a certain host in the LAN.

Troubleshooting can be performed as follows:

- Check the configuration of the Switch. Use the `display arp` command to view the ARP entry table that the Switch maintains.
- Troubleshooting: First check which VLAN includes the port of the Switch used to connect to the host. Check whether the VLAN has been configured with the VLAN interface. Then check whether the IP address of the VLAN interface and the host are on the same network segment.
- If the configuration is correct, enable ARP debugging on the Switch, and check whether the Switch can correctly send and receive ARP packets. If it can only send but cannot receive ARP packets, there are possibly errors occurring on the Ethernet physical layer.

ARP Configuration

Necessity of ARP

An IP address cannot be directly used for communication between network devices because network devices can only identify MAC addresses. An IP address is an address of a host in the network layer. To send the data packets transmitted through the network layer to the destination host, the physical address of the host is required. So the IP address must be resolved into a physical address.

ARP Implementation Procedure

When two hosts on the network communicate, they must know the MAC addresses of each other. Every host will maintain the IP-MAC address translation table, which is known as ARP mapping table. A series of maps between IP addresses and MAC addresses of other hosts which were recently used to communicate with the local host are stored in the ARP mapping table. When a dynamic ARP mapping entry is not in use for a specified period of time, the host will remove it from the ARP mapping table so as to save the memory space and shorten the interval for Switch to search ARP mapping table.

Suppose there are two hosts on the same network segment: Host A and Host B. The IP address of Host A is IP_A and the IP address of Host B is IP_B. Host A will transmit messages to Host B. Host A checks its own ARP mapping table first to make sure whether there are corresponding ARP entries of IP_B in the table. If the corresponding MAC address is detected, Host A will use the MAC address in the ARP mapping table to encapsulate the IP packet in frame and send it to Host B. If the corresponding MAC address is not detected, Host A will store the IP packet in the queue waiting for transmission, and broadcast it throughout the Ethernet. The ARP request packet contains the IP address of Host B and IP address and MAC address of Host A. Because the ARP request packet is broadcast, all hosts on the network segment can receive the request. However, only the requested host (that is, Host B) needs to process the request. Host B will first store the IP address and the MAC address of the request sender (Host A) in the ARP request packet in its own ARP mapping table. Then Host B will generate an ARP reply packet, into which it will add MAC address of Host B, and then send it to Host A. The reply packet will be directly sent to Host A in stead of being broadcast. Receiving the reply packet, Host A will extract the IP address and the corresponding MAC address of Host B and add them to its own ARP mapping table. Then Host A will send Host B all the packets standing in the queue.

Normally, dynamic ARP automatically executes and searches for the resolution from the IP address to the Ethernet MAC address without the administrator.

Configuring ARP

The ARP mapping table can be maintained dynamically or manually. Usually, the manually configured mapping from the IP addresses to the MAC addresses is known as static ARP. The user can display, add, or delete entries in the ARP mapping table through relevant manual maintenance commands.

Static ARP configuration is described in the following sections:

- Manually Adding/Deleting Static ARP Mapping Entries
- Configuring the Dynamic ARP Aging Timer
- Configuring the Creation of ARP Entries for Multicast Packets

Manually Adding/Deleting Static ARP Mapping Entries

You can configure static ARP mapping items either in System View or Ethernet Port View. In System View, you can configure global static ARP mapping entries, or configure static ARP mapping entries for the designated egress port; while in Ethernet Port View, you may set the current port as the egress port of static ARP.

Perform the following configuration in System View or Ethernet Port View.

Table 269 Manually Adding/Deleting Static ARP Mapping Entries

Operation	Command
Manually add a static ARP mapping entry (System View)	**arp static** *ip_address mac_address* [*vlan_id* { *interface_type interface_num* | *interface_name* }]
Manually add a static ARP mapping entry (Ethernet Port View)	**arp static** *ip_address mac_address vlan_id*
Manually delete a static ARP mapping entry (System View or Ethernet Port View)	**undo arp** *ip_address*

By default, the ARP mapping table is empty and the address mapping is obtained through dynamic ARP.

Note that:

- Static ARP map entry will be always valid as long as the Switch works normally. But if the VLAN corresponding to the ARP mapping entry is deleted, the ARP mapping entry will be also deleted. The valid period of dynamic ARP map entries will last only 20 minutes by default.
- The parameter *vlan-id* must be the ID of a VLAN that has been created by the user, and the Ethernet port specified behind this parameter must belong to the VLAN.
- The aggregation port or port with LACP enabled cannot be set as the egress port of static ARP.

Configuring the Dynamic ARP Aging Timer

For purpose of flexible configuration, the system provides the following commands to assign dynamic ARP aging period. When the system learns a dynamic ARP entry, its aging period is based on the current value configured.

Perform the following configuration in System View.

Table 270 Configuring the Dynamic ARP Aging Timer

Operation	Command
Configure the dynamic ARP aging timer	**arp timer aging** *aging_time*
Restore the default dynamic ARP aging time	**undo arp timer aging**

By default, the aging time of the dynamic ARP aging timer is 20 minutes.

Configuring the Creation of ARP Entries for Multicast Packets

Use the following command to specify whether the Switch should create ARP table entries for multicast MAC addresses. Address resolution, for multicast packets, is not required because the IANA (Internet Assigned Numbers Authority) have reserved a block of Ethernet addresses that map on to the Class D multicast addresses.

Perform the following configuration in System View.

Table 271 Configuring the Creation of ARP Entries for Multicast Packets

Operation	Command
Configure the Switch NOT to create ARP entries	**arp check enable**
Configure the Switch to create ARP entries	**undo arp check enable**

By default, this feature is enabled.

Introduction to Gratuitous ARP

The following are the characteristics of gratuitous ARP packets:

- Both source and destination IP addresses carried in a gratuitous ARP packet are the local IP address, and the source MAC address carried in the packet is the local MAC address.
- If a device finds that the IP address carried in a received gratuitous packet conflict with that of its own, it returns an ARP response to the sending device to notify of the IP address conflict.

By sending gratuitous ARP packets, a network device can:

- Determine whether or not IP address conflicts exist between it and other network devices.
- Trigger other network devices to update its hardware address stored in their caches.

When the gratuitous ARP packet learning function is enabled on a device and the device receives a gratuitous ARP packet, the device updates the corresponding ARP entry (if available in the cache of the switch) using the hardware address of the sender carried in the gratuitous ARP packet. A device operates like this whenever it receives a gratuitous ARP packet.

Gratuitous ARP Packet Learning Configuration

This section contains configuration information on Gratuitous ARP Packet Learning.

Configuring Gratuitous ARP Packet Sending

Gratuitous ARP packet sending is enabled as long as a Switch 5500 operates. And no command is for this function.

Configuring the Gratuitous ARP Packet Learning

Table 272 describes the procedure to configure the gratuitous ARP packet learning function.

Table 272 Configure the gratuitous ARP packet learning function

Operation	Command	Description
Enter system view	**system-view**	-
Enable the gratuitous ARP packet learning function	**gratuitous-arp-learning enable**	Required By default, the gratuitous ARP packet learning function is enabled.

Displaying and Debugging ARP

After the above configuration, enter the **display** command in any view to display the running of the ARP configuration, and to verify the effect of the configuration. Enter the **debugging** command in User View to debug ARP configuration. Enter the **reset** command in User View to clear ARP mapping table.

Table 273 Displaying and Debugging ARP

Operation	Command
Display the ARP mapping table	**display arp** [*ip_address* | [**dynamic** | **static**] [| { **begin** | **include** | **exclude** } *text*]]
Display the current setting of the dynamic ARP map aging timer	**display arp timer aging**
Reset the ARP mapping table	**reset arp** [**dynamic** | **static** | **interface** { *interface_type interface_num* | *interface_name* }]
Enable ARP information debugging	**debugging arp packet**
Disable ARP information debugging	**undo debugging arp packet**

Resilient ARP Configuration

This section contains configuration information for Resilient ARP.

Overview of Resilient ARP

To support resilient networking in XRN applications, redundant links are required between the XRN fabric and other devices. But if intra-fabric connections are broken and the original fabric is split, these redundant links may cause a situation where the network connects to two or more layer 3 devices of the same configuration and they run the same routing function. To eliminate this situation, you can resort to resilient ARP mechanism, which can immediately detect if there are layer 3 devices of the same configuration existing in the network. If yes, it will keep only one as a Layer 3 device and turn the others in to Layer 2 devices.

A resilient ARP state machine may be in one of six states: Initialize, LisentForL3Master, L3Master, L3Slave, L2Master and L2Slave. An L3Master state machine regularly sends resilient ARP messages to notify other XRN fabrics that its home fabric is in Layer 3 state.

The resilient ARP mechanism can implement state transition by sending/receiving resilient ARP messages regularly, so as to determine if a device serves as a Layer 3 or Layer 2 device.

Resilient ARP configuration is described in the following sections:

- Enabling/Disabling Resilient ARP Function
- Configuring Resilient ARP Packet-sending VLAN Interface

Enabling/Disabling Resilient ARP Function

After resilient ARP is enabled, the system can ensure there is only one Layer 3 device, and that others are Layer 2 devices.

Perform the following configuration in System View.

Table 274 Enabling/Disabling Resilient ARP Function

Operation	Command
Enable resilient ARP function	`resilient-arp enable`
Disable resilient ARP function	`undo resilient-arp enable`

By default, resilient ARP function is enabled.

If you are attempting to stop the Switch from transmitting packets, you need to disable all features which may generate packets. By default these are:

- DHCP
- Resilient ARP
- Spanning Tree

Configuring Resilient ARP Packet-sending VLAN Interface

You must configure the VLAN interface corresponding to the redundant links which connect the XRN fabric with other devices, to make resilient ARP operate normally. Then if intra-fabric connections are broken, resilient ARP packets can be sent through these VLAN interfaces corresponding to the redundant links, to determine if the system works as a layer 3 or layer 2 device.

You can use the following command to configure through which VLAN interface the resilient ARP packet is sent. The system provides a default VLAN interface to send resilient ARP packets.

Perform the following configuration in System View.

Table 275 Configuring/Deleting Resilient ARP Packet-sending VLAN Interface

Operation	Command
Configure resilient ARP packet-sending VLAN interface	**resilient-arp interface vlan-interface** *vlan_id*
Delete resilient ARP packet-sending VLAN interface	**undo resilient-arp interface vlan-interface** *vlan_id*

By default, the system sends resilient ARP packets through VLAN interface 1.

Note that you only specify resilient ARP packet-sending VLAN interfaces, and any VLAN interface can receive resilient ARP packets.

Displaying and Debugging Resilient ARP Configuration

After the above configurations are completed, you can enter the **display** command in any view to view the running of resilient ARP function and to further check configuration results.

You can also enter the **debugging** command in User View to debug the resilient ARP function.

Table 276 Displaying and Debugging Resilient ARP Configuration

Operation	Command
Display resilient ARP state information	**display resilient-arp** [**unit** *unit_id*]
Enable resilient ARP debugging	**debugging resilient-arp** { **packet** | **state** | **error** | **all** }
Disable resilient ARP debugging	**undo debugging resilient-arp** { **packet** | **state** | **error** | **all** }

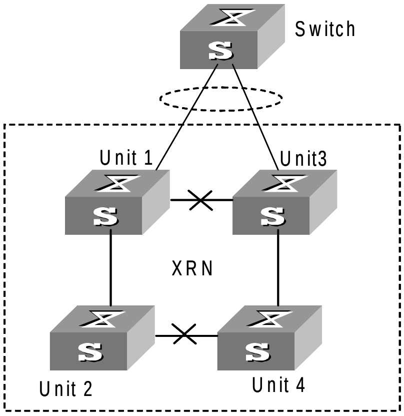
Resilient ARP Configuration Example

Networking Requirement

There are four units, numbered respectively Unit 1 through Unit 4, in the XRN network. Unit 1 and Unit 3 are connected to the Switch in link aggregation mode. Resilient ARP runs on the XRN fabric to avoid packet forwarding problems between the Switch and fabric when the network has two Layer 3 units, if the links between unit 1 and unit 3, between unit 2 and unit 4 are disconnected. MD5 authentication is enabled for the sake of security. The ports of Unit 1 and Unit 3, connecting the Switch, belong to VLAN 2.

Networking Diagram

Figure 64 Networking for Resilient ARP Configuration



Configuration Procedure

1 Enable resilient ARP function.

```
[SW5500]resilient-arp enable
```

2 Set VLAN interface 2 to send resilient ARP packets.

```
[SW5500]resilient-arp interface vlan-interface 2
```

BOOTP Client Configuration

This section contains configuration information for BOOTP Client.

Overview of BOOTP Client

A BOOTP client can request the server to allocate an IP address to it using BOOTP (bootstrap protocol). These two major processes are included on the BOOTP client:

- Sending BOOTP Request message to the server
- Processing BOOTP Response message returned from the server

In obtaining an IP address using BOOTP, the BOOTP client sends the server the BOOTP Request message. Upon receiving the request message, the server returns the BOOTP Response message. The BOOTP client can then obtain the allocated IP address from the received response message.

The BOOTP message is based on UDP, so a retransmission mechanism in the event of timeout is used to guarantee its reliable transmission. The BOOTP client also starts a retransmission timer when it sends the request message to the server. If the timer expires before the return of the response message from the server, the request message will be retransmitted. The retransmission occurs every five seconds and the maximum number of retransmissions is three, that is, the message shall not be retransmitted after the third time.

BOOTP Client Configuration

BOOTP client is described in the following section.

Configuring a VLAN Interface to Obtain the IP Address Using BOOTP

Perform the following configuration in VLAN Interface View.

Table 277 Configuring a VLAN Interface to Obtain the IP Address Using BOOTP

Operation	Command
Configure VLAN interface to obtain an IP address using BOOTP	**`ip address bootp-alloc`**
Remove the configuration	**`undo ip address bootp-alloc`**

By default, the VLAN interface cannot use BOOTP to get an IP address.

For further information on IP Address configuration, please refer to the Getting Started Guide that accompanies your Switch.

Debugging BOOTP Client

After the above configuration, verify the effect of the configuration.

Enter the **`debugging`** command in User View to debug BOOTP client.

Table 278 Debugging BOOTP Client

Operation	Command
Disable/enable hot backup debugging of BOOTP client	[**`undo`**] **`debugging dhcp xrn xha`**

DHCP Configuration

This section contains DHCP configuration information.

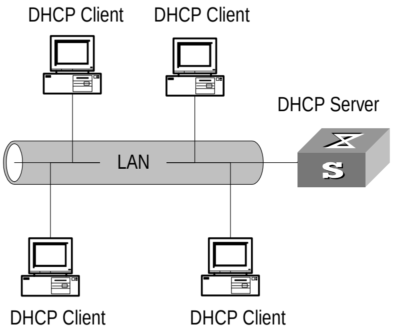
Overview of DHCP

Dynamic Host Configuration Protocol (DHCP) offers dynamic IP address assignment. DHCP works in Client-Server mode. With this protocol, the DHCP Client can dynamically request configuration information and the DHCP server can configure the information for the Client.

The DHCP relay serves as conduit between the DHCP Client and the server located on different subnets. The DHCP packets can be relayed to the destination DHCP server (or Client) across network segments. The DHCP clients on different networks can use the same DHCP server. This is economical and convenient for centralized management.

A typical DHCP application often contains a DHCP server and several clients (desktop and laptop PCs). See Figure 65

Figure 65 Typical DHCP Application.



To obtain valid dynamic IP addresses, the DHCP client exchanges different types of information with the server at different stages. One of the following three situations may occur:

- A DHCP client logs into the network for the first time

  When a DHCP client logs into the network for the first time, its communication with the DHCP server includes these four stages:

  - Discovery stage, the stage when the DHCP client looks for the DHCP server. The client broadcasts the DHCP_Discover message and only the DHCP server can respond.
  - Offer stage, the stage when the DHCP server allocates the IP address. After receiving the DHCP_Discover message from the client, the DHCP server chooses an IP address still available in the IP address pool for the client, and sends to the client the DHCP_Offer message containing the leased IP address and other settings.
  - Select stage, the stage when the client selects the IP address. If several DHCP servers send DHCP_Offer messages to the client, the client only accepts the first received one and then broadcasts DHCP_Request messages respectively to those DHCP servers. The message contains the information of the IP address request from the selected DHCP server.
  - Acknowledge stage, the stage when the DHCP server acknowledges the IP address. When receiving the DHCP_Request message from the client, the DHCP server sends the DHCP_ACK message containing the allocated IP address and other settings back to the client. Then the DHCP client binds its TCP/IP components to the NIC (network interface card).

  Other DHCP servers not selected still can allocate their IP addresses to other clients later.

- A DHCP client logs into the network for a second time

  When DHCP client logs into the network for a second time, its communication with the DHCP server includes these stages:

  - The client broadcasts the DHCP_Request message containing the IP address obtained last time, other than the DHCP_Discover message.
  - After the reception of the DHCP_Request message, the DHCP server returns the DHCP_ACK message if the requested IP address is still not allocated, to indicate the client to continue use of the IP address.
  - If the requested IP address becomes unavailable (for example, having been allocated to another client), the DHCP server returns the DHCP_NAK message. After receiving the DHCP_NAK message, the client sends the DHCP_Discover message to request another new IP address.

- A DHCP client extends its IP lease period

  There is a time limit for the IP addresses leased to DHCP clients. The DHCP server shall withdraw the IP addresses when their lease period expires. If the DHCP client wants to continue use of the old IP address, it has to extend the IP lease.

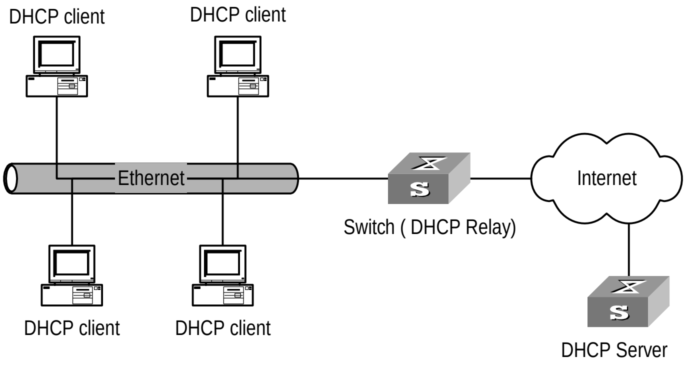
  In practice, the DHCP client, by default, shall originate the DHCP_Request message to the DHCP server right in the middle of the IP lease period, to update the IP lease. If the IP address is still available, the DHCP server responds with the DHCP_ACK message, notifying the client that it has got the new IP lease.

  The DHCP client implemented on the Switch supports automatic IP lease update.

DHCP Relay

The DHCP described above applies only when DHCP clients and server(s) are in the same subnet, and it does not support trans-segment networking. To achieve dynamic address configuration, you would have to configure a DHCP server for each subnet, which is not a practical solution. Introduction of DHCP relay has solved this problem: the clients in a LAN can communicate with DHCP servers in another subnet through DHCP relay, to get valid IP addresses. Then DHCP clients of multiple different networks can share a DHCP server, which saves networking cost, as well as facilitating centralized management. A typical DHCP relay application is shown in Figure 66.

Figure 66 Typical DHCP Relay Application



DHCP Relay works on the following principle:

- When the DHCP client starts and initializes DHCP, it broadcasts the request message to the local network.
- If there is a DHCP server on the local network, it can begin DHCP configuration without requiring a DHCP relay function. If not, the local network device configured for DHCP relay, upon receiving the broadcast message, will forward the message to the DHCP server on the specified network.
- The DHCP server determines a correct configuration based on the information from the client and returns the configuration information back to the client through DHCP relay.

In fact, several such interactions may be needed to complete a DHCP relay configuration.

Option 82 supporting

Introduction to option 82 supporting

Option 82 is a relay agent information option in DHCP packets. When a request packet from a DHCP client travels through a DHCP relay on its way to the DHCP server, the DHCP relay adds option 82 into the request packet. Option 82 includes many sub-options, but the DHCP server supports only sub-option 1 and sub-option 2 at present. Sub-option 1 defines agent circuit ID (that is, Circuit ID) and sub-option 2 defines remote agent ID (that is, Remote ID).

Option 82 enables a DHCP server to track the address information of DHCP clients and DHCP relays, through which and other proper software, you can achieve the DHCP assignment limitation and accounting functions.

Primary terminologies

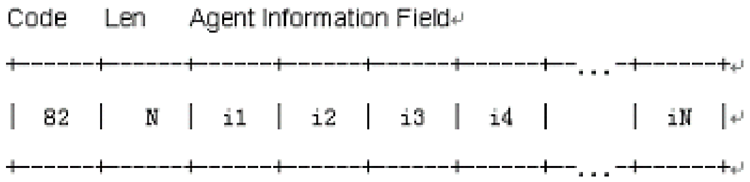
- Option: A length-variable field in DHCP packets, carrying information such as part of the lease information and packet type. It includes at least one option and at most 255 options.
- Option 82: Also known as relay agent information option. This option is a part of the Option field in DHCP packet. According to RFC3046, option 82 lies before option 255 and after the other options. Option 82 includes at least one sub-option and at most 255 sub-options. Currently, the commonly used sub-options in option 82 are sub-option 1, sub-option 2 and sub-option 5.
- Sub-option 1: A sub-option of option 82. Sub-option 1 represents the agent circuit ID, namely Circuit ID. It holds the VLAN-ID and MAC address of the switch port connected to the DHCP client, and is usually configured on the DHCP relay. Generally, sub-option 1 and sub-option 2 must be used together to identify information about a DHCP source.
- Sub-option 2: A sub-option of option 82. Sub-option 2 represents the remote agent ID, namely Remote ID. It holds the MAC address of the DHCP relay, and is usually configured on the DHCP relay. Generally, sub-option 1 and sub-option 2 must be used together to identify information about a DHCP source.
- Sub-option 5: A sub-option of option 82. Sub-option 5 represents link selection. It holds the IP address added by the DHCP relay, so that the DHCP server can assign an IP address on the same segment to the DHCP client.

Format of the option 82 field

1 Option 82 format

A DHCP packet contains a field named options, which can be empty or contain the option for a feature (such as option 82). Option 82 can contain multiple sub-options, as illustrated in Figure 67

Figure 67 Option 82 format



```
Code    Len    Agent Information Field
+------+------+------+------+------+------+--...-+------+
|  82  |   N  |  i1  |  i2  |  i3  |  i4  |      |  iN  |
+------+------+------+------+------+------+--...-+------+
```

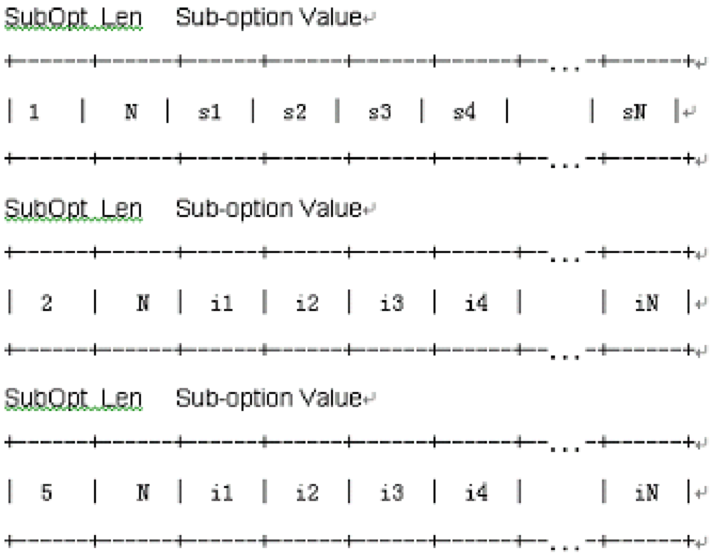
- Code: Identifies the relay agent information option number. As for packets containing option 82, the value of this field is 82. Option 82 lies before option 255 and after the other options.

- Len: Specifies the Length of the agent information field.
- Agent information field: Specifies the sub-options used.

2 Sub-option format

Figure 68 illustrates the sub-option format.

Figure 68 Sub-option format



```
SubOpt Len    Sub-option Value
+------+------+------+------+------+------+--...--+------+
| 1    |   N  |  s1  |  s2  |  s3  |  s4  |       |  sN  |
+------+------+------+------+------+------+--...--+------+
SubOpt Len    Sub-option Value
+------+------+------+------+------+------+--...--+------+
|  2   |   N  |  i1  |  i2  |  i3  |  i4  |       |  iN  |
+------+------+------+------+------+------+--...--+------+
SubOpt Len    Sub-option Value
+------+------+------+------+------+------+--...--+------+
|  5   |   N  |  i1  |  i2  |  i3  |  i4  |       |  iN  |
+------+------+------+------+------+------+--...--+------+
```

- SubOpt: Sub-option number. Currently, the value of this sub-field can be 1, 2, and 5, which have the following meanings:

1 represents this sub-option is for agent circuit ID (Circuit ID);

2 represents this sub-option is for remote agent ID (Remote ID);

5 represents this sub-option is for link selection.

- Len: Length of the Sub-option value sub-filed.
- Sub-option value: Value of the sub-option. For example, the value for sub-option 1 is Circuit ID.

3 Related specification

The following are the RFCs concerning option 82 supporting.

- RFC2131 Dynamic Host Configuration Protocol
- RFC3046 DHCP Relay Agent Information Option

Mechanism of option 82 supporting on DHCP relay

The procedure for a DHCP client to obtain an IP address from a DHCP server through a DHCP relay is exactly the same as that for the client to obtain an IP address from a DHCP server directly. The following are the mechanism of option 82 supporting on DHCP relay.

1 A DHCP client broadcasts a request packet when it initiates.

2 If a DHCP server exists in the local network, it assigns an IP address to the DHCP client directly. Otherwise, the DHCP relay on this network receives and processes the request packet. The DHCP relay checks whether the packet contains option 82 and processes the packet accordingly.

3 If the packet contains option 82, the DHCP relay processes the packet depending on the configured policy (that is, discards the packet, replaces the original option 82 in the packet with its own, or leaves the original option 82 unchanged in the packet), and forwards the packet (if not discarded) to the DHCP server.

4 If the packet does not contain option 82, the DHCP relay adds option 82 to the packet and forwards the packet to the DHCP server. The forwarded packet contains the MAC address of the switch port to which the DHCP client is connected, the VLAN to which the DHCP client belongs, and the MAC address of the DHCP relay.

5 Upon receiving the DHCP request packet forwarded by the DHCP relay, the DHCP server stores the information contained in the option field and sends a packet that contains DHCP configuration information and option 82 to the DHCP relay.

6 Upon receiving the packet returned from the DHCP server, the DHCP relay strips option 82 from the packet and forwards the packet with the DHCP configuration information to the DHCP client.

Request packets sent by a DHCP client fall into two categories: DHCP-DISCOVER packets and DHCP-REQUEST packets. As DHCP servers coming from different manufacturers process DHCP request packets in different ways (that is, some DHCP servers process option 82 in DHCP-DISCOVER packets, whereas the rest process option 82 in DHCP-REQUEST packets), a DHCP relay adds option 82 to both types of packets to accommodate to DHCP servers of different manufacturers.

DHCP Client Configuration

DHCP client configuration is described in the following section.

Configuring a VLAN Interface to Obtain an IP Address Using DHCP

Perform the following configuration in VLAN Interface View.

Table 279 Configuring a VLAN Interface to Obtain an IP Address Using DHCP

Operation	Command
Configure VLAN interface to obtain IP address using DHCP	**ip address dhcp-alloc**
Remove the configuration	**undo ip address dhcp-alloc**

By default, the Switch attempts to obtain an IP address by DHCP on VLAN 1.

If you are attempting to stop the Switch from transmitting packets, you need to disable all features which may generate packets. By default these are:

- DHCP
- Resilient ARP
- Spanning Tree

DHCP Relay Configuration

DHCP relay configuration is described in the following sections:

- Enabling DHCP
- Enabling DHCP
- Configuring the DHCP Server Group for the VLAN Interfaces
- Configuring the User Address Entry for the DHCP Server Group
- Enabling/Disabling the DHCP Security Feature on the VLAN interface

Enabling DHCP

Be sure to enable DHCP before you perform other DHCP relay-related configuration, for other DHCP-related configurations cannot take effect with DHCP disabled.

Table 280 Enable DHCP

Operation	Command	Description
Enter system view	system-view	-
Enable DHCP	dhcp enable	Required By default, DHCP is disabled.

Configuring the IP address for the DHCP server

You can configure a master and a backup DHCP server, which are in the same DHCP server group, in the same network segment to ensure reliability.

Perform the following configuration in System View.

Table 281 Configuring the IP Address for the DHCP Server

Operation	Command
Configure IP address for DHCP server	**dhcp-server** *groupNo* **ip** *ipaddress1* [*ipaddress2*]
Delete all DHCP server IP addresses (set the IP addresses of master and backup DHCP servers to 0)	**undo dhcp-server** *groupNo*

By default, no IP address is configured for the DHCP server.

Note that you must configure an IP address for the backup DHCP server together with that of the master server.

Configuring the DHCP Server Group for the VLAN Interfaces

Perform the following configuration in VLAN Interface View.

Table 282 Configuring the DHCP Server Group Corresponding to VLAN Interfaces

Operation	Command
Configure DHCP server group corresponding to VLAN interfaces	**dhcp-server** *groupNo*
Delete DHCP server group	**undo dhcp-server**

By default, no DHCP server corresponds to VLAN interfaces.

When associating a VLAN interface to a new DHCP server group, you can configure the association without disassociating it from the previous group.

Configuring the User Address Entry for the DHCP Server Group

To ensure that a valid user with a fixed IP address in a VLAN configured with DHCP Relay passes the address validity check of the DHCP security feature, you must add a static address entry which indicates the correspondence between an IP address and a MAC address.

If an illegal user configures a static IP address which is in conflict with the fixed IP address of a valid user, the Switch with DHCP Relay function enabled can identify the valid user and reject the illegal user's request to bind the IP address with the MAC address.

Perform the following configuration in System View..

Table 283 Configuring the User Address Entry for the DHCP Server Group

Operation	Command
Configure user address entry for DHCP server group	**`dhcp-security static`** *`ip_address mac_address`*
Delete the user address entry in the DHCP server group	**`undo dhcp-security`** { *`ip_address`* | **`all`** | **`dynamic`** | **`static`** }

Configuring DHCP Relay Security

Configuring address checking

When a DHCP client obtain an IP address from a DHCP server with the help of a DHCP relay, the DHCP relay creates an entry (dynamic entry) in the user address table to track the IP-MAC address binding information about the DHCP client. You can also configure user address entries manually (static entries) to bind an IP address and a MAC address statically.

The purpose of the address checking function on DHCP relay is to prevent unauthorized users from statically configuring IP addresses to access external networks. With this function enabled, a DHCP relay inhibits a user from accessing external networks if the IP address configured on the user end and the MAC address of the user end do not match any entries (including the entries dynamically tracked by the DHCP relay and the manually configured static entries) in the user address table on the DHCP relay.

Table 284 Configure address checking

Operation	Command	Description
Enter system view	**system-view**	-
Create a DHCP user address entry manually	**dhcp-security static** *ip-address mac-address*	Optional By default, there is no manually configured DHCP user address entry. Only S5500-EI series switches among S5500 series switches support this configuration.
Enter interface view	**interface** *interface-type interface-number*	-
Enable the address checking function	**address-check enable**	Required By default, the address checking function is disabled.

Configuring the dynamic user address entry updating function

When a DHCP client obtains an IP address from a DHCP server with the help of a DHCP relay, the DHCP relay creates an entry (dynamic entry) in the user address table to track the binding information about the IP address and MAC address of the DHCP client. But as a DHCP relay does not process DHCP-RELEASE packets, which are sent to DHCP servers by DHCP clients through unicast when the DHCP clients release IP addresses, the user address entries maintained by the DHCP cannot be updated in time. The dynamic user address entry updating function is developed to resolve this problem.

The dynamic user address entry updating function works as follows: at regular intervals, the DHCP relay sends a DHCP-REQUEST packet that carries the IP address assigned to a DHCP client and its own MAC address to the corresponding DHCP server. If the DHCP server answers with a DHCP-ACK packet, the IP address is available (it can be assigned again) and the DHCP relay ages out the corresponding entry in the user address table. If the DHCP server answers with a DHCP-NAK packet, the IP address is still in use (the lease is not expired) and the DHCP relay remains the corresponding user address entry unchanged.

Table 285 Configure the dynamic user address entry updating function

Operation	Command	Description
Enter system view	**system-view**	-
Set the interval to update DHCP user address entries	**dhcp-security tracker { *interval* | auto }**	Optional By default, the update interval is automatically determined by the number of DHCP user address entries. Only S5500-EI series switches among S5500 series switches support this configuration.

Enabling/Disabling the DHCP Security Feature on the VLAN interface

Enabling DHCP security features will start the address validity check on the VLAN interface; disabling DHCP security features will cancel the address validity check.

Perform the following configuration in VLAN Interface View.

Table 286 Enabling/Disabling DHCP Security Feature on the VLAN Interface

Operation	Command
Enable DHCP security feature on VLAN interface	`address-check enable`
Disable DHCP security feature on VLAN interface	`address-check disable`

By default, the DHCP security feature is disabled on the VLAN interface.

Option 82 Supporting Configuration

This section contains supporting configuration information for Option 82.

Prerequisites

Before configuring option 82 supporting on a DHCP relay, make sure that:

- The DHCP relay is configured and operates properly.
- The DHCP server operates properly. Address allocation policy-related configurations (such as address pools and the lease time) are performed.
- The routes between the DHCP relay and the DHCP server are reachable.

Enabling Option 82 Supporting on a DHCP Relay

The following operations are expected to be performed on a DHCP relay-enabled network device.

Table 287 Enable option 82 supporting on a DHCP relay

Operation	Command	Description
Enter system view	**system-view**	-

Table 287 Enable option 82 supporting on a DHCP relay

Operation	Command	Description
Enable option 82 supporting on the DHCP relay	dhcp relay information enable	Required By default, this function is disabled.
Configure the strategy for the DHCP relay to process request packets containing option 82	**dhcp relay information strategy { drop | keep | replace** }	Optional By default, the replace policy is adopted, that is, the DHCP relay replaces the original option 82 carried in a request packet with its own option 82.

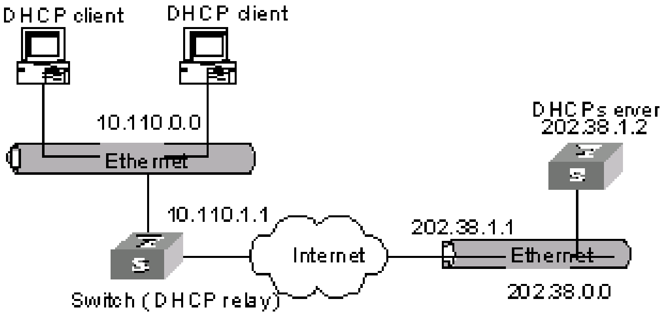
Option 82 Supporting Configuration Example

Network requirements

Two DHCP clients are on the network segment 10.110.0.0 (255.255.0.0). They obtain IP addresses from a DHCP server through a switch acting as DHCP relay. Option 82 supporting is enabled on the DHCP relay.

Network diagram

Figure 69 Network diagram for option 82 supporting



Configuration procedure

This example supposes that the routes between the DHCP relay and the DHCP server are reachable. The following configurations are only for the switch acting as DHCP relay.

1 Enter system view.

```
<S5500> system-view
```

2 Enable DHCP.

```
[S5500] dhcp enable
```

3 Configure the VLAN interface that is to carry out the DHCP relay function: First enter the corresponding VLAN interface view. Then assign an IP address and a subnet mask to the VLAN interface so that it is on the same network segment with the two DHCP clients.

```
[S5500] interface vlan-interface 100
[S5500-Vlan-interface 100] ip address 10.110.1.1 255.255.0.0
```

4 Specify the IP address of the DHCP server by configuring the IP address of the DHCP server to be used by DHCP server group 1.

```
[S5500] dhcp-server 1 ip address 202.38.1.2
```

5 Map VLAN 100 interface to DHCP server group1.

```
[S5500] interface Vlan-interface 100
[S5500-Vlan-interface100] dhcp-server 1
```

6 Return to system view.

```
[S5500-vlan-interface 100] quit
```

7 Enable option 82 supporting on the DHCP relay, with the **keep** keyword specified.

```
[S5500] dhcp relay information enable
[S5500] dhcp relay information strategy keep
```

Introduction to DHCP Snooping

For the sake of security, the IP addresses used by online DHCP clients need to be tracked for the administrator to verify the corresponding relationship between the IP addresses the DHCP clients obtained from DHCP servers and the MAC addresses of the DHCP clients.

- Layer 3 switches can track DHCP client IP addresses through DHCP relay.
- Layer 2 switches can track DHCP client IP addresses through the DHCP snooping function, which listens DHCP broadcast packets.

When an unauthorized DHCP server exists in the network, a DHCP client may obtains an illegal IP address. To ensure that the DHCP clients obtain IP addresses from valid DHCP servers, you can specify a port to be a trusted port or an untrusted port by the DHCP snooping function.

- Trusted ports can be used to connect DHCP servers or ports of other switches. Untrusted ports can be used to connect DHCP clients or networks.
- Trusted ports forward any received DHCP packets to ensure that DHCP clients can obtain IP addresses from valid DHCP servers. Untrusted ports discard the DHCP-ACK and DHCP-OFFER responses received from DHCP servers.

Figure 70 illustrates a typical network diagram for DHCP snooping application, where Switch A is an S5500 series switch.

Figure 70 Typical network diagram for DHCP snooping application

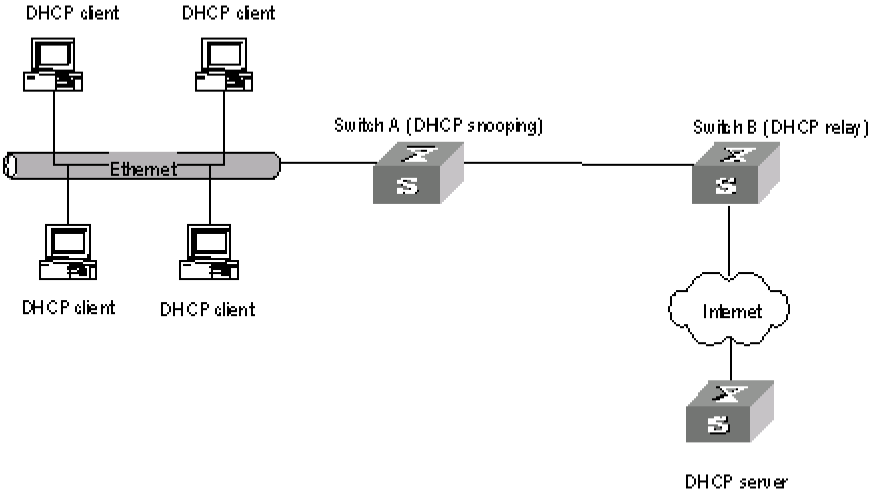
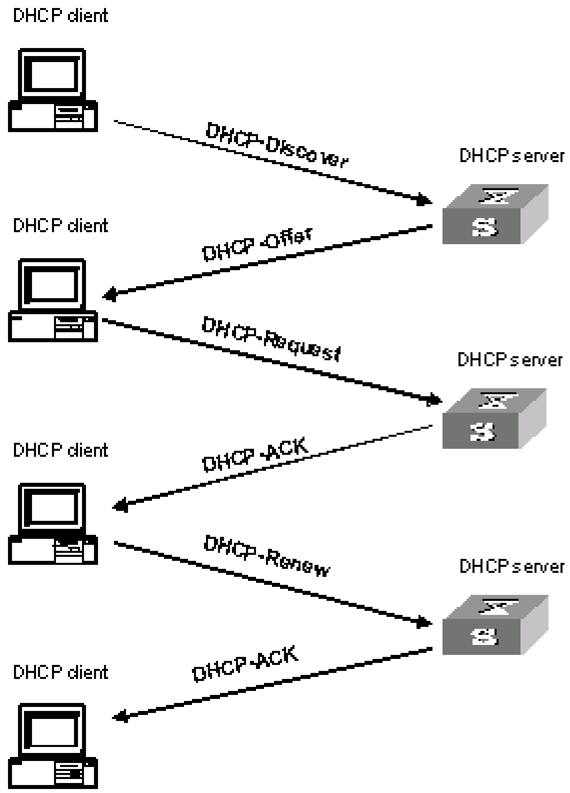


Figure 71 illustrates the interaction between a DHCP client and a DHCP server

Figure 71 Interaction between a DHCP client and a DHCP server.



- DHCP snooping listens the following two types of packets to retrieve the IP addresses the DHCP clients obtain from DHCP servers and the MAC addresses of the DHCP clients:
- DHCP-ACK packet
- DHCP-REQUEST packet

DHCP Snooping Configuration

Table 288 shows the configuration specifications for DHCP snooping.

Table 288 Configure the DHCP snooping function

Operation	Command	Description
Enter system view	**system-view**	-
Enable the DHCP snooping function	**dhcp-snooping**	Required By default, the DHCP snooping function is disabled.
Enter Ethernet port view	**interface** *interface-type* *interface-number*er	-
Set the port connected to a DHCP server to a trusted port	**dhcp-snooping trust**	Optional By default, all ports of a switch are untrusted ports.

Configuration Example

I. Network requirements

As shown in Figure 71, the Ethernet1/0/1 port of Switch A (an S5500 series switch) is connected to Switch B (acting as a DHCP relay). A network segment containing some DHCP clients is connect to the Ethernet1/0/2 port of Switch A.

- The DHCP snooping function is enabled on Switch A.
- The GigabitEthernet1/0/1 port of Switch A is a trusted port.

Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Enable the DHCP snooping function.

```
[S5500] dhcp-snooping
```

3 Enter Ethernet1/0/1 port view.

```
[S5500] interface Ethernet1/0/1
```

4 Set the port to a trusted port.

```
[S5500-Ethernet1/0/1] dhcp-snooping trust
```

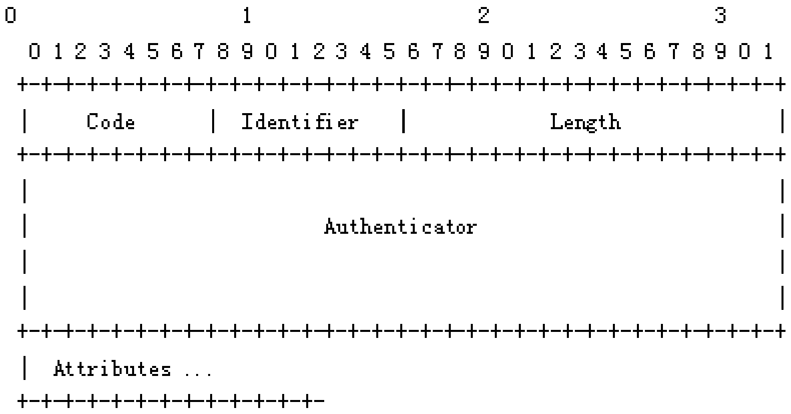
Introduction to DHCP Accounting

DHCP accounting allows a DHCP server to notify the RADIUS server of the start/end of accounting when it assigns/releases a lease. The cooperation of DHCP server and RADIUS server implements the network accounting function, and at the same time secures the network to a certain degree.

Structure of the DHCP Accounting Packets

The interaction between the DHCP server and the RADIUS server are based on two types of packets: Accounting START request and Accounting STOP request. The two types of packets have the similar structure, but are slightly different in the Attributes field. Figure 72 illustrates the packet structure.

Figure 72 Structure of the DHCP accounting packets



```
 0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Code      |  Identifier   |            Length             |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 |                         Authenticator                         |
 |                                                               |
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |  Attributes ...
 +-+-+-+-+-+-+-+-+-+-+-+-+-
```

- Code: One byte, identifying the type of the RADIUS packet. A packet with an invalid Code filed will be discarded. A value of 4 indicates this is a RADIUS START request, while a value of 5 indicates this is a RADIUS STOP request.
- Identifier: One byte, identifying the requests and the responses. The RADIUS server checks this field for duplicate requests from the same IP address and UDP port of a client.

- Length: Two bytes, identifying the total length of the accounting packet.
- Authenticator: 16 bytes, identifying the information between the RADIUS server and client.

The Attributes field contains multiple sub-fields. The content of the Attributes field is slightly different between an Accounting START packet and an Accounting STOP packet, as described in the following text.

Structure of the Attributes field of an Accounting START packet

- Acct session ID: Session ID used to match Accounting START packets with Accounting STOP packets. The Accounting START and Accounting STOP packets in the same group must have the same Acct session ID. This sub-field uniquely identifies a session.
- Framed IP address: IP address already assigned to the DHCP client by the DHCP server.
- Calling Station ID: MAC address of the DHCP client.
- Acct Authentic: Indicates whether or not the DHCP client needs to be authenticated and the authentication method. As DHCP clients are not authenticated, the value of this sub-field is 0, which means undefined.
- Acct Status Type: Accounting status type. The value of this sub-field is 1, which means to start account.
- Service Type: Type of the service the user applies for.
- NAS IP Address: IP address of the network access server (NAS).
- Acct Delay Time: Time delay (in seconds) in sending accounting packets.

Structure of the Attributes field of an Accounting STOP packet

- Acct session ID: Session ID used to match Accounting START packets with Accounting STOP packets. The Accounting START and Accounting STOP packets in the same group must have the same Acct session ID. This sub-field uniquely identifies a session.
- Framed IP address: IP address already assigned to the DHCP client by the DHCP server.
- Calling Station ID: MAC address of the DHCP client.
- Acct Authentic: Indicates whether or not the DHCP client needs to be authenticated and the authentication method. As DHCP clients are not authenticated, the value of this sub-field is 0, which means undefined.
- Acct Session Time: Lease time (in seconds) of the IP address assigned to the DHCP client.
- Acct Terminate Cause: Cause of reclaiming the IP address from the DHCP client. The value of this sub-field is 5, which means session timeout.
- Acct Status Type: Accounting status type. The value of this sub-field is 2, which means to stop accounting.
- Service Type: Type of the service the user applies for.
- NAS IP Address: IP address of the NAS.
- Acct Delay Time: Time delay (in seconds) in sending accounting packets.

DHCP Accounting Fundamentals

After you complete AAA and RADIUS configuration on a switch with the DHCP server function enabled, the DHCP server acts as a RADIUS client. For the authentication process of the DHCP server acting as a RADIUS client. The following describes only the accounting interaction between DHCP server and RADIUS server.

- After sending a DHCP-ACK packet with the IP configuration parameters to the DHCP client, the DHCP server sends an Accounting START packet to a specified RADIUS server. The RADIUS server processes the packet, makes a record, and sends a response to the DHCP server.
- Once releasing a lease for some reason, the DHCP server sends an Accounting STOP packet to the RADIUS server. The RADIUS server processes the packet, stops the recording for the DHCP client, and sends a response to the DHCP server. A lease can be released for the reasons such as lease expiration, a release request received from the DHCP client, a manual release operation, an address pool removal operation.
- If the RADIUS server of the specified domain is unreachable for some reason, the DHCP server sends up to three Accounting START packets (including the first sending attempt) at regular intervals. If the three packets bring no response from the RADIUS server, the DHCP server does not send Accounting START packets any more.

DHCP Accounting Configuration

The following section describes DHCP accounting configuration.

Prerequisites

Before configuring DHCP accounting, make sure that:

- The DHCP server is configured and operates properly. Address pools and lease time are configured.
- DHCP clients are configured and DHCP service is enabled.
- The network operates properly.

Configuring DHCP Accounting

Table 289 contains information for configuring DHCP Accounting.

Table 289 Configure DHCP accounting

Operation	Command	Description
Enter system view	**system-view**	-
Enter address pool view	**dhcp server ip-pool** *pool-name*	Required
Enable DHCP accounting	**accounting domain** *domain-name*	Required The domain identified by the domain-name argument can be created by using the domain command.

DHCP Accounting Configuration Example

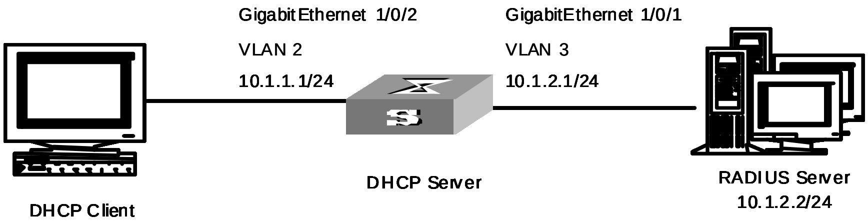
Network requirements

- The DHCP server connects to a DHCP client and a RADIUS server respectively through its Ethernet1/0/2 and Ethernet1/0/1 ports.
- Ethernet1/0/2 port belongs to VLAN 2; Ethernet1/0/1 port belongs to VLAN 3.
- The IP address of VLAN 2 interface is 10.1.1.1/24, and that of VLAN 3 interface is 10.1.2.1/24.
- The IP address of the RADIUS server is 10.1.2.2/24.

- DHCP accounting is enabled on the DHCP server.
- The IP addresses of the global DHCP address pool belongs to the network segment 10.1.1.0/24. The DHCP server operates as a RADIUS client and adopts AAA for authentication.

Network diagram

Figure 73 Network diagram for DHCP accounting configuration



Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Create VLAN 2.

```
[S5500] vlan 2
```

3 Create VLAN 3.

```
[S5500-vlan2] vlan 3
```

4 Return to system view.

```
[S5500-vlan3] quit
```

5 Enter Ethernet1/0/2 port view and add the port to VLAN 2.

```
[S5500] interface Ethernet 1/0/2
[S5500-Ethernet1/0/2] port access vlan 2
```

6 Return to system view.

```
[S5500-Ethernet1/0/2] quit
```

7 Enter Ethernet1/0/1 port view and add the port to VLAN 3.

```
[S5500] interface Ethernet 1/0/1
[S5500-Ethernet1/0/1] port access vlan 3
```

8 Return to system view.

```
[S5500-Ethernet1/0/1] quit
```

9 Enter VLAN 2 interface view and assign the IP address 10.1.1.1/24 to the VLAN interface.

[S5500] interface vlan-interface 2

[S5500-Vlan-interface2] ip address 10.1.1.1 24

10 Return to system view.

[S5500-Vlan-interface2] quit

11 Enter VLAN 3 interface view and assign the IP address 10.1.2.1/24 to the VLAN interface.

```
[S5500] interface vlan-interface 3
[S5500-Vlan-interface3] ip address 10.1.2.1 24
```

12 Return to system view.

```
[S5500-Vlan-interface3] quit
```

13 Create a domain and a RADIUS scheme. Associate the domain with the RADIUS scheme.

```
[S5500] radius scheme 123
[S5500-radius-123] primary authentication 10.1.2.2
[S5500-radius-123] primary accounting 10.1.2.2
[S5500] domain 123
[S5500-isp-123] scheme radius-scheme 123
[S5500-isp-123] quit
```

14 Create an address pool on the DHCP server.

```
[S5500] dhcp server ip-pool test
[S5500-dhcp-pool-test] network 10.1.1.0 mask 255.255.255.0
```

15 Enable DHCP accounting.

```
[S5500-dhcp-pool-test] accounting domain 123
```

Displaying and Debugging DHCP Configuration

After the above configuration, enter the **display** command in any view to display the running of the DHCP configuration, and to verify the effect of the configuration. Enter the **debugging** command in User View to debug DHCP configuration.

Table 290 Displaying and Debugging DHCP Configuration

Operation	Command
Display configuration information of DHCP server group	**display dhcp-server groupNo**
Display configuration information about the DHCP Server group corresponding to the VLAN interface	**display dhcp-server interface vlan-interface** *vlan_id*
Display all address information of the valid user address table for the DHCP server group	**display dhcp-security [** *ip_address* | **dynamic** | **static] [unit** *unit_id* **]**
Display address allocation information of DHCP client	**display dhcp client [verbose]**
Enable/disable DHCP client debugging	**[undo] debugging dhcp client { all** | **error** | **event** | **packet }**
Enable/disable DHCP Client hot backup debugging	**[undo] debugging dhcp xrn xha**
Enable/disable DHCP relay debugging	**[undo] debugging dhcp-relay**

DHCP Relay Displaying

You can verify your DHCP relay-related configuration by executing the following display commands in any view.

Table 291 Display DHCP relay information

Operation	Command
Display information about a specified DHCP server group	display dhcp-server groupNo
Display information about the DHCP server group to which a specified VLAN interface is mapped	display dhcp-server interface vlan-interface vlan-id
Display one or all user address entries, or a specified type of entries in the valid user address table of the DHCP server group	display dhcp-security [ip-address | dynamic | static | tracker]

DHCP Snooping Displaying

After the above configuration, you can display IP addresses and the corresponding MAC addresses tracked by the DHCP snooping function by executing the display command in any view.

Table 292 Display DHCP snooping

Operation	Command	Description
Display the user IP-MAC address mapping entries recorded by the DHCP snooping function	display dhcp-snooping [unit *unit-id*]	You can execute the display commands in any view.
Display the (enabled/disabled) state of the DHCP snooping function and the trusted ports	display dhcp-snooping trust	

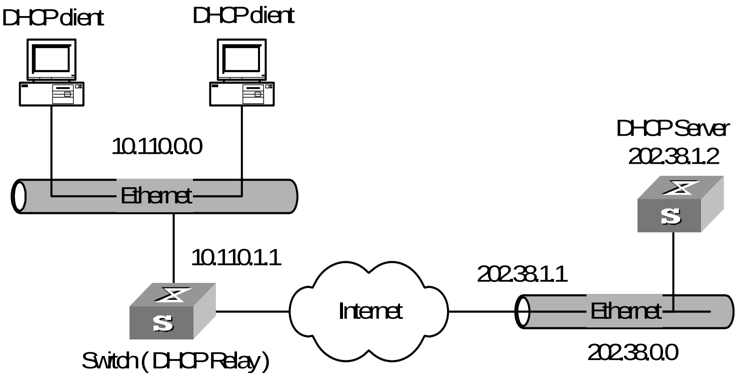
DHCP Relay Configuration Example One

Networking Requirements

There are two VLANs (1 and 10) and they both need to use the same DHCP server.

Networking Diagram

Figure 74 Configuring DHCP Relay



Configuration Procedure

1 Create a DHCP server group that will use two DHCP servers (a master and an optional backup) and assign it the IP addresses of the two DHCP servers (the first IP address is the master).

```
[SW5500]dhcp-server 0 ip 192.168.1.1 192.168.2.1
```

2 Configure the Switch so all clients use DHCP server group '0'.

```
[SW5500]interface vlan-interface 1
[SW5500-Vlan-interface1]dhcp-server 0
[SW5500-Vlan-interface1]quit
[SW5500]interface vlan-interface 10
[SW5500-Vlan-interface10]dhcp-server 0
[SW5500-Vlan-interface10]quit
```

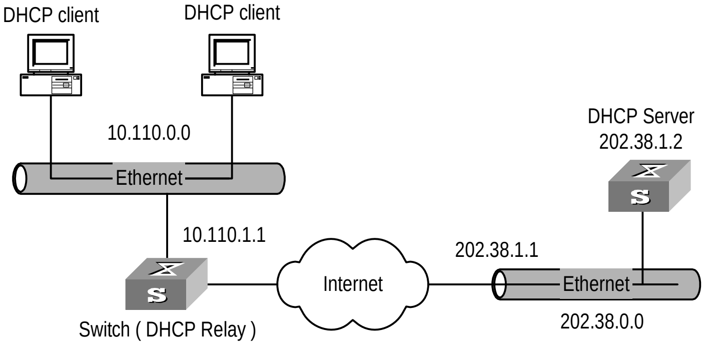
DHCP Relay Configuration Example Two

Networking Requirements

The segment address for the DHCP Client is 10.110.0.0, which is connected to a port in VLAN2 on the Switch. The IP address of the DHCP Server is 202.38.1.2. The DHCP packets should be forwarded using the Switch with DHCP Relay enabled. A DHCP Client can get its IP address and other configuration information from the DHCP Server.

Networking Diagram

Figure 75 Networking Diagram of Configuration DHCP Relay



Configuration Procedure

1 Configure the group number of DHCP Server as 1 and the IP address as 202.38.1.2.

```
[SW5500]dhcp-server 1 ip 202.38.1.2
```

2 Associate the VLAN interface 2 with DHCP Server group 1.

```
[SW5500]interface vlan 2
[SW5500-Vlan-interface2]dhcp-server 1
```

3 Configure the IP address of the VLAN interface 2, which must be in the same segment as DCHP Client.

```
[SW5500-Vlan-interface2]ip address 10.110.1.1 255.255.0.0
```

To allocate an IP address successfully for the DHCP Client, you need to make the necessary configuration on the DHCP Server, which varies, depending on device type.

Troubleshooting DHCP Relay Configuration

Perform the following procedure if a user cannot apply for an IP address dynamically:

1. Use the **`display dhcp-server`** *`groupNo`* command to check if the IP address of the corresponding DHCP Server has been configured.
2. Use the **`display vlan`** and **`display ip interface vlan-interface`** commands to check if the VLAN and the corresponding interface IP address have been configured.
3. Ping the configured DHCP Server to ensure that the link is connected.
4. Ping the IP address of the VLAN interface of the Switch to which the DHCP user is connected from the DHCP Server to make sure that the DHCP Server can correctly find the route of the network segment the user is on. If the ping execution fails, check if the default gateway of the DHCP Server has been configured as the address of the VLAN interface that it locates on.

If there is no problem found in the last two steps, use the **`display dhcp-server`** *`groupNo`* command to view which packet has been received. If you only see the Discover packet and there is no response packet, the DHCP Server has not sent the message to the Switch. In this case, check if the DHCP Server has been configured properly. If the numbers of request and response packets are normal, enable the **`debugging dhcp-relay`** in User View and then use the **`terminal debugging`** command to output the debugging information to the console. In this way, you can view the detailed information of all DHCP packets on the console as they apply for the IP address, and so locate the problem.

Access Management Configuration

This section contains Access Management configuration information.

Access Management Overview

In networking, the ports in a Switch which access different users belong to the same VLAN and they cannot communicate with each other, for the purposes of security, simplicity, and saving VLAN resources. Different ports have different IP addresses and only the users with an IP address which is allowed to pass the port can access the external network through the port. You can achieve this configuration using the functions binding Switch port with IP address and port layer-2 isolating.

Configuring Access Management

Access management configuration includes:

- Enabling/Disabling Access Management
- Configuring the Access Management IP Address Pool Based on the Port
- Configuring Layer 2 Isolation Between Ports
- Configuring Port Isolation on a Per-port Basis
- Enabling/Disabling Access Management Trap

Enabling/Disabling Access Management

You can use the following command to enable the access management function. Only after the access management function is enabled will the access management features (IP and port binding and Layer 2 port isolation) take effect.

Perform the following configuration in System View.

Table 293 Enabling/Disabling the Access Management Function

Operation	Command
Enable access management function	**`am enable`**

Table 293 Enabling/Disabling the Access Management Function

Operation	Command
Disable access management function	**`undo am enable`**

By default, the system disables the access management function.

Configuring the Access Management IP Address Pool Based on the Port

You can use the following command to set the IP address pool for access management on a port. The packet whose source IP address is in the specified pool is allowed to be forwarded on Layer 3 using the port of the Switch.

Perform the following configuration in Ethernet Port View.

Table 294 Configuring the Access Management IP Address Pool Based on the Port

Operation	Command
Configure the access management IP address pool based on the port	**`am ip-pool`** *`address_list`*
Cancel part or all of the IP addresses in the access management IP address pool of the port	**`undo am ip-pool`** { **`all`** | *`address_list`* }

By default, the IP address pools for access management on the port are null and all the packets are permitted.

Note that if the IP address pool to be configured contains the IP addresses configured in the static ARP at other ports, then the system prompts you to delete the static ARP to make the later binding effective.

Configuring Layer 2 Isolation Between Ports

You can add a port to an isolation group using the following commands, and achieve port-to-port isolation between this port and other ports of this group, that is, Layer 2 forwarding between the isolated ports is not available.

Perform the following configuration in Ethernet Port View.

Table 295 Configuring Layer 2 Isolation Between Ports

Operation	Command
Add a port to the isolation group	**`port isolate`**
Remove a port from the isolation group	**`undo port isolate`**

By default, a port is not in an isolation group, that is Layer 2 forwarding is achievable between this port and other ports.

Note that:

- One unit only supports one isolation group. That is, a port in an isolation group on a unit is isolated only from ports within this group, and not isolated from ports in isolation groups on other units.
- The port isolation feature is synchronous on the same unit within an aggregation group. Note the following:
  - When a port in an aggregation group is added to, or removed from, an isolation group, then all the other ports of this aggregation group on the same unit are automatically added in or removed from this isolation group.

- In the same aggregation group, the port isolation feature on one unit is consistent.
- If a port is removed from an aggregation group, its port isolation configuration will not change.
- If a port of an aggregation group is isolated on unit 1, then you can achieve port-to-port isolation between this aggregation group and all the ports of the isolation group on unit 1.
- If all the ports on unit 1 of this aggregation group are removed from this aggregation group, then the isolation feature of this aggregation group is disabled, that is, the port-to-port isolation mentioned above is unavailable.

Configuring Port Isolation on a Per-port Basis

You can use the following command to set Layer 2 isolation on a port so as to prevent the packets from being forwarded on Layer 2 between the specified port and some other ports (group).

Perform the following configuration in Ethernet Port View.

Table 296 Configuring Layer 2 Isolation Between Ports

Operation	Command
Configure Layer 2 isolation between ports	**am isolate** *interface_list*
Cancel Layer 2 isolation between ports	**undo am isolate** *interface_list*

By default, the isolation port pool is null and the packets are allowed to be forwarded between the specified port and all other ports on Layer 2.

Enabling/Disabling Access Management Trap

You can enable the access management trap function using the following commands. When this function is enabled, the trap information of access management is delivered to the console for the purpose of monitoring.

Perform the following configuration in System View.

Table 297 Enabling/Disabling Access Management Trap

Operation	Command
Enable access management trap	**am trap enable**
Disable access management trap	**undo am trap enable**

By default, the access management trap is disabled.

Displaying and Debugging Access Management

After the above configuration, enter the **display** command in any view to display the current configurations of access management and port isolation information, and to verify the effect of the configuration.

Table 298 Displaying Current Configuration of Access Management

Operation	Command
Display the status of access management function and configuration of IP address pool	**display am** [*interface_list*]
Display port isolation information	**display isolate port**

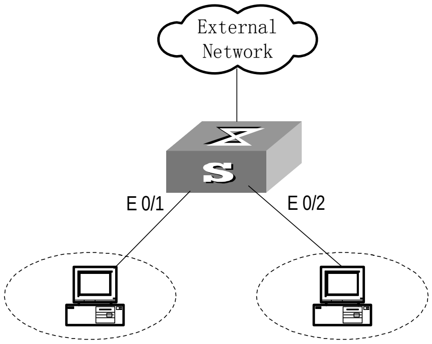
Access Management Configuration Example

Networking Requirements

Organization 1 is connected to port 1 of the Switch, and organization 2 to port 2. Ports 1 and 2 belong to the same VLAN. The IP addresses range 202.10.20.1 to 202.10.20.20 can be accessed from port 1 and the range 202.10.20.21 to 202.10.20.50 from the port 2. Organization 1 and organization 2 cannot communicate with each other.

Networking Diagram

Figure 76 Networking Diagram for Port Isolation Configuration



Configuration Procedure

1 Enable access management globally.

```
[SW5500]am enable
```

2 Configure the IP address pool for access management on port 1.

```
[SW5500]interface ethernet1/0/1
[SW5500-Ethernet1/0/1]am ip-pool 202.10.20.1 20
```

3 Add port 1 into isolation group.

```
[SW5500-Ethernet1/0/1]port isolate
```

4 Configure the IP address pool for access management on port 2

```
[SW5500-Ethernet1/0/1]interface etherntl/0/2
[SW5500-Ethernet1/0/2]am ip-pool 202.10.20.21 30
```

5 Add port 2 into isolation group.

```
[SW5500-Ethernet1/0/2]port isolate
```

Access Management using the Web

The Security/Authorized IP menu option on the Web interface allows the user to specify a range of IP addresses that will permit Web, Telnet and SSH access.

Network Requirements

Enter an IP address and a ‘wildcard’ value. For example, an authorized IP address of 10.10.10.1 with a wildcard of 0.0.0.255 will authorize all addresses from 10.10.10.0 to 10.10.10.254.

Configuration Procedure

To configure this feature using the CLI, the following commands should be entered from System View:

```
<SW5500>system-view
[SW5500]acl number 2500
[SW5500-acl-basic-2500]rule 0 permit source 10.10.10.1 0.0.0.255
```

To delete this feature, enter:

```
<SW5500>system-view
[SW5500]acl number 2500
[SW5500-acl-basic-2500]undo rule 0
```

UDP Helper Configuration

This section contains UDP Helper configuration information.

Overview of UDP Helper

The major function of the UDP Helper is to relay-forward UDP broadcast packets, that is, it can convert UDP broadcast packets into unicast packets and send them to the designated server, as a relay.

When UDP Helper starts, the Switch can judge whether to forward the UDP broadcast packets received at the port based on UDP port ID. If yes, the Switch then modifies the IP address in the IP packet header and sends the packet to the designated destination server. Otherwise, it sends the packet to the upper layer module for further processing. For the BOOTP/DHCP broadcast packet, if the client specifies in the request message that the response message needs to be received as broadcast packet, then the Switch broadcasts the response message to the client. Otherwise, it unicasts the response message.

UDP Helper Configuration

UDP Helper configuration includes:

- Enabling/Disabling UDP Helper Function
- Configuring UDP Port with Replay Function
- Configuring the Relay Destination Server for Broadcast Packet

Enabling/Disabling UDP Helper Function

When the UDP Helper function is enabled, you can configure the UDP ports where UDP function is required and the relay function is enabled at UDP ports 69, 53, 37, 137, 138, and 49. When the function is disabled, the relay function configured at all UDP ports, including the default six ports, is disabled.

Perform the following configuration in System View.

Table 299 Enabling/Disabling UDP Helper function

Operation	Command
Enable UDP Helper function	**udp-helper enable**
Disable UDP Helper function	**undo udp-helper enable**

By default, the UDP Helper function is disabled.

Configuring UDP Port with Replay Function

When the UDP relay function is enabled, by default the system forwards the broadcast packets on the UDP ports listed in Table 300. You can configure up to 256 UDP ports with the relay function.

Table 300 Default UDP Ports List

Protocol	UDP port ID
Trivial File Transfer Protocol (TFTP)	69
Domain Name System (DNS)	53
Time service	37

Table 300 Default UDP Ports List

Protocol	UDP port ID
NetBIOS Name Service (NetBIOS-NS)	137
NetBIOS Datagram Service (NetBIOS-DS)	138
Terminal Access Controller Access Control System (TACACS)	49

Perform the following configuration in System View.

Table 301 Configuring UDP Port with Replay Function

Operation	Command
Configure UDP port with replay function	**udp-helper port** { *port* | **dns** | **netbios-ds** | **netbios-ns** | **tacacs** | **tftp** | **time**}
Remove the configuration	**undo udp-helper port** { *port* | **dns** | **netbios-ds** | **netbios-ns** | **tacacs** | **tftp** | **time** }

Note that:

- You must first enable the UDP Helper function and then configure the UDP port with the relay function. Otherwise, error information will appear.
- The parameters **dns**, **netbios-ds**, **netbios-ns**, **tacacs**, **tftp** and **time** respectively refer to the six default ports. You can configure the default UDP port in two ways: specifying port IDs and specifying the correct parameters. For example, the **udp-helper port 53** command is equivalent to the **udp-helper port dns** command in function.
- The default UDP ports are not displayed when using the **display current-configuration** command. But its ID is displayed after its relay function is disabled.

Configuring the Relay Destination Server for Broadcast Packet

You can configure up to 20 relay destination servers for a VLAN interface. If a VLAN interface is configured with relay destination servers and UDP Helper function is enabled on the VLAN interface, then the broadcast packets of a designated UDP port received at the VLAN interface will be unicasted to the destination server.

Perform the following configuration in VLAN Interface View.

Table 302 Configuring the Relay Destination Server for Broadcast Packet

Operation	Command
Configure relay destination server for broadcast packet	**udp-helper server** *ip_address*
Delete relay destination server for broadcast packet	**undo udp-helper server** [*ip_address*]

Note that:

- The **undo udp-helper server** command (without any parameter) deletes all destination servers configured on the interface.
- By default, no relay destination server for UDP broadcast packets is configured.

Displaying and Debugging UDP Helper Configuration

After the above configuration, enter the **display** command in any view to display the running of the UDP Helper destination server, and to verify the effect of the configuration. Enter the **debugging** command in User View to debug UDP Helper configuration.

Table 303 Displaying and Debugging UDP Helper Configuration

Operation	Command
Display the destination server corresponding to VLAN interface	**display udp-helper server** [**interface vlan-interface** *vlan_id*]
Enable UDP Helper debugging	**debugging udp-helper** { **event** | **packet** [**receive** | **send**] }
Disable UDP Helper debugging	**undo debugging udp-helper** { **event** | **packet** [**receive** | **send**] }

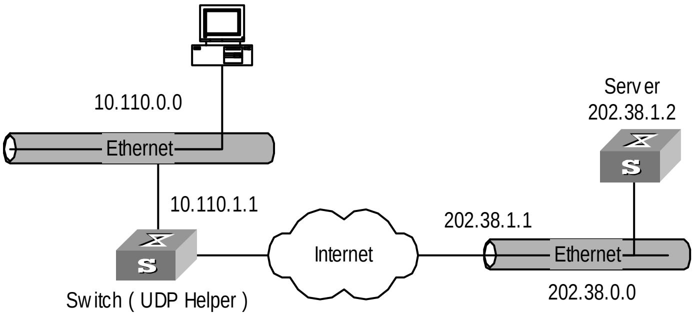
UDP Helper Configuration Example

Networking Requirement

The IP address of VLAN interface 2 on the Switch is 10.110.1.1, which is connected with network segment 10.110.0.0. Set to relay-forward the broadcast packets with destination IP of all 1s and destination UDP port 55 in the network segment 10.110.0.0 to the destination server 202.38.1.2.

Networking Diagram

Figure 77 Networking for UDP Helper Configuration



Configuration Procedure

1 Enable UDP Helper function.

```
[SW5500]udp-helper enable
```

2 Set to relay-forward the broadcast packets with destination UDP port 55.

```
[SW5500]udp-helper port 55
```

3 Set the IP address of the destination server corresponding to VLAN interface 2 as 202.38.1.2.

```
[SW5500]interface vlan 2
[SW5500-Vlan-interface2]udp-helper server 202.38.1.2
```

IP Performance Configuration

IP performance is described in the following section.

Configuring TCP Attributes

TCP attributes that can be configured include:

- synwait timer: When sending the syn packets, TCP starts the synwait timer. If response packets are not received before synwait timeout, the TCP connection will be terminated. The timeout of synwait timer range is 2 to 600 seconds and it is 75 seconds by default.

- finwait timer: When the TCP connection state turns from FIN_WAIT_1 to FIN_WAIT_2, finwait timer will be started. If FIN packets are not received before finwait timer timeout, the TCP connection will be terminated. Finwait timer range is 76 to 3600 seconds. By default, finwait timer is 675 seconds.
- The receiving/sending buffer size of the connection-oriented socket is in the range from 1 to 32K bytes and is 8K bytes by default.

Perform the following configuration in System View.

Table 304 Configuring TCP Attributes

Operation	Command
Configure synwait timer in TCP	**tcp timer syn-timeout** *time_value*
Restore synwait timer	**undo tcp timer syn-timeout**
Configure FIN_WAIT_2 timer in TCP	**tcp timer fin-timeout** *time_value*
Restore FIN_WAIT_2 timer	**undo tcp timer fin-timeout**
Configure the Socket receiving/sending buffer size of TCP	**tcp window** *window_size*
Restore the socket receiving/sending buffer size of TCP to default value	**undo tcp window**

By default, the TCP finwait timer is 675 seconds, the synwait timer is 75 seconds, and the receiving/sending buffer size of connection-oriented Socket is 8K bytes.

Displaying and debugging IP Performance

After the above configuration, enter the **display** command in any view to display the running of the IP Performance configuration, and to verify the effect of the configuration. Enter the **reset** command in User View to clear IP, TCP, and UDP statistics information.

Table 305 Displaying and Debugging IP Performance

Operation	Command
Display TCP connection state	**display tcp status**
Display TCP connection statistics data	**display tcp statistics**
Display UDP statistics information	**display udp statistics**
Display IP statistics information	**display ip statistics**
Display ICMP statistics information	**display icmp statistics**
Display socket interface information of current system	**display ip socket** [**socktype** *sock_type*] [*task_id socket_id*]
Display the summary of the Forwarding Information Base	**display fib**
Display the FIB entries matching the destination IP address (range)	**display fib** *ip_address1* [{ *mask1* | *mask_length1* } [*ip_address2* { *mask2* | *mask_length2* } | **longer**] | **longer**]
Display the FIB entries matching a specific ACL	**display fib acl** *number*
Display the FIB entries which are output from the buffer according to regular expression and related to the specific character string	**display fib** | { { **begin** | **include** | **exclude** } *text* }
Display the FIB entries matching the specific prefix list	**display fib ip-prefix** *listname*

Table 305 Displaying and Debugging IP Performance

Operation	Command
Display the total number of FIB entries	**display fib statistics** [{**begin**|**include**|**exclude**} *text*]
Reset IP statistics information	**reset ip statistics**
Reset TCP statistics information	**reset tcp statistics**
Reset UDP statistics information	**reset udp statistics**

Troubleshooting IP Performance

Fault: IP layer protocol works normally but TCP and UDP cannot work normally.

In the event of such a fault, you can enable the corresponding debugging information output to view the debugging information.

- Use the **terminal debugging** command to output the debugging information to the console.
- Use the command **debugging udp packet** to enable the UDP debugging to trace the UDP packet.

  The following are the UDP packet formats:

  ```
  UDP output packet:
  Source IP address:202.38.160.1
  Source port:1024
  Destination IP Address 202.38.160.1
  Destination port: 4296
  ```

- Use the **debugging tcp packet** command to enable the TCP debugging to trace the TCP packets.

  Operations include:

  ```
  [SW5500]terminal debugging
  <SW5500>debugging tcp packet
  ```

  Then the TCP packets received or sent can be checked in real time. Specific packet formats include:

  ```
  TCP output packet:
  Source IP address:202.38.160.1
  Source port:1024
  Destination IP Address 202.38.160.1
  Destination port: 4296
  Sequence number :4185089
  Ack number: 0
  Flag  :SYN
  Packet length :60
  Data offset: 10
  ```

18 MULTICAST PROTOCOL

This chapter includes information on the following:

- IP Multicast Overview
- IGMP Snooping
- Common Multicast Configuration
- Internet Group Management Protocol (IGMP)
- PIM-DM Overview
- PIM-SM Overview

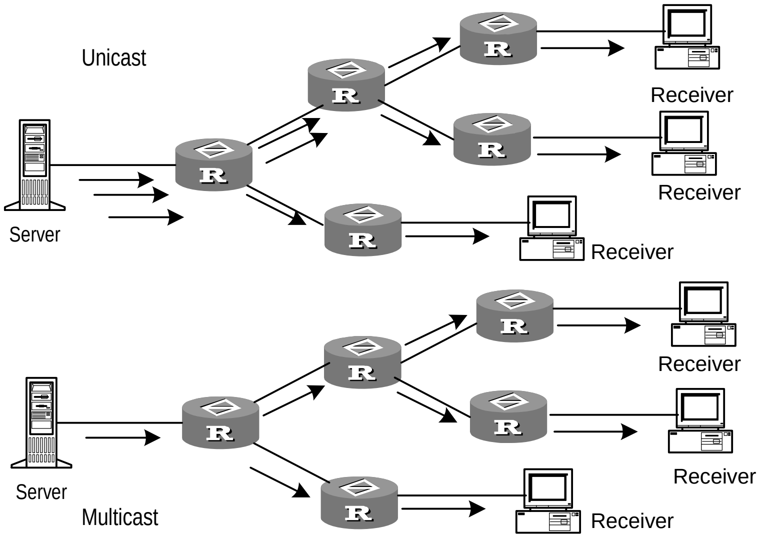
IP Multicast Overview

The Switch 5500-EI supports all of the multicast protocols listed in this manual; however, the Switch 5500-SI only supports the IGMP Snooping protocol.

Many transmission methods can be used when the destination (including data, voice and video) is the secondary use of the network. If the multicast method is used you should establish an independent data transmission path for each user. The broadcast mode can be used if you intend to send the information to all users on the network. In either case, the end users will receive the information. For example, if the same information is required by 200 users on the network, the traditional solution is to send the information 200 times in unicast mode. In the broadcast mode, the data is broadcast over the entire network. However, both of the methods waste bandwidth resources. In addition, the broadcast mode cannot ensure information security.

IP multicast technology solves this problem. The multicast source sends the information only once. Multicast routing protocols establish tree-type routing for multicast packets. The information being sent will be replicated and distributed as far as possible (see Figure 78). Therefore, the information can be correctly sent, with high efficiency, to each user.

Figure 78 Comparison between the unicast and multicast transmission



A multicast source does not necessarily belong to a multicast group. It only sends data to the multicast group and it is not necessarily a receiver. Multiple sources can send packets to a multicast group simultaneously.

A router that does not support multicast may exist on the network. A multicast router can encapsulate multicast packets in unicast IP packets by tunnelling and sending them on to the neighboring multicast router. The neighboring multicast router removes the unicast IP header and continues the multicast transmission.

Multicast advantages:

- Enhanced efficiency by reducing network traffic and relieving server and CPU loads.
- Optimized performance decreases traffic redundancy.
- Distributed applications make multipoint applications possible.

Multicast Addresses

The destination addresses of multicast packets use Class D IP addresses ranging from 224.0.0.0 to 239.255.255.255. Class D addresses cannot appear in the source IP address fields of IP packets.

During unicast data transmission, a packet is transmitted from the source address to the destination address with the “hop-by-hop” principle of the IP network. A packet has more than one destination address in a multi-cast environment, that is, a group of addresses. All the information receivers join a group. Once a receiver joins the group, data flowing to the group is sent to the receiver immediately. All members in the group can receive the packets. Membership of a multicast group is dynamic, that is, hosts can join and leave groups at any time.

A multicast group can be either permanent or temporary. Part of addresses in the multicast group are reserved by the IANA and are known as the permanent multicast group. IP addresses of a permanent group are unchanged, but the members in the group can change. The number of members in a permanent multicast group can be random or even 0. Those IP multicast addresses that are not reserved for permanent multicast groups can be used by temporary groups.

Ranges and meanings of Class D addresses are shown in Table 306

Table 306 Ranges and meaning of Class D addresses

Class D address range	Meaning
224.0.0.0~224.0.0.255	Reserved multicast addresses (addresses of permanent groups). Address 224.0.0.0 is reserved. The other addresses can be used by routing protocols.
224.0.1.0~238.255.255.255	Multicast addresses available for users (addresses of temporary groups). They are valid in the entire network.
239.0.0.0~239.255.255.255	Multicast addresses for local management. They are valid only in the specified local range.

Reserved multicast addresses that are commonly used are shown in Table 307.

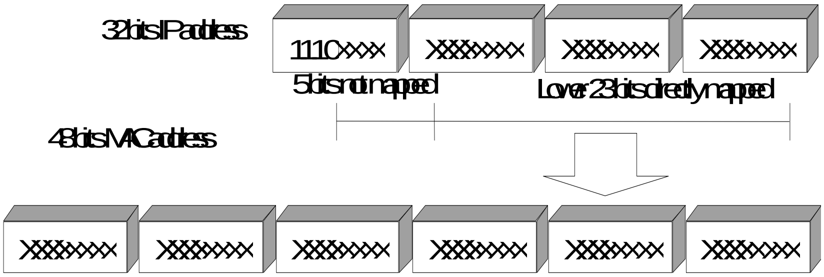
Table 307 Reserved multicast address list

Class D address	Meaning
224.0.0.0	Base Address (Reserved)
224.0.0.1	Addresses of all hosts
224.0.0.2	Addresses of all multicast routers
224.0.0.3	Unassigned
224.0.0.4	DVMRP routers
224.0.0.5	OSPF routers
224.0.0.6	OSPF DR (designated router)
224.0.0.7	ST routers
224.0.0.8	ST hosts
224.0.0.9	RIP-2 routers
224.0.0.10	IGRP routers
224.0.0.11	Mobile agents
224.0.0.12	DHCP server/Relay agent
224.0.0.13	All PIM routers
224.0.0.14	RSVP encapsulation
224.0.0.15	All CBT routers
224.0.0.16	Designated SBM
224.0.0.17	All SBMS
224.0.0.18	VRRP
....	....

Ethernet Multicast MAC Addresses

When unicast IP packets are transmitted in Ethernet, the destination MAC address is the MAC address of the receiver. However, when multicast packets are transmitted, the destination is no longer a specific receiver but a group with unspecific members. Therefore, the multicast MAC address should be used. Multicast MAC addresses correspond to multicast IP addresses. IANA (Internet Assigned Number Authority) stipulates that the higher 24 bits of the multicast MAC address is 0x01005e and the lower 23 bits of the MAC address is the lower 23 bits of the multicast IP address.

Figure 79 Mapping between the multicast IP address and the Ethernet MAC address



Only 23 bits of the last 28 bits in the IP multicast address are mapped to the MAC address. Therefore, the 32 IP multicast addresses are mapped to the same MAC address.

IP Multicast Protocols

Multicast uses the multicast group management protocol, and the multicast routing protocol. The multicast group management protocol uses Internet Group Management Protocol (IGMP) as the IP multicast basic signalling protocol. It is used between hosts and routers and enables routers to determine if members of the multicast group are on the network segment. The multicast routing protocol is used between multicast routers to create and maintain multicast routes, enabling highly-efficient multicast packet forwarding. Multicast routing protocols supported by the Switch 5500 include PIM-SM and PIM-DM.

Internet Group Management Protocol (IGMP)

Internet Group Management Protocol (IGMP) is the only protocol that hosts can use. It defines the membership establishment and maintenance mechanism between hosts and routers, and is the basis of the entire IP multicast. Hosts report the group membership to a router through IGMP and inform the router of the conditions of other members in the group through the directly connected host.

If a user on the network joins a multicast group through IGMP declaration, the multicast router on the network will transmit the information sent to the multicast group through the multicast routing protocol. Finally, the network will be added to the multicast tree as a branch. When the host, as a member of a multicast group, begins receiving the information, the router will query the group periodically to check whether members in the group are involved. As long as one host is involved, the router receives data. When all users on the network quit the multicast group, the related branches are removed from the multicast tree.

Multicast Routing Protocol

A multicast group address has a virtual address. Unicast allows packets to be routed from the data source to the specified destination address. This is not possible for multicast. The multicast application sends the packets to a group of receivers (as with multicast addresses) who are ready to receive the data but not only to one receiver (as with unicast address).

The multicast routing creates a loop-free data transmission path from one data source to multiple receivers. The task of the multicast routing protocol is to create a distribution tree architecture. A multicast router can use multiple methods to build up a path for data transmission, that is, the distribution tree.

PIM-DM (Protocol-Independent Multicast Dense Mode, PIM-DM) PIM dense mode is suitable for small networks. It assumes that each subnet in the network contains at least one receiver interested in the multicast source. As a result, multicast packets are flooded to all points of the network, consuming network bandwidth and increasing router processing. To reduce network resource consumption, branches that do not have members send Prune messages toward the source to reduce the unwanted/unnecessary traffic. To enable the receivers to receive multicast data streams, the pruned branches can be restored periodically to a forwarding state. To reduce latency time, the PIM dense mode uses the prune mechanism to actively restore multicast packet forwarding. Periodic flood and prune are characteristics of PIM dense mode. Generally, the forwarding path in dense mode is a "source tree" rooted at the source with multicast members as the branches. Since the source tree uses the shortest path from the multicast source to the receiver, it is also called the shortest path tree (SPT).

PIM-SM (Protocol-Independent Multicast Sparse Mode, PIM-SM) Dense mode uses the flood-prune technology, which is not applicable for WAN. In WAN, multicast receivers are sparse and therefore the sparse mode is used. In sparse mode, hosts need not receive multicast packets unless, by default, there is an explicit request for the packets. A multicast router must send a join message to the RP (Rendezvous Point, which needs to be built into the network and is a virtual place for data exchange) corresponding to the group for receiving the multicast data traffic from the specified group. The join message passes routers and finally reaches the root, that is, the RP. The join message becomes a branch of the shared tree. In PIM sparse mode, multicast packets are sent to the RP first, and then are forwarded along the shared tree rooted at the RP and with members as the branches. To prevent the branches of the shared tree from being deleted, PIM sparse mode sends join messages to branches periodically to maintain the multicast distribution tree.

To send data to the specified address, senders register with the RP first before forwarding data to the RP. When the data reaches the RP, the multicast packets are replicated and sent to receivers along the path of the distribution tree. Replication only happens at the branches of the distribution tree. This process can be repeated automatically until the packets reach the destination.

Forwarding IP Multicast Packets

In the multicast model, the source host sends information to the host group represented by the multicast group address within the destination address fields of the IP packets. The multicast model must forward the multicast packets to multiple external interfaces so that the packets can be sent to all receivers.

RPF (Reverse Path Forwarding)

To ensure that a multicast packet reaches the router along the shortest path, the multicast must depend on the unicast routing table or a unicast routing table independently provided for multicast to check the receiving interface of multicast packets. This check mechanism is the basis for most multicast routing protocols performing multicast forwarding, which is known as RPF (Reverse Path Forwarding) check. A multicast router uses the source address from the multicast packet to query the unicast routing table, or the independent multicast routing table, to determine that the incoming interface on which the packet arrives is the shortest path from the receiver to the source address. If a source tree is used, the source address is the address of the source host sending the multicast packet. If a shared tree is used, the source address is the address of the root of the shared tree. When a multicast packet arrives at the router, if RPF check succeeds, the packet will be forwarded according to the multicast forwarding entry. Otherwise, the packet will be dropped.

Applying Multicast

IP multicast technology effectively solves the problem of packet forwarding from single-point to multi-point. It implements highly-efficient data transmission from single-point to multi-point in IP networks and can save a large amount of network bandwidth and reduce network loads. New value-added services that use multicast can be delivered, including direct broadcasting, Web TV, distance learning, distance medicine, net broadcasting station and real-time audio/video conferencing.

- Multimedia and streaming media applications
- Communications at training and corporate sites
- Data repository and finance (stock) applications
- Any “point-to-multipoint” data distribution

With the increase of multimedia services on IP networks, multicast has huge market potential.

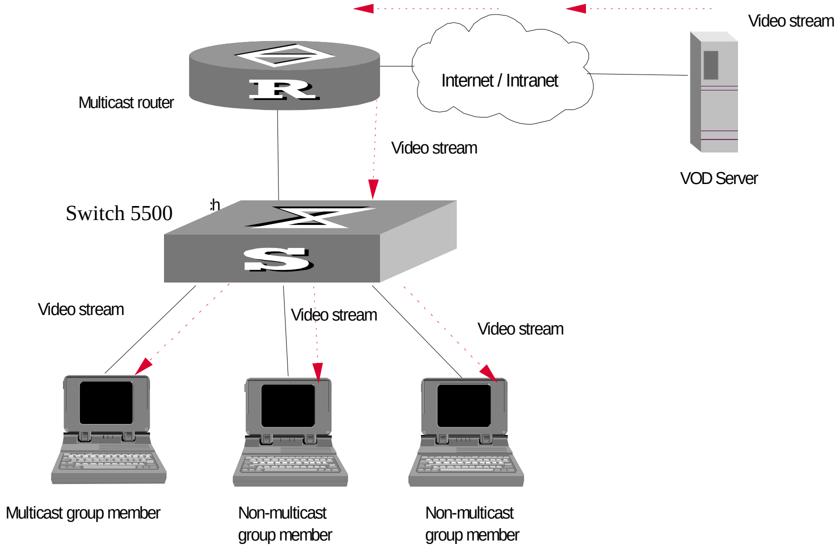
IGMP Snooping

IGMP Snooping (Internet Group Management Protocol Snooping) is a multicast control mechanism running on Layer 2 (the link layer) of the switch. It is used for multicast group management and control.

When receiving IGMP messages transmitted between the host and router, the Switch 5500 uses IGMP Snooping to analyze the information carried in the IGMP messages. If the switch hears an IGMP host report message from an IGMP host, it will add the host to the corresponding multicast table. If the switch hears an IGMP leave message from an IGMP host, it will remove the host from the corresponding multicast table. The switch continuously listens to the IGMP messages to create and maintain MAC multicast address table on Layer 2. And then it can forward the multicast packets transmitted from the upstream router according to the MAC multicast address table.

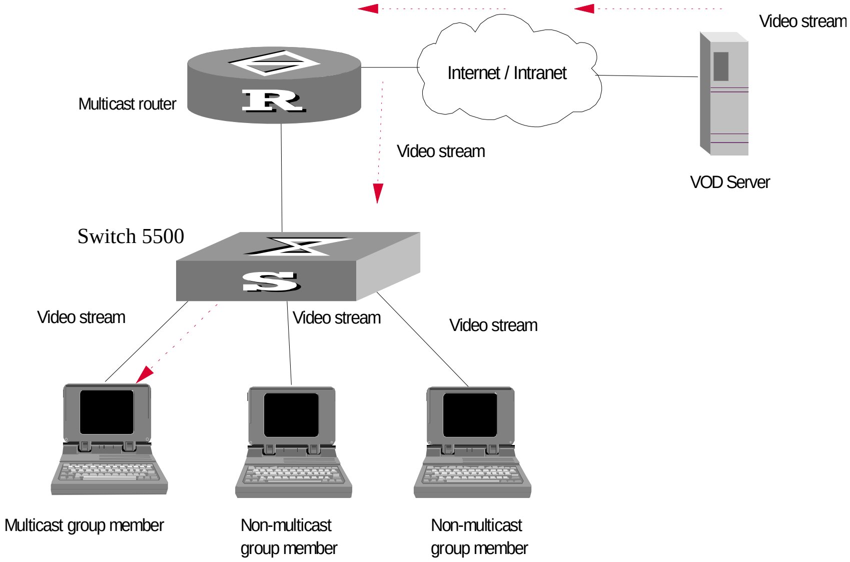
When IGMP Snooping is disabled, the packets are multicast to all ports, see Figure 80.

Figure 80 Multicast packet transmission without IGMP Snooping



When IGMP Snooping operates, packets are not forwarded to all ports, see Figure 81.

Figure 81 Multicast packet transmission when IGMP Snooping runs



IGMP Snooping Terminology

Table 308 explains switching terminology relevant to IGMP Snooping.

Table 308 Switching Terminology relevant to IGMP Snooping

Term	Meaning
Router Port	The port of the switch, directly connected to the multicast router.
Multicast member port	The port connected to the multicast member. The multicast member refers to a host that joined a multicast group.
MAC multicast group	The multicast group is identified with MAC multicast address and maintained by the Switch 5500.
Router port aging time	Time set on the router port aging timer. If the switch has not received any IGMP general query messages before the timer times out, it is no longer considered a router port.
Multicast group member port aging time	When a port joins an IP multicast group, the aging timer of the port will begin timing. If the switch has not received any IGMP report messages before the timer times out, it transmits IGMP specific query message to the port.
Maximum response time	When the switch transmits IGMP specific query message to the multicast member port, the Switch 5500 starts a response timer, which times before the response to the query. If the switch has not received any IGMP report message before the timer times out, it will remove the port from the multicast member ports

The Switch 5500 runs IGMP Snooping to listen to the IGMP messages and map the host and its ports to the corresponding multicast group address. To implement IGMP Snooping, the switch processes different IGMP messages as shown in Figure 82.

Figure 82 Implementing IGMP Snooping

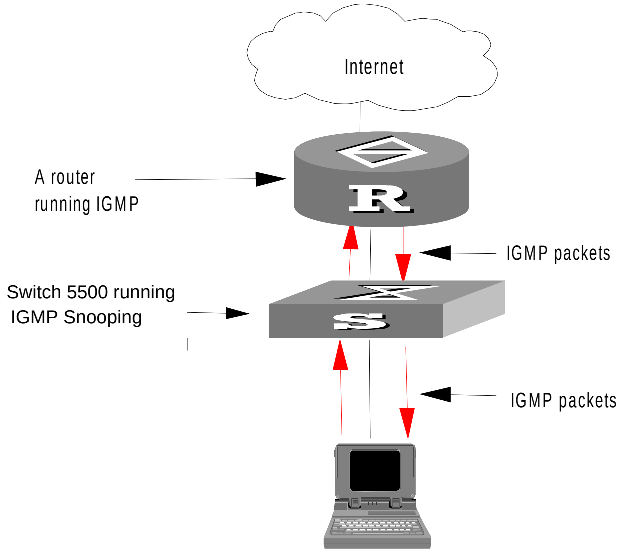


Table 309 explains IGMP Snooping terminology.

Table 309 IGMP Snooping Terminology

Term	Meaning
IGMP general query message	Transmitted by the multicast router to query which multicast group contains member. When a router port receives an IGMP general query message, the Switch 5500 will reset the aging timer of the port. When a port other than a router port receives the IGMP general query message, the Switch 5500 will notify the multicast router that a port is ready to join a multicast group and starts the aging timer for the port.
IGMP specific query message	Transmitted from the multicast router to the multicast members and used for querying if a specific group contains any member. When received IGMP specific query message, the switch only transmits the specific query message to the IP multicast group which is queried.
IGMP report message	Transmitted from the host to the multicast router and used for applying to a multicast group or responding to the IGMP query message. When received, the switch checks if the MAC multicast group is ready to join. If the corresponding MAC multicast group does not exist, the switch notifies the router that a member is ready to join a multicast group, creates a new MAC multicast group, adds the port that received the message to the group, starts the port aging timer, and then adds all the router ports in the native VLAN of the port into the MAC multicast forwarding table. Meanwhile, it creates an IP multicast group and adds the port received to it. If the corresponding MAC multicast group exists but does not contain the port that received the report message, the switch adds the port into the multicast group and starts the port aging timer. Then, the switch checks if the corresponding IP multicast group exists. If it does not exist, the switch creates a new IP multicast group and adds the port that received the report message to it. If it does exist, the switch adds the port. If the corresponding MAC multicast group exists and contains the port, the switch will only reset the aging timer of the port.

Table 309 IGMP Snooping Terminology (continued)

Term	Meaning
IGMP leave message	Transmitted from the multicast group member to the multicast router, to notify that a host has left the multicast group. The Switch 5500 transmits the specific query message, concerning the group, to the port that received the message in an effort to check if the host still has other members of this group, and then starts a maximum response timer. If the switch has not received any report message from the multicast group, the port will be removed from the corresponding MAC multicast group. If the MAC multicast group does not have any member, the switch will notify the multicast router to remove it from the multicast tree.

Configuring IGMP Snooping

IGMP Snooping configuration includes:

- Enabling/Disabling IGMP Snooping
- Configuring Router Port Aging Time
- Configuring Maximum Response Time
- Configuring Aging Time of Multicast Group Member

Of the above configuration tasks, enabling IGMP Snooping is required, while others are optional.

Enabling/Disabling IGMP Snooping

Use the commands in Table 310 to enable/disable IGMP Snooping on Layer 2. First enable IGMP Snooping globally in System View, and then enable IGMP Snooping of the corresponding VLAN in VLAN View.

Perform the following configuration in System View and VLAN View.

Table 310 Enabling/Disabling IGMP Snooping

Operation	Command
Enable/disable IGMP Snooping	**`igmp-snooping { enable	disable }`**

Although layer 2 and layer 3 multicast protocols can run together, they cannot run on the same VLAN or its corresponding VLAN interface at the same time. For example, if the layer 2 multicast protocol is enabled on a VLAN, then the layer 3 multicast protocol cannot operate on this VLAN, and vice-versa.

IGMP Snooping functions only when it is enabled both in System View and in VLAN View.

By default, IGMP Snooping is disabled.

Configuring Router Port Aging Time

Use the commands in Table 311 to manually configure the router port aging time. If the switch has not received a general query message from the router before the router port is aged, the switch will remove the port from the MAC multicast group.

Perform the following configuration in system view.

Table 311 Configuring router port aging time

Operation	**Command**
Configure router port aging time	**`igmp-snooping router-aging-time`** *`seconds`*
Restore the default aging time	**`undo igmp-snooping router-aging-time`**

By default, the port aging time is 105 seconds.

Configuring Maximum Response Time

Use the commands in Table 312 to manually configure the maximum response time. If the Switch 5500 receives no report message from a port within the maximum response time, the switch will remove the port from the multicast group.

Perform the following configuration in System View.

Table 312 Configuring the maximum response time

Operation	**Command**
Configure the maximum response time	**`igmp-snooping max-response-time`** *`seconds`*
Restore the default setting	**`undo igmp-snooping max-response-time`**

By default, the maximum response time is 10 seconds.

Configuring Aging Time of Multicast Group Member_

Use the commands in Table 313 to manually set the aging time of the multicast group member port. If the switch receives no multicast group report message during the member port aging time, it will transmit the specific query message to that port and start a maximum response timer.

Perform the following configuration in system view.

Table 313 Configuring aging time of the multicast member

Operation	**Command**
Configure aging time of the multicast member	**`igmp-snooping host-aging-time`** *`seconds`*
Restore the default setting	**`undo igmp-snooping host-aging-time`**

By default, the aging time of the multicast member is 260 seconds.

Enabling IGMP Fast Leave Processing

Normally, when receiving an IGMP Leave message, IGMP Snooping does not immediately remove the port from the multicast group, but sends a group-specific query message. If no response is received in a given period, it then removes the port from the multicast group.

If IGMP fast leave processing is enabled, when receiving an IGMP Leave message, IGMP Snooping immediately removes the port from the multicast group. When a port has only one user, enabling IGMP fast leave processing on the port can save bandwidth.

Table 314 Enable IGMP fast leave processing

Operation	Command	Description
Enter system view	**system-view**	—
Enter Ethernet port view	**interface** *interface-type interface-number*	—
Enable IGMP fast leave processing	**igmp-snooping fast-leave vlan** *vlan-id* [**to** *vlan-id*]	Required By default this function is disabled.

Configuring IGMP Snooping Filter ACL

You can configure multicast filter ACLs globally or on switch ports to use the IGMP Snooping filter function to limit the multicast programs that the users can order. With this function, you can treat different VoD users in different ways by allowing different users to order different groups of programs.

In practice, when a user orders a multicast program, an IGMP report message is generated. When the message arrives at the switch, the switch examines the multicast filter ACL referenced on the access port to determine if the port can join the corresponding multicast group or not. If yes, it adds the port to the forward port list of the multicast group. If not, it drops the IGMP report message and does not forward the corresponding data stream to the port. In this way, you can control the multicast programs that users can order.

Table 315 Configure IGMP Snooping filter ACL

Operation	Command	Description
Enter system view	**system-view**	—
Enable IGMP Snooping filter in system view	**igmp-snooping group-policy** *acl-number* **vlan** *vlan-list*	Required *acl-number* is the number of a basic ACL; *vlan-id* is a VLAN ID. By default, this function is not enabled.
Enter Ethernet port view	**interface** *interface-type interface-number*	—
Configure an IGMP Snooping filter ACL on the port	**igmp-snooping group-policy** *acl-number* **vlan** *vlan-list*	Required *acl-number* is the number of a basic ACL; *vlan-id* is a VLAN ID. By default, no ACL is configured on any port.

Configuring the Maximum Number of Multicast Groups on a Port

You can use the command here to limit the number of multicast groups on a switch port. After that, users on this port cannot unlimitedly order multicast programs because you have limited the number of multicast groups on this port. In this way, you can control the multicast bandwidth on a port.

Table 316 Configure the maximum number of multicast groups on a port

Operation	Command	Description
Enter system view	**system-view**	—
Enter Ethernet port view	**interface** *interface-type interface-number*	—

Table 316 Configure the maximum number of multicast groups on a port (continued)

Operation	Command	Description
Configure the maximum number of multicast groups the port can join.	**igmp-snooping group-limit** [**vlan** *vlan-list* | **overflow-replace**]	Required By default, there is no limit on the number of the multicast groups the port can join.

Configuring Multicast VLAN

In old multicast mode, when users in different VLANs order the same multicast group, the multicast stream is copied to each of the VLANs. This mode wastes a lot of bandwidth.

By configuring a multicast VLAN, adding switch ports to the multicast VLAN and enabling IGMP Snooping, you can make users in different VLANs share the same multicast VLAN. This saves bandwidth since multicast streams are transmitted only within the multicast VLAN, and also guarantees security because the multicast VLAN is isolated from user VLANs.

Multicast VLAN is mainly used in Layer 2 switching, but you must make corresponding configuration on the Layer 3 switch.

Table 317 describes the configuration tasks for multicast VLAN.

Table 317 Configure multicast VLAN on Layer 3 switch

Operation	Command	Description
Enter system view	system-view	—
Create a VLAN and enter the VLAN view	**vlan** *vlan-id*	*vlan-id* is a VLAN ID.
Exit the VLAN view	quit	—
Create a VLAN interface and enter the VLAN interface view	**interface vlan-interface** *vlan-id*	—
Enable IGMP	igmp enable	Required
Exit the VLAN interface view	quit	—
Enter the view of the Ethernet port connected to the Layer 2 switch	**interface** *interface-type interface-num*	—
Define the port as a trunk or hybrid port	**port link-type** { **trunk | hybrid** }	Required
Set the VLAN IDs allowed to pass through the Ethernet	**port hybrid vlan** *vlan-id-list* { **tagged** | **untagged** }	Required The multicast VLAN defined on the Layer 2 switch must be included and set as tagged.
	port trunk pvid vlan *vlan-id*	

Table 318 Configure multicast VLAN on Layer 2 switch

Operation	Command	Description
Enter system view	system-view	—
Enable IGMP Snooping globally	igmp-snooping enable	Required
Enter VLAN view	**vlan** *vlan-id*	*vlan-id* is a VLAN ID.
Enable IGMP Snooping on the VLAN	igmp-snooping enable	Required

Table 318 Configure multicast VLAN on Layer 2 switch (continued)

Operation	Command	Description
Enable multicast VLAN	service-type multicast	Required
Exit the VLAN view	quit	—
Enter the view of the Ethernet port connected to the Layer 3 switch	**interface** *interface-type interface-num*	—
Define the port as a trunk or hybrid port	**port link-type** { **trunk** | **hybrid** }	—
Set the VLAN IDs allowed for the Ethernet	**port hybrid vlan** *vlan-id-list* { **tagged** | **untagged** }	The multicast VLAN must be included and set as tagged.
	port trunk pvid vlan *vlan-id*	
Enter the view of the Ethernet port connected to a user device	**interface** *interface-type interface-num*	*interface-type* and *interface-num* are the interface type and interface number.
Define the port as a hybrid port	**port link-type hybrid**	Required
Set the VLAN IDs whose packets are allowed to pass the port	**port hybrid vlan** *vlan-id-list* { **tagged** | **untagged** }	Required The multicast VLAN must be included and set as untagged.

Note that:

- You cannot set the isolate VLAN as a multicast VLAN.
- One user port can belong to only one multicast VLAN.
- The port connected to a user end can only be set as a hybrid port.
- A multicast member port must belong to the same multicast VLAN with the router port. Or else, it cannot receive multicast packets.
- When setting a multicast VLAN ID on the router port, you must define the port as a trunk port or a tag-carried hybrid port, or else no multicast member port in this multicast VLAN can receive multicast packets.
- If a multicast member port needs to receive multicast packets forwarded by the router port but the router port does not belong to any multicast VLAN, you should remove the multicast member port from its multicast VLAN, or else it cannot receive multicast packets.

Displaying and Debugging IGMP Snooping

Execute `display` command in any view to display the running of the IGMP Snooping configuration, and to verify the effect of the configuration. Execute `reset` command in user view to reset the IGMP Snooping statistic information. Execute `debugging` command in user view to debug IGMP Snooping configuration.

Table 319 Displaying and debugging IGMP Snooping

Operation	Command
Display the information about current IGMP Snooping configuration	`display igmp-snooping configuration`
Display IGMP Snooping statistics of received and sent messages	`display igmp-snooping statistics`
Display IP/MAC multicast group information in the VLAN	`display igmp-snooping group [ vlan` *vlanid* `]`
Reset the IGMP Snooping statistic information	`reset igmp-snooping statistics`

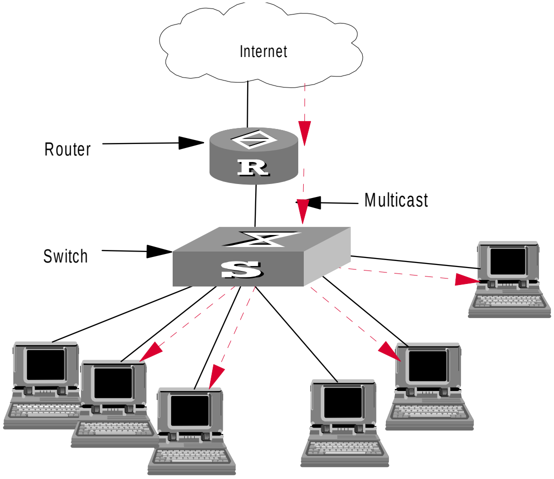
Configuration Example—Enable IGMP Snooping

Networking Requirements

To implement IGMP Snooping on the switch, first enable it. The switch is connected to the router via the router port, and with user PCs through the non-router ports on vlan 10.

Networking Diagram

Figure 83 IGMP Snooping configuration network



Configuration Procedure

Enable IGMP Snooping globally.

```
[SW5500]igmp-snooping enable
```

Enable IGMP Snooping on VLAN 10.

```
[SW5500]vlan 10
[SW5500-vlan10]igmp-snooping enable
```

IGMP Snooping Fault Diagnosis and Troubleshooting

Fault: Multicast function cannot be implemented on the switch.

Troubleshooting:

Diagnosis 1: IGMP Snooping is disabled.

1. Input the **display current-configuration** command to display the status of IGMP Snooping.
2. If the switch disabled IGMP Snooping, check whether the IGMP Snooping is enabled globally and also enabled on the VLAN. If IGMP Snooping is not enabled globally, first input the **igmp-snooping enable** command in System View and then input the **igmp-snooping enable** command in VLAN view. If IGMP Snooping is not enabled on the VLAN, input the **igmp-snooping enable** command in VLAN view.

Diagnosis 2: Multicast forwarding table set up by IGMP Snooping is wrong.

1. Input the **display igmp-snooping group** command to display if the multicast group is the expected one.
2. If the multicast group created by IGMP Snooping is not correct, refer to Technical Support for assistance.
3. Continue with diagnosis 3 if step 2 is completed.

Diagnosis 3: Multicast forwarding table set up on the bottom layer is wrong.

1. Enable IGMP Snooping group in user view and then input the command **`display igmp-snooping group`** to check if MAC multicast forwarding table in the bottom layer and that created by IGMP Snooping is consistent. You may also input the **`display mac vlan`** command in any view to check if MAC multicast forwarding table under vlanid in the bottom layer and that created by IGMP Snooping is consistent.
2. If they are not consistent, refer to Technical Support for assistance.

Common Multicast Configuration

A common multicast configuration covers both the multicast group management protocol and the multicast routing protocol. The configuration includes enabling multicast, configuring the multicast forwarding boundary, and displaying the multicast routing table and multicast forwarding table.

Common multicast configuration includes:

- Enabling multicast
- Configuring the multicast route limit
- Clearing MFC forwarding entries or statistics information
- Clearing route entries from the core multicast routing table

Enabling Multicast

Enable multicast first before enabling IGMP and the multicast routing protocol.

Perform the following configuration in system view.

Table 320 Enabling multicast

Operation	Command
Enable multicast	**`multicast routing-enable`**
Disable multicast	**`undo multicast routing-enable`**

By default, multicast is disabled.

Other multicast configurations can only become effective when multicast is enabled.

Configuring the Number Limit of Multicast Routing Entries

The number of multicast routing entries can be limited to prevent the router memory from being exhausted.

Perform the following configuration in System View.

Table 321 Configuring number limit of multicast routing entries

Operation	Command
Configure number limit of multicast routing entries	**`multicast route-limit`** *`limit`*
Restore the default number limit	**`undo multicast route-limit`**

By default, the multicast route-limit is 1000.

Multicast MAC Address Entry Configuration

In Layer 2 multicast, the system can add multicast forwarding entries dynamically through Layer 2 multicast protocol. However, you can also manually create a static multicast address entry to bind a port to a multicast address.

Generally, when receiving a multicast packet whose multicast address has not yet been registered on the switch, the switch broadcasts the packet in the VLAN. However, you can configure a static multicast MAC address entry to avoid this case.

Table 322 describes how to configure a multicast MAC address entry.

Table 322 Configure a multicast MAC address entry

Operation	Command	Description
Enter system view	system-view	—
Add a multicast MAC address entry	**mac-address multicast** *mac-address* **interface** *interface-list* **vlan** *vlan-id*	Required *mac-address* must be a multicast MAC address. *vlan-id* is the VLAN ID the port belongs to.
Enter Ethernet port view	**interface** *interface-type interface-number*	—
Add a multicast MAC address entry.	**mac-address multicast** *mac-address* **vlan** *vlan-id*	Required This command is used in Ethernet port view. It has the same effect with the above command used in system view with the same port specified.

You can use the corresponding **undo** command to cancel the creation.

Note that:

- If the multicast MAC address entry you are creating has already been existed, the system gives you a prompt.
- The switch will not learn a manually added multicast MAC address by IGMP Snooping. The **undo mac-address multicast** command can only remove manually created multicast MAC address entries and cannot remove those learned by the switch.
- When adding a port to a manually created multicast MAC address entry, you should first remove the entry, then re-create the entry and specify the port as the forward port of the entry.
- The system does not support the configuring of multicast MAC address on an IRF port. If you do this, the system will give you a prompt that the multicast MAC address configuration fails.
- You cannot enable port aggregation on a port where you have configured a multicast MAC address; and you cannot configure a multicast MAC address on an aggregated port.

Displaying Multicast MAC Address Configuration

You can use the following **display** command in any view to display the multicast MAC address entry configuration.

Table 323 Display multicast MAC address configuration

Operation	Command	Description
Display all the multicast MAC address entries added	**display mac-address multicast static** [**count** | *mac-address* **vlan** *vlan-id* **|** **vlan** *vlan-id*]	You can use the **display** command in any view.

Multicast Source Deny Configuration

The purpose of the multicast source deny feature is to filter out multicast packets on an unauthorized multicast source port to prevent the user connected to the port from setting up a multicast server without permission.

Enabling Multicast Source Deny

Table 324 Enable multicast source deny

Operation	Command	Description
Enter system view	**system-view**	—
Enable multicast source deny in system view	**multicast-source-deny** [**interface** *interface-list*]	Required Executing this command without specifying the *interface-list* argument will enable the feature globally (that is, on all the ports of the switch). Executing this command with the *interface-list* argument specified will enable the feature on the specified port. By default, this feature is disabled globally.
Enter Ethernet port view	**interface** *interface_type interface_num*	*interface_type* and *interface_num* are the type and number of a port.
Enable multicast source deny in Ethernet port view	multicast-source-deny	Optional By default, this feature is disabled on all the ports of the switch.

Clearing MFC Forwarding Entries or Statistics Information

Use the command in Table 325 to clear the multicast forwarding cache (MFC) forward entries or statistics information.

Perform the following configuration in User View.

Table 325 Clearing MFC forwarding entries or its statistic information

Operation	Command
Clear MFC forwarding entries or its statistic information	**reset multicast forwarding-table** [**statistics**] { **all** | { *group_address* [**mask** { *group_mask* | *group_mask_length* }] | *source_address* [**mask** { *source_mask* | *source_mask_length* }] | **incoming-interface** *interface_type interface_number* } * }

Clearing Route Entries From The Core Multicast Routing Table

Use the command in Table 326 to clear route entries from the core multicast routing table, as well as MFC forwarding entries.

Perform the following configuration in User View.

Table 326 Clearing routing entries from multicast routing table

Operation	Command
Clear routing entries from multicast routing table	**reset multicast routing-table** { **all** | { *group_address* [**mask** { *group_mask* | *group_mask_length* }] | *source_address* [**mask** { *source_mask* | *source_mask_length* }] | { **incoming-interface** *interface_type interface_number* } } * }

The forwarding entries in MFC are deleted along with the routing entries in the multicast kernel routing table.

Displaying and Debugging Common Multicast Configuration

Execute **display** command in any view to display the running of the multicast configuration, and to verify the effect of the configuration.

Execute **debugging** command in User View to debug multicast.

Table 327 Displaying and debugging Common Multicast Configuration

Operation	Command
Display the multicast routing table	**display multicast routing-table** [*group-address* [**mask** { *mask* | *mask_length* }] | *source_address* [**mask** { *mask* | *mask_length* }] | **incoming-interface** { *interface-type interface_number* | **register** }]*
Display the multicast forwarding table	**display multicast forwarding-table** [*group_address* [**mask** { *mask* | *mask_length* }] | *source_address* [**mask** { *mask* | *mask_length* }] | **incoming-interface** { *nterface-type interface_number* | **register** }]*
Enable multicast packet forwarding debugging	**debugging multicast forwarding**
Disable multicast packet forwarding debugging	**undo debugging multicast forwarding**
Enable multicast forwarding status debugging	**debugging multicast status-forwarding**
Disable multicast forwarding status debugging	**undo debugging multicast status-forwarding**
Enable multicast kernel routing debugging	**debugging multicast kernel-routing**
Disable multicast kernel routing debugging	**undo debugging multicast kernel-routing**

There are three types of multicast routing tables: individual multicast routing tables of each multicast routing protocol; a multicast kernel routing table integrating the routing information of those individual routing tables; and a multicast forwarding table in conformity with the kernel routing table and in charge of the multicast packet forwarding.

Multicast forwarding table is mainly used in debugging. Generally, users can obtain required information by viewing the multicast kernel routing table.

Internet Group Management Protocol (IGMP)

IGMP is a protocol in the TCP/IP suite, responsible for management of IP multicast members. It is used to establish and maintain multicast membership among IP hosts and their directly connected neighboring routers. IGMP excludes transmitting and maintenance of membership information among multicast routers, which are completed by multicast routing protocols. All hosts participating in multicast must implement IGMP.

Hosts participating in IP multicast can join and leave a multicast group at any time. The number of members of a multicast group can be any integer and their location can be anywhere. A multicast router does not need and cannot keep the membership of all hosts. It only uses IGMP to learn whether receivers (that is, group members) of a multicast group are present on the subnet connected to each interface. A host only needs to keep the multicast groups it has joined.

IGMP is not symmetric on hosts and routers. Hosts need to respond to IGMP query messages from the multicast router, —, report the group membership to the router. The router needs to send membership query messages periodically to discover whether hosts join the specified group on its subnets according to the received response messages. When the router receives the report that hosts leave the group, the router will send a group-specific query (IGMP Version 2) to discover whether there are no members in the group.

Up to now, IGMP has three versions, namely, IGMP Version 1 (defined by RFC1112), IGMP Version 2 (defined by RFC2236) and IGMP Version 3. IGMP Version 2 is currently the most widely used version.

IGMP Version 2 benefits from the following improvements over IGMP Version 1:

- Election mechanism of multicast routers on the shared network segment
- Leaving group mechanism
- Specific group query
- Max response time

Election Mechanism of Multicast Routers on the Shared Network Segment

A shared network segment means that there are multiple multicast routers on a network segment. In this case, all routers running IGMP on the network segment can receive the membership report from hosts. Therefore, only one router is necessary to send membership query messages. In this case, the router election mechanism is required to specify a router as the querier.

In IGMP Version 1, selection of the querier is determined by the multicast routing protocol. While IGMP Version 2 specifies that the multicast router with the lowest IP address is elected as the querier when there are multiple multicast routers on the same network segment.

Leaving Group Mechanism

In IGMP Version 1, hosts leave the multicast group quietly without informing the multicast router. The multicast router can only depend on the timeout of the response time of the multicast group to confirm that hosts leave the group. In Version 2, when a host leaves a multicast group, it will send a leave group message.

Specific Group Query

In IGMP Version 1, a query of multicast routers is targeted at all the multicast groups on the network segment. This is known as General Query.

In addition to General Query, IGMP Version 2 also supports Group-Specific Query. The destination IP address of the query packet is the IP address of the multicast group. The group address domain in the packet is also the IP address of the multicast group. This prevents the hosts of members of other multicast groups from sending response messages.

Max Response Time

The Max Response Time is added in IGMP Version 2. It is used to dynamically adjust the allowed maximum time for a host to respond to the membership query message.

Configuring IGMP

Basic IGMP configuration includes:

- Enabling Multicast
- Enabling IGMP on an Interface

Advanced IGMP configuration includes:

- Configuring the IGMP Version
- Configuring the Interval and the Number of IGMP Query Packets
- Configuring the Limit of IGMP Groups on an Interface
- Configuring a Router to Join Specified Multicast Group
- Limiting Multicast Groups An Interface Can Access
- Configuring the Interval to Send IGMP Query Message
- Configuring the Present Time of IGMP Querier
- Configuring Maximum Response Time for IGMP Query Message
- Deleting IGMP Groups Joined on an Interface

Enabling Multicast

Refer to "Common Multicast Configuration" on page 323.

Enabling IGMP on an Interface

You must enable multicast before you can execute the **`igmp enable`** command. After this, you can initiate IGMP feature configuration.

Perform the following configuration in Interface View.

Table 328 Enabling/Disabling IGMP on an interface

Operation	Command
Enable IGMP on an interface	**`igmp enable`**
Disable IGMP on an interface	**`undo igmp enable`**

By default, IGMP is not enabled.

Configuring the IGMP Version

Perform the following configuration in Interface View.

Table 329 Selecting the IGMP version

Operation	Command
Select the IGMP version that the router uses	**`igmp version { 1 | 2 }`**
Restore the default setting	**`undo igmp version`**

By default, IGMP Version 2 is used.

All routers on a subnet must support the same version of IGMP. After detecting the presence of IGMP Version 1 system, a router cannot automatically switch to Version 1.

Configuring the Interval for Querying IGMP Packets

The router finds out which multicast groups on its connected network segment have members by sending IGMP query messages periodically. Upon the reception of a response message, the router refreshes the membership information of the corresponding multicast group.

Perform the following configurations in Interface View.l

Table 330 Configuring query interval

Operation	Command
Configure query interval	**`igmp timer query`** *`seconds`*
Restore the default query interval	**`undo igmp timer query`**

When there are multiple multicast routers on a network segment, the querier is responsible for sending IGMP query messages to all the hosts on the LAN.

By default, the interval is 60 seconds.

Configuring the Interval and the Number of IGMP Query Packets

On a shared network, the query router (querier) maintains IGMP membership on the interface. When an IGMP querier receives an IGMP Leave Group message from a host, the last member query interval can be specified for Group-Specific Queries.

1. The host sends the IGMP Leave message.
2. Upon receiving the message, the IGMP querier sends the designated group IGMP query message for the specified number of times (defined by the *`robust_value`* in **`igmp robust-count`**, with the default value as 1 second) and at a time interval (defined by the *`seconds`* in **`igmp lastmember-queryinterval`**, with the default value as 2).
3. When other hosts receive the message from the IGMP querier and are interested in this group, they return the IGMP Membership Report message within the defined maximum response time.
4. If the IGMP querier receives the report messges from other hosts within the period equal to *robust-value* × *seconds*, it continues membership maintenance for this group.
5. If the IGMP querier does not receive a report message from any other host within this period, then it takes it as timeout and ends membership maintenance for this group.

This command can be used only when the querier runs IGMP version 2, since a host running IGMP Version 1 does not send an IGMP Leave Group message when it leaves a group.

Perform the following configuration in Interface View.

- Configure interval for querying IGMP packets, see Table 331. By default, the interval is 1 second.
- Configuring the number of last member querying, see Table 332. By default, an IGMP group-specific query message is sent for twice

Table 331 Configuring interval for querying IGMP packets

Operation	Command
Configure interval for querying IGMP packets	**igmp lastmember-queryinterval** *seconds*
Restore the default query interval	**undo igmp lastmember-queryinterval**

Table 332 Configure the number of last member querying

Operation	Command
Configure number of last member querying	**igmp robust-count** *robust-value*
Restore the default number of querying	**undo igmp robust-count**

Configuring the Limit of IGMP Groups on an Interface

If there is no limit to the number of IGMP groups added on a router interface or a router, the router memory may be exhausted, which may cause router failure.

You can set number limit for the IGMP groups added on the interface, but not the number limit for the IGMP groups added in the router, which is defined by the system.

Perform the following configuration in Interface view.

Table 333 Configuring the limit of IGMP groups on an interface

Operation	Command
Configure the limit of IGMP groups on an interface	**igmp group-limit** *limit*
Restore the limit of IGMP groups on an interface to the default value	**undo igmp group-limit**

By default, the maximum number of IGMP groups on an interface is 1024.

If the number of IGMP groups on an interface has exceeded the specified value during configuration, no IGMP group will be deleted.

Configuring a Router to Join Specified Multicast Group

Usually, the host operating IGMP will respond to IGMP query packet of the multicast router. In case of response failure, the multicast router will consider that there is no multicast member on this network segment and will cancel the corresponding path. Configuring one interface of the router as multicast member can avoid such problem. When the interface receives IGMP query packet, the router will respond, thus ensuring that the network segment where the interface is connected can normally receive multicast packets.

For a Switch 5500, you can configure a port in a VLAN interface to join a multicast group.

Perform the following configuration in the corresponding view.

Table 334 Configuring a router to join specified multicast group

Operation	Command
Configure a router to join specified multicast group (VLAN Interface View)	**igmp host-join** *group_address* **port** { *interface_type interface_ num* | *interface_name* } [**to** { *interface_type interface_ num* | *interface_name* }]
Quit from specified multicast group (VLAN Interface View)	**undo igmp host-join** *group-address* **port** { *interface_type interface_ num* | *interface_name* } [**to** { *interface_type interface_ num* | *interface_name* }]
Configure a router to join specified multicast group (Ethernet Port View)	**igmp host-join** *group-address* **vlan** *vlanid*
Quit from specified multicast group (Ethernet Port View)	**undo igmp host-join** *group-address* **vlan** *vlanid*

By default, a router joins no multicast group.

Limiting Multicast Groups An Interface Can Access

A multicast router learns whether there are members of a multicast group on the network via the received IGMP membership message. A filter can be set on an interface so as to limit the range of allowed multicast groups.

Perform the following configuration in Interface view.

Table 335 Limiting multicast groups an interface can access

Operation	Command
Limit the range of allowed multicast groups on current interface (Interface View)	**igmp group-policy** *acl_number* [**1** | **2** | **port** { *interface_type interface_ num* | *interface_name* } [**to** { *interface_type interface_ num* | *interface_name* }]]
Remove the filter set on the interface (Interface View)	**undo igmp group-policy** [**port** { *interface_type interface_ num* | *interface_name* } [**to** { *interface_type interface_ num* | *interface_name* }]]

By default, no filter is configured, that is, all multicast groups are allowed on the interface.

Configuring the Interval to Send IGMP Query Message

Multicast routers send IGMP query messages to discover which multicast groups are present on attached networks. Multicast routers send query messages periodically to refresh their knowledge of members present on their networks.

Perform the following configuration in Interface view.

Table 336 Configuring the interval to send IGMP query message

Operation	Command
Configure the interval to send IGMP query message	**igmp timer query** *seconds*
Restore the default value	**undo igmp timer query**

When there are multiple multicast routers on a network segment, the querier is responsible for sending IGMP query messages to all hosts on the LAN.

By default, the interval is 60 seconds.

Configuring the Present Time of IGMP Querier

The IGMP querier present timer defines the period of time before the router takes over as the querier sending query messages, after the previous querier has stopped doing so.

Perform the following configuration in Interface view.

Table 337 Configuring the present time of IGMP querier

Operation	Command
Change the present time of IGMP querier	**igmp timer other-querier-present** *seconds*
Restore the default value	**undo igmp timer other-querier-present**

By default, the value is 120 seconds. If the router has received no query message within twice the interval specified by the **igmp timer query** command, it will regard the previous querier invalid.

Configuring Maximum Response Time for IGMP Query Message

When a router receives a query message, the host will set a timer for each multicast group it belongs to. The value of the timer is randomly selected between 0 and the maximum response time. When any timer becomes 0, the host will send the membership report message of the multicast group.

Setting the maximum response time reasonably can enable the host to respond to query messages quickly. In this case, the router can fast master the existing status of the members of the multicast group.

Perform the following configuration in Interface view.

Table 338 Configuring the maximum response time for IGMP query message

Operation	Command
Configure the maximum response time for IGMP query message	**igmp max-response-time** *seconds*
Restore the maximum query response time to the default value	**undo igmp max-response-time**

The smaller the maximum query response time value, the faster the router prunes groups. The actual response time is a random value in the range from 1 to 25 seconds. By default, the maximum query response time is 10 seconds.

Deleting IGMP Groups Joined on an Interface

You can delete an existing IGMP group from the interface using the following command.

Perform the following configuration in Interface view.

Table 339 Deleting IGMP groups joined on an interface

Operation	Command
Delete IGMP groups joined on an interface	**reset igmp group** { **all** | **interface** *interface_type interface_number* { **all** | *group_address* [*group_mask*] } }

Displaying and debugging IGMP

After the above configuration, execute `display` command in any view to display the running of IGMP configuration, and to verify the effect of the configuration.

Execute `debugging` command in user view for the debugging of IGMP.

Table 340 Displaying and debugging IGMP

Operation	Command
Display the information about members of IGMP multicast groups	**display igmp group [** *group_address* **| interface** *interface_type interface_number* **]**
Display the IGMP configuration and running information about the interface	**display igmp interface [** *interface_type interface_number* **]**
Enable the IGMP information debugging	**debugging igmp { all | event | host | packet | timer }**
Disable the IGMP information debugging	**undo debugging igmp { all | event | host | packet | timer }**

PIM-DM Overview

PIM-DM (Protocol Independent Multicast, Dense Mode) belongs to dense mode multicast routing protocols. PIM-DM is suitable for small networks. Members of multicast groups are relatively dense in such network environments.

The working procedures of PIM-DM include:

- Neighbor discovery
- Graft
- Flood&Prune

Neighbor discovery

The PIM-DM router uses Hello messages to perform neighbor discovery when it is started. All network nodes running PIM-DM stay in touch with one another by periodically sending Hello messages.

Graft

When the pruned downstream node needs to be restored to the forwarding state, the node will send a graft packet to inform the upstream node.

Flood&Prune

PIM-DM assumes that all hosts on the network are ready to receive multicast data. When a multicast source "S" begins to send data to a multicast group "G", after the router receives the multicast packets, the router will perform RPF check according to the unicast routing table first. If the RPF check is passed, the router will create an (S, G) entry and then flood the data to all downstream PIM-DM nodes. If the RPF check is not passed, that is, multicast packets enter from an error interface, the packets will be discarded. After this process, an (S, G) entry will be created in the PIM-DM multicast domain.

If the downstream node has no multicast group members, it will send a Prune message to the upstream nodes to inform the upstream node not to forward data to the downstream node. Receiving the prune message, the upstream node will remove the corresponding interface from the outgoing interface list corresponding to the multicast forwarding entry (S, G). In this way, a SPT (Shortest Path Tree) rooted at Source S is built. The pruning process is initiated by leaf routers first.

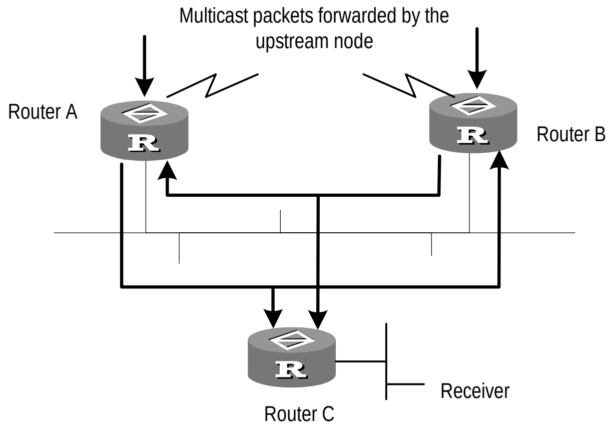
This process is called “flood & prune” process. In addition, nodes that are pruned provide timeout mechanism. Each router re-starts the “flood & prune” process upon pruning timeout. The consistent “flood & prune” process of PIM-DM is performed periodically.

During this process, PIM-DM uses the RPF check and the existing unicast routing table to build a multicast forwarding tree rooted at the data source. When a packet arrives, the router will first judge the correctness of the path. If the interface that the packet arrives is the one indicated by the unicast routing to the multicast source, the packet is regarded to be from the correct path. Otherwise, the packet will be discarded as a redundancy packet without the multicast forwarding. The unicast routing information as path judgment can come from any unicast routing protocol independent of any specified unicast routing protocol such as the routing information learned by RIP and OSPF

Assert Mechanism

As shown in the Figure 84, both routers A and B on the LAN have their own receiving paths to multicast source S. In this case, when they receive a multicast packet sent from multicast source S, they will both forward the packet to the LAN. Multicast Router C at the downstream node will receive two copies of the same multicast packet.

Figure 84 Assert mechanism diagram



When they detect such a case, routers need to select a unique sender by using the assert mechanism. Routers will send Assert packets to select the best path. If two or more than two paths have the same priority and metric, the path with a higher IP address will be the upstream neighbor of the (S, G) entry, which is responsible for forwarding the (S, G) multicast packet.

Graft

When the pruned downstream node needs to be restored to the forwarding state, the node will send a graft packet to inform the upstream node.

Configuring PIM-DM

PIM-DM basic configuration includes:

- Enabling Multicast
- Enabling PIM-DM

PIM-DM advanced configuration includes:

- Entering the PIM View
- Configuring Sending Interval for the Hello Packets
- Configuring the Filtering of Multicast Source/Group
- Configuring the Filtering of PIM Neighbor
- Configuring the Maximum Number of PIM Neighbor on an Interface
- Clearing Multicast Route Entries from PIM Routing Table
- Clearing PIM Neighbors

When the router is run in the PIM-DM domain, 3Com recommends that you enable PIM-DM on all interfaces of the non-border router.

Enabling Multicast

Refer to "Common Multicast Configuration" on page 323.

Enabling PIM-DM

PIM-DM needs to be enabled in the configuration of all interfaces.

After PIM-DM is enabled on an interface, it will send PIM Hello messages periodically and process protocol packets sent by PIM neighbors.

Perform the following configuration in Interface view.

Table 341 Enabling PIM-DM

Operation	Command
Enable PIM-DM on an interface	`pim dm`
Disable PIM-DM on an interface	`undo pim dm`

3Com recommends that you configure PIM-DM on all interfaces in non-special cases. This configuration is effective only after the multicast routing is enabled in System View.

Once PIM-DM is enabled on an interface, PIM-SM cannot be enabled on the same interface and vice versa.

Entering the PIM View

Global parameters of PIM should be configured in PIM View.

Perform the following configuration in System View.

Table 342 Entering PIM view

Operation	Command
Enter PIM view	`pim`
Back to system view	`undo pim`

Using **undo pim** command, you can clear the configuration in PIM view, and back to system view.

Configuring Sending Interval for the Hello Packets

After PIM is enabled on an interface, it will send Hello messages periodically on the interface. The interval at which Hello messages are sent can be modified according to the bandwidth and type of the network connected to the interface.

Perform the following configuration in Interface view.

Table 343 Configuring hello message interval on an interface

Operation	Command
Configure the hello message interval on an interface	**pim timer hello** *seconds*
Restore the interval to the default value	**undo pim timer hello**

The default interval is 30 seconds. You can configure the value according to different network environments. Generally, this parameter does not need to be modified.

This configuration can be performed only after PIM (PIM-DM or PIM-SM) is enabled in Interface View.

Configuring the Filtering of Multicast Source/Group

You can set to filter the source (and group) address of multicast data packets via this command. When this feature is configured, the router filters not only multicast data, but the multicast data encapsulated in the registration packets.

Perform the following configuration in the PIM view.

Table 344 Configuring the filtering of multicast source/group

Operation	Command
Configure the filtering of multicast source/group	**source-policy** *acl_number*
Remove the configuration of filtering	**undo source-policy**

If resource address filtering is configured, as well as basic ACLs, then the router filters the resource addresses of all multicast data packets received. Those not matched will be discarded.

If resource address filtering is configured, as well as advanced ACLs, then the router filters the resource and group addresses of all multicast data packets received. Those not matched will be discarded.

Configuring the Filtering of PIM Neighbor

You can set to filter the PIM neighbors on the current interface via the following configuration.

Perform the following configuration in the PIM View.

Table 345 Configuring the filtering of PIM neighbor

Operation	Command
Configure filtering of PIM neighbor	**pim neighbor-policy** *acl_number*
Remove the configuration of filtering	**undo pim neighbor-policy**

By default, no filtering rules are set.

Only the routers that match the filtering rule in the ACL can serve as a PIM neighbor of the current interface.

Configuring the Maximum Number of PIM Neighbor on an Interface

The maximum number of PIM neighbors of a router interface can be configured to avoid exhausting the memory of the router or router faults. The maximum number of PIM neighbors of a router is defined by the system, and is not open for modification.

Perform the following configuration in the PIM view.

Table 346 Configuring the maximum number of PIM neighbor on an interface

Operation	Command
Configure the maximum number of PIM neighbor on an interface	**pim neighbor-limit** *limit*
Restore the limit of PIN neighbor to the default value	**pim neighbor-limit**

By default, the PIM neighbors on the interface are limited to 128.

If the number of PIM neighbors of an interface has exceeded the configured value by the time of configuration, the existing PIM neighbors will not be deleted.

Clearing Multicast Route Entries from PIM Routing Table

Perform the following configuration in User View.

Table 347 Clearing multicast route entries from PIM routing table

Operation	Command
Clear multicast route entries from PIM routing table	**reset pim routing-table** { **all** | { *group_address* [**mask** { *group_mask* | *group_mask_length* }] | *source_address* [**mask** { *source_mask* | *source_mask_length* }] | { **incoming-interface** { *interface_type interface_number* | **null** } } } * }

If in this command, the *group-address* is 224.0.0.0/24 and *source-address* is the RP address (where group address can have a mask, but the resulted IP address must be 224.0.0.0, and source address has no mask), then it means only the (*, *, RP) item will be cleared.

If in this command, the *group-address* is any a group address, and *source-address* is 0 (where group address can have a mask, and source address has no mask), then only the (*, G) item will be cleared.

Note that this command clears not only multicast route entries from PIM routing table, but also the corresponding route entries and forward entries in the multicast core routing table and MFC.

Clearing PIM Neighbors

Perform the following configuration in User View.

Table 348 Resetting PIM neighbor

Operation	Command
Clear PIM neighbors	**reset pim neighbor** { **all** | { *neighbor_address* | **interface** *interface_type interface_number* } * }

Displaying and Debugging PIM-DM

After the above configuration, execute the `display` command in any view to display the running of PIM-DM configuration, and to verify the effect of the configuration.

Execute the `debugging` command in user view for the debugging of PIM-DM.

Table 349 Displaying and debugging PIM-DM

<table>
<tr><th>Operation</th><th>Command</th></tr>
<tr><td>Display the PIM multicast routing table</td><td>display pim routing-table [{ { *g [group_address [mask { mask_length | mask }]] | **rp [rp_address [mask { mask_length | mask }]] } | { group_address [mask { mask_length | mask }] | source_address [mask { mask_length | mask }] } * } | incoming-interface { interface-type interface_number | null } | { dense-mode | sparse-mode }] *</td></tr>
<tr><td>Display the PIM interface information</td><td>display pim interface [interface-type interface_number]</td></tr>
<tr><td>Display the information about PIM neighboring routers</td><td>display pim neighbor [interface-type interface_number]</td></tr>
<tr><td>Enable the PIM debugging</td><td>debugging pim common { all | event | packet | timer }</td></tr>
<tr><td>Disable the PIM debugging</td><td>undo debugging pim common { all | event | packet | timer }</td></tr>
<tr><td>Enable the PIM-DM debugging</td><td>debugging pim dm { alert | all | mbr | mrt | timer | warning | { recv | send } { all | assert | graft | graft-ack | join | prune } }</td></tr>
<tr><td>Disable the PIM-DM debugging</td><td>undo debugging pim dm { alert | all | mbr | mrt | timer | warning | { recv | send } { all | assert | graft | graft-ack | join | prune } }</td></tr>
</table>

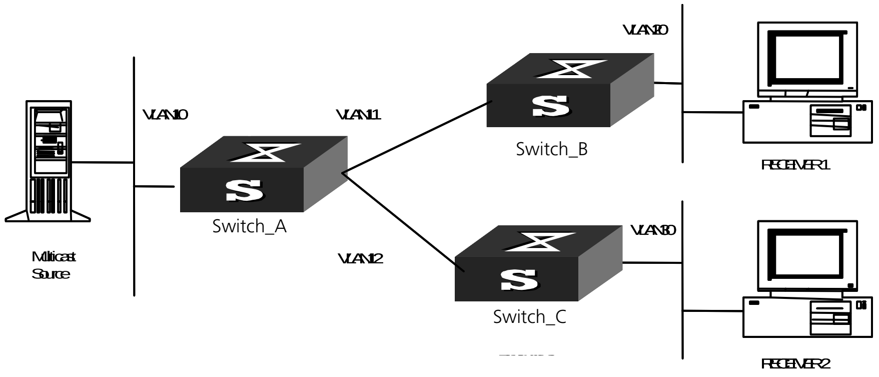
PIM-DM Configuration Example

Networking Requirements

Switch_A has a port carrying Vlan 10 to connect the Multicast Source, a port carrying Vlan11 to connect Switch_B and a port carrying Vlan12 to connect to Switch_C. Configure to implement multicast between Multicast Source and Receiver 1 and Receiver 2.

Networking Diagram

Figure 85 PIM-DM configuration networking



Configuration Procedure

This section only describes the configuration procedure for Switch_A. Follow a similar configuration procedure for Switch_B and Switch_C.

1 Enable the multicast routing protocol.

```
[SW5500]multicast routing-enable
```

2 Enable IGMP and PIM-DM.

```
[SW5500]vlan 10
[SW5500-vlan10]port ethernet 1/0/2 to ethernet 1/0/3
[SW5500-vlan10]quit
[SW5500]vlan 11
[SW5500-vlan11]port ethernet 1/0/4 to ethernet 1/0/5
[SW5500-vlan11]quit
[SW5500]vlan 12
[SW5500-vlan12]port ethernet 1/0/6 to ethernet 1/0/7
[SW5500-vlan12]quit
[SW5500]interface vlan-interface 10
[SW5500-vlan-interface10]ip address 1.1.1.1 255.255.0.0
[SW5500-vlan-interface10]igmp enable
[SW5500-vlan-interface10]pim dm
[SW5500-vlan-interface10]quit
[SW5500]interface vlan-interface 11
[SW5500-vlan-interface11]ip address 2.2.2.2 255.255.0.0
[SW5500-vlan-interface11]igmp enable
[SW5500-vlan-interface11]pim dm
[SW5500-vlan-interface11]quit
[SW5500]interface vlan-interface 12
[SW5500-vlan-interface12]ip address 3.3.3.3 255.255.0.0
[SW5500-vlan-interface12]igmp enable
[SW5500-vlan-interface12]pim dm
```

PIM-SM Overview

PIM-SM (Protocol Independent Multicast, Sparse Mode) is a multicast routing protocol, appropriate for large-scale networks (for example a WAN) where multicast group members are relatively sparse.

PIM-SM assumes that all hosts do not need to receive multicast packets, unless there is an explicit request for the packets. PIM-SM uses the RP (Rendezvous Point) and the BSR (Bootstrap Router) to advertise multicast information to all PIM-SM routers, and uses the join/prune information of the router to build the RP-rooted shared tree (RPT). This reduces the bandwidth occupied by data packets and control packets, and reduces the processing overhead on the router.

Multicast data flows along the shared tree to the network segments that have multicast group members. When the data traffic is sufficient, the multicast data flow can switch over to the SPT (Shortest Path Tree) rooted on the source to reduce network delay. PIM-SM does not depend on the specified unicast routing protocol but uses the present unicast routing table to perform the RPF check.

When running PIM-SM the user needs to configure candidate RPs and BSRs. The BSR is responsible for collecting the information from the candidate RP and advertising the information.

PIM-SM Operating Principle

The working procedures for PIM-SM include: neighbor discovery, building the RP-rooted shared tree (RPT), multicast source registration and switch over to the SPT.

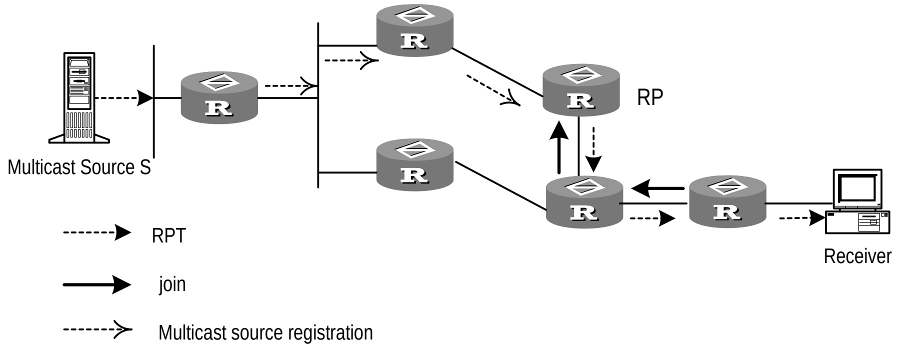
Neighbor Discovery

The PIM-SM router uses Hello messages to perform neighbor discovery when it is started. All network nodes running PIM-SM stay in touch with one another by periodically sending Hello messages.

Build the RP Shared Tree (RPT)

When hosts join a multicast group G, the leaf routers that directly connect with the hosts send IGMP messages to learn the receivers of multicast group G. In this way, the leaf routers calculate the corresponding rendezvous point (RP) for multicast group G and then send join messages to the node of a higher level toward the rendezvous point (RP). Each router along the path between the leaf routers and the RP will generate (*, G) entries in the forwarding table, indicating that all packets sent to multicast group G are applicable to the entries no matter from which source they are sent. When the RP receives the packets sent to multicast group G, the packets will be sent to leaf routers along the path built and then reach the hosts. In this way, an RP-rooted tree (RPT) is built as shown in Figure 86.

Figure 86 RPT schematic diagram



Multicast Source Registration

When multicast source S sends a multicast packet to the multicast group G, the PIM-SM multicast router directly connected to S will encapsulate the received packet into a registration packet and send it to the corresponding RP in unicast form. If there are multiple PIM-SM multicast routers on a network segment, the Designated Router (DR) will be responsible for sending the multicast packet.

Preparations before Configuring PIM-SM

Configuring Candidate RPs

In a PIM-SM network, multiple RPs (candidate-RPs) can be configured. Each Candidate-RP (C-RP) is responsible for forwarding multicast packets with the destination addresses in a certain range. Configuring multiple C-RPs is to implement load balancing of the RP. These C-RPs are equal. All multicast routers calculate the RPs corresponding to multicast groups according to the same algorithm after receiving the C-RP messages that the BSR advertises.

It should be noted that one RP can serve multiple multicast groups or all multicast groups. Each multicast group can only be uniquely correspondent to one RP at a time rather than multiple RPs.

Configuring BSRs

The BSR is the management core in a PIM-SM network. Candidate-RPs send announcement to the BSR, which is responsible for collecting and advertising the information about all candidate-RPs.

It should be noted that there can be only one BSR in a network but you can configure multiple candidate-BSRs. In this case, once a BSR fails, you can switch over to another BSR. A BSR is elected among the C-BSRs automatically. The C-BSR with the highest priority is elected as the BSR. If the priority is the same, the C-BSR with the largest IP address is elected as the BSR.

Configuring Static RP

The router that serves as the RP is the core router of multicast routes. If the dynamic RP elected by BSR mechanism is invalid for some reason, the static RP can be configured to specify RP. As the backup of dynamic RP, static RP improves network resilience and enhances the operation and management capability of multicast network.

Configuring PIM-SM

PIM-SM basic configuration includes:

- Enabling Multicast
- Enabling PIM-SM
- Configuring the PIM-SM Domain Border
- Entering the PIM View
- Configuring Candidate-BSRs
- Configuring Candidate-RPs
- Configuring Static RP

PIM-SM advanced configuration includes:

- Configuring the Sending Interval for the Hello Packets of the Interface
- Configuring the Filtering of Multicast Source/Group
- Configuring the Filtering of PIM Neighbor
- Configuring the Maximum Number of PIM Neighbor on an Interface
- Configuring RP to Filter the Register Messages Sent by DR
- Limiting the Range of Legal BSR
- Limiting the Range of Legal C-RP
- Clearing Multicast Route Entries from PIM Routing Table

- Clearing PIM Neighbors

It should be noted that at least one router in an entire PIM-SM domain should be configured with Candidate-RPs and Candidate-BSRs.

Enabling Multicast

Refer to "Common Multicast Configuration" on page 323.

Enabling PIM-SM

This configuration can be effective only after multicast is enabled.

Perform the following configuration in Interface view.

Table 350 Enabling PIM-SM

Operation	Command
Enable PIM-SM on an interface	**`pim sm`**
Disable PIM-SM on an interface	**`undo pim sm`**

Repeat this configuration to enable PIM-SM on other interfaces. Only one multicast routing protocol can be enabled on an interface at a time.

Once enabled PIM-SM on an interface, PIM-DM cannot be enabled on the same interface and vice versa.

Configuring the PIM-SM Domain Border

After the PIM-SM domain border is configured, bootstrap messages cannot cross the border in any direction. In this way, the PIM-SM domain can be split.

Perform the following configuration in Interface view.

Table 351 Configuring the PIM-SM domain border

Operation	Command
Set the PIM-SM domain border	**`pim bsr-boundary`**
Remove the PIM-SM domain border configured	**`undo pim bsr-boundary`**

By default, no domain border is set. After this configuration is performed, a bootstrap message cannot cross the border but other PIM packets can. This configuration can effectively divide a network into domains using different BSRs.

Entering the PIM View

Global parameters of PIM should be configured in PIM view.

Perform the following configuration in system view.

Table 352 Entering the PIM view

Operation	Command
Enter the PIM view	**`pim`**
Back to system view	**`undo`**

Using **`undo pim`** command, you can clear the configuration in PIM view, and back to system view.

Configuring Candidate-BSRs

In a PIM domain, one or more candidate BSRs should be configured. A BSR (Bootstrap Router) is elected among candidate BSRs. The BSR takes charge of collecting and advertising RP information.

The automatic election among candidate BSRs operates as follows:

- One interface which has started PIM-SM must be specified when configuring the router as the candidate BSR.
- At first, each candidate BSR considers itself as the BSR of the PIM-SM domain, and sends a Bootstrap message by taking the IP address of the interface as the BSR address.
- When receiving Bootstrap messages from other routers, the candidate BSR will compare the BSR address of the newly received Bootstrap message with that of itself. Comparison standards include priority and IP address. The bigger IP address is considered better when the priority is the same. If the new BSR address is better, the candidate BSR will replace its BSR address and stop regarding itself as the BSR. Otherwise, the candidate BSR will keep its BSR address and continue to regard itself as the BSR.

Perform the following configuration in PIM view.

Table 353 Configuring candidate-BSRs

Operation	Command
Configure a candidate-BSR	**c-bsr** *interface-type interface_number hash_mask_len* [*priority*]
Remove the candidate-BSR configured	**undo c-bsr**

Candidate-BSRs should be configured on the routers in the network backbone. By default, no BSR is set. The default priority is 0.

One Switch can only be configured with one candidate-BSR. When a candidate-BSR is configured on another interface, it will replace the previous configuration.

Configuring Candidate-RPs

In PIM-SM, the shared tree built by the multicast routing data is rooted at the RP. There is a mapping from a multicast group to an RP. A multicast group can be mapped to an RP. Different groups can be mapped to one RP.

Perform the following configuration in PIM view.

Table 354 Configuring candidate-RPs

Operation	Command
Configure a candidate-RP	**c-rp** *interface_type interface_number* [**group-policy** *acl_number* | **priority** *priority_value*]*
Remove the candidate-RP configured	**undo c-rp** { *interface_type interface_number* | **all** }

When configuring RP, if the range of the served multicast group is not specified, the RP will serve all multicast groups. Otherwise, the range of the served multicast group is the multicast group in the specified range. 3Com recommends that you configure Candidate RP on the backbone router.

Configuring Static RP

Static RP serves as the backup of dynamic RP, so as to improve network robusticity.

Perform the following configuration in PIM view.

Table 355 Configuring static RP

Operation	Command
Configure static RP	**static-rp** *rp_address* [*acl_number*]
Remove the configured static RP	**undo static-rp** *rp_address*

Basic ACL can control the range of multicast group served by static RP.

If static RP is in use, all routers in the PIM domain must adopt the same configuration. If the configured static RP address is the interface address of the local router whose state is UP, the router will function as the static RP. It is unnecessary to enable PIM on the interface that functions as static RP.

When the RP elected from BSR mechanism is valid, static RP does not work.

Configuring the Sending Interval for the Hello Packets of the Interface

Generally, PIM-SM advertises Hello messages periodically on the interface enabled with it to detect PIM neighbors and discover which router is the Designated Router (DR).

Perform the following configuration in Interface view.

Table 356 Configuring the sending interval for the Hello packets of the interface

Operation	Command
Configure the sending interval for the Hello packets of the interface	**pim timer hello** *seconds*
Restore the interval to the default value	**undo pim timer hello**

By default, the hello message interval is 30 seconds. Users can configure the value according to different network environments.

This configuration can be performed only after the PIM (PIM-DM or PIM-SM) is enabled in Interface view.

Configuring the Filtering of Multicast Source/Group

Refer to "PIM-DM Overview" on page 333.

Configuring the Filtering of PIM Neighbor

Refer to "PIM-DM Overview" on page 333.

Configuring the Maximum Number of PIM Neighbor on an Interface

Refer to "PIM-DM Overview" on page 333.

Configuring RP to Filter the Register Messages Sent by DR

In the PIM-SM network, the register message filtering mechanism can control which sources to send messages to which groups on the RP, that is, RP can filter the register messages sent by DR to accept specified messages only.

Perform the following configuration in PIM view.

Table 357 Configuring RP to filter the register messages sent by DR

Operation	Command
Configure RP to filter the register messages sent by DR	**register-policy** *acl_number*
Cancel the configured filter of messages	**undo register-policy**

If an entry of a source group is denied by the ACL, or the ACL does not define operation to it, or there is no ACL defined, the RP will send RegisterStop messages to the DR to prevent the register process of the multicast data stream.

Only the register messages matching the ACL **permit** *clause can be accepted by the RP. Specifying an undefined ACL will make the RP to deny all register messages.*

Limiting the Range of Legal BSR

In the PIM SM network using BSR (bootstrap router) mechanism, every router can set itself as C-BSR (candidate BSR) and take the authority to advertise RP information in the network once it wins in the contention. To prevent malicious BSR proofing in the network, the following two measures need to be taken:

- Prevent the router from being spoofed by hosts though faking legal BSR messages to modify RP mapping. BSR messages are of multicast type and their TTL is 1, so this type of attacks often hit edge routers. Fortunately, BSRs are inside the network, while assaulting hosts are outside, therefore neighbor and RPF checks can be used to stop this type of attack.
- If a router in the network is manipulated by an attacker, or an illegal router is accessed into the network, the attacker may set itself as C-BSR and try to win the contention and gain authority to advertise RP information among the network. Since the router configured as C-BSR shall propagate BSR messages, which are multicast messages sent hop by hop with TTL as 1, among the network, then the network cannot be affected as long as the peer routers do not receive these BSR messages. One way is to configure **bsr-policy** on each router to limit legal BSR range, for example, only 1.1.1.1/32 and 1.1.1.2/32 can be BSR, thus the routers cannot receive or forward BSR messages other than these two. Even legal BSRs cannot contest with them.

Perform the following configuration in PIM View.

Table 358 Limiting the range of legal BSR

Operation	Command
Set the legal BSR range limit	**bsr-policy** *acl_number*
Restore to the default setting	**undo bsr-policy**

For detailed information of **bsr-policy**, please refer to the command manual.

Limiting the Range of Legal C-RP

In the PIM-SM network using BSR mechanism, every router can set itself as C-RP (candidate rendezvous point) servicing particular groups. If elected, a C-RP becomes the RP servicing the current group.

In BSR mechanism, a C-RP router unicasts C-RP messages to the BSR, which then propagates the C-RP messages among the network by BSR message. To prevent C-RP spoofing, you need to configure **crp-policy** on the BSR to limit legal C-RP range and their service group range. Since each C-BSR has the chance to become BSR, you must configure the same filtering policy on each C-BSR router.

Perform the following configuration in PIM view.

Table 359 Limiting the range of legal C-RP

Operation	Command
Set the legal C-RP range limit	**crp-policy** *acl-number*
Restore to the default setting	**undo crp-policy**

For detailed information of **crp-policy**, please refer to the command manual.

Clearing Multicast Route Entries from PIM Routing Table

Refer to "PIM-DM Overview" on page 333.

Clearing PIM Neighbors

Refer to "PIM-DM Overview" on page 333.

Displaying and Debugging PIM-SM

After the above configuration, execute display command in any view to display the running of PIM-SM configuration, and to verify the effect of the configuration.

Execute **debugging** command in user view for the debugging of PIM-SM.

Table 360 Displaying and debugging PIM-SM

Operation	Command
Display the BSR information	**display pim bsr-info**
Display the RP information	**display pim rp-info** [*group-address*]
Enable the PIM-SM debugging	**debugging pim sm { all | verbose | mrt | warning | mbr { alert | fresh } | timer { assert | bsr | crpadv | jp | jpdelay | mrt | probe | spt } | { recv | send } { assert | bootstrap | crpadv | reg | regstop | jp } }**
Disable the PIM-SM debugging	**undo debugging pim sm { all | verbose | mrt | warning | mbr { alert | fresh } | timer { assert | bsr | crpadv | jp | jpdelay | mrt | probe | spt } | { recv | send } { assert | bootstrap | crpadv | reg | regstop | jp } }**

PIM-SM Configuration Example

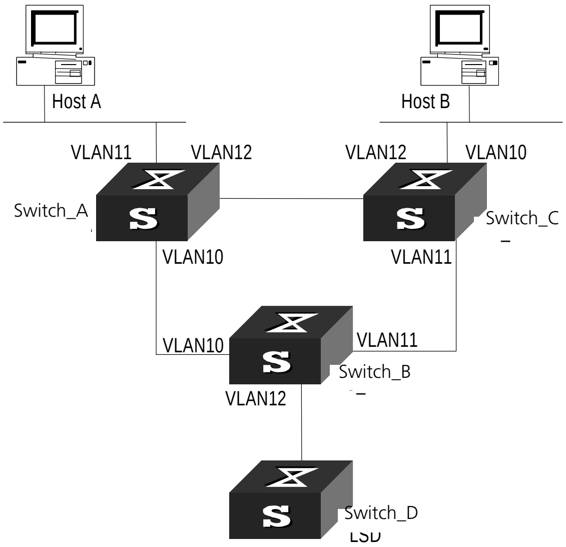
Networking Requirements

In actual network, we assume that the switches can intercommunicate.

Suppose that Host A is the receiver of the multicast group at 225.0.0.1. Host B begins transmitting data destined to 225.0.0.1. Switch_A receives the multicast data from Host B via Switch_B.

Networking Diagram

Figure 87 PIM-SM configuration networking



Configuration Procedure

1 On Switch_A:

a Enable PIM-SM.

```
[SW5500]multicast routing-enable
[SW5500]vlan 10
[SW5500-vlan10]port ethernet 1/0/2 to ethernet 1/0/3
[SW5500-vlan10]quit
[SW5500]interface vlan-interface 10
[SW5500-vlan-interface10]igmp enable
[SW5500-vlan-interface10]pim sm
[SW5500-vlan-interface10]quit
[SW5500]vlan 11
[SW5500-vlan11]port ethernet 1/0/4 to ethernet 1/0/5
[SW5500-vlan11]quit
[SW5500]interface vlan-interface 11
[SW5500-vlan-interface11]igmp enable
[SW5500-vlan-interface11]pim sm
[SW5500-vlan-interface11]quit
[SW5500]vlan 12
[SW5500-vlan12]port ethernet 1/0/6 to ethernet 1/0/7
[SW5500-vlan12]quit
[SW5500]interface vlan-interface 12
[SW5500-vlan-interface12]igmp enable
[SW5500-vlan-interface12]pim sm
[SW5500-vlan-interface12]quit
```

2 On Switch_B:

a Enable PIM-SM.

```
[SW5500]multicast routing-enable
[SW5500]vlan 10
[SW5500-vlan10]port ethernet 1/0/2 to ethernet 1/0/3
[SW5500-vlan10]quit
[SW5500]interface vlan-interface 10
[SW5500-vlan-interface10]igmp enable
[SW5500-vlan-interface10]pim sm
[SW5500-vlan-interface10]quit
```

```
[SW5500]vlan 11
[SW5500-vlan11]port ethernet 1/0/4 to ethernet 1/0/5
[SW5500-vlan11]quit
[SW5500]interface vlan-interface 11
[SW5500-vlan-interface11]igmp enable
[SW5500-vlan-interface11]pim sm
[SW5500-vlan-interface11]quit
[SW5500]vlan 12
[SW5500-vlan12]port ethernet 1/0/6 to ethernet 1/0/7
[SW5500-vlan12]quit
[SW5500]interface vlan-interface 12
[SW5500-vlan-interface12]igmp enable
[SW5500-vlan-interface12]pim sm
[SW5500-vlan-interface12]quit
```

b Configure the C-BSR.

```
[SW5500]pim
[SW5500-pim]c-bsr vlan-interface 10 30 2
```

c Configure the C-RP.

```
[SW5500]acl number 2000
[SW5500-acl-basic-2000]rule permit source 225.0.0.0 0.255.255.255
[SW5500]pim
[SW5500-pim]c-rp vlan-interface 10 group-policy 2000
```

d Configure PIM domain border.

```
[SW5500]interface vlan-interface 12
[SW5500-vlan-interface12]pim bsr-boundary
```

After VLAN-interface 12 is configured as the domain border, Switch_D will be excluded from the local PIM domain and will no longer receive the BSR information transmitted from Switch_B.

3 On Switch_C:

a Enable PIM-SM.

```
[SW5500]multicast routing-enable
[SW5500]vlan 10
[SW5500-vlan10]port ethernet 1/0/2 to ethernet 1/0/3
[SW5500-vlan10]quit
[SW5500]interface vlan-interface 10
[SW5500-vlan-interface10]igmp enable
[SW5500-vlan-interface10]pim sm
[SW5500-vlan-interface10]quit
[SW5500]vlan 11
[SW5500-vlan11]port ethernet 1/0/4 to ethernet 1/0/5
[SW5500-vlan11]quit
[SW5500]interface vlan-interface 11
[SW5500-vlan-interface11]igmp enable
[SW5500-vlan-interface11]pim sm
[SW5500-vlan-interface11]quit
[SW5500]vlan 12
[SW5500-vlan12]port ethernet 1/0/6 to ethernet 1/0/7
[SW5500-vlan12]quit
[SW5500]interface vlan-interface 12
[SW5500-vlan-interface12]igmp enable
[SW5500-vlan-interface12]pim sm
[SW5500-vlan-interface12]quit
```

19 ACL CONFIGURATION

This chapter covers the following topics:

- Brief Introduction to ACL
- QoS Configuration
- QoS Profile Configuration
- ACL Control Configuration
- ACL Control Configuration

Brief Introduction to ACL

A series of matching rules are required for the network devices to identify the packets to be filtered. After identifying the packets, the Switch can permit or deny them to pass through according to the defined policy. Access Control List (ACL) is used to implement such functions.

ACL classifies the data packets with a series of matching rules, including source address, destination address and port number, and so on. The Switch verifies the data packets with the rules in ACL and determines to forward or discard them.

The data packet matching rules defined by ACL can also be called in some other cases requiring traffic classification, such as defining traffic classification for QoS.

An access control rule includes several statements. Different statements specify different ranges of packets. When matching a data packet with the access control rule, the issue of match order arises.

The case of filter or classify the data transmitted by the hardware

ACL can be used to filter or classify the data transmitted by the hardware of the Switch. In this case, the match order of the ACL's sub-rules is determined by the Switch hardware. The match order defined by the user will not be effective.

The case includes: ACL cited by QoS function, ACL used for filter the packet transmitted by the hardware and so on.

The case of filter or classify the data transmitted by the software

ACL can be used to filter or classify the data treated by the software of the Switch. In this case, the match order of ACL's sub-rules can be determined by the user. There are two match-orders: `config` (by following the user-defined configuration order when matching the rule) and `auto` (according to the system sorting automatically when matching the rule, that is in depth-first order). Once the user specifies the match-order of an access control rule, it cannot be modified later, unless all the content is deleted and the match-order specified again.

The case includes: ACL cited by route policy function, ACL used for control logon user, and so on.

The depth-first principle is to put the statement specifying the smallest range of packets on the top of the list. This can be implemented through comparing the wildcards of the addresses. The smaller the wildcard is, the less hosts it can specify. For example, 129.102.1.1 0.0.0.0 specifies a host, while 129.102.1.1 0.0.255.255 specifies a network segment, 129.102.0.1 through 129.102.255.255. Obviously, the former one is listed ahead in the access control list.

The specific standard is as follows.

For basic access control list statements, compare the source address wildcards directly. If the wildcards are the same, follow the configuration sequence.

For the advanced access control list, compare the source address wildcards first. If they are the same, then compare the destination address wildcards. For the same destination address wildcards, compare the ranges of port numbers, the one with the smaller range is listed ahead. If the port numbers are in the same range, follow the configuration sequence.

ACL Supported by the Switch

Table 361 lists the limits to the numbers of different types of ACL on a Switch.

Table 361 Quantitative Limitation to the ACL

Item	Value range
Numbered basic ACL.	2000 to 2999
Numbered advanced ACL.	3000 to 3999
Numbered Layer-2 ACL.	4000 to 4999
Numbered user-defined ACL.	5000 to 5999
The sub items of an ACL	0 to 65534

Configuring ACL

ACL configuration includes:

- Configuring Time-Range
- Defining ACL
- Activating ACL

The above three steps must be done in sequence. Configure the time range first and then define the ACL (using the defined time range in the definition), then activate the ACL to validate it.

Configuring Time-Range

The process of configuring a time-range includes: configuring the hour-minute range, date ranges and period range. The hour-minute range is expressed in units of minute, hour. Date range is expressed in units of minute, hour, date, month and year. The periodic time range is expressed as the day of the week.

You can use the following command to set the time range by performing the following configuration in the System View.

Table 362 Set the Absolute Time Range

Operation	Command
Set the time range	**time-range** *time-name* { *start_time* **to** *end_time days_of_the_week* [**from** *start_time start_date*] [**to** *end_time end_date*] | **from** *start_time start_date* [**to** *end_time end_date*] | **to** *end_time end_date* }
Delete the time range	**undo time-range** *time-name* [*start_time* **to** *end_time days_of_the_week* [**from** *start_time start_date*] [**to** *end_time end_date*] | **from** *start_time start_date* [**to** *end_time end_date*] | **to** *end_time end_date*]

When the start-time and end-time are not configured, it will be all the time for one day. The end time shall be later than the start time.

When *end-time end-date* is not configured, it will be all the time from now to the date which can be displayed by the system. The end time shall be later than the start time.

Defining ACL

The Switch 5500 supports several types of ACL. This section introduces how to define these ACLs.

Defining ACL by following the steps below:

1. Enter the corresponding ACL view.
2. Add a rule to the ACL.

You can add multiple rules to one ACL.

- *If a specific time range is not defined, the ACL will always function after activated.*
- *During the process of defining the ACL, you can use the rule command several times to define multiple rules for an ACL.*
- *If ACL is used to filter or classify the data transmitted by the hardware of the Switch, the match order defined in the acl command will not be effective. If ACL is used to filter or classify the data treated by the software of the Switch, the match order of ACL's sub-rules will be effective. Once the user specifies the match-order of an ACL rule, he cannot modify it later.*
- *The default matching-order of ACL is config, that is following the order as that configured by the user.*

Define Basic ACL

The rules of the basic ACL are defined on the basis of the Layer-3 source IP address to analyze the data packets.

You can use the following command to define basic ACL.

Perform the following configuration in the corresponding view.

Table 363 Define Basic ACL

Operation	Command
Enter basic ACL view (from System View)	**acl number** *acl_number* **[match-order { config | auto }]**
add a sub-item to the ACL (from Basic ACL View)	**rule [** *rule_id* **] { permit | deny } [source {** *source_addr wildcard* **| any } | fragment | logging | time-range** *name* **]***
delete a sub-item from the ACL (from Basic ACL View)	**undo rule** *rule_id* **[source | fragment | logging | time-range]***
Delete one ACL or all the ACL (from System View)	**undo acl { number** *acl_number* **| all }**

Define Advanced ACL

The rules of the classification for advanced ACL are defined on the basis of the attributes such as source and destination IP address, the TCP or UDP port number in use and packet priority to process the data packets. The advanced ACL supports the analysis of three types of packet priorities, ToS (Type of Service), IP and DSCP priorities.

You can use the following command to define advanced ACL.

Perform the following configuration in the corresponding view.

Table 364 Define Advanced ACL

Operation	Command
Enter advanced ACL view (from System View)	**acl number** *acl_number* **[match-order { config | auto }]**
Add a sub-item to the ACL (from Advanced ACL View)	**rule [** *rule_id* **] { permit | deny }** *protocol* **[source {** *source_addr wildcard* **| any }] [destination {** *dest_addr wildcard* **| any }] [source-port** *operator port1* **[** *port2* **]] [destination-port** *operator port1* **[** *port2* **]] [icmp-type** *type code* **] [established] [[{ precedence** *precedence* **tos** *tos* **| dscp** *dscp* **}* | vpn-instance** *instance* **] | fragment | logging | time-range** *name* **]***
Delete a sub-item from the ACL (from Advanced ACL View)	**undo rule** *rule_id* **[source | destination | source-port | destination-port | icmp-type | precedence | tos | dscp | fragment | logging | time-range | vpn-instance]***
Delete one ACL or all the ACL (from System View)	**undo acl { number** *acl_number* **| all }**

Note that, the *port1* and *port2* in the above command specify the TCP or UDP ports used by various high-layer applications. For some common port numbers, you can use the mnemonic symbols as a shortcut. For example, “bgp” can represent the TCP number 179 used by BGP.

Define Layer-2 ACL

The rules of Layer-2 ACL are defined on the basis of the Layer-2 information such as source MAC address, source VLAN ID, Layer-2 protocol type, Layer-2 packet format and destination MAC address.

You can use the following command to define the numbered Layer-2 ACL.

Perform the following configuration in corresponding view.

Table 365 Define Layer-2 ACL

Operation	Command
Enter Layer-2 ACL view (from System View)	**acl number** *acl_number* **[match-order { config** | **auto }**
Add a sub-item to the ACL (from Layer-2 ACL View)	**rule [** *rule_id* **] { permit** | **deny } [[type** *protocol_type type_mask* | **lsap** *lsap_type type_mask* **]** | *format_type* | **cos** *cos* | **source {** *source_vlan_id* | *source_mac_addr source_mac_wildcard* **}*** | **dest {** *dest_mac_addr dest_mac_wildcard* **}** | **time-range** *name* **]***
Delete a sub-item from the ACL (from Layer-2 ACL View)	**undo rule** *rule_id*
Delete one ACL or all the ACL (from System View)	**undo acl { number** *acl_number* | **all }**

Defining the User-defined ACL

The user-defined ACL matches any bytes in the first 80 bytes of the Layer-2 data frame with the character string defined by the user and then processes them accordingly. To correctly use the user-defined ACL, you are required to understand the Layer-2 data frame structure.

Any packet ending up at the FFP (Fast Filter Processor), that performs ACL functionality, will contain a VLAN tag. Even packets that ingress the Switch untagged will be tagged at the FFP.

You can use the following commands to define user-defined ACL.

Perform the following configuration in corresponding view.

Table 366 Defining the User-defined ACL

Operation	Command
Enter user-defined ACL view (from System View)	**acl number** *acl_number* **[match-order { config** | **auto }]**
Add a sub-item to the ACL (from User-defined ACL View)	**rule [** *rule_id* **] { permit** | **deny } {** *rule_string rule_mask offset* **}&<1-8> [time-range** *name* **]**
Delete a sub-item from the ACL (from User-defined ACL View)	**undo rule** *rule_id*
Delete one ACL or all the ACL (from System View)	**undo acl { number** *acl_number* | **all }**

`rule-string` is a character string defined by a user. It is made up of a hexadecimal character string with even digits of characters. `rule-mask offset` is used to extract the packet information. Here, *rule-mask* is rule mask, used for logical AND operation with bytes from the data packets and corresponding bytes from the rule-mask and offset determines the start location of the rule-mask in the packet. `rule-mask offset` extracts a character string from the packet and compares it with the user-defined rule-string to identify and process the matched packets.

Activating ACL

The defined ACL can be active after being activated globally on the Switch. This function is used to activate the ACL filtering or classify the data transmitted by the hardware of the Switch.

You can use the following command to activate the defined ACL.

Perform the following configuration in Ethernet Port View.

Table 367 Activate ACL

Operation	Command
Activate an ACL	**packet-filter { inbound** | **outbound } { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**
Deactivate an ACL	**undo packet-filter { inbound** | **outbound } { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**

Displaying and Debugging ACL

After the above configuration, execute **display** command in all views to display the running of the ACL configuration, and to verify the effect of the configuration. Execute **reset** command in User View to clear the statistics of the ACL module.

Table 368 Display and Debug ACL

Operation	Command
Display the status of the time range	**display time-range { all** | *name* **}**
Display the detail information about the ACL	**display acl { all** | *acl_number* **}**
Display the information about the ACL running state	**display packet-filter { interface {** *interface_name* | *interface_type interface_num* **}** | **unitid** *unit_id* **}**
Clear ACL counters	**reset acl counter { all** | *acl_number* **}**

The matched information of **display acl** command specifies the rules treated by the Switch's CPU.

For syntax description, refer to the Command Reference Manual.

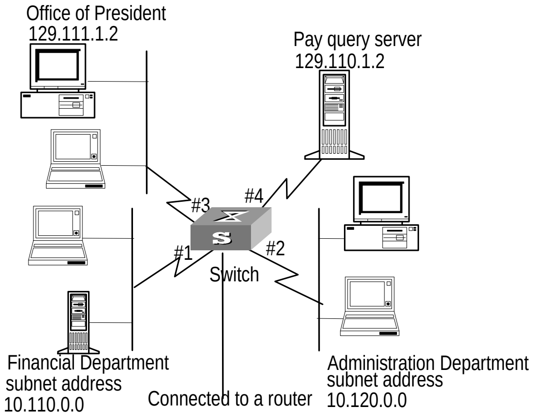
Advanced ACL Configuration Example

Networking Requirements

The interconnection between different departments on a company network is implemented through the 1000 Mbps ports of the Switch. The IP address of the payment query server of the Financial Dept. is 129.110.1.2. Financial Dept is accessed using GigabitEthernet1/0/50. It is required to properly configure the ACL and limit Financial Dept access to the payment query server between 8:00 and 18:00.

Networking Diagram

Figure 88 Access Control Configuration Example



Configuration Procedure

In the following configurations, only the commands related to ACL configurations are listed.

1 Define the work time range

Define time range from 8:00 to 18:00.

```
[SW5500]time-range 3Com 8:00 to 18:00 working-day
```

2 Define the ACL to access the payment server.

a Enter the numbered advanced ACL, number as 3000.

```
[SW5500]acl number 3000 match-order config
```

b Define the rules for other department to access the payment server.

```
[SW5500-acl-adv-3000]rule 1 deny ip source any destination 129.110.1.2
0.0.0.0 time-range 3Com
```

c Define the rules for the President's Office to access the payment server.

```
[SW5500-acl-adv-3000]rule 2 permit ip source 129.111.1.2 0.0.0.0
destination 129.110.1.2 0.0.0.0
```

3 Activate ACL.

Activate the ACL 3000.

```
[SW5500-GigabitEthernet1/0/50]packet-filter inbound ip-group 3000
```

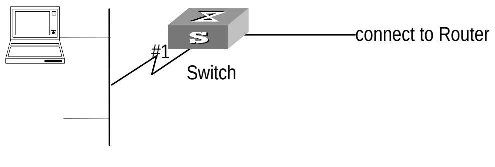
Basic ACL Configuration Example

Networking Requirements

Using basic ACL, filter the packet whose source IP address is 10.1.1.1 during the time range 8:00 ~ 18:00 every day. The host connects port GigabitEthernet1/0/50 of the Switch.

Networking Diagram

Figure 89 Access Control Configuration Example



Configuration Procedure

In the following configurations, only the commands related to ACL configurations are listed.

1 Define the time range

Define time range from 8:00 to 18:00.

```
[SW5500]time-range 3Com 8:00 to 18:00 daily
```

2 Define the ACL for packet which source IP is 10.1.1.1.

a Enter the number basic ACL, number as 2000.

```
[SW5500]acl number 2000
```

b Define the rules for packet which source IP is 10.1.1.1.

```
[SW5500-acl-basic-2000]rule 1 deny source 10.1.1.1 0 time-range 3Com
```

3 Activate ACL.

Activate the ACL 2000.

```
[SW5500-GigabitEthernet1/0/50]packet-filter inbound ip-group 2000
```

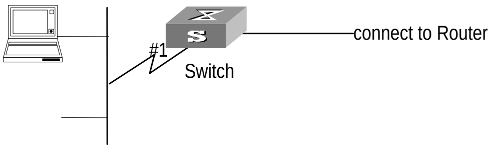
Link ACL Configuration Example

Networking Requirements

Using Link ACL, filter the packet whose source MAC address is 00e0-fc01-0101 and destination MAC address is 00e0-fc01-0303 during the time range 8:00 ~ 18:00 every day. The ACL is activated on GigabitEthernet1/0/50.

Networking Diagram

Figure 90 Access Control Configuration Example



Configuration Procedure

In the following configurations, only the commands related to ACL configurations are listed.

1 Define the time range

Define time range from 8:00 to 18:00.

```
[SW5500]time-range 3Com 8:00 to 18:00 daily
```

2 Define the ACL for the packet whose source MAC address is 00e0-fc01-0101 and destination MAC address is 00e0-fc01-0303.

a Enter the numbered link ACL, number as 4000.

```
[SW5500]acl number 4000
```

b Define the rules for the packet whose source MAC address is 00e0-fc01-0101 and destination MAC address is 00e0-fc01-0303.

```
[SW5500-acl-ethernetframe-4000]rule 1 deny source 00e0-fc01-0101
ffff-ffff-ffff source 00e0-fc01-0303 ffff-ffff-ffff time-range 3Com
```

3 Activate ACL.

Activate the ACL 4000 .

```
[SW5500-GigabitEthernet1/0/50]packet-filter inbound link-group 4000
```

QoS Configuration

Traffic

Traffic refers to all packets passing through a Switch.

Traffic Classification

Traffic classification means identifying the packets with certain characteristics, using the matching rule called classification rule, set by the configuration administrator based on the actual requirements. The rule can be very simple. For example, the traffic with different priorities can be identified according to the ToS field in IP packet header. There are also some complex rules. For example, the information over the integrated link layer (Layer-2), network layer (Layer-3) and transport layer (Layer-4), such as MAC address, IP protocol, source IP address, destination IP address and the port number of application etc can be used for traffic classification. Generally the classification standards are encapsulated in the header of the packets. The packet content is seldom used as the classification standard.

Packet Filter

Packet filter is used to filter traffic. For example, the operation “deny” discards the traffic that is matched with a traffic classification rule, while allowing other traffic to pass through. With the complex traffic classification rules, the Switch enables the filtering of various information carried in Layer 2 traffic to discard the useless, unreliable or doubtful traffic, thereby enhancing the network security.

The two key steps of realizing the frame filtering are as follows.

1. Classify the ingress traffic according to the classification rule;
2. Filter the classified traffic, that is the “deny” operation, the default ACL operation.

Traffic Policing

To deliver better service with the limited network resources, QoS monitors the traffic of the specific user on the ingress, so that it can make a better use of the assigned resource.

Port traffic limit

The port traffic limit is the port-based traffic limit used for limiting the general speed of packet output on the port.

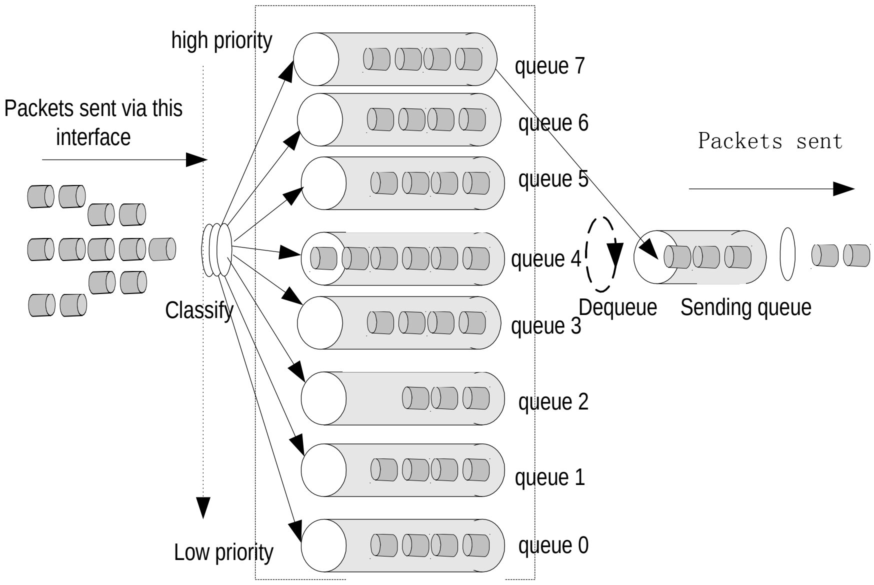
Traffic Priority

The Ethernet Switch can deliver priority tag service for some special packets. The tags include TOS, DSCP and 802.1p which can be used and defined in different QoS modules.

Queue Scheduling

When congestion occurs, several packets will compete for the resources. The queue scheduling algorithms are used to overcome the problem. Here Strict-Priority Queue (SP) queue scheduling algorithm is introduced.

Figure 91 SP



The SP is designed for the key service application. A significant feature of the key service is the need for priority to enjoy the service to reduce the responding delay when congestion occurs. Take 8 egress queues for each port as an example, SP divides the queue of the port into up to 8 kinds, from high-priority queue to low-priority queue (which are shown as the Queue 7, 6, 5, 4, 3, 2, 1 and 0 in turn) with sequentially reduced priority.

During the progress of queue dispatching, strictly following the priority order from high to low, the SP gives preference to and sends the packets in the higher-priority queue first. When the higher-priority queue is empty it will send the packets in the lower-priority group. In this way, put the packets of higher priority service in the higher-priority queue and put the packets of lower priority, like e-mail, in the lower-priority queue, can guarantee the key service packets of higher priority are transmitted first, while the packets of lower service priority are transmitted during the idling gap between transmitting the packets of higher service priorities.

Note that SP has the drawback that when congestion occurs, if there are many packets queuing in the higher-priority queue, it will require a long time to transmit these packets of higher service priority while the messages in the lower-priority queue are continuously set aside without service.

Traffic Mirroring

The traffic mirroring function is carried out by copying the specified data packets to the monitoring port for network diagnosis and troubleshooting.

Traffic Counting

With the flow-based traffic counting, you can request a traffic count to count and analyze the packets.

QoS Configuration

The process of QoS based traffic:

1. Identify the traffic by ACL
2. Perform the QoS operation to the traffic.

The configuration steps of QoS based traffic:

1. Define the ACL
2. Configure the QoS operation

If QoS is not based on traffic, you need not define ACL first.

See "Configuring ACL" for information on how to define ACL. This section mainly describes how to configure QoS operation.

Setting Port Priority

By default, the switch trusts the 802.1p prioiry and forwards a packet into one of the eight CoS queues accordingly. After configuring the port priority, the switch puts the packets into the specific queue associated with the prioirity assigned to the receiving port.

Perform the following configuration in Ethernet Port View.

Table 369 Setting Port Priority

Operation	Command
Set the port priority	**`priority`** *`priority_level`*
Restore the port to priority trust	**`undo priority`**

The Switch port supports eight priority levels. You can configure the port priority to your requirements.

priority-level ranges from 0 to 7.

Configuring the Priority for Protocol Packets

Each protocol packet has its own priority. Users can modify the priority of the protocol packet, and, with the help of relevant QoS commands, perform corresponding QoS operations.

Configuration procedures are as follows:

Table 370 Configure the priority for a protocol packet

Operation	Command	Description
Enter system view	system-view	—
Configure the priority of the protocol packet	**protocol-priority protocol-type** *protocol-type* { **ip-precedence** *ip-precedence* | **dscp** *dscp-value* }	Required. Users can modify the IP priority or DSCP priority of the protocol packet.
Display the priority of a protocol packet.	display protocol-priority	Optional. The **display** command can be used under any view.

To remove the relevant configuration, use the **undo** command.

Currently only packets of OSPF, LNET, MP, and MP can have their priorities modified.

Configuration example for setting priority of a protocol packet

1 Change OSPF protocol packets' IP priority to be 3.Enter system view.

```
<S5500> system-view
[S5500]
```

2 Set OSPF protocol packets' IP priority to be 3.

```
[S5500] protocol-priority protocol-type OSPF ip-precedence 3
```

3 Display the priority of protocol packets.

```
[S5500] display protocol-priority
```

Setting Port Mirroring

Port mirroring means duplicating data on the monitored port to the designated mirror port, for purpose of data analysis and supervision.

The Switch supports one monitor port and one mirroring port. If several Switches form a Fabric, only one monitor port and one mirroring port can be configured in the Fabric.

Configure Port Mirroring

1 Configure monitor port

Perform the following configuration in the Ethernet Port View.

Table 371 Configure Monitor Port

Operation	Command
Configure a monitor port	**`monitor-port`**

Only one monitor port can be configured on one Switch. If a group of Switches form a fabric, only one monitor port can be configured on one fabric.

2 Configure the mirroring port.

Perform the following configuration in the Ethernet Port View.

Table 372 Configure Mirroring Port

Operation	Command
Configure mirroring port	**`mirroring-port { inbound	outbound	both }`**

Delete Port Mirroring

1 Delete mirroring port

Perform the following configuration in the Ethernet Port View.

Table 373 Delete Mirroring Port

Operation	Command
Delete a mirroring port	**`undo mirroring-port { inbound	outbound	both }`**

2 Delete monitor port.

Perform the following configuration in the Ethernet Port View.

Table 374 Delete Monitor Port

Operation	Command
Delete monitor port	**`undo monitor`**

Configuring Traffic Mirroring

The function of traffic mirroring is to copy the traffic matching an ACL rule to the designated observing port to analyze and monitor the packets.

Configure Traffic Mirroring

1 Configure monitor port

Perform the following configuration in the Ethernet Port View.

Table 375 Configure Monitor Port

Operation	Command
Configure a monitor port.	**monitor-port**

Only one monitor port can be configured on one Switch. If a group of Switches form a Fabric, only one monitor port can be configured on one Fabric.

2 Configure traffic mirroring

Perform the following configuration in the Ethernet Port View.

Table 376 Configuring Traffic Mirroring

Operation	Command
Configure traffic mirroring	**mirrored-to { inbound** | **outbound } { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] } { cpu** | **monitor-interface }**

Delete Traffic Mirroring

1 Delete traffic mirroring

Perform the following configuration in the Ethernet Port View.

Table 377 Delete Traffic Mirroring

Operation	Command
Cancel the configuration of traffic mirroring	**undo mirrored-to { user-group** *acl_number* | *acl_name* **[rule** *rule* **]** | **{ ip-group {** *acl_number* | *acl_name* **} [rule** *rule* **]** | **link-group {** *acl_number* | *acl_name* **} [rule** *rule* **] }* }**

2 Delete monitor port.

Perform the following configuration in the Ethernet Port View.

Table 378 Delete Monitor Port

Operation	Command
Delete monitor port	**undo monitor**

For details about the command, refer to the *Command Manual*.

Setting Queue Scheduling

Queue scheduling is commonly used to resolve the problem that multiple messages compete for resource when the network congestion happens. The queue scheduling function puts the packet to the output queue of the port according to the 802.1p priority of the packet. The mapping relationship between 802.1p priority and output queue of the port is as shown in Table 379.

Table 379 Mapping between 802.1p Priority Levels and Outbound Queues

802.1p priority level	Queues
0	2
1	0
2	1
3	3
4	4

802.1p priority level	Queues
5	5
6	6
7	7

Configuring the Mapping Relationship Between COS and Local Precedence

Using the following commands, you can configure the maps.

Perform the following configuration in System View.

Table 380 Map Configuration

Operation	Command
Configure “COS ->Local-precedence” map	**qos cos-local-precedence-map** *cos0_map_local_prec cos1_map_local_prec cos2_map_local_prec cos3_map_local_prec cos4-map-local-prec cos5_map_local-prec cos6_map_local_prec cos7_map_local_prec*
Restore its default value	**undo qos cos-local-precedence-map**

By default, the Switch uses the default mapping relationship.

Configuring the Queue Scheduler.

Perform the following configuration in the Ethernet Port View.

Table 381 Configure the Queue Scheduling Algorithm

Operation	Command
Configure the queue scheduling algorithm	**queue-scheduler { wfq** *queue1_width queue2_width queue3_width queue4_width queue5_width queue6_width queue7_width queue8_width* | **wrr** *queue1_weight queue2_weight queue3_weight queue4_weight queue5_weight queue6_weight queue7_weight queue8_weight* **}**
Restore the default queue scheduling algorithm	**undo queue-scheduler**

The Switch supports three types of queue schedulers, that is, strict-priority, WFQ and WRR.

By default, the Switch uses the WRR algorithm.

For details about the command, refer to the Command Reference Manual.

Setting Traffic Limit

Traffic limit refers to rate limit based on traffic. If the traffic threshold is exceeded, corresponding measures will be taken, for example, dropping the excessive packets or re-defining their priority levels.

Perform the following configurations in the Ethernet Port View.

Table 382 Setting Traffic Limit

Operation	Command
Set traffic limit	**traffic-limit inbound { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }** *target_rate* **[exceed** *action* **]**

Operation	Command
Remove traffic limit	**undo traffic-limit inbound { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl-number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**

You should first define an ACL before this configuration task.

The granularity of traffic limit is 64kbps. If the *target-rate* user input is in (N*64, (N+1)*64], in which N is a natural number, Switch automaticaly sets (N+1)*64 as the parameter value.

This configuration achieves rate control for those packets that match the ACL. If the traffic rate threshold is exceeded, corresponding measures will be taken, for example, dropping excessive packets.

Setting Line Limit

Line limit refers to rate limit based on the port, that is, limiting the total rate at the port. The granularity of line rate is 64 kbps.

Perform the following configurations in the Ethernet Port View.

Table 383 Setting Line Rate

Operation	Command
Set line limit	**line-rate { inbound** | **outbound }** *target_rate*
Remove line limit	**undo line-rate{ inbound** | **outbound }**

Relabeling Priority Level

This configuration re-labels priority level for the packets that match ACL. The new priority label can be put in the priority domain in the header.

Perform the following configurations in the Ethernet Port View.

Table 384 Relabeling Priority Level

Operation	Command
Relabel traffic priority	**traffic-priority { inbound** | **outbound } { user-group** *acl-number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] } { { dscp** *dscp_value* | **ip-precedence {** *pre_value* | **from-cos } }** | **cos {** *pre_value* | **from-ipprec }** | **local-precedence** *pre_value* **}***
Remove the setting	**undo traffic-priority { inbound** | **outbound } { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl-number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**

Configuring Traffic Statistics

The traffic statistics function is used for counting the data packets of the specified traffic, that is, this function counts the transmitted data which matches the ACL rules. After the traffic statistics function is configured, the user can use **display qos-interface traffic-statistic** command to display the statistics information.

You can use the following command to configure traffic statistics.

Perform the following configuration in the Ethernet Port View.

Table 385 Configuring Traffic Statistics

Operation	Command
Configure traffic statistics	**traffic-statistic inbound {** **user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**
Cancel the configuration of traffic statistics	**undo traffic-statistic inbound { user-group** *acl_number* **[rule** *rule* **]** | **ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]]** | **link-group** *acl_number* **[rule** *rule* **] }**
Display the statistics information	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} traffic-statistic**

For details about the command, refer to the Command Reference Manual.

Configuring WRED Operation

The function of WRED Operation is to avoid congestion in advance.

Perform the following configuration in the Ethernet Port View.

Table 386 Configuring WRED Operation

Operation	Command
Configure WRED Operation	**wred** *queue_index qstart probability*
Cancel the configuration of WRED Operation	**undo wred** *queue_index*

For details about the command, refer to the Command Reference Manual.

Configuring Control Over Telnet

Table 387 describes the configuration specifications for control over logged in users.

Table 387 Control over logged in users

Login mode	Control Method	Implementation	Relevant links
Telnet	Control Telnet using source IP	Implement by means of basic ACL	1.9.2 Controlling Telnet using Source IP
	Control Telnet using source IP and destination IP	Implement by means of advanced ACL	1.9.3 Controlling Telnet using Source IP and Destination IP
	Control Telnet using source MAC	Implement by means of Layer 2 ACL	1.9.3 Controlling Telnet using Source MAC

Configuration Preparation

Decide the control policy over Telnet, configuring the source IP, destination IP, and source MAC to control over. Also specify whether the control action is permitting or denying access.

Controlling Telnet using Source IP

This configuration can be implemented by means of basic ACL, which ranges from 2000 to 2999.

Table 388 Control Telnet using source IP

Configuration Procedure	Command	Description
Enter system view	system-view	—

Table 388 Control Telnet using source IP

Configuration Procedure	Command	Description
Create or enter basic ACL view	**acl number** *acl-number* [**match-order** { **config** | **auto** }]	By default, the matching order is **config**.
Define the rule	**rule** [*rule-id*] { **permit** | **deny** } [**source** { *sour-addr sour-wildcard* | **any** }] [**time-range** *time-name*] [**fragment**]	Required.
Exit ACL view	quit	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Reference an ACL, and control Telnet using source IP	**acl** *acl-number* { **inbound** | **outbound** }	Required. **inbound**: Performs ACL control over users Telnetting to the local switch. **outbound**: Performs ACL control over users Telnetting to other switches from the local switch.

Controlling Telnet using Source IP and Destination IP

This configuration can be implemented by means of advanced ACL, which ranges from 3000 to 3999. For the definition of ACL, refer to ACL part.

Table 389 Control Telnet using source IP and destination IP

Configuration Procedure	Command	Description
Enter system view	system-view	—
Create or enter advanced ACL view	**acl number** *acl-number* [**match-order** { **config** | **auto** }]	By default, the matching order is **config**.
Define the rule	**rule** [*rule-id*] { **permit** | **deny** } *protocol* [**source** { *source-addr wildcard* | **any** }] [**destination** { *dest-addr wildcard* | **any** }] [**source-port** *operator port1* [*port2*]] [**destination-port** *operator port1* [*port2*]] [**icmp-type** *type code*] [**established**] [[{ precedence *precedence* **tos** *tos* | **dscp** *dscp* }* | **vpn-instance** *instance*] | **fragment** | **time-range** *name*]*	Required. Users can configure the filtering rules for the related source IP and destination IP based on actual requirements.
Exit ACL view	**quit**	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Refer to ACL, and control Telnet using source IP and destination IP	**acl** *acl-number* { **inbound** | **outbound** }	Required. Inbound: Performs ACL control over users Telnetting from the local switch. outbound: Performs ACL control over users Telnetting to other switches from the local switch.

Controlling Telnet using Source MAC

This configuration can be implemented by means of Layer 2 ACL, which ranges from 4000 to 4999. For the definition of ACL, refer to ACL part.

Table 390 Control Telnet using Source MAC

Configuration Procedure	Command	Description
Enter system view	system-view	—
Create or enter Layer 2 ACL view	**acl number** *acl-number*	—
Define the subset principle	**rule** [*rule-id*] { **permit** | **deny** } [[**type** *protocol-type type-mask* | **lsap** *lsap-type type-mask*] | *format-type* | **cos** *cos* | **source** { *source-vlan-id* | *source-mac-addr source-mac-mask* }* | **dest** { *dest-mac-addr dest-mac-mask* } | **time-range** *name*]*	Required. Users can configure the filtering rules for the related source MAC based on actual requirements.
Exit ACL view	quit	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Reference an ACL, and control Telnet using source MAC	**acl** *acl-number* { **inbound** | **outbound** }	Required. **inbound**: Perform ACL control over users Telnetting to the local switch. **outbound**: Performs ACL control over users Telnetting to other switches from the local switch.

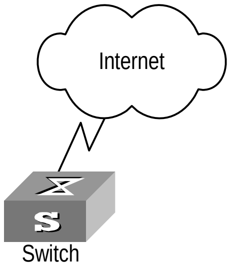
Configuration Example

Network requirements

Only Telnet users from 10.110.100.52 and 10.110.100.46 can access the switch.

Network diagram

Figure 92 Perform ACL control over Telnet users of the switch



Configuration Procedure

1 Define the basic ACL.

```
[S5500] acl number 2000 match-order config
[S5500-acl-basic-2000] rule 1 permit source 10.110.100.52 0
[S5500-acl-basic-2000] rule 2 permit source 10.110.100.46 0
[S5500-acl-basic-2000] rule 3 deny source any
[S5500-acl-basic-2000] quit
```

2 Reference an ACL.

```
[S5500] user-interface vty 0 4
[S5500-ui-vty0-4] acl 2000 inbound
```

Displaying and Debugging QoS Configuration

You can use the **display** command in any view to see the QoS operation and to check the status of the configuration. You can also clear the statistic information using the **reset** command in the Ethernet Interface View.

Table 391 Displaying and Debugging QoS Configuration

Operation	Command
Display mirroring configuration	**display mirror**
Display queue scheduling mode	**display queue-scheduler**
Display line rate for outbound packets	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} line-rate**
Display port QoS configuration	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} all**
Display traffic limit	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} traffic-limit**
Display priority label	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} traffic-priority**
Display the settings of the traffic mirror	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} mirrored-to**
Display the setting of the redirection parameters	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} traffic-redirect**
Display the traffic statistics information	**display qos-interface {** *interface_name* | *interface_type interface_num* | *unit_id* **} traffic-statistic**

QoS Configuration Example

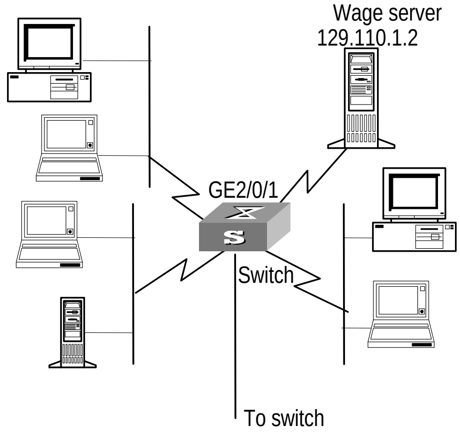
Traffic Limit and Line Rate Configuration Example

Networking Requirement

The intranet is connected through 1000 Mbps ports between departments and the wage server is connected through the port Ethernet1/0/1 (subnet address 129.110.1.2). For the wage server, the inbound traffic is limited at 128 kbps and the inbound port rate at 128 kbps. Those packets exceeding the threshold will be labelled with dscp priority level 4.

Networking Diagram

Figure 93 QoS Configuration Example



Configuration Procedure

Only the commands concerning QoS/ACL configuration are listed here.

1 Define outbound traffic for the wage server.

a Enter numbered advanced ACL view.

```
[SW5500]acl number 3000
```

b Define the traffic-of-payserver rule in the advanced ACL 3000.

```
[SW5500-acl-adv-3000]rule 1 permit ip source 129.110.1.2 0.0.0.0
destination any
```

2 Set traffic limit for the wage server.

a Limit average traffic from the wage server at 128 Kbps and label over-threshold packets with priority level 4.

```
[SW5500-Ethernet1/0/1]traffic-limit inbound ip-group 3000 128 exceed
remark-dscp 4
```

b Limit traffic to the wage server from the port Ethernet1/0/1 at 128 Kbps.

```
[SW5500-Ethernet1/0/1]line-rate outbound 128
```

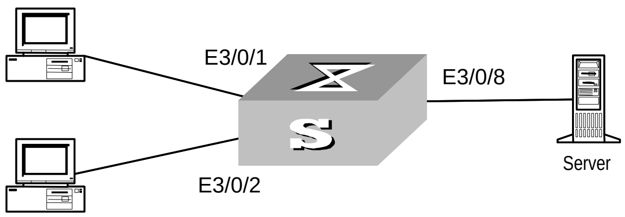
Port Mirroring Configuration Example

Networking Requirement

Use one server to monitor the packets of two PCs. One PC is accessed from the port E1/0/1 and the other from the port E1/0/2. The server is connected to the port E3/0/8. Require monitor the traffic of E3/0/1.

Networking Diagram

Figure 94 QoS Configuration Example



Configuration Procedure

Define port mirroring, with monitoring port being Ethernet3/0/8.

```
[SW5500-Ethernet3/0/8]monitor-port
[SW5500-Ethernet3/0/1]mirroring-port both
```

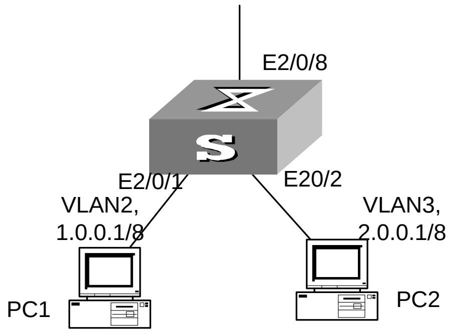
Priority Relabeling Configuration Example

Networking Requirement

In this example, ef labels are appended on packets sent between 8:00 and 18:00 each day from PC1 (IP 1.0.0.2), as priority labelling reference for the upper-layer device.

Networking Diagram

Figure 95 QoS Configuration Example



Configuration Procedure

1 Define the time range.

Define the time range 8:00~18:00.

```
[SW5500]time-range 3Com 8:00 to 18:00 daily
```

2 Define traffic rules for PC packets.

a Enter the number-based basic ACL and select the ACL 2000.

```
[SW5500]acl number 2000
```

b Define traffic classification rules for PC1 packets.

```
[SW5500-acl-basic-2000]rule 0 permit ip source 1.0.0.2 0 time-range
3Com
```

3 Relabel ef priority for PC1 packets.

```
[SW5500-Ethernet1/0/1]traffic-priority inbound ip-group 2000 dscp ef
```

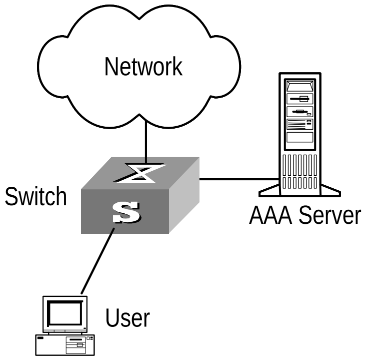
QoS Profile Configuration

When used together with the 802.1x authentication function, the QoS profile function can offer preconfigured QoS settings for a qualified user in authentication (or a group of users).

When the user passes the 802.1x authentication, the Switch delivers the right profile dynamically to the port from which the user is accessed after referring to the mapping between user names and profiles stored on the AAA server.

The QoS profile function can offer packet filtering, traffic policing and preference replacing functions together.

Figure 96 QoS Profile Configuration Environment



QoS profile configuration details:

Table 392 QoS Profile Configuration

Device	Configuration	Default	Description
AAA server	Configure user authentication information	—	—
	Configure mapping between user names and QoS profile	—	Multiple users can correspond to the same QoS profile.
Switch	Enable 802.1x authentication function	—	Refer to the Security part of this manual for detailed configuration.
	Define application mode on the port of QoS profile	Port-based mode	You can change it to user-based mode
	Configure QoS profile, including packet filtering, traffic policing and preference replacing	—	First define an ACL and then configure the QoS function. Refer to the ACL chapter of the QoS/ACL module for defining ACL
	Apply QoS profile to the port	—	You can apply the QoS profile actions to the current port with the right commands.

Configuring QoS Profile

You must first define ACLs for the traffic actions before adding the actions to the QoS profile.

Entering QoS Profile View

To configure the QoS profile, you must first enter QoS profile view.

Perform the following configuration in System View.

Table 393 Entering QoS Profile View

Operation	Command
Enter QoS profile view	**qos-profile** *profile-name*
Delete the QoS profile	**undo qos-profile** *profile-name*

You cannot delete the specific QoS profile which has been applied to the port.

Adding/Removing Traffic Action to a QoS Profile

From the QoS Profile View, you can configure the QoS actions for current QoS profile. The maximum action numbers in one QoS profile is 32.

Perform the following configuration in QoS Profile View.

Table 394 Adding/Removing Traffic Action to QoS Profile

Operation	Command
Add packet filtering action	**packet-filter { inbound | outbound } { user-group** *acl_number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl_number* **[rule** *rule* **] }**
Add traffic policing action	**traffic-limit inbound { user-group** *acl_number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl_number* **[rule** *rule* **] }** *target_rate* **[exceed** *action* **]**
Add preference replacing action	**traffic-priority { inbound | outbound } { user-group** *acl-number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl-number* **[rule** *rule* **] } { { dscp** *dscp_value* **| ip-precedence {** *pre_value* **| from-cos } } | {** *pre_value* **| from-ipprec } | local-precedence** *pre_value* **}***
Remove packet filtering action	**undo packet-filter { inbound | outbound } { user-group** *acl_number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl_number* **[rule** *rule* **] }**
Remove traffic policing action	**undo traffic-limit inbound { user-group** *acl_number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl_number* **[rule** *rule* **] }**
Remove preference replacing action	**undo traffic-priority { inbound | outbound } { user-group** *acl_number* **[rule** *rule* **] | ip-group** *acl_number* **[rule** *rule* **[link-group** *acl_number* **rule** *rule* **]] | link-group** *acl_number* **[rule** *rule* **] }**

You cannot remove the packet filtering, traffic policing or preference replacing action from the QoS profile which has been applied to the port.

Configuring Profile Application Mode

After you configure the QoS profiles and the user passes the authentication, the Switch will deliver the right profile dynamically to the port from which the user is accessed. The QoS profile can be delivered to the port in these different modes:

- User-based mode: If the source station information (source MAC address, source IP address or source MAC address + IP address) has been defined in the ACL which is referenced in the traffic actions, the Switch cannot deliver the QoS profile; if no source station information is available, the Switch generates a new ACL by adding the source MAC address into the existing ACL, and then delivers all traffic actions in the QoS profile to the user port.

- Port-based mode: The Switch delivers the traffic actions in the QoS profile directly to the user port.

Perform the following configuration in Ethernet Port View.

Table 395 Configuring Profile Application Mode

Operation	Command
Configure the user-based mode on the port	**qos-profile user-based**
Restore the default (port-based) mode on the port	**undo qos-profile** *profile_name*

By default, port-based mode is enabled on the port.

Applying QoS Profile to the Port

With this configuration, you can apply all traffic actions in the QoS profile to the current port.

In System View

In System View, you can apply the QoS profile to one or more consecutive ports.

Table 396 Applying QoS Profile to the Port in System View

Operation	Command
Apply the QoS profile to the port	**apply qos-profile** *profile_name* **interface {** *interface_name* | *interface_type interface_num* **} [to interface {** *interface_name* | *interface_type interface_num* **}]**
Remove the configuration	**undo apply qos-profile** *profile_name* **interface {** *interface_name* | *interface_type interface_num* **} [to interface {** *interface_name* | *interface_type interface_num* **}]**

In Ethernet Port View

In Ethernet Port View, you can only apply the QoS profile to the current port.

Table 397 Applying QoS Profile to the Port in Ethernet Port View

Operation	Command
Apply the QoS profile to the port	**apply qos-profile** *profile_name*
Remove the configuration	**undo apply qos-profile** *profile_name*

You cannot delete the specific QoS profile once you apply it to the port.

Displaying and Debugging QoS Profile Configuration

Use the **display** command in any view to check the configuration result of the QoS profile.

Table 398 Displaying QoS Profile Configuration

Operation	Command
Display QoS profile configuration	**display qos-profile { all** | **name** *profile_name* | **interface {** *interface_name* | *interface_type interface_num* **}** | **user** *user_name* **}**

QoS Profile Configuration Example

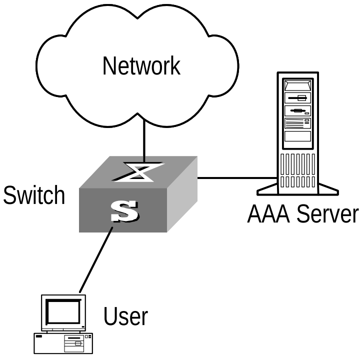
Networking Requirement

The Switch implements the QoS profile function for the accessed user.

The user (with user name **someone** and authentication password **hello**) is accessed from the Ethernet1/0/1 port into the Switch. The user is assigned into the 3com163.net domain. The QoS profile example references the ACL with bandwidth limited to 128 kbps and new DSCP preference value 46.

Network Diagram

Figure 97 Network Diagram for QoS Configuration



Configuration Procedure

1 Configuration on the AAA server

Configure on the AAA server the mapping between QoS profiles and user names/authentication information. The configuration details are omitted here.

2 Configuration on the Switch

a Enable 802.1x

```
[SW5500]dot1x
[SW5500]dot1x interface ethernet 1/0/1
```

b Configure IP address for the RADIUS server

```
[SW5500]radius scheme radius1
[SW5500-radius-radius1]primary authentication 10.11.1.1
[SW5500-radius-radius1]primary accounting 10.11.1.2
[SW5500-radius-radius1]secondary authentication 10.11.1.2
[SW5500-radius-radius1]secondary accounting 10.11.1.1
```

c Configure authentication password on the RADIUS server for the Switch

```
[SW5500-radius-radius1]key authentication name
[SW5500-radius-radius1]key accounting money
```

d Configure the Switch to remove the user domain name from the user name and then to transfer it to the RADIUS server

```
[SW5500-radius-radius1]user-name-format without-domain
[SW5500-radius-radius1]quit
```

e Create the user domain 3com163.net and specify radius1 as the RADIUS server group for the user.

```
[SW5500]domain 3com163.net
[SW5500-isp-3com163.net]radius-scheme radius1
[SW5500-isp-3com163.net]quit
```

f Define the ACL

```
[SW5500]acl number 3000
[SW5500-acl-adv-3000]rule 1 permit ip destination any
[SW5500-acl-adv-3000]quit
```

g Configure the QoS profile

```
[SW5500]qos-profile example
[SW5500-qos-profile-example]traffic-limit inbound ip-group 3000 128
exceed drop
[SW5500-qos-profile-example]traffic-priority inbound ip-group 3000
dscp 46
[SW5500-qos-profile-example]quit
```

h Set user based mode on the Ethernet1/0/1 port

```
[SW5500]interface ethernet1/0/1
[SW5500-Ethernet1/0/1]qos-profile user-based
```

ACL Control Configuration

The Switch supports three major access modes: SNMP (Simple Network Management Protocol) access, Telnet access and HTTP (Hypertext Transfer Protocol) access. Security control is achieved at two levels: Connection request control is achieved at the first level and appropriate ACL configuration ensures that only legal users can be connected to the Switch. Password authentication is achieved at the second level and only those connected, with correct passwords, can log successfully onto the Switch.

In this section only the first level security control, ACL configuration, is detailed. See the Getting Started for the second level control.

Configuring ACL for Telnet Users

This configuration can filter out malicious or illegal connection request before password authentication.

Two steps are included in this configuration:

1 Define an ACL

2 Import the ACL to control Telnet users

Defining ACL

Currently only number-based ACLs can be imported, with the number ranging from 2000 to 3999.

Perform the following configuration in System View.

Table 399 Defining Basic ACL

Operation	Command
Enter basic ACL (System View)	**acl number** *acl_number* **match-order { config | auto }**
Define a sub-rule (Basic ACL View)	**rule [** *rule-id* **] { permit | deny } [source {** *source_addr wildcard* | **any } | fragment | logging | time-range** *name* **]***
Delete a sub-rule (Basic ACL View)	**undo rule** *rule_id* **[source | fragment | logging | time-range]***
Delete an ACL or all ACLs (System View)	**undo acl { number** *acl_number* | **all }**

You can define multiple rules for an ACL by using the `rule` command several times.

Importing ACL

You can import a defined ACL in User Interface View to achieve ACL control.

Perform the following configurations respectively in System View and User Interface View.

Table 400 Importing ACL

Operation	Command
Enter user interface view (System View)	**user-interface [** *type* **]** *first_number* **[** *last_number*]
Import the ACL (User Interface View)	**acl** *acl_number* **{ inbound** | **outbound }**

See the Command Reference Manual for details about these commands.

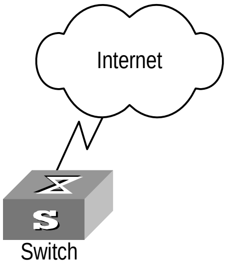
Configuration Example

Networking Requirement

Only the Telnet users from 10.110.100.52 and 10.110.100.46 can access the Switch.

Networking Diagram

Figure 98 ACL configuration for Telnet users



Configuration Procedure

1 Define a basic ACL.

```
[SW5500]acl number 2000 match-order config
[SW5500-acl-basic-2000]rule 1 permit source 10.110.100.52 0
[SW5500-acl-basic-2000]rule 2 permit source 10.110.100.46 0
[SW5500-acl-basic-2000]quit
```

2 Import the ACL.

```
[SW5500]user-interface vty 0 4
[SW5500-ui-vty0-4]acl 2000 inbound
```

Configuring ACL for SNMP Users

The Switch 5500 Family supports remote network management (NM) and the user can use SNMP to access them. Proper ACL configuration can prevent illegal users from logging onto the Switches.

Two steps are included in this configuration:

1 Define an ACL

2 Import the ACL to control SNMP users

Defining ACL

Currently only number-based ACLs can be imported, with the number ranging from 2000 to 2999. See “Defining ACL” on page 353 for detailed configuration.

Importing ACL

Import the defined ACL into the commands with SNMP community, username and group name configured, to achieve ACL control over SNMP users.

Perform the following configurations in System View.

Table 401 Importing ACL

Operation	Command
Import the defined ACL into the commands with SNMP community configured	**snmp-agent community { read | write }** *community_name* **[[mib-view** *view_name* **] | [acl** *acl_number* **]]***
Import the defined ACL into the commands with SNMP group name configured	**snmp-agent group { v1 | v2c }** *group_name* **[read-view** *read_view* **] [write-view** *write_view* **] [notify-view** *notify_view* **] [acl acl-number]**
	snmp-agent group v3 *group_name* **[authentication | privacy] [read-view** *read_view* **] [write-view** *write_view* **] [notify-view** *notify_view* **] [acl** *acl_number* **]**
Import the defined ACL into the commands with SNMP username configured	**snmp-agent usm-user { v1 | v2c }** *user_name group_name* **[acl** *acl_number* **]**
	snmp-agent usm-user v3 *user_name group_name* **[authentication-mode { md5 | sha }** *auth_password* **] [privacy-mode des56** *priv_password* **] [acl** *acl_number* **]**

SNMP community is one of the features of SNMP v1 and SNMP v2, so you import the ACL into the commands with SNMP community configured, for the SNMP V1 and SNMP V2.

SNMP username or group name is one of the features of SNMP V2 and above, therefore you import the ACL into the commands with SNMP username or group name configured, for the SNMP V2 and above. If you import the ACL into both features, the Switch will filter both features for the users.

You can import different ACLs in the three commands listed above.

See the Command Manual for details about these commands.

You can import only the basic ACLs with digit IDs.

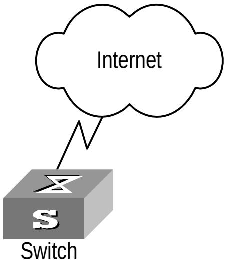
Configuration Example

Networking Requirement

Only SNMP users from 10.110.100.52 and 10.110.100.46 can access the Switch.

Networking Diagram

Figure 99 ACL Configuration for SNMP Users



Configuration Procedure

1 Define a basic ACL.

```
[SW5500]acl number 2000 match-order config
[SW5500-acl-baisc-2000]rule 1 permit source 10.110.100.52 0
[SW5500-acl-baisc-2000]rule 2 permit source 10.110.100.46 0
[SW5500-acl-baisc-2000]quit
```

2 Import the ACL.

```
[SW5500]snmp-agent community read 3Com acl 2000
[SW5500]snmp-agent group v2c 3Comgroup acl 2000
[SW5500]snmp-agent usm-user v2c 3Comuser 3Comgroup acl 2000
```

Configuring ACL Control over the HTTP Users

The Switch 5500 Family supports the remote management through the Web interface. The users can access the Switch through HTTP. Controlling such users with ACL can help filter the illegal users and prevent them from accessing the local Switch. After configuring ACL control over these users, the Switch allows only one Web user to access the Ethernet Switch at one time.

Take the following steps to control the HTTP users with ACL.

1 Defining ACL

2 Calling ACL to control HTTP users

The follow section introduces the configuration procedures.

Defining ACL

You can only call the numbered basic ACL, ranging from 2000 to 2999, to implement ACL control function. Use the same configuration commands introduced in the last section.

Calling ACL to Control HTTP Users

To control the Web network management users with ACL, call the defined ACL.

You can use the following commands to call an ACL. Perform the following configuration in System View.

Table 402 Calling ACL to Control HTTP Users

Operation	Command
Call an ACL to control the WEB NM users.	**ip http acl** *acl_number*
Cancel the ACL control function.	**undo ip http acl**

For more about the commands, refer to the *Command Reference Manual.*

Only the numbered basic ACL can be called for WEB NM user control.

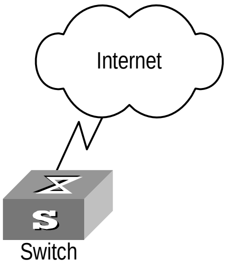
Configuration Example

Networking Requirements

Only permit Web NM user from 10.110.100.46 access Switch.

Networking Diagram

Figure 100 Controlling Web NM users with ACL



Configuration Procedure

1 Define the basic ACL.

```
[SW5500]acl number 2030 match-order config
[SW5500-acl-basic-2030]rule 1 permit source 10.110.100.46 0
[SW5500-acl-basic-2030]quit
```

2 Call the basic ACL.

```
[SW5500]ip http acl 2030
```

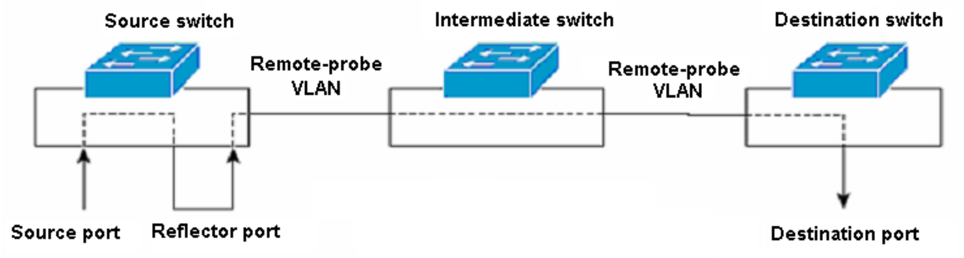
20 CONFIGURATION FOR QOS FEATURES

RSPAN Features

Remote switched port analyzer (RSPAN) refers to remote port mirroring. It breaks through the limitation that the mirrored port and the mirroring port have to be located in the same switch, and makes it possible that the mirrored and mirroring ports be located across several devices in the network, and greatly enhances the way that the network administrator can manage the switch.

The application of RSPAN is illustrated in Figure 101.

Figure 101 RSPAN application



There are three types of switches with the RSPAN enabled.

- Source switch: the switch to which the monitored port belong.
- Intermediate switch: the switches that are between the source and destination switches on the network.
- Destination switch: the switch to which the remote mirroring destination port belong.

Table 403 gives an illustration of how various ports are involved in the mirroring operation.

Table 403 The ports involved in the mirroring

Switch	The ports involved	Function
Source switch	Source port	The port to be mirrored. By means of local port mirroring, the users' data packets can be copied to the reflector port. There could be more than one source port.
	Reflector port	Receive users' data packets that are mirrored on a local port.
	Trunk port	Send the mirrored packets to the intermediate switch or the destination switch.
Intermediate switch	Trunk port	Send the mirrored packets to the destination switch. Two Trunk ports are necessary for the intermediate switch in order to connect with devices from both the source and destination switches.
Destination switch	Trunk port	Receive remote mirrored packets.
	Destination port	Monitor the remote mirrored packets

To implement the remote port management, a special VLAN, called Remote-probe VLAN, needs to be defined in all three types of switches. All the mirrored packets will be forwarded to destination switch from the source switch using this VLAN, and therefore the destination switch can monitor the port packets sent from the source switch.

Remote-probe VLAN has the following characteristics:

- None of the ports in this VLAN should have their PVID (Port VLAN ID) set as Remote-probe VLAN ID.
- All the ports in this VLAN must be Trunk ports, rather than Access ports or Hybrid ports.
- The default VLAN, Management VLAN, Fabric VLAN, and Protocol VLAN cannot be configured as Remote-probe VLAN.
- Remote-probe VLAN cannot have the source ports of remote mirroring.

Configuration Prerequisite

- Specify the source switch, intermediate switch, and the destination switch.
- Specify the source port, the reflector port, the destination port, and the Remote-probe VLAN.
- Specify whether the packets to be monitored are inbound or outbound.
- Intermediate switch and source switch support the function of MAC-learning-disabled-based-on-VLAN, which also is enabled for Remote-probe VLAN.

Configuration Procedures in the Source Switch

Table 404 Configuration procedures in the source switch

Operation	Command	Description
Enter system view	system-view	—
Establish Remote-probe VLAN, and enter VLAN view	**vlan** *vlan-id*	The parameter *vlan-id* represents the ID of the Remote-probe VLAN.
Define the current VLAN as Remote-probe VLAN	remote-probe vlan enable	Required.
Exit the current view	quit	—
Enter the Ethernet port view of Trunk ports	**interface** *interface-type interface-number*	—
Configure Trunk ports so that packets of the Remote-probe VLAN can pass through	**port trunk permit vlan** *remote*-probe-*vlan-id*	Required.
Exit the current view	quit	—
Configure the source group of remote mirroring	**mirroring-group** *group-id* **remote-source**	Required.
Configure the source ports of remote mirroring	**mirroring-group** *group-id* **mirroring-port** *mirroring-port-list* { **both** | **inbound** | **outbound** }	Required.
Configure the reflector ports of remote mirroring	**mirroring-group** *group-id* **reflector-port** *reflector-port*	Required. The reflector ports of remote mirroring cannot enable STP, and have to be Access ports. The reflector ports cannot have the vlan-vpn commands configured.
Configure the remote-probe VLAN for the source group of remote mirroring	**mirroring-group** *group-id* **remote-probe vlan** *remote-probe-vlan-id*	Required.
Display the configuration for the source group of remote mirroring	display mirroring-group remote-source	Optional. The **display** command can be used under any view.

Configuration Procedures in the Intermediate Switch

Table 405 Configuration procedures in the intermediate switch

Operation	Command	Description
Enter system view	system-view	—
Establish remote-probe VLAN, and enter VLAN view	**vlan** *vlan-id*	The parameter *vlan-id* represents the ID of the remote-probe VLAN.
Exit the current view	quit	—
Enter the Ethernet port view of Trunk ports	**interface** *interface-type interface-number*	—
Configure Trunk ports so that packets in the remote-probe VLAN can pass through	**port trunk permit vlan** *remote-probe-vlan-id*	Required. This configuration is necessary for ports of intermediate switch that are connected with the source switch or the destination switch.

Configuration Procedures in the Source Switch

Table 406 Configuration procedures in the source switch

Operation	Command	Description
Enter system view	system-view	—
Establish remote-probe VLAN, and enter VLAN view	**vlan** *vlan-id*	The parameter *vlan-id* represents the ID of the remote-probe VLAN.
Define the current VLAN as remote-probe VLAN.	remote-probe vlan enable	Required.
Exit the current view	quit	—
Enter the Ethernet port view of Trunk ports	**interface** *interface-type interface-number*	—
Configure Trunk ports so that packets in the remote-probe VLAN can pass through	**port trunk permit vlan** *remote*-probe-*vlan-id*	Required.
Exit the current view	quit	—
Configure the destination group of remote mirroring	**mirroring-group** *group-id* **remote-destination**	Required.
Configure the destination ports of remote mirroring	**mirroring-group** *group-id* **monitor-port** *monitor-port*	Required. The destination ports of remote mirroring cannot enable STP. Once a port has been configured as a destination port of remote mirroring, its port type and default VLAN ID can no longer be modified.
Configure the remote-probe VLAN for the destination group of remote mirroring	**mirroring-group** *group-id* **remote-probe vlan** *remote-probe-vlan-id*	Required.
Display the configuration of destination group of remote mirroring	display mirroring-group remote-destination	Optional. The **display** command can be used under any view.

Configuration Example

Network diagram requirements

The network description is as follows:

- Switch A is connected to the data monitoring device using Ethernet1/0/2.
- Ethernet1/0/1, the Trunk port of Switch A, is connected to Ethernet 1/0/1, the Trunk port of Switch B.
- Ethernet1/0/2, the Trunk port of Switch B, is connected to Ethernet 1/0/1, the Trunk port of Switch C.
- Ethernet1/0/2, the port of Switch C, is connected to PC1.

The requirement is to monitor and analyze the packets sent to PC1 using the data monitoring device.

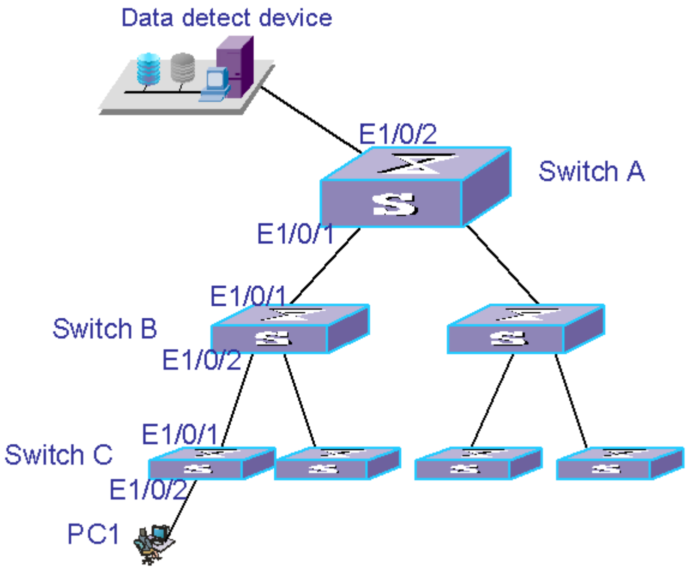
To meet the above requirement using the RSPAN function, perform the following configurations:

- Define VLAN10 as remote-probe VLAN.
- Configure Switch A to be the destination switch, Ethernet1/0/2, the port that connects the data monitoring device, to be the destination port of remote mirroring. Disable the STP function for Ethernet1/0/2.
- Configure Switch B to be the intermediate switch.

- Configure Switch C to be the source switch, Ethernet1/0/2 to be the source port of remote mirroring, and Ethernet1/0/5 to be the reflector port. Set Ethernet1/0/5 to be Access port, with STP disabled.

Network Diagram

Figure 102 Network diagram for RSPAN



Configuration Procedure

1 Configure Switch C.

```
<S5500> system-view
[S5500] vlan 10
[S5500-vlan10] remote-probe vlan enable
[S5500-vlan10] quit
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] port trunk permit vlan 10
[S5500-Ethernet1/0/1] quit
[S5500] mirroring-group 1 remote-source
[S5500] mirroring-group 1 mirroring-port ethernet1/0/2 outbound
[S5500] mirroring-group 1 reflector-port ethernet1/0/5
[S5500] mirroring-group 1 remote-probe vlan 10
[S5500] display mirroring-group remote-source
```

2 Configure Switch B.

```
<S5500> system-view
[S5500] vlan 10
[S5500-vlan10] quit
[S5500] interface ethernet1/0/1
[S5500-Ethernet1/0/1] port trunk permit vlan 10
[S5500-Ethernet1/0/1] quit
[S5500] interface ethernet1/0/2
[S5500-Ethernet1/0/2] port trunk permit vlan 10
```

3 Configure Switch A.

```
<S5500> system-view
[S5500] vlan 10
[S5500-vlan10] remote-probe vlan enable
[S5500-vlan10] quit
[S5500] interface ethernet1/0/1
```

```
[S5500-Ethernet1/0/1] port trunk permit vlan 10
[S5500-Ethernet1/0/1] quit
[S5500] mirroring-group 1 remote-destination
[S5500] mirroring-group 1 monitor-port ethernet1/0/2
[S5500] mirroring-group 1 remote-probe vlan 10
[S5500] display mirroring-group remote-destination
```

Features of Traffic Statistics

Traffic statistics is employed to count data packets within a specified traffic flow. Traffic statistics counts data information in the data packets that match a defined access control list (ACL).

The newly added features of traffic statistics allow the switch to count data packets with their action defined as deny in the ACL rules.

For detailed configuration regarding traffic statistics, refer to the QoS/ACL part of *3Com Switch 5500 Family Operation Manual*.

Improving the Depth First Order of ACL Matching

The depth first order of ACL matching can be configured by selecting auto option while defining the ACL matching order.

The priority sequence is determined based on the following rules:

1. Compare the protocol range of the ACL rules first. The range for IP protocol is 0 to 255 and those of other protocols are the same as their protocol numbers. The smaller the protocol range, the higher the priority.
2. Compare the range of source IP addresses. Those with smaller source IP address range have higher priority.
3. Compare the range of destination IP addresses. Those with smaller destination IP address range have higher priority.
4. Compare the Layer 4 port numbers (the TCP/UDP port numbers). Those with smaller range have higher priority.
5. While all the above checks show the same priority, sort according to the configuration order.

In the new version of the software, improvements have been made based on the above matching order, as illustrated below.

- If rule A is rule B’s proper subset, then rule B has a higher priority.
- If based on the original matching order, rule A and rule B are the same in all the following aspects: the range of their protocols, the range of their source IP address, the range of their destination IP address, and their Layer 4 port numbers, and furthermore, their numbers of other elements to be considered in deciding their priority order are also the same, weighting principles will be used in deciding their priority order.

The weighting principles work as follows:

- Each element is given a fixed weighting value. This weighting value and the value of the element itself will jointly decide the final matching order.
- The weighting value for each element ranks in the following descending order: DSCP, ToS, ICMP, established, VPN-instance, precedence, fragment.

- A fixed weighting value is deducted from the weighting value of each element of the rule. The rule with the smallest weighting value left has the highest priority.
- If the number and type of elements are the same for all rules, then the rule with the smallest sum value of all its elements has the highest priority.

For more ACL configuration, refer to the QoS/ACL part of the *Switch 5500 Series Ethernet Operation Manual*.

Displaying Information of the display acl command

The **display acl** command has included the total number of ACLs as newly added displaying information:

For example:

```
<S5500> display acl all
Total ACL Number: 1
Advanced ACL  3000, 1 rule
Acl's step is 1
 rule 0 permit ip
```

For more information on the **display acl** command, refer to the QoS/ACL part of the *Switch 5500 Series Ethernet Command Manual*.

Subdividing DSCP while Defining ACL Rules

The new version has subdivided the value range of DSCP while defining the ACL rules, as illustrated in Table 407.

Table 407 Detailed information on subdivision of DSCP Priority

Before subdivision	After subdivision	DSCP value(in binary format)	DSCP value(in decimal format)
af1	af11	001010	10
	af12	001100	12
	af13	001110	14
af2	af21	010010	18
	af22	010100	20
	af23	010110	22
af3	af31	011010	26
	af32	011100	28
	af33	011110	30
af4	af41	100010	32
	af42	100100	34
	af43	100110	36

When updating the software, the device automatically converts the fields af1, af2, af3, af4 in the old DSCP configuration into af11, af21, af31, af41 respectively.

For more information on the ACL commands, refer to the QoS/ACL part of the *Switch 5500 Series Ethernet Command Manual*.

The Synchronization Feature of Queue Scheduling for Aggregation Ports

This feature provides the synchronization function of queue scheduling on each individual port of the aggregation port group, as illustrated as follows:

1 The new feature supports the synchronization of queue scheduling within the aggregation port group.

When users modify or delete the queue scheduling mode for a given port under Ethernet port view, if the port belongs to an aggregation port group, then the queue scheduling modes for all the other ports will be modified or deleted; if the port does not belong to any aggregation port group, then only the queue scheduling mode for this port will be modified or deleted.

2 Queue scheduling supports dynamic aggregation.

If the port is in the UP state, and the LACP feature of the port is also enabled, then ports with the same queue scheduling information can be aggregated as a group.

Queue scheduling of ports supports static and manual aggregation.

Users can include those ports with their queue scheduling features configured in a static or manual aggregation group. This operation can be done either on a local device or in an XRN across various devices.

The new feature also supports the use of the **copy** command to copy the queue scheduling configuration.

For more configurations on queue scheduling, refer to the QoS/ACL part of the *Switch 5500 Series Ethernet Operation Manual*. For further information on the **copy** command, refer to *Switch 5500 Series Ethernet Operation Manual*.

Configuring Control Over Telnet

Table 408 describes the configuration specifications for control over logged in users.

Table 408 Control over logged in users

Login mode	Control Method	Implementation	Relevant links
Telnet	Control Telnet using source IP	Implement by means of basic ACL	1.9.2 Controlling Telnet using Source IP
	Control Telnet using source IP and destination IP	Implement by means of advanced ACL	1.9.3 Controlling Telnet using Source IP and Destination IP
	Control Telnet using source MAC	Implement by means of Layer 2 ACL	1.9.3 Controlling Telnet using Source MAC

Configuration Preparation

Decide the control policy over Telnet, configuring the source IP, destination IP, and source MAC to control over. Also specify whether the control action is permitting or denying access.

Controlling Telnet using Source IP

This configuration can be implemented by means of basic ACL, which ranges from 2000 to 2999.

Table 409 Control Telnet using source IP

Configuration Procedure	Command	Description
Enter system view	system-view	—
Create or enter basic ACL view	**acl number** *acl-number* [**match-order** { **config** | **auto** }]	By default, the matching order is **config**.
Define the rule	**rule** [*rule-id*] { **permit** | **deny** } [**source** { *sour-addr sour-wildcard* | **any** }] [**time-range** *time-name*] [**fragment**]	Required.
Exit ACL view	quit	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Reference an ACL, and control Telnet using source IP	**acl** *acl-number* { **inbound** | **outbound** }	Required. **inbound**: Performs ACL control over users Telnetting to the local switch. **outbound**: Performs ACL control over users Telnetting to other switches from the local switch.

Controlling Telnet using Source IP and Destination IP

This configuration can be implemented by means of advanced ACL, which ranges from 3000 to 3999. For the definition of ACL, refer to ACL part.

Table 410 Control Telnet using source IP and destination IP

Configuration Procedure	Command	Description
Enter system view	system-view	—
Create or enter advanced ACL view	**acl number** *acl-number* [**match-order** { **config** | **auto** }]	By default, the matching order is **config**.
Define the rule	**rule** [*rule-id*] { **permit** | **deny** } *protocol* [**source** { *source-addr wildcard* | **any** }] [**destination** { *dest-addr wildcard* | **any** }] [**source-port** *operator port1* [*port2*]] [**destination-port** *operator port1* [*port2*]] [**icmp-type** *type code*] [**established**] [[{ precedence *precedence* **tos** *tos* | **dscp** *dscp* }* | **vpn-instance** *instance*] | **fragment** | **time-range** *name*]*	Required. Users can configure the filtering rules for the related source IP and destination IP based on actual requirements.
Exit ACL view	**quit**	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Refer to ACL, and control Telnet using source IP and destination IP	**acl** *acl-number* { **inbound** | **outbound** }	Required. Inbound: Performs ACL control over users Telnetting from the local switch. outbound: Performs ACL control over users Telnetting to other switches from the local switch.

Controlling Telnet using Source MAC

This configuration can be implemented by means of Layer 2 ACL, which ranges from 4000 to 4999. For the definition of ACL, refer to ACL part.

Table 411 Control Telnet using Source MAC

Configuration Procedure	Command	Description
Enter system view	system-view	—
Create or enter Layer 2 ACL view	**acl number** *acl-number*	—
Define the subset principle	**rule** [*rule-id*] { **permit** | **deny** } [[**type** *protocol-type type-mask* | **lsap** *lsap-type type-mask*] | *format-type* | **cos** *cos* | **source** { *source-vlan-id* | *source-mac-addr source-mac-mask* }* | **dest** { *dest-mac-addr dest-mac-mask* } | **time-range** *name*]*	Required. Users can configure the filtering rules for the related source MAC based on actual requirements.
Exit ACL view	quit	—
Enter user interface view	**user-interface** [*type*] *first-number* [*last-number*]	—
Reference an ACL, and control Telnet using source MAC	**acl** *acl-number* { **inbound** | **outbound** }	Required. **inbound**: Perform ACL control over users Telnetting to the local switch. **outbound**: Performs ACL control over users Telnetting to other switches from the local switch.

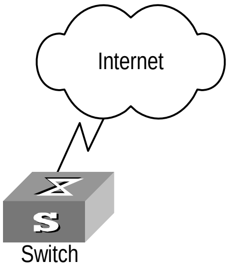
Configuration Example

Network requirements

Only Telnet users from 10.110.100.52 and 10.110.100.46 can access the switch.

Network diagram

Figure 103 Perform ACL control over Telnet users of the switch



Configuration Procedure

1 Define the basic ACL.

```
[S5500] acl number 2000 match-order config
[S5500-acl-basic-2000] rule 1 permit source 10.110.100.52 0
[S5500-acl-basic-2000] rule 2 permit source 10.110.100.46 0
[S5500-acl-basic-2000] rule 3 deny source any
[S5500-acl-basic-2000] quit
```

2 Reference an ACL.

```
[S5500] user-interface vty 0 4
[S5500-ui-vty0-4] acl 2000 inbound
```

21 802.1X CONFIGURATION

This chapter covers the following topics:

- IEEE 802.1x Overview
- Configuring 802.1x
- Centralized MAC Address Authentication
- AAA and RADIUS Protocol Configuration

For information on setting up a RADIUS server and RADIUS client refer to Appendix B.

For details on how to authenticate the Switch5500 with a Cisco Secure ACS server with TACACS+, refer to Appendix C.

IEEE 802.1x Overview

IEEE 802.1x (hereinafter simplified as 802.1x) is a port-based network access control protocol that is used as the standard for LAN user access authentication.

In the LANs complying with the IEEE 802 standards, the user can access the devices and share the resources in the LAN through connecting the LAN access control device like the LAN Switch. However, in telecom access, commercial LAN (a typical example is the LAN in the office building) and mobile office and so on, the LAN providers generally hope to control the user's access. In these cases, the requirement on the above-mentioned “Port Based Network Access Control” originates.

As the name implies, "Port Based Network Access Control" means to authenticate and control all the accessed devices on the port of LAN access control device. If the user's device connected to the port can pass the authentication, the user can access the resources in the LAN. Otherwise, the user cannot access the resources in the LAN. It equals that the user is physically disconnected.

802.1x defines port based network access control protocol and only defines the point-to-point connection between the access device and the access port. The port can be either physical or logical. The typical application environment is as follows: Each physical port of the LAN Switch only connects to one user workstation (based on the physical port) and the wireless LAN access environment defined by the IEEE 802.11 standard (based on the logical port).

802.1x System Architecture

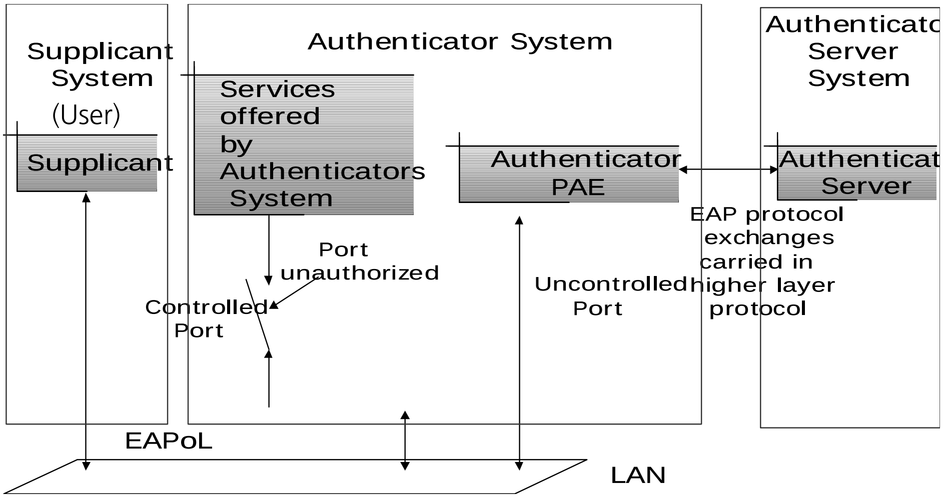
The system using the 802.1x is the typical C/S (Client/Server) system architecture. It contains three entities, which are illustrated in Figure 104: Supplicant System (User), Authenticator System and Authentication Server System.

The LAN access control device needs to provide the Authenticator System of 802.1x. The devices at the user side such as the computers need to be installed with the 802.1x client Supplicant (User) software, for example, the 802.1x client provided by 3Com (or by Microsoft Windows XP). The 802.1x Authentication Server system normally stays in the carrier's AAA center.

Authenticator and Authentication Server exchange information through EAP (Extensible Authentication Protocol) frames. The user and the Authenticator exchange information through the EAPoL (Extensible Authentication Protocol over LANs) frame defined by IEEE 802.1x. Authentication data are encapsulated in the EAP frame, which is to be encapsulated in the packets of other AAA upper layer protocols (for example, RADIUS) so as to go through the complicated network to reach the Authentication Server. Such procedure is called EAP Relay.

There are two types of ports for the Authenticator. One is the Uncontrolled Port, and the other is the Controlled Port. The Uncontrolled Port is always in bi-directional connection state. The user can access and share the network resources any time through the ports. The Controlled Port will be in connecting state only after the user passes the authentication. Then the user is allowed to access the network resources.

Figure 104 802.1x System Architecture



802.1x Authentication Process

802.1x configures EAP frame to carry the authentication information. The Standard defines the following types of EAP frames:

- EAP-Packet: Authentication information frame, used to carry the authentication information.
- EAPoL-Start: Authentication originating frame, actively originated by the user.
- EAPoL-Logoff: Logoff request frame, actively terminating the authenticated state.
- EAPoL-Key: Key information frame, supporting to encrypt the EAP packets.
- EAPoL-Encapsulated-ASF-Alert: Supports the Alerting message of Alert Standard Forum (ASF).

The EAPoL-Start, EAPoL-Logoff and EAPoL-Key only exist between the user and the Authenticator. The EAP-Packet information is re-encapsulated by the Authenticator System and then transmitted to the Authentication Server System. The EAPoL-Encapsulated-ASF-Alert is related to the network management information and terminated by the Authenticator.

Although 802.1x provides user ID authentication, 802.1x itself is not enough to implement the scheme. The administrator of the access device should configure the AAA scheme by selecting RADIUS or local authentication to assist 802.1x to implement the user ID authentication. For detailed description of AAA, refer to the corresponding AAA configuration.

Implementing 802.1x on the Switch

The Switch 5500 Family not only supports the port access authentication method regulated by 802.1x, but also extends and optimizes it in the following way:

- Support to connect several End Stations in the downstream using a physical port.
- The access control (or the user authentication method) can be based on port or MAC address.
- In this way, the system becomes much securer and easier to manage.

Configuring 802.1x

The configuration tasks of 802.1x itself can be fulfilled in System View of the Ethernet switch. When the global 802.1x is not enabled, you can configure the 802.1x state of the port. The configured items will take effect after the global 802.1x is enabled.

When 802.1x is enabled on a port, the maximum number of MAC address learning which is configured by the command **`mac-address max-mac-count`** *cannot be configured on the port, and vice versa.*

The main 802.1x configuration includes:

- Enabling/disabling 802.1x
- Setting the port access control mode
- Setting the port access control method
- Checking the users that log on the Switch using proxy
- Setting the maximum number of users using each port
- Setting the Authentication in DHCP Environment
- Configuring the authentication method for 802.1x user
- Setting the maximum times of authentication request message retransmission
- Configuring timers
- Enabling/disabling a quiet-period timer

Among the above tasks, the first one is compulsory, otherwise 802.1x will not take any effect. The other tasks are optional. You can perform the configurations at requirements.

Enabling/Disabling 802.1x

The following command can be used to enable/disable the 802.1x on the specified port or globally. When it is used in System View ,if the parameter *`interface-list`* is not specified, 802.1x will be globally enabled. If the parameter *`interface-list`* is specified, 802.1x will be enabled on the specified port. When this command is used in Ethernet port view, the parameter *`interface-list`* cannot be input and 802.1x can only be enabled on the current port.

Perform the following configurations in System View or Ethernet Port View.

Table 412 Enabling/Disabling 802.1x

Operation	Command
Enable the 802.1x	**`dot1x [ interface`** *`interface_list`* **`]`**
Disable the 802.1x	**`undo dot1x [ interface`** *`interface_list`* **`]`**

You can configure 802.1x on an individual port before it is enabled globally. The configuration will take effect after 802.1x is enabled globally.

By default, 802.1x authentication has not been enabled globally and on any port.

Setting the Port Access Control Mode

The following commands can be used for setting 802.1x access control mode on the specified port. When no port is specified, the access control mode of all ports is configured.

Perform the following configurations in System View or Ethernet Port View.

Table 413 Setting the Port Access Control Mode.

Operation	Command
Set the port access control mode.	**dot1x port-control { authorized-force | unauthorized-force | auto } [interface** *interface_list* **]**
Restore the default access control mode of the port.	**undo dot1x port-control [interface** *interface_list* **]**

By default, the mode of 802.1x performing access control on the port is **auto** (automatic identification mode, which is also called protocol control mode). That is, the initial state of the port is unauthorized. It only permits EAPoL packets receiving/transmitting and does not permit the user to access the network resources. If the authentication flow is passed, the port will be switched to the authorized state and permit the user to access the network resources. This is the most common case.

Setting the Port Access Control Method

The following commands are used for setting 802.1x access control method on the specified port. When no port is specified in System View, the access control method of the port is configured globally.

Perform the following configurations in System View or Ethernet Port View.

Table 414 Setting the Port Access Control Method

Operation	Command
Set port access control method	**dot1x port-method { macbased | portbased } [interface** *interface_list* **]**
Restore the default port access control method	**undo dot1x port-method [interface** *interface_list* **]**

By default, 802.1x authentication method on the port is **macbased**. That is, authentication is performed based on MAC addresses.

Checking the Users that Log on the Switch using Proxy

The following commands are used for checking the users that log on the Switch using proxy.

Perform the following configurations in System View or Ethernet Port View.

Table 415 Checking the Users that Log on the Switch using Proxy

Operation	Command
Enable the check for access users using proxy	**dot1x supp-proxy-check { logoff | trap } [interface** *interface_list* **]**
Cancel the check for access users using proxy	**undo dot1x supp-proxy-check { logoff | trap } [interface** *interface_list* **]**

These commands can be used to check on the specified interface when executed in system view. The parameter *interface-list* cannot be input when the command is executed in Ethernet Port view and it has effect only on the current interface. After globally enabling proxy user detection and control in system view, only if you enable this feature on a specific port can this configuration take effect on the port.

Setting the User Number on a Port

The following commands are used for setting the number of users allowed by 802.1x on a specified port. When no port is specified, all the ports accept the same number of users.

Perform the following configurations in System View or Ethernet Port View.

Table 416 Setting the Maximum Number of Users using a Specified Port

Operation	Command
Set maximum number of users using specified port	**dot1x max-user** *user_number* **[interface** *interface_list* **]**
Restore the maximum number of users on the port to the default value	**undo dot1x max-user [interface** *interface_list* **]**

By default, 802.1x allows up to 256 users on each port for Series 5500 Switches.

Setting the Authentication in DHCP Environment

If in a DHCP environment the users configure static IP addresses, you can set 802.1x to disable the Switch to trigger the user ID authentication over them with the following command.

Perform the following configurations in System View.

Table 417 Setting the Authentication in DHCP Environment

Operation	Command
Disable the switch to trigger the user ID authentication over the users who configure static IP addresses in DHCP environment	**dot1x dhcp-launch**
Enable the switch to trigger the authentication over them	**undo dot1x dhcp-launch**

By default, the Switch can trigger the user ID authentication over the users who configure static IP addresses in DHCP environment.

Configuring the Authentication Method for 802.1x User

The following commands can be used to configure the authentication method for 802.1x user. Three methods are available: PAP authentication (the RADIUS server must support PAP authentication), CHAP authentication (the RADIUS server must support CHAP authentication), EAP relay authentication (the Switch sends authentication information to the RADIUS server in the form of EAP packets directly and the RADIUS server must support EAP authentication).

Perform the following configurations in System View.

Table 418 Configuring the Authentication Method for 802.1x User

Operation	Command
Configure authentication method for 802.1x user	**dot1x authentication-method { chap** | **pap** | **eap md5-challenge}**
Restore the default authentication method for 802.1x user	**undo dot1x authentication-method**

By default, CHAP authentication is used for 802.1x user authentication.

802.1x PEAP Configuration

Protected extensible authentication protocol (PEAP) authenticates supplicant systems in a securer way. With PEAP employed, a security channel is created, which is encrypted and is protected using transport level security (TLS) to ensure integrity. And authentication is carried out through a new type of EAP (extensible authentication protocol) negotiation between supplicant systems and authentication servers.

The EAP-TLS mode authenticates supplicant systems by authenticating licenses of both authentication servers and supplicant systems on both sides. In this mode, supplicant systems are authenticated by their licenses only, which are applied for from authentication servers. User name and password are not needed. Before the course of authentication, a supplicant system and the authentication server negotiate with each other by invoking TLS mechanism to obtain the way to encrypt session and then verify the licenses of each other in the way just negotiated.

EAP-TTLS is an extension of EAP-TLS. It extends the two-way authentication of supplicant system and authentication server implemented in EAP-TLS and uses security channels created by TLS to transport information.

In EAP-TTLS, the authentication procedure includes two steps:

1. The supplicant system authenticates the server by verifying the license of the server, and creates an encrypted TLS channel in EAP-TTLS mode.
2. The supplicant system is authenticated by way of the created TLS channel in the way negotiated by the supplicant system and the authentication server. The supplicant system transmits its authentication information transparently through the TLS channel to the TTLS server, which in turn extracts the authentication information and delivers it to the AAA server to accomplish the authentication.

As the four authentication modes, that is, PEAP, EAP-TLS, EAP-TTLS, and EAP-MD5, are all EAP authentication mode for a switch, you can perform the operations listed in Table 419 to specify any one of the four authentication modes. The actual authentication mode adopted depends on the authentication mode configured on the supplicant system.

Configuring 802.1x EAP Authentication

Table 419 Configure 802.1x EAP authentication

Operation	Command	Description
Enter system view	system-view	
Configure to authenticate supplicant systems by using EAP	**dot1x authentication-method eap**	Required By default, supplicant systems are authenticated by using CHAP (challenge handshake authentication protocol).
Enter Ethernet port view (supplicant system side)	**interface** *interface-type interface-number*	
Configure the port to operate in MAC address-based authentication mode	dot1x port-method macbased	Optional By default, an Ethernet port operates in MAC address-based authentication mode. When using EAP to authenticate supplicant systems, make sure the related ports operate in MAC address-based authentication mode.

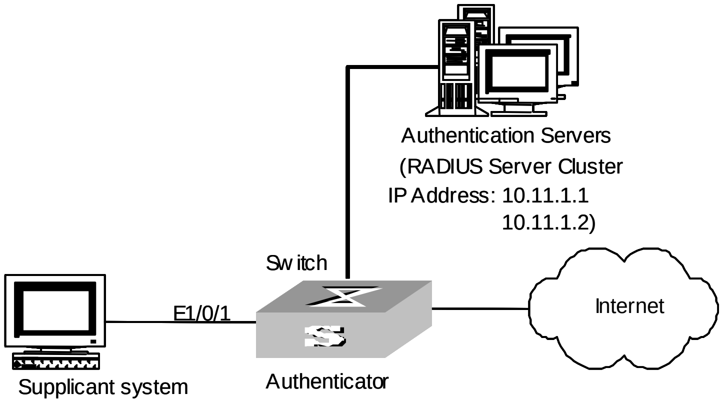
802.1x PEAP Configuration Example

Network requirements

- A supplicant system is connected to Ethernet1/0/1 port of a switch.
- Control the accesses to the Internet by authenticating supplicant systems on each port of the switch using PEAP. The ports operate in MAC address-based authentication mode.

Network diagram

Figure 105 Network diagram for 802.1x PEAP configuration



Configuration procedure

The following configurations assume that PEAP is selected on 802.1x clients and the RADIUS server to authenticate 802.1x supplicant systems.

Configure the switch.

1 Enter system view.

```
<S5500> system-view
```

2 Enable 802.1x globally.

```
[S5500] dot1x
```

3 Enable 802.1x for Ethernet1/0/1 port.

```
[S5500] dot1x interface ethernet 1/0/1
```

4 Configure to use 802.1x PEAP to authenticate supplicant systems.

```
[S5500] dot1x authentication-method eap
```

5 Enter Ethernet1/0/1 port view.

```
[S5500] interface ethernet 1/0/1
```

6 Configure the port to operate in MAC address-based authentication mode. (By default, a port operates in MAC address-based authentication mode.)

```
[S5500] dot1x port-method macbased
```

Setting the Maximum Times of Authentication Request Message Retransmission

The following commands are used for setting the maximum retransmission times of the authentication request message that the Switch sends to the user.

Perform the following configurations in System View.

Table 420 Setting the Maximum Times of the Authentication Request Message Retransmission

Operation	Command
Set the maximum times of the authentication request message retransmission	**dot1x retry** *max_retry_value*
Restore the default maximum retransmission times	**undo dot1x retry**

By default, the *max-retry-value* is 3. That is, the Switch can retransmit the authentication request message to a user for a maximum of 3 times.

Configuring Timers

The following commands are used for configuring the 802.1x timers.

Perform the following configurations in System View.

Table 421 Configuring Timers

Operation	Command
Configure timers	**dot1x timer { { handshake-period** *handshake-period-value* | **quiet-period** *quiet_period_value* | **tx-period** *tx_period_value* | **supp-timeout** *supp_timeout_value* | **server-timeout** *server_timeout_value* **}**
Restore default settings of the timers	**undo dot1x timer { handshake-period** | **quiet-period** | **tx-period** | **supp-timeout** | **server-timeout }**

handshake-period: This timer begins after the user has passed the authentication. After setting handshake-period, system will send the handshake packet by the period. Suppose the dot1x retry time is configured as N, the system will consider the user having logged off and set the user as logoff state if system doesn't receive the response from user for consecutive N times.

handshake-period-value: Handshake period. The value ranges from 1 to 1024 in units of second and defaults to 15.

quiet-period: Specify the quiet timer. If an 802.1x user has not passed the authentication, the Authenticator will keep quiet for a while (which is specified by **quiet-period** timer) before launching the authentication again. During the quiet period, the Authenticator does not do anything related to 802.1x authentication.

quiet-period-value: Specify how long the quiet period is. The value ranges from 10 to 120 in units of second and defaults to 60.

server-timeout: Specify the timeout timer of an Authentication Server. If an Authentication Server has not responded before the specified period expires, the Authenticator will resend the authentication request.

server-timeout-value: Specify how long the duration of a timeout timer of an Authentication Server is. The value ranges from 100 to 300 in units of second and defaults to 100.

supp-timeout: Specify the authentication timeout timer of a user. After the Authenticator sends a Request/Challenge request packet to request the MD5 encrypted text, the supp-timeout timer of the Authenticator begins to run. If the user does not respond back successfully within the time range set by this timer, the Authenticator will resend the above packet.

supp-timeout-value: Specify how long the duration of an authentication timeout timer of a user is. The value ranges from 10 to 120 in units of second, and defaults to 30.

tx-period: Specify the transmission timeout timer. After the Authenticator sends a Request/Identity request packet which requests the user name, or the user name and password together the tx-period timer of the Authenticator begins to run. If the user does not respond back successfully with an authentication reply packet, then the Authenticator will resend the authentication request packet.

tx-period-value: Specify how long the duration of the transmission timeout timer is. The value ranges from 10 to 120 in units of second, and defaults to 30.

Enabling/Disabling a Quiet-Period Timer

You can use the following commands to enable/disable a quiet-period timer of an Authenticator (which can be a Switch 5500). If an 802.1x user has not passed the authentication, the Authenticator will keep quiet for a while (which is specified by `dot1x timer quiet-period` command) before launching the authentication again. During the quiet period, the Authenticator does not do anything related to 802.1x authentication.

Perform the following configuration in System View.

Table 422 Enabling/Disabling a Quiet-Period Timer

Operation	Command
Enable a quiet-period timer	`dot1x quiet-period`
Disable a quiet-period timer	`undo dot1x quiet-period`

By default, the quiet-period timer is disabled.

802.1x Client Version Checking Configuration

With the 802.1x client version checking function enabled on a switch, the switch checks the version and validity of the 802.1x client running on supplicant systems to prevent those that use earlier versions of 802.1x client or illegal clients from logging in. The following are configurations concerning the 802.1x client version checking function.

- Enabling the 802.1x Client Version Checking Function
- Configuring the Maximum Number of Retires to Send Version Checking Request Packets
- Configuring the Version Checking Timer

Enabling the 802.1x Client Version Checking Function

Table 423 Enable the 802.1x client version checking function

Operation	Command	Description
Enter system view	system-view	—
Enable the 802.1x client version checking function	**dot1x version-check** [**interface** *interface-list*]	Required By default, 802.1x client version checking is disabled.

*As for the **dot1x version-check** command, if you execute it in system view without specifying the interface-list argument, the command applies to all ports. Otherwise, the command applies to the specified ports.*

*You can also execute the **dot1x version-check** command in Ethernet port view. In this case, the interface-list argument is unnecessary and the command applies to the current port only.*

Configuring the Maximum Number of Retires to Send Version Checking Request Packets

After sending a version request packet to a supplicant system, a switch sends another one to the supplicant system if it does not receive the response from the supplicant system for the period set by the version checking timer. It continues to send version request packets to the supplicant system if it still does not receive the response from the supplicant system. Such a process goes on and on until the maximum number of retries is reached. If the maximum number of retries is reached and the supplicant system still does not respond, the switch ceases checking the client version of the supplicant system and continues the followed authentication procedures.

Table 424 Configure the maximum number of retires to send version checking request packets

Operation	Command	Description
Enter system view	system-view	—
Configure the maximum number of retires to send version checking request packets	**dot1x retry-version-max** *max-retry-version-value*	Optional By default, the maximum number of retires to send version checking request packets is 3.

Configuring the Version Checking Timer

Table 425 Configure the version checking timer

Operation	Command	Description
Enter system view	system-view	—
Configure the version checking timer	**dot1x timer ver-period** *ver-period-value*	Optional By default, the version checking timer is set to 30 seconds.

It is recommended that you adopt the default version checking timer setting.

802.1x Client Version Checking Configuration Example

Network requirements

- The 802.1x client version checking function is enabled on all ports.
- Configure the maximum number of retires to send version checking request packets to be 6.
- Set the version checking timer to 5 seconds.

Configuration procedures

1 Enter system view.

```
<S5500> system-view
```

2 Enable the 802.1x client version checking function on all ports.

```
[S5500] dot1x version-check
```

3 Configure the maximum number of retires to send version checking request packets to be 6.

```
[S5500] dot1x retry-version-max 6
```

4 Set the version checking timer to 5 seconds.

```
[S5500] dot1x timer ver-period 5
```

Guest VLAN Configuration

The Guest VLAN function enables supplicant systems that are not authenticated to access specific resources and thus perform the corresponding operations, such as obtaining 802.1x client, upgrading client, or obtaining other upgrading programs.

With the Guest VLAN function enabled, supplicant systems that do not have 802.1x client installed can access specific network resources. And those that have 802.1x client installed can upgrade their 802.1x clients without being authenticated.

When the Guest VLAN function is enabled:

- The switch broadcasts active authentication packets to all 802.1x-enabled ports.
- The switch adds the ports that do not return response packets to Guest VLAN When the maximum number of authentication retries is reached.
- Users belonging to the Guest VLAN can access the resources of the Guest VLAN without being authenticated. But they need to be authenticated before accessing external resources.

Prerequisites

- The ports operate in port-based authentication mode.
- The VLAN specified to be the Guest VLAN already exists.

Guest VLAN Configuration

Configuring Guest VLAN in system view

Table 426 Configure Guest VLAN in system view

Operation	Command	Description
Enter system view	system-view	—
Configure Guest VLAN for specified ports	**dot1x guest-vlan** *vlan-id* [**interface** *interface-list*]	Required This operation applies to all ports of the switch if you do not provide the *interface-list* argument. And if you specify the *interface-list* argument, the operation applies to the specified Ethernet ports.

Configure Guest VLAN in Ethernet port view

Table 427 Configure Guest VLAN in Ethernet port view

Operation	Command	Description
Enter system view	system-view	—
Enter Ethernet port view	**interface** *interface-type interface-num*	—
Configure Guest VLAN for the port	**dot1x guest-vlan** *vlan-id*	Required This operation configures Guest VLAN for the current port only.

The Guest VLAN function is available only when the switch operates in the port-based authentication mode.

Only one Guest VLAN can be configured for a switch.

Supplicant systems that are not authenticated, fail to pass the authentication, or are offline belong to Guest VLANs.

Guest VLAN Configuration Example

Network requirements

- Create VLAN 2.
- Configure Ethernet1/0/1 port to operate in port-based authentication mode.
- Configure Guest VLAN for Ethernet1/0/1 port.

Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Create VLAN 2.

```
[S5500] vlan 2
```

3 Enter Ethernet1/0/1 port view.

```
[S5500] interface ethernet1/0/1
```

4 Configure the port to operate in port-based authentication mode.

```
[S5500-Ethernet1/0/1] dot1x port-method portbased
```

5 Configure Guest VLAN for the port.

```
[S5500-Ethernet1/0/1] dot1x guest-vlan 2
```

The 802.1x Trusted MAC Address Synchronization Function

Trusted MAC address here refers to the MAC address of a supplicant system that passes 802.1x authentication and MAC address-based authentication. In this case, the MAC address becomes a trusted Mac address. The 802.1x trusted MAC Address synchronization function propagates the trusted MAC addresses in IRF (intelligent resilient framework) if the corresponding supplicant systems pass the authentication performed by IRF-enabled switches.

- In an IRF that does not support the 802.1x trusted MAC address synchronization function, an authentication operation is only performed in the unit where the port with the supplicant system attached resides in. And after the supplicant system passes the authentication, its MAC address is not propagated to other units (That is, the MAC address can only be recognized by the unit the supplicant system directly connected to.) This may result in broadcast storms in the fabric.
- In an IRF that supports the 802.1x trusted MAC address synchronization function, the MAC address of an authenticated supplicant system is propagated in all units of the fabric. And when the supplicant system logs off, all the units in the fabric remove the corresponding MAC address. That is, trusted MAC addresses are synchronized in all units whenever supplicant systems join in or leave a fabric.

802.1x Supplicant System Checking

When accompanied by a CAMS server, a Switch 5500 can check for:

- Supplicant systems logging in through proxies
- Supplicant systems logging in through IE proxies
- Whether or not a supplicant system logs in with more than one network adapters installed in it being active

A Switch 5500 can optionally take the following measures against any of the three cases:

- Disconnecting the supplicant system and sending Trap packets (This can be achieved by using the **dot1x supp-proxy-check logoff** command.)
- Sending Trap packets without disconnecting the supplicant system (This can be achieved by using the **dot1x supp-proxy-check trap** command.)

To achieve this function, following are to meet for 802.1x clients and CAMS.

- The 802.1x clients are capable of detecting multiple network adapters, proxies, and IE proxies.

- CAMS is configured to disable use of multiple network adapters, proxies, or IE proxies.

By default, an 802.1x client allows the use of multiple network adapters, proxies, and IE proxies. If CAMS is configured to disable the use of multiple network adapters, proxies, or IE proxies, it prompts the 802.1x client to disable use of multiple network adapters, proxies, or IE proxies through messages after the supplicant system passes the authentication.

This function needs the support of 3Com's 802.1x client.

*As for the proxy detecting function, you need to enable this function on both the 802.1x client and CAMS. You need also to enable client version detecting on the switch (refer to the **dot1x version-check** command for more).*

Displaying and Debugging 802.1x

After the above configuration, execute **display** command in any view to display the running of the VLAN configuration, and to verify the effect of the configuration. Execute **reset** command in User View to reset 802.1x statistics. Execute **debugging** command in User View to debug 802.1x.

Table 428 Displaying and Debugging 802.1x

Operation	Command
Display the configuration, running and statistics information of 802.1x	**display dot1x [sessions | statistics] [interface** *interface_list* **]**
Reset the 802.1x statistics information	**reset dot1x statistics [interface** *interface_list* **]**
Enable the error/event/packet/all debugging of 802.1x	**debugging dot1x { error | event | packet | all }**
Disable the error/event/packet/all debugging of 802.1x.	**undo debugging dot1x { error | event | packet | all }**

Auto QoS

Auto QoS uses the Filter-ID standard RADIUS attribute.

Table 429 Auto QoS

Auto QoS	Return String	Comment
`Filter-id`	student	QoS profile name

802.1x Configuration Example

Networking Requirements

As shown in the Figure 106, the workstation of a user is connected to the port Ethernet 1/0/1 of the Switch.

The switch administrator will enable 802.1x on all the ports to authenticate the users so as to control their access to the Internet. The access control mode is configured as based on the MAC address

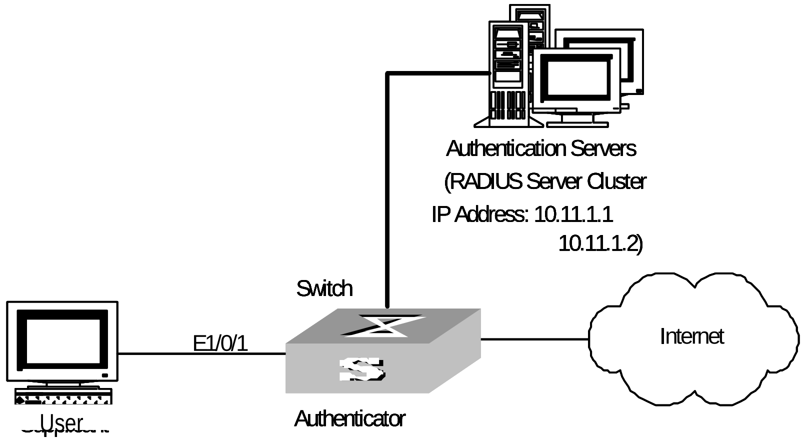
All the users belong to the default domain `3com163.net`, which can contain up to 30 users. RADIUS authentication is performed first. If there is no response from the RADIUS server, local authentication will be performed. For accounting, if the RADIUS server fails to account, the user will be disconnected. In addition, when the user is accessed, the domain name does not follow the user name. Normally, if the user's traffic is less than 2 kbps consistently over 20 minutes, they will be disconnected.

A server group, consisting of two RADIUS servers at 10.11.1.1 and 10.11.1.2 respectively, is connected to the switch. The former one acts as the primary-authentication/second-accounting server. The latter one acts as the secondary-authentication/primary-accounting server. Set the encryption key as "name" when the system exchanges packets with the authentication RADIUS server and "money" when the system exchanges packets with the accounting RADIUS server. Configure the system to retransmit packets to the RADIUS server if no response is received within 5 seconds. Retransmit the packet no more than 5 times in all. Configure the system to transmit a real-time accounting packet to the RADIUS server every 15 minutes. The system is instructed to transmit the user name to the RADIUS server after removing the user domain name.

The user name of the local 802.1x access user is `localuser` and the password is `localpass` (input in plain text). The idle cut function is enabled.

Networking Diagram

Figure 106 Enabling 802.1x and RADIUS to Perform AAA on the User



Configuration Procedure

The following examples concern most of the AAA/RADIUS configuration commands. For details, refer to the chapter AAA and RADIUS Protocol Configuration.

The configurations of accessing user workstation and the RADIUS server are omitted.

1 Enable the 802.1x performance on the specified port Ethernet 1/0/1.

```
[SW5500]dot1x interface Ethernet 1/0/1
```

2 Set the access control mode. (This command could not be configured, when it is configured as MAC-based by default.)

```
[SW5500]dot1x port-method macbased interface Ethernet 1/0/1
```

3 Create the RADIUS scheme radius1 and enters its view.

```
[SW5500]radius scheme radius1
```

4 Set IP address of the primary authentication/accounting RADIUS servers.

```
[SW5500-radius-radius1]primary authentication 10.11.1.1
[SW5500-radius-radius1]primary accounting 10.11.1.2
```

5 Set the IP address of the second authentication/accounting RADIUS servers.

```
[SW5500-radius-radius1]secondary authentication 10.11.1.2
[SW5500-radius-radius1]secondary accounting 10.11.1.1
```

6 Set the encryption key when the system exchanges packets with the authentication RADIUS server.

```
[SW5500-radius-radius1]key authentication name
```

7 Set the encryption key when the system exchanges packets with the accounting RADIUS server.

```
[SW5500-radius-radius1]key accounting money
```

8 Set the timeouts and times for the system to retransmit packets to the RADIUS server.

```
[SW5500-radius-radius1]timer 5
[SW5500-radius-radius1]retry 5
```

9 Set the interval for the system to transmit real-time accounting packets to the RADIUS server.

```
[SW5500-radius-radius1]timer realtime-accounting 15
```

10 Configure the system to transmit the user name to the RADIUS server after removing the domain name.

```
[SW5500-radius-radius1]user-name-format without-domain
[SW5500-radius-radius1]quit
```

11 Create the user domain 3com163.net and enters isp configuration mode.

```
[SW5500]domain 3com163.net
```

12 Specify radius1 as the RADIUS scheme for the users in the domain 3com163.net.

```
[SW5500-isp-3com163.net]scheme radius-scheme radius1 local
```

13 Set a limit of 30 users to the domain 3com163.net.

```
[SW5500-isp-3com163.net]access-limit enable 30
```

14 Enable idle cut function for the user and set the idle cut parameter in the domain 3com163.net.

```
[SW5500-isp-3com163.net]idle-cut enable 20 2000
```

15 Add a local user and sets its parameter.

```
[SW5500]local-user localuser
[SW5500-luser-localuser]service-type lan-access
[SW5500-luser-localuser]password simple localpass
```

16 Enable the 802.1x globally.

```
[SW5500]dot1x
```

Centralized MAC Address Authentication

Centralized MAC address authentication is a type of authentication method that controls the user network access rights using the port and MAC address. It requires no client software for the user and uses the user's MAC address as the user name and password. The authentication to the user initiates after the Switch detects the user's MAC address for the first time.

The Switch 5500-EI supports local and RADIUS MAC address authentication. When it functions as the RADIUS client and works with the RADIUS server to finish the MAC address authentication, it sends the detected user MAC address used as the user name and password to the RADIUS server and the rest processing is the same to 802.1x. After passing the authentication conducted by the RADIUS server, the user then can access the network.

Centralized MAC Address Authentication Configuration

Centralized MAC address authentication configuration includes:

- Enabling MAC address authentication both globally and on the port
- Configuring domain name used by the MAC address authentication user
- Configuring centralized MAC address authentication timers

***CAUTION:** Note the following two items in local authentication:*

- The MAC address which is used as local user name and password must be in the "HHH" format and exclude hyphens.
- The service type of local user must be set to lan-access.

Enabling MAC Address Authentication Both Globally and On the Port

You can use the following commands to enable/disable the centralized MAC address authentication on the specified port; if you do not specify the port, the feature is enabled globally.

Perform the following configuration in System View or Ethernet Port View.

Table 430 Enabling/Disabling Centralized MAC Address Authentication

Operation	Command
Enable centralized MAC address authentication	**`mac-authentication [ interface`** *`interface_list`* **`]`**
Disable centralized MAC address authentication	**`undo mac-authentication [ interface`** *`interface_list`* **`]`**

You can configure the centralized MAC address authentication status on the ports first. However, the configuration does not function on each port until the feature has been enabled globally.

Centralized MAC address authentication and 802.1x cannot be used on the same port together.

By default, the centralized MAC address authentication feature is disabled both on each port and globally.

Configuring Centralized MAC Address Authentication Mode

Table 431 lists the operations to configure centralized MAC address authentication mode.

Table 431 Configure centralized MAC address authentication mode

Operation	Command	Description
Enter system view	system-view	
Configure centralized MAC address authentication mode	**mac-authentication authmode** { **usernameasmacaddress** | **usernamefixed** }	Optional By default, the authentication mode is MAC address mode.

Configuring the User Name and Password for Fixed Mode

If you configure the centralized MAC address authentication mode to be fixed mode, you need to configure the user name and password for fixed mode.

Table 432 Configure the user name and password for fixed mode

Operation	Command	Description
Enter system view	system-view	—
Configure a user name for fixed mode	**mac-authentication authusername** *username*	Optional By default, the user name is mac and the password is not required.
Configure the password for fixed mode	**mac-authentication authpassword** *password*	Required

Configuring Domain Name Used by the MAC Address Authentication User

You can use the following commands to configure the ISP domain used by the centralized MAC address authentication user.

Perform the following configuration in System View.

Table 433 Configuring the ISP Domain used by the Centralized MAC Address Authentication User

Operation	Command
Configure the ISP domain used by the centralized MAC address authentication user	`mac-authentication domain` *`isp_name`*
Return to the defaults	`undo mac-authentication domain`

By default, the domain used by the centralized MAC address authentication user is null, that is, not configured.

Configuring Centralized MAC Address Authentication Timers

Centralized MAC address authentication timers include:

Offline-detect: Sets the time interval for the Switch to detect whether the user is offline. When the Switch detects that the user is offline, it notifies the RADIUS server immediately, and the server stops charging the user from that address.

Quiet: If the authentication to the user fails, the Switch needs a period of quiet time (set by the quiet timer) before it re-authenticates. The Switch does not authenticate during the quiet time.

Server-timeout: During the authentication to the user, if the connection between the Switch and the RADIUS server times out, the Switch denies the user's access to the network on corresponding ports.

Perform the following configuration in System View.

Table 434 Configuring Centralized MAC Address Authentication Timers

Operation	Command
Configure centralized MAC address authentication timers	`mac-authentication timer { offline-detect offline_detect_value	quiet quiet_value	server-timeout server_timeout_value }`
Return to the defaults	`undo mac-authentication timer { offline-detect	quiet	server-timeout }`

By default, the offline-detect time is 300 seconds; quiet time is 60 seconds; and the server-timeout time is 100 seconds.

Displaying and Debugging Centralized MAC Address Authentication

After the above configuration, perform the **display** command in any view, you can view the centralized MAC address authentication running state and check the configuration result. Perform the **debugging** command in User View, you can debug the centralized MAC address authentication.

Table 435 Displaying and Debugging Centralized MAC Address Authentication

Operation	Command
Display the global information of the centralized MAC address authentication	**display mac-authentication [interface** *interface_list* **]**
Enable the centralized MAC address authentication debugging switch	**debugging mac-authentication event**
Disable the centralized MAC address authentication debugging switch	**undo debugging mac-authentication event**

Auto VLAN

Auto VLAN uses three return list attributes to dynamically assign VLAN(s) to a port as the user logs in.

Table 436 Auto VLAN

Auto VLAN	Return String	Comment
Tunnel-Medium-type	802	
Tunnel-Private-Group-ID	2	VLAN value
Tunnel-Type	VLAN	

Before the VLAN is correctly received by the Switch 5500, you need to execute the following command on the Switch 5500 to use standard private-group-ID:

```
[5500-xx]private-group-id mode standard
```

Configuration Example of Centralized MAC Address Authentication

How to enable centralized MAC address authentication both on a port and globally, and how to configure a local user are shown as follows. For other configurations, see “802.1x Configuration Example”.

The configurations of centralized MAC address authentication is similar to 802.1x, their differences are:

1) Enabling centralized MAC address authentication both globally and on a port.

2) User name and password of the local authentication must be configured to the MAC address of the user.

3) User name and password on the RADIUS server must be configured to the MAC address of the user.

The following example shows how to enabling centralized MAC address authentication both on a port and globally, and the way of configuring local user are shown as follows. For other configurations, see

1 Enable centralized MAC address authentication on port Ethernet 1/0/2.

```
[SW5500]mac-authentication interface Ethernet 1/0/2
```

2 Add local access user.

a Set the user name and password.

```
[SW5500]local-user 00e0fc010101
[SW5500-luser-00e0fc010101]password simple 00e0fc010101
```

b Set the service type of the user to lan-access.

```
[SW5500-luser-00e0fc010101]service-type lan-access
```

3 Enable the MAC address authentication globally.

```
[SW5500]mac-authentication
```

4 Configure the ISP domain used by the user.

```
[SW5500]mac-authentication domain 3com163.net
```

For the configuration of the domain 3com163.net, see "802.1x Configuration Example" on page 403.

AAA and RADIUS Protocol Configuration

Authentication, Authorization and Accounting (AAA) provide a uniform framework used for configuring these three security functions to implement the network security management.

The network security mentioned here refers to access control and it includes:

- Which user can access the network server?
- Which service can the authorized user enjoy?
- How to keep accounts for the user who is using the network resource?

Accordingly, AAA provides the following services:

- Authentication: authenticates if the user can access the network server.
- Authorization: authorizes the user with specified services.
- Accounting: traces network resources consumed by the user.

RADIUS Protocol Overview

As mentioned above, AAA is a management framework, so it can be implemented by some protocols. RADIUS is such a protocol that is frequently used.

What is RADIUS?

Remote Authentication Dial-In User Service, RADIUS for short, is a type of distributed information switching protocol in Client/Server architecture. RADIUS can prevent the network from interruption of unauthorized access and it is often used in the network environments requiring both high security and remote user access. For example, it is often used for managing a large number of scattering dial-in users who use serial ports and modems. RADIUS system is the important auxiliary part of Network Access Server (NAS).

After RADIUS system is started, if the user wants to have the right to access other networks or consume some network resources through connection to NAS (dial-in access server in PSTN environment or a Switch with the access function in an Ethernet environment), NAS, namely RADIUS client end, will transmit user AAA request to the RADIUS server. A RADIUS server has a user database recording all the information of user authentication and network service access. When receiving a user's request from NAS, the RADIUS server performs AAA through user database query and update and returns the configuration information and accounting data to NAS. Here, NAS controls users and corresponding connections, while the RADIUS protocol regulates how to transmit configuration and accounting information between NAS and RADIUS.

NAS and RADIUS exchange the information with UDP packets. During the interaction, both sides encrypt the packets with keys before uploading user configuration information (for example, password) to avoid being intercepted or stolen.

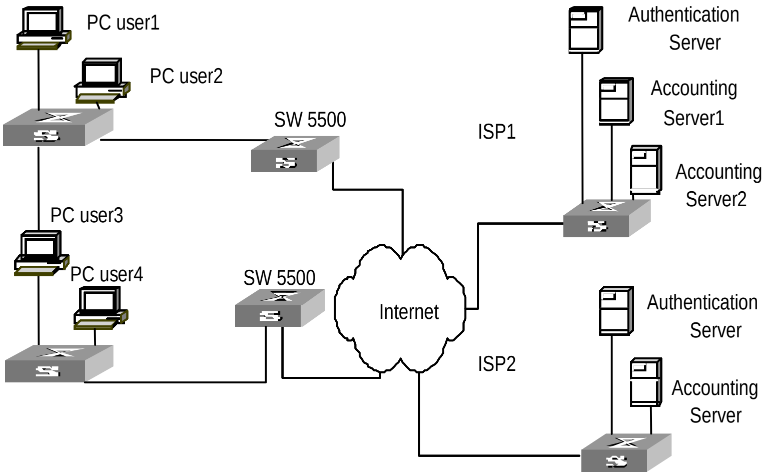
RADIUS Operation

A RADIUS server generally uses proxy function of the devices such as an access server to perform user authentication. The operation process is as follows: First, the user sends a request message (the client username and encrypted password is included in the message) to the RADIUS server. Second, the user will receive from the RADIUS server various kinds of response messages in which the ACCEPT message indicates that the user has passed the authentication, and the REJECT message indicates that the user has not passed the authentication and needs to input their username and password again, otherwise they will be rejected access.

Implementing AAA/RADIUS on the Ethernet Switch

In the above-mentioned AAA/RADIUS framework, the Switch 5500 Family, serving as the user access device or NAS, is the client end of RADIUS. In other words, the AAA/RADIUS concerning the client-end is implemented on the Switch 5500. Figure 107 illustrates the RADIUS authentication network including 5500 Switches.

Figure 107 Networking when Switch 5500 Units are Applying RADIUS Authentication



Configuring AAA

AAA configuration includes:

- Creating/deleting an ISP domain
- Configuring relevant attributes of the ISP domain
- Creating a local user
- Setting attributes of the local user
- Disconnecting a user by force

Among the above configuration tasks, creating ISP domain is compulsory, otherwise the user attributes cannot be distinguished. The other tasks are optional. You can configure them at requirements.

Creating/Deleting an ISP Domain

What is Internet Service Provider (ISP) domain? To make it simple, ISP domain is a group of users belonging to the same ISP. Generally, for a username in the userid@isp-name format, taking gw20010608@3com163.net as an example, the isp-name (that is 3com163.net) following the @ is the ISP domain name. When the Switch 5500 controls user access, as for an ISP user whose username is in userid@isp-name format, the system will take userid part as username for identification and take isp-name part as domain name.

The purpose of introducing ISP domain settings is to support the multi-ISP application environment. In such an environment, one access device might access users of different ISP. Because the attributes of ISP users, such as username and password formats, and so on, may be different, it is necessary to differentiate them through setting ISP domain. In the Switch 5500 units, ISP domain view, you can configure a complete set of exclusive ISP domain attributes on a per-ISP domain basis, which includes AAA policy (RADIUS scheme applied)

For the Switch 5500, each user belongs to an ISP domain. Up to 16 domains can be configured in the system. If a user has not reported their ISP domain name, the system will put them into the default domain.

Perform the following configurations in System View.

Table 437 Creating/Deleting an ISP Domain

Operation	Command
Create ISP domain or enter the view of a specified domain.	**domain** *isp_name*
Remove a specified ISP domain	**undo domain** *isp_name*
Enable the default ISP domain specified by *isp-name*	**domain default enable** *isp_name*
Restore the default ISP domain to "system"	**domain default disable**

By default, a domain named “system” has been created in the system. Its attributes are all default values.

Configuring Relevant Attributes of the ISP Domain

The relevant attributes of ISP domain include the AAA scheme, domain state, maximum number of users, the idle-cut function, the accounting optional option, the messenger alert and self-service server URL.

Perform the following configurations in ISP Domain View.

Configuring AAA Scheme

The AAA schemes includes:

- RADIUS scheme—you can implement authentication, authorization, and accounting by referencing the RADIUS server group. The adopted RADIUS scheme is the one used by all the users in the ISP domain. For detailed information of the commands of setting RADIUS scheme, refer to “Configuring the RADIUS Protocol”.
- Local authentication—if you use the local scheme, you can only implement authentication and authorization at local without RADIUS server.

- None—no authentication and accounting.

Table 438 Configuring AAA Scheme Adopted by the ISP Domain

Operation	Command
Configure an AAA scheme for the domain.	**scheme { radius-scheme** *radius_scheme_name* | **local** | **none** }
Configure a RADIUS scheme	**radius-scheme** *radius_scheme_name*
Restore the default AAA scheme.	**undo scheme { radius-scheme** *radius_scheme_name* | **none }**

By default, after an ISP domain is created, the default AAA scheme is **local**. You cannot use a RADIUS scheme together with the **local** or **none** scheme.

You can use either **scheme** *or* **radius-scheme** *command to specify the RADIUS scheme for an ISP domain. If both of these two commands are used, the latest configuration will take effect.*

Configuring ISP Domain State

Every ISP has active/block states. If an ISP domain is in active state, the users in it can request for network service, while in block state, its users cannot request for any network service, which will not affect the users already online.

Table 439 Configuring ISP Domain State

Operation	Command
Specify the ISP domain state to be active	**state active**
Specify the ISP domain state to be block	**state block**

By default, after an ISP domain is created, the state of the domain is **active**.

Setting Access Limit

Maximum number of users specifies how many users can be contained in the ISP. For any ISP domain, there is no limit to the number of users by default.

Table 440 Setting Access Limit

Operation	Command
Set a limit to the amount of users	**access-limit { disable** | **enable** *max_user_number* **}**
Restore the limit to the default setting	**undo access-limit**

By default, there is no limit to the amount of users.

Enabling/Disabling the Idle-Cut Function

The idle cut function means if the traffic from a certain connection is lower than the defined traffic, this connection is cut off.

Table 441 Enabling/Disabling the Idle-cut Function

Operation	Command
Set the idle	**idle-cut enable** *minute flow*
Disable the idle-cut function	**idle-cut disable**

By default, the idle-cut function is disabled.

Enabling the Selection of the RADIUS Accounting Option

If no RADIUS server is available or if the RADIUS accounting server fails when the `accounting optional` is configured, the user can still use the network resource, otherwise, the user will be disconnected. The user configured with the `accounting optional` command in RADIUS scheme will no longer send real-time accounting update packets or offline accounting packets.

Perform the following configurations in ISP Domain View.

Table 442 Enabling the Selection of the RADIUS Accounting Option

Operation	Command
Enable the selection of RADIUS accounting option	`accounting optional`
Disable the selection of RADIUS accounting option	`undo accounting optional`

By default, the selection of RADIUS accounting option is disabled.

The `accounting optional` command can also be configured in the RADIUS scheme view which is only effective on the accounting that uses this RADIUS scheme. If this command is configured both on an ISP domain and the RADIUS scheme it uses, the latest configuration will take effect.

AAA Separation

AAA (authentication, authorization and accounting) is a management framework for network access control. It provides the following three services:

- Authentication: Checks if a user can access the network.
- Authorization: Authorizes a user to use a specific service.
- Accounting: Records the network usage of a user.

In AAA management, you can use the **authentication**, **authorization**, and **accounting** commands separately to specify a scheme for each of the three AAA functions (authentication, authorization and accounting) respectively. This AAA separation feature brings flexibility to AAA configuration. The following lists the implementations of AAA separation for the services supported by AAA.

- For terminal users

Authentication method: RADIUS, local, RADIUS-local, or none.

Authorization method: none.

Accounting method: RADIUS or none.

You can configure combined authentication, authorization and accounting schemes depending on the methods supported by the switch according to your needs.

- For FTP users

Only authentication is supported for FTP users.

Authentication method: RADIUS, local, or RADIUS-local.

Configuring Separate AAA Schemes

Table 443 Configure separate AAA schemes

Operation	Command	Description
Enter system view	system-view	—
Create an ISP domain or enter an existing ISP domain view	**domain** *isp-name*	Required
Configure an authentication scheme for the ISP domain	**authentication** { **radius-scheme** *radius-scheme-name* [**local**] | **local** | **none** }	Optional By default, no separate authentication scheme is configured.
Allow users in current ISP domain to use network services without being authorized	authorization none	Optional By default, no separate authorization scheme is configured.
Configure an accounting scheme for the ISP domain	**accounting** { **none** | **radius-scheme** *radius-scheme-name* }	Optional By default, no separate accounting scheme is configured.

If a bound AAA scheme (that is, the authentication, authorization and accounting are bound in one scheme) is configured as well as the separate authentication, authorization and accounting schemes, the separate ones will be adopted in precedence.

RADIUS scheme and local scheme do not support the separation of authentication and authorization. Therefore, pay attention when you perform authentication and authorization configuration: when the ***scheme radius-scheme*** *or* ***scheme local*** *command is executed and the* ***authentication*** *command is not executed, the authorization information returned from the RADIUS or local scheme will still take effect even if the* ***authorization none*** *command is executed.*

Configuration Example for Separate AAA Schemes

Network requirements

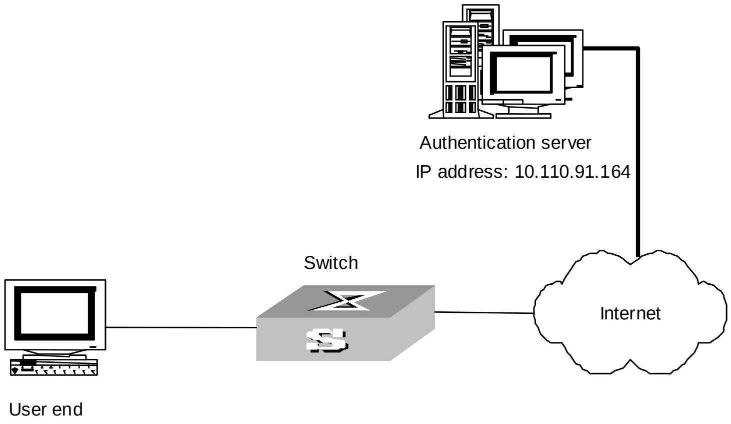
A RADIUS server with IP address 10.110.91.164 is connected to the switch. This server will be used as an authentication server.

On the switch, set the shared key it uses to exchange packets with the RADIUS server to "expert".

Configure the RADIUS scheme radius as both the authentication and accounting schemes of the ISP domain cams, and allow users in this ISP domain to use network services without being authorized.

Network diagram

Figure 108 Network diagram for separate AAA schemes



Configuration procedure

1. Enter system view.

```
<S5500> system-view
```

2. Create an ISP domain named cams.

```
[S5500] domain cams
```

3. Return to system view.

```
[S5500-isp-cams] quit
```

4. Configure a RADIUS scheme named radius.

```
[S5500] radius scheme radius
[S5500-radius-radius] primary accounting 10.110.91.164 1813
[S5500-radius-radius] primary authentication 10.110.91.164 1812
[S5500-radius-radius] key authentication expert
[S5500-radius-radius] user-name-format with-domain
[S5500-radius-radius] quit
```

5. Enter the ISP domain cams.

```
[S5500] domain cams
```

6. Configure the RADIUS scheme radius as both the authentication and accounting schemes of the ISP domain cams, and allow users in this ISP domain to use network services without being authorized.

```
[S5500-isp-cams] authentication radius-scheme radius
[S5500-isp-cams] accounting radius-scheme radius
[S5500-isp-cams] authorization none
```

Enabling/Disabling the Messenger Alert

Messenger alert function allows the clients to inform the online users about their remaining online time through the message alert dialog box.

The implementation of this function is as follows:

- On the switch, use the following command to enable this function and to configure the remaining-online-time threshold (the *limit* argument) and the alert message interval.

- If the threshold is reached, the switch sends messages containing the user's remaining online time to the client at the interval you configured.
- The client keeps the user informed of the updated remaining online time through a dialog box.

Perform the following configuration in ISP domain view.

Table 444 Enabling/disabling message alert

Operation	Command
Enable messenger alert and configure the remaining-online-time threshold and the interval at which the alert message is sent	**messenger time enable *limit interval***
Disable messenger alert	**messenger time disable**
Restore the messenger alert as the default setting	**undo messenger time**

By default, messenger alert is disabled on the switch.

Configuring Self-Service Server URL

The self-service-url enable command can be used to configure self-service server uniform resource locator (URL). This command must be incorporated with a RADIUS server (such as a CAMS) that supports self-service. Self-service means that users can manage their accounts and card numbers by themselves. And a server with the self-service software is called a self-service server.

Once this function is enabled on the switch, users can locate the self-service server and perform self-management through the following operations:

- Select Change user password on the 802.1x client.
- After the client opens the default explorer (IE or NetScape), locate the specified URL page used to change the user password on the self-service server.
- Change user password on this page.

Perform the following configuration in ISP domain view.

Table 445 Configuring the self-service server URL

Operation	Command
Configure self-service server URL and configure the URL address used to change the user password on the self-service server	**self-service-url enable** *url-string*
Remove the configuration of self-service server URL	**self-service-url disable**

By default, the self-service server URL is not configured on the switch.

Note that, if "**?**" is contained in the URL, you must replace it with "|" when inputting the URL in the command line.

The "Change user password" option is available only when the user passes the authentication; otherwise, this option is in grey and unavailable.

Dynamic VLAN Assignment

Through dynamic VLAN assignment, the Ethernet switch dynamically adds the ports of the successfully authenticated users to different VLANs depending on the attribute values assigned by RADIUS server, so as to control the network resources the users can access.

Currently, the switch supports the following two data types of VLAN IDs assigned by RADIUS authentication server:

- Integer: The switch adds the port to a VLAN depending on the integer type of VLAN ID assigned by the RADIUS authentication server. If the VLAN does not exist, the switch creates the VLAN, and then adds the port to the new VLAN.
- String: The switch compares the character string type of VLAN ID assigned by the RADIUS authentication server with the existing VLAN names on it. If the switch finds a match, it adds the port to the corresponding VLAN; otherwise the VLAN assignment fails and the user fails to pass the authentication.

In actual application, to co-operate with Guest VLAN, port control is usually set to the port-based mode. If it is set to the MAC address-based mode, each port can have only one user end connected.

Configuring Dynamic VLAN Assignment

Configure dynamic VLAN assignment

Operation	Command	Description
Enter system view	system-view	—
Create an ISP domain and enter its view	**domain** *isp-name*	—
Set the VLAN assignment mode to integer	**vlan-assignment-mode integer**	By default, this mode is integer.
Set the VLAN assignment mode to string	vlan-assignment-mode string	You must perform one of the two operations (this one and the above one)
Create a VLAN and enter its view	**vlan** *vlan_id*	—
Set a name for the assigned VLAN	**name** *string*	This operation is required when the VLAN assignment mode is set to string.

⚠ *In string mode, if the VLAN name assigned by the RADIUS server is a string that contains only digital characters (for example, 1024) and the string can be transformed to an integer number in the valid VLAN range, the switch transforms this string to an integer number and adds the authenticated port to the VLAN whose ID is this number (VLAN 1024, for example).*

⚠ *If you want to implement the dynamic VLAN assignment function on a port where both MSTP multi-instance and 802.1x is enabled, you must set the MSTP port to an edge port.*

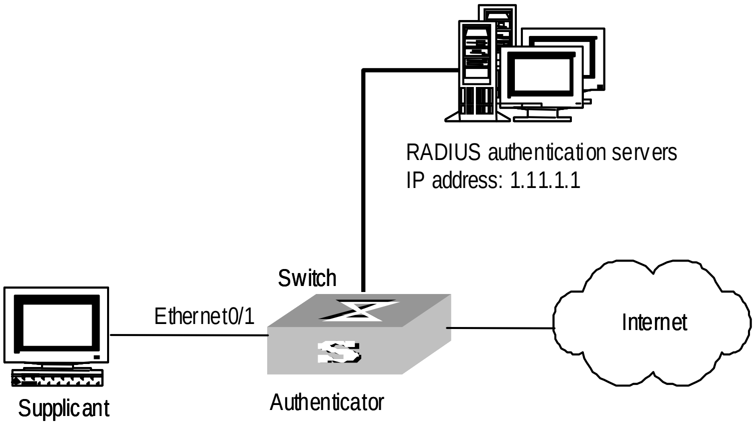
Configuration Example for Dynamic VLAN Assignment

Network requirements

- The RADIUS authentication server (in this example, a Windows IAS server) assigns a string type of VLAN ID (test).
- The VLAN name corresponding to this assigned VLAN ID is vlan 100.
- It is required that the switch adds the port to vlan 100 when test is assigned by the RADIUS server.

Network diagram

Figure 109 Network diagram for dynamic VLAN assignment



Configuration procedure

1 Create a RADIUS scheme.

```
[S5500] radius scheme ias
[S5500-radius-ias] primary authentication 1.11.1.1
[S5500-radius-ias] primary accounting 1.11.1.1
[S5500-radius-ias] key authentication hello
[S5500-radius-ias] key accounting hello
[S5500-radius-ias] quit
```

2 Create an ISP domain and reference the created RADIUS scheme in the domain.

```
[S5500] domain ias
[S5500-isp-ias] radius-scheme ias
```

3 Configure the VLAN assignment mode to string and return to the system view.

```
[S5500-isp-ias] vlan-assignment-mode string
[S5500-isp-ias] quit
```

4 Create a VLAN and specify a name for the VLAN.

```
[S5500] vlan 100
```

5 Set the name of the assigned VLAN to test.

```
[S5500-vlan100] name test
```

Creating a Local User

A local user is a group of users set on NAS. The user name is the unique identifier of a user. A user requesting network service may use local authentication only if its corresponding local user has been added onto NAS.

Perform the following configurations in System View

Table 446 Creating/Deleting a Local User and Relevant Properties

Operation	Command
Add local users	**local-user** *user_name*
Delete all the local users	**undo local-user all**
Delete a local user by specifying its type	**undo local-user {** *user_name* | **all [service-type { lan_access** | **ftp** | **telnet** | **ssh** | **terminal }] }**

By default, there is no local user in the system.

Setting Attributes of the Local User

The attributes of a local user include its password display mode, state, service type and some other settings.

Setting the Password Display Mode

Perform the following configurations in System View.

Table 447 Setting the Password Display Mode of Local Users

Operation	Command
Set the password display mode of local users	**local-user password-display-mode { cipher-force | auto }**
Cancel the configuration of password display mode	**undo local-user password-display-mode**

auto means that the password display mode will be the one specified by the user at the time of configuring the password (see the **password** command in Table 448 for reference), and **cipher-force** means that the password display mode of all the accessing users must be in cipher text.

Setting the Attributes of Local Users

Perform the following configurations in Local User View.

Table 448 Setting/Removing the Attributes Concerned with a Specified User

Operation	Command
Set a password for a specified user	**password { simple | cipher }** *password*
Remove the password set for the specified user	**undo password**
Set the state of the specified user	**state { active | block }**
Set a priority level for the user	**level** *level*
Restore the default priority level	**undo level**
Set a service type for the specified user	**service-type { ftp [ftp-directory** *directory* **] | lan-access | { ssh | telnet | terminal }* }**
Cancel the service type of the specified user	**undo service-type { ftp [ftp-directory] | lan-access | { ssh | telnet | terminal }* [level** *level* **] }**
Configure the attributes of lan-access users	**attribute { ip** *ip_address* **| mac** *mac_address* **| idle-cut** *second* **| access-limit** *max_user_number* **| vlan** *vlanid* **| location { nas-ip** *ip_address* **port** *portnum* **| port** *portnum* **} }***
Remove the attributes defined for the lan-access users	**undo attribute { ip | mac | idle-cut | access-limit | vlan | location }***

Note the following two items when you configure these service types: SSH, Telnet or Terminal.

- When you configure a new service type for a user, the system adds the requested service-type to any existing configuration. For example, if the user previously had just Telnet access, and SSH was added, the user would now have access to both Telnet and SSH.
- You can set user level when you configure a service type. If you set multiple service types and specify the user levels, then only the last configured user level is valid. Some of the service types allow a user-privilege level to be entered as an optional extra parameter. For example Telnet, Terminal and SSH.

However, the user-privilege level is a global value for all service types. Entering the following two commands will result in the user having a level of 3 for all service types. In this case both telnet and SSH:

```
[5500-SI-luser-adminpwd]service-type telnet level 1
[5500-SI-luser-adminpwd]service-type ssh level 3
```

You can use either **level** *or* **service-type** *command to specify the level for a local user. If both of these two commands are used, the latest configuration will take effect.*

Disconnecting a User by Force

Sometimes it is necessary to disconnect a user or a category of users by force. The system provides the following command to serve this purpose.

Perform the following configurations in System View.

Table 449 Disconnecting a User by Force

Operation	Command
Disconnect a user by force	**cut connection { all** | **access-type { dot1x** | **gcm** | **mac-authentication }** | **domain** *domain_name* | **interface** *interface_type interface_number* | **ip** *ip_address* | **mac** *mac_address* | **radius-scheme** *radius_scheme_name* | **vlan** *vlanid* | **ucibindex** *ucib_index* | **user-name** *user_name* **}**

By default, no online user will be disconnected by force.

Configuring the RADIUS Protocol

For the Switch 5500, the RADIUS protocol is configured on the per RADIUS scheme basis. In a real networking environment, a RADIUS scheme can be an independent RADIUS server or a set of primary/secondary RADIUS servers with the same configuration but two different IP addresses. Accordingly, attributes of every RADIUS scheme include IP addresses of primary and secondary servers, shared key and RADIUS server type.

RADIUS protocol configuration only defines some necessary parameters used for information interaction between NAS and RADIUS Server. To make these parameters effective, it is necessary to configure, in the view, an ISP domain to use the RADIUS scheme and specify it to use RADIUS AAA schemes. For more information about the configuration commands, refer to “Configuring AAA”.

RADIUS protocol configuration includes:

- Creating/Deleting a RADIUS Scheme
- Configuring RADIUS Authentication/ Authorization Servers
- Configuring RADIUS Accounting Servers and the Related Attributes
- Setting the RADIUS Packet Encryption Key
- Setting Retransmission Times of RADIUS Request Packet
- Setting the Supported Type of the RADIUS Server
- Setting the RADIUS Server State
- Setting the Username Format Transmitted to the RADIUS Server
- Configuring the Local RADIUS Authentication Server
- Configuring Source Address for RADIUS Packets Sent by NAS
- Setting the Timers of the RADIUS Server

Among the above tasks, creating the RADIUS scheme and setting the IP address of the RADIUS server are required, while other tasks are optional and can be performed as per your requirements.

Creating/Deleting a RADIUS Scheme

As mentioned above, RADIUS protocol configurations are performed on the per RADIUS scheme basis. Therefore, before performing other RADIUS protocol configurations, it is essential to create the RADIUS scheme and enter its view to set its IP address.

You can use the following commands to create/delete a RADIUS scheme.

Perform the following configurations in System View.

Table 450 Creating/Deleting a RADIUS Server Group

Operation	Command
Create a RADIUS scheme and enter its view	**radius scheme** *radius_scheme_name*
Delete a RADIUS scheme	**undo radius scheme** *radius_scheme_name*

Several ISP domains can use a RADIUS scheme at the same time. You can configure up to 16 RADIUS schemes, including the default scheme named as **system**.

By default, the system has a RADIUS scheme named as system whose attributes are all default values. The default attribute values will be introduced in the following text.

Configuring RADIUS Authentication/ Authorization Servers

After creating a RADIUS scheme, you have to set IP addresses and UDP port numbers for the RADIUS servers, including primary/secondary authentication/authorization servers and accounting servers. You can configure up to four groups of IP addresses and UDP port numbers. However, as a minimum, you have to set one group of IP address and UDP port number for each pair of primary/secondary servers to ensure the normal AAA operation.

You can use the following commands to configure the IP address and port number for RADIUS servers.

Perform the following configurations in RADIUS Scheme View.

Table 451 Configuring RADIUS Authentication/Authorization Servers

Operation	Command
Set IP address and port number of primary RADIUS authentication/authorization server.	**primary authentication** *ip_address* **[** *port_number* **]**
Restore IP address and port number of primary RADIUS authentication/authorization server to the default values.	**undo primary authentication**
Set IP address and port number of secondary RADIUS authentication/authorization server.	**secondary authentication** *ip_address* **[** *port_number* **]**
Restore IP address and port number of second RADIUS authentication/authorization server to the default values.	**undo secondary authentication**

By default, as for the newly created RADIUS scheme, the IP address of the primary authentication server is 0.0.0.0, and the UDP port number of this server is 1812; as for the "system" RADIUS scheme created by the system, the IP address of the primary authentication server is 127.0.0.1, and the UDP port number is 1645.

The authorization information from the RADIUS server is sent to RADIUS clients in authentication response packets, so you do not need to specify a separate authorization server.

In real networking environments, you may specify two RADIUS servers as primary and secondary authentication/authorization servers respectively, or specify one server to function as both.

The RADIUS service port settings on the Switch 5500 should be consistent with the port settings on the RADIUS server. Normally, the authentication/authorization service port is 1812.

Configuring RADIUS Accounting Servers and the Related Attributes

Configuring RADIUS Accounting Servers

You can use the following commands to configure the IP address and port number for RADIUS accounting servers.

Perform the following configurations in RADIUS Scheme View.

Table 452 Configuring RADIUS Accounting Servers

Operation	Command
Set IP address and port number of primary RADIUS accounting server.	**primary accounting** *ip_address* [*port_number*]
Restore IP address and port number of primary RADIUS accounting server to the default values.	**undo primary accounting**
Set IP address and port number of second RADIUS accounting server.	**secondary accounting** *ip_address* [*port_number*]
Restore IP address and port number of second RADIUS accounting server to the default values.	**undo secondary accounting**

By default, as for the newly created RADIUS scheme, the IP address of the primary accounting server is 0.0.0.0, and the UDP port number of this server is 1813; as for the "system" RADIUS scheme created by the system, the IP address of the primary accounting server is 127.0.0.1, and the UDP port number is 1646.

In real networking environments, you can specify two RADIUS servers as the primary and the secondary accounting servers respectively; or specify one server to function as both.

To guarantee the normal interaction between NAS and RADIUS server, you are supposed to guarantee the normal routes between RADIUS server and NAS before setting the IP address and UDP port of the RADIUS server. In addition, because RADIUS protocol uses different UDP ports to receive/transmit authentication/authorization and accounting packets, you need to set two different ports accordingly. Suggested by RFC2138/2139, authentication/authorization port number is 1812 and accounting port number is 1813. However, you may use values other than the suggested ones. (Especially for some earlier RADIUS Servers, authentication/authorization port number is often set to 1645 and accounting port number is 1646.)

The RADIUS service port settings on the Switch 5500 units are supposed to be consistent with the port settings on RADIUS server. Normally, RADIUS accounting service port is 1813.

Setting the Maximum Times of Real-time Accounting Request Failing to be Responded to

A RADIUS server usually checks if a user is online with a timeout timer. If the RADIUS server has not received the real-time accounting packet from NAS for a while, it will consider that there is device failure and stop accounting. It is necessary to disconnect the user at the NAS end and on the RADIUS server synchronously when some unpredictable failure occurs. The Switch allows you to set the maximum number of times of a real-time accounting request failing to be responded to. NAS will disconnect the user if it has not received a real-time accounting response from the RADIUS server for the specified number of times.

You can use the following command to set the maximum number of times of a real-time accounting request failing to be responded to.

Perform the following configurations in RADIUS Scheme View.

Table 453 Setting the Maximum Times of Real-time Accounting Request Failing to be Responded

Operation	Command
Set maximum times of real-time accounting request failing to be responded	**`retry realtime-accounting`** *`retry_times`*
Restore the maximum times to the default value	**`undo retry realtime-accounting`**

How to calculate the value of *`retry-times`*? Suppose that RADIUS server connection will timeout in T and the real-time accounting interval of NAS is t, then the integer part of the result from dividing T by t is the value of *`count`*. Therefore, when applied, it is suggested that T should be a number that can be divided exactly by t.

By default, the real-time accounting request can fail to be responded to no more than 5 times.

Enabling/Disabling the Stopping Accounting Request Buffer

Because the stopping accounting request concerns the account balance and will affect the amount of charge, which is very important for both the subscribers and the ISP, NAS shall make its best effort to send the message to the RADIUS accounting server. If the message from the Switch to the RADIUS accounting server has not been responded to, the Switch will save it in the local buffer and retransmit it until the server responds or discards the messages after transmitting for the specified number of times. The following command can be used for setting to save the message or not.

Perform the following configurations in RADIUS Scheme View.

Table 454 Enabling/Disabling the Stopping Accounting Request Buffer

Operation	Command
Enable stopping accounting request buffer	**`stop-accounting-buffer enable`**
Disable stopping accounting request buffer	**`undo stop-accounting-buffer enable`**

By default, the stopping accounting request will be saved in the buffer.

Setting the Maximum Retransmitting Times of Stopping Accounting Request

Use this command to set the maximum number of retransmission times that the Switch will attempt to retransmit the saved message from its local buffer.

Perform the following configurations in RADIUS Scheme View.

Table 455 Setting the Maximum Retransmitting Times of Stopping Accounting Request

Operation	Command
Set the maximum retransmitting times of stopping accounting request	**`retry stop-accounting`** *`retry_times`*
Restore the maximum retransmitting times of stopping accounting request to the default value	**`undo retry stop-accounting`**

By default, the stopping accounting request can be retransmitted up to 500 times.

Enabling the Selection of the Radius Accounting Option

Perform the following configurations in RADIUS Scheme View.

Table 456 Enabling the Selection of RADIUS Accounting Option

Operation	Command
Enable the selection of RADIUS accounting option	**`accounting optional`**
Disable the selection of RADIUS accounting option	**`undo accounting optional`**

This command can also be configured in ISP Domain View. For details, refer to Configuring Relevant Attributes of the ISP Domain.

User Re-authentication at Reboot

This section contains information for User Re-authentication at Reboot.

The feature applies to the environments where the RADIUS authentication/accounting server is CAMS.

In an AAA scheme implemented jointly by the switch and CAMS, if the switch reboots after an exclusive user (a user whose concurrent online number is set to 1 on the CAMS) passes the authentication, gets authorized and begins being charged, the switch will give a prompt that the user has already been online when the user re-logs onto the network before the CAMS makes online detection. Therefore, the user cannot access network resources as usual. In this situation, the user can log onto the network again only after the network administrator manually removes the user's online information.

The user re-authentication at reboot feature is designed to resolve this problem. After this feature is enabled, every time the switch reboots:

- The switch generates an Accounting-On packet, which mainly contains the following information: NAS-ID, NAS-IP (source IP address), and session ID.
- The switch sends the Accounting-On packet to the CAMS at regular intervals.
- Once the CAMS receives the Accounting-On packet, it sends a response to the switch. At the same time it finds and deletes the existing online information of the users who were accessing the network through the switch before the reboot based on the NAS-ID, NAS-IP and session ID contained in the Accounting-On packet, and ends the charging of the users according to the last accounting update packet.
- Once the switch receives the response from the CAMS, it stops sending other Accounting-On packets.
- If the switch has tried the set maximum times to transmit the Accounting-On packet but still does not receive any response from the CAMS, it stops the sending of the Accounting-On packet.

The switch can automatically generate the main attributes (NAS-ID, NAS-IP and session ID) of the Accounting-On packets. However, you can also manually configure the NAS-IP attribute with the ***nas-ip*** *command. When doing this, be sure to configure a correct and valid IP address. If this attribute is not manually configured, the switch will automatically select the IP address of the VLAN interface as the NAS-IP address.*

Configuring User Re-authentication at Reboot

Table 457 Configure user re-authentication at reboot

Operation	Command	Description
Enter system view	system-view	—
Enter RADIUS scheme view	**radius scheme** *radius-scheme-name*	—
Enable user re-authentication at reboot	**accounting-on enable** [**send** *times* | **interval** *interval*]	Optional By default, this feature is disabled. When this feature is enabled, the system can send the Accounting-On packet at most 15 times at intervals of three seconds by default.

Configuration Example for User Re-authentication at Reboot

Network requirements

Enable user re-authentication at reboot.

Configuration procedure

1 Enter system view.

```
<S5500> system-view
```

2 Enter the view of the RADIUS scheme named CAMS (supposing this scheme has already existed).

```
[S5500] radius scheme CAMS
```

3 Enable user re-authentication at reboot.

```
[S5500-radius-CAMS] accounting-on enable
```

Setting the RADIUS Packet Encryption Key

The RADIUS client (Switch system) and the RADIUS server use MD5 algorithm to encrypt the exchanged packets. The two ends verify the packet through setting the encryption key. Only when the keys are identical can both ends accept the packets from each other and give responses.

You can use the following commands to set the encryption key for RADIUS packets.

Perform the following configurations in RADIUS Scheme View.

Table 458 Setting the RADIUS Packet Encryption Key

Operation	Command
Set RADIUS authentication/authorization packet encryption key	**`key authentication`** *`string`*
Restore the default RADIUS authentication/authorization packet encryption key.	**`undo key authentication`**
Set RADIUS accounting packet key	**`key accounting`** *`string`*
Restore the default RADIUS accounting packet key	**`undo key accounting`**

By default, the keys of RADIUS authentication/authorization and accounting packets are all “3com”.

Tag VLAN Assignment on Trunk/Hybrid Port Supported by 802.1x Authentication

Currently, the 802.1x authentication module supports Tag VLAN assignment only on Access port. But some applications (for example, this kind of connection: switch—IP phone—PC) needs 802.1x authentication on Trunk/Hybrid port. For this reason, a new feature, Tag VLAN assignment on Trunk/Hybrid port, is designed.

- After a MAC address authentication succeeds, the address information is synchronously assigned in the whole fabric.
- When a user logs off, the system restores the original VLAN information on the Trunk/Hybrid port and synchronously deletes the corresponding address information from the whole fabric.

Identifier Authentication Method Attribute in RADIUS

The purpose of adding identifier authentication method attribute into RADIUS authentication packets is to distinguish different access modes, such as Portal, 802.1x, and PPPoE. For the non-3Com client block function, you can limit its operation range to only 802.1x authentication, that is, allow the function to take effect only when the identifier authentication method attribute is 802.1x.

The adding of identifier authentication method attribute into an RADIUS authentication packet is to fill the Framed Protocol attribute in the RADIUS authentication request packet based on the access mode of the user.

Setting Retransmission Times of RADIUS Request Packet

Since RADIUS protocol uses UDP packets to carry the data, the communication process is not reliable. If the RADIUS server has not responded to NAS before timeout, NAS has to retransmit the RADIUS request packet. If it transmits more than the specified *retry-times*, NAS considers the communication with the primary and secondary RADIUS servers has been disconnected.

You can use the following command to set the retransmission times of the RADIUS request packet.

Perform the following configurations in RADIUS Scheme View.

Table 459 Setting Retransmission Times of RADIUS Request Packet

Operation	Command
Set retransmission times of RADIUS request packet	**retry** *retry_times*
Restore the default value of retransmission times	**undo retry**

By default, RADIUS request packet will be retransmitted up to three times.

Setting the Supported Type of the RADIUS Server

The Switch 5500 supports the standard RADIUS protocol and the extended RADIUS service platforms.

You can use the following command to set the supported types of RADIUS servers. Perform the following configurations in RADIUS Scheme View.

Table 460 Setting the Supported Type of the RADIUS Server

Operation	Command
Setting the Supported Type of RADIUS Server	**server-type { 3com | standard }**
Restore the RADIUS server type to the default setting	**undo server_type**

By default, the newly created RADIUS scheme supports the server type **standard**, while the "system" RADIUS scheme created by the system supports the server type **3com**.

Setting the RADIUS Server State

For the primary and secondary servers (no matter if they are an authentication/authorization server or accounting server), if the primary server is disconnected from the NAS for some fault, the NAS will automatically turn to exchange packets with the secondary server. However, after the primary server recovers, the NAS will not resume the communication with it at once, instead, it continues communicating with the secondary server. When the secondary server fails to communicate, the NAS will turn to the primary server again. The following commands can be used to set the primary server to be **active** manually, in order that NAS can communicate with it immediately after a fault has been resolved.

When the primary and secondary servers are both **active** or **block**, NAS will send the packets to the primary server only.

Perform the following configurations in RADIUS Scheme View.

Table 461 Setting the RADIUS Server State

Operation	Command
Set the state of primary RADIUS server	**state primary { accounting | authentication } { block | active }**
Set the state of second RADIUS server	**state secondary{ accounting | authentication } { block | active }**

By default, for the newly created RADIUS scheme, the primary and secondary accounting/authentication servers are in the state of **block**; for the "system" RADIUS scheme created by the system, the primary accounting/authentication servers are in the state of **active**, and the secondary accounting/authentication servers are in the state of **block**.

Setting the Username Format Transmitted to the RADIUS Server

As mentioned above, the users are generally named in userid@isp-name format. The part following “@” is the ISP domain name. The Switch will put the users into different ISP domains according to the domain names. However, some earlier RADIUS servers reject the username including ISP domain name. In this case, you have to remove the domain name before sending the username to the RADIUS server. The following command of switch decides whether the username to be sent to RADIUS server carries ISP domain name or not.

Perform the following configurations in RADIUS Scheme View.

Table 462 Setting the Username Format Transmitted to the RADIUS Server

Operation	Command
Set Username Format Transmitted to RADIUS Server	**user-name-format { with-domain | without-domain }**

If a RADIUS scheme is configured not to allow usernames including ISP domain names, the RADIUS scheme shall not be simultaneously used in more than one ISP domain. Otherwise, the RADIUS server will regard two users in different ISP domains as the same user by mistake, if they have the same username (excluding their respective domain names.)

By default, the RADIUS scheme acknowledges that the username sent to it includes the ISP domain name.

Setting the Unit of Data Flow that Transmitted to the RADIUS Server

The following command defines the unit of the data flow sent to RADIUS server.

Perform the following configurations in RADIUS Scheme View

Table 463 Setting the Unit of Data Flow Transmitted to the RADIUS Server

Operation	Command
Set the unit of data flow transmitted to RADIUS server	**data-flow-format data { byte | giga-byte | kilo-byte | mega-byte } packet { giga-byte | kilo-byte | mega-byte | one-packet }**
Restore the unit to the default setting	**undo data-flow-format**

By default, the default data unit is byte and the default data packet unit is one packet.

Configuring the Local RADIUS Authentication Server

RADIUS service adopts authentication/authorization/accounting servers to manage users. Local authentication/authorization/accounting service is also used in these products and it is called local RADIUS authentication server function.

Perform the following commands in System View to create/delete local RADIUS authentication server.

Table 464 Creating/Deleting the Local RADIUS Authentication Server

Operation	Command
Create the local RADIUS authentication server	**local-server nas-ip** *ip_address* **key** *password*
Delete the local RADIUSauthentication server	**undo local-server nas-ip** *ip_address*

By default, the IP address of the local RADIUS authentication server is 127.0.0.1 and the password is 3com.

1) When using local RADIUS server function of 3com, remember the number of the UDP port used for authentication is 1645 and that for accounting is 1646.

2) The password configured by this command must be the same as that of the RADIUS authentication/authorization packet configured by the command **key authentication** *in RADIUS Scheme View.*

Configuring Source Address for RADIUS Packets Sent by NAS

Perform the following configurations in the corresponding view.

Table 465 Configuring Source Address for the RADIUS Packets sent by the NAS

Operation	Command
Configure the source address to be carried in the RADIUS packets sent by the NAS(RADIUS scheme view).	**nas-ip** *ip_address*
Cancel the configured source address to be carried in the RADIUS packets sent by the NAS(RADIUS scheme view).	**undo nas-ip**
Configure the source address to be carried in the RADIUS packets sent by the NAS(System view).	**radius nas-ip** *ip_address*
Cancel the configured source address to be carried in the RADIUS packets sent by the NAS(System view).	**undo radius nas-ip**

You can use either command to bind a source address with the NAS.

By default, no source address is specified and the source address of a packet is the address of the interface to where it is sent.

Setting the Timers of the RADIUS Server

Setting the Response Timeout Timer of the RADIUS Server

After RADIUS (authentication/authorization or accounting) request packet has been transmitted for a period of time, if NAS has not received the response from the RADIUS server, it has to retransmit the request to guarantee RADIUS service for the user.

You can use the following command to set response timeout timer of RADIUS server.

Perform the following configurations in RADIUS Scheme View.

Table 466 Setting the Response Timeout Timer of the RADIUS Server

Operation	Command
Set response timeout timer of RADIUS server	**timer** *second*
Restore the response timeout timer of RADIUS server to default value	**undo timer**

By default, timeout timer of RADIUS server is 3 seconds.

Setting a Real-time Accounting Interval

To implement real-time accounting, it is necessary to set a real-time accounting interval. After the attribute is set, NAS will transmit the accounting information of online users to the RADIUS server regularly.

You can use the following command to set a real-time accounting interval.

Perform the following configurations in RADIUS Scheme View.

Table 467 Setting a Real-time Accounting Interval

Operation	Command
Set a real-time accounting interval	**timer realtime-accounting** *minute*
Restore the default value of the interval	**undo timer realtime-accounting**

minute specifies the real-time accounting interval in minutes. The value should be a multiple of 3.

The value of *minute* is related to the performance of NAS and RADIUS server. The smaller the value, the higher the performances of NAS and RADIUS that are required. When there are a large amount of users (more than 1000, inclusive), 3Com suggests a larger value. Table 468 recommends the ratio of *minute* value to the number of users.

Table 468 Recommended Ratio of Minute to Number of Users

Number of users	Real-time accounting interval (minute)
1 to 99	3
100 to 499	6
500 to 999	12
1000	15

By default, *minute* is set to 12 minutes.

Configure the RADIUS Server Response Timer

If the NAS receives no response from the RADIUS server after sending a RADIUS request (authentication/authorization or accounting request) for a period of time, the NAS resends the request, thus ensuring the user can obtain the RADIUS service. You can specify this period by setting the RADIUS server response timeout timer, taking into consideration the network condition and the desired system performance.

Perform the following configurations in RADIUS Scheme View.

Table 469 Configure the RADIUS Server Response Timer

Operation	Command
Configure the RADIUS server response timer	**timer response-timeout** *seconds*
Restore the default value of the interval	**undo timer response-timeout**

By default, the response timeout timer for the RADIUS server is set to three seconds.

Displaying and Debugging AAA and RADIUS Protocol

After the above configuration, execute the **display** command in any view to display the running of the AAA and RADIUS configuration, and to verify the effect of the configuration. Execute the **reset** command in User View to reset AAA and RADIUS statistics. Execute the **debugging** command in User View to debug AAA and RADIUS.

Table 470 Displaying and Debugging AAA and RADIUS Protocol

Operation	Command
Display the configuration information of the specified or all the ISP domains.	**display domain [** *isp_name* **]**
Display related information of user's connection	**display connection [access-type { dot1x** | **mac-authentication }** | **domain** *domain_name* | **interface** *interface_type interface_number* | **ip** *ip_address* | **mac** *mac_address* | **radius-scheme** *radius_scheme_name* | **vlan** *vlanid* | **ucibindex** *ucib_index* | **user-name** *user_name* **]**
Display related information of the local user	**display local-user [domain** *isp_name* | **idle-cut { disable** | **enable }** | **service-type { telnet** | **ftp** | **lan-access** | **ssh** | **terminal }** | **state { active** | **block }** | **user-name** *user_name* | **vlan** *vlan_id* **]**
Display the statistics of local RADIUS authentication server	**display local-server statistics**
Display the configuration information of all the RADIUS schemes or a specified one	**display radius [** *radius_scheme_name* **]**
Display the statistics of RADIUS packets	**display radius statistics**
Display the stopping accounting requests saved in buffer without response (from System View)	**display stop-accounting-buffer { radius-scheme** *radius_scheme_name* | **session-id** *session_id* | **time-range** *start_time stop_time* | **user-name** *user_name* **}**
Delete the stopping accounting requests saved in buffer without response (from System View)	**reset stop-accounting-buffer { radius-scheme** *radius_scheme_name* | **session-id** *session_id* | **time-range** *start_time stop_time* | **user-name** *user_name* **}**

Table 470 Displaying and Debugging AAA and RADIUS Protocol (continued)

Operation	Command
Clear stop-accounting packets from the buffer.	**reset stop-accounting-buffer {** **radius-scheme** *radius_scheme_name* | **session-id** *session_id* | **time-range** *start_time stop_time* | **user-name** *user_name* **}**
Reset the statistics of RADIUS server.	**reset radius statistics**
Enable RADIUS packet debugging	**debugging radius packet**
Disable RADIUS packet debugging	**undo debugging radius packet**
Enable debugging of localRADIUS scheme	**debugging local-server { all | error | event | packet }**
Disable debugging of localRADIUS scheme	**undo debugging local-server { all | error | event | packet }**

AAA and RADIUS Protocol Configuration Example

For the hybrid configuration example of AAA/RADIUS protocol and 802.1x protocol, refer to “802.1x Configuration Example” on page 403.

Configuring the FTP/Telnet User Authentication at a Remote RADIUS Server

Configuring Telnet user authentication at the remote server is similar to configuring FTP users. The following description is based on Telnet users.

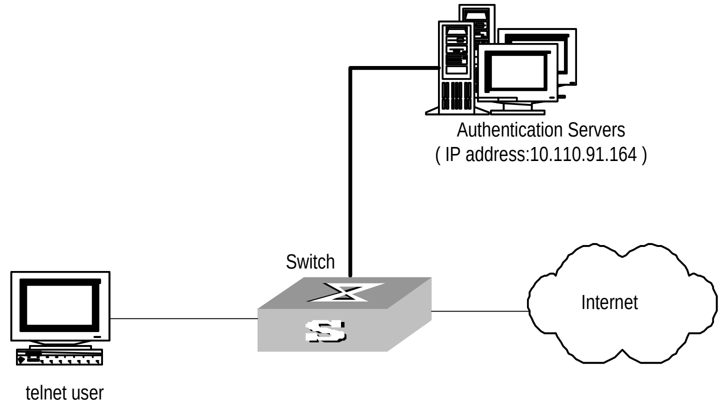
Networking Requirements

In Figure 110, it is required to configure the remote RADIUS authentication of Telnet users.

One RADIUS server (as authentication server) is connected to the Switch and the server IP address is 10.110.91.146. The password for exchanging messages between the Switch and the authentication server is "expert”. The Switch cuts off the domain name from username and sends the remaining part to the RADIUS server.

Networking Topology

Figure 110 Configuring the Remote RADIUS Authentication for Telnet Users



Configuration Procedure

1 Add a Telnet user.

For details about configuring FTP and Telnet users, refer to User Interface Configuration in the Getting Started chapter.

2 Configure remote authentication mode for the Telnet user, that is, scheme mode.

```
[SW5500-ui-vty0-4]authentication-mode scheme
```

3 Configure domain.

```
[SW5500]domain cams
[SW5500-isp-cams]quit
```

4 Configure RADIUS scheme.

```
[SW5500]radius scheme cams
[SW5500-radius-cams]primary authentication 10.110.91.146 1812
[SW5500-radius-cams]key authentication expert
[SW5500-radius-cams]server-type 3com
[SW5500-radius-cams]user-name-format without-domain
```

5 Configuration association between domain and RADIUS.

```
[SW5500-radius-cams]quit
[SW5500]domain cams
[SW5500-isp-cams]scheme radius-scheme cams
```

Configuring the FTP/Telnet User Local Authentication

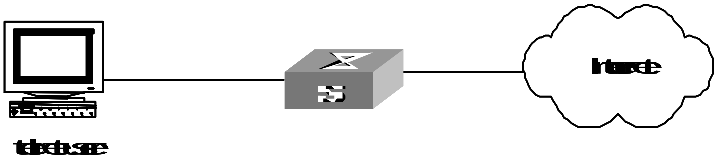
Configuring local authentication for FTP users is similar to that for Telnet users. The following example is based on Telnet users.

Networking Requirements

Configure the router to authenticate the login Telnet users locally (see Figure 111).

Networking Diagram

Figure 111 Local Authentication for Telnet Users



Configuration Procedure

1 Method 1: Using Local scheme.

a Apply AAA authentication to Telnet users.

```
[SW5500-ui-vty0-4]authentication-mode scheme
```

b Create a local user telnet.

```
[SW5500]local-user telnet
[SW5500-luser-telnet]service-type telnet
[SW5500-luser-telnet]password simple 3com
[SW5500-luser-telnet]attribute idle-cut 300 access-limit 5
[SW5500]domain system
[SW5500-isp-system]scheme local
```

Telnet users use usernames in the "*userid*@system" format to log onto the network and are to be authenticated as users of the system domain.

2 Method 2: Using Local RADIUS authentication server.

Local server method is similar to remote RADIUS authentication. But you should modify the server IP address to 127.0.0.1, authentication password to 3com, the UDP port number of the authentication server to 1645.

Configuring the Switch 5500

General RADIUS setup

The Switch 5500 supports multiple RADIUS schemes, which can be assigned to a domain.

This guide covers the recommended steps to setup the Switch5500 for login.

Domain and RADIUS scheme creation

The Switch 5500 can have 1 or more domains created on it. A domain on the Switch 5500 is similar to a windows domain. By default, there is one domain created called "system". This uses the local scheme to validate users. The information about the local domain can be seen by typing "display domain". For example:

```
<SW5500>display domain
0  Domain = system
   State = Active
   Scheme = LOCAL
   Access-limit = Disable
   Domain User Template:
   Idle-cut = Disable
   Self-service = Disable
   Messenger Time = Disable
```

This system domain uses the local scheme.

It is not recommended that you change the system domain, as it could result in locking all users out of the switch. This could happen if you change the default local scheme to use an external RADIUS server, which is unavailable.

1 A new RADIUS scheme should be created as follows:

```
[SW5500]radius scheme NewSchemeName
New Radius scheme
[SW5500-radius-NewSchemeName]
```

2 Next, we need to add the attributes of the RADIUS scheme. This involves configuring the RADIUS server IP address and shared secret.

```
[SW5500-radius-NewSchemeName]key authentication mysharedsecret
[SW5500-radius-NewSchemeName]primary authentication 161.71.67.250
```

3 The RADIUS scheme will not become active unless an accounting server is also defined. If you don't have an accounting server, then the RADIUS scheme needs to have accounting set to "optional".

```
[SW5500-radius-NewSchemeName]accounting optional
```

4 Next, create a new domain as follows:

```
[SW5500]domain Demo
New Domain added.
[SW5500-isp-Demo]
```

5 Change the domain to use the new RADIUS scheme that you have configured:

```
[SW5500-isp-demo]radius-scheme NewSchemeName
```

And that completes the configuration of the new radius server and associating it with a domain.

Network Login

Network login must first be enabled globally by issuing the command dot1x:

```
[5500-xx]dot1x
802.1x is enabled globally
```

(where `xx` is either EI or SI)

Once enabled globally, the network login needs to be enabled on a per port basis. This can be done in one of two ways:

- To enable dot1x on one port, enter the interface of the port and enable dot1x on the port. For example:

  ```
  [5500-xx]interface ethernet 1/0/7
  [5500-xx-Ethernet1/0/7]dot1x
  802.1x is enabled on port Ethernet1/0/7
  [5500-xx-Ethernet1/0/7]
  ```

- To enable dot1x on more than 1 port, enter the global dot1x command as follows:

  ```
  [5500-xx]dot1x interface Ethernet 1/0/7 to Ethernet 1/0/12 Ethernet
  1/0/14 to Ethernet 1/0/20
  802.1x is enabled on port Ethernet1/0/7 already
  802.1x is enabled on port Ethernet1/0/8
  802.1x is enabled on port Ethernet1/0/9
  802.1x is enabled on port Ethernet1/0/10
  802.1x is enabled on port Ethernet1/0/11
  802.1x is enabled on port Ethernet1/0/12
  802.1x is enabled on port Ethernet1/0/14
  802.1x is enabled on port Ethernet1/0/15
  802.1x is enabled on port Ethernet1/0/16
  802.1x is enabled on port Ethernet1/0/17
  802.1x is enabled on port Ethernet1/0/18
  802.1x is enabled on port Ethernet1/0/19
  802.1x is enabled on port Ethernet1/0/20
  [5500-xx]
  ```

802.1x login is now enabled on the port. When a device with an 802.1x client connects to the port, the user will be challenged for a username and password. The username should be in the form ìuser@domainî where ìdomainî is the name of the domain that was created on the Switch. This will tell the Switch which domain, and subsequently which RADIUS server the user is associated with.

By default, the username sent to the RADIUS server for verification will be in the form user@domain.

You can send the username without the domain extension to the RADIUS server This can be changed under the RADIUS scheme as follows:

```
[5500-xx-radius-NewSchemeName]user-name-format without-domain
```

Switch Login

The Switch 5500 supports Switch login, to allow multiple users access to the management interface of the switch.

Once the RADIUS scheme and domain have been set up, see Domain and RADIUS scheme creation, then switch login is enabled.

By default, when you use the username admin to login, you are actually logging in as "admin@local". If no domain is given, the "@local" is automatically added at the end of the username. This states the user is a member of the local domain, and as a result uses the local RADIUS server.

Based on the steps in section Domain and RADIUS scheme creation to login using the external RADIUS server defined, you need to login as user@domain, eg joe@demo. This will try to log you into the demo domain, which uses the external, rather than the internal RADIUS server.

By default, the username sent to the RADIUS server for verification will be in the form user@domain. To just send the username without the domain extension to the RADIUS server. This is changed under the RADIUS scheme as follows:

```
[SW5500-radius-NewSchemeName]user-name-format without-domain
```

AAA and RADIUS Protocol Fault Diagnosis and Troubleshooting

The RADIUS protocol of the TCP/IP protocol suite is located on the application layer. It mainly specifies how to exchange user information between NAS and RADIUS server of ISP. So it is likely to be invalid.

Fault One: User authentication/authorization always fails

Troubleshooting:

- The username may not be in the *userid@isp-name* format or NAS has not been configured with a default ISP domain. Use the username in proper format and configure the default ISP domain on NAS.
- The user may have not been configured in the RADIUS server database. Check the database and make sure that the configuration information of the user does exist in the database.
- The user may have input a wrong password. So make sure that the user inputs the correct password.
- The encryption keys of RADIUS server and NAS may be different. Check carefully and make sure that they are identical.
- There might be some communication fault between NAS and RADIUS server, which can be discovered through pinging RADIUS from NAS. So ensure there is normal communication between NAS and RADIUS.

Fault Two: RADIUS packet cannot be transmitted to RADIUS server.

Troubleshooting:

- The communication lines (on physical layer or link layer) connecting NAS and the RADIUS server may not work well. So ensure the lines work well.
- The IP address of the corresponding RADIUS server may not have been set on NAS. Set a proper IP address for RADIUS server.
- UDP ports of authentication/authorization and accounting services may not be set properly. So make sure they are consistent with the ports provided by RADIUS server.

Fault Three: After being authenticated and authorized, the user cannot send charging bill to the RADIUS server.

Troubleshooting:

- The accounting port number may be set improperly. Please set a proper number.
- The accounting service and authentication/authorization service are provided on different servers, but NAS requires the services to be provided on one server (by specifying the same IP address). So make sure the settings of the servers are consistent with the actual conditions.

Problem Diagnosis

The Switch 5500 provides debugging of RADIUS. Terminal debugging can be enabled with the command:

```
<5500-xx>terminal debugging
```

Once enabled, different debug traces can be enabled to the terminal. For example, to turn on RADIUS debugging, enter the command:

- `<5500-xx> debugging radius packet`

3Com-User-Access-Level

This determines the Access level a user will have with Switch login. This can be administrator, manager , monitor or visitor.

You may need to add the return list attributes to a dictionary file using the following information:

```
VENDOR     3Com                    43

ATTRIBUTE  3Com-User-Access-Level  1              Integer  3Com

VALUE      3Com-User-Access-Level  Visit          0
VALUE      3Com-User-Access-Level  Monitor        1
VALUE      3Com-User-Access-Level  Manager        2
VALUE      3Com-User-Access-Level  Administrator  3
```

22 FILE SYSTEM MANAGEMENT

This chapter covers the following topics:

- File System Overview
- File Attribute Configuration
- Configuring File Management
- Configuration File Backup and Restoration
- FTP Overview
- TFTP Overview
- MAC Address Table Management
- Device Management
- System Maintenance and Debugging
- Terminating the FTP Connection of a Specified User
- Restarting the Switch
- Displaying the State and Information of the System
- Testing Tools for Network Connection
- Remote-ping Configuration
- Logging Function
- RMON Configuration
- NTP Overview
- NTP Configuration
- SSH Terminal Services
- File Attribute Configuration
- FTP Lighting Configuration
- TFTP Lighting Configuration

File System Overview

The Switch provides a flash file system for efficient management of the storage devices such as flash memory. The file system offers file access and directory management, including creating the file system, creating, deleting, modifying and renaming a file or a directory, and opening a file.

By default, the file system requires that the user confirm before executing commands. This prevents unwanted data loss.

In the Switches supporting XRN, the file URL must start with “unit[No.]>flash:/:”, the [No.] is the unit ID. For example, suppose unit ID is 1, and the URL of the “text.txt” file under the root directory must be “unit1>flash:/text.txt”.

Based on the operated objects, the file system can be divided as follows:

- Directory operation
- File operation
- Storage device operation
- Set the prompt mode of the file system

Directory Operation

You can use the file system to create or delete a directory, display the current working directory, and display the information about the files or directories under a specified directory. You can use the following commands to perform directory operations.

Perform the following configuration in User View.

Table 471 Directory Operation

Operation	Command
Create a directory	**mkdir** *directory*
Delete a directory	**rmdir** *directory*
Display the current working directory	**pwd**
Display the information about directories or files	**dir [/ all] [** *file-url* **]**
Change the current directory	**cd** *directory*

File Attribute Configuration

The app, configuration and web files support three attributes: main, backup and none, as described in Table 472.

Table 472 File attribute description

Attribute name	Purpose	Characteristic	Display identifier
main	Identify the main boot file, which takes precedence over other files when the switch starts up.	There can be respectively only one App/configuration/Web file having the main attribute in the flash memory.	(*)
backup	Identify the backup boot file, which is used when the switch fails to start up by using the main boot file.	There can be respectively only one App/configuration/Web file having the backup attribute in the flash memory.	(b)
none	Identify other files whose attribute is neither main nor backup.		None

*A file can have both main and backup attributes; this kind of files are identified by *b.*

The file with the main attribute will lose the main attribute when you assign the main attribute to another file (which now has the main attribute). This ensures that there is only one App/configuration/Web file having the main attribute in the flash memory. It is the same with the backup attribute.

The operation on file and the operation on file attribute are separate. For example, you delete a file with the main attribute from the flash memory; however, the mapping relationship between the main attribute and the name of this file is not cancelled. And after you download another valid file having the same name to the flash memory, this new file will inherit the main attribute.

The file attribute characteristic of switch is compatible with the earlier released versions. After the BootROM is updated, the original default App boot file takes the main attribute.

File Attribute Configuration

You can assign the main/backup attribute to a file so as to use this file as the main/backup startup file upon next startup of switch, check the main and backup files, and toggle between the main and backup attributes of file.

You can use an App, BootROM, or Web file on one unit in the fabric to update all other units in the fabric. You can easily update the key software (including App, BootROM and Web) on the whole fabric through CLI (command line interface).

Perform the following operations in user view (among which, the **display** commands can be executed in any view).

Table 473 Assign attributes to files

Operation	Command	Description
Assign the main attribute to a file so as to use this file as the main boot file upon next startup	**boot boot-loader** *file-url* [**fabric**]	Optional
Assign the backup attribute to a file so as to use this file as the backup boot file upon next startup	**boot boot-loader backup-attribute** *file-url* [**fabric**]	Optional
Assign the main or backup attribute to a Web file so as to use this file as the main or backup Web file upon next startup.	**boot web-package** *webfile* { **backup** | **main** }	Optional
Assign the main or backup attribute to a configuration file so as to use this file as the main or backup configuration file upon next startup.	**startup saved-configuration** *cfgfile* [**backup** | **main**]	Optional Executing this command with neither **backup** nor **main** keyword will assign the main attribute to the configuration file by default.
Configure the switch(es) to use null configuration file upon next startup	**undo startup saved-configuration** [**unit** *unit-id*]	Optional
Toggle between the main and backup attributes of file	**boot attribute-switch** { **all** | **app** | **configuration** | **web** }	Optional
Enable the user to enter the main Boot Menu with customized password	startup bootrom-access enable	Optional By default, the user is disabled from entering the main Boot Menu with customized password.
Display the information about the App boot files	**display boot-loader** [**unit** *unit-id*]	Optional You can execute the **display** commands in any view.
Display the information about the startup configuration files	**display startup** [**unit** *unit-id*]	

You can assign the main/backup attribute to a file on the whole fabric only when the file exists in all the switches of the fabric.

The assignment of the main or backup attribute to a Web file takes effect immediately without the need of restarting the switches.

Currently, the configuration files use .cfg as the extension names, and are stored in the root directory of the storage.

File Operation

The file system can be used to delete or undelete a file and permanently delete a file. Also, it can be used to display file contents, rename, copy and move a file and display the information about a specified file.

Using the **delete file-url** command to delete a file, leaves the contents of the file on the flash file system and does not free flash space. The file can be recovered using the **undelete** command. To delete a file and free space on the flash file system use the **delete /unreserved file-url** command. Using this command will ensure that space is made available on the flash file system for additional information. To ensure that all deleted files have been removed from the system use the **reset recycle-bin** command, this will prompt for removal of all files in the file system.

When operating in a stack of switches to clear space the user has to change to the flash of each switch in the stack separately and then clear space in the file system of each switch in turn. Use the **cd directory** *command for changing focus to a different switches file system or the* `unit2>flash: device name` *parameter for the command "reset recycle".*

You can use the following commands to perform file operations.

Perform the following configuration in User View.

Table 474 File Operation

Operation	Command
Update the software on the whole fabric	**update fabric** *file-name*
Delete a file	**delete [/unreserved]** *file-url*
Undelete a file	**undelete** *file-url*
Delete a file from the recycle bin permanently	**reset recycle-bin** *file-url*
View contents of a file	**more** *file-url*
Rename a file	**rename** *fileurl-source fileurl-dest*
Copy a file	**copy** *fileurl-source fileurl-dest*
Move a file	**move** *fileurl-source fileurl-dest*
Display the information about directories or files	**dir [/ all] [** *file-url* *

Perform the following configuration in System View.

Table 475 Execute the Specified Batch File

Operation	Command
Execute the specified batch file	**execute** *filename*

Storage Device Operation

The file system can be used to format a specified memory device. You can use the following commands to format a specified memory device.

Perform the following configuration in User View.

Table 476 Storage Device Operation

Operation	Command
Format the storage device	**format** *filesystem*

Setting the Prompt Mode of the File System

The following command can be used for setting the prompt mode of the current file system.

Perform the following configuration in System View.

Table 477 File System Operation

Operation	Command
Set the file system prompt mode.	**file prompt { alert | quiet }**

Configuring File Management

The management module of the configuration file provides a user-friendly operation interface. It saves the configuration of the Switch in the text format of command line to record the whole configuration process. Thus you can view the configuration information conveniently.

The format of the configuration file includes:

- It is saved in the command format.
- Only the non-default constants will be saved
- The organization of commands is based on command views. The commands in the same command mode are sorted in one section. The sections are separated with a blank line or a comment line (a comment line begins with exclamation mark "#").
- Generally, the sections in the file are arranged in the following order: system configuration, ethernet port configuration, vlan interface configuration, routing protocol configuration and so on.
- It ends with "return".

The management over the configuration files includes:

- Display the current-configuration and saved-configuration of the Switch
- Save the current-configuration
- Erase configuration files from Flash Memory

Displaying the Current-configuration and Saved-configuration of the Switch

After being powered on, the system reads the configuration files from Flash for the initialization of the device. (Such configuration files are called saved-configuration files.) If there is no configuration file in Flash, the system will begin the initialization with the default parameters. Relative to the saved-configuration, the configuration in effect during the operating process of the system is called current-configuration. You can use the following commands to display the current-configuration and saved-configuration information of the Switch.

Perform the following configuration in all views.

Table 478 Display the Configurations of the Switch

Operation	Command
Display the saved-configuration information of the Switch	**display saved-configuration**
Display the current-configuration information of the Switch	**display current-configuration [controller | interface** *interface-type* **[** *interface-number* **] | configuration [** *configuration* **]] [| { begin | exclude | include }** *regular-expression* **]**
Display the running configuration of the current view	**display this**

The configuration files are displayed in their corresponding saving formats.

Saving the Current-configuration

Use the **save** command to save the current-configuration in the Flash Memory, and the configurations will become the saved-configuration when the system is powered on for the next time.

Perform the following configuration in any view.

Table 479 Save the Current-Configuration

Operation	Command
Save the current-configuration	**save** [*file-name* | **safely**]

After a Fabric is formed, if you execute the **save** command, every switch in the Fabric saves the current configuration to its individual configuration file. If you do not enter the *file-name* parameter in this command, for the Switches that have specified the configuration file for booting, the current configurations will be stored to the specified configuration file; and for the Switches that have not specified the configuration file for booting, the current configurations will be stored to the default configuration file, which is sw5500cfg.cfg for Series 5500 Switches.

Erasing Configuration Files from Flash Memory

The **reset saved-configuration** command can be used to erase configuration files from Flash Memory. The system will use the default configuration parameters for initialization when the Switch is powered on for the next time.

Perform the following configuration in User View.

Table 480 Erase Configuration Files from Flash Memory

Operation	Command
Erase configuration files from Flash Memory	**reset saved-configuration**

You may erase the configuration files from the Flash in the following cases:

- After being upgraded, the software does not match with the configuration files.
- The configuration files in flash are damaged. (A common case is that a wrong configuration file has been downloaded.)

Configuring the Name of the Configuration File used for the Next Startup.

Perform the following configuration in User View.

Table 481 Configure the Name of the Configuration File used for the Next Startup

Operation	Command
Configure the name of the configuration file used for the next startup	**startup saved-configuration** *cfgfile*

cfgfile is the name of the configuration file and its extension name can be ".cfg". The file is stored in the root directory of the storage devices.

After the above configuration, execute **display** command in all views to display the running of the configuration files, and to verify the effect of the configuration.

Table 482 Display the Information of the File used at Startup

Operation	Command
Display the information of the file used at startup	**display startup**

Configuration File Backup and Restoration

The configuration file backup and restoration feature enables you to perform the following tasks:

1. Copy the current configurations on switch to a file on a TFTP server as a backup.
2. Download the configuration file backed up on the TFTP server to switch, and set this file as the configuration file that will be used upon next start.

Configuration Preparation

Before performing the following operations, you should first start the TFTP server and make sure the switch can communicate with the TFTP server normally.

Configuration Procedure

Perform the following operations in user view.

Table 483 Back up and restore configuration file

Operation	Command	Description
Back up the current configurations on one specified switch or all the switches in the fabric to a file on a TFTP server.	**backup** { **unit** *unit-id* | **fabric** } **current-configuration to** *tftp-address file-name*	Optional
Download configuration the file backed up on a TFTP server to switch and set the file to the configuration file used upon next startup of switch	**restore** { **unit** *unit-id* | **fabric** } **startup-configuration from** *tftp-address file-name*	Optional

FTP Overview

FTP is a common way to transmit files on the Internet and IP network. Before the World Wide Web (WWW), files were transmitted in the command line mode and FTP was the most popular application. Even now, FTP is still used widely, while most users transmit files using e-mail and Web.

FTP, a TCP/IP protocol on the application layer, is used for transmitting files between a remote server and a local host.

The Switch provides the following FTP services:

- FTP server: You can run FTP client program to log in the server and access the files on it.
- FTP client: After connected to the server through running the terminal emulator or Telnet on a PC, you can access the files on it, using FTP command.

Figure 112 FTP Configuration

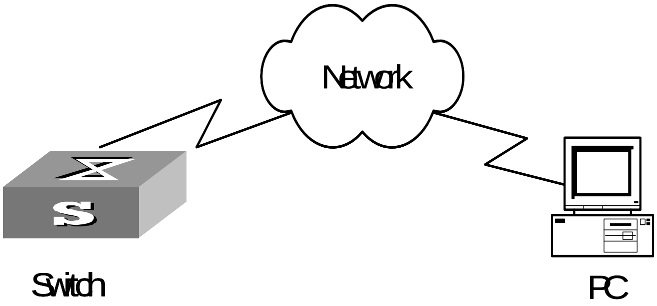


Table 484 Configuration of the Switch as FTP Client

Device	Configuration
Default	Description
Switch	Log into the remote FTP server directly with the **`ftp`** command.
--	You need first get FTP user command and password, and then log into the remote FTP server. Then you can get the directory and file authority.
PC	Start FTP server and make such settings as username, password, authority.
--	--

Table 485 Configuration of the Switch as FTP Server

Device	Configuration	Default	Description
Switch	Start FTP server.	FTP server is disabled.	You can view the configuration information of FTP server with the **`ftp-server`** command.
	Configure authentication and authorization for FTP server.	-	Configure username, password and authorized directory for FTP users.
	Configure running parameters for FTP server.	-	Configure timeout time value for FTP server.
PC	Log into the Switch from FTP client.	-	-

The prerequisite for normal FTP function is that the Switch and PC are reachable.

Enabling/Disabling FTP Server

You can use the following commands to enable/disable the FTP server on the Switch. Perform the following configuration in System View.

Table 486 Enable/Disable FTP Server

Operation	Command
Enable the FTP server	**`ftp server enable`**
Disable the FTP server	**`undo ftp server`**

FTP server supports multiple users to access at the same time. A remote FTP client sends request to the FTP server. Then, the FTP server will carry out the corresponding operation and return the result to the client.

By default, FTP server is disabled.

Configuring Source IP Address for FTP Serve and Client

You can configure source IP address or source interface for the FTP server and FTP client to enhance service manageability.

Table 487 shows the source IP address configuration tasks.

Table 487 Configure source IP address for FTP Server and Client

Operation	Command	Remarks
Enter system view	system-view	-
Specify source IP address for the FTP server	ftp-server source-ip ip-addr	Optional
Specify source interface for the FTP server	ftp-server source-interface interface-type interface-number	Optional
Use a specified source IP address to establish a connection with an FTP server	ftp { cluster | remote-server } source-ip ip-addr	Optional

Table 487 Configure source IP address for FTP Server and Client (continued)

Operation	Command	Remarks
Use a specified source interface to establish a connection with an FTP server	ftp { cluster | remote-server } source-interface interface-type interface-number	Optional
Specify source IP address for the FTP client	ftp source-ip ip-addr	Optional
Specify source interface for the FTP client	ftp source-interface interface-type interface-number	Optional

If the ip-addr in the command is not an address of the device, your configuration fails.

If you specify a non-existent interface in the command, your configuration fails.

Configuring the FTP Server Authentication and Authorization

You can use the following commands to configure FTP server authentication and authorization. The authorization information of FTP server includes the top working directory provided for FTP clients.

Perform the following configuration in the corresponding view.

Table 488 Configure the FTP Server Authentication and Authorization

Operation	Command
Create new local user and enter local User View (System View)	**local-user** *username*
Delete local user (System View)	**undo local-user [** *username* | **all [service-type ftp]]**
Configure password for local user (Local User View)	**password [cipher** | **simple]** *password*
Configure service type for local user (Local User View)	**service-type ftp ftp-directory** *directory*
Cancel password for local user (Local User View)	**undo password**
Cancel service type for local user (Local User View)	**undo service-type ftp [ftp-directory]**
Set the password displaymode of local users	**local-user-password-display-mode [auto** | **cipher-force]**

Only the clients who have passed the authentication and authorization successfully can access the FTP server.

Configuring the Running Parameters of FTP Server

You can use the following commands to configure the connection timeout of the FTP server. If the FTP server receives no service request from the FTP client for a period of time, it will cut the connection to it, thereby avoiding the illegal access from the unauthorized users. The period of time is FTP connection timeout.

Perform the following configuration in System View.

Table 489 Configure FTP Server Connection Timeout

Operation	Command
Configure FTP server connection timeouts	**ftp timeout** *minute*
Restoring the default FTP server connection timeouts	**undo ftp timeout**

By default, the FTP server connection timeout is 30 minutes.

Displaying and Debugging FTP Server

After the above configuration, execute *display* command in all views to display the running of the FTP Server configuration, and to verify the effect of the configuration.

Table 490 Display and Debug FTP Server

Operation	Command
Display FTP server	**display ftp-server**
Display the connected FTP users.	**display ftp-user**

The **display ftp-server** command can be used for displaying the configuration information about the current FTP server, including the maximum amount of users supported by the FTP server and the FTP connection timeout. The **display ftp-user** command can be used for displaying the detailed information about the connected FTP users.

Displaying the Source IP Address Configuration

Use the display commands in any view to display the source IP address configuration for service packets.

Table 491 Display the source IP address FTP Server and Client

Operation	Command
Display the source IP address of the FTP server	display ftp-server source-ip
Display the source IP address of the FTP client	display ftp source-ip

Introduction to FTP Client

As an additional function provided by the Switch, FTP client is an application module and has no configuration functions. The Switch connects the FTP clients and the remote server and inputs the command from the clients for corresponding operations (such as creating or deleting a directory).

Configuring Source IP Address for TFTP Service Packets

You can configure source IP address or source interface for the TFTP server and TFTP client, to enhance service manageability.

Table 492 shows the source IP address configuration tasks.

Table 492 Configure source IP address for service packets

Operation	Command	Remarks
Enter system view	system-view	-
Use a specified source IP address to establish a connection with a TFTP server	tftp tftp-server source-ip ip-addr	Optional
Use a specified source interface to establish a connection with a TFTP server	tftp tftp-server source-interface interface-type interface-number	Optional
Specify source IP address for the TFTP client	tftp source-ip ip-addr	Optional

If the ip-addr in the command is not an address of the device, your configuration fails.

If you specify a non-existent interface in the command, your configuration fails.

Displaying the Source IP Address of the FTP Client

Use the display command in any view to display the source IP address of the FTP client for service packets.

Table 493 Display the source IP address of the FTP Client

Operation	Command
Display the source IP address of the TFTP client	display tftp source-ip

FTP Client Configuration Example

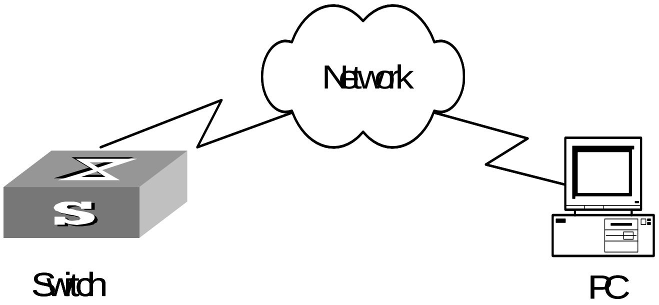
Networking Requirement

The Switch serves as the FTP client and the remote PC as the FTP server. The configuration on the FTP server: Configure a FTP user named as Switch, with the password hello and with read and write authority over the Switch root directory on the PC. The IP address of a VLAN interface on the Switch is 1.1.1.1, and that of the PC is 2.2.2.2. The Switch and PC are reachable.

The Switch application *switch.app* is stored on the PC. Using FTP, the Switch can download the **switch.app** from the remote FTP server and upload the *config.cfg* to the FTP server under the Switch directory for backup purpose.

Networking Diagram

Figure 113 Networking for FTP Configuration



Configuration Procedure

1 Configure the FTP server parameters on the PC: a user named as Switch, password hello, read and write authority over the Switch directory on the PC.

2 Configure the Switch

Log into the Switch (locally through the Console port or remotely using Telnet).

```
<SW5500>
```

⚠ *If the flash memory of the Switch is not enough, you need to first delete the existing programs in the flash memory and then upload the new ones.*

Type in the right command in User View to establish FTP connection, then correct username and password to log into the FTP server.

```
<SW5500> ftp 2.2.2.2
Trying ...
Press CTRL+K to abort
Connected.
220 WFTPD 2.0 service (by Texas Imperial Software) ready for new user
User(none):switch
331 Give me your password, please
```

```
Password:*****
230 Logged in successfully
[ftp]
```

3 Type in the authorized directory of the FTP server.

```
[ftp]cd switch
```

4 Use the **put** command to upload the config.cfg to the FTP server.

```
[ftp]put config.cfg
```

5 Use the **get** command to download the switch.app from the FTP server to the flash directory on the FTP server.

```
[ftp]get switch.app
```

6 Use the **quit** command to release FTP connection and return to User View.

```
[ftp]quit
<SW5500>
```

7 Use the **boot boot-loader** command to specify the downloaded program as the application at the next login and reboot the Switch.

```
<SW5500> boot boot-loader switch.app
<SW5500> reboot
```

FTP Server Configuration Example

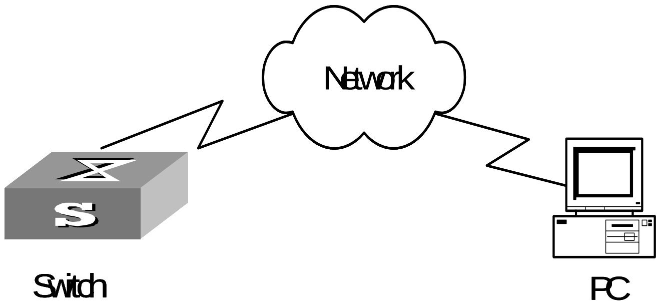
Networking Requirement

The Switch serves as FTP server and the remote PC as FTP client. The configuration on FTP server: Configure a FTP user named as Switch, with password hello and with read and write authority over the flash root directory on the PC. The IP address of a VLAN interface on the Switch is 1.1.1.1, and that of the PC is 2.2.2.2. The Switch and PC are reachable.

The Switch application *switch.app* is stored on the PC. Using FTP, the PC can upload the *switch.app* from the remote FTP server and download the *config.cfg* from the FTP server for backup purpose.

Networking Diagram

Figure 114 Networking for FTP Configuration



1 Configure the Switch

Log into the Switch (locally through the Console port or remotely using Telnet).

```
<SW5500>
```

2 Start FTP function and set username, password and file directory.

```
[SW5500]ftp server enable
[SW5500]local-user switch
[SW5500-luser-switch]service-type ftp ftp-directory flash:
[SW5500-luser-switch]password simple hello
```

3 Run FTP client on the PC and establish FTP connection. Upload the *switch.app* to the Switch under the Flash directory and download the *config.cfg* from the Switch. FTP client is not shipped with the Switch, so you need to buy it separately.

⚠ *If the flash memory of the Switch is not enough, you need to first delete the existing programs in the flash memory and then upload the new ones.*

4 When the uploading is completed, initiate the file upgrade on the Switch.

```
<SW5500>
```

Use the **boot boot-loader** command to specify the downloaded program as the application at the next login and reboot the Switch.

```
<SW5500> boot boot-loader switch.app
<SW5500> reboot
```

TFTP Overview

Trivial File Transfer Protocol (TFTP) is a simple protocol for file transmission. Compared with FTP, another file transmission protocol, TFTP has no complicated interactive access interface or authentication control, and therefore it can be used when there is no complicated interaction between the clients and server. TFTP is implemented on the basis of UDP.

TFTP transmission is originated from the client end. To download a file, the client sends a request to the TFTP server and then receives data from it and sends an acknowledgement to it. To upload a file, the client sends a request to the TFTP server and then transmits data to it and receives the acknowledgement from it. TFTP transmits files in two modes: binary mode for program files and ASCII mode for text files.

Figure 115 TFTP Configuration

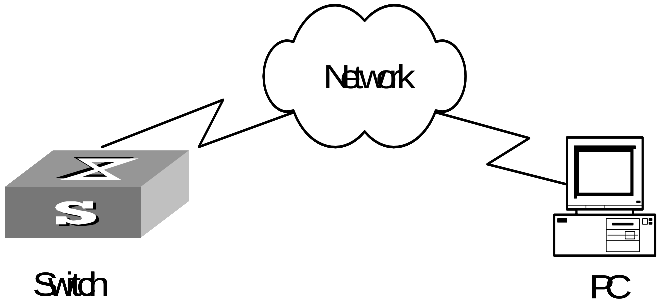


Table 494 Configuration of the Switch as TFTP Client

Device	Configuration	Default	Description
Switch	Configure IP address for the VLAN interface of the Switch, in the same network segment as that of TFTP server.	-	TFTP is right for the case where no complicated interactions are required between the client and server. Make sure that the IP address of the VLAN interface on the Switch is in the same network segment as that of the TFTP server.
	Use the **tftp** command to log into the remote TFTP server for file uploading and downloading.	-	-
PC	Start TFTP server and set authorized TFTP directory.	-	-

Downloading Files by means of TFTP

To download a file, the client sends a request to the TFTP server and then receives data from it and sends acknowledgement to it. You can use the following commands to download files by means of TFTP.

Perform the following configuration in User View.

Table 495 Download Files by means of TFTP

Operation	Command
Download files by means of TFTP	**tftp** *tftp-server* **get** *source-file* **[** *dest-file* **]**

Uploading Files by means of TFTP

To upload a file, the client sends a request to the TFTP server and then transmits data to it and receives the acknowledgement from it. You can use the following commands to upload files.

Perform the following configuration in User View.

Table 496 Upload Files by means of TFTP

Operation	Command
Upload files by means of TFTP	**tftp** *tftp-server* **put** *source-file* **[** *dest-file* **]**

TFTP Client Configuration Example

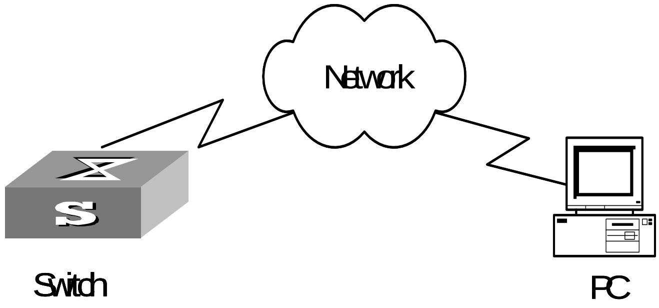
Networking Requirement

The Switch serves as TFTP client and the remote PC as TFTP server. Authorized TFTP directory is set on the TFTP server. The IP address of a VLAN interface on the Switch is 1.1.1.1, and that of the PC is 2.2.2.2. The interface on the Switch connecting the PC belong to the same VLAN.

The Switch application *switch.app* is stored on the PC. Using TFTP, the Switch can download the *switch.app* from the remote TFTP server and upload the *config.cfg* to the TFTP server under the Switch directory for backup purpose.

Networking Diagram

Figure 116 Networking for TFTP Configuration



Configuration Procedure

1 Start TFTP server on the PC and set authorized TFTP directory.

2 Configure the Switch

Log into the Switch (locally through the Console port or remotely using Telnet).

```
<SW5500>
```

If the flash memory of the Switch is not enough, you need to first delete the existing programs in the flash memory and then upload the new ones.

3 Enter System View and download the switch.app from the TFTP server to the flash memory of the Switch.

```
<SW5500> system-view
[SW5500]
```

4 Configure IP address 1.1.1.1 for the VLAN interface, ensure the port connecting the PC is also in this VALN (VLAN 1 in this example).

```
[SW5500]interface vlan 1
[SW5500-vlan-interface1]ip address 1.1.1.1 255.255.255.0
[SW5500-vlan-interface1]quit
```

5 Upload the *config.cfg* to the TFTP server.

```
<SW5500> tftp 1.1.1.2 put config.cfg config.cfg
```

6 Download the *switch.app* from the TFTP server.

```
<SW5500> tftp 1.1.1.2 get switch.app switch.app
```

7 Use the **boot boot-loader** command to specify the downloaded program as the application at the next login and reboot the Switch.

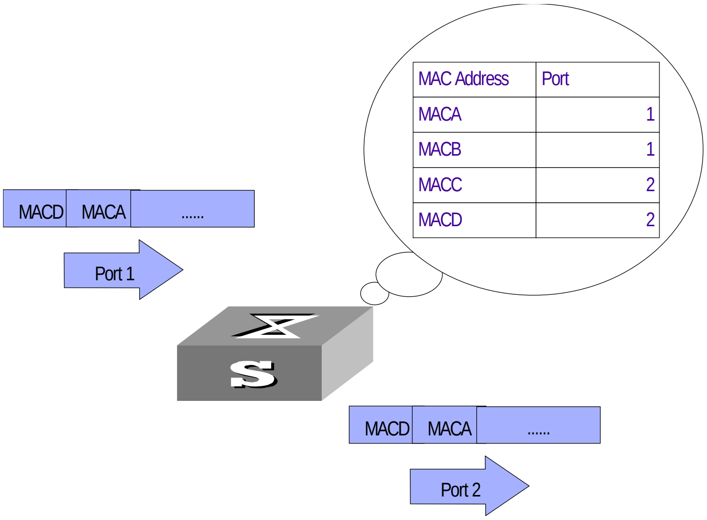
```
<SW5500> boot boot-loader switch.app
<SW5500> reboot
```

MAC Address Table Management

A Switch maintains a MAC address table for fast forwarding packets. A table entry includes the MAC address of a device and the port ID of the Switch connected to it. The dynamic entries (not configured manually) are learned by the Switch. The Switch learns a MAC address in the following way: after receiving a data frame from a port (assumed as port A), the Switch analyzes its source MAC address (assumed as MAC_SOURCE) and considers that the packets destined at MAC_SOURCE can be forwarded using the port A. If the MAC address table contains the MAC_SOURCE, the Switch will update the corresponding entry, otherwise, it will add the new MAC address (and the corresponding forwarding port) as a new entry to the table.

The system forwards the packets whose destination addresses can be found in the MAC address table directly through the hardware and broadcasts those packets whose addresses are not contained in the table. The network device will respond after receiving a broadcast packet and the response contains the MAC address of the device, which will then be learned and added into the MAC address table by the Switch. The consequent packets destined for the same MAC address can be forwarded directly thereafter.

Figure 117 The Switch Forwards Packets with MAC Address Table



The Switch also provides the function of MAC address aging. If the Switch receives no packet for a period of time, it will delete the related entry from the MAC address table. However, this function takes no effect on the static MAC addresses.

You can configure (add or modify) the MAC address entries manually according to the actual networking environment. The entries can be static ones or dynamic ones.

MAC Address Table Configuration

MAC address table management includes:

- Setting MAC Address Table Entries
- Setting MAC Address Aging Time
- Setting the Max Count of MAC Addresses Learned by a Port

Setting MAC Address Table Entries

Administrators can manually add, modify, or delete the entries in MAC address table according to the actual needs. They can also delete all the (unicast) MAC address table entries related to a specified port or delete a specified type of entry, such as dynamic entries or static entries.

You can use the following commands to add, modify, or delete the entries in the MAC address table.

Perform the following configuration in System View.

Table 497 Set MAC Address Table Entries

Operation	Command
Add/Modify an address entry	**mac-address { static | dynamic | blackhole }** *mac-address* **interface {** *interface-name* | *interface-type interface-num* **} vlan** *vlan-id*
Delete an address entry	**undo mac-address [{ static | dynamic | blackhole }** *mac-address* **interface {** *interface-name* | *interface-type interface-num* **} vlan** *vlan-id* **]**

When deleting the dynamic address table entries, the learned entries will be deleted simultaneously.

Setting MAC Address Aging Time

Setting an appropriate aging time implements MAC address aging. Too long or too short an aging time set by subscribers will cause the Ethernet switch to flood a large amount of data packets. This affects the switch operation performance.

If the aging time is set too long, the Switch will store a great number of out-of-date MAC address tables. This will consume MAC address table resources and the Switch will not be able to update the MAC address table according to the network change.

If the aging time is set too short, the Switch may delete valid MAC address table entries.

You can use the following commands to set the MAC address aging time for the system.

Perform the following configuration in System View.

Table 498 Set the MAC Address Aging Time for the System

Operation	Command
Set the dynamic MAC address aging time	**mac-address timer { aging** *age* | **no-aging }**
Restore the default MAC address aging time	**undo mac-address timer aging**

In addition, this command takes effect on all the ports. However the address aging only functions on the dynamic addresses (manual entries added to the Switch are not aged).

By default, the *aging-time* is 300 seconds. With the **no-aging** parameter, the command performs no aging on the MAC address entries.

Setting the Max Count of MAC Addresses Learned by a Port

With the address learning function, a Switch can learn new MAC addresses. After its received a packet destined for an already learned MAC address, the Switch will forward it directly with the hardware, instead of broadcasting it. However, too many MAC address items learned by a port will affect the Switch operation performance.

You can control the MAC address items learned by a port through setting the max count of MAC addresses learned by a port. If a user sets the max count value of a port as *count*, the port will not learn new MAC address items when the count of MAC address items reaches the *count* value.

You can use the following commands to set the max count of MAC addresses learned by a port.

Perform the following configuration in Ethernet Port View.

Table 499 Set the Max Count of MAC Address Learned by a Port

Operation	Command
Set the Max Count of MAC Address Learned by a Port	**mac-address max-mac-count** *count*
Restore the default Max Count of MAC Address Learned by a Port	**undo mac-address max-mac-count**

By default, there is no limit to the MAC addresses learned using the Ethernet port.

Displaying MAC Address Table

After the above configuration, execute the **display** command in all views to display the running of the MAC address table configuration, and to verify the effect of the configuration.

Execute the **debugging** command in User View to debug MAC address table configuration.

Table 500 Display and Debug MAC Address Table

Operation	Command
Display the information in the address table	**display mac-address [** *mac-addr* **[vlan** *vlan-id* **]** | **[static** | **dynamic** | **blackhole] [interface {** *interface-name* | *interface-type interface-num* **}] [vlan** *vlan-id* **] [count]]**
Display the aging time of dynamic address table entries	**display mac-address aging-time**

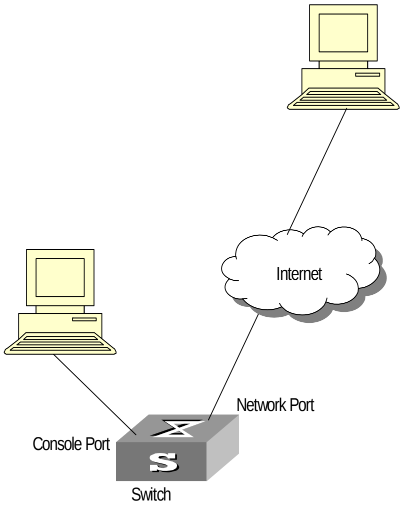
MAC Address Table Management Display Example

Networking requirements

The user logs into the switch using the Console port to display the MAC address table. Switch display the entire MAC address table of the the switch. If this switch is a member of a stack then the entire database of all the switches will be shown here.

Networking diagram

Figure 118 Display MAC address table



Configuration procedure

The **display** command shows a stack wide view of the MAC address table.

```
[SW5500]display mac-address
MAC ADDR        VLAN ID STATE PORT INDEX AGING TIME(s)
00e0-fc00-3943     1  Learned Ethernet1/0/11         300
0000-0000-5100     1 Learned Ethernet2/0/22         300
0020-9c08-e774     1 Learned Ethernet2/0/7          288
0000-0000-5000     1 Learned Ethernet2/0/3          143
  ---  4 mac address(es) found  ---
```

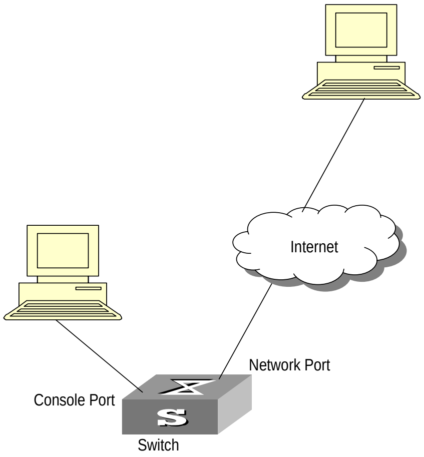
MAC Address Table Management Configuration Example

Networking Requirements

The user logs into the Switch using the Console port to configure the address table management. It is required to set the address aging time to 500s and add a static address 00e0-fc35-dc71 to Ethernet1/0/2 in vlan1.

Networking Diagram

Figure 119 Typical Configuration of Address Table Management



Configuration Procedure

1 Enter the System View of the Switch.

```
<SW5500> system-view
```

2 Add a MAC address (specify the native VLAN, port and state).

```
[SW5500]mac-address static 00e0-fc35-dc71 interface ethernet1/0/2 vlan
1
```

3 Set the address aging time to 500s.

```
[SW5500]mac-address timer aging 500
```

4 Display the MAC address configurations in all views.

```
[SW5500]display mac-address interface ethernet1/0/2
MAC ADDR        VLAN IDSTATEPORT INDEXAGING TIME(s)
00-e0-fc-35-dc-711StaticEthernet1/0/2NOAGED
00-e0-fc-17-a7-d61LearnedEthernet1/0/2500
00-e0-fc-5e-b1-fb1LearnedEthernet1/0/2500
00-e0-fc-55-f1-161LearnedEthernet1/0/2500
---  4 mac address(es) found ---
```

Device Management

With the device management function, the Switch can display the current running state and event debugging information about the unit, thereby implementing the maintenance and management of the state and communication of the physical devices. In addition, there is a command available for rebooting the system, when some function failure occurs.

The device management configuration task is simple. As far as a user is concerned, it is mainly to display and debug the device management.

Device Management Configuration

Rebooting the Switch

It is necessary to reboot the Switch when failure occurs.

Perform the following configuration in User View.

Table 501 Reboot the Switch

Operation	Command
Reboot the Switch	**reboot [unit** *unit-id* **]**

Enabling the Timing Reboot Function

After enabling the timing reboot function on the Switch, the Switch will be rebooted at the specified time.

Perform the following configuration in User View, and the **display schedule reboot** command can be performed in any view.

Table 502 Reboot the Switch

Operation	Command
Enable the timing reboot function of the Switch, and set specified time and date	**schedule reboot at** *hh:mm* **[** *yyyy/mm/dd* **]**
Enable the timing reboot function of the Switch, and set waiting time	**schedule reboot delay {** *hhh:mm* | *mmm* **}**
Cancel the parameter configuration of timing reboot function of the Switch	**undo schedule reboot**
Check the parameter configuration of the reboot terminal service of the current Switch	**display schedule reboot**

Designating the APP Adopted when Booting the Switch Next Time

In the case that there are several APPs in the Flash Memory, you can use this command to designate the APP adopted when booting the Switch next time.

Perform the following configuration in User View.

Table 503 Designate the APP Adopted when Booting the Switch Next Time

Operation	Command
Designate the APP adopted when booting the Switch next time	**boot boot-loader** *file-url*

Upgrading BootROM

You can use this command to upgrade the BootROM with the BootROM program in the Flash Memory. This configuration task facilitates the remote upgrade. You can upload the BootROM program file from a remote end to the Switch using FTP and then use this command to upgrade the BootROM.

Perform the following configuration in User View.

Table 504 Upgrade BootROM

Operation	Command
Upgrade BootROM	**boot bootrom** *file-url*

Displaying and Debugging Device Management

After the above configuration, execute **display** command in all views to display the running of the device management configuration, and to verify the effect of the configuration.

Table 505 Display and Debug Device Management

Operation	Command
Display the module types and running states of each card.	**display device [unit** *unit-id* **]**
Display the running state of the built-in fans.	**display fan [unit** *unit-id* **]**
Display the Used status of Switch memory	**display memory [unit** *unit-id* **]**
Display the state of the power.	**display power [unit** *unit-id* **] [** *power-ID* **]**
Display the APP to be applied when rebooting the Switch.	**display boot-loader [unit** *unit-id* **]**
Display the busy status of CPU	**display cpu [unit** *unit-id* **]**

Device Management Configuration Example

Networking Requirement

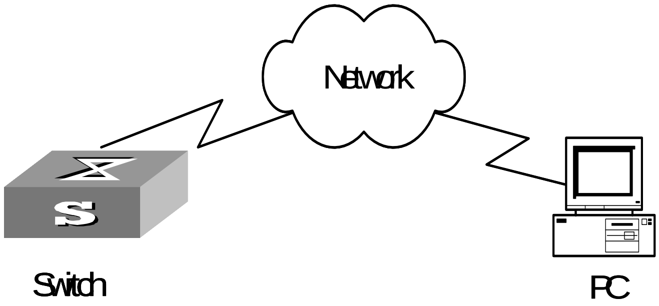
The user logs into the Switch using Telnet, downloads the application from the FTP server to the flash memory of the Switch, and implements remote upgrade using the right commands.

The Switch serves as FTP client and the remote PC as FTP server. The configuration on the FTP server: Configure an FTP user named as Switch, with password hello and with read and write authority over the Switch root directory on the PC. The IP address of a VLAN interface on the Switch is 1.1.1.1, and that of the PC is 2.2.2.2. The Switch and PC are reachable.

The Switch applications *Switch.app* and *boot.app* are stored on the PC. Using FTP, the Switch can download the *switch.app* and *boot.app* from the remote FTP server.

Networking Diagram

Figure 120 Networking for FTP Configuration



Configuration Procedure

1 Configure FTP server parameters on the PC. Define a user named as *Switch*, password *hello*, read and write authority over the Switch directory on the PC.

2 Configure the Switch

The Switch has been configured with a Telnet user named as *user*, as 3-level user, with password *hello*, requiring username and password authentication.

Use the **telnet** command to log into the Switch.

```
<SW5500>
```

If the flash memory of the Switch is not enough, you need to first delete the existing programs in the flash memory and then upload the new ones.

3 Type in the correct command in User View to establish FTP connection, then enter the correct username and password to log into the FTP server.

```
<SW5500> ftp 2.2.2.2
Trying ...
Press CTRL+K to abort
Connected.
220 WFTPD 2.0 service (by Texas Imperial Software) ready for new user
User(none):switch
331 Give me your password, please
Password:*****
230 Logged in successfully
[ftp]
```

4 Enter the authorized directory of the FTP server.

```
[ftp]cd switch
```

5 Use the **get** command to download the switch.app from the FTP server to the flash directory on the FTP server.

```
[ftp]get switch.app
[ftp]get boot.app
```

6 Use the **quit** command to release the FTP connection and return to User View.

```
[ftp]quit
<SW5500>
```

7 Upgrade BootROM.

```
<SW5500> boot bootrom boot.app
This will update BootRom file on unit 1. Continue? [Y/N]y
Upgrading BOOTROM, please wait...
Upgrade BOOTROM succeeded!
```

8 Use the `boot boot-loader` command to specify the downloaded program as the application at the next login and reboot the Switch.

```
<SW5500> boot boot-loader switch.app
<SW5500>display boot-loader
The app to boot at the next time is: flash:/Switch.app
The app to boot of board 0 at this time is: flash:/PLAT.APP
<SW5500> reboot
```

System Maintenance and Debugging

The following section describes System Maintenance and Debugging.

Setting the Daylight Saving Time

You can use the following command to set the name, time range and offset of the daylight saving time. This reduces your workload of manually adjusting the system time.

- The system adds an offset to the current time and toggles from the system time to the daylight saving time at the specified start date and time.
- The system subtracts an offset from the current time and toggles from the daylight saving time to the normal system time at the specified end date and time.

Perform the following operation in user view.

Table 506 Set the daylight saving time

Operation	Command	Description
Set the name and time range of the daylight saving time	**clock summer-time** *zone-name* { **one-off** | **repeating** } *start-time start-date end-time end-date add-time*	Optional

Telneting with Specified Source IP Address/Source Interface IP Address

When you use the **telnet** *ip-address* [*port*] command to log into another device from your current switch that acts as a Telnet client, you cannot specify the source IP address, because this address is selected by your switch automatically.

However, the following commands allow you to specify the source IP address/source interface IP address when you order the switch to initiate a Telnet connection. Furthermore, you can configure ACL to enhance the monitor of the network.

Perform the following operation in user view.

Table 507 Telnet to a server with specified source IP address/source interface IP address

Operation	Command	Description
Use a specified source IP address to initiate a Telnet connection	**telnet** *ip-address* [*port*] [**source-ip** *source-ip*]	Required
Use the IP address of a specified source interface to initiate a Telnet connection	**telnet** *ip-address* [*port*] [**source-interface vlan-interface** *vlan-interface-num*]	The source interface is a Layer 3 interface

Basic System Configuration

Setting the System Name for the Switch

Perform the operation of **sysname** command in the System View.

Table 508 Set the Name for the Switch

Operation	Command
Set the Switch system name	**sysname** *sysname*
Restore Switch system name to default value	**undo sysname**

Setting the System Clock

Perform the operation of **clock datetime** command in the User View.

Table 509 Set the System Clock

Operation	Command
Set the system clock	**clock datetime** *time date*

Setting the Time Zone

You can configure the name of the local time zone and the time difference between the local time and the standard Universal Time Coordinated (UTC).

Perform the following operations in the User View.

Table 510 Setting the Time Zone

Operation	Command
Set the local time	**clock timezone** *zone_name* **{ add | minus }** *HH:MM:SS*
Restore to the default UTC time zone	**undo clock timezone**

By default, the UTC time zone is adopted.

Setting the Summer Time

You can set the name, start and end time of the summer time.

Perform the following operations in the User View.

Table 511 Setting the Summer Time

Operation	Command
Set the name and range of the summer time	**clock summer-time** *zone_name* **{ one-off | repeating }** *start-time start-date end-time end-date offset-time*
Remove the setting of the summer time	**undo clock summer-time**

By default, the summer time is not set.

Terminating the FTP Connection of a Specified User

By using the following command, the network administrator can forcibly terminate the FTP connection of a specified user on the FTP server, in order to secure the operation of the network.

Table 512 Terminate the FTP connection of a specified user

Operation	Command	Description
Enter system view	system-view	—
Terminate the FTP connection of a specified user on the FTP server	**ftp disconnect** *user-name*	Required

Restarting the Switch

You can use the following command in user view to restart your switch when your switch is in trouble or needs to be restarted.*The system will check whether there is any configuration change before it restarts, and will ask whether you want to proceed or not if there is any change, to prevent you from losing your original configuration due to forgetting after the restart.*

Table 513 Restart the switch

Operation	Command	Description
Restart the switch	**reboot** [**unit** *unit-id*]	—

Displaying the State and Information of the System

The **`display`** commands can be classified as follows according to their functions.

- Commands for displaying the system configuration information
- Commands for displaying the system running state
- Commands for displaying the system statistics information

For the **`display`** commands related to each protocol and different ports, refer to the relevant chapters. The following **`display`** commands are used for displaying the system state and the statistics information.

Configuration agent is one of the XRN features. You can log into one Switch of the Fabric to configure and manage the Fabric. The functions of the configuration agent include:

- Distributing configuration commands to the right destination Switches or processing modules based on the resolution result of the commands input.
- Sending output information of the commands from the Switch you have logged into to your terminal.
- Supporting simultaneous configuration of multiple users.

You cannot configure the configuration agent, but can view the statistics of the configuration agent.

Perform the following operations in all views.

Table 514 The Display Commands of the System

Operation	Command
Display the system clock	**`display clock`**
Display the system version	**`display version`**
Display the saved-configuration	**`display saved-configuration`**

Table 514 The Display Commands of the System (continued)

Operation	Command
Display the current-configuration	**display current-configuration [controller** | **interface** *interface-type* **[** *interface-number* **]** | **configuration [** *configuration* **]] [** | **{ begin** | **exclude** | **include }** *regular-expression* **]**
Display the state of the debugging	**display debugging [interface {** *interface-name* | *interface-type interface-number* **}] [** *module-name* **]**
Display statistics of the configuration agent	**display config-agent unit-id** *unit-id*

System Debugging

Enable/Disable the Terminal Debugging

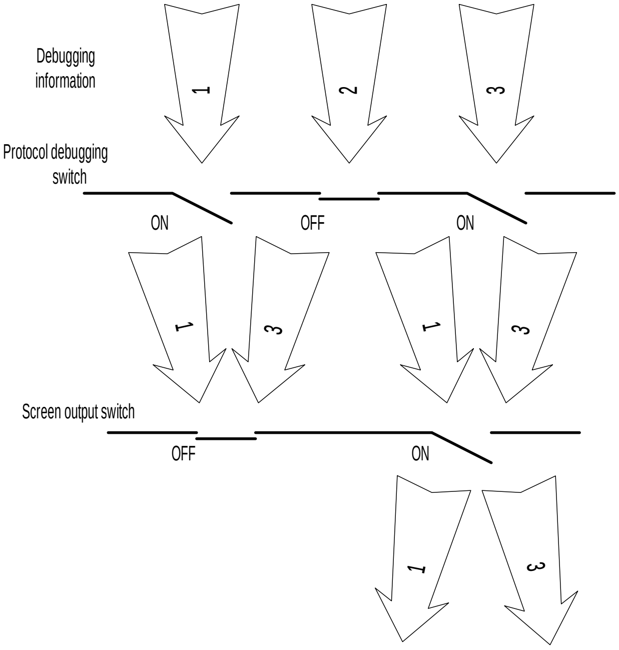
The Switch provides various ways for debugging most of the supported protocols and functions, which can help you diagnose and address the errors.

The following Switches can control the outputs of the debugging information:

- Protocol debugging Switch controls the debugging output of a protocol.
- Terminal debugging Switch controls the debugging output on a specified user screen.

Figure 121 illustrates the relationship between two Switches.

Figure 121 Debug Output



You can use the following commands to control the above-mentioned debugging.

Perform the following operations in User View.

Table 515 Enable/Disable the Debugging

Operation	Command
Enable the protocol debugging	**debugging { all [timeout** *interval* **] |** *module-name* **[** *debugging-option* **] }**
Disable the protocol debugging	**undo debugging { all | {** *protocol-name* | *function-name* **} [** *debugging-option* **] }**
Enable the terminal debugging	**terminal debugging**
Disable the terminal debugging	**undo terminal debugging**

For more about the usage and format of the debugging commands, refer to the relevant chapters.

Since the debugging output will affect the system operating efficiency, do not enable the debugging without necessity, especially use the **debugging all** *command with caution. When the debugging is over, disable all the debugging.*

By default, if multiple devices form a fabric, the debugging information of the master is broadcasted within the fabric and the debugging information of the slave is only displayed on the slave device. You can view the debugging information including that of the master and the device in which the login port resides.

You can enable the logging, debugging and trap information switches within the fabric by executing the **info-center switch-on all** command. Synchronization is a process that each switch sends its own information to the other switches in the fabric, and meantime receives information from others to update local information, ensuring the consistency of logging, debugging and trap information in a fabric.

After the synchronization of the whole fabric, a great deal of terminal display is generated. You are recommended not to enable the information synchronization switch of the whole fabric. If you enabled the information synchronization switch, after the synchronization information statistics and detection, you must execute the **undo info-center switch-on** *command to disable the switch in time.*

Display Diagnostic Information

You can collect information about the Switch to locate the source of a fault. However, each module has its corresponding **display** command, which makes it difficult to collate all the information needed. In this case, you can use **display diagnostic-information** command.

You can perform the following operations in all views.

Table 516 Display Diagnostic Information

Operation	Command	Description
Display the system diagnostic information, or save the system diagnostic information to a file (with a suffix of "diag") in the flash memory.	**display diagnostic-information**	You can execute these display commands in any view
Display the debugging switches opened on a specified switch or in the whole fabric	display debugging { fabric | unit *unit-id* } [interface *interface-type interface-number* | *module-name*]	
Display the debugging switches opened in the fabric by module names	**display debugging fabric by-module**	

Testing Tools for Network Connection

This section contains the tools necessary to test network connections.

ping

The **ping** command can be used to check the network connection and if the host is reachable.

Perform the following operation in all views.

Table 517 The ping Command

Operation	Command
Support IP ping	**ping [-a** *ip-address* **] [-c** *count* **] [-d] [-h** *ttl* **] [-i {** *interface-type interface-num* | *interface-name* **}] [ip] [-n] [- p** *pattern* **] [-q] [-r] [-s** *packetsize* **] [-t** *timeout* **] [-tos** *tos* **] [-v]** *host*

The output of the command includes:

- The response to each ping message. If no response packet is received when time is out, ”Request time out” information appears. Otherwise, the data bytes, the packet sequence number, TTL, and the round-trip time of the response packet will be displayed.
- The final statistics, including the number of the packets the Switch sent out and received, the packet loss ratio, the round-trip time in its minimum value, mean value and maximum value.

Test Periodically if the IP Address is Reachable

You can use the **end-station polling ip-address** command in System View to configure the IP address requiring periodical testing.

Perform the following configuration in System View.

Table 518 Test Periodically if the IP address is Reachable

Operation	Command
Configure the IP address requiring periodical testing	**end-station polling ip-address** *ip-address*
Delete the IP address requiring periodical testing	**undo end-station polling ip-address** *ip-address*

The Switch can ping an IP address every one minute to test if it is reachable. Three PING packets can be sent at most for every IP address in every testing with a time interval of five seconds. If the Switch cannot successfully ping the IP address after the three PING packets, it assumes that the IP address is unreachable.

You can configure up to 50 IP addresses by using the command repeatedly.

tracert

The **tracert** is used for testing the gateways passed by the packets from the source host to the destination one. It is mainly used for checking if the network is connected and analyzing where the fault occurs in the network.

The execution process of **tracert** is described as follows: Send a packet with TTL value as 1 and the first hop sends back an ICMP error message indicating that the packet cannot be sent, for the TTL is timeout. Re-send the packet with TTL value as 2 and the second hop returns the TTL timeout message. The process is carried over and over until the packet reaches the destination. The purpose to carry out the process is to record the source address of each ICMP TTL timeout message, so as to provide the route of an IP packet to the destination.

Perform the following operation in all views.

Figure 122 The tracert Command

Operation	Command
Trace route	**tracert [-a** *source-IP* **] [-f** *first-TTL* **] [-m** *max-TTL* **] [-p** *port* **] [-q** *nqueries* **] [-w** *timeout* **]** *string*

Introduction to Remote-ping

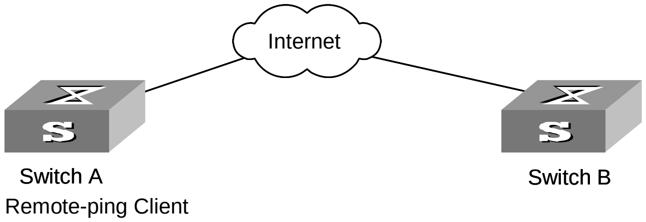
Remote-ping is a network diagnostic tool used to test the performance of protocols (only ICMP by far) operating on network. It is an enhanced alternative to the ping command.

Remote-ping test group is a set of remote-ping test parameters. A test group contains several test parameters and is uniquely identified by an administrator name plus a test tag.

You can perform an remote-ping test after creating a test group and configuring the test parameters.

Being different from the ping command, remote-ping does not display the round trip time (RTT) and timeout status of each packet on the console terminal in real time. You need to execute the display remote-ping command to view the statistic results of your remote-ping test operation. remote-ping allows administrators to set the parameters of remote-ping test groups and start remote-ping test operations.

Figure 123 Illustration for Remote-ping



Remote-ping Configuration

This section contains information on remote-ping.

Introduction to Remote-ping Configuration

The configuration tasks for remote-ping include:

- Enabling remote-ping Client
- Creating test group
- Configuring test parameters

The test parameters that you can configure include:

- Destination IP address

It is equivalent to the destination IP address in the ping command.

Test type. Currently, remote-ping supports only one test type: ICMP.

- Number of test packets sent in a test

If this parameter is set to a number greater than one, the system sends the second test packet once it receives a response to the first one, or when the test timer times out if it receives no response after sending the first one, and so forth until the last test packet is sent out. This parameter is equivalent to the -n parameter in the ping command.

Automatic test interval. This parameter is used to allow the system to automatically perform the same test at regular intervals.

- Test timeout time

Test timeout time is the time the system waits for an ECHO-RESPONSE packet after it sends out an ECHO-REQUEST packet. If no ECHO-RESPONSE packet is received within this time, this test is considered a failure. This parameter is similar to the -t parameter in the ping command, but has a different unit (the -t parameter in the ping command is in ms, while the timeout time in the remote-ping command is in seconds).

Configuring Remote-ping

Refer to Table 519 for remote-ping configuration information.

Table 519 Configure Remote-ping

Operation	Command	Description
Enter system view	system-view	-
Enable remote-ping Client	Remote-ping-agent enable	Required By default, remote-ping Client is disabled.
Create an remote-ping test group	Remote-ping administrator-name test-tag	Required By default, no remote-ping test group is configured.

Table 519 Configure Remote-ping (continued)

Operation		Command	Description
Configure the test parameters	Configure the destination IP address of the test	destination-ip ip-address	Required By default, no destination IP address is configured.
	Configure the type of the test.	test-type type	Optional By default, the test type is ICMP.
	Configure the packet sending times in each test.	count times	Optional By default, the packet sending times in each test is 1.
	Configure the automatic test interval.	frequency interval	Optional By default, the automatic test interval is zero, which indicating the test will be performed only once.
	Configure the timeout time of the test.	timeout time	Optional By default, the timeout time is 3 seconds.
Execute the test		test-enable	Required
Display test results		display remote-ping { history | results } [administrator-name test-tag]	Required You can execute the command in any view.

The remote-ping test does not display test results. You can use the display remote-ping command to view the test results.

You can use the display remote-ping command to check the test history as well as the latest test results.

Configuration Example

Network Requirement

Perform an remote-ping ICMP test between two switches. Like a ping test, this test uses ICMP to test the RTTs of data packets between the source and the destination.

Configuration procedure

1 Enable remote-ping Client.

```
[S5500] remote-ping-agent enable
```

2 Create an remote-ping test group administrator icmp.

```
[S5500] remote-ping administrator icmp
```

3 Configure the test parameters.

```
[S5500-remote-ping-administrator-icmp] test-type icmp
[S5500-remote-ping-administrator-icmp] destination-ip 10.10.10.10
[S5500-remote-ping-administrator-icmp] count 10
[S5500-remote-ping-administrator-icmp] timeout 3
```

4 Enable the test operation.

```
[S5500-remote-ping-administrator-icmp] test-enable
```

5 Display the test results.

```
[S5500-remote-ping-administrator-icmp] display remote-ping results
administrator icmp
[S5500-remote-ping-administrator-icmp] display remote-ping history
administrator icmp
```

Logging Function

This section contains information on the Logging function.

Introduction to Info-center

The Info-center serves as an information center of the system software modules. The logging system is responsible for most of the information outputs, and it also makes detailed classification to filter the information efficiently. Coupled with the debugging program, the info-center provides powerful support for network administrators and support personnel to monitor the operating state of networks and diagnose network failures.

When the log information is output to terminal or log buffer, the following parts will be included:

```
%Timestamp Sysname Module name/Severity/Digest: Content
```

For example:

```
%Jun 7 05:22:03 2003 SW5500 IFNET/6/UPDOWN:Line protocol on interface
Ethernet1/0/2, changed state to UP
```

When the log information is output to the info-center, the first part will be "`<Priority>`".

For example:

```
<187>Jun 7 05:22:03 2003 SW5500 IFNET/6/UPDOWN:Line protocol on
interface Ethernet1/0/2, changed state to UP
```

The description of the components of log information is as follows:

1 Priority

The priority is computed according to following formula: facility*8+severity-1. The default value for the facility is 23. The range of severity is 1~8, and the severity will be introduced in a separate section.

The value of the facility can be set by command **info-center loghost**, .local1 to local7 corresponding to 16 to 23 respectively, for detailed information, refer to RFC3164 (The BSD syslog Protocol).

Priority is only effective when information is send to loghost. There is no character between priority and timestamp.

2 Timestamp

If the logging information is sent to the log host, the default format of the timestamp is the date, and it can be changed to **boot** format or **none** format through the command:

info-center timestamp log { date | boot | none }

The date format of timestamp is "*mm dd hh:mm:ss yyyy*".

"*mm*" is the month field, such as: Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec.

"*dd*" is the day field, if the day is less than the 10th, one blank should be added, such as " 7".

"*hh:mm:ss*" is the time field, "*hh*" is from 00 to 23, "*mm*" and "*ss*" are from 00 to 59.

"*yyyy*" is the year field.

If changed to boot format, it represents the milliseconds from system booting. Generally, the data are so large that two 32 bits integers are used, and separated with a dot '.'.

For example:

```
<189>0.166970 SW5500 IFNET/6/UPDOWN:Line protocol on interface
Ethernet1/0/2, changed state to UP
```

It means that 166970ms (0*2^32+166970) has passed from system booting.

If changed to **none** format, the timestamp field is not present in logging information.

There is a blank between timestamp and sysname. If the timestamp is **none** *format, there is a blank between priority and sysname.*

3 Sysname

The sysname is the host name, the default value is "SW5500".

You can change the host name through **sysname** command.

There is a blank between sysname and module name.

4 Module name

The module name is the name of module which created this logging information, the following sheet lists some examples:

Table 520 Module Names in Logging Information

Module name	Description
8021X	802.1X module
ACL	Access control list module
AM	Access management module
ARP	Address resolution protocol module
CFAX	Configuration proxy module
CFG	Configuration management platform module
CFM	Configuration file management module
CMD	Command line module
COMMONSY	Common system MIB module
DEV	Device management module
DHCC	DHCP Client module
DHCP	Dynamic host configuration protocol module
DRV	Driver module
DRV_MNT	Driver maintenance module
ESP	End-station polling module
ETH	Ethernet module
FIB	Forwarding module
FTM	Fabric topology management module
FTMCMD	Fabric topology management command line module
FTPS	FTP server module
HA	High availability module
HTTPD	HTTP server module
IFNET	Interface management module
IGSP	IGMP snooping module

Table 520 Module Names in Logging Information

Module name	Description
IP	IP module
IPC	Inter-process communication module
IPMC	IP multicast module
L2INF	Interface management module
LACL	LANswitch ACL module
LQOS	LANswitch QoS module
LS	Local server module
MPM	Multicast port management module
NTP	Network time protocol module
PPRDT	Protocol packet redirection module
PTVL	Driver port, VLAN (Port and VLAN) module
QACL	QoS/ACL module
QOSF	Qos profile module
RDS	Radius module
RM	Routing management
RMON	Remote monitor module
RSA	Revest, shamir and adleman encryption system
RTPRO	Routing protocol
SHELL	User interface
SNMP	Simple network management protocol
SOCKET	Socket
SSH	Secure shell module
STP	Spanning tree protocol module
SYSMIB	System MIB module
TELNET	Telnet module
UDPH	UDP helper module
VFS	Virtual file system module
VTY	Virtual type terminal module
WCN	Web management module
XM	XModem module

Note that there is a slash ('/') between module name and severity.

5 Severity

Switch information falls into three categories: log information, debugging information and trap information. The info-center classifies every kind of information into 8 severity or urgent levels. The log filtering rule is that the system prohibits outputting the information whose severity level is greater than the set threshold. The more urgent the logging packet is, the smaller its severity level. The level represented by “emergencies” is 1, and that represented by ”debugging” is 8. Therefore, when the threshold of the severity level is “debugging”, the system will output all the information.

Definition of severity in logging information is in Table 521.

Table 521 Info-Center-Defined Severity

Severity	Description
emergencies	Extremely emergent errors
alerts	Errors that need to be corrected immediately
critical	Critical errors
errors	Errors that need to be addressed but are not critical
warnings	Warning, there may be some types of errors
notifications	Information that should be noted
informational	Common prompting information
debugging	Debugging information

Note that there is a slash between severity and digest.

6 Digest

The digest is abbreviation, it represent the abstract of contents.

Note that there is a colon between digest and content.

7 Content

It is the contents of logging information.

Info-Center Configuration

The Switch supports six output directions of information.

The system assigns a channel in each output direction by default. See Table 522.

Table 522 Numbers and Names of the Channels for Log Output

Output direction	Channel number	Default channel name
Console	0	console
Monitor	1	monitor
Info-center loghost	2	loghost
Trap buffer	3	trapbuf
Logging buffer	4	logbuf
snmp	5	snmpagent

The settings in the six directions are independent from each other. The settings will take effect only after enabling the information center.

The Switch info-center has the following features:

- Support to output log in six directions, that is, Console, monitor to Telnet terminal, logbuffer, loghost, trapbuffer, and SNMP.
- The log is divided into 8 levels according to the significance and it can be filtered based on the levels.
- The information can be classified in terms of the source modules and the information can be filtered in accordance with the modules.
- The output language can be selected between Chinese and English.

1 Sending the information to loghost.

Table 523 Sending the Information to Loghost

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to loghost	-	The configuration about the loghost on the Switch and that on loghost must be the same; otherwise the information cannot be sent to the loghost correctly.
	Set information source	-	You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.
Loghost	Refer to configuration cases for related log host configuration	-	-

2 Sending the information to the control terminal.

Table 524 Sending the Information to the Control Terminal.

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to Console	-	-
	Set information source	-	You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.
	Enable terminal display function	-	You can view debugging information after enabling terminal display function

3 Sending the Information to monitor terminal

Table 525 Sending the Information to Monitor Terminal

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to monitor	-	-
	Set information source	-	You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.
	Enable the terminal display function and this function for the corresponding information	-	For Telnet terminal and dumb terminal, to view the information, you must enable the current terminal display function using the `terminal monitor` command.

4 Sending the Information to log buffer.

Table 526 Sending the Information to Log Buffer

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to logbuffer	-	You can configure the size of the log buffer at the same time.
	Set information source	-	You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.

5 Sending the Information to trap buffer.

Table 527 Sending the Information to Trap Buffer

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to trapbuffer		You can configure the size of the trap buffer at the same time.
	Set information source		You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.

6 Sending the Information to SNMP

Table 528 Sending the Information to SNMP

Device	Configuration	Default value	Configuration description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to SNMP	-	-
	Set information source	-	You can define which modules and information to be sent out and the time-stamp format of information, and so on. You must turn on the Switch of the corresponding module before defining output debugging information.
	Configuring SNMP features	-	See RMON Configuration
Network management workstation	The same as the SNMP configuration of the Switch	-	-

7 Turn on/off the information synchronization Switch in Fabric

Figure 124 Turn on/off the Information Synchronization Switch in Fabric

Device	Configuration	Default Value	Configuration Description
Switch	Enable info-center	By default, info-center is enabled.	Other configurations are valid only if the info-center is enabled.
	Set the information output direction to SNMP	By default, Switches of master log in Fabric, debugging and trap information synchronization are turned on, so as log and strap information synchronization Switches in other Switches.	This configuration can keep log information, debugging information and trap information in Fabric in every Switch synchronized.

Sending the Information to Loghost

To send information to the loghost, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 529 Enable/Disable Info-Center

Operation	Command
Enable info-center	**`info-center enable`**
Disable info-center	**`undo info-center enable`**

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to loghost

Perform the following operation in Table 530.

Table 530 Configuring to Output Information to Loghost

Operation	Command
Output information to loghost	**info-center loghost** *host-ip-addr* **[channel {** *channel-number* | *channel-name* **}] [facility** *local-number* **] [language { chinese** | **english }]**
Cancel the configuration of outputting information to loghost	**undo info-center loghost** *host-ip-addr*

Ensure to enter the correct IP address using the **info-center loghost** *command to configure loghost IP address. If you enter a loopback address, the system prompts of invalid address appears.*

3 Configuring the information source on the Switch

With this command, you can define the information that is sent to the control terminal, such as: generated by which modules, information type, information level, and so on.

Perform the following operation in System View.

Figure 125 Defining Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log** | **trap** | **debug }* { level** *severity* | **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

modu-name specifies the module name; **default** represents all the modules; **level** refers to the severity levels; *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

When defining the information sent to the loghost, *channel-number* or *channel-name* must be set to the channel that corresponds to loghost direction.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

If you want to view the debugging information of some modules on the Switch, you must select **debugging** *as the information type when configuring information source, meantime using the* **debugging** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View:

Table 531 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**info-center timestamp { log** | **trap** | **debugging } { boot** | **date** | **none }**
Output time-stamp is disabled	**undo info-center timestamp { log** | **trap** | **debugging }**

4 Configuring loghost

The configuration on the loghost must be the same with that on the Switch. For related configuration, see the configuration examples in the latter part of this chapter.

Setting Format of Time Stamps Due to be Sent to Log Host

Table 532 describes the detailed configuration tasks on the switch.

Table 532 Configure the information to be sent to log host

Operation	Command	Description
Enter system view	system-view	-
Enable information center	info-center enable	Optional; Enabled by default.
Output information to log host	**info-center loghost** *host-ip-addr* [**channel** { *channel-number* | *channel-name* } | **facility** *local-number* | **language** { **chinese** | **english** }]	Required; By default, the switch does not send information to log host. Enter the proper IP address. The system will take loopback addresses as invalid and indicate as such.
Specify the interface that sends log information to log host	**info-center loghost source** *interface-type interface-number*	Optional
Define source of information	**info-center source** { *modu-name* | **default** } **channel** { *channel-number* | *channel-name* } [{ **log** | **trap** | **debug** } * { **level** *severity* | **state** *state* } *]	Required
Set the format of time stamps to be sent to log host	**info-center timestamp loghost** { **date** | **no-year-date** | **none** }	Optional

*If users require debugging messages for some modules of the switch, they need to specify the type of information as **debug** while setting information source, and to enable debugging for the corresponding modules using the **debugging** command.*

Sending the Information to Control Terminal

To send information to the control terminal, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 533 Enable/disable info-center

Operation	Command
Enable info-center	`info-center enable`
Disable info-center	`undo info-center enable`

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to the control terminal.

Perform the following operation in Table 534.

Table 534 Configuring to Output Information to Control Terminal

Operation	Command
Output information to Console	**info-center console channel{** *channel-number* | *channel-name* **}**
Cancel the configuration of outputting information to Console	**undo info-center console channel**

3 Configuring the information source on the Switch.

With this configuration, you can define the information sent to the control terminal that is generated by which modules, information type, information level, and so on.

Perform the following operation in System View:

Table 535 Defining Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log** | **trap** | **debug }* { level** *severity* | **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

modu-name specifies the module name; **default** represents all the modules; **level** refers to the severity levels; *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

When defining the information sent to the control terminal, *channel-number* or *channel-name* must be set to the channel that corresponds to the Console direction.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

If you want to view the debugging information of some modules on the Switch, you must select **debugging** *as the information type when configuring information source, meantime using the* **debugging** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View:

Table 536 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**info-center timestamp { log** | **trap** | **debugging } { boot** | **date** | **none }**
Output time-stamp is disabled	**undo info-center timestamp { log** | **trap** | **debugging }**

4 Enable terminal display function

To view the output information at the control terminal, you must first enable the corresponding log, debugging and trap information functions at the Switch.

For example, if you have set the log information as the information sent to the control terminal, now you need to use the **terminal logging** command to enable the terminal display function of log information on the Switch, then you can view the information at the control terminal.

Perform the following operation in User View:

Table 537 Enabling Terminal Display Function

Operation	Command
Enable terminal display function of debugging information	**`terminal debugging`**
Disable terminal display function of debugging information	**`undo terminal debugging`**
Enable terminal display function of log information	**`terminal logging`**
Disable terminal display function of log information	**`undo terminal logging`**
Enable terminal display function of trap information	**`terminal trapping`**
Disable terminal display function of trap information	**`undo terminal trapping`**

Sending the Information to Telnet Terminal or Dumb Terminal

To send information to a Telnet terminal or dumb terminal, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 538 Enable/Disable Info-Center

Operation	Command
Enable info-center	**`info-center enable`**
Disable info-center	**`undo info-center enable`**

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to Telnet terminal or dumb terminal

Perform the following operation in System View.

Table 539 Configuring to Output Information to Telnet Terminal or Dumb Terminal

Operation	Command
Output information to Telnet terminal or dumb terminal	**info-center monitor channel {** *channel-number* | *channel-name* **}**
Cancel the configuration of outputting information to Telnet terminal or dumb terminal	**`undo info-center monitor channel`**

3 Configuring information source on the Switch

With this configuration, you can define the information that is sent to the Telnet terminal or dumb terminal that is generated by which modules, information type, information level, and so on.

Perform the following operation in System View:

Table 540 Defining Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log** | **trap** | **debug }* { level** *severity* | **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

modu-name specifies the module name; **default** represents all the modules; **level** refers to the severity levels; *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

When defining the information sent to Telnet terminal or dumb terminal, *channel-number* or *channel-name* must be set to the channel that corresponds to the Console direction.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

When there are more than one Telnet users or monitor users at the same time, some configuration parameters should be shared among the users, such as module-based filtering settings and severity threshold. When a user modifies these settings, it will be reflected on other clients.

If you want to view the debugging information of some modules on the Switch, you must select **debugging** *as the information type when configuring information source, meantime using the* **debugging** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View.

Table 541 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**info-center timestamp { log | trap | debugging } { boot | date | none }**
Output time-stamp is disabled	**undo info-center timestamp { log | trap | debugging }**

4 Enabling terminal display function

To view the output information at the Telnet terminal or dumb terminal, you must first enable the corresponding log, debugging and trap information functions at the Switch.

For example, if you have set the log information as the information sent to the Telnet terminal or dumb terminal, you need to use the **terminal logging** command to enable the terminal display function of log information on the Switch, then you can view the information at the Telnet terminal or dumb terminal.

Perform the following operation in User View.

Table 542 Enabling Terminal Display Function

Operation	Command
Enable terminal display function of log, debugging and trap information	**terminal monitor**
Disable terminal display function of the above information	**undo terminal monitor**
Enable terminal display function of debugging information	**terminal debugging**
Disable terminal display function of debugging information	**undo terminal debugging**
Enable terminal display function of log information	**terminal logging**
Disable terminal display function of log information	**undo terminal logging**
Enable terminal display function of trap information	**terminal trapping**

Operation	Command
Disable terminal display function of trap information	**undo terminal trapping**

Sending the Information to the Log Buffer

To send information to the log buffer, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 543 Enabling/Disabling Info-center

Operation	Command
Enable info-center	**info-center enable**
Disable info-center	**undo info-center enable**

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to the log buffer

Perform the following operation in System View.

Table 544 Configuring to Output Information to Log Buffer

Operation	Command
Output information to log buffer	**info-center logbuffer [channel {** *channel-number* | *channel-name* **}] [size** *buffersize* **]**
Cancel the configuration of outputting information to log buffer	**undo info-center logbuffer [channel** | **size]**

3 Configuring the information source on the Switch

With this configuration, you can define the information that is sent to the log buffer: generated by which modules, information type, information level, and so on.

Perform the following operation in System View:

Table 545 Defining the Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log** | **trap** | **debug }* { level** *severity* | **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

modu-name specifies the module name; **default** represents all the modules; **level** refers to the severity levels; *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

When defining the information sent to the log buffer, *channel-number* or *channel-name* must be set to the channel that corresponds to the Console direction.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

If you want to view the debugging information of some modules on the Switch, you must select **debugging** *as the information type when configuring the information source, meantime using the* **debugging** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View.

Table 546 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**info-center timestamp { log | trap | debugging } { boot | date | none }**
Output time-stamp is disabled	**undo info-center timestamp { log | trap | debugging }**

Sending the Information to the Trap Buffer

To send information to the trap buffer, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 547 Enabling/Disabling Info-center

Operation	Command
Enable info-center	**info-center enable**
Disable info-center	**undo info-center enable**

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to the trap buffer.

Perform the following operation in System View.

Table 548 Configuring to Output Information to Trap Buffer

Operation	Command
Output information to trap buffer	**info-center trapbuffer [size** *buffersize* **] [channel {** *channel-number* | *channel-name* **}]**
Cancel the configuration of outputting information to trap buffer	**undo info-center trapbuffer [channel | size]**

3 Configuring the information source on the Switch.

With this configuration, you can define the information that is sent to the trap buffer: generated by which modules, information type, information level, and so on.

Perform the following operation in System View.

Table 549 Defining Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log | trap | debug }* { level** *severity*| **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

`modu-name` specifies the module name; **`default`** represents all the modules; **`level`** refers to the severity levels; *`severity`* specifies the severity level of information. The information with the level below it will not be output. *`channel-number`* specifies the channel number and *`channel-name`* specifies the channel name.

When defining the information sent to the trap buffer, *`channel-number`* or *`channel-name`* must be set to the channel that corresponds to the Console direction.

Every channel has been set with a default record, whose module name is **`default`** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

If you want to view the debugging information of some modules on the Switch, you must select **`debugging`** *as the information type when configuring information source, meantime using the* **`debugging`** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View.

Table 550 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**`info-center timestamp { log | trap | debugging } { boot | date | none }`**
Output time-stamp is disabled	**`undo info-center timestamp { log | trap | debugging }`**

Sending the Information to SNMP Network Management

To send information to SNMP NM, follow the steps below:

1 Enabling info-center

Perform the following operation in System View.

Table 551 Enabling/Disabling Info-center

Operation	Command
Enable info-center	**`info-center enable`**
Disable info-center	**`undo info-center enable`**

Info-center is enabled by default. After info-center is enabled, system performances are affected when the system processes much information because of information classification and outputting.

2 Configuring to output information to SNMP NM

Perform the following operation in System View.

Table 552 Configuring to Output Information to SNMP NM

Operation	Command
Output information to SNMP NM	**`info-center snmp channel {`** *`channel-number`* | *`channel-name`* **`}`**
Cancel the configuration of outputting information to SNMP NM	**`undo info-center snmp channel`**

3 Configuring the information source on the Switch.

With this configuration, you can define the information that is sent to SNMP NM: generated by which modules, information type, information level, and so on.

Perform the following operation in System View.

Table 553 Defining Information Source

Operation	Command
Define information source	**info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **} [{ log** | **trap** | **debug }* { level** *severity* | **state** *state* **}*]**
Cancel the configuration of information source	**undo info-center source {** *modu-name* | **default } channel {** *channel-number* | *channel-name* **}**

modu-name specifies the module name; **default** represents all the modules; **level** refers to the severity levels; *severity* specifies the severity level of information. The information with the level below it will not be output. *channel-number* specifies the channel number and *channel-name* specifies the channel name.

When defining the information sent to SNMP NM, *channel-number* or *channel-name* must be set to the channel that corresponds to Console direction.

Every channel has been set with a default record, whose module name is **default** and the module number is 0xffff0000. However, for different channels, the default record may have different default settings of log, trap and debugging. When there is no specific configuration record for a module in the channel, use the default one.

If you want to view the debugging information of some modules on the Switch, you must select **debugging** *as the information type when configuring information source, meantime using the* **debugging** *command to turn on the debugging Switch of those modules.*

You can use the following commands to configure log information, debugging information and the time-stamp output format of trap information.

Perform the following operation in System View:

Table 554 Configuring the Output Format of Time-stamp

Operation	Command
Configure the output format of the time-stamp	**info-center timestamp { log | trap | debugging } { boot | date | none }**
Output time-stamp is disabled	**undo info-center timestamp { log | trap | debugging }**

4 Configuring SNMP and a network management workstation on the Switch

You have to configure SNMP on the Switch and the remote workstation to ensure that the information is correctly sent to the SNMP NM. Then you can get correct information from the network management workstation.

Turning on/off the Information Synchronization Switch in Fabric

After the forming of a Fabric by Switches which support XRN; the log, debugging and trap information among the Switches is synchronous. The synchronization process is as follows: each Switch sends its own information to other Switches in the Fabric and meantime receives the information from others, and then the Switch updates the local information to ensure the information synchronizes within the Fabric.

The Switch provides a command to turn on/off the synchronization Switch in every Switch. If the synchronization Switch of a Switch is turned off, it does not send information to other Switches but still receives information from others.

1 Enable info-center

Perform the following operation in System View.

Table 555 Enable/Disable Info-center

Operation	Command
Enable info-center	**`info-center enable`**
Disable info-center	**`undo info-center enable`**

2 Turn on the information synchronization Switch

Perform the following operation in System View.

Table 556 Turn on/off the Information Synchronization Switch of every Switch

Operation	Command
Turn on the information synchronization Switch of the specified Switch	**info-center switch-on {** *unit-id* | **master** | **all } [debugging** | **logging** | **trapping]***
Turn off the information synchronization Switch of the specified Switch	**undo info-center switch-on {** *unit-id* | *master* | **all } [debugging** | **logging** | **trapping]***

You can turn on/off the synchronization Switch of the specified information on the specified Switch as needed.

Displaying and Debugging Info-center

After the above configuration, performing the **`display`** command in any view, you can view the running state of the info-center. You can also authenticate the effect of the configuration by viewing displayed information. By performing the **`reset`** command in User View, you can clear the statistics of info-center.

Perform the following operation in User View. The **`display`** command still can be performed in any view.

Figure 126 Displaying and Debugging Info-center

Operation	Command
Display the content of information channel	**display channel [** *channel-number* | *channel-name* **]**
Display configuration of system log and memory buffer	**`display info-center`**
Clear information in memory buffer	**`reset logbuffer`**
Clear information in trap buffer	**`reset trapbuffer`**

Configuring Synchronous Information Output Function

Synchronous information output function works to prevent users' input from being interrupted by system output. While enabled, this function allows users to view their input so far after each system output; thus avoids displaying commands on separate lines and increases the system usability.

Table 557 Configure the synchronous information output function

Operation	Command	Description
Enter system view	system-view	
Configure the synchronous information output	info-center synchronous	Optional Disabled by default.

*It is recommended that you disable this function during debugging, as the **info-center synchronous** command can result in displaying of command prompts after each piece of debugging information, and therefore increases redundant outputs.*

Configuration Examples of Sending Log to Unix Loghost

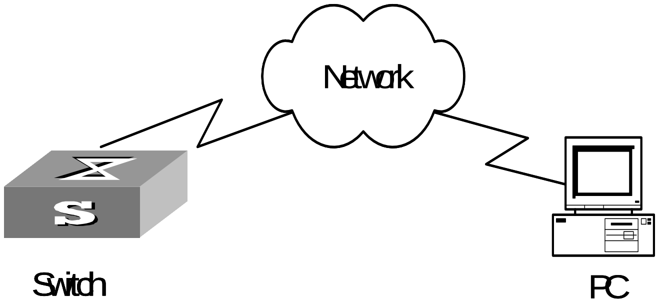
Networking Requirement

The networking requirements are as follows:

- Sending the log information of the Switch to Unix loghost
- The IP address of the loghost is 202.38.1.10
- The information with the severity level above informational will be sent to the loghost
- The output language is English
- The modules that allowed to output information are ARP and IP

Networking Diagram

Figure 127 Schematic Diagram of Configuration



Configuration Procedure

1 Configuration on the Switch

a Enabling info-center

```
[SW5500]info-center enable
```

b Set the host with the IP address of 202.38.1.10 as the loghost; set the severity level threshold value as informational, set the output language to English; set that the modules which are allowed to output information are ARP and IP.

```
[SW5500]info-center loghost 202.38.1.10 facility local4 language
english
[SW5500]info-center source arp channel loghost log level
informational
[SW5500]info-center source ip channel loghost log level
informational
```

2 Configuration on the loghost

This configuration is performed on the loghost. The following example is performed on SunOS 4.0 and the operation on Unix operation system produced by other manufactures is generally the same to the operation on SunOS 4.0.

a Perform the following command as the super user (root).

```
# mkdir /var/log/SW5500
# touch /var/log/SW5500/information
```

b Edit file /etc/syslog.conf as the super user (root), add the following selector/actor pairs.

```
# SW5500 configuration messages
local4.info /var/log/SW5500/information
```

Note the following points when editing /etc/syslog.conf:

(1) The note must occupy a line and start with the character #.

(2) There must be a tab other than a space as the separator in selector/actor pairs.

(3) No redundant space after file name.

(4) The device name and the acceptant log information level specified in /etc/syslog.conf must be consistent with info-center loghost and info-center loghost a.b.c.d facility configured on the Switch. Otherwise, the log information probably cannot be output to the loghost correctly.

c After the establishment of information (log file) and the revision of `/etc/syslog.conf`, you should send a HUP signal to `syslogd` (system daemon), through the following command, to make syslogd reread its configuration file `/etc/syslog.conf`.

```
# ps -ae | grep syslogd
147
# kill -HUP 147
```

After the above operation, the Switch system can record information in related log files.

To configure facility, severity, filter and the file syslog.conf synthetically, you can get classification in great detail and filter the information.

Configuration Examples for Sending Log to Linux Loghost

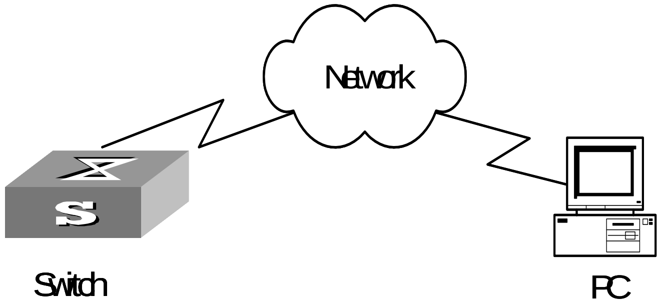
Networking Requirement

The networking requirements are as follows:

- Sending the log information of the Switch to Linux loghost
- The IP address of the loghost is 202.38.1.10
- The information with the severity level above informational will be sent to the loghost
- The output language is English
- All modules are allowed to output information

Networking diagram

Figure 128 Schematic Diagram of Configuration



Configuration Procedure

1 Enabling info-center

```
[SW5500]info-center enable
```

Set the host with the IP address of 202.38.1.10 as the loghost; set the severity level threshold value as informational, set the output language to English; set all the modules are allowed output information.

```
[SW5500]info-center loghost 202.38.1.10 facility local7 language
english
[SW5500]info-center source default channel loghost log level
informational
```

2 Configuration on the loghost

This configuration is performed on the loghost.

a Perform the following command as the super user (root).

```
# mkdir /var/log/SW5500
# touch /var/log/SW5500/information
```

b Edit file `/etc/syslog.conf` as the super user (root), add the following selector/actor pairs.

```
# SW5500 configuration messages
local7.info /var/log/SW5500/information
```

Note the following points when editing /etc/syslog.conf:

(1) The note must occupy a line and start with the character #.

(2) There must be a tab other than a space as the separator in selector/actor pairs.

(3) No redundant space after file name.

(4) The device name and the acceptant log information level specified in /etc/syslog.conf must be consistent with info-center loghost and info-center loghost a.b.c.d facility configured on the Switch. Otherwise, the log information probably cannot be output to the loghost correctly.

c After the establishment of information (log file) and the revision of */etc/syslog.conf*, you should view the number of *syslogd* (system daemon) through the following command, kill syslogd daemon and reuse -r option the start syslogd in daemon.

```
# ps -ae | grep syslogd
147
# kill -9 147
# syslogd -r &
```

For Linux loghost, you must ensure that syslogd daemon is started by -r option.

After the above operation, the Switch system can record information in related log files.

To configure facility, severity, filter and the file syslog.conf synthetically, you can get classification in great detail and filter the information.

Configuration Examples of Sending Log to Control Terminal

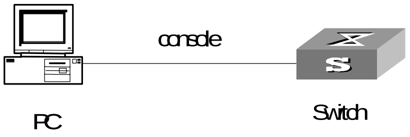
Networking Requirement

The networking requirements are as follows:

- Sending the log information of the Switch to Unix loghost
- The IP address of the loghost is 202.38.1.10
- The information with the severity level above informational will be sent to the loghost
- The output language is English
- The modules that allowed to output information are ARP and IP

Networking Diagram

Figure 129 Schematic Diagram of Configuration



Configuration Procedure

1 Configuration on the Switch

Enabling info-center

```
[SW5500]info-center enable
```

2 Configure control terminal log output; allow modules ARP and IP to output information; the severity level is restricted within the range of emergencies to informational.

```
[SW5500]info-center console channel console
[SW5500]info-center source arp channel console log level informational
[SW5500]info-center source ip channel console log level informational
```

3 Enabling terminal display function

```
<SW5500> terminal logging
```

RMON Configuration

Remote Network Monitoring (RMON) is a type of IETF-defined MIB. It is the most important enhancement to the MIB II standard. It is mainly used for monitoring the data traffic on a segment and even on a whole network. It is one of the most widely used Network Management standards.

RMON is implemented fully based on the SNMP architecture (which is one of its outstanding advantages) and compatible with the existing SNMP framework, and therefore it is unnecessary to adjust the protocol. RMON includes NMS and the Agent running on the network devices. On the network monitor or detector, RMON Agent tracks and accounts different traffic information on the segment connected to its port, such as the total number of packets on a segment in a certain period of time or that of the correct packets sent to a host. RMON helps SNMP monitor the remote network device more actively and effectively, which provides a highly efficient means for the monitoring of the subnet operations. RMON can reduce the communication traffic between the NMS and the agent, thus facilitating effective management over large interconnected networks.

RMON allows multiple monitors. It can collect data in two ways.

- One is to collect data with a special RMON probe. NMS directly obtains the management information from the RMON probe and controls the network resource. In this way, it can obtain all the information of the RMON MIB.
- Another way is to implant the RMON Agent directly into the network devices (such as a Switch, Hub), so that the devices become network facilities with RMON probe function. RMON NMS uses the basic SNMP commands to exchange data information with SNMP Agent and collect NM information. However, limited by the device resources, normally, not all the data of the RMON MIB can be obtained with this method. In most cases, only four groups of information can be collected. The four groups include trap information, event information, history information and statistics information.

The Switch implements RMON as described in the second bullet point above. With the RMON-supported SNMP Agent running on the network monitor, NMS can obtain such information as the overall traffic of the segment connected to the managed network device port, the error statistics and performance statistics, thereby implementing the management (generally remote management) over the network.

Configuring RMON

RMON configuration includes:

- Adding/Deleting an Entry to/from the Alarm Table
- Adding/Deleting an Entry to/from the Event Table
- Adding/Deleting an Entry to/from the History Control Terminal
- Adding/Deleting an Entry to/from the Extended RMON Alarm Table
- Adding/Deleting an Entry to/from the Extended RMON Alarm Table

Adding/Deleting an Entry to/from the Alarm Table

RMON alarm management can monitor the specified alarm variables such as the statistics on a port. When a value of the monitored data exceeds the defined threshold, an alarm event will be generated. Generally, the event will be recorded in the device log table and a trap message will be sent to the NMS. The events are defined in the event management. The alarm management includes browsing, adding and deleting the alarm entries.

You can use the following commands to add/delete an entry to/from the alarm table.

Perform the following configuration in System View.

Table 558 Add/Delete an Entry to/from the Alarm Table

Operation	Command
Add an entry to the alarm table.	**rmon alarm** *entry-number alarm-variable sampling-time* **{ delta | absolute } rising-threshold** *threshold-value1 event-entry1* **falling-threshold** *threshold-value2 event-entry2* **[owner** *text* **]**
Delete an entry from the alarm table.	**undo rmon alarm** *entry-number*

Adding/Deleting an Entry to/from the Event Table

RMON event management defines the event ID and the handling of the event by keeping logs, sending trap messages to NMS or performing both at the same time.

You can use the following commands to add/delete an entry to/from the event table.

Perform the following configuration in System View.

Table 559 Add/Delete an Entry to/from the Event Table

Operation	Command
Add an entry to the event table.	**rmon event** *event-entry* **[description** *string*] **{ log** | **trap** *trap-community* | **log-trap** *log-trapcommunity* | **none } [owner** *rmon-station* **]**
Delete an entry from the event table.	**undo rmon event** *event-entry*

Adding/Deleting an Entry to/from the History Control Terminal

The history data management helps you set the history data collection, periodical data collection and storage of the specified ports. The sampling information includes the utilization ratio, error counts and total number of packets.

You can use the following commands to add/delete an entry to/from the history control terminal.

Perform the following configuration in Ethernet Port View.

Table 560 Add/Delete an Entry to/from the History Control Terminal

Operation	Command
Add an entry to the history control terminal.	**rmon history** *entry-number* **buckets** *number* **interval** *sampling-interval* **[owner** *text-string* **]**
Delete an entry from the history control terminal.	**undo rmon history** *entry-number*

Adding/Deleting an Entry to/from the Extended RMON Alarm Table

You can use the command to add/delete an entry to/from the extended RMON alarm table. Perform the following configuration in System View.

Table 561 Add/Delete an Entry to/from the Extended RMON Alarm Table

Operation	Command
Add an entry to the extended RMON alarm table.	**rmon prialarm** *entry-number alarm-var* **[** *alarm-des* **]** *sampling-timer* **{ delta** | **absolute** | **changeratio } rising-threshold** *threshold-value1 event-entry1* **falling-threshold** *threshold-value2 event-entry2* **entrytype { forever** | **cycle** *cycle-period* **} [owner text]**
Delete an entry from the extended RMON alarm table.	**undo rmon prialarm** *entry-number*

Adding/Deleting an Entry to/from the Statistics Table

The RMON statistics management concerns the port usage monitoring and error statistics when using the ports. The statistics include collision, CRC and queuing, undersize packets or oversize packets, timeout transmission, fragments, broadcast, multicast and unicast messages and the usage ratio of bandwidth.

You can use the following commands to add/delete an entry to/from the statistics table.

Perform the following configuration in Ethernet Port View.

Table 562 Add/Delete an Entry to/from the Statistics Table

Operation	Command
Add an entry to the statistics table	**rmon statistics** *entry-number* **[owner** *text-string* **]**
Delete an entry from the statistics table	**undo rmon statistics** *entry-number*

Displaying and Debugging RMON

After the above configuration, execute the **display** command in all views to display the running of the RMON configuration, and to verify the effect of the configuration. Display and Debug RMON

Operation	Command
Display the RMON statistics	**display rmon statistics [** *port-num* **]**
Display the history information of RMON	**display rmon history [** *port-num* **]**
Display the alarm information of RMON	**display rmon alarm [** *alarm-table-entry* **]**
Display the extended alarm information of RMON	**display rmon prialarm [** *prialarm-table-entry* **]**
Display the RMON event	**display rmon event [** *event-table-entry* **]**
Display the event log of RMON	**display rmon eventlog [** *event-number* **]**

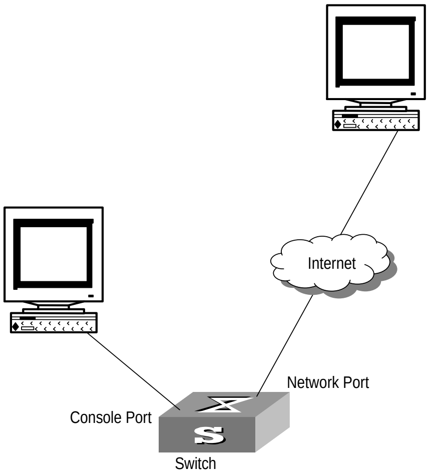
RMON Configuration Example

Networking Requirements

Set an entry in RMON Ethernet statistics table for the Ethernet port performance, which is convenient for network administrators' query.

Networking Diagram

Figure 130 RMON Configuration Networking



Configuration Procedure

1 Configure RMON.

```
[SW5500-Ethernet1/0/1]rmon statistics 1 owner 3com-rmon
```

2 View the configurations in User View.

```
<SW5500> display rmon statistics Ethernet 1/0/1
Statistics entry 1 owned by 3com-rmon is VALID.
  Gathers statistics of interface Ethernet1/0/1. Received:
  octets              : 270149,packets          : 1954
  broadcast packets   :1570   ,multicast packets:365
  undersized packets  :0      ,oversized packets:0
  fragments packets   :0      ,jabbers packets  :0
  CRC alignment errors:0      ,collisions       :0
  Dropped packet events (due to lack of resources):0
  Packets received according to length (in octets):
  64     :644      ,  65-127  :518       ,  128-255  :688
  256-511:101      ,  512-1023:3         ,  1024-1518:0
```

NTP Overview

As the network topology gets more and more complex, it becomes important to synchronize the clocks of the equipment on the whole network. Network Time Protocol (NTP) is the TCP/IP that advertises the accurate time throughout the network.

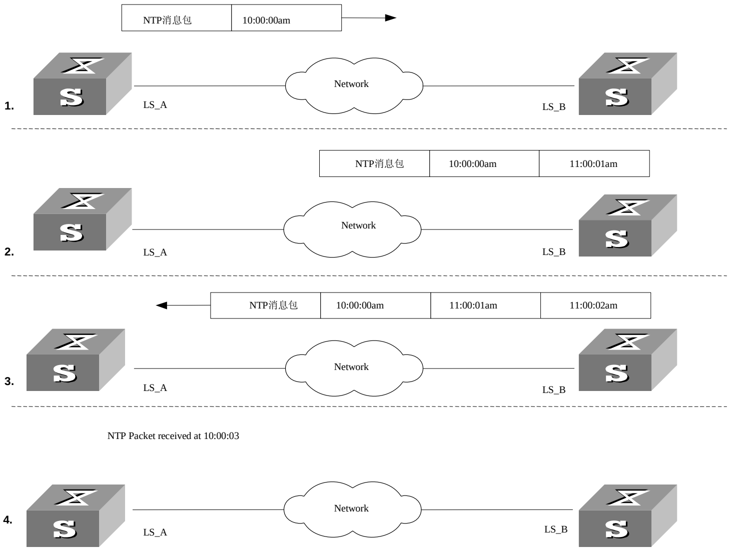
NTP ensures the consistency of the following applications:

- For the increment backup between the backup server and client, NTP ensures the clock synchronization between the two systems.
- For multiple systems that coordinate to process a complex event, NTP ensures them to reference the same clock and guarantee the right order of the event.
- Guarantee the normal operation of the inter-system (Remote Procedure Call).

- Record for an application when a user logs in to a system, a file is modified, or Basic Operating Principle of NTP

Figure 131 illustrates the basic operating principle of NTP:

Figure 131 Basic Operating Principle of NTP



In Figure 131, Switch A and Switch B are connected using the Ethernet port. They have independent system clocks. Before implementing automatic clock synchronization on both Switches, it is assume that:

- The clock on Switch A is set to 10:00:00am, and that on B is set to 11:00:00am.
- Switch B serves as an NTP time server. That is, Switch A synchronizes the local clock with the clock of B.
- It takes 1 second to transmit a data packet from either A or B to the opposite end.

The system clocks are synchronized as follows:

- Switch A sends an NTP packet to Switch B. The packet carries the timestamp 10:00:00am (T_1) that tells when it left Switch A.
- When the NTP packet arrives at Switch B, Switch B adds a local timestamp 11:00:01am (T_2) to it.
- When the NTP packet leaves Switch B, Switch B adds another local timestamp 11:00:02am (T_3) to it.
- When Switch A receives the acknowledgement packet, it adds a new timestamp 10:00:03am (T_4) to it.

Now Switch A collects enough information to calculate the following two important parameters:

- The delay for a round trip of an NTP packet travelling between the Switch A and B: Delay= $(T_4\text{-}T_1) - (T_3\text{-}T_2)$.
- Offset of Switch A clock relative to Switch B clock: offset= $((T_2\text{-}T_1) + (T_4\text{-}T_3)) /2$.

In this way, Switch A uses the above information to set the local clock and synchronize it with the clock on Switch B.

The operating principle of NTP is briefly introduced above. For more information, refer to RFC1305.

NTP Configuration

NTP is used for time synchronization throughout a network. NTP configuration tasks include:

- Configure NTP operating mode
- Configure NTP ID authentication
- Set NTP authentication key
- Set the specified key to be reliable
- Set a local interface for transmitting NTP packets
- Set an external reference clock or the local clock as the master NTP clock
- Enable/Disable an interface to receive NTP packets
- Set control authority to access the local Switch service
- Set maximum local sessions

Configuring NTP Operating Mode

You can set the NTP operating mode of a Switch according to its location in the network and the network structure. For example, you can set a remote server as the time server of the local equipment. In this case the local Switch works as an NTP client. If you set a remote server as a peer of the local Switch, the local equipment operates in symmetric active mode. If you configure an interface on the local Switch to transmit NTP broadcast packets, the local Switch will operate in broadcast mode. If you configure an interface on the local Switch to receive NTP broadcast packets, the local Switch will operate in broadcast client mode. If you configure an interface on the local Switch to transmit NTP multicast packets, the local Switch will operate in multicast mode. Or you may also configure an interface on the local Switch to receive NTP multicast packets, the local Switch will operate in multicast client mode.

- Configure NTP server mode
- Configure NTP peer mode
- Configure NTP broadcast server mode
- Configure NTP broadcast client mode
- Configure NTP multicast server mode
- Configure NTP multicast client mode

Configuring NTP Server Mode

Set a remote server whose ip address is *ip-address* as the local time server. *ip-address* specifies a host address other than a broadcast, multicast or reference clock IP address. In this case, the local Switch operates in client mode. In this mode, only the local client synchronizes its clock with the clock of the remote server, while the reverse synchronization will not happen.

Perform the following configurations in System View.

Table 563 Configure NTP Time Server

Operation	Command
Configure NTP time server	**ntp-service unicast-server** *ip-address* **[version** *number* **] [authentication-keyid** *keyid* **] [source-interface {** *interface-name* | *interface-type interface-number* **}] [priority]**
Cancel NTP server mode	**undo ntp-service unicast-server** *ip-address*

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295; *interface-name* or *interface-type interface-number* specifies the IP address of an interface, from which the source IP address of the NTP packets sent from the local Switch to the time server will be taken; **priority** indicates the time server will be the first choice.

Configuring NTP Peer Mode

Set a remote server whose ip address is *ip-address* as the peer of the local equipment. In this case, the local equipment operates in symmetric active mode. *ip-address* specifies a host address other than a broadcast, multicast or reference clock IP address. In this mode, both the local Switch and the remote server can synchronize their clocks with the clock at the opposite end.

Perform the following configurations in System View.

Table 564 Configure NTP Peer Mode

Operation	Command
Configure NTP peer mode	**ntp-service unicast-peer** *ip-address* **[version** *number* **] [authentication-key** *keyid* **] [source-interface {** *interface-name* | *interface-type interface-number* **}] [priority]**
Cancel NTP peer mode	**undo ntp-service unicast-peer** *ip-address*

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295; *interface-name* or *interface-type interface-number* specifies the IP address of an interface, from which the source IP address of the NTP packets sent from the local Switch to the peer will be taken; **priority** indicates the peer will be the first choice for the time server.

Configuring NTP Broadcast Server Mode

Designate an interface on the local Switch to transmit NTP broadcast packets. In this case, the local equipment operates in broadcast mode and serves as a broadcast server to broadcast messages to its clients regularly.

Perform the following configurations in the VLAN interface view.

Table 565 Configure NTP Broadcast Server Mode

Operation	Command
Configure NTP broadcast server mode	**ntp-service broadcast-server [authentication-keyid** *keyid* **version** *number* **]**
Cancel NTP broadcast server mode	**undo ntp-service broadcast-server**

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295. This command can only be configured on the interface where the NTP broadcast packets will be transmitted.

Configuring NTP Broadcast Client Mode

Designate an interface on the local Switch to receive NTP broadcast messages and operate in broadcast client mode. The local Switch listens to the broadcast from the server. When it receives the first broadcast packets, it starts a brief client/server mode to Switch messages with a remote server for estimating the network delay. Thereafter, the local Switch enters broadcast client mode and continues listening to the broadcast and synchronizes the local clock according to the arrived broadcast message.

Perform the following configurations in the VLAN Interface View.

Table 566 Configure NTP Broadcast Client Mode

Operation	Command
Configure NTP broadcast client mode	**`ntp-service broadcast-client`**
Disable NTP broadcast client mode	**`undo ntp-service broadcast-client`**

This command can only be configured on the interface where the NTP broadcast packets will be received.

Configuring NTP Multicast Server Mode

Designate an interface on the local Switch to transmit NTP multicast packets. In this case, the local equipment operates in multicast mode and serves as a multicast server to multicast messages to its clients regularly.

Perform the following configurations in the VLAN Interface View.

Table 567 Configure NTP Multicast Server Mode

Operation	Command
Configure NTP multicast server mode	**ntp-service multicast-server [** *ip-address* **] [authentication-keyid** *keyid* **] [ttl** *ttl-number* **] [version** *number* **]**
Cancel NTP multicast server mode	**`undo ntp-service multicast-server`**

NTP version number *number* ranges from 1 to 3 and defaults to 3; the authentication key ID *keyid* ranges from 0 to 4294967295; *ttl-number* of the multicast packets ranges from 1 to 255; and the multicast IP address defaults to 224.0.1.1.

This command can only be configured on the interface where the NTP multicast packet will be transmitted.

Configuring NTP Multicast Client Mode

Designate an interface on the local Switch to receive NTP multicast messages and operate in multicast client mode. The local Switch listens to the multicast from the server. When it receives the first multicast packets, it starts a brief client/server mode to Switch messages with a remote server for estimating the network delay. Thereafter, the local Switch enters multicast client mode and continues listening to the multicast and synchronizes the local clock by the arrived multicast message.

Perform the following configurations in VLAN interface view.

Table 568 Configure NTP multicast client mode

Operation	Command
Configure NTP multicast client mode	**ntp-service multicast-client [** *ip-address* **]**
Cancel NTP multicast client mode	**`undo ntp-service multicast-client`**

Multicast IP address *ip-address* defaults to 224.0.1.1. This command can only be configured on the interface where the NTP multicast packets will be received.

Configuring NTP ID Authentication

Enable NTP authentication, set MD5 authentication key, and specify the reliable key. A client will synchronize itself by a server only if the server can provide a reliable key.

Perform the following configurations in System View.

Table 569 Configure NTP Authentication

Operation	Command
Enable NTP authentication	**ntp-service authentication enable**
Disable NTP authentication	**undo ntp-service authentication enable**

Setting NTP Authentication Key

This configuration task is to set NTP authentication key.

Perform the following configurations in System View.

Table 570 Configure NTP Authentication Key

Operation	Command
Configure NTP authentication key	**ntp-service authentication-keyid** *number* **authentication-mode md5** *value*
Remove NTP authentication key	**undo ntp-service authentication-keyid** *number*

Key number *number* ranges from 1 to 4294967295; the key *value* contains 1 to 32 ASCII characters.

Setting Specified Key as Reliable

This configuration task is to set the specified key as reliable.

Perform the following configurations in System View.

Table 571 Set the Specified Key as Reliable

Operation	Command
Set the specified key as reliable	**ntp-service reliable authentication-keyid** *key-number*
Cancel the specified reliable key.	**undo ntp-service reliable authentication-keyid** *key-number*

Key number *key-number* ranges from 1 to 4294967295.

Designating an Interface to Transmit NTP Message

If the local equipment is configured to transmit all the NTP messages, these packets will have the same source IP address, which is taken from the IP address of the designated interface.

Perform the following configurations in System View.

Table 572 Designate an Interface to Transmit NTP Message

Operation	Command
Designate an interface to transmit NTP message	**ntp-service source-interface {** *interface-name* | *interface-type interface-number* **}**

Operation	Command
Cancel the interface to transmit NTP message	**undo ntp-service source-interface**

An interface is specified by *interface-name* or *interface-type interface-number*. The source address of the packets will be taken from the IP address of the interface. If the **ntp-service unicast-server** or **ntp-service unicast-peer** command also designates a transmitting interface, use the one designated by them.

Enabling/Disabling an Interface to Receive NTP Message

This configuration task is to enable/disable an interface to receive NTP message.

Perform the following configurations in VLAN interface view.

Table 573 Enable/Disable an Interface to Receive NTP Message

Operation	Command
Disable an interface to receive NTP message	**ntp-service in-interface disable**
Enable an interface to receive NTP message	**undo ntp-service in-interface disable**

This configuration task must be performed on the interface to be disabled to receive NTP message.

Setting Authority to Access a Local Switch

Set authority to access the NTP services on a local Switch. This is a basic and brief security measure, compared to authentication. An access request will be matched with **peer**, **serve**, **serve only**, and **query only** in an ascending order of the limitation. The first matched authority will be given.

Perform the following configurations in System View.

Table 574 Set Authority to Access a Local Switch

Operation	Command
Set authority to access a local Switch	**ntp-service access { query | synchronization | serve | peer }** *acl-number*
Cancel settings of the authority to access a local Switch	**undo ntp-service access { query | synchronization | serve | peer }**

IP address ACL number is specified through the *acl-number* parameter and ranges from 2000 to 2999. The meanings of other authority levels are as follows:

query: Allow control query for the local NTP service only.

synchronization: Allow request for local NTP time service only.

serve: Allow local NTP time service request and control query. However, the local clock will not be synchronized by a remote server.

peer: Allow local NTP time service request and control query. The local clock will also be synchronized by a remote server.

Setting Maximum Local Sessions

This configuration task is to set the maximum local sessions.

Perform the following configurations in System View.

Table 575 Set the Maximum Local Sessions

Operation	Command
Set the maximum local sessions	**ntp-service max-dynamic-sessions** *number*
Resume the maximum number of local sessions	**undo ntp-service max-dynamic-sessions**

number specifies the maximum number of local sessions, ranges from 0 to 100, and defaults to 100.

Displaying and Debugging NTP

After completing the above configurations, you can use the **display** command to show how NTP runs and verify the configurations according to the outputs.

In User View, you can use the **debugging** command to debug NTP.

Table 576 NTP Display and Debugging

Operation	Command
Display the status of NTP service	**display ntp-service status**
Display the status of sessions maintained by NTP service	**display ntp-service sessions [verbose]**
Display the brief information about every NTP time server on the way from the local equipment to the reference clock source.	**display ntp-service trace**
Enable NTP debugging	**debugging ntp-service**

Typical NTP Configuration Examples

This section contains examples of typical NTP configurations.

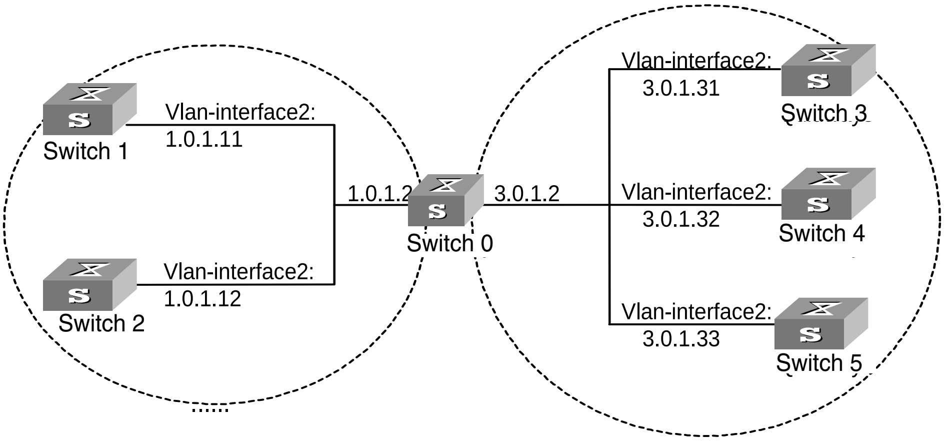
Configure NTP Server

Network Requirements

On Switch1, set the local clock as the NTP master clock at stratum 2. On Switch 2, configure Switch 1 as the time server in server mode and set the local equipment as in client mode. (Note that Switch 1 must support setting local clock as the NTP master clock.)

Networking Diagram

Figure 132 Typical NTP Configuration Networking Diagram



Configuration Procedure

Configure Switch 1:

1 Enter System View.

```
<switch1> system-view
```

2 Set the local clock as the NTP master clock at stratum 2.

```
[switch1]ntp-service refclock-master 2
```

Configure Switch 2:

1 Enter System View.

```
<switch2> system-view
```

2 Set SW5500 1 as the NTP server.

```
[switch2]ntp-service unicast-server 1.0.1.11
```

The above examples synchronized Switch 2 by Switch 1. Before the synchronization, the Switch 2 is shown in the following status:

```
[switch2]display ntp-service status
clock status: unsynchronized
 clock stratum: 16
 reference clock ID: none
 nominal frequency: 100.0000 Hz
 actual frequency: 100.0000 Hz
 clock precision: 2^17
 clock offset: 0.0000 ms
 root delay: 0.00 ms
 root dispersion: 0.00 ms
 peer dispersion: 0.00 ms
 reference time: 00:00:00.000 UTC Jan 1 1900(00000000.00000000)
```

After the synchronization, Switch 2 turns into the following status:

```
[switch2]display ntp-service status
clock status: synchronized
 clock stratum: 8
 reference clock ID: 1.0.1.11
 nominal frequency: 100.0000 Hz
 actual frequency: 100.0000 Hz
 clock precision: 2^17
 clock offset: 0.0000 ms
 root delay: 0.00 ms
 root dispersion: 10.94 ms
 peer dispersion: 10.00 ms
 reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, Switch 2 has been synchronized by Switch 1 and is at stratum 3, higher than Switch 1 by 1.

Display the sessions of Switch 2 and you will see Switch 2 has been connected with Switch 1.

```
[switch2]display ntp-service sessions
source          reference stra reach poll now offset delay disper
********************************************************************
[12345]127.127.1.0 LOCAL(0) 7   377  64   57    0.0    0.0    1.0
[5]1.0.1.11     0.0.0.016     0   64    -    0.0    0.0    0.0
[5]128.108.22.44 0.0.0.0 16     0   64    -    0.0    0.0    0.0
note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

NTP peer Configuration

Network Requirements

On Switch 3, set local clock as the NTP master clock at stratum 2. On Switch 2, configure SW5500 1 as the time server in server mode and set the local equipment as in client mode. At the same time, Switch 5 sets Switch 4 as its peer. (Note that Switch 3 must support setting local clock as the NTP master clock.)

Networking Diagram

See Figure 132.

Configuration Procedure

1. Configure Switch 3:
   - **a** Enter System View.

     ```
     <switch3> system-view
     ```

   - **b** Set the local clock as the NTP master clock at stratum 2.

     ```
     [switch3]ntp-service refclock-master 2
     ```

2. Configure Switch 4:
   - **a** Enter System View.

     ```
     <switch4> system-view
     ```

   - **b** Set Switch 1 as the NTP server at stratum 3 after synchronization.

     ```
     [switch4]ntp-service unicast-server 3.0.1.31
     ```

3 Configure Switch 5: (Switch 4 has been synchronized by Switch 3)

a Enter System View.

```
<switch5> system-view
```

b After performing local synchronization, set Switch 4 as a peer.

```
[switch5]ntp-service unicast-peer 3.0.1.32
```

The above examples configure Switch 4 and Switch 5 as peers and configures Switch 5 in active peer mode and Switch 4 in passive peer mode. Since Switch 5 is at stratum 1 and Switch 4 is at stratum 3, synchronize Switch 4 by Switch 5.

After synchronization, Switch 4 status is shown as follows:

```
[switch4]display ntp-service status
clock status: synchronized
 clock stratum: 8
 reference clock ID: 3.0.1.31
 nominal frequency: 100.0000 Hz
 actual frequency: 100.0000 Hz
 clock precision: 2^17
 clock offset: 0.0000 ms
 root delay: 0.00 ms
 root dispersion: 10.94 ms
 peer dispersion: 10.00 ms
reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, Switch 4 has been synchronized by Switch 5 and it is at stratum 2, or higher than Switch 5 by 1.

Display the sessions of Switch 4 and you will see Switch 4 has been connected with Switch 5.

```
[switch4]display ntp-service sessions
source          reference stra reach poll  now offset  delay disper
*************************************************************************
[12345]127.127.1.0 LOCAL(0) 7   377   64   57    0.0    0.0    1.0
[5]1.0.1.11        0.0.0.0 16     0   64    -    0.0    0.0    0.0
[5]128.108.22.44   0.0.0.0 16     0   64    -    0.0    0.0    0.0
note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

Configure NTP Broadcast Mode

Network Requirements

On Switch 3, set local clock as the NTP master clock at stratum 2 and configure to broadcast packets from Vlan-interface2. Configure Switch 4 and Switch 1 to listen to the broadcast from their Vlan-interface2 respectively. (Note that Switch 3 must support setting local clock as the NTP master clock.)

Networking Diagram

See Figure 132.

Configuration Procedure

1 Configure Switch 3:

a Enter System View.

```
<switch3> system-view
```

b Set the local clock as the NTP master clock at stratum 2.

```
[switch3]ntp-service refclock-master 2
```

c Enter Vlan-interface2 view.

```
[switch3]interface vlan-interface 2
```

d Set it as broadcast server.

```
[switch3-Vlan-Interface2]ntp-service broadcast-server
```

2 Configure Switch 4:

a Enter System View.

```
<switch4> system-view
```

b Enter Vlan-interface2 view.

```
[switch4]interface vlan-interface 2
[switch4-Vlan-Interface2]ntp-service broadcast-client
```

3 Configure Switch 1:

a Enter System View.

```
<switch1> system-view
```

b Enter Vlan-interface2 view.

```
[switch1]interface vlan-interface 2
[switch1-Vlan-Interface2]ntp-service broadcast-client
```

In the above examples Switch 4 and Switch 1 are configured to listen to the broadcast using Vlan-interface2, Switch 3 to broadcast packets from Vlan-interface2. As Switch 1 and Switch 3 are not located on the same segment, they cannot receive any broadcast packets from Switch 3, while Switch 4 is synchronized by Switch 3 after receiving its broadcast packet.

After the synchronization, you can find the state of Switch 4 as follows:

```
[switch4]display ntp-service status
clock status: synchronized
 clock stratum: 8
 reference clock ID: LOCAL(0)
 nominal frequency: 100.0000 Hz
 actual frequency: 100.0000 Hz
 clock precision: 2^17
 clock offset: 0.0000 ms
 root delay: 0.00 ms
 root dispersion: 10.94 ms
 peer dispersion: 10.00 ms
 reference time: 20:54:25.156 UTC Mar 7 2002(C0325201.2811A112)
```

By this time, Switch 4 has been synchronized by Switch 3 and it is at stratum 3, higher than Switch 3 by 1.

Display the status of Switch 4 sessions and you will see Switch 4 has been connected to Switch 3.

```
[switch2]display ntp-service sessions
source       reference stra reach poll  now offset  delay disper
********************************************************************
[12345]127.127.1.0 LOCAL(0) 7   377   64   57    0.0    0.0    1.0
[5]1.0.1.11        0.0.0.0 16     0   64    -    0.0    0.0    0.0
[5]128.108.22.44   0.0.0.0 16     0   64    -    0.0    0.0    0.0
note: 1 source(master),2 source(peer),3 selected,4 candidate,5
configured
```

Configure NTP Multicast Mode

Network Requirements

Switch 3 sets the local clock as the master clock at stratum 2 and multicast packets from Vlan-interface2. Set Switch 4 and Switch 1 to receive multicast messages from their respective Vlan-interface2. (Note that Switch 3 must support setting local clock as the NTP master clock.)

Networking Diagram

See Figure 132.

Configuration Procedure

1 Configure Switch 3:

a Enter System View.

```
<switch3> system-view
```

b Set the local clock as the NTP master clock at stratum 2.

```
[switch3]ntp-service refclock-master 2
```

c Enter Vlan-interface2 view.

```
[switch3]interface vlan-interface 2
```

d Set it as a multicast server.

```
[switch3-Vlan-Interface2]ntp-service multicast-server
```

2 Configure Switch 4:

a Enter System View.

```
<switch4> system-view
```

b Enter Vlan-interface2 view.

```
[switch4]interface vlan-interface 2
```

c Enable multicast client mode.

```
[switch4-Vlan-Interface2]ntp-service multicast-client
```

3 Configure Switch 1:

a Enter System View.

```
<switch1> system-view
```

b Enter Vlan-interface2 view.

```
[switch1]interface vlan-interface 2
```

c Enable multicast client mode.

```
[switch1-Vlan-Interface2]ntp-service multicast-client
```

The above examples configure Switch 4 and Switch 1 to receive multicast messages from Vlan-interface2, Switch 3 multicast messages from Vlan-interface2. Since Switch 1 and Switch 3 are not located on the same segments, Switch 1 cannot receive the multicast packets from Switch 3, while Switch 4 is synchronized by Switch 3 after receiving the multicast packet.

Configure Authentication-enabled NTP Server Mode

Network Requirements

Switch 1 sets the local clock as the NTP master clock at stratum 2. Switch 2 sets Switch 1 as its time server in server mode and itself in client mode and enables authentication. (Note that Switch 1 must support setting local clock as the NTP master clock.)

Networking Diagram

See Figure 132.

Configuration Procedure

1 Configure Switch 1:

a Enter System View.

```
<switch1> system-view
```

b Set the local clock as the NTP master clock at stratum 2.

```
[switch1]ntp-service refclock-master 2
```

2 Configure Switch 2:

a Enter System View.

```
<switch2> system-view
```

b Set Switch 1 as time server.

```
[switch2]ntp-service unicast-server 1.0.1.11
```

c Enable authentication.

```
[switch2]ntp-service authentication enable
```

d Set the key.

```
[switch2]ntp-service authentication-keyid 42 authentication-mode md5
aNiceKey
```

e Set the key as reliable.

```
[switch2]ntp-service reliable authentication-keyid 42
```

The above examples synchronized Switch 2 by Switch 1. Since Switch 1 has not been enabled authentication, it cannot synchronize Switch 2. And now let us do the following additional configurations on Switch 1:

1 Enable authentication.

```
[switch1]ntp-service authentication enable
```

2 Set the key.

```
[switch1]ntp-service authentication-keyid 42 authentication-mode md5
aNiceKey
```

3 Configure the key as reliable.

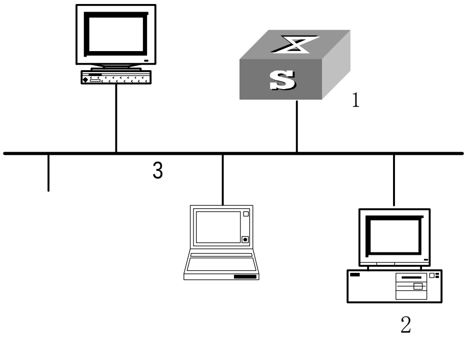
```
[switch1]ntp-service reliable authentication-keyid 42
```

SSH Terminal Services

Secure Shell (SSH) can provide information security and powerful authentication to prevent such assaults as IP address spoofing, plain-text password interception when users log on to the Switch remotely from an insecure network environment. A Switch can connect to multiple SSH clients. SSH Client functions to enable SSH connections between users and the Switch or UNIX host that support SSH Server. You can set up SSH channels for local connection. See Figure 133.

Currently the Switch that runs SSH server supports SSH version 1.5.

Figure 133 Setting up SSH channels in LAN



1: Switch running SSH server
2: PC running SSH client
3: Ethernet LAN

In Figure 133, the VLAN for the Ethernet port must have been configured with VLAN interfaces and IP address.

The communication process between the server and client include these five stages: version negotiation stage, key negotiation stage, authentication stage, session request stage, interactive session stage.

- Version negotiation stage: The client sends TCP connection requirement to the server. When TCP connection is established, both ends begin to negotiate the SSH version. If they can work together in harmony, they enter the key algorithm negotiation stage. Otherwise the server clears the TCP connection.
- Key negotiation stage: Both ends negotiate key algorithm and compute session key. The server randomly generates its RSA key and sends the public key to the client. The client figures out session key based on the public key from the server and the random number generated locally. The client encrypts the random number with the public key from the server and sends the result back to the server. The server then decrypts the received data with the server private key to get the client random number. It then uses the same algorithm to work out the session key based on server public key and the returned random number. Then both ends get the same key without data transfer over the network, while the key is used at both ends for encryption and description.
- Authentication stage: The server authenticates the user at the client after obtaining a session key. The client sends its username to the server: If the username has been created and configured as no authentication, authentication stage is skipped for this user. Otherwise, the authentication process continues. SSH supports two authentication types: password authentication and RSA authentication. In the first type, the server compares the username and password received with those configured locally. The user is allowed to log on to the Switch if the usernames and passwords match exactly. RSA authentication works in this

way: The RSA public key of the client user is configured at the server. The client first sends the member modules of its RSA public key to the server, which checks its validity. If it is valid, the server generates a random number, which is sent to the client after being encrypted with RSA public key. Both ends calculate authentication data based on the random number and session ID. The client sends the authentication data calculated back to the server, which compares it with its attention data obtained locally. If they match exactly, the user is allowed to access the Switch. Otherwise, authentication process fails.

- Session request stage: The client sends session request messages to the server which processes the request messages.
- Interactive session stage: Both ends exchange data till the session ends.

  Session packets are encrypted in transfer and the session key is generated randomly. Encryption is used in exchanging session key and RSA authentication achieves key exchange without transfer over the network. SSH can protect server-client data security. The authentication will also start even if the username received is not configured at the server, so malicious intruders cannot judge whether a username they key in exists or not. This is also a way to protect a username.

Configuring SSH Server

Basic configuration tasks refer to those required for successful connection from SSH client to SSH server, which advanced configuration tasks are those modifying SSH parameters.

Configuration tasks on the SSH server include:

- Setting system protocol and link maximum
- Configuring and deleting local RSA key pair
- Configuring authentication type
- Defining update interval of server key
- Defining SSH authentication timeout value
- Defining SSH authentication retry value
- Entering public key view and editing public key
- Associating public key with SSH user

Setting System Protocol

You must specify SSH protocol for the system before enabling SSH.

Perform the following configuration in System View.

Table 577 Setting System Protocols and Link Maximum

Operation	Command
Set system protocol and link maximum	`protocol inbound { all | ssh | telnet }`

By default, the system supports Telnet and SSH protocols.

If SSH protocol is specified, to ensure a successful login, you must configure the AAA authentication using the **`authentication-mode scheme`** *command. The* **`protocol inbound ssh`** *configuration fails if you configure* **`authentication-mode password`** *and* **`authentication-mode none`**. *When you configure SSH protocol successfully for the user interface, then you cannot configure* **`authentication-mode password`** *and* **`authentication-mode none`** *any more.*

Configuring and Canceling Local RSA Key Pair

In executing this command, if you have configured RSA host key pair, the system gives an alarm after using this command and prompts that the existing one will be replaced. The server key pair is created dynamically by the SSH server. The maximum bit range of both key pairs is 2048 bits and the minimum is 512.

Please perform the following configurations in System View.

Table 578 Configuring and Canceling Local RSA Key Pair

Operation	Command
Configure local RSA key pair	**rsa local-key-pair create**
Cancel local RSA key pair	**rsa local-key-pair destroy**

For a successful SSH login, you must configure and generate the local RSA key pairs. To generate local key pairs, you just need to execute the command once, with no further action required even after the system is rebooted.

Configuring Authentication Type

For a new user, you must specify authentication type. Otherwise, they cannot access the Switch.

Perform the following configurations in System View.

Table 579 Configuring Authentication Type

Operation	Command
Configure authentication type	**ssh user** *username* **authentication-type { password** | **rsa** | **all }**
Remove authentication type setting	**undo ssh user** *username* **authentication-type**

If the configuration is RSA authentication type, then the RSA public key of the client user must be configured on the Switch, that is to perform the 7 and 8 serial number marked configuration.

By default, no authentication type is specified for a new user, so they cannot access the Switch.

Defining Update Interval of Server Key

Perform the following configurations in System View.

Table 580 Defining Update Interval of Server Key

Operation	Command
Define update interval of server key	**ssh server rekey-interval** *hours*
Restore the default update interval	**undo ssh server rekey-interval**

By default, the system does not update server key.

Defining SSH Authentication Timeout Value

Perform the following configurations in System View.

Table 581 Defining SSH Authentication Timeout Value

Operation	Command
Define SSH authentication timeout value	**ssh server timeout** *seconds*
Restore the default timeout value	**undo ssh server timeout**

By default, the timeout value for SSH authentication is 60 seconds.

Defining SSH Authentication Retry Value

Setting SSH authentication retry value can effectively prevent malicious registration attempt.

Perform the following configurations in System View.

Table 582 Defining SSH Authentication Retry Value

Operation	Command
Define SSH authentication retry value	**ssh server authentication-retries** *times*
Restore the default retry value	**undo ssh server authentication-retries**

By default, the retry value is 3.

Entering Public Key Edit View and Editing Public Key

You can enter the public key edit view and edit the client public key.

This operation is only available for the SSH users using RSA authentication. At the Switch, you configure the RSA public key of the client, while at the client, you specify the RSA private key which corresponds to the RSA public key.

This operation will fail if you configure password authentication for the SSH user.

Perform the following configurations in System View.

Table 583 Configuring Public Key

Operation	Command
Enter public key view	**rsa peer-public-key** *key-name*
Delete a designated public key	**undo rsa peer-public-key** *key-name*

When entering the public key edit view with the **rsa peer-public-key** command, you can begin editing the public key with the **public-key-code begin** command. You can key in a blank space between characters, since the system can remove the blank space automatically. But the public key should be composed of hexadecimal characters. Terminate public key editing and save the result with the **public-key-code end** command. Validity check comes before saving: the public key editing fails if the key contains invalid characters.

Perform the following configurations in the Public Key View.

Figure 134 Starting/Terminating Public Key Editing

Operation	Command
Enter public key edit view	**public-key-code begin**
Terminate public key edit view	**public-key-code end**
Quit public key view	**peer-public-key end**

Associating Public Key with SSH User

Please perform the following configurations in System View.

Figure 135 Associating Public Key with SSH User

Operation	Command
Associate existing public with an SSH user	**ssh user** *username* **assign rsa-key** *keyname*
Remove the association	**undo ssh user** *username* **assign rsa-key**

Configuring SSH Client

There are several types of SSH client software, such as PuTTY and FreeBSD. You should first configure the client's connection with the server. The basic configuration tasks on the client include:

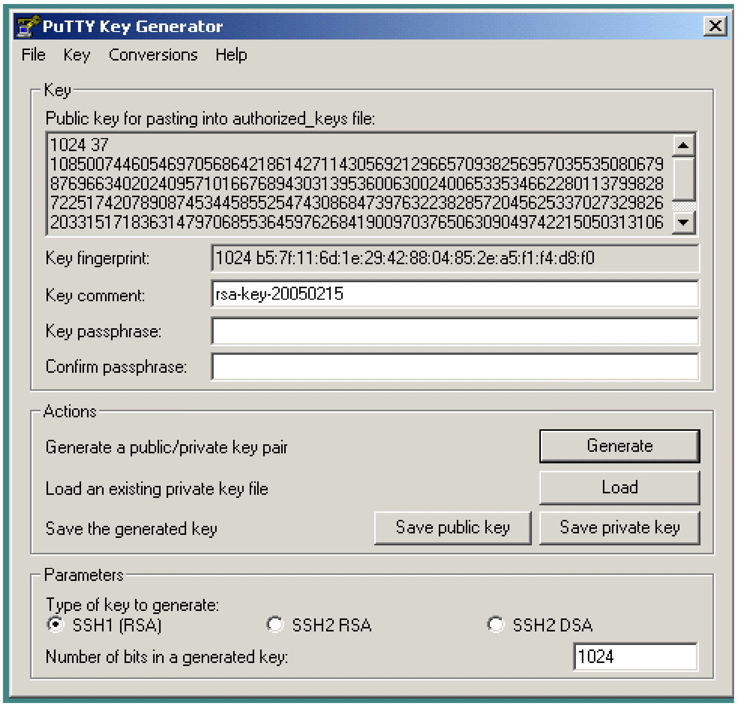
- Specifying server IP address.
- Selecting SSH protocol. The client supports the remote connection protocols link Telnet, Rlogin and SSH. To set up SSH connection, you must select SSH protocol.
- Choosing SSH version. The Switch currently supports SSH Server 1.5, so you have to choose 1.5 or an earlier version.
- Specifying RSA private key file. If you specify RSA authentication for the SSH user, you must specify RSA private key file. The RSA key, which includes the public key and private key, are generated by the client software. The former is configured in the server (Switch) and the latter is in the client.

The following description takes the PuTTY as an example.

Generating the Key

Start the Puttygen program, choose SSH1(RSA), then click on the Generate button and follow the instructions

Figure 136 PuTTy key generator



PuTTY Key Generator

Key

Public key for pasting into authorized_keys file:

```
1024 37
10850074460546970568642186142711430569212966570938256957035535080679
87696634020240957101667689430313953600630024006533534662280113799828
72251742078908745344585525474308684739763223828572045625337027329826
20331517183631479706855364597626841900970376506309049742215050313106
```

Key fingerprint: 1024 b5:7f:11:6d:1e:29:42:88:04:85:2e:a5:f1:f4:d8:f0

Key comment: rsa-key-20050215

Key passphrase:

Confirm passphrase:

Actions

Generate a public/private key pair — Generate

Load an existing private key file — Load

Save the generated key — Save public key — Save private key

Parameters

Type of key to generate:
● SSH1 (RSA) ○ SSH2 RSA ○ SSH2 DSA

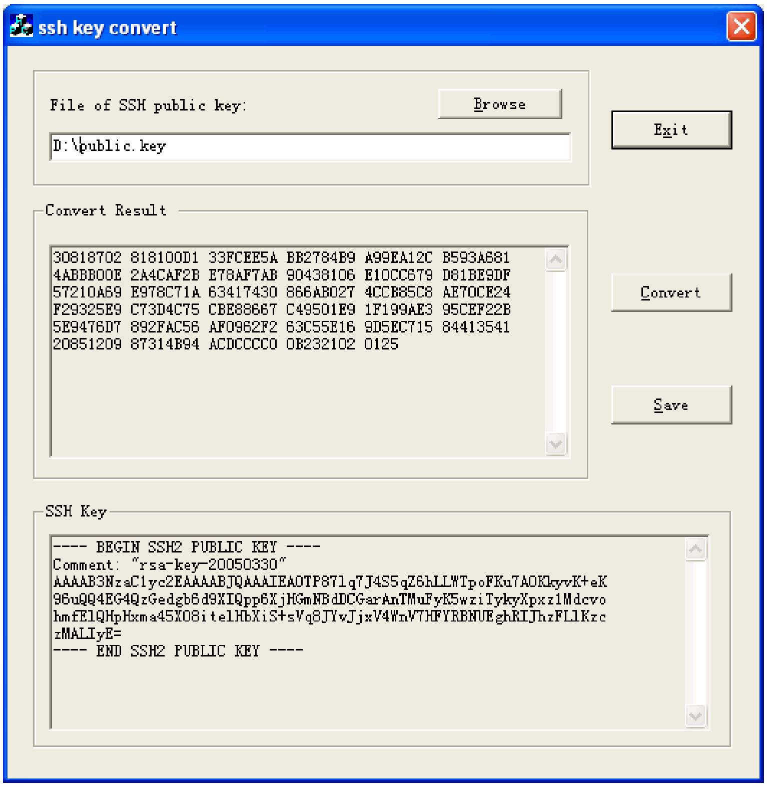
Number of bits in a generated key: 1024

When the generation process has finished, save the generated public and private keys to files using the Save buttons.

Run the sshkey program. This converts SSH public key to the format required by the switch.

Open the public key file generated by puttygen, then click the Convert button

Figure 137 SSH key convert.



File of SSH public key: D:\public.key

Convert Result

```
30818702 818100D1 33FCEE5A BB2784B9 A99EA12C B593A681
4ABBB00E 2A4CAF2B E78AF7AB 90438106 E10CC679 D81BE9DF
57210A69 E978C71A 63417430 866AB027 4CCB85C8 AE70CE24
F29325E9 C73D4C75 CBE88667 C49501E9 1F199AE3 95CEF22B
5E9476D7 892FAC56 AF0962F2 63C55E16 9D5EC715 84413541
20851209 87314B94 ACDCCCC0 0B232102 0125
```

SSH Key

```
---- BEGIN SSH2 PUBLIC KEY ----
Comment: "rsa-key-20050330"
AAAAB3NzaC1yc2EAAAABJQAAAIEA0TP871q7J4S5qZ6hLLWTpoFKu7A0KkyvK+eK
96uQQ4EG4QrGedgb6d9XIQpp6XjHGmNBdDCGarAnTMuFyK5wziTykyXpxz1Mdcvo
hmfElQHpHxma45XO8itelHbXiS+sVq8JYvJjxV4WnV7HFYRBNUEghRIJhzFLlKzc
zMALIyE=
---- END SSH2 PUBLIC KEY ----
```

Use the save button to save this converted key to a file.

Open the public key file in Notepad and the following lines of text before the existing text:

```
rsa peer-public-key mykey
public-key-code begin
```

where *myKey* is a name used to identify the key within the switch, you may choose any name for this.

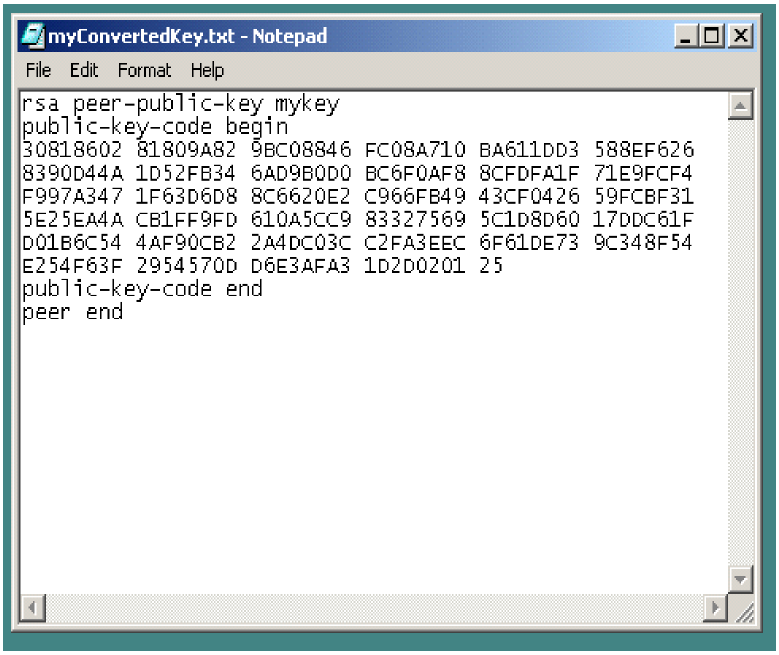
Then add the following after the existing text:

```
public-key-code end
peer end
```

Also remove any blank lines from the file.

The file should look like this:

Figure 138 Text file of myKey



```
rsa peer-public-key mykey
public-key-code begin
30818602 81809A82 9BC08846 FC08A710 BA611DD3 588EF626
8390D44A 1D52FB34 6AD9B0D0 BC6F0AF8 8CFDFA1F 71E9FCF4
F997A347 1F63D6D8 8C6620E2 C966FB49 43CF0426 59FCBF31
5E25EA4A CB1FF9FD 610A5CC9 83327569 5C1D8D60 17DDC61F
D01B6C54 4AF90CB2 2A4DC03C C2FA3EEC 6F61DE73 9C348F54
E254F63F 2954570D D6E3AFA3 1D2D0201 25
public-key-code end
peer end
```

Save this to a file ending with a ".bat" extension e.g "keys.bat".

This file can be transferred to the switch using FTP or TFTP.

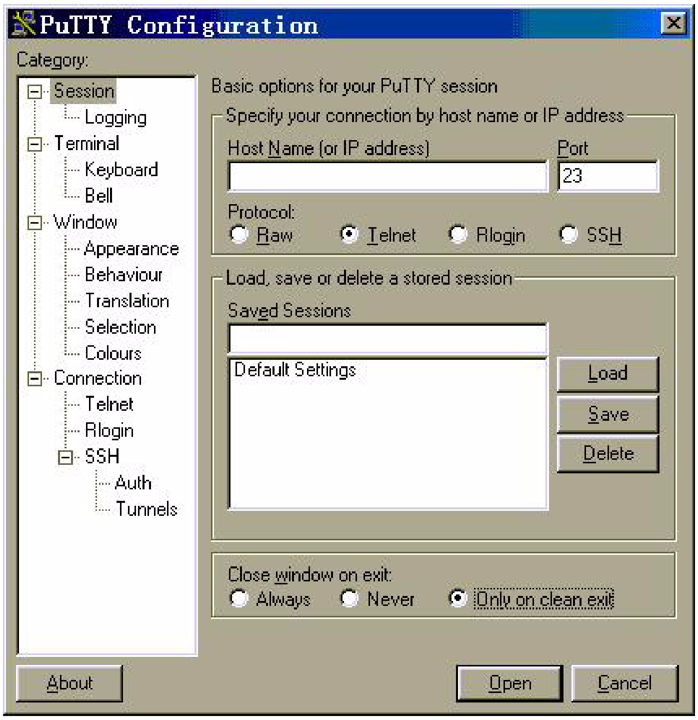
The key is installed using the execute command in the System view

```
[SW5500]execute keys.bat
```

Specifying Server IP Address

Start PuTTY program and the client configuration interface pops up.

Figure 139 SSH Client Configuration Interface (1)



Basic options for your PuTTY session

Specify your connection by host name or IP address

Host Name (or IP address):

Port: 23

Protocol: ○ Raw ● Telnet ○ Rlogin ○ SSH

Load, save or delete a stored session

Saved Sessions:

Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

In the Host Name (or IP address) text box key in the IP address of the Switch, for example, 10.110.28.10. You can also input the IP address of an interface in UP state, but its route to SSH client PC must be reachable.

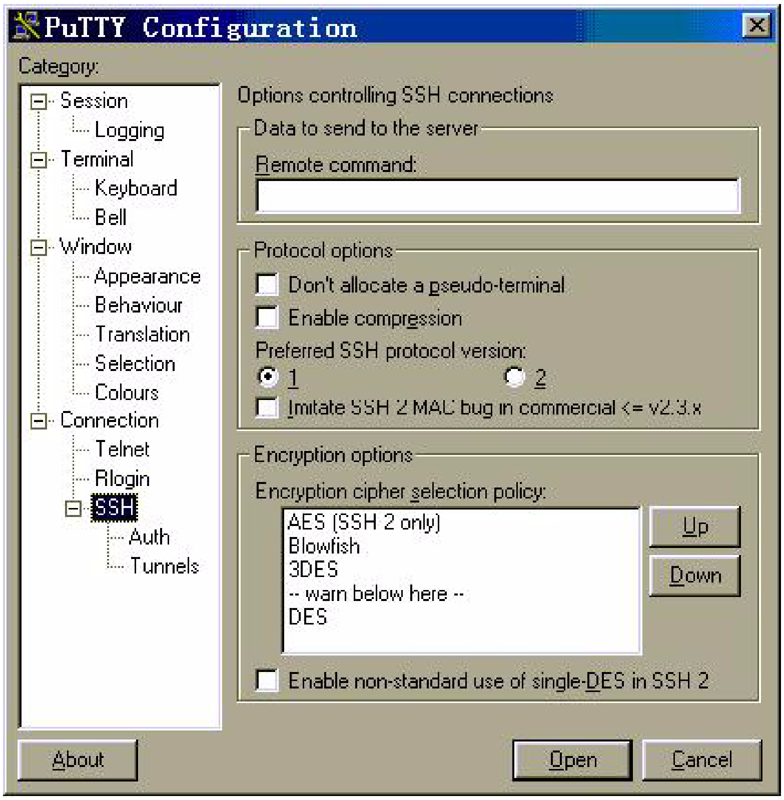
Selecting SSH Protocol

Select SSH for the Protocol item.

Choosing SSH Version

Click the left menu *[Category/Connection/SSH]* to enter the interface shown in Figure 140.

Figure 140 SSH Client Configuration Interface (2)



Options controlling SSH connections

Data to send to the server

Remote command:

Protocol options

□ Don't allocate a pseudo-terminal

□ Enable compression

Preferred SSH protocol version:

● 1 ○ 2

□ Imitate SSH 2 MAC bug in commercial <= v2.3.x

Encryption options

Encryption cipher selection policy:

AES (SSH 2 only)
Blowfish
3DES
-- warn below here --
DES

□ Enable non-standard use of single-DES in SSH 2

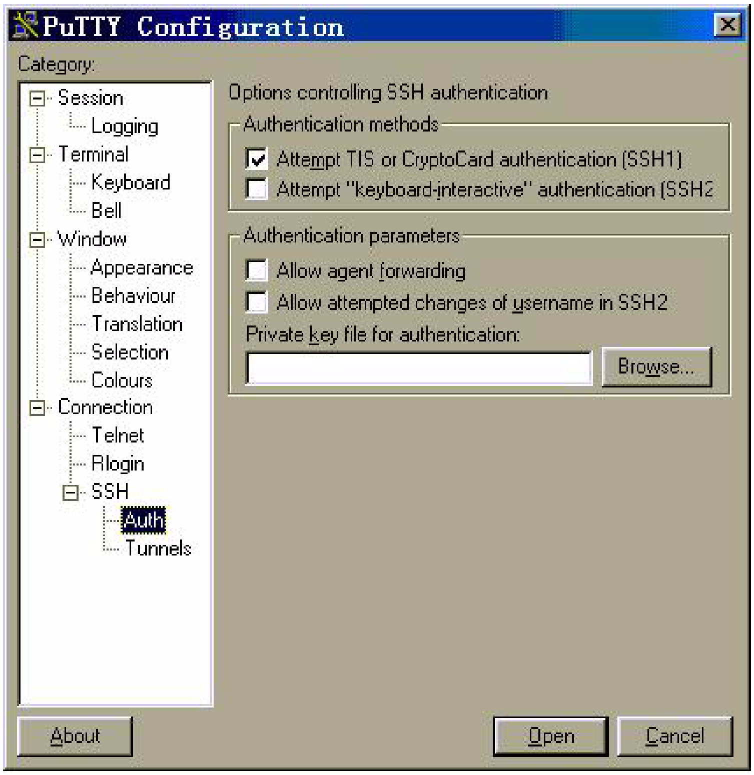
You can select 1, as shown in Figure 140.

Specifying RSA Private Key File

If you want to enable RSA authentication, you must specify RSA private key file, which is not required for password authentication.

Click *[SSH/Auth]* to enter the interface as shown in Figure 141.

Figure 141 SSH client configuration interface (3)



Options controlling SSH authentication

Authentication methods

☑ Attempt TIS or CryptoCard authentication (SSH1)

□ Attempt "keyboard-interactive" authentication (SSH2

Authentication parameters

□ Allow agent forwarding

□ Allow attempted changes of username in SSH2

Private key file for authentication:

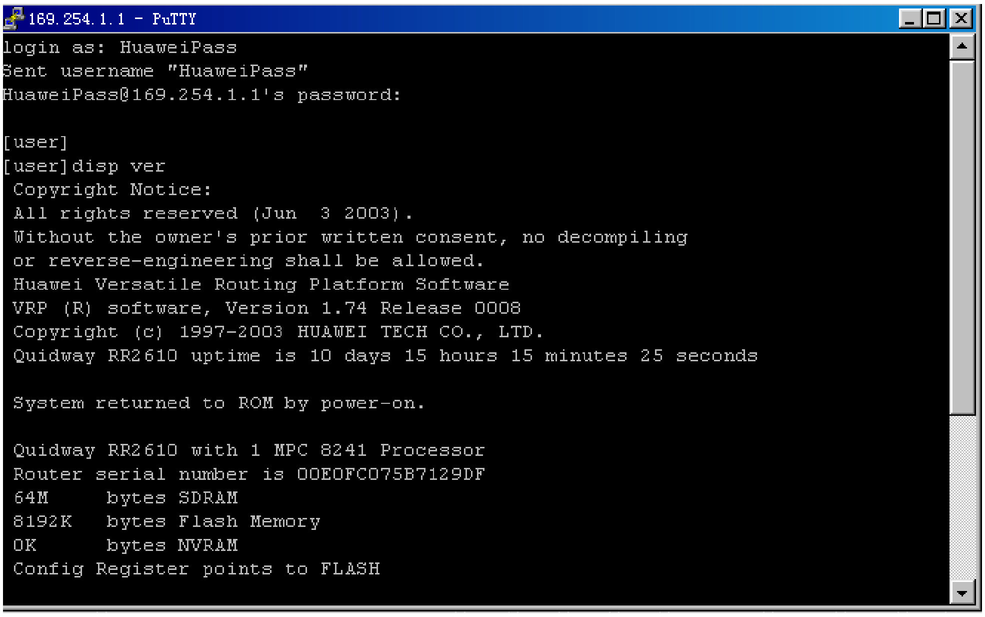
Browse...

Click *Browse* to enter the File Select interface. Choose a desired file and click *OK*.

Opening SSH Connection

Click *Open* to enter SSH client interface. If it runs normally, you are prompted to enter username and password. See Figure 142.

Figure 142 SSH client interface



```
login as: HuaweiPass
Sent username "HuaweiPass"
HuaweiPass@169.254.1.1's password:

[user]
[user]disp ver
 Copyright Notice:
 All rights reserved (Jun  3 2003).
 Without the owner's prior written consent, no decompiling
 or reverse-engineering shall be allowed.
 Huawei Versatile Routing Platform Software
 VRP (R) software, Version 1.74 Release 0008
 Copyright (c) 1997-2003 HUAWEI TECH CO., LTD.
 Quidway RR2610 uptime is 10 days 15 hours 15 minutes 25 seconds

 System returned to ROM by power-on.

 Quidway RR2610 with 1 MPC 8241 Processor
 Router serial number is 00E0FC075B7129DF
 64M     bytes SDRAM
 8192K   bytes Flash Memory
 0K      bytes NVRAM
 Config Register points to FLASH
```

Key in the correct username and password and log into SSH connection.

Log out of SSH connection with the **logout** command.

Displaying and Debugging SSH

Run the **display** command in any view to view the running of SSH and further to check configuration result.

Run the **debugging** command to debug the SSH.

Perform the following configurations in any view.

Table 584 Display SSH Information

Operation	Command
Display host and server public keys	**display rsa local-key-pair public**
Display client RSA public key	**display rsa peer-public-key [brief | name** *keyname* **]**
Display SSH state information and session	**display ssh server { status | session }**
Display SSH user information	**display ssh user-information [** *username* **]**
Enable SSH debugging	**debugging ssh server { VTY** *index* **| all }**
Disable SSH debugging	**undo debugging ssh server { VTY** *index* **| all }**

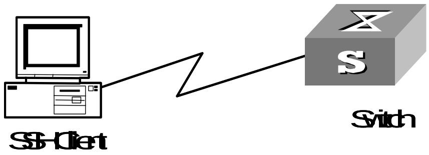
SSH Configuration Example

Networking Requirements

As shown in Figure 143, configure a local connection from the SSH Client to the Switch. The client uses SSH protocol to access the Switch.

Networking Diagram

Figure 143 Networking for SSH Local Configuration



Configuration Procedure

1 You should run this command before any other configuration:

```
[SW5500]rsa local-key-pair create
```

If you have configured local key pair in advance, this operation is unnecessary.

2 For password authentication mode

```
[SW5500]user-interface vty 0 4
[SW5500-ui-vty0-4]authentication-mode scheme
[SW5500-ui-vty0-4]protocol inbound ssh
[SW5500]local-user client001
[SW5500-luser-client001]password simple 3com
[SW5500-luser-client001]service-type ssh
[SW5500]ssh user client001 authentication-type password
```

Select the default values for SSH authentication timeout value, retry value and update interval of server key. Then run SSH1.5 client program on the PC which is connected to the Switch and access the Switch using username “client001” and password “3com”.

3 For RSA authentication mode:

Create local user client002

```
[SW5500]local-user client002
```

```
[SW5500-luser-client002]service-type ssh
```

4 Specify AAA authentication on the user interface.

```
[SW5500]user-interface vty 0 4
[SW5500-ui-vty0-4]authentication-mode scheme
```

5 Select SSH protocol on the Switch.

```
[SW5500-ui-vty0-4]protocol inbound ssh
```

6 Specify RSA authentication on the Switch.

```
[SW5500]ssh user client002 authentication-type RSA
```

7 Configure RSA key pair on the Switch.

If you followed the procedure for generating and executing a ".bat" file containing keys then you need not perform this step.

```
[SW5500]rsa peer-public-key switch002
[SW5500-rsa-public]public-key-code begin
[SW5500-key-code]308186028180739A291ABDA704F5D93DC8FDF84C427463
[SW5500-key-code]1991C164B0DF178C55FA833591C7D47D5381D09CE82913
[SW5500-key-code]D7EDF9C08511D83CA4ED2B30B809808EB0D1F52D045DE4
[SW5500-key-code]0861B74A0E135523CCD74CAC61F8E58C452B2F3F2DA0DC
[SW5500-key-code]C48E3306367FE187BDD944018B3B69F3CBB0A573202C16
[SW5500-key-code]BB2FC1ACF3EC8F828D55A36F1CDDC4BB45504F020125
[SW5500-key-code]public-key-code end
[SW5500-rsa-public]peer-public-key end
[SW5500]ssh user client002 assign rsa-key key002
```

You need to specify RSA private key which corresponds to the public key for the SSH user client002.

Run SSH1.5 client program on the PC that has been configured with private RSA private key and you can set up SSH connection.

File System Configuration

This section contains configuration information for the File System.

Introduction to File System

The Ethernet switch provides the file system module for your convenience to manage the storage devices such as flash memory. The file system provides you with the functions to access and manage the files and directories.

In an Ethernet switch supporting expandable resilient networking (XRN), you can input a path/file name in one of the following forms:

Beginning with unit[No.]>flash:/, where, [No.] is the unit ID of a switch. This form indicates the path/file is on the specified unit. For example, the unit ID of a switch is 1, the URL of the text.txt file in the root directory on the switch must be unit1>flash:/text.txt.

Beginning with flash:/. This form indicates the path/file is in the flash memory of the local unit.

Direct path/file name. This form indicates the path/file is under the current working path.

File System Configuration

Perform the following file system configuration in user view.

Table 585 Configure the file system

Operation	Command	Description
Delete file(s)	**delete** [**/unreserved**] *file-url* **delete** { **running-files** | **standby-files** } [**/fabric**] [**/unreserved**]	Optional You can use the **undelete** command to restore the files which are deleted by using the **delete** command without the **/unreserved** keyword.
Delete the files in the recycle bin completely	**reset recycle-bin** [*file-url*] [**/force**] **reset recycle-bin** [**/fabric**]	Optional
Delete configuration file in flash memory	**reset saved-configuration** [**backup** | **main**]	Optional
Update the software on the whole fabric	**update fabric** *file-name*	Optional You can use this command only after inhibiting service traffic.
Display the directory or file information	**dir** [**/all**] [**/fabric** | *file-url*]	Optional
Save the current configurations to a file in the flash memory so as to use the file as the main or backup configuration file upon next startup	**save** [*cfgfile* | [**safely**] [**backup** | **main**]]	Optional You can execute the **display** commands in any view.
Display the current configuration file	**display saved-configuration** [**unit** *unit-id*] [**by-linenum**]	
Display the current configurations	**display current-configuration** [**configuration** [*configuration-type*] | **interface** [*interface-type*] [*interface-number*] | **vlan** [*vlan-id*]] [**by-linenum**] [| { **begin** | **include** | **exclude** } *regular-expression*]	
Display the information about the startup configuration files	**display startup** [**unit** *unit-id*]	
Display the running configurations in the current view of the system	**display this** [**by-linenum**]	

If you delete a file and then another file with the same name under the same directory, the recycle bin only reserves the last deleted file.

*The files which are deleted by using the **delete** command without the **/unreserved** parameter will be saved in the recycle bin and therefore still occupy storage space. You can use the **reset recycle-bin** command to clear all useless files in the recycle bin to recycle storage space.*

*You can use the **update fabric** command only after inhibiting service traffic.*

*In the display output of the **dir /all** command, the deleted files reserved in the recycle bin will be marked with square brackets.*

If all configuration files are deleted, the system will use the default configuration parameters for initialization when the Ethernet switch starts up next time.

*To ensure that the switch can use the current configurations after it restarts, you are recommended to save the current configurations by using the **save** command before restarting the switch.*

*If multiple switches compose one fabric, executing the **save** command will make each unit in the fabric save its own startup configuration file*

FTP Lighting Configuration

This section contains configuration information for FTP Lighting.

Introduction to FTP

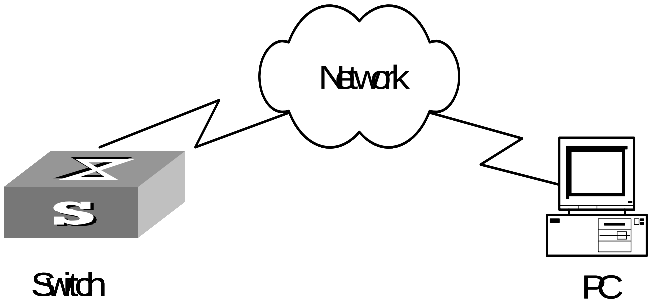
File transfer protocol (FTP) is a commonly used method to transfer files over the Internet and IP networks. Before the emergence of World Wide Web (WWW), users transfer files with command line method, and the most commonly used application for this method is FTP. Now, most users choose e-mail and Web to transfer files. However, FTP is still used widely.

FTP is an application-layer protocol in the TCP/IP protocol suite. It is used for file transfer between remote server and local host.

The Ethernet switch provides the following FTP services:

- FTP server: A user runs FTP client on a PC and logs into the Ethernet switch which acts as an FTP server (the network administrator should configure the IP address of the FTP server before the user can successfully log in). Then the user can access the files on the FTP server.
- FTP client: A user runs a terminal emulation program or Telnet program on a PC and connects to the Ethernet switch which acts as an FTP client. After that, the user input the **ftp** X.X.X.X command (where, X.X.X.X represents the IP address of an FTP server) to establish a connection between the Ethernet switch and a remote FTP server. Then, the user can access the files on the remote FTP server.

Figure 144 Network diagram for FTP configuration



FTP Lighting Procedure

The FTP server and the FTP client must be reachable to each other for the FTP function to operate normally.

Enabling FTP Server on Switch

After FTP server is enabled on an SWITCH 5500 switch, the seven-segment digital LED on the front panel of the switch will rotate clockwise when an FTP client is uploading file to the FTP server (the SWITCH 5500 switch), and will stop rotating when the file uploading is finished, as show in Figure 145.

Figure 145 7Clockwise rotating of the seven-segment digital LED

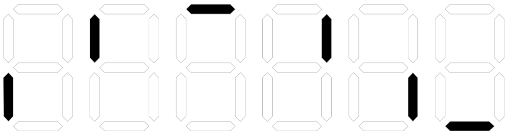


Table 586 Upload file from an FTP client to the switch acting as FTP server

Device	Operation	Command	Description
FTP client	Log into the remote FTP server		Required For detailed configuration, refer to the configuration instruction relevant to FTP client.
	Upload file from the FTP client to the FTP server		Required For detailed configuration, refer to the configuration instruction relevant to FTP client.
FTP server (SWITCH 5500)	Enable FTP server	ftp sever enable	Required By default, FTP server is disabled.
	Add a local user and enter local user view	**local-user** *user-name*	Required
	Set a password for the local user	**password** { **simple** | **cipher** } *password*	Required
	Set the password display mode of local users	**local-user password-display -mode** { **auto** | **cipher-force** }	Optional By default, this mode is **auto** (that is, the switch displays user passwords in the modes adopted when the passwords are set).

Enabling FTP Client on the Switch

After FTP client is enabled on an SWITCH 5500 switch, the seven-segment digital LED on the front panel of the switch will rotate clockwise when the FTP client (the SWITCH 5500 switch) is downloading file from a FTP server, and will stop rotating when the file downloading is finished, as show in Figure 145.

Table 587: Download file from an FTP server to the switch acting as an FTP client

Device	Operation	Command	Description
FTP client (SWITCH 5500)	Log into the remote FTP server	**ftp** [*ipaddress* [*port*]]	Required ■ The switch is an FTP client by default. ■ The user should first obtain an FTP user name and password, then log into the remote FTP server. Only after that, can the user obtain the access rights of corresponding directory and file. ■ At the same time the user logs into the FTP server, the switch enters FTP client command view.
	Download files from the remote FTP server and save the files to the local device	**get** *remotefile* [*localfile*]	Required If no local file name is specified, the system will consider that the local file name is identical with the file name on the remote FTP server by default.
FTP server	Enable FTP server	-	Required For detailed configuration, refer to the configuration instruction relevant to FTP server.
	Configure authentication/authorization of the FTP server	-	Required For detailed configuration, refer to the configuration instruction relevant to FTP server.

TFTP Lighting Configuration

Introduction to TFTP

Trivial file transfer protocol (TFTP) is a simple protocol. Compared with FTP, TFTP does not provide complex interactive access interface and authentication control, and is suitable for the environments that do not need complex interaction. Generally, TFTP is implemented based on UDP.

The TFTP file transfer is initiated by a client:

- When a file needs to be downloaded, the client sends a read request to the TFTP server. It then receives data from the server and sends acknowledgement to the server.
- When a file needs to be uploaded, the client sends a write request to the TFTP server. It then sends data to the server and receives acknowledgement from the server.

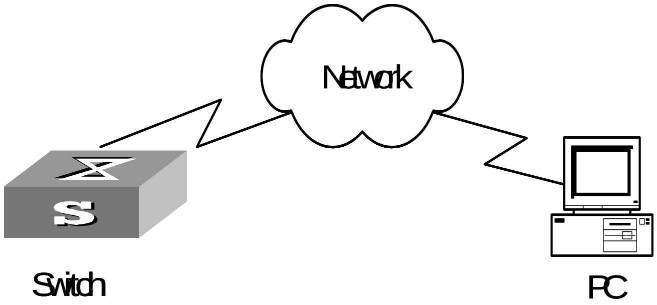
TFTP can transfer files in two formats:

- Binary: used to transfer programs.
- ASCII code: used to transfer text files.

Before configuring TFTP, the network administrator should first configure the IP addresses of the TFTP client and server and ensure that the client and the server are reachable to each other.

The switch can only act as a TFTP client.

Figure 146 Network diagram for TFTP configuration



TFTP Lighting Procedure

The TFTP server and the TFTP client must be reachable to each other for the TFTP function operates normally.

After TFTP client is enabled on an SWITCH 5500 switch, the seven-segment digital LED on the front panel of the switch will rotate clockwise when the TFTP client (the SWITCH 5500 switch) is downloading file from a TFTP server, and will stop rotating when the file downloading is finished, as show in Figure 145.

Table 588 Download file from an TFTP server to the switch acting as an TFTP client

Device	Operation	Command	Description
TFTP client (SWITCH 5500)	Log into a remote TFTP server, download and save a remote file to a local file	**tftp** *tftp-server* **get** *source-file* [*dest-file*]	Required
TFTP server	Enable TFTP server	—	Required For detailed configuration, refer to the configuration instruction relevant to TFTP server.

23 PORT TRACKING CONFIGURATION

Introduction to the Port Tracking Function

With the port tracking function enabled, you can specify to track the link state of the master's uplink port and decrease the priority of the switch when the port fails.

This in turn triggers the new master to be determined in the backup group.

Port Tracking Configuration

This section contains configuration information for Port Tracking.

Configuring the Port Tracking Function

Table 589 Configure the port tracking function

Operation	Command	Description
Enter system view	system-view	-
Create a VLAN	**vlan** *vlan-id*	This operation creates the VLAN to which the backup group corresponds. The *vlan-id* argument is the ID of the VLAN.
Add an Ethernet port to the VLAN	**port** *interface-type interface-number*	-
Quit to system view	quit	-
Enter VLAN interface view	**interface vlan-interface** *vlan-id*	Required
Enable the port monitor function	**vrrp vlan-interface** *vlan-id* **vrid** *virtual-router-ID* **track** [**reduced** *value-reduced*]	*virtual-router-ID:* VRRP backup group ID. *value-reduced*: The value by which the priority of a device is to decrease. This argument defaults to 10. *vlan-id*: ID of the VLAN interface.

The port to be tracked can be in the VLAN which the backup group belongs to.

Up to eight ports can be monitored simultaneously.

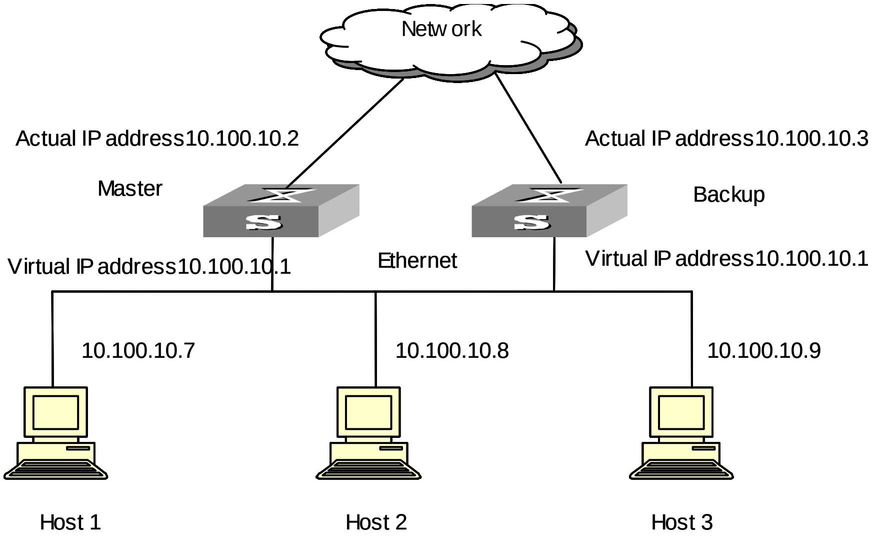
Port Tracking Configuration Example

Network requirements

- Backup group 1 comprises two switch, which operate as the master switch and a backup switch.
- The IP addresses of the master and the backup switches are 10.100.10.2 and 10.100.10.3.
- The master switch is connected to the upstream network through its Ethernet1/0/1 port. The backup switch is connected to the upstream network through its Ethernet1/0/2 port.
- The virtual router IP address of the backup group is 10.100.10.1.
- Enable the port tracking function on Ethernet1/0/1 port of the master switch and specify that the priority of the master decreases by 50 when Ethernet1/0/1 port fails, which triggers new master switch being determined in the backup group.

Network diagram

Figure 147 Network diagram for port tracking configuration


Netw ork
Actual IP address10.100.10.2
Actual IP address10.100.10.3
Master
Backup
Virtual IP address10.100.10.1
Ethernet
Virtual IP address10.100.10.1
10.100.10.7
10.100.10.8
10.100.10.9
Host 1
Host 2
Host 3

Configuration procedure

Configure the master switch.

1 Enter system view.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
```

2 Create VLAN 2.

```
[S5500] vlan 2
[S5500-vlan2] port Ethernet1/0/1
[S5500-vlan2] quit
```

3 Enter VLAN 2 interface view and enable the port tracking function.

```
[S5500] interface vlan-interface2
[S5500-Vlan-interface2] vrrp vlan-Interface 2 vrid 1 track
```

24 DYNAMICALLY APPLY ACL BY RADIUS SERVER CONFIGURATION

Introduction to Dynamically Apply ACL by RADIUS Server

The switch can dynamically provide pre-defined ACL rules for one or one group of authenticated user(s) through the combination of Dynamically Apply ACL by RADIUS Server function and 802.1x authentication function.

After you have passed the 802.1x authentication mode, the switch will dynamically issue the corresponding ACLs to your login port according to the matching relationship between the user name and the ACL configured on the RADIUS server.

The Dynamically Apply ACL by RADIUS Server function of the switch can restrict the resource that the 802.1x users can access, such as the destination networks.

Introduction to Dynamically Apply ACL by RADIUS Server Configurations

Figure 148 Dynamically Apply ACL by RADIUS Server Configurations

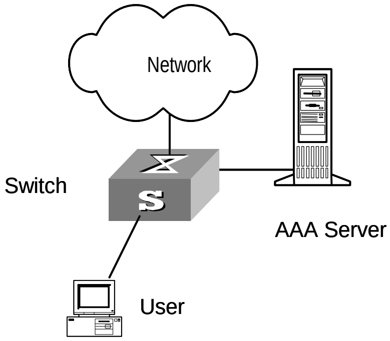


Table 590 describes the Dynamically Apply ACL by RADIUS Server configurations:

Table 590 Configuring Dynamically Apply ACL by RADIUS Server

Device	Configuration	Configuration link
RADIUS server	Configure user authentication information	-
	Configure the matching relationship between ACL number and the user name	One ACL can match with more than one users
Switch	Enable the 802.1x authentication function: The global 802.1x authentication function is enabled and 802.1x authentication function is enabled on the user access port	Refer to *10-Security Operation* module in this manual for the related configuration procedure
	Configure AAA and RADIUS: Configure the RADIUS scheme, Configure domain, specify the RADIUS scheme used by the domain.	Refer to *10-Security Operation* module in this manual for the related configuration procedure
	Configure ACL: The ACLs are pre-defined according the restriction requirement of user.	Refer to *07-QACL Operation* module in this manual for the related configuration procedure

Configuration Example

This section contains a configuration example.

Network requirements

The switch implements the Dynamically Apply ACL by RADIUS Server function for the access users.

The IP address of the VLAN interface, which connects the switch and the RADIUS Server, is 10.153.1.1.

The encryption key of the NAS (that is the switch) is aaaa.

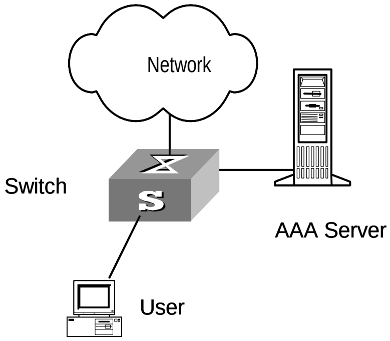
The user name is test and its authentication password is test. It is accessed on Ethernet1/0/1 of the switch and belongs to the test163.net domain. Its corresponding ACL is ACL 3000 and the content of ACL 3000 is to forbid the users to access the 10.153.1.0/24.

The IP address of the user PC is 10.153.1.9.

Take Shiva access manager as the RADIUS server, the IP address of the server is 10.153.1.2. Note that, the Shiva use the 1645 and 1646 as the authentication and account port number.

Network diagram

Figure 149 QoS configuration example

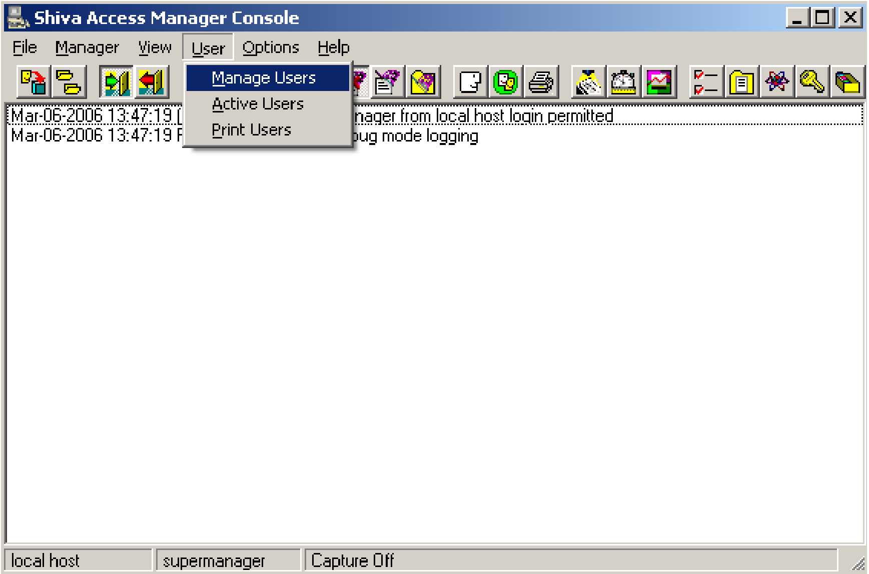


Configuration procedure

Configuration on the RADIUS server

1 Click User/Manage Users. See Figure 150.

Figure 150 The first step

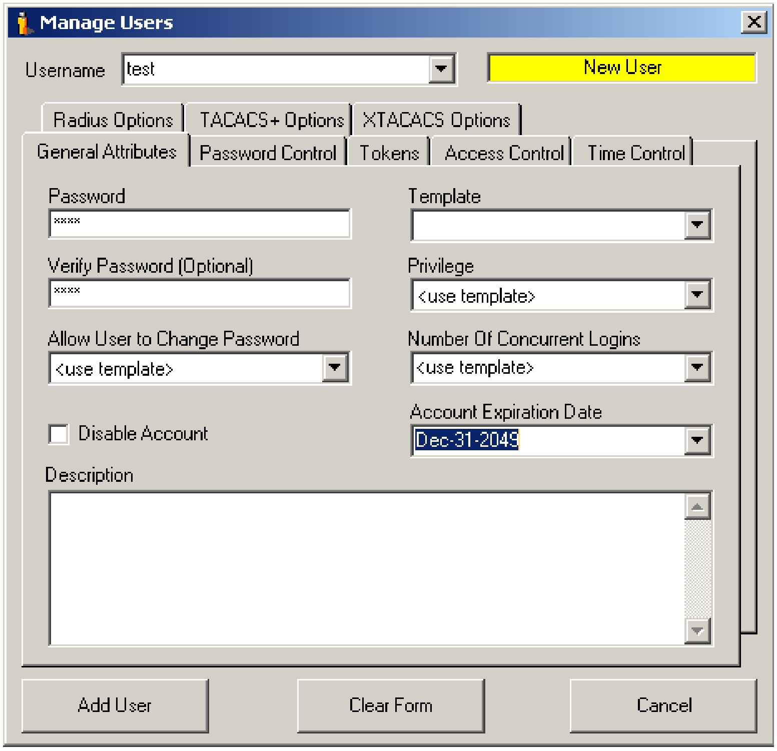


```
Mar-06-2006 13:47:19 [        nager from local host login permitted
Mar-06-2006 13:47:19 F        bug mode logging
```

local host | supermanager | Capture Off

2 Create a new user, and then on the General Attributes page input the password of the user, meanwhile set the "Account Expiration Date" as Dec-31-2049. See Figure 151.

Figure 151 The second step



Username: test

Password: ****

Template:

Verify Password (Optional): ****

Privilege: <use template>

Allow User to Change Password: <use template>

Number Of Concurrent Logins: <use template>

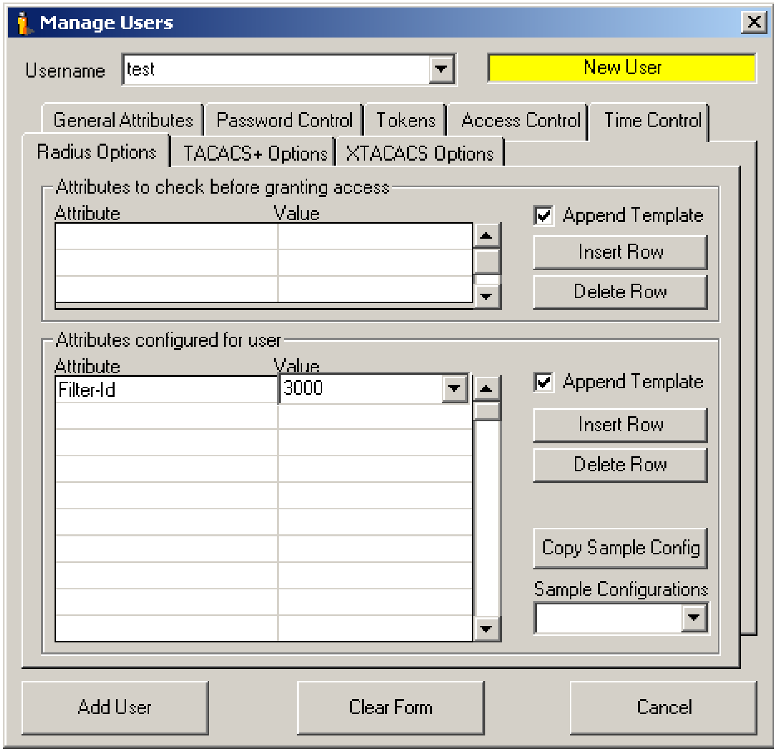
Account Expiration Date: Dec-31-2049

□ Disable Account

Description:

3 On the Radius Options page, set the Filter-Id to 3000. See Figure 152.

Figure 152 The third step



Username: test

Attributes to check before granting access

Attribute	Value

☑ Append Template

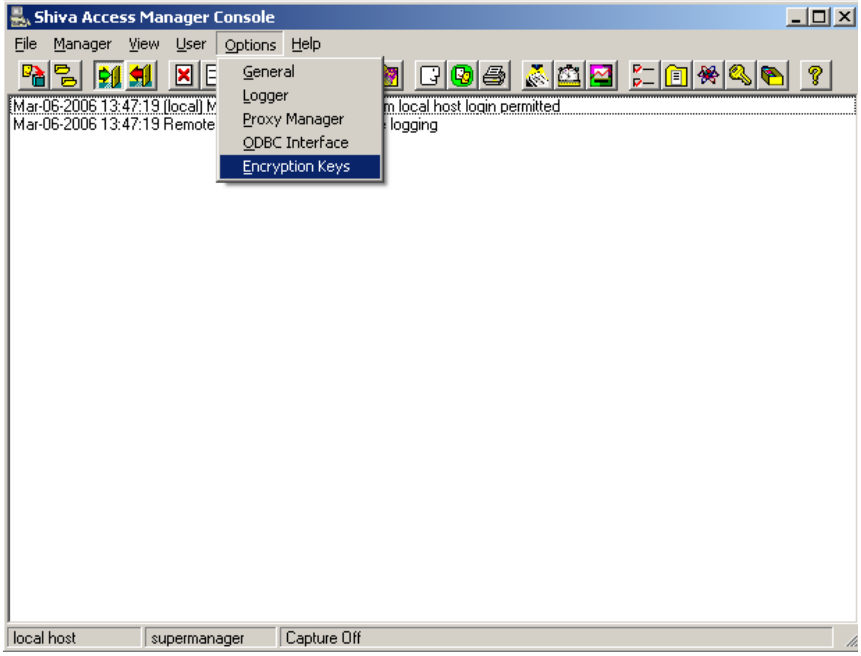
Attributes configured for user

Attribute	Value
Filter-Id	3000

☑ Append Template

4 Click Options/Encryption Keys, set the encryption key. See Figure 153.

Figure 153 The fourth step

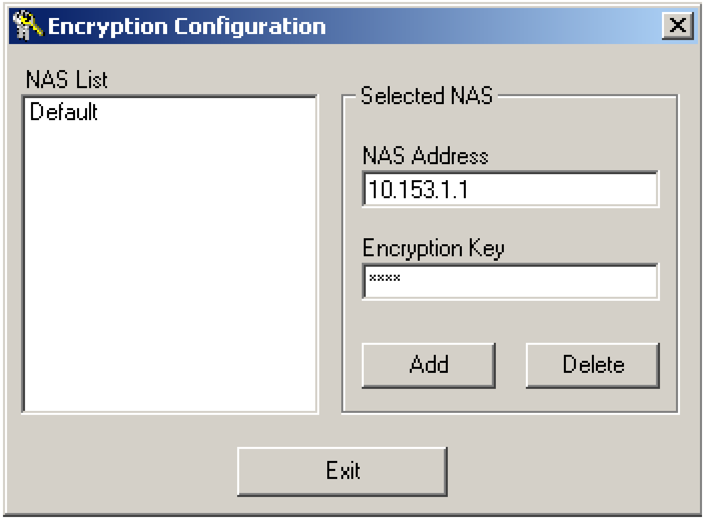


```
Mar-06-2006 13:47:19 (local) M          m local host login permitted
Mar-06-2006 13:47:19 Remote             : logging
```

local host | supermanager | Capture Off

5 Input the NAS IP and the encryption key. See Figure 154.

Figure 154 The fifth step



NAS Address: 10.153.1.1

Encryption Key: ****

Configuration on the switch

1 Enable 802.1x.

```
<S5500> system-view
[S5500] dot1x
[S5500] dot1x interface ethernet 1/0/1
```

2 Configure the IP address information for the RADIUS server.

```
[S5500] radius scheme radius1
[S5500-radius-radius1] primary authentication 10.153.1.2 1645
[S5500-radius-radius1] primary accounting 10.153.1.2 1646
```

3 Set the encryption passwords for the switch to exchange packets with the authentication RADIUS servers and accounting RADIUS servers.

```
[S5500-radius-radius1] key authentication aaaa
[S5500-radius-radius1] key accounting aaaa
```

4 Order the switch to delete the user domain name from the user name and then send the user name to the RADIUS sever.

```
[S5500-radius-radius1] user-name-format without-domain
[S5500-radius-radius1] quit
```

5 Create the user domain test163.net and specify radius1 as your RADIUS server group.

```
[S5500] domain test163.net
[S5500-isp-test163.net] radius-scheme radius1
[S5500-isp-test163.net] quit
```

6 Define the ACL rules

```
[S5500] acl number 3000
[S5500-acl-adv-3000] rule 0 deny ip destination 10.153.1.0 0.0.0.255
[S5500-acl-adv-3000] quit
```

7 After the above configuration, you can use the display commands to show the ACL is applied dynamically.

```
[S5500] display connection
------------------------Unit 1------------------------
Index=28  ,Username=test@test163.net
 MAC=000a-eb7e-d28e   ,IP=10.153.1.9
 On Unit 1:Total 1 connections matched, 1 listed.

 Total 1 connections matched, 1 listed.

[S5500] display connection ucibindex 28
------------------------Unit 1------------------------
Index=28  , Username=test@test163.net
MAC=000a-eb7e-d28e   , IP=10.153.1.9
Access=8021X   ,Auth=CHAP    ,Port=Ether   ,Port NO=0x10001001
Initial VLAN=1, Authorization VLAN=1
ACL Group=3000
CAR=Disable
Priority=Disable
Start=2005-01-02 20:43:56 ,Current=2005-01-02 20:50:00
,Online=00h06m04s
 On Unit 1:Total 1 connections matched, 1 listed.

 Total 1 connections matched, 1 listed.
```

You can check the result through ping command: on the user PC, you can not ping the IP address in the 10.153.1.0/24 segment successfully except the PC's own I

25 AUTO DETECT CONFIGURATION

Introduction to the Auto Detect Function

The auto detect function uses ICMP request/reply packets to test the connectivity of a network regularly.

The auto detect function is carried out through detecting groups. A detecting group comprises of a group of the IP addresses to be detected. You can examine the connectivity of a network by checking the results of detecting groups, which in turn enables you to locate network problems in time and take proper measures.

Configuring the auto detect function

Table 591 Configure the auto detect function

Operation	Command	Description
Enter system view	system-view	
Create a detecting group and enter detecting group view	**detect-group** *group-number*	Required
Add an IP address to be detected to the detecting group	**detect-list** *list-number* **ip address** *ip-address* [**nexthop** *ip-address*]	Required
Specify how the detecting result is generated	**option** [**and** | **or**]	Optional By default, the **and** keyword is specified.
Set the detecting interval	**timer loop** *seconds*	Optional By default, the detecting interval is 15 seconds.
Set the maximum number of retries during a detecting operation	**retry** *retry-times*	Optional By default, the maximum number of retries is 2.
Set the detecting timeout time	**timer wait** *seconds*	Optional By default, the detecting timeout time is 2 seconds.
Display the configuration of a specified detecting group or all detecting groups	**display detect-group** [*group-number*]	Optional You can execute this command in any view.

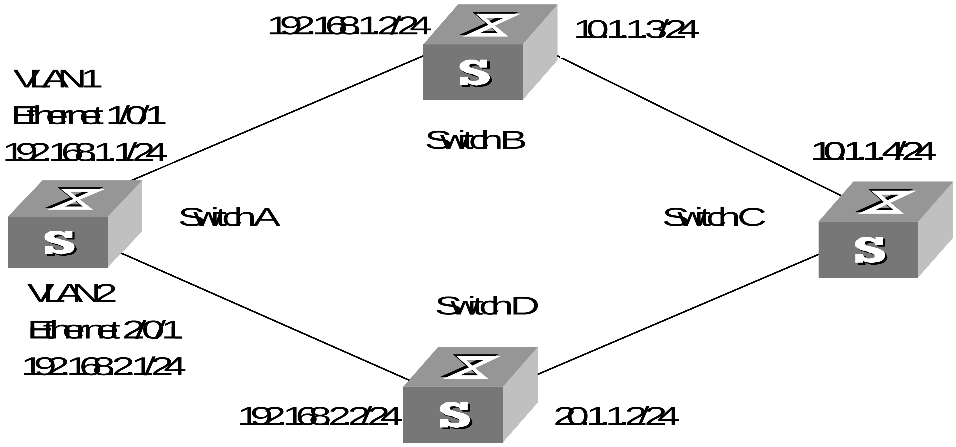
Auto Detect Configuration Example

Network requirements

- Create detecting group 10 on Switch A and add two IP addresses, 10.1.1.4 and 192.168.2.2, to it to test the reachability to the two IP address.
- Specify to return **reachable** as the detecting result if one of the two IP addresses is reachable, that is, specify the **or** keyword for the **option** command.
- Set the detecting interval to 60 seconds; the maximum number of retries to 3, and the timeout time to 3 seconds.

Network diagram

Figure 155 Network diagram for auto detect configuration



Configuration procedure

1. Enter system view.

```
<S5500> system-view
```

2. Create detecting group 10.

```
[S5500] detect-group 10
```

3. Specify to detect the IP address of 10.1.1.4, taking the IP address of 192.168.1.2 as the next hop and setting the detecting number to 1.

```
[S5500-detect-group-10] detect-list 1 ip address 10.1.1.4 nexthop
192.168.1.2
```

4. Specify to detect the IP address of 192.168.2.2, setting the detecting number to 2.

```
[S5500-detect-group-10] detect-list 2 ip address 192.168.2.2
```

5. Specify to return **reachable** as the detecting result if one of the two IP addresses is reachable.

```
[S5500-detect-group-10] option or
```

6. Set the detecting interval to 60 seconds.

```
[S5500-detect-group-10] timer loop 60
```

7. Set the maximum number of retries during a detecting operation to 3.

```
[S5500-detect-group-10] retry 3
```

8. Set the detecting timeout time to 3 seconds.

```
[S5500-detect-group-10] timer wait 3
[S5500-detect-group-10] quit
```

Auto Detect Implementation

The results of auto detect operations (reachable or unreachable) can be used to determine whether or not to enable some functions. The auto detect function can be utilized in:

- Static routing
- Virtual router redundancy protocol (VRRP)
- Interface backup

You can utilize a single detecting group simultaneously in multiple implementations mentioned above.

Refer to the Routing Protocol part in Switch 5500 Series Switch Operation Manual for information about static routing.

Refer to the Reliability part in Switch 5500 Series Switch Operation Manual for information about VRRP.

Auto Detect Implementation in Static Routing

By binding a detecting group to a static route, you can control the validity of a static route according to auto detect results as follows:

- Enable the static route when the result of the detecting group is **reachable**.
- Disable the static route when the result of the detecting group is **unreachable**.

Configuring the Detect Function Static Route

You need to create a detecting group before performing the following operations.

Table 592 Configure the auto detect function for a static route

Operation	Command	Description
Enter system view	system-view	
Bind a detecting group to a static route	**ip route-static** *ip-address* { *mask* | *mask-length* } *next-hop* [**preference** *preference-value*] [**reject** | **blackhole**] **detect-group** *group-number*	Required

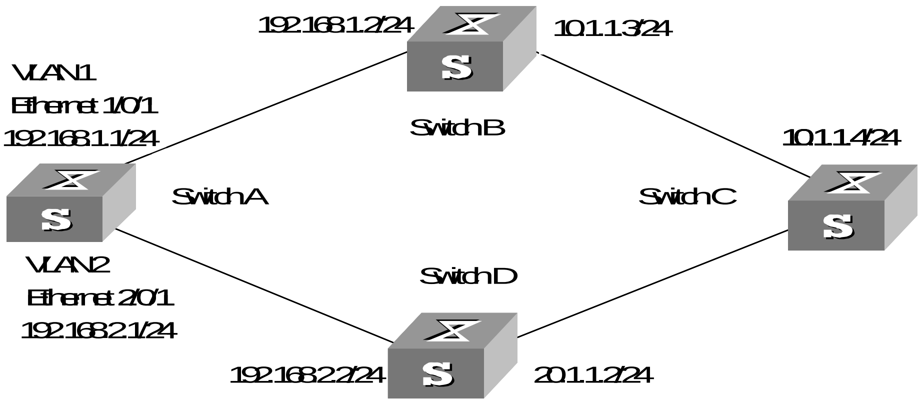
Configuration Example

Network requirements

- Create detecting group 8 on Switch A.
- Configure a static route between Switch A and Switch B.
- Enable the static route when the result of detecting group 8 is **reachable**.

Network diagram

Figure 156 Network diagram for static routing



Configuration procedure

Configure Switch A.

```
<S5500 A> system-view
[S5500 A] detect-group 8
[S5500 A-detect-group-8] detect-list 1 ip address 10.1.1.4 nexthop
192.168.1.2
[S5500 A] ip route-static 10.1.1.4 24 192.168.1.2 detect-group 8
```

Auto Detect Implementation in VRRP

You can control the preferences of VRRP backup groups according to auto detect results to enable automatic switch between the master and the backup switch as follows:

- Decrease the preference value of a VRRP backup group when the result of the detecting group is **unreachable**.
- Resume the preference of a VRRP backup group when the result of the detecting group is **reachable**.

Configuring the Auto Detect Function for VRRP

You need to create a detecting group and perform VRRP-related configurations before the following operations.

Table 593 Configure the auto detect function for VRRP

Operation	Command	Description
Enter system view	system-view	-
Enter VLAN interface view	**interface vlan-interface** *vlan_id*	-
Enable the auto detect function for VRRP	**vrrp vrid** *virtual-router-id* **track detect-group** *group-number* [**reduced** *value-reduced*]	Required

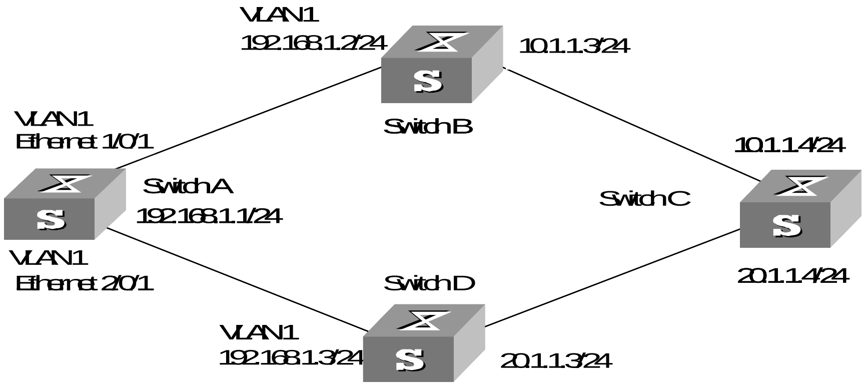
Configuration Example

Network requirements

- Switch B and switch D form VRRP backup group 1, whose virtual IP address is 192.168.1.10.
- Packets sourced from Switch A and destined for Switch C is forwarded by Switch B under normal situations.
- When the connection between Switch B and Switch C fails, Switch D becomes the Master in backup group 1 automatically and the link from Switch D to Switch C, the secondary link, is enabled.

Network diagram

Figure 157 Network diagram for VRRP



Configuration procedure

1 Configure Switch B.

a Create detecting group 9.

```
<S5500 B> system-view
[S5500 B] detect-group 9
```

b Specify to detect the reachability of the IP address 10.1.1.4, setting the detect number to 1.

```
[S5500 B-detect-group-9] detect-list 1 ip address 10.1.1.4
[S5500 B-detect-group-9] quit
```

c Assign an IP address to VLAN 1 interface.

```
[S5500 B] vlan 1
[S5500 B-vlan1] port ethernet1/0/1
[S5500 B-vlan1] quit
[S5500 B] interface vlan-interface 1
[S5500 B-vlan-interface1] ip address 192.168.1.2 24
```

d Enable VRRP on VLAN 1 interface and assign a virtual IP address to the backup group.

```
[S5500 B-vlan-interface1] vrrp vrid 1 virtual-ip 192.168.1.10
```

e Set the backup group preference value of switch B to 110, and specify to decrease the preference value by 20 when the result of detecting group 9 is **unreachable**.

```
[S5500 B-vlan-interface1] vrrp vrid 1 priority 110
[S5500 B-vlan-interface1] vrrp vrid 1 track detect-group 9 reduced
20
```

2 Configure Switch D.

a Assign an IP address to VLAN 1 interface.

```
<S5500 D> system-view
[S5500 D] vlan 1
[S5500 D-vlan1] port ethernet1/0/1
[S5500 D-vlan1] quit
[S5500 D] interface vlan-interface 1
[S5500 D-vlan-interface1] ip address 192.168.1.3 24
```

b Enable VRRP on VLAN 1 interface and assign a virtual IP address to the backup group.

```
[S5500 D-vlan-interface1] vrrp vrid 1 virtual-ip 192.168.1.10
```

c Set the backup group preference value of Switch D to 100.

```
[S5500 D-vlan-interface1] vrrp vrid 1 priority 100
```

Auto Detect Implementation in VLAN Interface Backup

The interface backup function is used to back up VLAN interfaces by using the auto detect function. For two VLAN interfaces configured with the same destination device, you can configure them to be the primary interface and the secondary interface. The latter is enabled automatically when the primary fails, so as to ensure the connectivity. In this case, the auto detect function is implemented as follows:

- In normal situations (that is, the result of the detecting group is **reachable**), the secondary VLAN interface is down and packets are transmitted through the primary VLAN interface.
- When the link between the primary VLAN interface and the destination operates improperly (that is, the result of the detecting group is **unreachable**), the system shuts down the primary VLAN interface and enables the secondary VLAN interface.
- When the link between the primary VLAN interface and the destination comes back up (that is, the result of the detecting group becomes **reachable** again), the system enables the primary VLAN interface and shuts down the secondary.

Configuring the A Detect Functio VLAN Interface Backup

You need to create a detecting group and perform configurations concerning VLAN interfaces before the following operations.

Table 594 Configure the auto detect function for VLAN interface backup

Operation	Command	Description
Enter system view	system-view	-
Enter VLAN interface view	**interface vlan-interface** *vlan_id*	-
Enable the auto detect function to implement VLAN interface backup	**standby detect-group** *group-number*	Required This operation is only needed on the secondary VLAN interface.

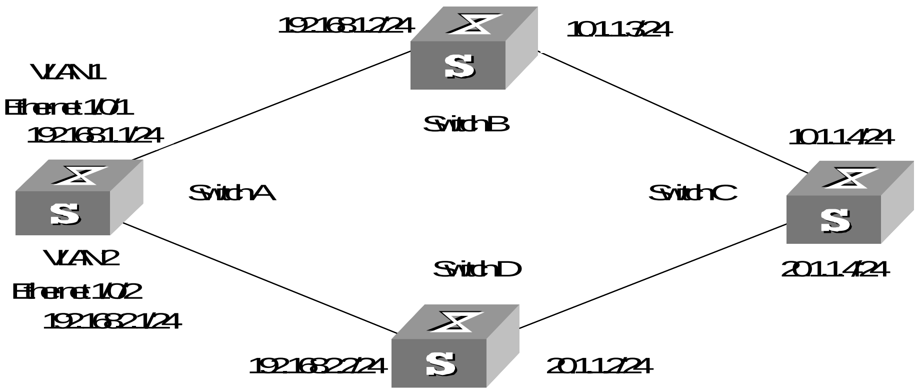
Configuration Example

Network requirements

- Configure a static route between Switch B and Switch C.
- Create detecting group 10 on Switch A, which is used to detect the connectivity between Switch B and Switch C.
- Configure VLAN 1 interface to be the primary interface, which operates when the result of detecting group 10 is **reachable**.
- Configure VLAN 2 interface to be the secondary interface, which operates when the result of the detecting group is **unreachable**.
- Make sure the dynamic routes between Switch A, Switch B, and Switch C are reachable; and those between Switch A, Switch D, and Switch C are also reachable.

Network diagram

Figure 158 Network diagram for VLAN interface backup



Configuration procedure

1 Configure Switch C.

a Enter system view.

```
<S5500 C> system-view
```

b Configure a static route to VLAN interface 1 on Switch A as the primary route, with the IP address of 10.1.1.3 as the next hop.

```
[S5500 C] ip route-static 192.168.1.1 24 10.1.1.3
```

c Configure a static route to VLAN interface 2 on Switch A as the secondary route, with the IP address of 20.1.1.3 as the next hop.

```
[S5500 C] ip route-static 192.168.2.1 24 20.1.1.3
```

2 Configure Switch A.

a Enter system view.

```
<S5500 A> system-view
```

b Add Ethernet1/0/1 port to VLAN 1.

```
[S5500 A] vlan 1
[S5500 A-vlan1] port ethernet1/0/1
[S5500 A-vlan1] quit
```

c Assign an IP address to VLAN 1 interface.

```
[S5500 A] interface vlan-interface 1
[S5500 A-vlan-interface1] ip address 192.168.1.1 24
```

d Add Ethernet1/0/2 port to VLAN 2.

```
[S5500 A] vlan 2
[S5500 A-vlan2] port ethernet1/0/2
```

e Assign an IP address to VLAN 2 interface.

```
[S5500 A] interface vlan-interface 2
[S5500 A-vlan-interface2] ip address 192.168.2.1 24
```

f Create detecting group 10.

```
[S5500 A] detect-group 10
```

g Add the IP address of 10.1.1.4 to detecting group 10 to detect the reachability of the IP address, with the IP address of 192.168.1.2 as the next hop, and set the detecting number to 1.

```
[S5500 A-detect-group-10] detect-list 1 ip address 10.1.1.4 nexthop
192.168.1.2
[S5500 A-detect-group-10] quit
```

h Specify to enable VLAN 2 interface when the result of detecting group 10 is **unreachable**.

```
[S5500 A] interface vlan-interface 2
[S5500 A-vlan-interface2] standby detect-group 10
```

26 RSTP CONFIGURATION

This chapter covers the following topics:

- STP Overview
- RSTP Configuration
- RSTP Configuration Example

STP Overview

Spanning Tree Protocol (STP) is applied in loop networks to block some undesirable redundant paths with certain algorithms and prune the network into a loop-free tree, thereby avoiding the proliferation and infinite cycling of the packet in the loop network.

Implement STP

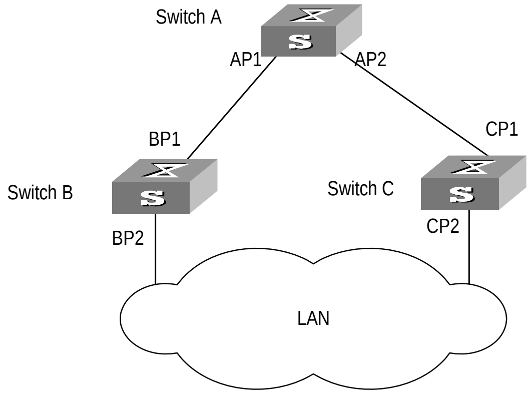
The fundamental of STP is that the Switches exchange a special type of protocol packet (which is called configuration Bridge Protocol Data Units, or BPDU, in IEEE 802.1D) to decide the topology of the network. The configuration BPDU contains the information enough to ensure the Switches to compute the spanning tree.

The configuration BPDU mainly contains the following information:

- The root ID consisting of root priority and MAC address
- The cost of the shortest path to the root
- Designated bridge ID consisting of designated bridge priority and MAC address
- Designated port ID consisting of port priority and port number
- The age of the configuration BPDU: MessageAge
- The maximum age of the configuration BPDU: MaxAge
- Configuration BPDU interval: HelloTime
- Forward delay of the port: ForwardDelay.

What are the Designated Bridge and Designated Port?

Figure 159 Designated Bridge and Designated Port



For a Switch, the designated bridge is a Switch in charge of forwarding BPDU to the local Switch using a port called the designated port. For a LAN, the designated bridge is a Switch that is in charge of forwarding BPDU to the network segment using a port called the designated port. As illustrated in Figure 159, Switch A forwards data to Switch B using the port AP1. So to Switch B, the designated bridge is Switch A and the designated port is AP1. Also in Figure 159, Switch B and Switch C are connected to the LAN and Switch B forwards BPDU to LAN. So the designated bridge of LAN is Switch B and the designated port is BP2.

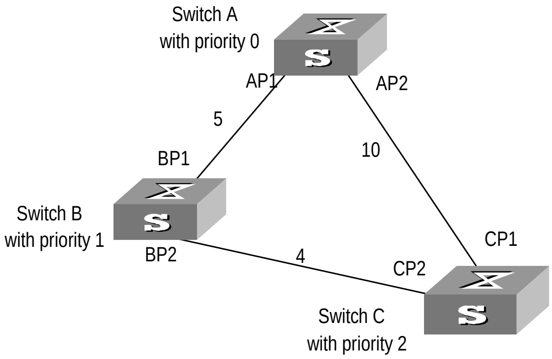
AP1, AP2, BP1, BP2, CP1 and CP2 respectively delegate the ports of Switch A, Switch B and Switch C.

The Specific Calculation Process of STP Algorithm

The following example illustrates the calculation process of STP.

Figure 160 illustrates the network.

Figure 160 Switch Networking.



To facilitate the descriptions, only the first four parts of the configuration BPDU are described in the example. They are root ID (expressed as Ethernet Switch priority), path cost to the root, designated bridge ID (expressed as Ethernet Switch priority) and the designated port ID (expressed as the port number). As illustrated in Figure 160, the priorities of Switch A, B and C are 0, 1 and 2 and the path costs of their links are 5, 10 and 4 respectively.

1 Initial state

When initialized, each port of the Switches will generate the configuration BPDU taking itself as the root with a root path cost as 0, designated bridge IDs as their own Switch IDs and the designated ports as their ports.

- Switch A:

  Configuration BPDU of AP1: {0, 0, 0, AP1}

  Configuration BPDU of AP2: {0, 0, 0, AP2}

- Switch B:

  Configuration BPDU of BP1: {1, 0, 1, BP1}

  Configuration BPDU of BP2: {1, 0, 1, BP2}

- Switch C:

  Configuration BPDU of CP2: {2, 0, 2, CP2}

  Configuration BPDU of CP1: {2, 0, 2, CP1}

2 Select the optimum configuration BPDU

Every Switch transmits its configuration BPDU to others. When a port receives a configuration BPDU with a lower priority than that of its own, it will discard the message and keep the local BPDU unchanged. When a higher-priority configuration BPDU is received, the local BPDU is updated. And the optimum configuration BPDU will be elected through comparing the configuration BPDUs of all the ports.

The comparison rules are:

- The configuration BPDU with a smaller root ID has a higher priority
- If the root IDs are the same, perform the comparison based on root path costs. The cost comparison is as follows: the path cost to the root recorded in the configuration BPDU plus the corresponding path cost of the local port is set as X, the configuration BPDU with a lower X has a higher priority.
- If the costs of path to the root are also the same, compare in sequence the designated bridge ID, designated port ID and the ID of the port using which the configuration BPDU was received.

3 Specify the root port and designated port, block the redundancy link and update the configuration BPDU of the designated port.

The port receiving the optimum configuration BPDU is designated to be the root port, whose configuration BPDU remains the same. The Switch calculates a designated port BPDU for every other port: substituting the root ID with the root ID in the configuration BPDU of the root port, the cost of path to root with the value made by the root path cost plus the path cost corresponding to the root port, the designated bridge ID with the local Switch ID and the designated port ID with the local port ID.

The Switch compares the calculated BPDU with the BPDU of the corresponding port. If the BPDU of the corresponding port is better, the BPDU of the port remains the same. If the calculated BPDU is better, the port will be the designated port, and the port BPDU will be modified by the calculated BPDU.

The comparison process of each Switch is as follows.

- Switch A:

  AP1 receives the configuration BPDU from Switch B and finds out that the local configuration BPDU priority is higher than that of the received one, so it discards the received configuration BPDU. The configuration BPDU is processed on the AP2 in a similar way. Thus Switch A finds itself the root and designated bridge in the configuration BPDU of every port; it regards itself as the root, retains the configuration BPDU of each port and transmits configuration BPDU to others regularly thereafter. By now, the configuration BPDUs of the two ports are as follows:

  Configuration BPDU of AP1: {0, 0, 0, AP1}.

  Configuration BPDU of AP2: {0, 0, 0, AP2}.

- Switch B:

  BP1 receives the configuration BPDU from Switch A and finds that the received BPDU has a higher priority than the local one, so it updates its configuration BPDU.

  BP2 receives the configuration BPDU from Switch C and finds that the local BPDU priority is higher than that of the received one, so it discards the received BPDU.

  By now the configuration BPDUs of each port are as follows: Configuration BPDU of BP1: {0, 0, 0, AP1}, Configuration BPDU of BP2: {1, 0, 1, BP2}.

Switch B compares the configuration BPDUs of the ports and selects the BP1 BPDU as the optimum one. Thus BP1 is elected as the root port and the configuration BPDUs of Switch B ports are updated as follows.

The configuration BPDU of the root port BP1 retains as {0, 0, 0, BP1}. BP2 updates root ID with that in the optimum configuration BPDU, the path cost to root with 5, sets the designated bridge as the local Switch ID and the designated port ID as the local port ID. Thus the configuration BPDU becomes {0, 5, 1, BP2}.

Then all the designated ports of Switch B transmit the configuration BPDUs regularly.

- Switch C:

  CP2 receives from the BP2 of Switch B the configuration BPDU {1, 0, 1, BP2} that has not been updated and then the updating process is launched. {1, 0, 1, BP2}.

  CP1 receives the configuration BPDU {0, 0, 0, AP2} from Switch A and Switch C launches the updating. The configuration BPDU is updated as {0, 0, 0, AP2}.

  By comparison, CP1 configuration BPDU is elected as the optimum one. The CP1 is thus specified as the root port with no modifications made on its configuration BPDU. However, CP2 will be blocked and its BPDU also remains the same, but it will not receive the data (excluding the STP packet) forwarded from Switch B until spanning tree calculation is launched again by some new events. For example, the link from Switch B to C is down or the port receives a better configuration BPDU.

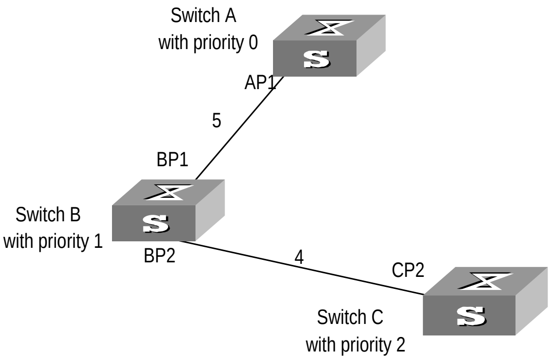
  CP2 will receive the updated configuration BPDU, {0, 5, 1, BP2}, from Switch B. Since this configuration BPDU is better then the old one, the old BPDU will be updated to {0, 5, 1, BP2}.

  Meanwhile, CP1 receives the configuration BPDU from Switch A but its configuration BPDU will not be updated and retain {0, 0, 0, AP2}.

  By comparison, {0, 5, 1, BP2}, the configuration BPDU of CP2, is elected as the optimum one, CP2 is elected as the root port, whose BPDU will not change, while CP1 will be blocked and retain its BPDU, but it will not receive the data forwarded from Switch A until spanning tree calculation is triggered again by some changes. For example, the link from Switch B to C as down.

  Thus the spanning tree is stabilized. The tree with the root bridge A is illustrated in Figure 161.

Figure 161 The Final Stabilized Spanning Tree



To facilitate the descriptions, the description of the example is simplified. For example, the root ID and the designated bridge ID in actual calculation should comprise both Switch priority and Switch MAC address. Designated port ID should comprise port priority and port MAC address. In the updating process of a configuration BPDU, other configuration BPDUs besides the first four items will make modifications according to certain rules. The basic calculation process is described below:

Configuration BPDU Forwarding Mechanism in STP

Upon the initiation of the network, all the Switches regard themselves as the roots. The designated ports send the configuration BPDUs of local ports at a regular interval of HelloTime. If it is the root port that receives the configuration BPDU, the Switch will enable a timer to time the configuration BPDU as well as increase MessageAge carried in the configuration BPDU by certain rules. If a path goes wrong, the root port on this path will not receive configuration BPDUs any more and the old configuration BPDUs will be discarded due to timeout. Hence, recalculation of the spanning tree will be initiated to generate a new path to replace the failed one and thus restore the network connectivity.

However, the new configuration BPDU as now recalculated will not be propagated throughout the network right away, so the old root ports and designated ports that have not detected the topology change will still forward the data through the old path. If the new root port and designated port begin to forward data immediately after they are elected, an occasional loop may still occur. In RSTP, a transitional state mechanism is thus adopted to ensure the new configuration BPDU has been propagated throughout the network before the root port and designated port begin to send data again. That is, the root port and designated port should undergo a transitional state for a period of Forward Delay before they enter the forwarding state.

Implement RSTP on the Switch

The Switch implements the Rapid Spanning Tree Protocol (RSTP), an enhanced form of STP. The Forward Delay for the root ports and designated ports to enter forwarding state is greatly reduced in certain conditions, thereby shortening the time period for stabilizing the network topology.

To achieve the rapid transition of the root port state, the following requirement should be met: The old root port on this Switch has stopped data forwarding and the designated port in the upstream has begun forwarding data.

The conditions for rapid state transition of the designated port are:

- The port is an edge port that does not connect with any Switch directly or indirectly. If the designated port is an edge port, it can Switch to forwarding state directly without immediately forwarding data.
- The port is connected with the point-to-point link, that is, it is the master port in aggregation ports or full duplex port. It is feasible to configure a point-to-point connection. However, errors may occur and therefore this configuration is not recommended. If the designated port is connected with the point-to-point link, it can enter the forwarding state right after handshaking with the downstream Switch and receiving the response.

The Switch that uses RSTP is compatible with the one using STP. Both protocol packets can be identified by the Switch running RSTP and used in spanning tree calculation.

In a Switch equipped with the XRN feature, RSTP has the following characteristics:

1) Processing the whole Fabric as a node;

2) Participation of all ports except those used as Fabric ports in role selection;

3) A single root port and bridge id for the whole Fabric;

4) Distributed saving of RSTP port information

RSTP Configuration

The configuration of RSTP changes with the position of the Switch in the network, as discussed below.

Figure 162 Configuring STP

Switch A and Switch B: Root bridge and backup root bridge

Switch C and Switch D: Intermediate Switches in the Switched network

Switch E, Switch F and Switch G: Switches directly connected with user PCs

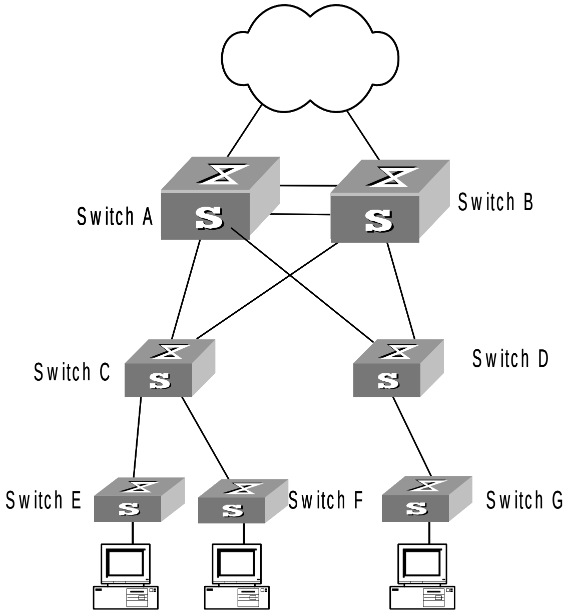


Table 595 RSTP Configuration

Device	Configuration	Default Value	Note
Switch A and Switch B	Enable the STP feature on the Switch Enable the STP feature on the port	The STP feature is disabled from the Switch, but will be enabled on all ports once being enabled on the Switch.	The configuration of STP feature status on the port will not take effect if the STP feature is disabled from the Switch.
	Configure RSTP operational mode	The Switch works in RSTP mode.	If there are Switches respectively running STP and RSTP on the network, it is recommended to set the Switch in STP-compatible mode.
	Configure the STP-Ignore attribute of VLANs on a Switch	No VLAN on a STP-enabled Switch is STP-Ignored.	Once a VLAN is specified to be STP-Ignored, the packets of this VLAN will be forwarded on any Switch port, with no restriction from the calculated STP path.

Table 595 RSTP Configuration (continued)

Device	Configuration	Default Value	Note
	Specify a Switch as the root or backup root bridge	The role of the current Switch as the root or backup root bridge depends on the STP calculation.	A Switch can be made the root bridge by specifying its Bridge preference to 0.
	Configure the Bridge preference of a Switch	The Bridge preference of a Switch is 32768.	A Switch can be made the root bridge by specifying its Bridge preference to 0.
	Specify Forward Delay, Hello Time, and Max Age	Forward Delay fixes on 15 seconds, Hello Times on 2 seconds, and Max Age on 20 seconds.	The other Switches copies the configuration on the root bridge with respect to these time parameters. You can therefore only configure them on the root bridge. The default values are highly recommended.
	Specify the maximum transmission rate of STP packets on a port	No Ethernet port can send more than 3 STP packets within one Hello Time.	The more STP packets a port sends within one Hello Time, the more resources are consumed. It is therefore recommended to limit the transmission rate of STP packets on a port, preferably to the default value.
	Configure whether to connect a port with a peer-to-peer link	RSTP can detect automatically whether the current Ethernet port is connect to a peer-to-peer link.	The two ports connected with a peer-to-peer link can rapidly transit to the forwarding status by sending synchronous packets, eliminating unnecessary forwarding delay.
	Specify the Path Cost on a port Specify the standard to follow in Path Cost calculation	The Switch gets the path cost of a port from the link rate under the IEEE 802.1t standard.	The path cost of a port is closely related to the transmission rate of the link the port connected with. The larger the link rate is, the smaller the path cost shall be. It is recommended to use the default configuration.
	Specify mCheck for a port	-	You can change the operational mode of a port from STP-compatible to RSTP.
	Configure the protection functions on a Switch	No protection function is enabled on a Switch.	It is recommended to enable the Root protection function on the root bridge.
Switch C and Switch D	Enable the STP feature on the Switch Enable the STP feature on the port	The STP feature is disabled from the Switch, but will be enabled on all ports once being enabled on the Switch.	The configuration of STP feature status on the port will not take effect if the STP feature is disabled from the Switch.
	Configure RSTP operational mode	The Switch works in RSTP mode.	If there are Switches respectively running STP and RSTP on the network, it is recommended to set the Switch in STP-compatible mode.
	Configure the Bridge preference of a Switch	The Bridge preference of a Switch is 32768.	A Switch can be made the designated bridge of the downstream Switches by specifying an appropriate Bridge preference in the STP calculation.

Table 595 RSTP Configuration (continued)

Device	Configuration	Default Value	Note
	Configure the timeout time factor of a Switch	The Switch, if has not received any Hello packet from the upstream Switch for thrice the Hello Time, will consider the upstream Switch failed and recalculate the spanning tree.	In a stable network, it is recommended to set the timeout time factor to 5, 6, or 7. Then the Switch will not consider the upstream Switch failed unless it has not received any Hello packet from it for 5, 6, or 7 times the Hello Time.
	Specify the maximum transmission rate of STP packets on a port	No Ethernet port can send more than 3 STP packets within one Hello Time.	The more STP packets a port sends within one Hello Time, the more resources are consumed. It is therefore recommended to limit the transmission rate of STP packets on a port, preferably to the default value.
	Specify the preference of a port	All Ethernet ports are at the preference 128.	The port preference plays an important role in root port selection. You can make a port to be root port by giving it a smallest preference value.
	Configure whether to connect a port with a peer-to-peer link	RSTP can detect automatically whether the current Ethernet port is connect to a peer-to-peer link.	The two ports connected with a peer-to-peer link can rapidly transit to the forwarding status by sending synchronous packets, eliminating unnecessary forwarding delay.
	Specify the Path Cost on a port Specify the standard to follow in Path Cost calculation	The Switch gets the path cost of a port from the link rate under the IEEE 802.1t standard.	The path cost of a port is closely related to the transmission rate of the link the port connected with. The larger the link rate is, the smaller the path cost shall be. It is recommended to use the default configuration.
	Specify mCheck for a port	-	You can change the operational mode of a port from STP-compatible to RSTP.
	Configure the protection functions on a Switch	No protection function is enabled on a Switch.	It is recommended to enable the loop protection function on the intermediate Switches.
Switch E, Switch F and Switch G	Enable the STP feature on the Switch Enable the STP feature on the port	The STP feature is disabled from the Switch, but will be enabled on all ports once being enabled on the Switch.	The configuration of STP feature status on the port will not take effect if the STP feature is disabled from the Switch.
	Configure RSTP operational mode	The Switch works in RSTP mode.	If there are Switches respectively running STP and RSTP on the network, it is recommended to set the Switch in STP-compatible mode.
	Configure the timeout time factor of a Switch	The Switch, if has not received any Hello packet from the upstream Switch for thrice the Hello Time, will consider the upstream Switch failed and recalculate the spanning tree.	In a stable network, it is recommended to set the timeout time factor to 5, 6, or 7. Then the Switch will not consider the upstream Switch failed unless it has not received any Hello packet from it for 5, 6, or 7 times the Hello Time.

Table 595 RSTP Configuration (continued)

Device	Configuration	Default Value	Note
	Specify the maximum transmission rate of STP packets on a port	No Ethernet pot can send more than 3 STP packets within one Hello Time.	The more STP packets a port sends within one Hello Time, the more resources are consumed. It is therefore recommended to limit the transmission rate of STP packets on a port, preferably to the default value.
	Specify the preference of a port	All Ethernet ports are at the preference 128.	The port preference plays an important role in root port selection. You can make a port to be root port by giving it a smallest preference value.
	Configure whether to connect a port with a peer-to-peer link	RSTP can detect automatically whether the current Ethernet port is connect to a peer-to-peer link.	The two ports connected with a peer-to-peer link can rapidly transit to the forwarding status by sending synchronous packets, eliminating unnecessary forwarding delay.
	Specify the Path Cost on a port Specify the standard to follow in Path Cost calculation	The Switch gets the path cost of a port from the link rate under the IEEE 802.1t standard.	The path cost of a port is closely related to the transmission rate of the link the port connected with. The larger the link rate is, the smaller the path cost shall be. It is recommended to use the default configuration.
	Configure whether a port can be an Edge Port	All Ethernet ports are configured as non-edge ports.	For ports directly connected with terminals, please configure them as edge ports, and enable the BPDU protection function on them.
	Specify mCheck for a port	-	You can change the operational mode of a port from STP-compatible to RSTP.
	Configure the protection functions on a Switch	No protection function is enabled on a Switch.	It is recommended to enable the BPDU protection function on the Switches directly connected with user PCs.

After the STP protocol is enabled, the modification of any parameter will result in the re-calculation of the spanning tree on the Switch. It is therefore recommended to configure all the RSTP parameters before enabling the STP feature on the Switch and the port.

Enable/Disable RSTP on a Switch

You can use the following command to enable RSTP on the Switch.

Perform the following configurations in System View.

Table 596 Enable/Disable RSTP on a Device

Operation	Command
Enable/Disable RSTP on a device	`stp { enable	disable }`
Restore RSTP to the default value	`undo stp`

Only after the RSTP is enabled on the Switch can other configurations take effect.

By default, RSTP is enabled.

Enable/Disable RSTP on a Port

You can use the following command to enable/disable the RSTP on the designated port. To flexibly control the RSTP operations, after RSTP is enabled on the Ethernet ports of the Switch, it can be disabled again to prevent the ports from participating in the spanning tree calculation.

Perform the following configurations in Ethernet Port View.

Table 597 Enable/Disable RSTP on a Port

Operation	Command
Enable RSTP on a specified port	**stp enable**
Disable RSTP on a specified port	**stp disable**

Note that the redundancy route may be generated after RSTP is disabled on the Ethernet port.

By default, RSTP on all the ports will be enabled after it is enabled on the Switch.

Configure RSTP Operating Mode

RSTP is executable in RSTP mode or STP-compatible mode. RSTP mode is applied when all the network devices provided for executing RSTP, while the STP-compatible mode is applied when both STP and RSTP are executable on the network.

You can use the following command to set the RSTP operating mode.

Perform the following configurations in System View.

Table 598 Set RSTP Operating Mode

Operation	Command
Configure to run RSTP in STP-compatible/RSTP mode	**stp mode { stp | rstp }**
Restore the default RSTP mode	**undo stp mode**

Normally, if there is a bridge provided to execute STP in the Switching network, the port (in the Switch running RSTP), which connects to another port (in the Switch for executing STP), can automatically Switch to STP compatible mode from RSTP mode.

By default, RSTP runs in RSTP mode.

Configure the STP-Ignore attribute of VLANs on a Switch

RSTP is a single spanning tree protocol, under which only one spanning tree will be generated on one Switched network. To ensure the successful communication between VLANs on a network, all of them must be distributed consecutively along the STP path; otherwise, some VLANs will be isolated due to the blocking of intra-links, causing the failure in cross-VLAN communication. Once there are VLANs specially required to be located away from the STP path, you can solve the consequent blocking by configuring the STP-Ignore attribute on the appropriate Switch.

Once an STP-Ignored VLAN is configured, the packets of this VLAN will be forwarded on any Switch port, with no restriction from the calculated STP path.

You can configure the STP-Ignore attribute on a Switch by using the following commands.

Perform the following configuration in System View.

Table 599 Configuring the STP-Ignore Attribute of VLANs on a Switch

Operation	Command
Specify an STP-Ignored VLAN	**stp ignored vlan** *vlan_list*
Cancel the configuration of the STP-Ignored VLAN	**undo stp ignored vlan** *vlan_list*

By default, no VLAN is STP-Ignored if STP is enabled on the Switch.

Set Priority of a Specified Bridge

Whether a bridge can be selected as the “root” of the spanning tree depends on its priority. By assigning a lower priority, a bridge can be artificially specified as the root of the spanning tree.

You can use the following command to configure the priority of a specified bridge. Perform the following configurations in System View.

Table 600 Set Priority of a Specified Bridge

Operation	Command
Set priority of a specified bridge	**stp priority** *bridge_priority*
Restore the default priority of specified bridge	**undo stp priority**

Note that if the priorities of all the bridges in the Switching network are the same, the bridge with the smallest MAC address will be selected as the “root”. When RSTP is enabled, an assignment of a priority to the bridge will lead to recalculation of the spanning tree.

By default, the priority of the bridge is 32768.

Specify the Switch as Primary or Secondary Root Bridge

RSTP can determine the spanning tree root through calculation. You can also specify the current Switch as the root using this command.

You can use the following commands to specify the current Switch as the primary or secondary root of the spanning tree.

Perform the following configuration in System View.

Table 601 Specify the Switch as Primary or Secondary Root Bridge

Operation	Command
Specify the current Switch as the primary root bridge of the spanning tree.	**stp root primary**
Specify the current Switch as the secondary root bridge of the spanning tree.	**stp root secondary**
Disqualify the current Switch as the primary or secondary root.	**undo stp root**

After a Switch is configured as primary root bridge or secondary root bridge, you cannot modify the bridge priority of the Switch.

A Switch can either be a primary or secondary root bridge, but not both of them.

If the primary root of a spanning tree instance is down or powered off, the secondary root will take its place, unless you configure a new primary root. Of two or more configured secondary root bridges, RSTP selects the one with the smallest MAC address to take the place of the failed primary root.

To configure a Switch as the root of the spanning tree instance, you can specify its priority as 0 or simply set it as the root, using the command.

It is not necessary to specify two or more roots for an STI—do not specify the root for an STI on two or more Switches.

You can configure more than one secondary root for a spanning tree through specifying the secondary STI root on two or more Switches.

Generally, you are recommended to designate one primary root and more than one secondary roots for a spanning tree.

By default, a Switch is neither the primary root nor the secondary root of the spanning tree.

Set Forward Delay of a Specified Bridge

Link failure will cause recalculation of the spanning tree and change its structure. However, the newly calculated configuration BPDU cannot be propagated throughout the network immediately. If the newly selected root port and designated port begin to forward data frames right away, this can cause an occasional loop. Accordingly, the protocol adopts a state transition mechanism, that is, the root port and the designated port must undergo a transition state for a period of Forward Delay before they transition to the forwarding state and resume data frame forwarding. This delay ensures that the new configuration BPDU has been propagated throughout the network before the data frame forwarding is resumed.

You can use the following command to set the Forward Delay for a specified bridge.

Perform the following configurations in System View.

Table 602 Set Forward Delay of a Specified Bridge

Operation	Command
Set Forward Delay of a specified bridge	**stp timer forward-delay** *centiseconds*
Restore the default Forward Delay of specified bridge	**undo stp timer forward-delay**

Forward Delay of the bridge is related to the diameter of the Switching network. As a rule, the larger the network diameter, the longer the Forward Delay. Note that if the Forward Delay is configured too short, occasional path redundancy may occur. If the Forward Delay is configured too long, restoring the network connection may take a long time. It is recommended to use the default setting.

By default, the bridge Forward Delay is 15 seconds.

Set Hello Time of the Specified Bridge

A bridge transmits hello packet regularly to the adjacent bridges to check if there is link failure.

You can use the following command to set the Hello Time of a specified bridge.

Perform the following configurations in System View.

Table 603 Set Hello Time of the Specified Bridge

Operation	Command
Set Hello Time of the specified bridge	**stp timer hello** *centiseconds*
Restore the default Hello Time of the specified bridge	**undo stp timer hello**

An appropriate Hello Time can ensure that the bridge can detect certain link failures in the network in a timely manner. It is strongly recommended that default value of 2 seconds is retained.

By default, the Hello Time of the bridge is 2 seconds.

Set Max Age of the Specified Bridge

Max Age is a parameter to judge whether the configuration BPDU is “timeout”. Users can configure it according to the actual network situation.

You can use the following command to set Max Age of a specified bridge.

Perform the following configuration in System View.

Table 604 Set Max Age of the Specified Bridge

Operation	Command
Set Max Age of the specified bridge	**stp timer max-age** *centiseconds*
Restore the default Max Age of the specified bridge	**undo stp timer max-age**

If the Max Age is too short, it will result in frequent calculation of spanning tree or misjudge the network congestion as a link fault. On the other hand, too long Max Age may make the bridge unable to find link failure in time and weaken the network auto-sensing ability. It is recommended to use the default setting.

By default, the bridge Max Age is 20 seconds.

Set Timeout Factor of the Bridge

A bridge transmits hello packet regularly to the adjacent bridges to check if there is link failure. Generally, if the Switch does not receive the RSTP packets from the upstream Switch for 3 occurrences of hello time, the Switch will decide the upstream Switch is dead and will recalculate the topology of the network. Then in a steady network, the recalculation may be caused when the upstream Switch is busy. In this case, you can redefine the timeout interval to a longer time by defining the multiple value of hello time.

You can use the following command to set the multiple value of hello time of a specified bridge.

Perform the following configurations in System View.

Table 605 Set Timeout Factor of the Bridge

Operation	Command
Set the multiple value of hello time of a specified bridge	**stp timeout-factor** *number*
Restore the default multiple value of hello time	**undo stp timeout-factor**

It is recommended to set 5, 6 or 7 as the value of multiple in the steady network.

By default, the multiple value of hello time of the bridge is 3.

Specifying the Maximum Transmission Rate of STP Packets on a Port

The maximum transmission rate of STP packets on an Ethernet port is dependent on the physical status of the port and the network architecture. You can specify it as needed.

You can specify the maximum transmission rate on a port by using the following commands.

Perform the following configuration in Ethernet Interface View.

Table 606 Specifying the Maximum Transmission Rate of STP Packets on a Port

Operation	Command
Specify the maximum transmission rate of STP packets on a port	**stp transmit-limit** *packetnum*
Restore the default transmission rate of STP packets on a port	**undo stp transmit-limit**

Notably, though a higher transmission rate is introduced at larger *Packetnum*, more Switch resources are consequently occupied. It is therefore recommended to use the default value.

By default, an Ethernet port can transmit at most 3 STP packets within one Hello Time.

Set Specified Port to be an EdgePort

EdgePort is not connected to any Switch directly or indirectly using the connected network.

You can use the following command to set a specified port as an EdgePort.

Perform the following configurations in Ethernet Port View.

Table 607 Set Specified Port as the EdgePort

Operation	Command
Set a specified port as an EdgePort or a non-EdgePort	**stp edged-port { enable | disable }**
Set the specified port as the non-EdgePort, as defaulted	**undo stp edged-port**

In the process of recalculating the spanning tree, the EdgePort can transfer to the forwarding state directly and reduce unnecessary transition time. If the current Ethernet port is not connected with any Ethernet port of other bridges, this port should be set as an EdgePort. If a specified port connected to a port of any other bridge is configured as an edge port, RSTP will automatically detect and reconfigure it as a non-EdgePort.

After the network topology changed, if a configured non-EdgePort changes to an EdgePort and is not connected to any other port, it is recommended to configure it as an EdgePort manually because RSTP cannot configure a non-EdgePort as an EdgePort automatically.

Configure the port directly connected to the terminal as an EdgePort, so that the port can transfer immediately to the forwarding state.

By default, all the Ethernet ports are configured as non-EdgePort.

Specifying the Path Cost on a Port

Path Cost is a parameter related with the link rate.

Specify the Path Cost on a Port

You can specify the Path Cost on a port by using the following commands.

Perform the following configuration in Ethernet Interface View.

Table 608 Specifying the Path Cost on a Port

Operation	Command
Specify the Path Cost on a port	**stp cost** *cost*
Restore the default Path Cost on the port	**undo stp cost**

The path cost on an Ethernet port is related to the transmission rate of the link the port connects to. The larger the link rate is, the smaller the path cost shall be. RSTP can automatically detect the link rate and calculate the path cost for the current Ethernet port. The configuration of path cost brings about the re-calculation of the spanning tree. It is recommended to adopt the default value, with which RSTP will automatically calculate the path cost of the current port.

By default, the Switch calculates the path cost directly from the link rate.

Specify the standard to be followed in Path Cost calculation

The following two standards are currently available on the Switch:

- **dot1d-1998**: The Switch calculates the default Path Cost of a port by the IEEE 802.1D-1998 standard.
- **dot1t**: The Switch calculates the default Path Cost of a port by the IEEE 802.1t standard.

You can specify the intended standard by using the following commands.

Perform the following configuration in System View.

Table 609 Specifying the Standard to be Followed in Path Cost Calculation

Operation	Command
Specify the standard to be adopted when the Switch calculates the default Path Cost for the connected link	**stp pathcost-standard { dot1d-1998 | dot1t }**
Restore the default standard to be used	**undo stp pathcost-standard**

By default, the Switch calculates the default Path Cost of a port by the IEEE 802.1t standard.

Set the Priority of a Specified Port

The port priority is an important basis to decide if the port can be a root port. In the calculation of the spanning tree, the port with the highest priority will be selected as the root assuming all other conditions are the same.

You can use the following command to set the priority of a specified port.

Perform the following configurations in the Ethernet Port View.

Table 610 Set the Priority of a Specified Port

Operation	Command
Set the priority of a specified port	**stp port priority** *port_priority*
Restore the default priority of the specified port	**undo stp port priority**

By setting the priority of an Ethernet port, you can put a specified Ethernet port into the final spanning tree. Generally, the lower the value is set, the higher priority the port has and the more likely it is for this Ethernet port to be included in the spanning tree. If all the Ethernet ports of the bridge adopt the same priority parameter value, then the priority of these ports depends on the Ethernet port index number. Note that changing the priority of Ethernet port will cause recalculation of the spanning tree. You can set the port priority at the time when setting up the networking requirements.

By default, priorities of all the Ethernet ports are 128.

Configure a Specified Port to be Connected to Point-to-Point Link

Generally, a point-to-point link connects the Switches.

You can use the following command to configure a specified port to be connected to a point-to-point link.

Perform the following configurations in the Ethernet Port View.

Table 611 Configure a Specified Port to be Connected to a Point-to-Point Link

Operation	Command
Configure a specified port to be connected to a point-to-point link	`stp point-to-point force-true`
Configure a specified port not to be connected to a point-to-point link	`stp point-to-point force-false`
Configure RSTP to automatically detect if the port is connected to a point-to-point link.	`stp point-to-point auto`
Configure the port to be automatically detected if it is connected to a point-to-point link, as defaulted	`undo stp point-to-point`

The two ports connected using the Point-to-Point link can enter the forwarding state rapidly by transmitting synchronous packets, so that the unnecessary forwarding delay can be reduced. If this parameter is configured to be **auto** mode, RSTP can automatically detect if the current Ethernet port is connected to a Point-to-Point link. Note that, for an aggregated port, only the master port can be configured to connect with the point-to-point link. After auto-negotiation, the port working in full duplex can also be configured to connect with such a link.

You can manually configure the active Ethernet port to connect with the point-to-point link. However, if the link is not a point-to-point link, the command may cause a system problem, and therefore it is recommended to set it as **auto** mode.

By default, this parameter is configured to **auto**, namely in auto mode.

Set mCheck of the Specified Port

RSTP is STP-compatible, so on a Switching network it does not matter if some Switches are running STP and other Switches are running RSTP. In a relatively stable network though the bridge running STP has been removed, the port of the Switch running RSTP is still working in STP-compatible mode. You can use the following command to manually configure the port to work in RSTP mode. This command can only be issued if the bridge runs RSTP in RSTP mode and has no effect in the STP-compatible mode.

You can use the following command to configure mCheck of a specified port.

Perform the following configuration in Ethernet Port View or System View.

Table 612 Set mCheck of the Specified Port

Operation	Command
Set mCheck of the specified port	`stp mcheck`

This command can be used when the bridge runs RSTP in RSTP mode, but it cannot be used when the bridge runs RSTP in STP-compatible mode.

Configure the Switch Security Function

An RSTP Switch provides BPDU protection and root protection functions.

It looks like 'flapping' refers to Spanning Tree reconfiguring it's topology, which may cause links to switch state.

For an access device, the access port is generally directly connected to the user terminal, for example, a PC or a file server, and the access port is set to edgeport to implement fast transition. When such a port receives a BPDU packet, the system will automatically set it as a non-edge port and recalculate the spanning tree, which causes the network topology to reconfigure and may cause links to switch state. In normal cases, these ports will not receive STP BPDU. If someone forges a BPDU to attack the Switch, the network topology to reconfigure. BPDU protection function is used against such network attack.

In case of configuration error or malicious attack, the primary root may receive the BPDU with a higher priority and then lose its place, which causes network topology change errors. Due to the erroneous change, the traffic supposed to travel over the high-speed link may be pulled to the low-speed link and congestion will occur on the network. Root protection function is used against such problem.

The root port and other blocked ports maintain their state according to the BPDUs sent by the uplink Switch. Once the link is blocked or encountering a faulty condition, the ports cannot receive BPDUs and the Switch will select the root port again. In this case, the former root port will turn into a BPDU specified port and the former blocked ports will enter into a forwarding state, as a result, a link loop will be generated.

The security functions can control the generation of loops. After it is enabled, the root port cannot be changed, the blocked port will remain in "Discarding" state and will not forward packets, thus avoiding link loops.

You can use the following command to configure the security functions of the Switch.

Perform the following configuration in corresponding views.

Table 613 Configure the Switch Security Function

Operation	Command
Configure Switch BPDU protection (from System View)	**stp bpdu-protection**
Restore the disabled BPDU protection state, as defaulted, (from System View).	**undo stp bpdu-protection**
Configure Switch Root protection (from Ethernet Port View)	**stp root-protection**
Restore the disabled Root protection state, as defaulted, (from Ethernet Port View)	**undo stp root-protection**
Configure Switch loop protection function (from Ethernet Port View)	**stp loop-protection**
Restore the disabled loop protection state, as defaulted (from Ethernet Port View)	**undo stp loop-protection**

After being configured with BPDU protection, the Switch will disable the edge port through RSTP, which receives a BPDU, and notify the network manager at the same time. Only the network manager can resume these ports.

The port configured with Root protection only plays a role of a designated port. Whenever such a port receives a higher-priority BPDU when it is about to turn into a non-designated port, it will be set to a listening state and not forward packets any more (as if the link to the port is disconnected). If the port has not received any higher-priority BPDU for a certain period of time thereafter, it will resume to the normal state.

When you configure a port, only one configuration at a time can be effective among loop protection, root protection, and edge port configuration.

By default, the Switch does not enable loop protection, BPDU protection or Root protection.

For detailed information about the configuration commands, refer to the *Command Manual*.

Display and Debug RSTP

After the above configuration, execute **display** command in all views to display the running of the RSTP configuration, and to verify the effect of the configuration. Execute **reset** command in User View to clear the statistics of RSTP module. Execute **debugging** command in User View to debug the RSTP module.

Table 614 Display and Debug RSTP

Operation	Command
Display RSTP configuration information about the local Switch and the specified ports	**display stp [interface** *interface_list* **]**
Display the list of STP-Ignored VLANs	**display stp ignored-vlan**
Clear RSTP statistics information	**reset stp [interface** *interface_list* **]**
Enable RSTP (error/event/packet) debugging	**debugging stp { error** | **event** | **packet }**
Disable RSTP debugging	**undo debugging stp { error** | **event** | **packet }**

RSTP Configuration Example

Networking Requirements

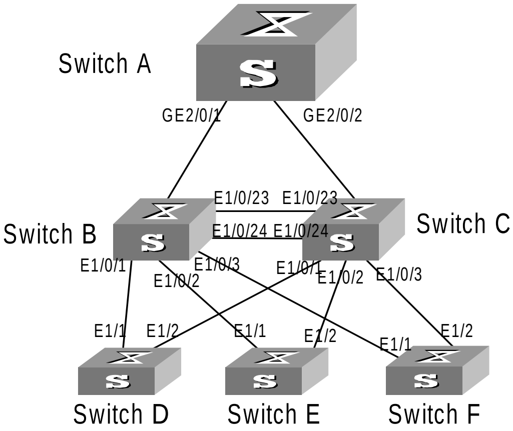
In the following scenario, Switch C serves as a standby of Switch B and forwards data when a fault occurs on Switch B. They are connected to each other with two links, so that, in case one of the links fails, the other one can still work normally. Switch D through Switch F are directly connected with the downstream user computers and they are connected to Switch C and Switch B with uplink ports.

You can configure RSTP on the Switch B through Switch F to meet these requirements.

Only the configurations related to RSTP are listed in the following procedure. Switch A serves as the root. Switch D through Switch F are configured in same way basically, so only the RSTP configuration on Switch D will be introduced.

Networking Diagram

Figure 163 RSTP Configuration Example



Configuration Procedure

1 Configure Switch A

a Enable RSTP globally.

```
[SW5500]stp enable
```

b The port RSTP defaults are enabled after global RSTP is enabled. You can disable RSTP on those ports that are not involved in the RSTP calculation, however, be careful and do not disable those involved. (The following configuration takes GigabitEthernet 1/0/4 as an example.)

```
[SW5500]interface gigabitethernet 2/0/4
[SW5500-GigabitEthernet2/0/4]stp disable
```

c To configure Switch A as a root, you can either configure the Bridge priority of it as 0 or simply use the command to specify it as the root.

Set the Bridge priority of Switch A to 0

```
[SW5500]stp priority 0
```

d Designate Switch A as the root, using the following command.

```
[SW5500]stp root primary
```

e Enable the Root protection function on every designated port.

```
[SW5500]interface Gigabitethernet 2/0/1
[SW5500-GigabitEthernet2/0/1]stp root-protection
[SW5500]interface Gigabitethernet 2/0/2
[SW5500-GigabitEthernet2/0/2]stp root-protection
```

2 Configure Switch B

a Enable RSTP globally.

```
[SW5500]stp enable
```

b The port RSTP defaults are enabled after global RSTP is enabled. You can disable RSTP on those ports that are not involved in RSTP calculation, however, be careful and do not disable those involved. (The following configuration takes Ethernet 1/0/4 as an example.)

```
[SW5500]interface Ethernet 1/0/4
[SW5500-Ethernet1/0/4]stp disable
```

c Configure Switch C and Switch B to serve as standby of each other and sets the Bridge priority of Switch B to 4096.

```
[SW5500]stp priority 4096
```

d Enable the Root protection function on every designated port.

```
[SW5500]interface Ethernet 1/0/1
[SW5500-Ethernet1/0/1]stp root-protection
[SW5500]interface Ethernet 1/0/2
[SW5500-Ethernet1/0/2]stp root-protection
[SW5500]interface Ethernet 1/0/3
[SW5500-Ethernet1/0/3]stp root-protection
```

RSTP operating mode, time parameters, and port parameters take default values.

3 Configure Switch C

a Enable RSTP globally.

```
[SW5500]stp enable
```

b The port RSTP defaults are enabled after global RSTP is enabled. You can disable RSTP on those ports that are not involved in RSTP calculation, however, be careful and do not disable those involved. (The following configuration takes Ethernet 1/0/4 as an example.)

```
[SW5500]interface Ethernet 1/0/4
[SW5500-Ethernet1/0/4]stp disable
```

c Configure Switch C and Switch B to serve as standby of each other and sets the Bridge priority of Switch C to 8192.

```
[SW5500]stp priority 8192
```

d Enable the Root protection function on every designated port.

```
[SW5500]interface Ethernet 1/0/1
[SW5500-Ethernet1/0/1]stp root-protection
[SW5500]interface Ethernet 1/0/2
[SW5500-Ethernet1/0/2]stp root-protection
[SW5500]interface Ethernet 1/0/3
[SW5500-Ethernet1/0/3]stp root-protection
```

RSTP operating mode, time parameters, and port parameters take default values.

4 Configure Switch D

a Enable RSTP globally.

```
[SW5500]stp enable
```

b The port RSTP defaults are enabled after global RSTP is enabled. You can disable RSTP on those ports that are not involved in RSTP calculation, however, be careful and do not disable those involved. (The following configuration takes Ethernet 1/3 as an example.)

```
[SW5500]interface Ethernet 1/3
[SW5500-Ethernet1/3]stp disable
```

c Configure the ports (Ethernet 0/1 through Ethernet 0/24) directly connected to users as edge ports and enables BPDU PROTECTION function. (Take Ethernet 0/1 as an example.)

```
[SW5500]interface Ethernet 1/3
[SW5500-Ethernet1/3]stp edged-port enable
[SW5500-Ethernet1/3]quit
[SW5500]stp bpdu-protection
```

RSTP operating mode, time parameters, and port parameters take default values.

27 PoE Profile Configuration

Introduction to PoE Profile

On a large-sized network or a network with mobile users, to help network administrators to monitor the PoE features of the switch, 3Com Switch 5500 Family have provided PoE Profile features.

Features of PoE Profile:

- Various PoE Profiles can be created. PoE policy configurations applicable to different user groups are stored in the corresponding PoE Profiles. These PoE Profiles can be applied to the ports used by the corresponding user groups.
- When users connect a PD device to the port that currently has PoE Profile stored, the switch will automatically apply the PoE configuration defined in the corresponding port's PoE Profile to the PD device.

PoE Profile Configuration

This section contains information on PoE configuration

PoE Profile Configuration Tasks

Table 615 describes PoE Profile configuration tasks.

Table 615 PoE Profile Configuration

Operation		Command	Description
Enter system view		system-view	—
Create PoE Profile		**poe-profile** *profilename*	Required. Enter PoE Profile view while creating PoE Profile.
Configure the relevant features in PoE Profile	Enable power over Ethernet	poe enable	Required.
	Configure PoE mode for Ethernet ports	**poe mode** { **signal** | **spare** }	Optional. By default, PoE mode is set to be **signal**.
	Configure the PoE priority for Ethernet ports	**poe priority** { **critical** | **high** | **low** }	Optional. By default, PoE priority is set to **low**.
	Configure maximum power for Ethernet ports	**poe max-power** *max-power*	Optional. By default, maximum power is set to be 15,400 mW.
Quit system view		quit	—
Under system view, apply the existing PoE Profile configuration to the specified Ethernet port		**apply poe-profile** *profilename* **interface** *interface-type interface-number* [**to** *interface-type interface-number*]	Required. Users can decide whether to configure the settings under system view or port view.
		interface *interface-type interface-number*	
Enter Ethernet port view and apply the existing PoE Profile to ports		**apply poe-profile** *profilename*	

Table 615 PoE Profile Configuration (continued)

Operation	Command	Description
Display detailed configuration information on the existing PoE Profile	**display poe-profile** { **all-profile** | **interface** *interface-type interface-number* | name *profilename* }	You can use the **display** command under any view.

Various PoE features can be configured within one PoE Profile. The following holds while using the ***apply poe-profile*** *command to apply a PoE Profile to a group of ports:*

- The **display current-configuration** command can be used to indicate that the PoE Profile is being used properly, so long as one PoE feature in the PoE Profile is in proper use for a given port.
- If one or more features of the PoE Profile are not used properly for a given port, the terminal will show clearly which feature on what port is not used properly.
- PoE Profile configuration is a global configuration, and applies synchronously in the XRN system.
- Combination of Unit creates a new Fabric. In the newly created Fabric, the PoE Profile configuration of the Unit with the smallest Unit ID number will become the PoE Profile configuration for the Fabric currently in use.
- Split of Fabric results in many new Fabrics. In each newly created Fabric, the PoE Profile configuration of each Unit remains the same as it was before the split.

PoE Profile Configuration Example

Network requirements

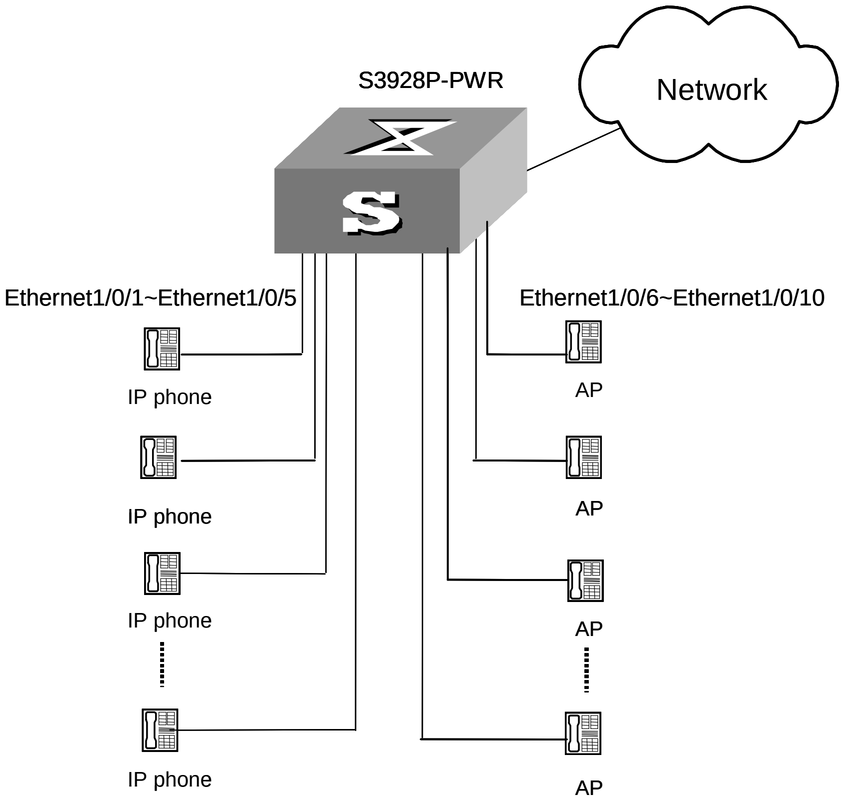
Ethernent1/0/1 through thernet1/0/10 ports of the Switch 5500 are classified as type A group users, who have the following requirements:

- All ports in use can enable PoE function;
- Use data cable to supply power;
- The PoE priority for Ethernet1/0/1 through Ethernet1/0/5 ports is Critical, whereas The PoE priority for Ethernet1/0/6 through Ethernet1/0/10 is High.
- The maximum power for Ethernet1/0/1 through Ethernet1/0/5 ports is 3000mW, whereas the maximum power for Ethernet1/0/6 through Ethernet1/0/10 is 15,400mW.

Based on the above requirements, two PoE Profiles are made for type A group users.

- Use PoE Profile1 for Ethernet1/0/1 through Ethernet1/0/5 ports;
- Use PoE Profile2 for Ethernet1/0/6 through Ethernet1/0/10 ports.

Figure 164 PoE Profile application



Configuration procedures

1 Create Profile 1, and enter PoE Profile view.

```
<S5500> system-view
[S5500] poe-profile Profile1
```

2 In Profile 1, add the PoE policy configuration applicable to Ethernet1/0/1 through Ethernet1/0/5 ports for type A group users.

```
[S5500-poe-profile-Profile1] poe enable
[S5500-poe-profile-Profile1] poe mode signal
[S5500-poe-profile-Profile1] poe priority critical
[S5500-poe-profile-Profile1] poe max-power 3000
[S5500-poe-profile-Profile1] quit
```

3 Display detailed configuration information for Profile 1.

```
[S5500] display poe-profile name Profile1
```

4 Create Profile 2, and enter poe-profile view.

```
[S5500] poe-profile profile2
```

5 In Profile 2, add the PoE policy configuration applicable to Ethernet1/0/6 through Ethernet1/0/10 ports for type A group users.

```
[S5500-poe-profile-Profile2] poe enable
[S5500-poe-profile-Profile2] poe mode signal
[S5500-poe-profile-Profile2] poe priority high
[S5500-poe-profile-Profile2] poe max-power 15400
[S5500-poe-profile-Profile2] quit
```

6 Display detailed configuration information for Profile 2.

```
[S5500] display poe-profile name profile2
```

7 Apply the configured Profile 1 to Ethernet1/0/1 through Ethernet1/0/5 ports.

```
[S5500] apply poe-profile profile1 interface ethernet1/0/1 to
ethernet1/0/5
```

8 Apply the configured Profile 2 to Ethernet1/0/6 through Ethernet1/0/10 ports.

```
[S5500] apply poe-profile profile2 interface ethernet1/0/6 to
ethernet1/0/10
```

28 SNMP CONFIGURATION

SNMP Configuration Introduction

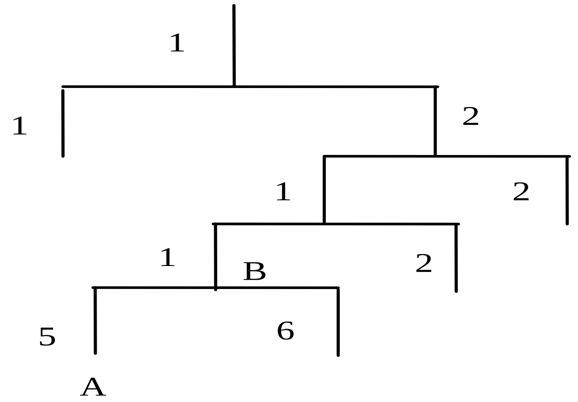
The Simple Network Management Protocol (SNMP) has gained the most extensive application in the computer networks. SNMP has been put into use and widely accepted as an industry standard in practice. It is used for ensuring the transmission of the management information between any two nodes. In this way, network administrators can easily search and modify the information on any node on the network. In the meantime, they can locate faults promptly and implement the fault diagnosis, capacity planning and report generating. SNMP adopts the polling mechanism and provides the most basic function set. It is most applicable to the small-sized, fast-speed and low-cost environment. It only requires the unverified transport layer protocol UDP; and is thus widely supported by many other products.

In terms of structure, SNMP can be divided into two parts, namely, Network Management Station and Agent. Network Management Station is the workstation for running the client program. At present, the commonly used NM platforms include Sun NetManager and IBM NetView. Agent is the server software operated on network devices. Network Management Station can send GetRequest, GetNextRequest and SetRequest messages to the Agent. Upon receiving the requests from the Network Management Station, Agent will perform Read or Write operation according to the message types, generate and return the Response message to Network Management Station. On the other hand, Agent will send Trap message on its own initiative to the Network Management Station to report the events whenever the device encounters any abnormalities such as new device found and restart.

SNMP Versions and Supported MIB

To uniquely identify the management variables of a device in SNMP messages, SNMP adopts the hierarchical naming scheme to identify the managed objects. It is like a tree. A tree node represents a managed object, as shown in the Figure 165. Thus the object can be identified with the unique path starting from the root.

Figure 165 Architecture of the MIB Tree



The MIB (Management Information Base) is used to describe the hierarchical architecture of the tree and it is the set defined by the standard variables of the monitored network device. In Figure 166, the managed object B can be uniquely specified by a string of numbers {1.2.1.1}. The number string is the Object Identifier of the managed object.

The current SNMP Agent of the Switch supports SNMP V1, V2C and V3. The MIBs supported are listed in Table 616.

Table 616 MIBs Supported by the Switch (Sheet 1 of 2)

MIB attribute	MIB content	References
Public MIB	MIB II based on TCP/IP network device	RFC1213
	OSPF MIB	RFC1253
	BRIDGE MIB	RFC1493
	IF MIB-II	RFC1573
	RIP MIB	RFC1724
	SNMPV2	RFC1907
	RMON II Probe Config	RFC2021
	IP-FORWARDING-MIB	RFC2096
	Interfaces MIB	RFC2233
	SNMP-FRAMEWORK-MIB	RFC2571
	SNMP-MPD-MIB	RFC2572
	SNMP-NOTIFICATION-MIB SNMP-TARGET-MIB	RFC2573
	RADIUS-AUTH-CLIENT-MIB	RFC2618
	RADIUS-ACC-CLIENT-MIB	RFC2620
	EtherLike MIB	RFC2665
	IP Tunnel MIB	RFC2667
	MAU MIB	RFC2668
	Q-BRIDGE MIB P-BRIDGE MIB Bridge MIB Extensions	RFC2674
	RIP MIB	RFC2675
	ENTITY-MIB	RFC2737
	Ethernet MIB RMON I	RFC2819
	IGMP-STD-MIB	RFC2933
	HC-RMON-MIB	RFC3273
	SNMP-USER-BASED-SM-MIB	RFC3414
	SNMR-VIEW-BASED-ACM-MIB	RFC3415
	SNMP-MIB	RFC3418
	PoE MIB	RFC3621

Table 616 MIBs Supported by the Switch (Sheet 2 of 2)

MIB attribute	MIB content	References
Private MIB	Configuration Management MIB	
	Flash Management MIB	
	System Management MIB	
	MIBs for LGMP Snooping	
	MIBs for DHCP Client	
	MIBs for DHCP Relay	
	MIBs for DHCP Server	
	MIBs for MSTP	
	Entity Environment MIB	
	Topology Management of Fabric	
	Support for Bulk Configuration of user and access levels and trusted IP	
	MAC Address Management	
	QOS	
	QACL MIB	
	ADBM MIB	
	RSTP MIB	
	VLAN MIB	
	Device management	
	Interface management	

Configure SNMP

The main configuration of SNMP includes:

- Set community name
- Set the Method of Identifying and Contacting the Administrator
- Enable/Disable snmp Agent to Send Trap
- Set the Destination Address of Trap
- Set SNMP System Information
- Set the Engine ID of a Local or Remote Device
- Set/Delete an SNMP Group
- Set the Source Address of Trap
- Add/Delete a User to/from an SNMP Group
- Create/Update View Information or Deleting a View
- Set the Size of SNMP Packet Sent/Received by an Agent
- Enable/Disable a Port Transmitting Trap Information SNMP Agent
- Disable SNMP Agent

Setting Community Name

SNMP V1 and SNMPV2C adopt the community name authentication scheme. The SNMP message incompliant with the community name accepted by the device will be discarded. SNMP Community is named with a character string, which is called Community Name. The various communities can have read-only or read-write access mode. The community with read-only authority can only query the device information, whereas the community with read-write authority can also configure the device.

You can use the following commands to set the community name.

Perform the following configuration in System View.

Table 617 Set Community Name

Operation	Command
Set the community name and the access authority	**snmp-agent community { read | write }** *community-name* **[mib-view** *view-name* **] [acl** *acl-list* **]**
Remove the community name and the access authority	**undo snmp-agent community** *community-name*

Enabling/Disabling SNMP Agent to Send Trap

The managed device transmits a trap without request to the Network Management Station to report some critical and urgent events (such as restart).

You can use the following commands to enable or disable the managed device to transmit trap messages.

Perform the following configuration in System View.

Table 618 Enable/Disable SNMP Agent to Send Trap

Operation	Command
Enable to send trap	**snmp-agent trap enable [configuration | flash | ospf [** *process-id* **] [** *ospf-trap-list* **] | standard [authentication | coldstart | linkdown | linkup | warmstart]* | system]**
Disable to send trap	**undo snmp-agent trap enable [bgp [backwardtransition] [established] | configuration | flash | ospf [** *process-id* **] [** *ospf-trap-list* **] | standard [authentication | coldstart | linkdown | linkup | warmstart]* | system]**

Setting the Destination Address of Trap

You can use the following commands to set or delete the destination address of the trap.

Perform the following configuration in System View.

Table 619 Set the Destination Address of Trap

Operation	Command
Set the destination address of trap	**snmp-agent target-host trap address udp-domain** *host-addr* **[udp-port** *udp-port-number* **] params securityname** *community-string* **[v1 | v2c | v3 [authentication | privacy]]**
Delete the destination address of trap	**undo snmp-agent target-host** *host-addr* **securityname** *community-string*

Setting Lifetime of Trap Message

You can use the following command to set the lifetime of a Trap message. A trap message that exists longer than the set lifetime will be dropped.

Perform the following configuration in System View.

Table 620 Set the Lifetime of Trap Message

Operation	Command
Set lifetime of Trap message	**snmp-agent trap life** *seconds*
Restore lifetime of Trap message	**undo snmp-agent trap life**

By default, the lifetime of Trap message is 120 seconds.

Setting SNMP System Information

The SNMP system information includes the character string sysContact (system contact), the character string describing the system location, the version information about the SNMP operating in the system.

You can use the following commands to set the system information.

Perform the following configuration in System View.

Table 621 Set SNMP System Information

Operation	Command
Set SNMP System Information	**snmp-agent sys-info { contact** *sysContact* | **location** *syslocation* | **version { { v1** | **v2c** | **v3 } *** | **all } }**
Restore the default SNMP System Information of the Switch	**undo snmp-agent sys-info [{ contact** | **location }*** | **version { { v1** | **v2c** | **v3 }*** | **all }]**

By default, the sysLocation is specified as a blank string, that is, “”.

Setting the Engine ID of a Local or Remote Device

You can use the following commands to set the engine ID of a local or remote device.

Perform the following configuration in System View.

Table 622 Set the Engine ID of a Local or Remote Device

Operation	Command
Set the engine ID of the device	**snmp-agent local-engineid** *engineid*
Restore the default engine ID of the device.	**undo snmp-agent local-engineid**

By default, the engine ID is expressed as enterprise No. + device information. The device information can be IP address, MAC address, or user-defined text.

Setting/Deleting an SNMP Group

You can use the following commands to set or delete an SNMP group.

Perform the following configuration in System View.

Table 623 Set/Delete an SNMP Group

Operation	Command
Setting an SNMP group	**snmp-agent group { v1 | v2c }** *group-name* **[read-view** *read-view* **] [write-view** *write-view* **] [notify-view** *notify-view* **] [acl** *acl-list* **]** **snmp-agent group v3** *group-name* **[authentication | privacy] [read-view** *read-view* **] [write-view** *write-view* **] [notify-view** *notify-view* **] [acl** *acl-list* **]**
Deleting an SNMP group	**undo snmp-agent group { v1 | v2c }** *group-name* **undo snmp-agent group v3** *group-name* **[authentication | privacy]**

Setting the Source Address of Trap

You can use the following commands to set or remove the source address of the trap.

Perform the following configuration in System View.

Table 624 Set the Source Address of Trap

Operation	Command
Set the source address of trap	**snmp-agent trap source** *interface-name interface-num*
Remove the source address of trap	**undo snmp-agent trap source**

Adding/Deleting a User to/from an SNMP Group

You can use the following commands to add or delete a user to/from an SNMP group.

Perform the following configuration in System View.

Table 625 Add/Delete a user to/from an SNMP Group

Operation	Command
Add a user to an SNMP group.	**snmp-agent usm-user { v1 | v2c }** *username groupname* **[acl** *acl-list* **] snmp-agent usm-user v3** *username groupname* **[authentication-mode { md5 | sha }** *authpassstring* **[privacy-mode { des56** *privpassstring* **}]] [acl** *acl-list* **]**
Delete a user from an SNMP group.	**undo snmp-agent usm-user { v1 | v2c }** *username groupname* **undo snmp-agent usm-user v3** *username groupname* **{ local | engineid** *engine-id* **}**

Creating/Updating View Information or Deleting a View

You can use the following commands to create, update the information of views or delete a view.

Perform the following configuration in System View.

Table 626 Create/Update View Information or Deleting a View

Operation	Command
Create/Update view information	**snmp-agent mib-view { included | excluded }** *view-name oid-tree*
Delete a view	**undo snmp-agent mib-view** *view-name*

Setting the Size of SNMP Packet Sent/Received by an Agent

You can use the following commands to set the size of SNMP packet sent/received by an agent.

Perform the following configuration in System View.

Table 627 Set the Size of SNMP Packet sent/received by an Agent

Operation	Command
Set the size of SNMP packet sent/received by an agent	**snmp-agent packet max-size** *byte-count*
Restore the default size of SNMP packet sent/received by an agent	**undo snmp-agent packet max-size**

The agent can receive/send the SNMP packets of the sizes ranging from 484 to 17940, measured in bytes. By default, the size of SNMP packet is 1500 bytes.

Enabling/Disabling a Port Transmitting Trap Information SNMP Agent

To enable/disable a port transmitting trap information SNMP Agent. Perform the following configuration in Ethernet Port View.

Table 628 Enable/Disable a Port Transmitting Trap Information SNMP Agent

Operation	Command
enable current port to transmit the trap information	**enable snmp trap updown**
disable current port to transmit the trap information	**undo enable snmp trap updown**

Disabling SNMP Agent

To disable SNMP Agent perform the following configuration in System View.

Table 629 Disable SNMP Agent

Operation	Command
Disable snmp agent	**undo snmp-agent**

If user disable NMP Agent, it will be enabled whatever **snmp-agent** command is configured thereafter.

Network Management Operation Logging Configuration

Existing log management systems only log configuration commands executed on terminals (or through TELNET) instead of the operations performed by SNMP network administrators.

The network management operation logging function logs operations performed remotely by administrators through SNMP (simple network management protocol), such as querying (the get command)/setting (the set command) device status.

Configuring the Network Management Operation Logging Function

Table 630 Configure the Network Management Operation Logging Function

Operation	Command	Description
Enter system view	system-view	-
Enable the network management operation logging function	snmp-agent log { set-operation | get-operation | all }	Optional: By default, the network management operation logging function is disabled.

In a network that contains no fabric, you can use the display logbuffer command to view the logs of the get and set operations performed by the network administrator.

As for a fabric, you can execute the display logbuffer command on the master device to view the logs of the set operations performed by the network administrator, and execute the display logbuffer command on the devices to which the get operations are performed to view the logs of corresponding get operations.

Displaying and Debugging SNMP

After the above configuration, execute the **display** command in all views to display the running of the SNMP configuration, and to verify the effect of the configuration. Execute the **debugging** command in User View to debug SNMP configuration.

Table 631 Display and Debug SNMP

Operation	Command
Display the modules with trap enabled and the module with trap not enabled	**display snmp-agent trap-list**
Display the statistics information about SNMP packets	**display snmp-agent statistics**
Display the engine ID of the active device	**display snmp-agent { local-engineid | remote-engineid }**
Display the group name, the security mode, the states for all types of views, and the storage mode of each group of the Switch.	**display snmp-agent group [** *group-name* **]**
Display the names of all users in the group user table	**display snmp-agent usm-user [engineid** *engineid* **] [group** *groupname* **] [username** *username* **]**
Display the current community name	**display snmp-agent community [read | write]**
Display the current MIB view	**display snmp-agent mib-view [exclude | include | viewname** *mib-view* **]**
Display the contact character string of the system	**display snmp-agent sys-info contact**
Display the location character string of the system	**display snmp-agent sys-info location**
Display the version character string of the system	**display snmp-agent sys-info version**

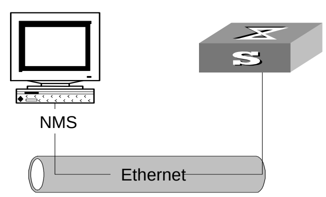
SNMP Configuration Example

Networking Requirements

Network Management Station and the Switch are connected using the Ethernet. The IP address of Network Management Station is 129.102.149.23 and that of the VLAN interface on the Switch is 129.102.0.1. Perform the following configurations on the Switch: set the community name and access authority, administrator ID, contact and Switch location, and enable the Switch to send trap packet.

Networking Diagram

Figure 166 SNMP Configuration Example



Configuration Procedure

1 Enter the System View.

```
<SW5500> system-view
```

2 Set the community name , group name and user.

```
[SW5500]snmp-agent sys-info version all
[SW5500]snmp-agent community write public
[SW5500]snmp-agent mib include internet 1.3.6.1
[SW5500]snmp-agent group v3 managev3group write-view internet
[SW5500]snmp-agent usm v3 managev3user managev3group
```

3 Set the VLAN interface 2 as the interface used by network management. Add port Ethernet 1/0/3 to the VLAN 2. This port will be used for network management. set the IP address of VLAN interface 2 as 129.102.0.1.

```
[SW5500]vlan 2
[SW5500-vlan2]port ethernet 1/0/3
[SW5500-vlan2]interface vlan 2
[SW5500-Vlan-interface2]ip address 129.102.0.1 255.255.255.0
```

4 Set the administrator ID, contact and the physical location of the Switch.

```
[SW5500]snmp-agent sys-info contact Mr.Wang-Tel:3306
[SW5500]snmp-agent sys-info location telephone-closet,3rd-floor
```

5 Enable SNMP agent to send the trap to Network Management Station whose ip address is 129.102.149.23. The SNMP community is public.

```
[SW5500]snmp-agent trap enable standard authentication
[SW5500]snmp-agent trap enable standard coldstart
[SW5500]snmp-agent trap enable standard linkup
[SW5500]snmp-agent trap enable standard linkdown
[SW5500]snmp-agent target-host trap address udp-domain 129.102.149.23
udp-port 5000 params securityname public
```

Configure Network Management System

The Switch supports 3Com Network Director. Users can query and configure the Switch through the network management system. For more information, refer to the network management user documentation.

Reading Usmusr Table Configuration Example

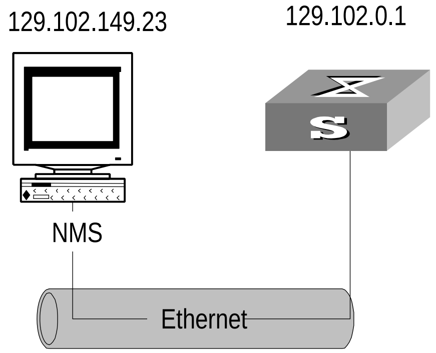
Networking requirements

ViewDefault view should be reconfigured if you use SNMP V3 to read the usmusr table.

The snmpVacmMIB and snmpUsmMIB should be included in ViewDefault view.

Networking diagram

Figure 167 SNMP configuration example



Configuration procedure

```
[SW5500]snmp-agent community read public
[SW5500]snmp-agent community write private
[SW5500]snmp-agent sys-info version all
[SW5500]snmp-agent group v3 sdsdsd
[SW5500]snmp-agent usm-user v3 paul sdsdsd authentication-mode md5
hello
[SW5500]snmp-agent mib-view included ViewDefault snmpUsmMIB
[SW5500]snmp-agent mib-view included ViewDefault snmpVacmMIB
[SW5500]display snmp-agent mib-view
  View name:ViewDefault
       MIB Subtree:iso
       Subtree mask:
       Storage-type: nonVolatile
       View Type:included
       View status:active

   View name:ViewDefault
       MIB Subtree:snmpUsmMIB
       Subtree mask:
       Storage-type: nonVolatile
       View Type:excluded
       View status:active

   View name:ViewDefault
       MIB Subtree:snmpVacmMIB
       Subtree mask:
       Storage-type: nonVolatile
       View Type:excluded
       View status:active
View name:ViewDefault
       MIB Subtree:snmpModules.18
       Subtree mask:
       Storage-type: nonVolatile
       View Type:excluded
       View status:active
```

29 SOURCE IP ADDRESS CONFIGURATION

Configuring Source IP Address for Service Packets

You can configure source IP address or source interface for the FTP server, FTP client, TFTP client, Telnet server, Telnet client, SSH server, SSH2 client and SFTP client to enhance service manageability.

Table 632 shows the source IP address configuration tasks.

Table 632 Configure source IP address for service packets

Operation	Command	Remarks
Enter system view	system-view	-
Specify source IP address for the FTP server	ftp-server source-ip ip-addr	Optional
Specify source interface for the FTP server	ftp-server source-interface interface-type interface-number	Optional
Use a specified source IP address to establish a connection with an FTP server	ftp { cluster | remote-server } source-ip ip-addr	Optional
Use a specified source interface to establish a connection with an FTP server	ftp { cluster | remote-server } source-interface interface-type interface-number	Optional
Specify source IP address for the FTP client	ftp source-ip ip-addr	Optional
Specify source interface for the FTP client	ftp source-interface interface-type interface-number	Optional
Use a specified source IP address to establish a connection with a TFTP server	tftp tftp-server source-ip ip-addr	Optional
Use a specified source interface to establish a connection with a TFTP server	tftp tftp-server source-interface interface-type interface-number	Optional
Specify source IP address for the TFTP client	tftp source-ip ip-addr	Optional
Specify source interface for the FTPT client	tftp source-interface interface-type interface-number	Optional
Specify source IP address for the Telnet server	telnet-server source-ip ip-addr	Optional
Specify source interface for the Telnet server	telnet-server source-interface interface-type interface-number	Optional
Specify source IP address for the Telnet client	telnet source-ip ip-addr	Optional
Specify source interface for the Telnet client	telnet source-interface interface-type interface-number	Optional
Specify source IP address for the SSH server	ssh-server source-ip ip-addr	Optional
Specify source interface for the SSH server	ssh-server source-interface interface-type interface-number	Optional
Specify source IP address for the SSH2 client	ssh2 source-ip ip-addr	Optional
Specify source interface for the SSH2 client	ssh2 source-interface interface-type interface-number	Optional

Table 632 Configure source IP address for service packets (continued)

Operation	Command	Remarks
Specify source IP address for the SFTP client	sftp source-ip ip-addr	Optional
Specify source interface for the SFTP client	sftp source-interface interface-type interface-number	Optional

If the ip-addr in the command is not an address of the device, your configuration fails.

If you specify a non-existent interface in the command, your configuration fails.

Displaying the Source IP Address Configuration

Use the display commands in any view to display the source IP address configuration for service packets.

Table 633 Display the source IP address configuration

Operation	Command
Display the source IP address of the FTP server	display ftp-server source-ip
Display the source IP address of the FTP client	display ftp source-ip
Display the source IP address of the TFTP client	display tftp source-ip
Display the source IP address of the Telnet server	display telnet-server source-ip
Display the source IP address of the SSH server	display ssh-server source-ip
Display the source IP address of the SSH2 client	display ssh2 source-ip
Display the source IP address of the SFTP client	display sftp source-ip

30 PASSWORD CONTROL CONFIGURATION OPERATIONS

Introduction to Password Control Configuration

The password control feature is designed to manage the following passwords:

- Telnet passwords: passwords for logging into the switch through Telnet.
- SSH passwords: passwords for logging into the switch through SSH.
- FTP passwords: passwords for logging into the switch through FTP.
- Super passwords: passwords used by the users who have logged into the switch and are changing from a lower privilege level to a higher privilege level.

Password control provides the following functions:

Table 634 Functions provided by password control

Function	Description	Application
Password aging	The password aging function has the following sub-functions: **1** Password aging time setting: Users can set the aging time for their passwords. If a password ages out, its user must change it, otherwise the user cannot log into the device. **2** Password change: After a password ages out, the user can change it when logging into the device. **3** Alert before password expiration: Users can set their respective alert time. If a user logs into the system when the password is about to age out (that is, the remaining usable time of the password is no more than the set alert time), the switch will alert the user to the forthcoming expiration and prompts the user to change the password as soon as possible.	Telnet and SSH passwords: all password aging sub-functions are applicable. Super passwords: only the password aging time setting and the password change sub-functions are applicable. FTP passwords: only the password aging time setting sub-function is applicable.
Limitation of minimum password	This function is used to limit the minimum length of the passwords. A user can successfully configure a password only when the password is not shorter than its minimum length.	Telnet, SSH, super, and FTP passwords.
History password recording	The password configured and once used by a user is called a history (old) password. The switch is able to record the user history password. Users cannot successfully replace their passwords with used passwords. The history passwords are saved in a readable file in the flash memory, so they will not be lost when the switch reboots. As for history passwords, the secondary SRPC serves as a hot backup to the primary SRPC, that is, the history passwords keep synchronized between primary and secondary SRPCs	Telnet, SSH, super, and FTP passwords.
Password protection and encryption	The switch protects the displayed password. The password is always displayed as a string containing only the asterisk (*) characters in the configuration file or on the command line. The switch encrypts the configured passwords and save the passwords in ciphertext mode in the configuration file.	Telnet, SSH, super, and FTP passwords.

Table 634 Functions provided by password control (continued)

Function	Description	Application
Login attempt limitation and failure processing.	You can use this function to enable the switch to limit the number of login attempts allowed for each user. If the number of login attempts exceeds the configured maximum number, the user fails to log in. In this case, the switch operates in one of the following processing mode: **1** Inhibit the user from re-logging in within a certain time period. After the period, the user is allowed to log into the switch again. **2** Inhibit the user from re-logging in forever. The user is allowed to log into the switch again only after the administrator manually removes the user from the user blacklist. **3** Allow the user to log in again without any inhibition. By default, the switch adopts the first mode, but you can actually specify the processing mode as needed.	Telnet, SSH, and FTP passwords: the limitation and all the three modes of processing are applicable. Super passwords: the limitation and the first mode of processing are applicable.
User blacklist	If the maximum number of attempts is exceeded, the user cannot log into the switch and is added to the blacklist by the switch. All users in the blacklist are not allowed to log into the switch. For the user inhibited from logging in for a certain time period, the switch will remove the user from the blacklist when the time period expires. For the user inhibited from logging in forever, the switch provides a command which allows the administrator to manually remove the user from the blacklist. The blacklist is saved in the RAM of the switch, so it will be lost when the switch reboots. Blacklist can be hot backups so that they keep synchronized between the primary and secondary SRP cards of the switch.	—
System logging	The switch automatically logs the following events: **1** Successful user login: The switch logs the user name, user IP address, and VTY ID. **2** Inhibition of a user due to ACL rule: The switch logs the user IP address. **3** User authentication failure. The switch logs the user name, user IP address, VTY ID, and failure reason.	No configuration is needed for this function.

Password Control Configuration

This section contains configuration information on Password Control.

Configuration Prerequisites

A user PC is connected to the switch to be configured; both devices are operating normally.

Configuration Tasks

The following sections describe the configuration tasks for password control:

- Configuring Password Aging
- Configuring the Limitation of Minimum Password Length
- Configuring History Password Recording
- Configuring a User Login Password in Encryption Mode
- Configuring Login Attempts Limitation and Failure Processing Mode
- Configuring the Timeout Time for Users to be authenticated

After the above configuration, you can execute the **display password-control** command in any view to check the information about the password control for all users, including the enable/disable state of password aging, the aging time, the alert time before password expiration; the enable/disable state of the minimum password length limitation, the configured minimum password length (if available); the enable/disable state of history password recording, the maximum number of history password records, the time when the password history was last cleared; the timeout time for password authentication; the maximum number of attempts, and the processing mode for login attempt failures.

If all the password attempts of a user fail, the system adds the user to the blacklist. You can execute the **display password-control blacklist** command in any view to check the names and the IP addresses of such users.

Configuring Password Aging

Table 635 Configure password aging

Operation	Command	Description
Enter system view	system-view	—
Enable password aging	**password-control aging enable**	Optional By default, password aging is enabled.
Set aging time for super passwords	**password-control super aging** *aging-time*	Optional By default, the aging time is 90 days.
Set aging time for system login passwords	**password-control aging** *aging-time*	Optional By default, the aging time is 90 days.
Enable the system to alert users to change their passwords when their passwords will soon expire, and specify how many days ahead of the expiration the system alerts the users.	**password-control alert-before-expire** *alert-time*	By default, users are alerted seven days ahead of the password expiration.
Display the information about the global password control for all users	display password-control	You can execute the **display** command in any view.
Display the information about the password control for super passwords, including the aging time and minimum password length.	display password-control super	

To cancel the above configurations, use the corresponding **undo** commands.

You can configure the password aging time when password aging is not yet enabled, but these configured parameters will not take effect.

After password aging is enabled, the device will decide whether the user password ages out when a user logging into the system is undergoing the password authentication. This has three cases:

1 The password has not expired. The user logs in before the configured alert time. In this case, the user logs in successfully.

2 The password has not expired. The user logs in after the configured alert time. In this case, the system alerts the user to the remaining time (in days) for the password to expire and prompts the user to change the password.

   - If the user chooses to change the password and changes it successfully, the system records the new password, restarts the password aging, and allows the user to log in at the same time.
   - If the user chooses to change the password but fails to do so, or the user chooses not to change the password, the system allows the user to log in.

3 The password has already expired. In this case, the system alerts the user to the expiration, requires the user to change the password, and requires the user to change the password again if the user inputs an inappropriate password or the two input passwords are inconsistent.

- After the user changes the password successfully, the switch saves the old password in a readable file in the flash memory.
- The switch does not provide the alert function for super passwords.
- The switch does not provide the alert function for FTP passwords. And when an FTP user logs in with a wrong password, the system just informs the user of the password error, and it does not allow the user to change the password.

Configuring the Limitation of Minimum Password Length

This function is used to enable the switch to check the password length when a password is configured. If the switch finds the length of the input password does not meet the limitation, it informs the user of this case and requires the user to input a new password.

Table 636 Configure the limitation of the minimum password length

Operation	Command	Description
Enter system view	system-view	—
Enable the limitation of minimum password length	password-control length enable	By default, the limitation of minimum password length is enabled.
Configure the minimum length for Super passwords	**password-control super length** *min-length*	Optional By default, the minimum length is 10 characters.
Configure the minimum length for system login passwords	**password-control length** *length*	Optional By default, the minimum length is 10 characters.

Configuring History Password Recording

With this function enabled, when a login password expires, the system requires the user to input a new password and save the old password automatically. You can configure the maximum number of history records allowed for each user. The purpose is to inhibit the users from using one single password or using an old password for a long time to enhance the security.

Table 637 Configure history password recording

Operation	Command	Description
Enter system view	**system-view**	—
Enable history password recording	password-control history enable	Optional By default, history password recording is enabled.
Configure the maximum number of the history password records	**password-control history** *max-record-num*	Optional By default, the maximum number is four.
Display the information about the global password control for all users.		Optional You can execute the **display** command in any view.

- When the system adds a new record but the number of the recorded history passwords has reached the configured maximum number, the system replaces the oldest record with the new one.
- When you configure the maximum number of history password records for a user, the excessive old records will be lost if the number of the history password records exceeds the configured number.
- When changing a password, do not use the recorded history password; otherwise, the system will prompt you to reset a password.

The system administrator can perform the following operations to manually remove history password records.

Table 638 Manually remove history password records

Operation	Command	Description
Enter system view	system-view	—
Remove history password records of one or all users	**reset password-control history-record** [**username** *username*]	Executing this command without the **username** *username* option removes the history password records of all users. Executing this command with the **username** *username* option removes the history password records of the specified user.
Remove history records of one or all super passwords	**reset password-control history-record super** [**level** *level-value*]	Executing this command without the **level** *level-value* option removes the history records of all super passwords. Executing this command with the **level** *level-value* option removes the history records of the super password for the users at the specified level.

Configuring a User Login Password in Encryption Mode

Table 639 Configuring a user login password in encryption mode

Operation	**Command**	**Description**
Enter system view	system-view	—
Enter the specified user view	**local-user** *username*	—
Configure a user login password in encryption mode	password	Optional Input a password according to the system prompt and ensure the two input passwords are consistent.

Configuring Login Attempts Limitation and Failure Processing Mode

Table 640 Configure the login attempts limitation and the failure processing mode

Operation	**Command**	**Description**
Enter system view	system-view	—
Enable the login attempts limitation, configure the maximum number of attempts and configure the processing mode used when the maximum number of attempts is exceeded.	**password-control login-attempt** *login-times* [**exceed** { **lock | unlock | locktime** *time* }]	Optional By default, the maximum number of attempts is three, and the switch operates in the **locktime** processing mode when the maximum number of attempts is exceeded.
View the user information in the blacklist	display password-control blacklist	Optional You can use the **display** command in any view

When the maximum number of attempts is exceeded, the system operates in one of the following processing mode:

- **locktime**: In this mode, the system inhibits the user from re-logging in within a certain time period. After the period, the user is allowed to log into the switch again. By default, this time is 120 minutes.
- **lock**: In this mode, the system inhibits the user from re-logging in forever. The user is allowed to log into the switch again only after the administrator removes the user from the user blacklist.
- **unlock**: In this mode, the system allows the user to log in again.

No inhibition operation is performed for the users who execute the ***Super*** *command but fail to log in using the password.*

If a user in the blacklist changes his/her IP address, the blacklist will not affect the user any more when the user logs into the switch.

The system administrator can perform the following operations to manually remove one or all user entries in the blacklist.

Table 641 Manually remove one or all user entries in the blacklist

Operation	Command	Description
Enter system view	system-view	—
Delete one specific or all user entries in the blacklist	**reset password-control blacklist** [**username** *username*]	Executing this command without the **username** *username* option removes all the user entries in the blacklist. Executing this command with the **username** *username* option removes the specified user entry in the blacklist.

Configuring the Timeout Time for Users to be authenticated

When the local/remote server receives the user name, the authentication starts; when the user authentication is completed, the authentication ends. Whether the user is authenticated on the local server or on a remote server is determined by the related AAA configuration. For more details, see the Security Part of *3Com SWITCH 5500 Series Ethernet Switches Operation Manual*.

If a password authentication is not completed before the authentication timeout expires, the authentication fails, and the system terminates the connection and makes some logging.

If a password authentication is completed before the authentication timeout expires, the user will log into the switch normally.

Table 642 Configure the timeout time for users to be authenticated

Operation	Command	Description
Enter system view	system-view	—
Configure the timeout time for users to be authenticated	**password-control authentication-timeout** *authentication-timeout*	Optional By default, it is 60 seconds.

Displaying Password Control

After completing the above configuration, you can execute the **display** command in any view to display the operation of the password control and verify your configuration.

Table 643 Displaying password control

Operation	Command
Display the information about the password control for all users	display password-control
Display the information about the super password control	display password-control super
Display the information about one or all users who have been added to the blacklist because of password attempt failure	**display password-control blacklist** [**username** *username* | **ipaddress** *ip-address*]

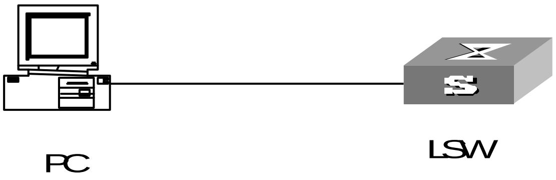
Password Control Configuration Example

Network requirements

A PC is connected to the switch to be configured. You can configure the password control parameters as required.

Network diagram

Figure 168 Network diagram for password control configuration



Configuration procedure

1 Configure the system login password.

```
S5500<S5500>system-view
System View: return to User View with Ctrl+Z.
S5500[S5500]local-user test
New local user added.
[S5500-luser-test]password
Password:**********
confirm:**********
```

2 Change the system login password to 0123456789.

```
[S5500-luser-test]password
Password:**********
Confirm :**********
Updating the password file ,please wait ...
```

3 Enable password aging.

```
S5500[S5500]password-control aging  enable
Password aging enabled for all users. Default: 90 days.
```

4 Enable the limitation of the minimum password length.

```
S5500[S5500]password-control length  enable
Password minimum length enabled for all users. Default: 10 characters.
```

5 Enable history password recording.

```
S5500[S5500]password-control history  enable
Password history enabled for all users.
```

6 Configure the aging time of Super passwords to 10 days.

```
S5500[S5500]password-control super aging 10
The super password aging time is 10 days.
```

7 Display the information about the password control for all users.

```
S5500[S5500] display password-control
Global password settings for all users:
  Password Aging:     Enabled (90 days)
  Password Length:   Enabled (10 Characters)
  Password History:   Enabled   (Max history-record  num : 6)
  Password alert-before-expire:  7  days
  Password  Authentication-timeout : 60 seconds
Password Attemp-failed action  :  Disable
Password History was last reset 38 days ago.
```

8 Display the names and corresponding IP addresses of all the users that have been added to the blacklist because of password attempt failure.

```
S5500[S5500] display password-control blacklist
USERNAME                            IP
Jack                                10.1.1.2
The number of users in blacklist is :1
```

9 Remove the history password records of all users.

```
S5500<S5500> reset password-control history-record
Are you sure to delete all  the  history record?[Y/N]
```

10 If you input "Y", the system removes the history records of all users and gives the following prompt:

```
All historical passwords have been cleared for
```

31 MSDP CONFIGURATION

Among Switch 5500 Series Ethernet Switches, only Switch 5500-EI Series Ethernet Switches support the configurations described in this chapter.

Routers and router icons in this chapter represent routers in the common sense and Ethernet switches running routing protocols.

Introduction to MSDP

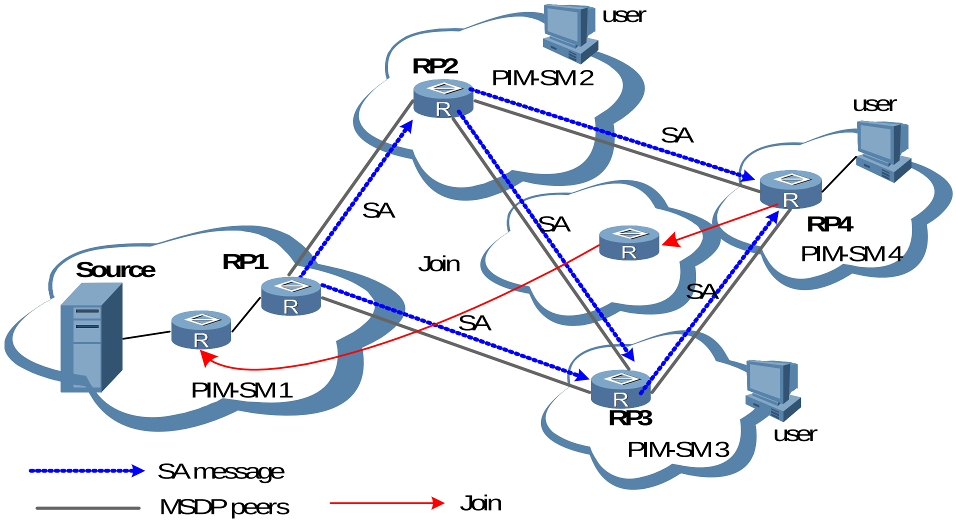
Internet service providers (ISP) are not willing rely on devices of their competitors to forward multicast traffic. On the other hand, ISPs want to obtain information from information sources no matter where the information resources reside and forward the information to their own members. The multicast source discovery protocol (MSDP) is designed to address this issue and used to discover multicast sources in other protocol independent multicast sparse mode (PIM-SM) domains. MSDP is only valid for the any-source multicast (ASM) model.

MSDP describes a mechanism of interconnecting multiple PIM-SM domains. It requires that the inter-domain multicast routing protocol must be PIM-SM and allows the rendezvous points (RPs) of different domains to share multicast source information.

MSDP peers

The RP in a PIM-SM domain can sense the existence of an active multicast source S, if any, in this domain through multicast source register messages. If a PIM-SM domain managed by another ISP wants to obtain information from this multicast source, the routers in both PIM-SM domains must establish an MSDP peering relationship with each other, as shown in Figure 169.

Figure 169 MSDP peering relationship



MSDP peers are interconnected over TCP connections (using port 639). A TCP connection can be established between RPs in different PIM-SM domains, between RPs in the same PIM-SM domain, between an RP and a common router, or between common routers. Figure 169 shows the MSDP peering relationship between RPs. Unless otherwise specified, examples in the following descriptions are based on MSDP peering relationship between RPs.

An active multicast source S exists in the PIM-SM1 domain. RP1 in this domain learns the specific location of the multicast source S through multicast source register messages, and then sends source active (SA) messages periodically to MSDP peers (RP nodes) in other PIM-SM domains. An SA message contains the IP address of the multicast source S, the multicast group address G, the address of the RP that has generated the SA message, and the first multicast data received by the RP in the PIM-SM1 domain. The SA message is forwarded by peers. Finally, the SA message reaches all the MSDP peers. In this way, the information of multicast source S in the PIM-SM domain is delivered to all PIM-SM domains.

By performing reverse path forwarding (RPF) check, MSDP peers accept SA messages only from the correct paths and forward the SA messages, thus avoiding SA message loop. In addition, you can configure a mesh group among MSDP peers to avoid SA flooding among MSDP peers.

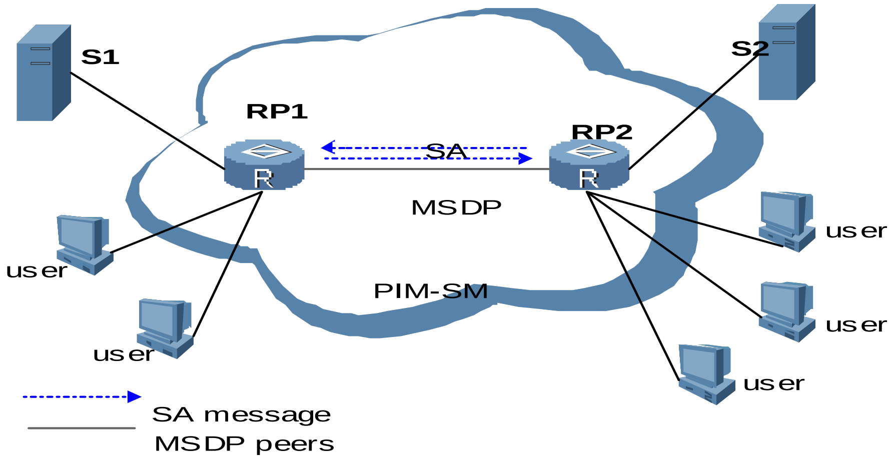
Assume that RP4 in the PIM-SM4 domain receives the SA message. RP4 checks whether receivers exist in the corresponding multicast group. If so, RP4 sends an (S, G) join message hop by hop to the multicast source S, thus creating a shortest path tree (SPT) based on the multicast source S. A rendezvous point tree (RPT) exists between RP4 and receivers in the PIM-SM4 domain.

Through MSDP, a PIM-SM domain receiving information from the multicast source S does not rely on RPs in other PIM-SM domains, that is, receivers can directly join the SPT tree based on the multicast source without passing RPs in other PIM-SM domains.

MSDP application

You can also implement Anycast RP through MSDP. Anycast RP refers to such an application that an MSDP peering relationship can be established between two RPs with the same IP address in the same PIM-SM domain, to enable load balancing and redundancy backup between the two RPs in the same domain. The candidate RP (C-RP) function is enabled on an interface (typically the loopback interface) of each of multiple routers in the same PIM-SM domain, and these interfaces have the same IP address. An MSDP peering relationship is formed among these interfaces, as shown in Figure 170

Figure 170 Typical networking of Anycast RP.



Typically, a multicast source S registers to the nearest RP to create an SPT, and receivers also send Join messages to the nearest RP to construct an RPT, so it is likely that the RP to which the multicast source has registered is not the RP that receivers Join. To ensure information consistency between RPs, the RPs, serving as MSDP peers of one another, learn information of the peer multicast source by sending SA messages to one another. As a result, each RP can know all the multicast sources in the PIM-SM domain. In this way, the receivers connected to each RP can receive multicast data sent by all the multicast sources in the entire PIM-SM domain.

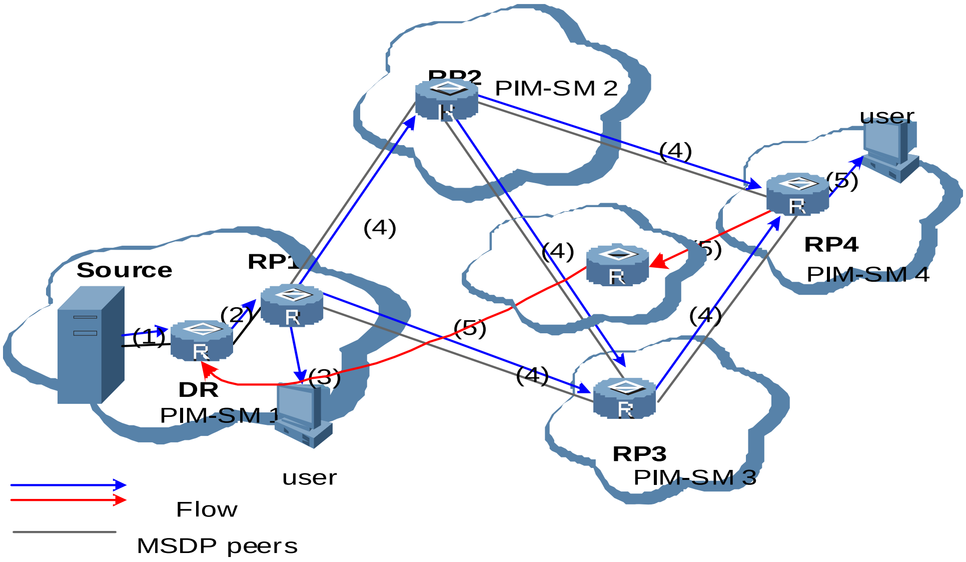
As described above, RPs exchange information among one another through MSDP, a multicast source registers with the nearest RP, and receivers join the nearest RPT, so RP load balancing can be achieved. When an RP fails, the multicast source and receivers previously registered to/joined it will register to or join another nearest RP automatically, thus implementing RP redundancy backup.

MSDP Working Mechanism

Identifying a multicast source and receiving multicast data

A network contains four PIM-SM domains, PIM-SM1, PIM-SM2, PIM-SM3, and PIM-SM4. An MSDP peering relationship is established between RPs in different domains. Multicast group members exist in the PIM-SM1 and PIM-SM4 domains. See Figure 171.

Figure 171 Identifying the multicast source and receiving multicast data



The complete interoperation process between a multicast source S in the PIM-SM1 domain and receivers in the PIM-SM1 and PIM-SM4 domains is as follows:

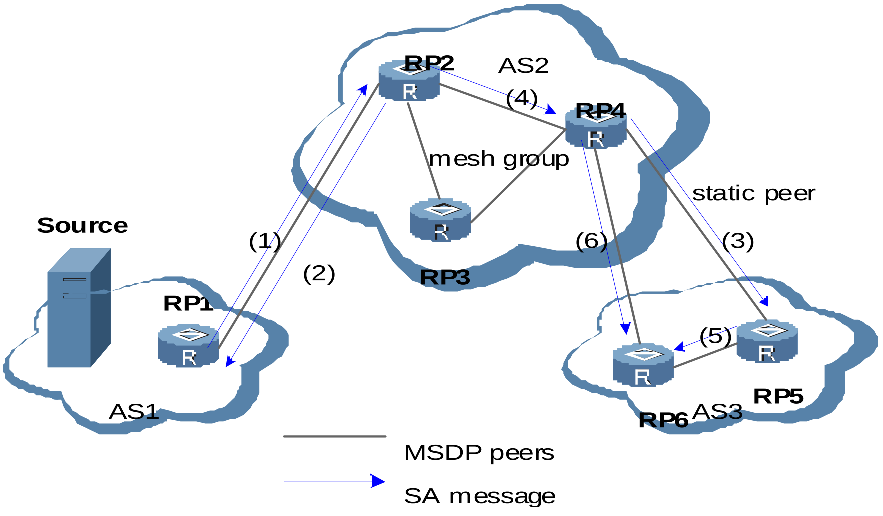
1. The multicast source S in the PIM-SM1 domain begins to send data packets.
2. The designated router (DR) connected to the multicast source S encapsulates the received data in a Register message, and then forwards the message to RP1 in the PIM-SM1 domain.
3. RP1 in the PIM-SM1 domain decapsulates the Register message, and then forwards the message to all the members in the domain along the RPT. The members in the domain can select whether to switch to the SPT.
4. At the same time, RP1 in the PIM-SM1 domain creates an SA message and sends the message to the corresponding MSDP peers (RPs in the PIM-SM2 and PIM-SM3 domains). Finally, the SA message is forwarded to the RP in the PIM-SM4 domain. The SA message contains the IP address of the multicast source, the multicast group address, the address of the RP that has generate the SA message, and the first multicast data received by the RP in the PIM-SM1 domain.
5. If group members (namely, receivers) exists in the PIM-SM domains where MSDP peers of RP1 reside, for example, if group members exist in the PIM-SM4 domain, RP4 decapsulates the multicast data in the SA message and distributes the multicast data to receivers along the RPT. RP4 also sends a Join message to the multicast source S at the same time.
6. To avoid SA loop, MSDP peers perform RPF check on the received SA message. After the RPF path is established, the data from the multicast source S is directly sent to RP4 in the PIM-SM4 domain. Then RP4 forwards the data along the RPT within the domain. Now the last-hop router of connected with group members in the PIM-SM4 domain selects whether to switch to the SPT.

Forwarding messages between MSDP peers and performing RPF check

To establish an MSDP peering relationship between routers, you have to create routes between routers to for SA messages to travel.

Assume that three autonomous systems (AS) exist. They are AS1, AS2, and AS3. Each AS has a PIM-SM domain associated with it. Each PIM-SM domain contains at least one RP. See Figure 172.

Figure 172 Forwarding SA messages between MSDP peers



As shown above, RP1 belongs to AS1. RP2, RP3 and RP4 belong to AS2. RP5 and RP6 belong to AS3. An MSDP peering relationship exists among these RPs. RP2, RP3, and RP4 form a mesh group. These MSDP peers perform RPF check and process SA messages forwarded to one another according to the following rules:

1. If an MSDP peer sending an SA message is an RP in the PIM-SM domain where the multicast source resides (for example, when RP1 sends an SA message to RP2), the receiver accepts the SA message and forwards the message to other peers.
2. If an RP has only one MSDP peer (for example, when RP2 sends an SA message to RP1), the receiver accepts the SA message from the peer.
3. If an SA message comes from a static RPF peer (for example, when RP4 sends an SA message to RP5), the receiver accepts the SA message and forwards it to other peers.
4. If an SA message comes from a peer that belongs to the same MSDP mesh group with the receiver, the receiver accepts the SA message and forwards it to peers out of the mesh group. For example, when RP2 sends an SA message to RP4, RP4 accepts the message and forwards it to RP5 and RP6.
5. If an SA message comes from an MSDP peer in the same AS, and this peer is the next hop on the optimal path to the RP in the PIM-SM domain where the multicast source resides, the receiver accepts the SA message and forwards it to other peers. For example, when RP4 sends an SA message to RP5, RP5 receives the message and forwards it to RP6.
6. If an SA message comes from an MSDP peer in a different AS, and this AS is the next AS of the RP optimal path in the PIM-SM domain where the multicast source resides (for example, when RP4 sends an SA message to RP6), the receiver accepts the SA message and forwards it to other peers.
7. The receiver does not accept or forward other SA messages.

Switch 5500 series switches do not support inter-domain routing. The RPF check rules applies to the description in 5) only.

Configuring MSDP Basic Functions

To enable exchange of information from the multicast source S between two PIM-SM domains, you need to establish MSDP peering relationships between RPs in these PIM-SM domains, so that the information from the multicast source can be sent through SA messages between the MSDP peers, and the receivers in other PIM-SM domains can finally receive the multicast source information.

A route is required between two routers that are MSDP peers to each other. Through this route the two routers can transfer SA messages between PIM-SM domains. An area containing only one MSDP peer, known as a stub area, the route is not compulsory. SA messages are transferred in a stub area through the configuration of static RPF peers. In addition, the use of static RPF peers can avoid RPF check on the received SA messages, thus saving resources.

Before configuring static RPF peers, you must create an MSDP peering connection. If you configure only one MSDP peer on a router, the MSDP peer will act as a static RPF peer. If you configure multiple RPF peers, you need to handle them based on the configured filtering policy using the **rp-policy** parameter.

When configuring multiple static RPF peers for the same router, you must follow the following two configuration methods:

- In the case that all the peers use the **rp-policy** keyword: Multiple static RPF peers function at the same time. RPs in SA messages are filtered based on the configured prefix list, and only the SA messages whose RP addresses pass the filtering are received. If multiple static RPF peers **using** the same **rp-policy** keyword are configured, when any of the peers receives an SA message, it will forward the SA message to other peers.
- None of the peers use the **rp-policy** keyword: Based on the configured sequence, only the first static RPF peer whose connection state is UP is active. All the SA messages from this peer will be received, while the SA messages from other static RPF peers will be discarded. **Once the active static RPF peer fails (because the configuration is removed or the connection is terminated), based on the configuration sequence, the subsequent first static RPF peer whose connection is in the UP state will be selected as the active static RPF peer.**

Configuration Prerequisites

Before configuring basic MSDP functions, you need to configure:

- A unicast routing protocol
- PIM-SM basic functions

Configuring MSDP Basic Functions

Table 644 Configure MSDP basic functions

Operation	Command	Description
Enter system view	system-view	-
Enable IP multicast routing	multicast routing-enable	Required The multicast function must be enabled before other multicast configurations can take effect.
Enable MSDP function and enter MSDP view	msdp	Required Enable the MSDP function.
Create an MSDP peer connection	**peer** *peer-address* **connect-interface** *interface-type interface-number*	Required To establish an MSDP peer connection, you must configure the parameters on both peers. The peers are identified by an address pair (the address of the interface on the local router and the IP address of the remote MSDP peer).
Configure a static RPF peer	**static-rpf-peer** *peer-address* [**rp-policy** *ip-prefix-name*]	Optional For an area containing only one MSDP peer, if the BGP or MBGP does not run in this area, you need to configure a static RPF peer.

Configuring Connection Between MSDP Peers

An AS may contain multiple MSDP peers. To avoid SA flooding between the MSDP peers, you can use the MSDP mesh mechanism to improve traffic. When multiple MSDP peers are fully connected with one another, these MSDP peers form a mesh group. When an MSDP peer in the mesh group receives SA messages from outside the mesh group, it sends them to other members of the group. On the other hand, a mesh group member does not perform RPF check on SA messages from within the mesh group and does not forward the messages to other members of the mesh group. This avoids SA message flooding since it is unnecessary to run BGP or MBGP between MSDP peers, thus simplifying the RPF checking mechanism.

The sessions between MSDP peers can be terminated and reactivated sessions as required. When a session between MSDP peers is terminated, the TCP connection is closed, and there will be no reconnection attempts. However, the configuration information is kept.

Configuration Prerequisites

Before configuring an MSDP peer connection, you need to configure:

- A unicast routing protocol
- Basic functions of IP multicast
- PIM-SM basic functions
- MSDP basic functions

Configuring Description Information for MSDP Peers

You can configure description information for each MSDP peer to manage and memorize the MSDP peers.

Table 645 Configure description information for an MSDP peer

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Configure description information for an MSDP peer	**peer** *peer-address* **description** *text*	Optional By default, an MSDP peer has no description text.

Configuring Anycast RP Application

If you configure RPs that have the same address on two routers in the same PIM-SM domain, the two routers will be MSDP peers to each other. To prevent failure of RPF check on SA messages between MSDP peers, you must configure the RP address to be carried in the SA messages.

Table 646 Configure anycast RP application

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Create an MSDP peer connection	**peer** *peer-address* **connect-interface** *interface-type interface-number*	Required
Configure the RP address to be carried in SA messages	**originating-rp** *interface-type interface-number*	Required By default, the RP address in SA messages is the RP address configured by PIM.

In Anycast RP application, C-BSR and C-RP must be configured on different devices or ports.

Configuring an MSDP Mesh Group

Configure a mesh group name on all the peers that will become members of the MSDP mesh group, so that the peers are fully connected with one another in the mesh group.

Table 647 Configure an MSDP mesh group

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Add an MSDP peer in a mesh group	**peer** *peer-address* **mesh-group** *name*	Required

Before you configure an MSDP mesh group, make sure the routers must be fully connected with one another.

The same group name must be configured on all the peers.

If you add the same MSDP peer into multiple mesh groups, only the latest configuration takes effect.

Configuring MSDP Peer Connection Control

The connection between MSDP peers can be flexibly controlled. You can disable the MSDP peering relationships temporarily by shutting down the MSDP peers. As a result, SA messages cannot be transmitted between such two peers. On the other hand, when resetting an MSDP peering relationship between faulty MSDP peers or bringing faulty MSDP peers back to work, you can adjust the retry interval of establishing a peering relationship through the following configuration.

Table 648 Configure MSDP peer connection control

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Shut down an MSDP peer	**shutdown** *peer-address*	Optional
Configure retry interval of setting up an MSDP peer connection	**timer retry** *seconds*	Optional The default value is 30 seconds.

Configuring SA Message Transmission

An SA message contains the IP address of the multicast source S, multicast group address G, and RP address. In addition, it contains the first multicast data received by the RP in the domain where the multicast source resides. For some burst multicast data, if the multicast data interval exceeds the SA message hold time, the multicast data must be encapsulated in the SA message; otherwise, the receiver will never receive the multicast source information.

By default, when a new receiver joins in, a router does not send an SA request message to its MSDP peer but has to wait for the next SA message. This defers the reception of the multicast information by the receiver. In order for the new receiver to know about the currently active multicast source as quickly as possible, the router needs to send SA request messages to the MSDP peer.

Generally, a router accepts all SA messages sent by all MSDP peers and sends all SA messages to all MSDP peers. By configuring the rules for filtering SA messages to receive/send, you can effectively control the transmission of SA messages among MSDP peers. For forwarded SA messages, you can also configure a Time-to-Live (TTL) threshold to control the range where SA messages carrying encapsulated data are transmitted.

To reduce the delay in obtaining the multicast source information, you can cache SA messages on the router. The number of SA messages cached must not exceed the system limit. The more messages cached, the more router memory occupied; therefore, be flexible when dealing with the cache size.

Configuration Prerequisites

Before you configure SA message transmission, perform the following tasks:

- Configuring a unicast routing protocol.
- Configuring basic IP multicast functions.
- Configuring basic PIM-SM functions.
- Configuring basic MSDP functions.

Configuring the Transmission and Filtering of SA Request Messages

After you enable sending SA request messages to MSDP peers, when a router receives a Join message, it sends an SA request message to the specified remote MSDP peer, which responds with an SA message that it has cached. After sending an SA request message, the router will get immediately a response from all active multicast sources. By default, the router does not send an SA request message to its MSDP peers upon receipt of a Join message; instead, it waits for the next SA message.

The SA message that the remote MSDP responds with is cached in advance; therefore, you must enable the SA message caching mechanism in advance. Typically, only the routers caching SA messages can respond to SA request messages.

After you have configured a rule for filtering received SA messages, if no ACL is specified, all SA request messages sent by the corresponding MSDP peer will be ignored; if an ACL is specified, the SA request messages that satisfy the ACL rule are received while others are ignored.

Table 649 Configure the transmission and filtering of SA request messages

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	Msdp	-
Enable SA message caching mechanism	Cache-sa-enable	Optional By default, the router caches the SA state upon receipt of an SA message.
Enable sending SA request messages to the MSDP peer	**peer** *peer-address* **request-sa-enable**	Optional By default, upon receipt of a Join message, the router sends no SA request message to its MSDP peer but waits for the next SA message.
Configure a rule for filtering the SA messages to be received by an MSDP peer	**peer** *peer-address* **sa-request-policy** [**acl** *acl-number*]	Optional By default, a router receives all SA request messages from the MSDP peer.

Configuring a Rule for Filtering the Multicast Sources of SA Messages

An RP filters each registered source to control the information of active sources advertised in the SA message. An MSDP peer can be configured to advertise only the (S, G) entries in the multicast routing table that satisfy the filtering rule when the MSDP creates the SA message, that is, to control the (S, G) entries to be imported from the multicast routing table to the PIM-SM domain. If the **import-source** command is executed without the **acl** keyword , no source will be advertised in the SA message.

Table 650 Configure a rule for filtering multicast sources using SA messages

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Configure to filter multicast sources using SA messages	**import-source** [**acl** *acl-number*]	Optional By default, all the (S, G) entries in the domain are advertised in the SA message.

Configuring a Rule for Filtering Received and Forwarded SA Messages

Besides the creation of source information, controlling multicast source information allows you to control the forwarding and reception of source information. You can control the reception of SA messages using the MSDP inbound filter (corresponding to the **import** keyword); you can control the forwarding of SA messages by using either the MSDP outbound filter (corresponding to the **export** argument) or the TTL threshold. By default, an MSDP peer receives and forwards all SA messages.

MSDP inbound/outbound filter implements the following functions:

- Filtering out all (S, G) entries
- Receiving/forwarding only the SA messages permitted by advanced ACL rules

An SA message carrying encapsulated data can reach the specified MSDP peer outside the domain only when the TTL in its IP header exceeds the threshold; therefore, you can control the forwarding of SA messages that carry encapsulated data by configuring the TTL threshold.

Table 651: Configure a rule for filtering received and forwarded SA messages

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Configure the filtering list for receiving or forwarding SA messages from the specified MSDP peer	**peer** *peer-address* **sa-policy** { **import** | **export** } [**acl** *acl-number*]	Optional By default, no filtering is imposed on SA messages to be received or forwarded, namely all SA messages from MSDP peers are received or forwarded.
Configure the minimum TTL for the multicast packets sent to the specified MSDP peer	**peer** *peer-address* **minimum-ttl** *ttl-value*	Optional By default, the value of TTL threshold is 0.

Configuring SA Message Cache

With the SA message caching mechanism enabled on the router, the group that a new member subsequently joins can obtain all active sources directly from the SA cache and join the corresponding SPT source tree, instead of waiting for the next SA message.

You can configure the number of SA entries cached in each MSDP peer on the router by executing the following command, but the number must be within the system limit. The system sets the maximum number of SA messages cached in each MSDP peer and the maximum number of SA messages cached in all MSDP peers on the router; these thresholds must not exceed the system limits. To protect a router against Deny of Service (DoS) attacks, you can manually configure the maximum number of SA messages cached on the router. Generally, the configured number of SA messages cached should be less than the system limit.

Table 652 Configure SA message cache

Operation	Command	Description
Enter system view	system-view	-
Enter MSDP view	msdp	-
Enable SA message caching mechanism	cache-sa-enable	Optional By default, the SA message caching mechanism is enabled.

Table 652 Configure SA message cache (continued)

Operation	Command	Description
Configure the maximum number of SA messages cached	**peer** *peer-address* **sa-cache-maximum** *sa-limit*	Optional By default, the maximum number of SA messages cached on a router is 2,048.

Displaying and Debugging MSDP Configuration

After the above-mentioned configuration, you can use the **display** command in any view to view the MSDP running information, so as to verify configuration result.

In the user view, you can execute the **reset** command to reset the MSDP counter.

Table 653 Display and debug MSDP configuration

Operation	Command
Display the brief information of MSDP peer state	display msdp brief
Display the detailed information of MSDP peer state	**display msdp peer-status** [*peer-address*]
Display the (S, G) state learned from MSDP peers	**display msdp sa-cache** [*group-address* | [*source-address*]] [*autonomous-system-number*]
Display the number of sources and groups in the MSDP cache	**display msdp sa-count** [*autonomous-system-number*]
Reset the TCP connection with the specified MSDP peer	**reset msdp peer** *peer-address*
Clear the cached SA messages	**reset msdp sa-cache** [*group-address*]
Clear the statistics information of the specified MSDP peer without resetting the MSDP peer	**reset msdp statistics** [*peer-address*]

Tracing the transmission path of an SA message over the network

You can use the **msdp-tracert** command in any view to trace the path along which the multicast data travels from the multicast source to the destination receiver over the network, so as to locate errors, if any.

Table 654 Trace the transmission path of an SA message over the network

Operation	Command
Trace the transmission path of an SA message over the network	**msdp-tracert** *source-address group-address rp-address* [**max-hops** *max-hops*] [**next-hop-info** | **sa-info** | **peer-info**]* [**skip-hops** *skip-hops*]

You can locate message loss and configuration errors by tracing the network path of the specified (S, G, RP) entries. Once the transmission path of SA messages is determined, correct configuration can prevent the flooding of SA messages.

MSDP Configuration Example

This section contains an MSDP configuration example.

Configuration Example of Anycast RP Application

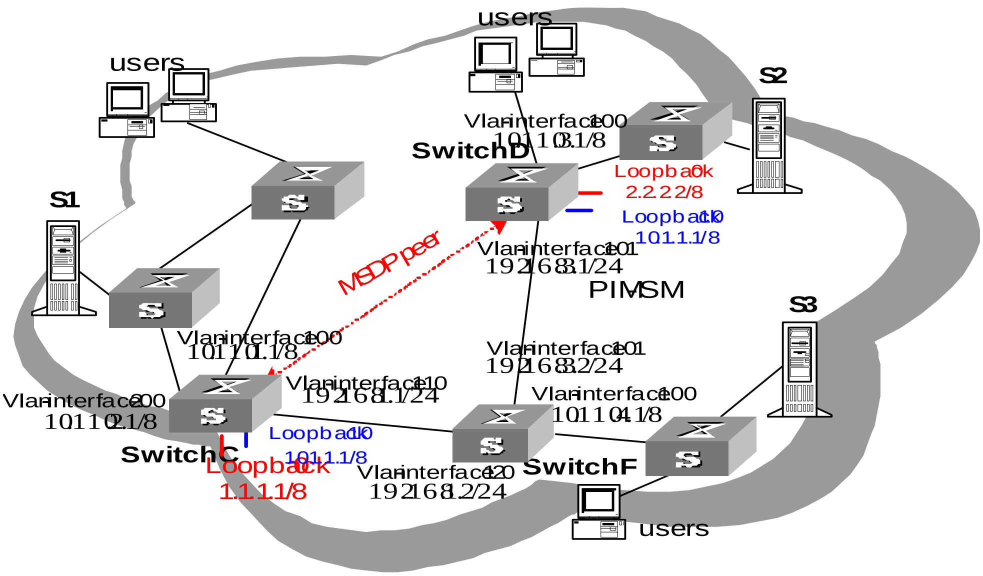
Network requirements

Each PIM-SM network is a single-BSR administrative domain, with multiple multicast sources (S) and receivers. With Anycast RP configured in each PIM-SM domain, when a new member joins the multicast group, the switch directly connected to the receiver can send a Join message to the nearest RP on the topology.

The PIM-SM network implements OSPF to provide unicast routes and establish MSDP peers between SwitchC and SwitchD. Meanwhile, the Loopback10 interfaces of SwitchC and SwitchD play the roles of C-BSR and C-RP.

Network diagram

Figure 173 Network diagram for Anycast RP configuration



Configuration procedure

1 Configure interface IP addresses and unicast routing protocol on the switches.

In the PIM-SM domain, configure the interface IP addresses on the switches and interconnect the switches through OSPF. Configure the IP address and mask of each interface according to Figure 173. The details are omitted here.

2 Enable multicast and configure PIM-SM.

a Enable multicast on SwitchC and enable PIM-SM on all interfaces. The configuration procedures on other switches are similar to that on SwitchC. The details are omitted here.

```
[SwitchC] multicast routing-enable
[SwitchC] interface vlan-interface 100
[SwitchC-Vlan-interface100] pim sm
[SwitchC-Vlan-interface100] interface vlan-interface 200
[SwitchC-Vlan-interface200] pim sm
[SwitchC-Vlan-interface200] interface vlan-interface 110
[SwitchC-Vlan-interface110] pim sm
[SwitchC-Vlan-interface110] quit
```

b Configure the same Loopback10 interface address on SwitchC and SwitchD and configure the locations of C-BSR and C-RP. The configuration procedure on SwitchD is similar to that on SwitchC. The details are omitted here.

```
[SwitchC] interface loopback 10
[SwitchC-LoopBack10] ip address 10.1.1.1 255.255.255.255
[SwitchC-LoopBack10] pim sm
[SwitchC-LoopBack10] quit
[SwitchC] pim
[SwitchC-pim] c-bsr loopback 10
[SwitchC-pim] c-rp loopback 10
[SwitchC-pim] quit
```

c When the multicast source S1 in the PIM-SM domain sends multicast information, the receivers attached to SwitchD can receive the multicast information and can view the PIM routing information on the switch by using the **display pim routing-table** command. For example, the following PIM routing information is displayed on SwitchC and SwitchD.

```
[SwitchC] display pim routing-table
Total 0 (*, G) entry; 1 (S, G) entry
 (10.110.5.100, 225.1.1.1), RP: 10.1.1.1 (local)
     Protocol: pim-sm, Flag: SPT LOC ACT
     UpTime: 00:10:20
     Upstream interface: Vlan-interface200
         RPF neighbor: Vlan-interface200
     Downstream interface(s) information:
     Total number of downstreams: 1
         1: Vlan-interface110
             Protocol: pim-sm, UpTime: 00:10:20, Expires: 00:03:10
[SwitchD] display pim routing-table
Total 0 (*, G) entry; 1 (S, G) entry
(10.110.5.100, 225.1.1.1), RP: 10.1.1.1
     Protocol: pim-sm, Flag: SPT ACT
     UpTime: 00:03:32
     Upstream interface: Vlan-interface101
         RPF neighbor: 192.168.3.2
     Downstream interface(s) information:
     Total number of downstreams: 1
         1: Vlan-interface100
             Protocol: pim-sm, UpTime: 00:03:32, Expires: -
```

3 Configure an MSDP peer

a Configure an MSDP peer on Loopback0 on SwitchC.

```
[SwitchC] msdp
[SwitchC-msdp] originating-rp loopback0
[SwitchC-msdp] peer 2.2.2.2 connect-interface loopback0
[SwitchC-msdp] quit
```

b Configure an MSDP peer on Loopback0 on SwitchD.

```
[SwitchD] msdp
[SwitchD-msdp] originating-rp loopback0
[SwitchD-msdp] peer 1.1.1.1 connect-interface loopback0
[SwitchD-msdp] quit
```

c You can use the **display msdp brief** command to view the MSDP peer relationship established between the switches. The following MSDP peer information is displayed on SwitchC and SwitchD.

```
[SwitchC] display msdp brief
MSDP Peer Brief Information
  Peer's Address    State     Up/Down time   AS     SA Count   Reset
Count
  2.2.2.2            Up        00:10:17        ?      0          0
[SwitchD] display msdp brief
MSDP Peer Brief Information
  Peer's Address    State     Up/Down time   AS     SA Count   Reset
Count
  1.1.1.1            Up        00:10:18        ?      0          0
```

Troubleshooting MSDP Configuration

The following sections provide troubleshooting guidelines for MSDP configuration.

MSDP Peer Always in the Down State

Symptom

An MSDP peer is configured, but it is always in the down state.

Analysis

An MSDP peer relationship between the locally configured **connect-interface** interface address and the configured peer address is based on a TCP connection. If the address of local **connect-interface** interface is inconsistent with the peer address configured on the peer router, no TCP connection can be established. If there is no route between the two peers, no TCP connection can be established.

Solution

1 Check the connectivity of the route between the routers. Use the **display ip routing-table** command to check that the unicast route between the routers are correct.

2 Further check that a unicast route exists between two routers that will become MSDP peers and that the route leads to the two peers.

3 Check that the interface addresses of the MSDP peers are consistent. Use the **display current-configuration** command to check that the address of the local connect-interface interface is consistent with the address of the corresponding MSDP peer.

No SA Entry in the SA Cache of the Router

Symptom

An MSDP fails to send (S, G) forwarding entries using an SA message.

Analysis

You can use the **import-source** command to send the (S, G) entries of the local multicast domain to the neighboring MSDP peer using SA messages. The **acl** keyword is optional. If you do not use this keyword, all (S, G) entries will be filtered out by default, that is, none of the (S, G) entries in the local multicast domain will be advertised. Before the **import-source** command is carried out, the system will send all (S, G) entries in the local multicast domain. If the MSDP fails to send the (S, G) entries of the local multicast domain using SA messages, verify that the **import-source** command is configured correctly.

Solution

1 Check the connectivity of the route between the routers. Use the **display ip routing-table** command to check that the unicast route between the routers are correct.

2 Further check that a unicast route exists between two routers that will become MSDP peers and that the route leads to the two peers.

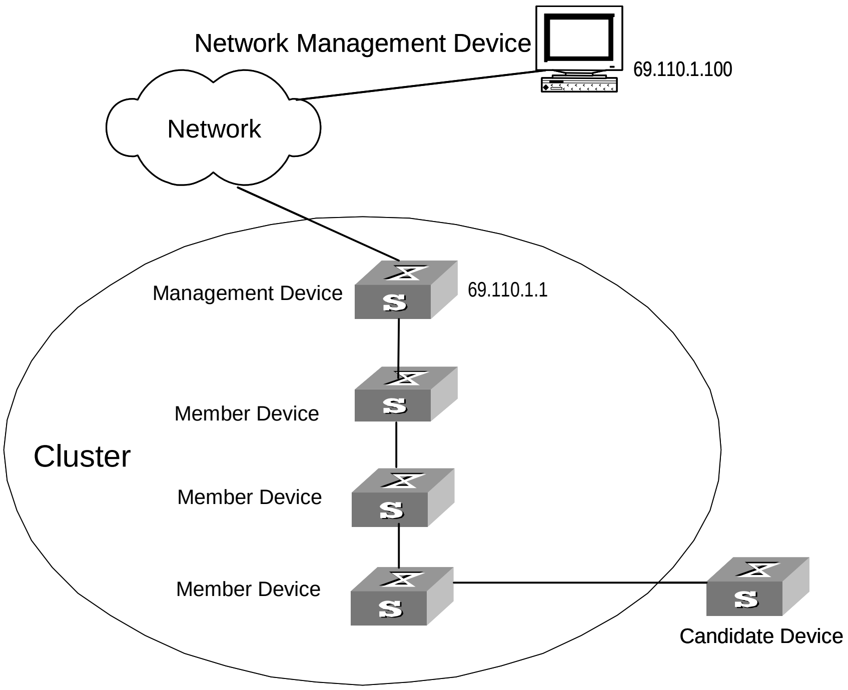
3 Verify the configuration of the **import-source** command and the corresponding ACL to ensure that the ACL rule filters the right (S, G) entries.

32 CLUSTERING

Clustering Overview

Clustering enables the network to manage multiple switches through the public IP address of a switch named the management device. Managed switches in a cluster are member devices, and often may not have an assigned public IP address. Management and maintenance on member devices are made through management device redirection. The management and member devices form a cluster, whose typical application is shown in Figure 174.

Figure 174 Clustering



Clustering offers the following advantages:

- Simple configuration and management on multiple switches through one public IP address on the administer device. Login to the configuration port of each member device is not necessary.
- Topology discovery and display functions that help network monitoring and debugging.
- Concurrent software upgrade and parameter configurations on multiple switches.
- Being free from topology and distance limitations.
- Saving IP address resource.

Clustering provides the following functions:

- Topology discovery: Clustering implements NDP (Neighbor Discovery Protocol) to discover information about directly connected neighbor devices, including device type, software/hardware version, connecting port and so on. The device ID, port duplex mode, product version and Bootrom version can also be given.

- Topology collection: Clustering implements NTDP (Neighbor Topology Discovery Protocol) to collect information on device connections and candidate devices within a specified hop range.
- Member recognition: Members in the cluster can be located, thus the management device can recognize them and deliver configuration and management commands.
- Member management: Devices can be added into or removed from a cluster on the management device. Management device authentication and handshake interval can also be configured on the management device.

Related configurations are described in the following sections.

Switch Roles

Switches in a cluster are assigned with different roles according to their own functions. You can specify or change the role for a switch.

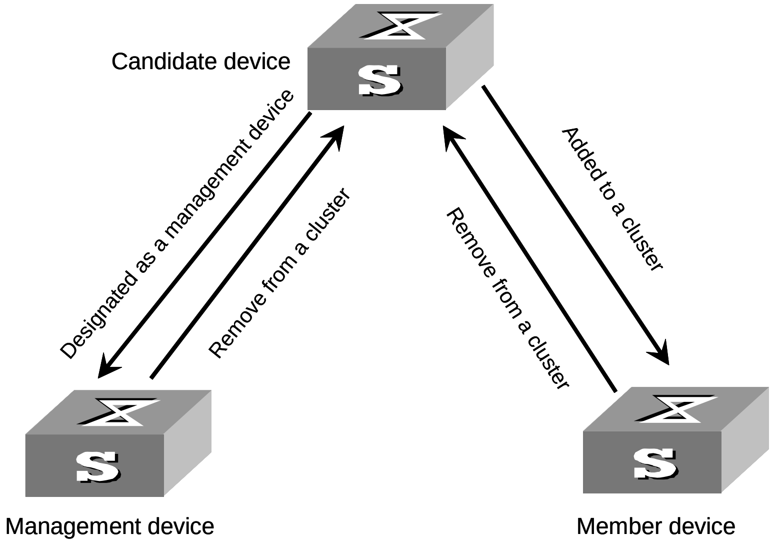
A switch in a cluster can be the management device, a member device or a candidate device.

Table 655 Devices in a cluster

Role	Configurations	Functions
Management device	• Is configured with a public IP address. • Receives management commands that the user sends through the public network for processing.	• Provides management interfaces for all switches in the cluster. • Manages member devices through command redirection. • Forwards commands to be executed on member devices to the proper member for processing. • Supports neighbor discovery, topology collection, cluster management, cluster state maintenance and proxies.
Member device	Often is not configured with public IP address.	• Acts as cluster members • Supports neighbor discovery, being managed by the management device, running commands from proxies and failure/log report.
Candidate device	Often not configured with a public IP address.	Candidate devices are switches that are not cluster members and can be added into a cluster.

Figure 175 shows the role changing rule.

Figure 175 Role changing rule



- A cluster can have only one management device, which is necessary to the cluster. The management device collects NDP/NTDP information to discover and confirm candidate devices, which can be then added into the cluster through manual configurations.
- A candidate device can be added into a cluster to become a member device.
- A member device can be removed from the cluster and becomes a candidate device.

Introduction to NDP

NDP is the protocol for discovering the related information of the adjacent points. NDP runs on the data link layer, so it supports different network layer protocols.

NDP is used to discover the information of directly connected neighbors, including the device type, software/hardware version, and connecting port of the adjacent devices. It can also provide the information concerning device ID, port address, hardware platform and so on.

All the devices supporting NDP maintain an NDP information table. The table entry will be removed by NDP automatically when the aging timer expires. You can also clear the current NDP information to collect new adjacent information.

The device running NDP broadcasts packets carrying NDP data to all the activated ports regularly. The packet carries the holdtime, indicating how long the receiving device has to keep the updating data. The receiver only keeps the information in the NDP packet, but not forwards it. The corresponding data entry in the NDP table will be updated with the arriving information. If the new information is same as the old one, only the holdtime will be updated.

Introduction to NTDP

NTDP is a protocol for network topology information collection. NTDP provides the information of available devices to join the cluster and collects the information about switches within the specified hops for cluster management.

Based on the adjacent table information provided by NDP, NTDP transmits and forwards NTDP topology collection request to collect NDP information and neighboring connection information of every device in a certain network range. After collecting the information, the management device or the network administrator can perform needed functions.

When the NDP on the member device finds changes of neighbors, it will advertise the changes to the management device by handshake packets. The management device can run NTDP to collect the specified topology information and show the network topology changes in time.

On a management device, you need to enable system NTDP and port NTDP, and configure the NTDP parameters as well. However, for a member device, you only need to enable system NTDP and the corresponding port NTDP. As the protocol runs, the member device will automatically adopt parameters sent from the management device.

Introduction to Cluster Roles

There must be a unique management device in a cluster. Note the following items when you create a cluster:

- You are supposed to designate a management device first. It is the entrance and exit to access the cluster members, that is, a user on the external network can access, configure, manage, and monitor the cluster members through it.
- The management device recognizes and controls all members in its cluster, no matter where they are located on the network or how they are connected.
- The management device collects topology information about all the member and candidate devices to provide useful information for a user when he establishes a cluster.
- The management device learns the network topology through NDP/NTDP information collection for device management and monitoring.

Before you perform other configuration tasks, the cluster function is supposed to be enabled first.

You need to enable the cluster function and configure cluster parameters on a management device. However, you only have to enable the cluster function on the member devices and candidate devices.

You can also configure an FTP,TFTP,SNMP host and loghost server for a cluster on the management device. In this case, the communications between a member device in the cluster and an external server are carried out by the management device. For clusters with no FTP/TFTP server configured, the management device operates as the public FTP/TFTP server.

By specifying the NM interface of a management switch, you can enable an administrator to log into the management switch of a cluster to manage the devices in the cluster. Note that an administrator can only log into a management switch through the NM interface.

The management VLAN interface is the default NM interface.

You can configure only one NM interface, and the new configured one will override the original one.

Management Device Configuration

Management device configuration involves:

- Enable system and port NDP
- Configure NDP parameters
- Enable system and port NTDP
- Configure NTDP parameters
- Enable the cluster function
- Configure cluster parameters
- Configuring internal-external interaction
- NM Interface for Cluster Management Configuration

Enabling System and Port NDP

Table 656 Enable system and port NDP

Operation	Command	Remark
Enter system view	system-view	—
Enable system NDP	ndp enable	Required
Enable port NDP	**ndp enable interface** *port-list*	Optional
Enter the Ethernet port	**interface** *interface-type interface-number*	—
Enable port NDP	ndp enable	Required

Configuring NDP Parameters

Table 657 Configure NDP parameters

Operation	Command	Remark
Enter system view	system-view	—
Configure holdtime of NDP information	**ndp timer aging** *aging-in-seconds*	Argument *aging-in-seconds* is the holdtime of NDP information.
Configure interval of NDP packets	**ndp timer hello** *seconds*	Argument *Seconds* is the interval of NDP packets.

Enabling System and Port NTDP

Table 658 Enable system and port NTDP

Operation	Command	Remark
Enter system view	system-view	—
Enable system NTDP	ntdp enable	Required
Enter the Ethernet port	**interface** *interface-type interface-number*	—
Enable port NTDP	ntdp enable	Required

Configuring NTDP Parameters

Table 659 Configure NTDP parameters

Operation	Command	Remark
Enter system view	system-view	—
Configure the topology collection range	**ntdp hop** *hop-value*	Optional Argument *hop-value* is the hop range.

Table 659 Configure NTDP parameters (continued)

Operation	Command	Remark
Configure the time that collected devices wait before forwarding the topology-collection request	**ntdp timer hop-delay** *time*	Optional Argument *time* is the delay time.
Configure the time that a port waits before it forwards the topology request packet to the next port	**ntdp timer port-delay** *time*	Optional Argument *time* is the delay time.
Configure the interval of periodic topology information collection	**ntdp timer** *interval-in-minutes*	Optional Argument *interval-in-minutes* is the needed time.
Exit system view.	quit	—
Start topology information collection	ntdp explore	Optional

Enabling the Cluster Function

Table 660 Enable the cluster function on a switch

Operation	Command	Remark
Enter system view	system-view	—
Enable the cluster function on a switch	cluster enable	Required

Configuring Cluster Parameters

Configuring cluster parameters manually

Table 661 Configure cluster parameters manually

Operation	Command	Remark
Enter system view	system-view	—
Specify the management VLAN	**management-vlan** *vlan-id*	This is to specify the management VLAN on the switch
Enter cluster view	cluster	—
Configure an IP address range for cluster members	**ip-pool** *administrator-ip-address* { *ip-mask* | *ip-mask-length* }	Optional
Configure a cluster with the current switch as the management device	**build** *name*	Optional Argument *name* is the cluster name.
Configure a multicast MAC address for the cluster	**cluster-mac** *H-H-H*	Optional This is to set a multicast MAC address for the cluster.
Set the interval for the management device to send multicast packets	**cluster-mac syn-interval** *time-interval*	Optional Argument *time-interval* is the multicast packet interval.
Configure the valid holdtime for a switch	**holdtime** *seconds*	Optional Argument *seconds* is the valid holdtime, which is 60 seconds by default.
Set the interval of handshake packets	**timer** *interval*	Optional Argument *interval* is the handshake packet interval, which is 10 seconds by default.

Table 661 Configure cluster parameters manually (continued)

Operation	Command	Remark
Configure VLAN check on the management device for the communication inside a cluster	port-tagged management-vlan	Optional
Exit system view	quit	—

Configuring a cluster Automatically

Table 662 Configure a cluster automatically

Operation	Command	Remark
Enter system view	system-view	—
Configure a cluster automatically	**auto-build** [**recover**]	Required This is to set up a cluster based on your instructions.

Configuring Internal-External Interaction

Table 663 Configure internal-external interaction

Operation	Command	Description
Enter system view	system-view	—
Enter cluster view	cluster	Required
Configure an FTP server for the cluster	**ftp-server** *ip-address*	Optional
Configure a TFTP server for the cluster	**tftp-server** *ip-address*	Optional
Configure a log host for the cluster	**logging-host** *ip-address*	Optional
Configure an SNMP host for the cluster	**snmp-host** *ip-address*	Optional

NM Interface for Cluster Management Configuration

Configuration Preparation

- The cluster switches are properly connected.
- The internal server is properly connected with the management switch.

Configuration Procedure

Table 664 Configuration procedure

Step	Command	Description
Enter system view	**system-view**	
Enter cluster view	cluster	Required
Configure the NM interface	**nm-interface Vlan-interface** *vlan_id*	*vlan_id*: VLAN ID
Display information about current configuration	**display current-configuration**	You can execute this command in any view.

Member Device Configuration

Member device configuration involves:

- Enable system and port NDP
- Enable system and port NTDP
- Specifying the cluster FTP/TFTP server

Enabling System and Port NDP

Table 665 Enable system and port NDP

Operation	Command	Remark
Enter system view	system-view	—
Enable system NDP	ndp enable	Required
Enable port NDP	**ndp enable interface** *port-list*	Optional
Enter the Ethernet port	**interface** *interface-type interface-number*	—
Enable port NDP	ndp enable	Required

Enabling System and Port NTDP

Table 666 Enable system and port NTDP

Operation	Command	Remark
Enter system view	system-view	—
Enable system NTDP	ntdp enable	Required
Enter the Ethernet port	**interface** *interface-type interface-number*	—
Enable port NTDP	ntdp enable	Required

Specifying the cluster FTP/TFTP server

Table 667 Enable the cluster FTP/TFTP server

Operation	Command	Description
Establish a connection with the cluster FTP server	ftp cluster	Optional
Download a file from the cluster TFTP server	**tftp cluster get** *source-file [destination-file]*	Optional
Upload a file to the cluster TFTP server	**tftp cluster put** *source-file [destination-file]*	Optional

Configuring Cluster Parameters

Table 668 Configure cluster parameters

Operation	Command	Remark
Enter system view	system-view	—
Enter cluster view	cluster	—
Add a candidate device to a cluster	**add-member** [*member-number*] **mac-address** *H-H-H* [**password** *password*]	This is to add a new member. Arguments *member-number, H-H-H and password* are the ID, MAC address and password of the member device respectively.
Remove a member from the cluster	**delete-member** *member-number*	Optional This is to remove a member from the cluster.
Reset a specified member device	**reboot member** { *member-num* | **mac-address** *H-H-H* } [**eraseflash**]	Optional
Exit cluster view	quit	—
Exit system view	quit	—
Switch between the management device and member devices	**cluster switch-to** { *member-number* | **mac-address** *H-H-H* | **administrator** }	Optional This is to switch to a member device according to the MAC address.

Displaying and Maintaining Cluster Configurations

You can view the configuration information of a cluster with the **display** commands, which can be executed in any view.

Table 669 Display and maintain cluster configurations

Operation	Command	Remark
Display global NDP configuration information including NDP packet interval and hold time	display ndp	Optional The **display** command can be executed in any view.
Display neighbor information collected through port NDP	**display ndp interface** *port-list*	Optional The **display** command can be executed in any view.
Display global NTDP information	display ntdp	Optional The **display** command can be executed in any view.
Display device information collected through NTDP	**display ntdp device-list** [**verbose**]	Optional The **display** command can be executed in any view.
Display state and basic configuration information of a cluster	display cluster	Optional The **display** command can be executed in any view.
Display candidate devices of a cluster	**display cluster candidates** [**mac-address** *H-H-H* | **verbose**]	Optional The **display** command can be executed in any view.
Display cluster member information	**display cluster members** [*member-num* | **verbose**]	Optional The **display** command can be executed in any view.
Clear the NDP statistics on a port	**reset ndp statistics** [**interface** *port-list*]	Optional

Clustering Configuration Example

Network requirements

Three switches form a cluster, in which:

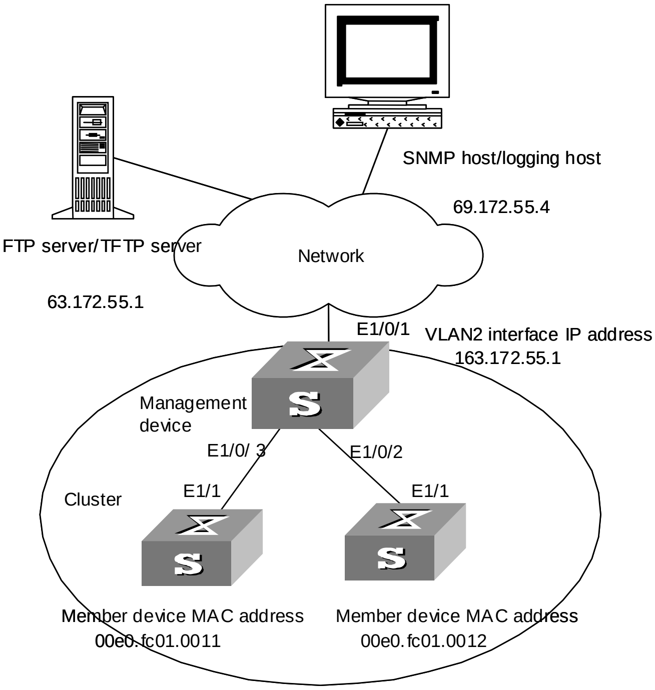
- Switch 5500 acts as the management device.
- Other two switches act as member devices.

As the management device, Switch 5500 manages the member devices and is configured as follows:

- It attaches two member devices through ports Ethernet1/0/2 and Ethernet1/0/3 respectively.
- It connects with the external network through port Ethernet1/0/1.
- Ethernet1/0/1 belongs to VLAN2, whose interface IP address is 163.172.55.1.
- The same FTP server and TFTP server is used through the cluster.
- The IP address of the FTP server and TFTP server is 63.172.55.1.
- The IP address of the SNMP site and logging host is 69.172.55.4.

Network diagram

Cluster Management



Configuration procedure

1 Configure the management device

a Enable system NDP and port NDP on E1/0/2 and E1/0/3.

```
[S5500] ndp enable
[S5500] interface ethernet 1/0/2
[S5500-Ethernet1/0/2] ndp enable
[S5500-Ethernet1/0/2] interface ethernet 1/0/3
[S5500-Ethernet1/0/3] ndp enable
```

b Configure holdtime of NDP information as 200 seconds.

```
[S5500] ndp timer aging 200
```

c Configure interval of NDP packets as 70 seconds.

```
[S5500] ndp timer hello 70
```

d Enable system NTDP and port NTDP on E1/0/2 and E1/0/3.

```
[S5500] ntdp enable
[S5500] interface ethernet 1/0/2
[S5500-Ethernet1/0/2] ntdp enable
[S5500-Ethernet1/0/2] interface ethernet 1/0/3
[S5500-Ethernet1/0/3] ntdp enable
```

e Configure the topology collection range as two hops.

```
[S5500] ntdp hop 2
```

f Configure the time that collected devices wait before forwarding the topology-collection request as 150 ms.

```
[S5500] ntdp timer hop-delay 150
```

g Configure the time that a port waits before it forwards the topology request packet to the next port as 15 ms.

```
[S5500] ntdp timer port-delay 15
```

h Configure the interval of periodic topology information collection as 3 minutes.

```
[S5500] ntdp timer 3
```

i Enable the cluster function.

```
[S5500] cluster enable
```

j Enter cluster view.

```
[S5500] cluster
[S5500-cluster]
```

k Configure an IP address pool for cluster members. The pool contains with eight addresses, starting from 172.16.0.1.

```
[S5500-cluster] ip-pool 172.16.0.1 255.255.255.248
```

l Specify a cluster name to create the cluster.

```
[S5500-cluster] build aaa
[aaa_0.S5500-cluster]
```

m Add the attached two switches into the cluster.

```
[aaa_0.S5500-cluster] add-member 1 mac-address 00e0-fc01-0011
[aaa_0.S5500-cluster] add-member 17 mac-address 00e0-fc01-0012
```

n Configure the valid holdtime of the member devices as 100 seconds.

```
[aaa_0.S5500-cluster] holdtime 100
```

o Set the interval of handshake packets as 10 seconds.

```
[aaa_0.S5500-cluster] timer 10
```

p Configure the public FTP Server, TFTP Server, Logging host and SNMP host for the cluster.

```
[aaa_0.S5500-cluster] ftp-server 63.172.55.1
[aaa_0.S5500-cluster] tftp-server 63.172.55.1
[aaa_0.S5500-cluster] logging-host 69.172.55.4
[aaa_0.S5500-cluster] snmp-host 69.172.55.4
```

2 Configure member devices (take one member as example)

a Enable system NDP and port NDP on port Ethernet1/1.

```
[S5500] ndp enable
[S5500] interface ethernet 1/1
[S5500-Ethernet1/1] ndp enable
```

b Enable system NTDP and port NTDP on port Ethernet1/1.

```
[S5500] ntdp enable
[S5500] interface ethernet 1/1
[S5500-Ethernet1/1] ntdp enable
```

c Enable the cluster function.

```
[S5500] cluster enable
```

3 After adding the two switches to the cluster, perform the following configurations on the member device.

a Establish a connection with the cluster FTP server.

```
<aaa_1.S5500> ftp cluster
```

b Download the file named aaa.txt from the cluster TFTP server.

```
<aaa_1.S5500> tftp cluster get aaa.txt
```

c Upload the file named bbb.txt to the cluster TFTP server.

```
<aaa_1.S5500> tftp cluster put bbb.txt
```

*Upon the completion of the above configurations, you can execute the **cluster switch-to** { member-number | **mac-address** H-H-H } command on the management device to switch to member device view to maintain and manage a member device. You can then execute the **cluster switch-to administrator** command to resume the management device view.*

*You can also reboot a member device by executing the **reboot member** { member-number | **mac-address** H.H.H } [**eraseflash**] command on the management device. For detailed information about these configurations, refer to the preceding description in this chapter.*

After the above configuration, you can check cluster member log and SNMP trap messages through the SNMP host.

NM Interface for Cluster Management Configuration Example

Network requirements

Configure Vlan-interface2 as the NM interface.

Specify VLAN 3 as the management VLAN.

Configure the devices as follows:

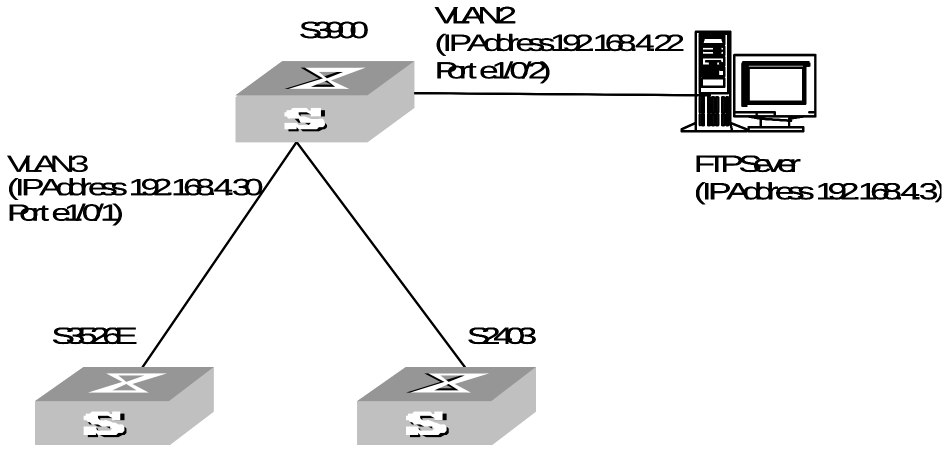
- The IP address of the FTP server is 192.168.4.3.
- Switch 5500 is the management switch.
- S3526E and S2403 are managed switches.

Table 670 Connection of the management switch

VLAN (connect to other switch or a server)	IP address	Connection port
VLAN 3 (S3526E)	192.168.4.30/24	Ethernet 1/0/1
VLAN 2 (FTP Sever)	192.168.4.22/24	Ethernet 1/0/2

Network diagram

Figure 176 Network diagram for the interfaces of cluster management network



Configuration procedure

Configuring the Switch 5500 switch

1 Enter system view. Specify VLAN 3 as the management VLAN.

```
<S5500> system-view
System View: return to User View with Ctrl+Z.
[S5500] management-vlan 3
```

2 Assign port Ethernet 1/0/1 to VLAN 3.

```
[S5500] vlan 3
[S5500-vlan3] port Ethernet 1/0/1
[S5500-vlan3] quit
```

3 Configure the IP address of Vlan-interface3 to 192.168.4.30.

```
[S5500] interface Vlan-interface 3
[S5500-Vlan-interface3] ip address 192.168.4.30 255.255.255.0
[S5500-Vlan-interface3] quit
```

4 Assign port Ethernet 1/0/2 to VLAN 2.

```
[S5500] vlan 2
[S5500-vlan2] port Ethernet 1/0/2
[S5500-vlan2] quit
```

5 Configure the IP address of Vlan-interface2 to 192.168.4.22.

```
[S5500] interface Vlan-interface 2
[S5500-Vlan-interface2] ip address 192.168.4.22 255.255.255.0
[S5500-Vlan-interface2] quit
```

6 Configure Vlan-interface2 as the NM interface.

```
[S5500] cluster
[S5500-cluster] nm-interface Vlan-interface 2
```

33 HWTACACS CONFIGURATION

Configuring HWTACACS

This chapter contains information on HWTACACS configuration.

HWTACACS configuration tasks

Refer to the tasks in Table 671 to configure HWTACACS.

Table 671 HWTACACS configuration

Section	Task	Command	View	Description
Creating a HWTACAS Scheme	Creating a HWTACACS scheme	**hwtacacs scheme**	System	Creating a scheme
Configuring HWTACACS Authentication Servers	Configuring the TACACS authentication server	**primary authentication**	HWTACACS	Configuring the primary authentication server
		secondary authentication	HWTACACS	Configuring the secondary authentication server
	Configuring the TACACS authorization server	**primary authorization**	HWTACACS	Configuring the primary authorization server
		secondary authorization	HWTACACS	Configuring the secondary authorization server
Configuring HWTACACS Accounting Servers and the Related Attributes	Configuring the TACACS accounting server and related features	**primary accounting**	HWTACACS	Configuring the primary accounting server
		secondary accounting	HWTACACS	Configuring the secondary accounting server
		retry stop-accounting	HWTACACS	Enabling stop-accounting packet retransmission and setting the allowed maximum number of transmission attempts
		reset stop-accounting-buffer hwtacacs-scheme	User	Clearing the stop-accounting request packets that have no response
Configuring Source Address for HWTACACS Packets Sent by NAS	Configuring the source address for HWTACACS packets sent from NAS	**nas-ip**	HWTACACS	Optional
		hwtacacs nas-ip	System	Required
Setting a Key for Securing the Communication with TACACS Server	Setting the key of the TACACS server	**key**	HWTACACS	Configuring keys

Table 671 HWTACACS configuration (continued)

Section	Task	Command	View	Description
Setting the Username Format Acceptable to the TACACS Server	Setting the username format for the TACACS server	**user-name-format**	HWTACACS	Configuring the format of user name
Setting the Unit of Data Flows Destined for the TACACS Server	Setting the data flow unit for the TACACS server	**data-flow-format**	HWTACACS	Configuring flow traffic unit
Setting Timers Regarding TACACS Server	Setting the timers of the TACACS server	**timer response-timeout**	HWTACACS	Setting the TACACS server response timeout time
		timer quiet	HWTACACS	Setting the waiting time before the primary TACACS server resumes the active state
		timer realtime-accounting	HWTACACS	Setting the real-time accounting interval

Pay attention to the following when configuring a TACACS server:

- HWTACACS server does not check whether a scheme is being used by users when changing most of HWTACACS attributes, unless you delete the scheme.
- By default, the TACACS server has no key.

In the above configuration tasks, creating HWTACACS scheme and configuring TACACS authentication/authorization server are required; all other tasks are optional and you can determine whether to perform these configurations as needed.

Creating a HWTACAS Scheme

As afore mentioned, HWTACACS protocol is configured scheme by scheme. Therefore, you must create a HWTACACS scheme and enter HWTACACS view before you perform other configuration tasks.

Perform the following configuration in system view.

Table 672 Creating a HWTACACS scheme

Operation	Command
Create a HWTACACS scheme and enter HWTACACS view.	**hwtacacs scheme** *hwtacacs-scheme-name*
Delete a HWTACACS scheme.	**undo hwtacacs scheme** *hwtacacs-scheme-name*

By default, no HWTACACS scheme exists.

If the HWTACACS scheme you specify does not exist, the system creates it and enters HWTACACS view.

The system supports up to 16 HWTACACS schemes. You can only delete the schemes that are not being used.

Configuring HWTACACS Authentication Servers

Perform the following configuration in HWTACACS view.

Table 673 Configuring HWTACACS authentication servers

Operation	Command
Configure the HWTACACS primary authentication server.	**primary authentication** *ip-address* [*port*]
Delete the HWTACACS primary authentication server.	undo primary authentication
Configure the HWTACACS secondary authentication server.	**secondary authentication** *ip-address* [*port*]
Delete the HWTACACS secondary authentication server.	**undo secondary authentication**

The primary and secondary authentication servers cannot use the same IP address. The default port number is 49.

If you execute this command repeatedly, the new settings will replace the old settings.

The authentication server can be deleted only when there is no active TCP connection used for sending authentication packets.

Configuring HWTACACS Accounting Servers and the Related Attributes

Configuring HWTACACS accounting servers

Perform the following configuration in HWTACACS view.

Table 674 Configuring HWTACACS accounting servers

Operation	Command
Configure the primary TACACS accounting server.	**primary accounting** *ip-address* [*port*]
Delete the primary TACACS accounting server.	**undo primary accounting**
Configure the secondary TACACS accounting server.	**secondary accounting** *ip-address* [*port*]
Delete the secondary TACACS accounting server.	**undo secondary accounting**

The primary and secondary accounting servers cannot use the same IP address. The default port number is 49.

If you execute this command repeatedly, the new settings will replace the old settings.

Enabling stop-accounting packet retransmission

Perform the following configuration in the corresponding view.

Table 675 Configuring stop-accounting packet retransmission

Operation	Command
Enable stop-accounting packet retransmission and set the allowed maximum number of transmission attempts (HWTACACS view)	**retry stop-accounting** *retry-times*
Disable stop-accounting packet retransmission (HWTACACS view)	**undo retry stop-accounting**
Clear the stop-accounting request packets that have no response (User view)	**reset stop-accounting-buffer hwtacacs-scheme** *hwtacacs-scheme-name*

By default, stop-accounting packet retransmission is enabled, and the maximum number of transmission attempts is 100.

Configuring Source Address for HWTACACS Packets Sent by NAS

Perform the following configuration in the corresponding view.

Table 676 Configuring source address for HWTACACS packets sent by the NAS

Operation	Command
Configure the source address for HWTACACS packets sent from the NAS (HWTACACS view).	**nas-ip** *ip-address*
Delete the configured source address for HWTACACS packets sent from the NAS (HWTACACS view).	**undo nas-ip**
Configure the source address for HWTACACS packets sent from the NAS (System view).	**hwtacacs nas-ip** *ip-address*
Cancel the configured source address for HWTACACS packets sent from the NAS (System view).	**undo hwtacacs nas-ip**

The HWTACACS view takes precedence over the system view when configuring the source address for HWTACACS packets sent from the NAS.

By default, the source address is not specified, and the interface address for packet sending is used as the source address.

Setting a Key for Securing the Communication with TACACS Server

When using a TACACS server as an AAA server, you can set a key to improve the communication security between the switch and the TACACS server.

Perform the following configuration in HWTACACS view.

Table 677 Setting a key for securing the communication with the HWTACACS server

Operation	Command
Configure a key for securing the communication with the accounting, authorization or authentication server	**key** { **accounting** | **authorization** | **authentication** } *string*
Delete the configuration	**undo key** { **accounting** | **authorization** | **authentication** }

No key is configured by default.

Setting the Username Format Acceptable to the TACACS Server

Username is usually in the “userid@isp-name” format, with the domain name following “@”.

If a TACACS server does not accept the username with domain name, you can remove the domain name and resend it to the TACACS server.

Perform the following configuration in HWTACACS view.

Table 678 Setting the username format acceptable to the TACACS server

Operation	Command
Send username with domain name.	**user-name-format with-domain**
Send username without domain name.	**user-name-format without-domain**

By default, each username sent to a TACACS server contains a domain name.

Setting the Unit of Data Flows Destined for the TACACS Server

Perform the following configuration in HWTACACS view.

Table 679 Setting the unit of data flows destined for the TACACS server

Operation	Command
Set the unit of data flows destined for the TACACS server	**data-flow-format data** { **byte** | **giga-byte** | **kilo-byte** | **mega-byte** }
	data-flow-format packet { **giga-packet** | **kilo-packet** | **mega-packet** | **one-packet** }
Restore the default unit of data flows destined for the TACACS server	**undo data-flow-format** { **data** | **packet** }

The default data flow unit is byte.

Setting Timers Regarding TACACS Server

Setting the response timeout timer

Since HWTACACS is implemented on the basis of TCP, server response timeout or TCP timeout may terminate the connection to the TACACS server.

Perform the following configuration in HWTACACS view.

Setting the response timeout timer

Table 680 Setting the response timeout timer

Operation	Command
Set the response timeout time	**timer response-timeout** *seconds*
Restore the default setting	**undo timer response-timeout**

The default response timeout timer is set to 5 seconds.

Setting the quiet timer for the primary TACACS server

Perform the following configuration in HWTACACS view.

Table 681 Setting the quiet timer for the primary TACACS server

Operation	Command
Set the quiet timer for the primary TACACS server.	**timer quiet** *minutes*
Restore the default setting.	**undo timer quiet**

By default, the primary TACACS server must wait five minutes before it can resume the active state.

Setting a realtime accounting interval

The setting of real-time accounting interval is necessary to real-time accounting. After an interval value is set, the NAS transmits the accounting information of online users to the TACACS accounting server periodically.

Perform the following configuration in HWTACACS view.

Table 682 Setting a real-time accounting interval

Operation	Command
Set a real-time accounting interval	**timer realtime-accounting** *minutes*
Restore the default real-time accounting interval	**undo timer realtime-accounting**

The interval is in minutes and must be a multiple of 3.

The setting of real-time accounting interval somewhat depends on the performance of the NAS and the TACACS server: a shorter interval requires higher device performance. You are therefore recommended to adopt a longer interval when there are a large number of users (more than 1000, inclusive). Table 683 lists the numbers of users and the recommended intervals.

Table 683 Numbers of users and the recommended intervals

Number of users	Real-time accounting interval (minutes)
1–99	3
100–499	6
500–999	12
ƒ1000	ƒ15

The real-time accounting interval defaults to 12 minutes.

Displaying and Debugging HWTACACS Protocol

After the above configuration, execute **display** command in any view to display the running of the AAA and RADIUS/HWTACACS configuration, and to verify the effect of the configuration. Execute **reset** command in user view to reset AAA and RADIUS/HWTACACS statistics, etc . Execute **debugging** command in user view to debug AAA and RADIUS/HWTACACS.

Table 684 Displaying and debugging AAA and RADIUS/HWTACACS protocol

Operation	Command
Display the configuration information of the specified or all the ISP domains.	**display domain** [isp-name]
Display related information of user's connection	**display connection [access-type dot1x | domain** *domain-name* | **interface** *interface-type interface-number* | **ip** *ip-address* | **mac** *mac-address* | **radius-scheme** *radius-scheme-name* | **vlan** *vlanid* | **ucibindex** *ucib-index* | **user-name** *user-name*]
Display related information of the local user	**display local-user** [**domain** *isp-name* | **idle-cut** { **disable** | **enable** } | **service-type** { **telnet** | **ftp** | **lan-access** | **ssh** | **terminal** } | **state** { **active** | **block** } | **user-name** *user-name* | **vlan vlan-id**]
Display the statistics of local RADIUS authentication server	**display local-server statistics**
Display the configuration information of RADIUS schemes	**display radius** [*radius-scheme-name*]
Display the statistics of RADIUS packets	**display radius statistics**
Display the stopping accounting requests saved in buffer without response	**display stop-accounting-buffer** { **radius-scheme** *radius-scheme-name* | **session-id** *session-id* | **time-range** *start-time stop-time* | **user-name** *user-name* }
Display the specified or all the HWTACACS schemes	**display hwtacacs** [*hwtacacs-scheme-name*]
Display information on the stop-accounting packets in the buffer	**display stop-accounting-buffer hwtacacs-scheme** *hwtacacs-scheme-name*
Delete the stopping accounting requests saved in buffer without response	**reset stop-accounting-buffer** { **radius-scheme** *radius-scheme-name* | **session-id** *session-id* | **time-range** *start-time stop-time* | **user-name** *user-name* }
Reset the statistics of RADIUS server	**reset radius statistics**
Clear stop-accounting packets from the buffer	**reset stop-accounting-buffer hwtacacs-scheme** *hwtacacs-scheme-name*

Table 684 Displaying and debugging AAA and RADIUS/HWTACACS protocol (continued)

Operation	Command
Reset the statistics of HWTACACS server	**reset hwtacacs statistics** { **accounting** | **authentication** | **authorization** | **all** }
Enable RADIUS packet debugging	**debugging radius packet**
Disable RADIUS packet debugging	**undo debugging radius packet**
Enable debugging of local RADIUS authentication server	**debugging local-server** { **all** | **error** | **event** | **packet** }
Disable debugging of local RADIUS authentication server	**undo debugging local-server** { **all** | **error** | **event** | **packet** }
Enable HWTACACS debugging	**debugging hwtacacs** { **all** | **error** | **event** | **message** | **receive-packet** | **send-packet** }
Disable HWTACACS debugging	**undo debugging hwtacacs** { **all** | **error** | **event** | **message** | **receive-packet** | **send-packet** }

HWTACACS Protocol Configuration Example

For the hybrid configuration example of AAA/RADIUS protocol and 802.1x protocol, refer to Configuration Example in 802.1x Configuration. It will not be detailed here.

Configuring the FTP/Telnet User Authentication at a Remote TACACS Server

Networking requirements

Configure the switch to use a TACACS server to provide AAA services to login users (see Figure 177).

Connect the switch to one TACACS server (providing the services of authentication and authorization) with the IP address 10.110.91.164. On the switch, set the shared key for AAA packet encryption to “expert”. Configure the switch to send usernames to the TACACS server with *isp-name* removed.

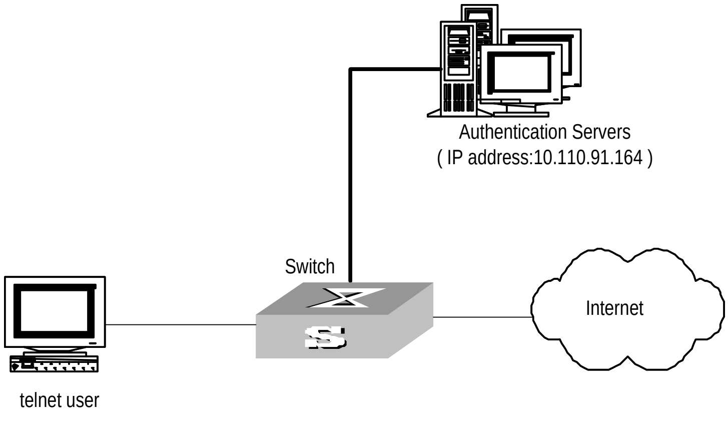
On the TACACS server, set the shared key for encrypting the packets exchanged with the switch to “expert”; add the usernames and passwords of users.

Networking diagram

See Figure 177.

Networking topology

Figure 177 Configuring the remote RADIUS authentication for Telnet users



Configuration procedure

1 Configure a HWTACACS scheme.

```
[S5500] hwtacacs scheme hwtac
[S5500-hwtacacs-hwtac] primary authentication 10.110.91.164 49
[S5500-hwtacacs-hwtac] primary authorization 10.110.91.164 49
[S5500-hwtacacs-hwtac] key authentication expert
[S5500-hwtacacs-hwtac] key authorization expert
[S5500-hwtacacs-hwtac] undo user-name-format with-domain
[S5500-hwtacacs-hwtac] quit
```

2 Associate the domain with the HWTACACS.

```
[S5500] domain hwtacacs
[S5500-isp-hwtacacs] scheme hwtacacs-scheme hwtac
```

A PASSWORD RECOVERY PROCESS

Introduction

The Switch 5500 has two separate password systems:

- Passwords which are used by the Web User Interface and the CLI and are stored in the 3comoscfg.cfg file.

  For more information on this, refer to the Getting Started Guide which accompanies your Switch.
- A password system which protects the bootrom and is stored in the bootrom.

  If the password protecting the bootrom is forgotten or lost, a fixed (unit unique) password can be provided by 3Com Technical Support to bypass the lost password.

  This fixed password recovery mechanism can be disabled within the bootrom menu. However, if the password recovery mechanism is disabled and the user configurable bootrom password is lost, there is no recovery mechanism available. In this instance, the Switch will need to be returned to 3Com for repair.

The following commands are all executed from the Bootrom directly using the console.

CLI Commands Controlling Bootrom Access

Access to the bootrom is enabled by default on your Switch.To disable access enter the following command:

```
<5500-XX>undo startup bootrom-access enable
```

(where **xx** is either SI or EI)

If the bootrom is disabled, *Ctrl-B* is still available during the initial boot phase. The only password that will be accepted at the prompt is the unit unique password. any user configured bootrom password will be inactive.

The following commands enable and display the current bootrom access settings respectively:

```
<5500-xx>startup bootrom-access enable
<5500-xx>display startup
```

Bootrom Interface

During the initial boot phase of the Switch (when directly connected using the console), various messages are displayed and the following prompt is shown with a five second countdown timer:

```
Press Ctrl-B to enter Boot Menu... 4
```

Before the countdown reaches 0 enter <CTRL>B.

The timer is followed by a password prompt. The default is no password.

Press *Enter* to display the following boot menu:

```
        BOOT  MENU

1. Download application file to flash
2. Select application file to boot
3. Display all files in flash
4. Delete file from flash
5. Modify bootrom password
6. Enter bootrom upgrade menu
7. Skip current configuration file
8. Set bootrom password recovery
9. Set switch startup mode
0. Reboot

Enter your choice(0-9):
```

Enter the boot menu number to display that menu option.

Displaying all Files in Flash

Enter boot menu option 3 to display the following:

```
Boot menu choice: 3
File Number      File Size(bytes)     File Name
====================================================
1                714784               s4h03_01_00.zip
2                164                  private-data.txt
3                11043                3ComOScfg.def
4                4                    snmpboots
5*               4529259              s4b03_01_00s168.app
6                11343                3ComOScfg.cfg

Free Space: 10460160 bytes
The current application file is s4b03_01_00s168.app.
```

Table 685 displays the configuration files:

Table 685 Configuration Files

Filename	Description
3comoscfg.def	This file contains the factory default configurations. It is only used if there is no other configuration file present. This file should not be modified.
3comoscfg.cfg	This file contains the live configurations and is always used to load the active configuration into the Switch unless the bootrom `Skip current configuration file` is specified.

Skipping the Current Configuration File

Enter boot menu option 7 to enable the Switch to boot from the factory default configuration file `3comoscfg.def`.

When the Switch has booted from the factory default it can be configured with an IP address and default gateway if needed.

The live configuration file (`3comoscfg.cfg`) can be added to a TFTP server and edited.

Search through the file with a text editor until the following section is found:

```
#
local-user admin
 password cipher ZG6-:\Y>MQGQ=^Q`MAF4<1!!
 service-type telnet terminal
 level 3
local-user manager
 password simple manager
 service-type telnet terminal
 level 2
local-user monitor
 password simple monitor
 service-type telnet terminal
 level 1
#
```

In the `local-user admin` section there is an entry called `password` which is followed by either of the following entries:

- **Simple** - this enables you to read and/or change a password and send the configuration file using TFTP back into the Switch.
- **Cipher** - change this word to **`simple`** and replace the encrypted password with a plain text password and send the configuration file using TFTP back into the Switch.

The `manager` and `monitor` passwords can be modified in the same way.

Bootrom Passwords

The bootrom can be configured with a user defined password. Select Option 5 to display the following:

```
Boot menu choice: 5

Old password:
New password:xxxx
Confirm password:xxxx
Current password has been changed successfully!
```

If the user configured bootrom password is lost, a fixed, unit unique password can be provided by 3Com Technical Support to bypass the lost password.

Please ensure that the Switch is registered with 3Com promptly as the unit unique password will only be supplied to the registered owner of the Switch.

This final password recovery safeguard can be disabled.

Bootrom Password Recovery

Select option 8 to set the bootrom password discovery. The following is displayed:

```
Warning: if disable the bootrom password recovery, the super
password based on switch mac address is invalid!
The current mode is enable bootrom password recovery.
Are you sure to disable bootrom password recovery? Yes or No(Y/N)
```

This option allows the user to disable the fixed, unit unique password recovery mechanism. If this is disabled and the bootrom password recovery is lost then a recovery will not be possible. In this instance, the Switch will need to be returned to 3Com for repair.

B RADIUS SERVER AND RADIUS CLIENT SETUP

This appendix covers the following topics:

- Setting Up A RADIUS Server
- Setting Up the RADIUS Client

Setting Up A RADIUS Server

There are many third party applications available to configure a RADIUS server. 3Com has successfully installed and tested the following applications on networks with the Switch 5500.

For Windows servers:

- Microsoft IAS RADIUS (creates a standard RADIUS server)
- Funk RADIUS (creates an enhanced RADIUS server)

For Solaris and Linux servers:

- FreeRADIUS

The remainder of this section describes how to setup a RADIUS server using these products.

Microsoft IAS RADIUS, Funk RADIUS and FreeRADIUS are not 3Com products and are not supported by 3Com.

Configuring Microsoft IAS RADIUS

3Com has successfully installed and tested Microsoft IAS RADIUS running on a Windows server in a network with Switch 5500 deployed.

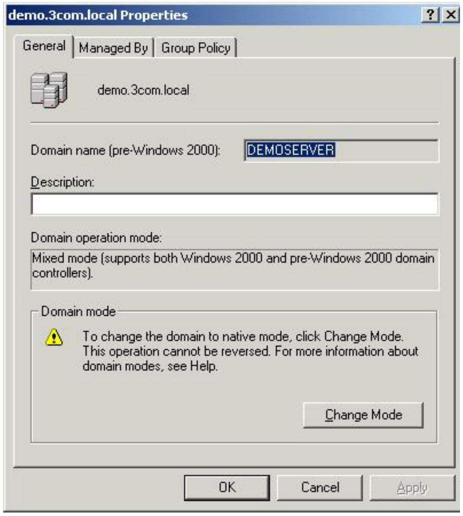
The following steps are required to setup a RADIUS server using the Microsoft IAS RADIUS application. You will need to use the Install CD for Microsoft Windows 2000 Server to complete the process.

1 Install Windows 2000 Server (Vanilla Install) on a Windows PC, with the latest available patches from **`http://windowsupdate.microsoft.com`**.

2 Configure the server as a Domain Name Server (DNS) by running **`dcpromo`**

a For example, create the domain **`demo.3com.local`** and enable it as a DNS server for the network.

b The server will need to run in Native mode in order to support EAP-TLS which is not available in Mixed mode. To change mode go to the *Active Directory Users and Computers* window, right-click *Domain* and choose *Properties*, select *Change Mode*.



demo.3com.local Properties

General | Managed By | Group Policy

demo.3com.local

Domain name (pre-Windows 2000): DEMOSERVER

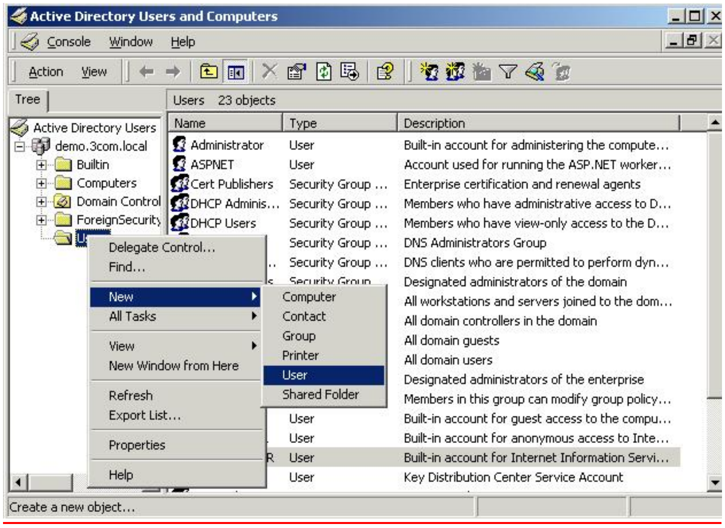
Description:

Domain operation mode:
Mixed mode (supports both Windows 2000 and pre-Windows 2000 domain controllers).

Domain mode

To change the domain to native mode, click Change Mode. This operation cannot be reversed. For more information about domain modes, see Help.

c Add a user that is allowed to use the network. Go to *Active Directory Users and Computers,* from the left hand window right-click the *Users* folder and choose *New* > *User*, as shown below.

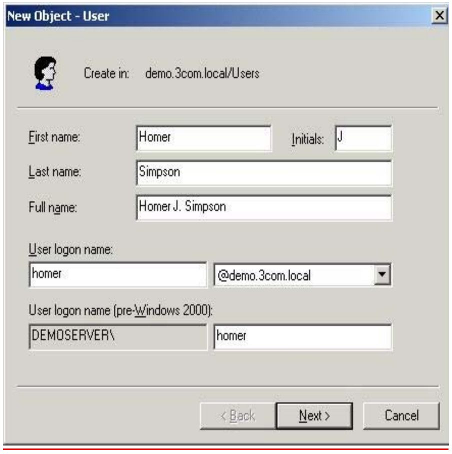


Users 23 objects

Name	Type	Description
Administrator	User	Built-in account for administering the compute…
ASPNET	User	Account used for running the ASP.NET worker…
Cert Publishers	Security Group …	Enterprise certification and renewal agents
DHCP Adminis…	Security Group …	Members who have administrative access to D…
DHCP Users	Security Group …	Members who have view-only access to the D…
	Security Group …	DNS Administrators Group
..	Security Group …	DNS clients who are permitted to perform dyn…
s	Security Group	Designated administrators of the domain
		All workstations and servers joined to the dom…
		All domain controllers in the domain
		All domain guests
		All domain users
		Designated administrators of the enterprise
		Members in this group can modify group policy…
	User	Built-in account for guest access to the compu…
	User	Built-in account for anonymous access to Inte…
R	User	Built-in account for Internet Information Servi…
	User	Key Distribution Center Service Account

Create a new object…

d Follow the wizard to create a user, enter the required information at each stage



New Object - User

Create in: demo.3com.local/Users

First name: Homer Initials: J

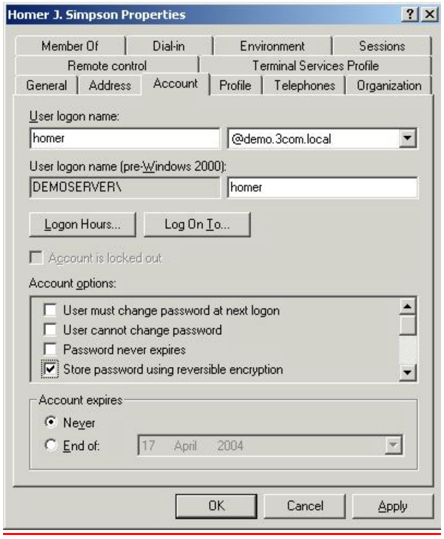
Last name: Simpson

Full name: Homer J. Simpson

User logon name: homer @demo.3com.local

User logon name (pre-Windows 2000): DEMOSERVER\ homer

e The password for the user must be set to be stored in reversible encryption. Right-click the user account and select *Properties*. Select the *Account* tab, check the box labelled *Store password using reversible encryption*.



Homer J. Simpson Properties

User logon name: homer @demo.3com.local

User logon name (pre-Windows 2000): DEMOSERVER\ homer

□ Account is locked out

Account options:

□ User must change password at next logon

□ User cannot change password

□ Password never expires

☑ Store password using reversible encryption

Account expires

● Never

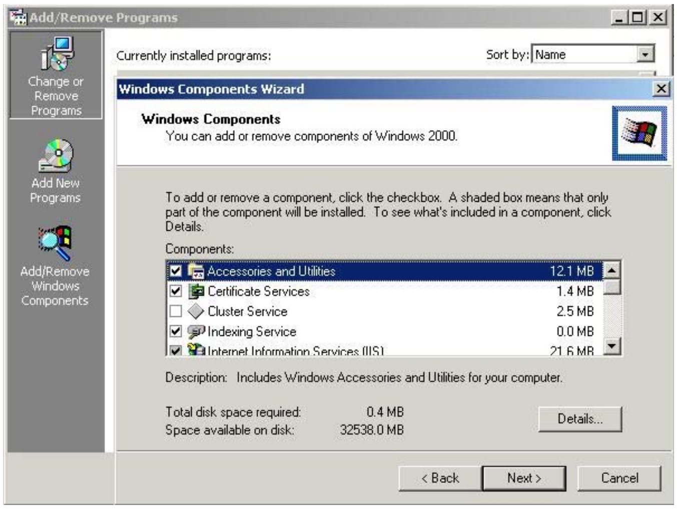
○ End of: 17 April 2004

f Now re-enter the password for the account, right-click the user account and select *Reset Password…*

3 Enable the server as a certificate server. To use EAP-TLS certificate based authentication, you need to enable the Certificate services in windows.

Make sure you have completed step 2 and created the DNS server, before enabling Certificate services. You will not be able to create the DNS server after certification has been enabled.

a Go to *Control Panel* > *Add/Remove Programs* > *Add/Remove Windows Components*. The *Certificate Services* component should be checked.


Add/Remove Programs
Change or Remove Programs
Add New Programs
Add/Remove Windows Components
Windows Components Wizard
< Back
Next >
Cancel
Details...

Currently installed programs: Sort by: Name

Windows Components

You can add or remove components of Windows 2000.

To add or remove a component, click the checkbox. A shaded box means that only part of the component will be installed. To see what's included in a component, click Details.

Components:

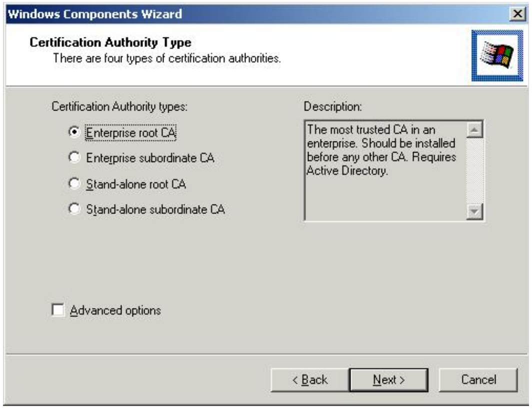
☑	Accessories and Utilities	12.1 MB
☑	Certificate Services	1.4 MB
□	Cluster Service	2.5 MB
☑	Indexing Service	0.0 MB
☑	Internet Information Services (IIS)	21.6 MB

Description: Includes Windows Accessories and Utilities for your computer.

Total disk space required: 0.4 MB
Space available on disk: 32538.0 MB

b Select *Next* and continue through the wizard.

In the *Certificate Authority Type* window select *Enterprise root CA*



Certification Authority Type

There are four types of certification authorities.

Certification Authority types:

● Enterprise root CA
○ Enterprise subordinate CA
○ Stand-alone root CA
○ Stand-alone subordinate CA

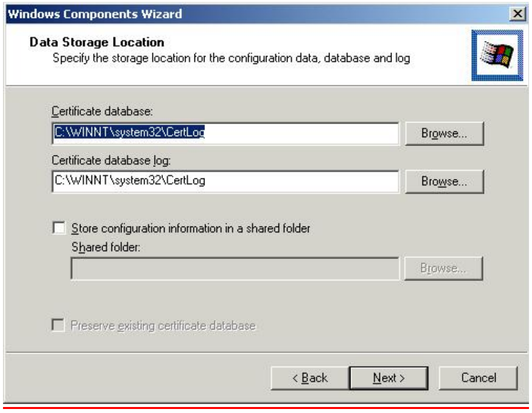
Description:

The most trusted CA in an enterprise. Should be installed before any other CA. Requires Active Directory.

□ Advanced options

Enter information to identify the Certificate Authority on the *CA Identifying Information* window.

Enter the storage location on the *Data Storage Location* window.



Data Storage Location

Specify the storage location for the configuration data, database and log

Certificate database: C:\WINNT\system32\CertLog

Certificate database log: C:\WINNT\system32\CertLog

□ Store configuration information in a shared folder

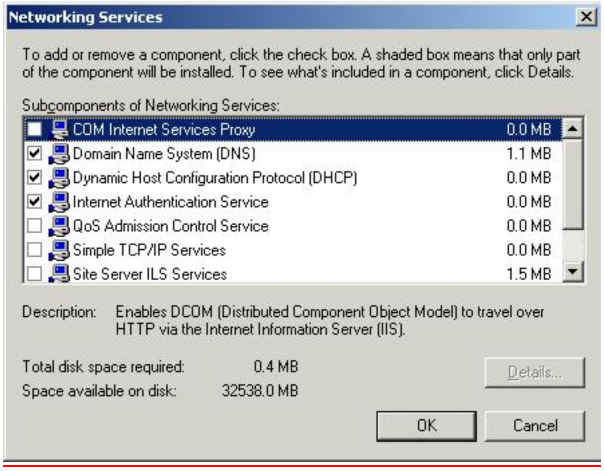
Shared folder:

□ Preserve existing certificate database

To complete the installation and set up of the certificates server, the wizard will require the Install CD for Microsoft Windows 2000 Server.

4 Install the Internet Authentication Service (IAS) program.

a Go to *Control Panel > Add/Remove Programs > Add/Remove Windows Components.* Enable *Networking Services* and ensure *Internet Authentication Service* component is checked.



Networking Services

To add or remove a component, click the check box. A shaded box means that only part of the component will be installed. To see what's included in a component, click Details.

Subcomponents of Networking Services:

☐	COM Internet Services Proxy	0.0 MB
☑	Domain Name System (DNS)	1.1 MB
☑	Dynamic Host Configuration Protocol (DHCP)	0.0 MB
☑	Internet Authentication Service	0.0 MB
☐	QoS Admission Control Service	0.0 MB
☐	Simple TCP/IP Services	0.0 MB
☐	Site Server ILS Services	1.5 MB

Description: Enables DCOM (Distributed Component Object Model) to travel over HTTP via the Internet Information Server (IIS).

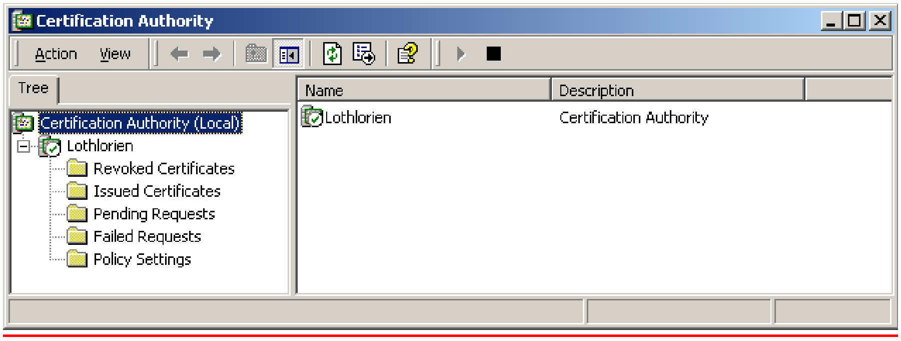
Total disk space required: 0.4 MB

Space available on disk: 32538.0 MB

b Select *OK* to end the wizard.

5 Configure a Certificate Authority

a Go to *Programs > Administrative Tools > Certification Authority* and right-click *Policy Settings* under your Certificate Authority server.



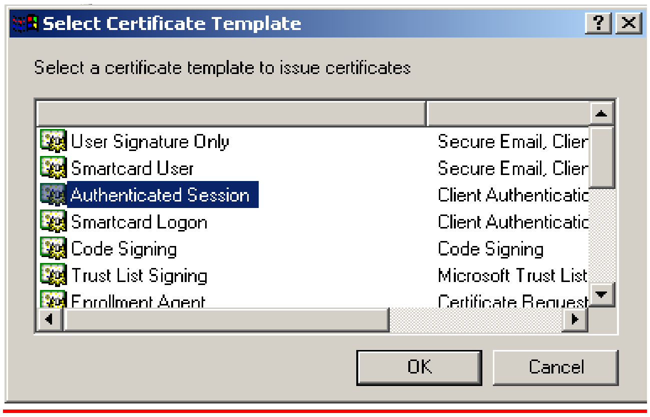
Certification Authority

Certification Authority (Local)
- Lothlorien
  - Revoked Certificates
  - Issued Certificates
  - Pending Requests
  - Failed Requests
  - Policy Settings

Name	Description
Lothlorien	Certification Authority

b Select *New > Certificate to Issue*

c Select *Authenticated Session* and select *OK*.

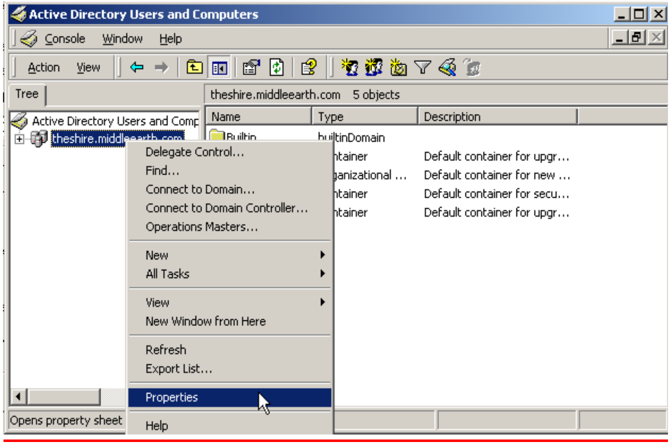


Select Certificate Template

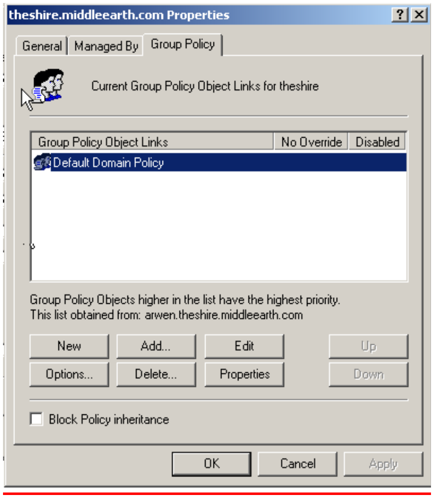
Select a certificate template to issue certificates

User Signature Only	Secure Email, Clier
Smartcard User	Secure Email, Clier
Authenticated Session	Client Authenticatic
Smartcard Logon	Client Authenticatic
Code Signing	Code Signing
Trust List Signing	Microsoft Trust List
Enrollment Agent	Certificate Request

d Go to *Programs > Administrative Tools > Active Directory Users and Computers* and right-click your active directory domain. Select *Properties*


Active Directory Users and Computers
Console Window Help
Action View
Tree
Active Directory Users and Comp
theshire.middleearth.com
theshire.middleearth.com 5 objects
Name Type Description
Builtin builtinDomain
ntainer Default container for upgr...
ganizational ... Default container for new ...
ntainer Default container for secu...
ntainer Default container for upgr...
Delegate Control...
Find...
Connect to Domain...
Connect to Domain Controller...
Operations Masters...
New
All Tasks
View
New Window from Here
Refresh
Export List...
Properties
Help
Opens property sheet

e Select the *Group Policy* tab, and ensure that the *Default Domain Policy* is highlighted. Click *Edit* to launch the Group Policy editor.



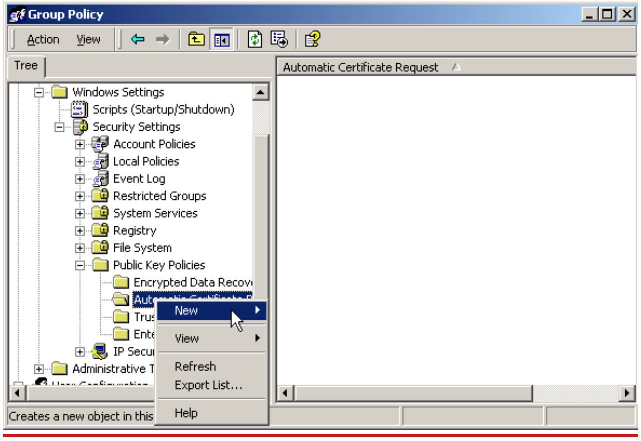
Current Group Policy Object Links for theshire

Group Policy Object Links	No Override	Disabled
Default Domain Policy		

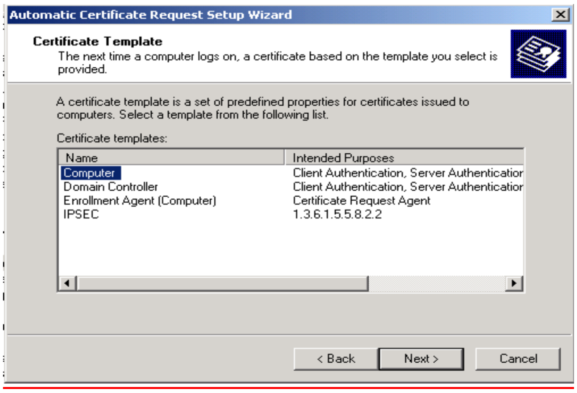
Group Policy Objects higher in the list have the highest priority.
This list obtained from: arwen.theshire.middleearth.com

□ Block Policy inheritance

f Go to *Computer Configuration > Windows Settings > Security Settings > Public Key Policies,* and right-click *Automatic Certificate Request Settings*. Select *New > Automatic Certificate Request.*



g The Certificate Request Wizard will start. Select *Next* > *Computer certificate template* and click *Next*.



Certificate Template

The next time a computer logs on, a certificate based on the template you select is provided.

A certificate template is a set of predefined properties for certificates issued to computers. Select a template from the following list.

Certificate templates:

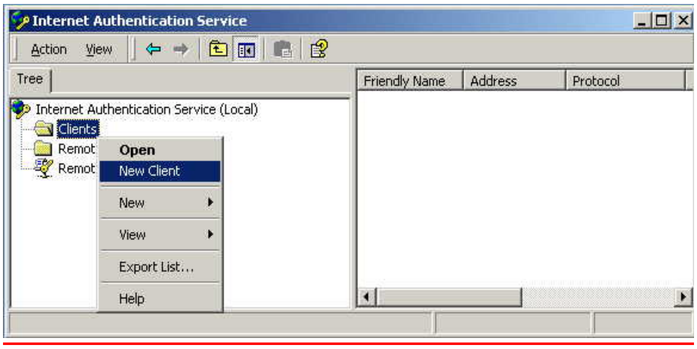
Name	Intended Purposes
Computer	Client Authentication, Server Authenticatior
Domain Controller	Client Authentication, Server Authenticatior
Enrollment Agent (Computer)	Certificate Request Agent
IPSEC	1.3.6.1.5.5.8.2.2

h Ensure that your *Certificate Authority* is checked, then click *Next*. Review the *Policy Change Information* and click *Finish*.

i Open up a command prompt (*Start* > *Run*, enter **`cmd`**). Enter **`secedit /refreshpolicy machine_policy`**. The command may take a few minutes to take effect.

6 Setup the Internet Authentication Service (IAS) RADIUS Server

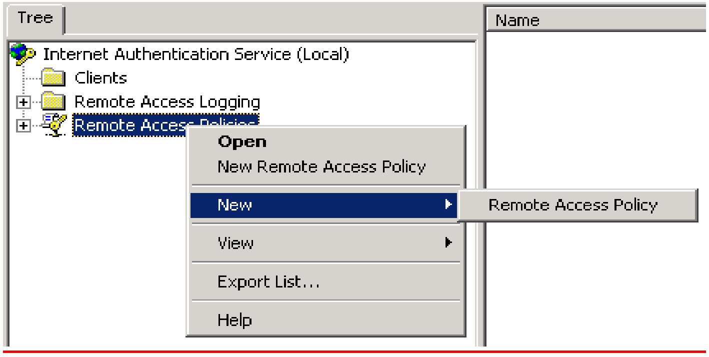
a Go to *Programs* > *Administrative Tools* > *Internet Authentication Service*, right-click *Clients*, and *Select New Client*.



b Enter a name for your device that supports IEEE 802.1x. Click *Next.*

c Enter the IP address of your device that supports IEEE 802.1x, and set a shared secret. Select *Finish*. Leave all the other settings as default.

d Right-click *Remote Access Policies*, and select *New Remote Access Policy.*

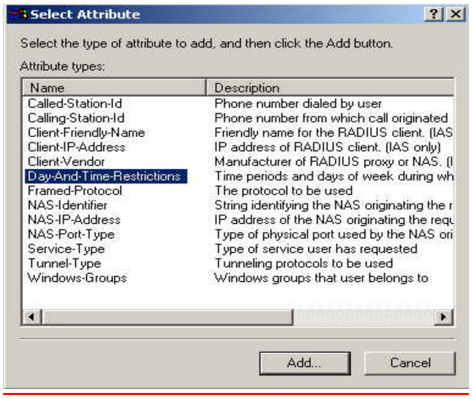


e Give the policy a name, for example EAP-TLS, and select *Next*.

f Click *Add...*

g Set the conditions for using the policy to access the network.

Select *Day-And-Time-Restrictions,* and click *Add...*



Select the type of attribute to add, and then click the Add button.

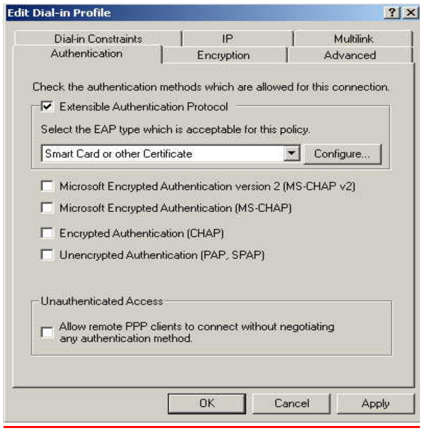
Attribute types:

Name	Description
Called-Station-Id	Phone number dialed by user
Calling-Station-Id	Phone number from which call originated
Client-Friendly-Name	Friendly name for the RADIUS client. (IAS
Client-IP-Address	IP address of RADIUS client. (IAS only)
Client-Vendor	Manufacturer of RADIUS proxy or NAS. (I
Day-And-Time-Restrictions	Time periods and days of week during wh
Framed-Protocol	The protocol to be used
NAS-Identifier	String identifying the NAS originating the r
NAS-IP-Address	IP address of the NAS originating the requ
NAS-Port-Type	Type of physical port used by the NAS ori
Service-Type	Type of service user has requested
Tunnel-Type	Tunneling protocols to be used
Windows-Groups	Windows groups that user belongs to

Click *Permitted*, then *OK.* Select *Next*.

h Select *Grant remote access permission*, and select *Next*

i Click on *Edit Profile...* and select the *Authentication* tab. Ensure *Extensible Authentication Protocol* is selected, and *Smart Card or other Certificate* is set. Deselect any other authentication methods listed. Click *OK*.



Check the authentication methods which are allowed for this connection.

☑ Extensible Authentication Protocol

Select the EAP type which is acceptable for this policy.

Smart Card or other Certificate

☐ Microsoft Encrypted Authentication version 2 (MS-CHAP v2)

☐ Microsoft Encrypted Authentication (MS-CHAP)

☐ Encrypted Authentication (CHAP)

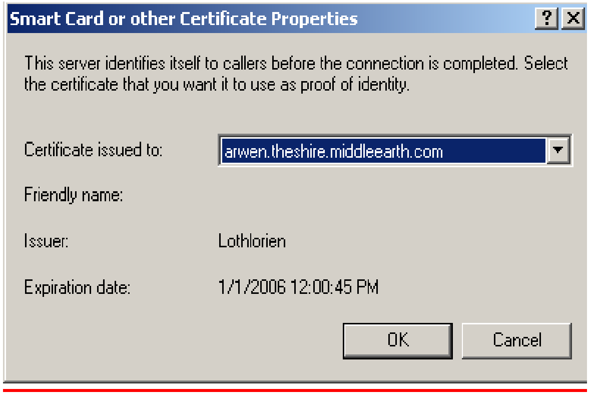
☐ Unencrypted Authentication (PAP, SPAP)

Unauthenticated Access

☐ Allow remote PPP clients to connect without negotiating any authentication method.

j Click the *Configure* button next to the *EAP type selector.*

k Select the appropriate certificate and click *OK*. There should be at least one certificate. This is the certificate that has been created during the installation of the Certification Authority Service.



Smart Card or other Certificate Properties

This server identifies itself to callers before the connection is completed. Select the certificate that you want it to use as proof of identity.

Certificate issued to: arwen.theshire.middleearth.com

Friendly name:

Issuer: Lothlorien

Expiration date: 1/1/2006 12:00:45 PM

Windows may ask if you wish to view the Help topic for EAP. Select No if you want to continue with the installation.

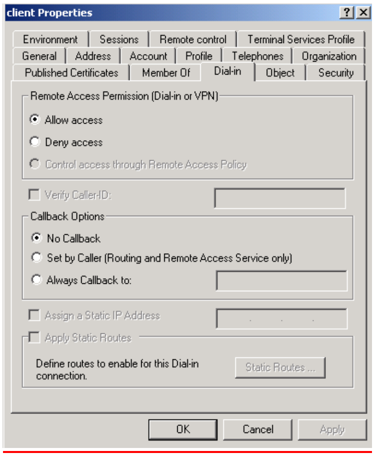
l Click *Finish*.

IFor EAP-TLS to work correctly, it is important that there is only one policy configured in IAS.

7 Enable Remote Access Login for Users.

a Select *Programs* > *Administrative Tools* > *Active Directory Users and Computers*. Double-click the user account for which you want to enable authentication.

b Select the *Dial-in* tab from the client *Properties* window. Select *Allow access*. Click *OK*.



client Properties

Remote Access Permission (Dial-in or VPN)

● Allow access

○ Deny access

○ Control access through Remote Access Policy

□ Verify Caller-ID:

Callback Options

● No Callback

○ Set by Caller (Routing and Remote Access Service only)

○ Always Callback to:

□ Assign a Static IP Address

□ Apply Static Routes

Define routes to enable for this Dial-in connection.

c Click *OK* to confirm.

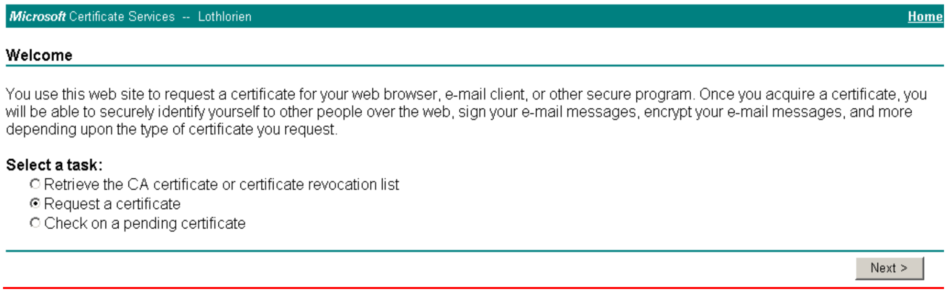
8 Configure the Switch 5500 for RADUIS access and client authentication see Chapter 21 “802.1x Configuration”.

9 Generate a certificate by requesting a certificate from the Certification Authority. The certificate is used to authorize the RADIUS client with the RADIUS Server.

a On the RADIUS server, open *Internet Explorer* and enter the URL **`http://localhost/certsrv`**

b When you are prompted for a login, enter the user account name and password that you will be using for the certificate.

c Select *Request a certificate* and click *Next >*



Microsoft Certificate Services -- Lothlorien

Home

Welcome

You use this web site to request a certificate for your web browser, e-mail client, or other secure program. Once you acquire a certificate, you will be able to securely identify yourself to other people over the web, sign your e-mail messages, encrypt your e-mail messages, and more depending upon the type of certificate you request.

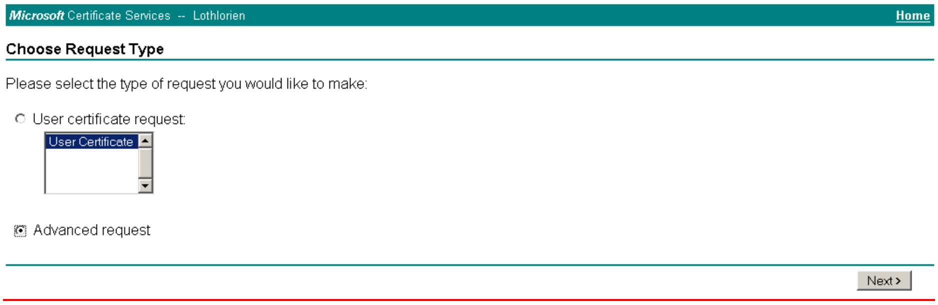
Select a task:

○ Retrieve the CA certificate or certificate revocation list
● Request a certificate
○ Check on a pending certificate

There are two ways to request a certificate: the Advanced Request or the Standard Request. The following steps show an Advanced Request.

The Standard Request differs in the way the certificate is stored on the local computer, it allows you to install the certificate on your computer directly after it is generated and does not require the complex configuration of the Advanced Request. You will, however, still need to map the certificate to the username in the Active Directory Services for the Standard Request, see step u.

d Select *Advanced request* and click *Next >*



Microsoft Certificate Services -- Lothlorien

Home

Choose Request Type

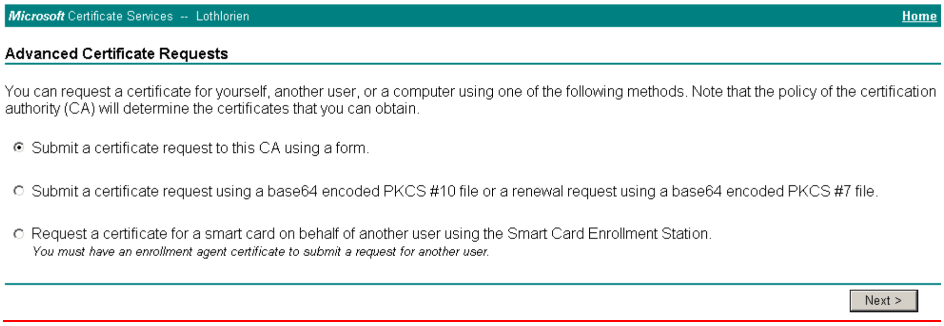
Please select the type of request you would like to make:

○ User certificate request:

User Certificate

● Advanced request

e Select the first option and click *Next >*



Microsoft Certificate Services -- Lothlorien

Home

Advanced Certificate Requests

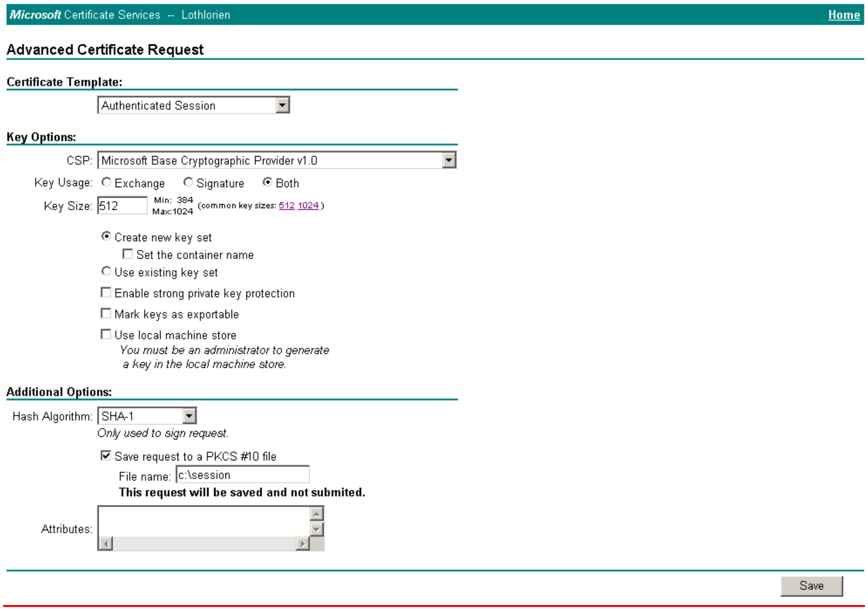
You can request a certificate for yourself, another user, or a computer using one of the following methods. Note that the policy of the certification authority (CA) will determine the certificates that you can obtain.

● Submit a certificate request to this CA using a form.

○ Submit a certificate request using a base64 encoded PKCS #10 file or a renewal request using a base64 encoded PKCS #7 file.

○ Request a certificate for a smart card on behalf of another user using the Smart Card Enrollment Station.
You must have an enrollment agent certificate to submit a request for another user.

f Either copy the settings from the screenshot below or choose different key options. Click *Save* to save the PKCS #10 file.



Microsoft Certificate Services -- Lothlorien

Advanced Certificate Request

Certificate Template:

Authenticated Session

Key Options:

CSP: Microsoft Base Cryptographic Provider v1.0

Key Usage: ○ Exchange ○ Signature ● Both

Key Size: 512 Min: 384 Max:1024 (common key sizes: 512 1024)

● Create new key set

□ Set the container name

○ Use existing key set

□ Enable strong private key protection

□ Mark keys as exportable

□ Use local machine store

You must be an administrator to generate a key in the local machine store.

Additional Options:

Hash Algorithm: SHA-1

Only used to sign request.

☑ Save request to a PKCS #10 file

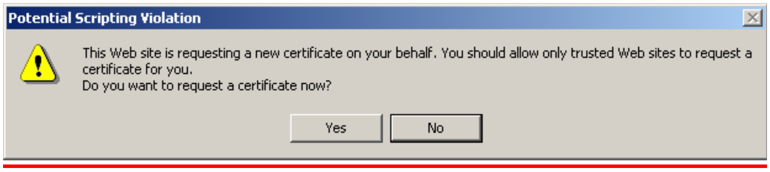
File name: c:\session

This request will be saved and not submited.

Attributes:

The PKCS #10 file is used to generate a certificate.

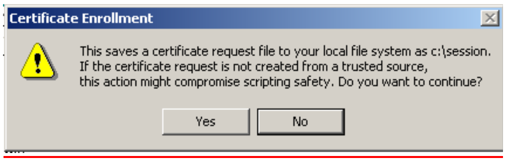
g You will receive this warning messages, select *Yes*



Potential Scripting Violation

This Web site is requesting a new certificate on your behalf. You should allow only trusted Web sites to request a certificate for you.
Do you want to request a certificate now?

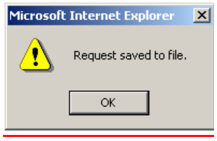
followed by this warning message, select *Yes*



Certificate Enrollment

This saves a certificate request file to your local file system as c:\session.
If the certificate request is not created from a trusted source,
this action might compromise scripting safety. Do you want to continue?

and then *OK*

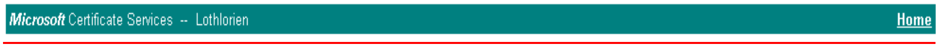


Microsoft Internet Explorer

Request saved to file.

The PKCS #10 file is now saved to the local drive.

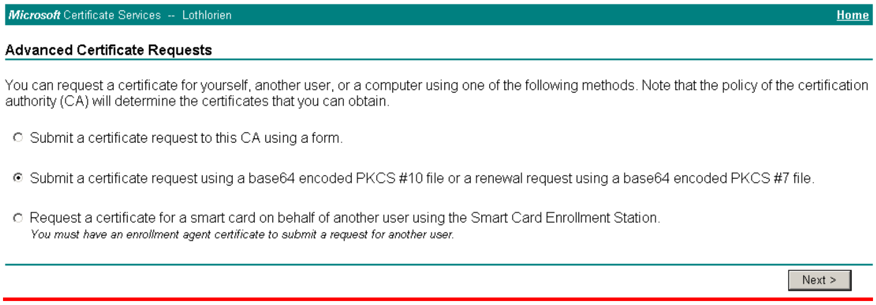
h To generate a portable certificate using PKCS #10, click the *Home* hyperlink at the top right of the CA Webpage.



Microsoft Certificate Services -- Lothlorien

i Select *Request a certificate* > *Next* > *Advanced request* > *Next*

j Select the second option as shown in the screenshot below, and click *Next >*



Advanced Certificate Requests

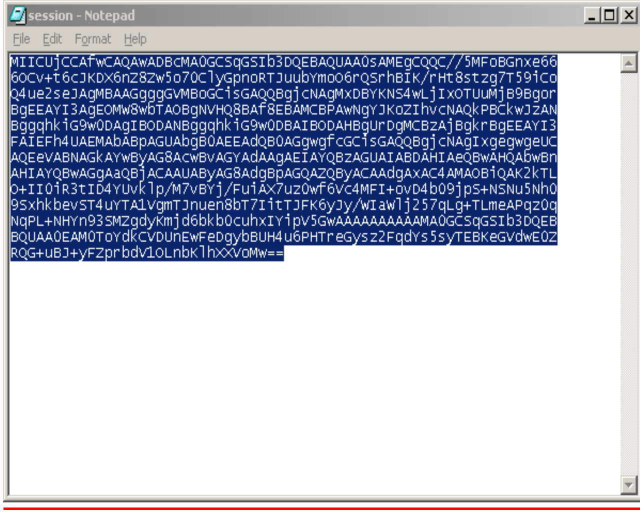
You can request a certificate for yourself, another user, or a computer using one of the following methods. Note that the policy of the certification authority (CA) will determine the certificates that you can obtain.

○ Submit a certificate request to this CA using a form.

● Submit a certificate request using a base64 encoded PKCS #10 file or a renewal request using a base64 encoded PKCS #7 file.

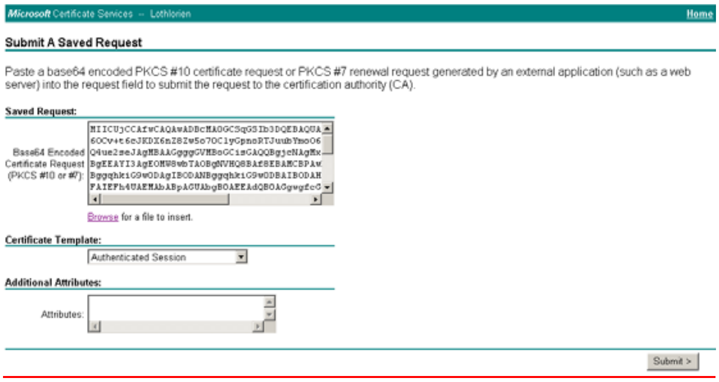
○ Request a certificate for a smart card on behalf of another user using the Smart Card Enrollment Station.
You must have an enrollment agent certificate to submit a request for another user.

k Open the previously saved PKCS #10 certificate file in Notepad, select all (Control + a) and copy (Control + c), as shown below



```
MIICUjCCAfwCAQAwADBcMA0GCSqGSIb3DQEBAQUAA0sAMEgCQQC//5MFoBGnxe66
6OCv+t6cJKDX6nZ8Zw5o70ClyGpnoRTJuubYmoO6rQSrhBIK/rHt8stzg7T59iCo
Q4ue2seJAgMBAAGgggGVMBoGCisGAQQBgjcNAgMxDBYKNS4wLjIxOTUuMjB9Bgor
BgEEAYI3AgEOMW8wbTAOBgNVHQ8BAf8EBAMCBPAwNgYJKoZIhvcNAQkPBCkwJzAN
BggqhkiG9w0DAgIBODANBggqhkiG9w0DBAIBODAHBgUrDgMCBzAjBgkrBgEEAYI3
FAIEFh4UAEMAbABpAGUAbgB0AEEAdQB0AGgwgfcGCisGAQQBgjcNAgIxgegwgeUC
AQEeVABNAGkAYwByAG8AcwBvAGYAdAAgAEIAYQBzAGUAIABDAHIAeQBwAHQAbwBn
AHIAYQBwAGgAaQBjACAAUAByAG8AdgBpAGQAZQByACAAdgAxAC4AMAOBiQAK2kTL
O+II0iR3tID4YUvklp/M7vBYj/FuiAX7uz0wf6Vc4MFI+ovD4b09jpS+NSNu5Nh0
9SxhkbevST4uYTA1VgmTJnuen8bT7IitTJFK6yJy/wIaWlj257qLg+TLmeAPqz0q
NqPL+NHYn93SMZgdyKmjd6bkb0cuhxIYipV5GwAAAAAAAAAAMA0GCSqGSIb3DQEB
BQUAA0EAM0ToYdkCVDUnEwFeDgybBUH4u6PHTreGysz2FqdYs5syTEBKeGVdwE0Z
RQG+uBJ+yFZprbdV1oLnbKlhXXVoMw==
```

l Paste the copied information into the *Saved Request* field as shown below. Select *Authenticated Session* from the *Certificate Template* selector and click *Submit >*



Submit A Saved Request

Paste a base64 encoded PKCS #10 certificate request or PKCS #7 renewal request generated by an external application (such as a web server) into the request field to submit the request to the certification authority (CA).

Saved Request:

Base64 Encoded Certificate Request (PKCS #10 or #7):

```
MIICUjCCAfwCAQAwADBcMA0GCSqGSIb3DQEBAQUA
6OCv+t6cJKDX6nZ8Zw5o70ClyGpnoRTJuubYmoO6
Q4ue2seJAgMBAAGgggGVMBoGCisGAQQBgjcNAgMx
BgEEAYI3AgEOMW8wbTAOBgNVHQ8BAf8EBAMCBPAw
BggqhkiG9w0DAgIBODANBggqhkiG9w0DBAIBODAH
FAIEFh4UAEMAbABpAGUAbgB0AEEAdQB0AGgwgfcG
```

Browse for a file to insert.

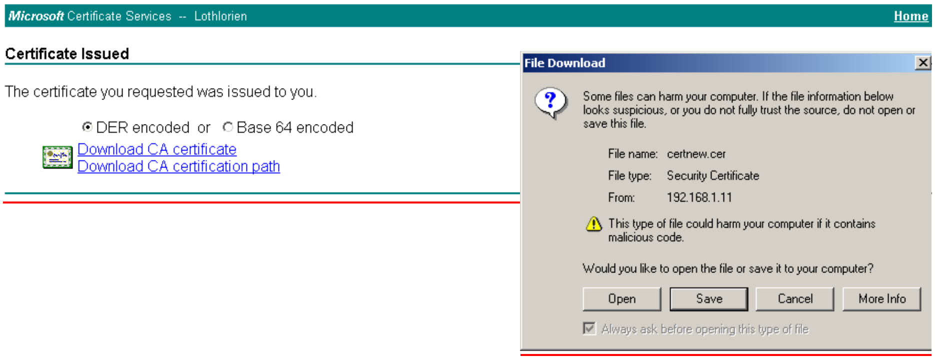
Certificate Template:

Authenticated Session

Additional Attributes:

Attributes:

m Download the certificate and certification path. Click on the *Download CA Certificate* hyperlink to save the certificate. Save the file as DER encoded.



Microsoft Certificate Services -- Lothlorien

Certificate Issued

The certificate you requested was issued to you.

● DER encoded or ○ Base 64 encoded

Download CA certificate
Download CA certification path

File Download

Some files can harm your computer. If the file information below looks suspicious, or you do not fully trust the source, do not open or save this file.

File name: certnew.cer
File type: Security Certificate
From: 192.168.1.11

This type of file could harm your computer if it contains malicious code.

Would you like to open the file or save it to your computer?

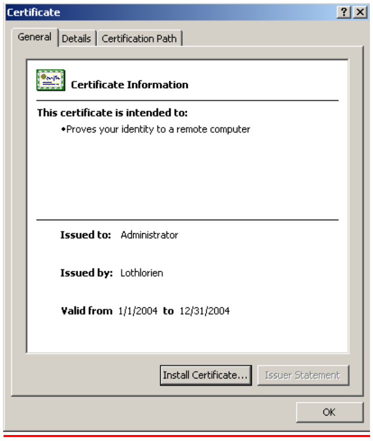
☑ Always ask before opening this type of file

Click on the *Download CA certification path* hyperlink to save the PKCS #7, and select *Save*

The certificate is also installed on the Certification Authority. You can verify this in the CA Administration tool under Issued Certificates

The PKCS #7 file is not actually required for IEEE 802.1x functionality.

n Install both PKCS #10 and PKCS #7 files on the workstation that requires IEEE 802.1x Network Login. On the workstation, double-click the certificate file (extension is .cer)



Certificate

Certificate Information

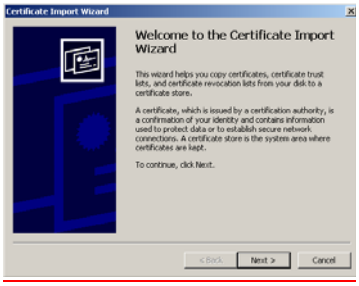
This certificate is intended to:
•Proves your identity to a remote computer

Issued to: Administrator

Issued by: Lothlorien

Valid from 1/1/2004 **to** 12/31/2004

o Click *Install Certificate* to launch the certificate import wizard



Certificate Import Wizard

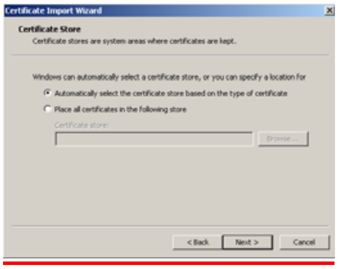
Welcome to the Certificate Import Wizard

This wizard helps you copy certificates, certificate trust lists, and certificate revocation lists from your disk to a certificate store.

A certificate, which is issued by a certification authority, is a confirmation of your identity and contains information used to protect data or to establish secure network connections. A certificate store is the system area where certificates are kept.

To continue, click Next.

p Leave the settings on the next screen as is, click *Next >* followed by *Finish* and *OK*. This will install the certificate,



Certificate Import Wizard

Certificate Store

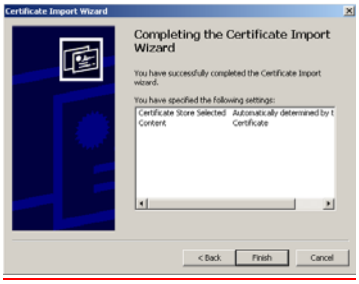
Certificate stores are system areas where certificates are kept.

Windows can automatically select a certificate store, or you can specify a location for

● Automatically select the certificate store based on the type of certificate

○ Place all certificates in the following store

Certificate store:



Certificate Import Wizard

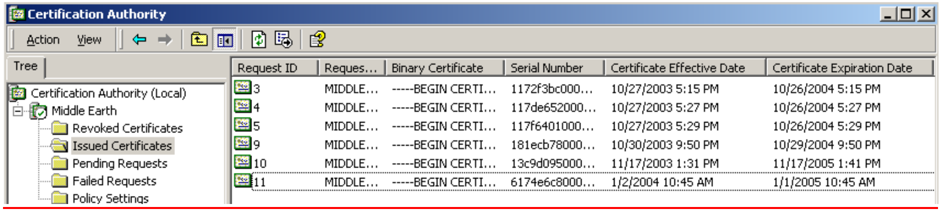
Completing the Certificate Import Wizard

You have successfully completed the Certificate Import wizard.

You have specified the following settings:

Certificate Store Selected	Automatically determined by t
Content	Certificate

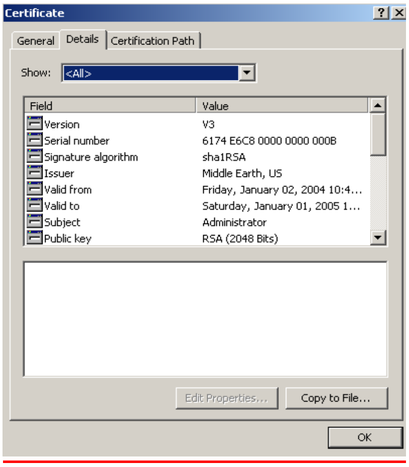
q Launch the *Certification Authority* management tool on the server and expand the *Issued Certificates* folder. You should see the newly created certificate.



Certification Authority

Request ID	Reques...	Binary Certificate	Serial Number	Certificate Effective Date	Certificate Expiration Date
3	MIDDLE...	-----BEGIN CERTI...	1172f3bc000...	10/27/2003 5:15 PM	10/26/2004 5:15 PM
4	MIDDLE...	-----BEGIN CERTI...	117de652000...	10/27/2003 5:27 PM	10/26/2004 5:27 PM
5	MIDDLE...	-----BEGIN CERTI...	117f6401000...	10/27/2003 5:29 PM	10/26/2004 5:29 PM
9	MIDDLE...	-----BEGIN CERTI...	181ecb78000...	10/30/2003 9:50 PM	10/29/2004 9:50 PM
10	MIDDLE...	-----BEGIN CERTI...	13c9d095000...	11/17/2003 1:31 PM	11/17/2005 1:41 PM
11	MIDDLE...	-----BEGIN CERTI...	6174e6c8000...	1/2/2004 10:45 AM	1/1/2005 10:45 AM

r Double-click the certificate that was generated by the client and select the *Details* tab

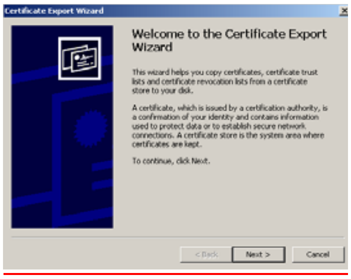


Certificate

Show: <All>

Field	Value
Version	V3
Serial number	6174 E6C8 0000 0000 000B
Signature algorithm	sha1RSA
Issuer	Middle Earth, US
Valid from	Friday, January 02, 2004 10:4...
Valid to	Saturday, January 01, 2005 1...
Subject	Administrator
Public key	RSA (2048 Bits)

s Click *Copy to File* to save the certificate. This action is actually already performed with the Advanced Request, but this is an alternative way to save the certificate. Click *Next* when the wizard is launched.



Certificate Export Wizard

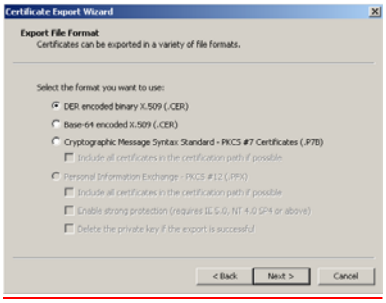
Welcome to the Certificate Export Wizard

This wizard helps you copy certificates, certificate trust lists and certificate revocation lists from a certificate store to your disk.

A certificate, which is issued by a certification authority, is a confirmation of your identity and contains information used to protect data or to establish secure network connections. A certificate store is the system area where certificates are kept.

To continue, click Next.

Save the certificate using DER x.509 encoding, select *DER encoded binary* followed by *Next*. Provide a name for the certificate and save it to a specified location.



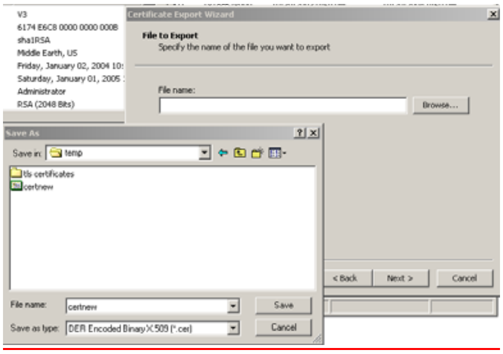
Certificate Export Wizard

Export File Format

Certificates can be exported in a variety of file formats.

Select the format you want to use:

- ● DER encoded binary X.509 (.CER)
- ○ Base-64 encoded X.509 (.CER)
- ○ Cryptographic Message Syntax Standard - PKCS #7 Certificates (.P7B)
  - □ Include all certificates in the certification path if possible
- ○ Personal Information Exchange - PKCS #12 (.PFX)
  - □ Include all certificates in the certification path if possible
  - □ Enable strong protection (requires IE 5.0, NT 4.0 SP4 or above)
  - □ Delete the private key if the export is successful



V3
6174 E6C8 0000 0000 0008
sha1RSA
Middle Earth, US
Friday, January 02, 2004 10:
Saturday, January 01, 2005
Administrator
RSA (2048 Bits)

Certificate Export Wizard

File to Export

Specify the name of the file you want to export

File name:

Save As

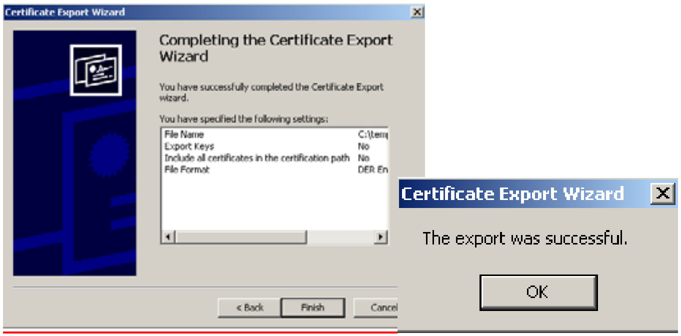
Save in: temp

tls certificates
certnew

File name: certnew

Save as type: DER Encoded Binary X.509 (*.cer)

Click *Finish* and followed by *OK*.



Certificate Export Wizard

Completing the Certificate Export Wizard

You have successfully completed the Certificate Export wizard.

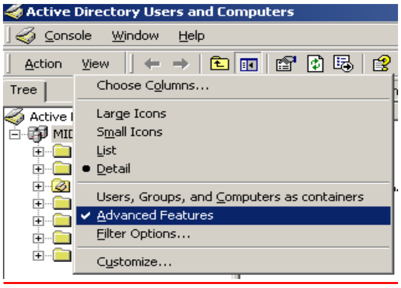
You have specified the following settings:

File Name	C:\tem
Export Keys	No
Include all certificates in the certification path	No
File Format	DER En

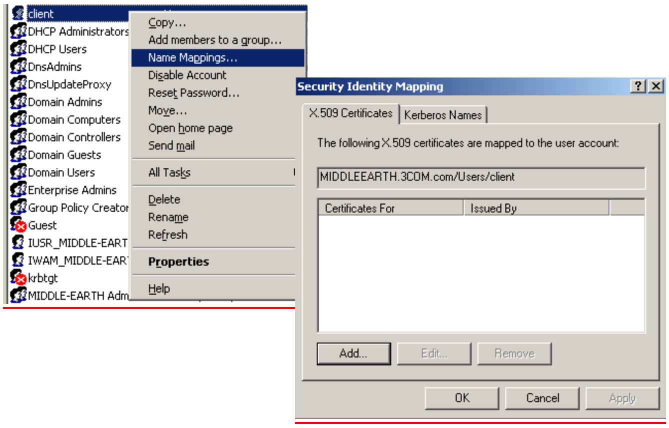
Certificate Export Wizard

The export was successful.

t Exit the *Certification Authority* management tool and launch the *Active Directory Users and Computers* management tool. Ensure that the *Advanced Features* are enabled in the *Action* menu, as shown below.



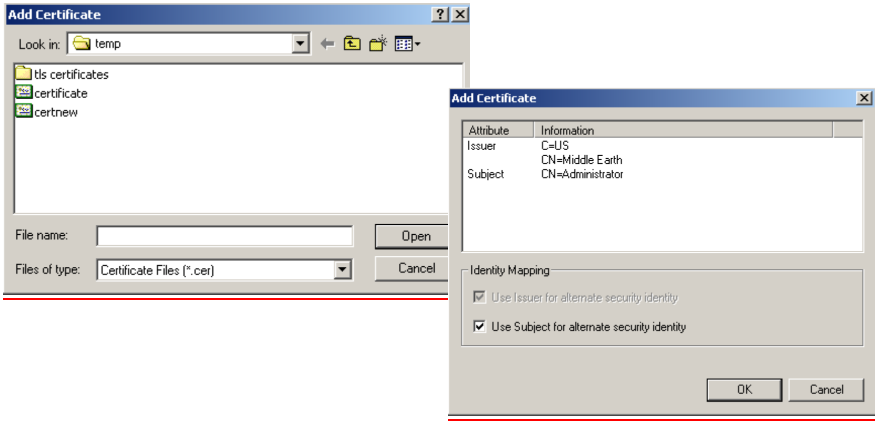
u Select the user that becomes the IEEE 802.1x client. Right-click on the user and select *Name mappings*. Select *Add*



The following X.509 certificates are mapped to the user account:

MIDDLEEARTH.3COM.com/Users/client

v Select the certificate that you have just exported and click *Open*. Click *OK*



Attribute	Information

Issuer	C=US
	CN=Middle Earth

Subject	CN=Administrator

☑ Use Issuer for alternate security identity

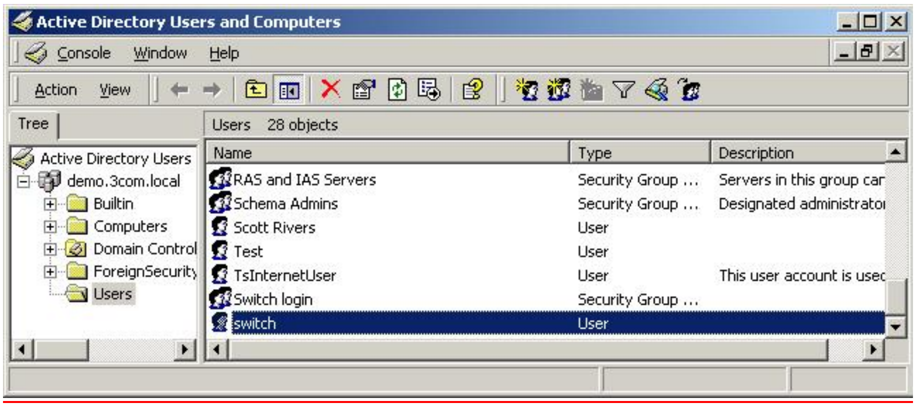
☑ Use Subject for alternate security identity

w In the *Security Identity Mapping* screen, click *OK* to close it.

x Close the *Active Directory Users and Domains* management tool. This completes the configuration of the RADIUS server.

10 Configure Microsoft IAS RADIUS Server for Switch Login.

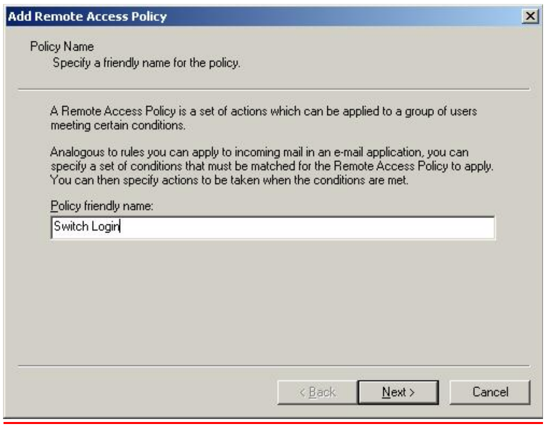
a Create a Windows Group that contains the users that are allowed access to the Switch 5500. Add an additional user as a member of this windows group:



Users 28 objects

Name	Type	Description
RAS and IAS Servers	Security Group ...	Servers in this group car
Schema Admins	Security Group ...	Designated administrato
Scott Rivers	User	
Test	User	
TsInternetUser	User	This user account is usec
Switch login	Security Group ...	
switch	User	

b Create a new remote access policy under IAS and name it *Switch Login. S*elect *Next>*


Add Remote Access Policy

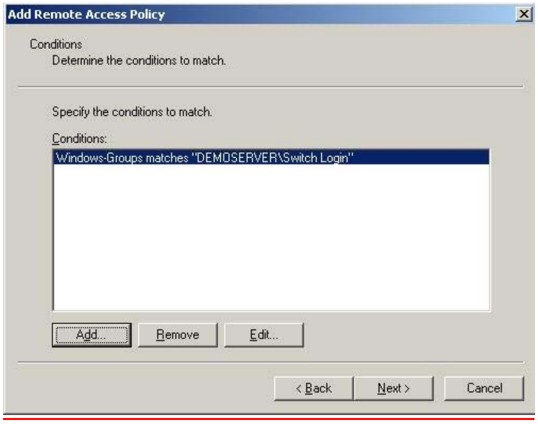
Policy Name
Specify a friendly name for the policy.

A Remote Access Policy is a set of actions which can be applied to a group of users meeting certain conditions.

Analogous to rules you can apply to incoming mail in an e-mail application, you can specify a set of conditions that must be matched for the Remote Access Policy to apply. You can then specify actions to be taken when the conditions are met.

Policy friendly name: Switch Login

c Specify *Switch Login* to match the users in the switch access group, select *Next >*

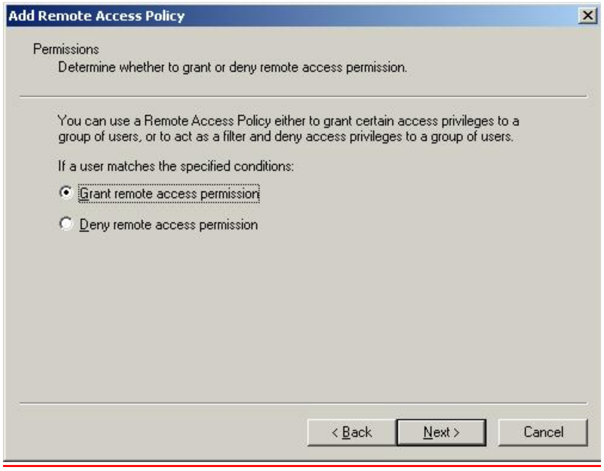

Add Remote Access Policy

Conditions
Determine the conditions to match.

Specify the conditions to match.

Conditions:
Windows-Groups matches "DEMOSERVER\Switch Login"

d Allow *Switch Login* to grant access to these users, select *Next >*


Add Remote Access Policy

Permissions
Determine whether to grant or deny remote access permission.

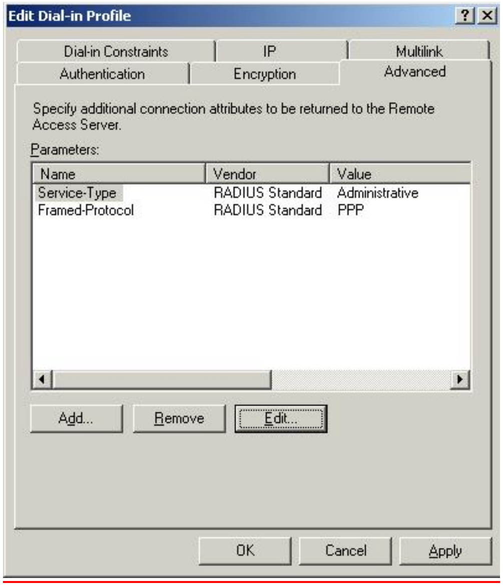
You can use a Remote Access Policy either to grant certain access privileges to a group of users, or to act as a filter and deny access privileges to a group of users.

If a user matches the specified conditions:

● Grant remote access permission

○ Deny remote access permission

e Use the *Edit* button to change the *Service-Type* to *Administrative.*

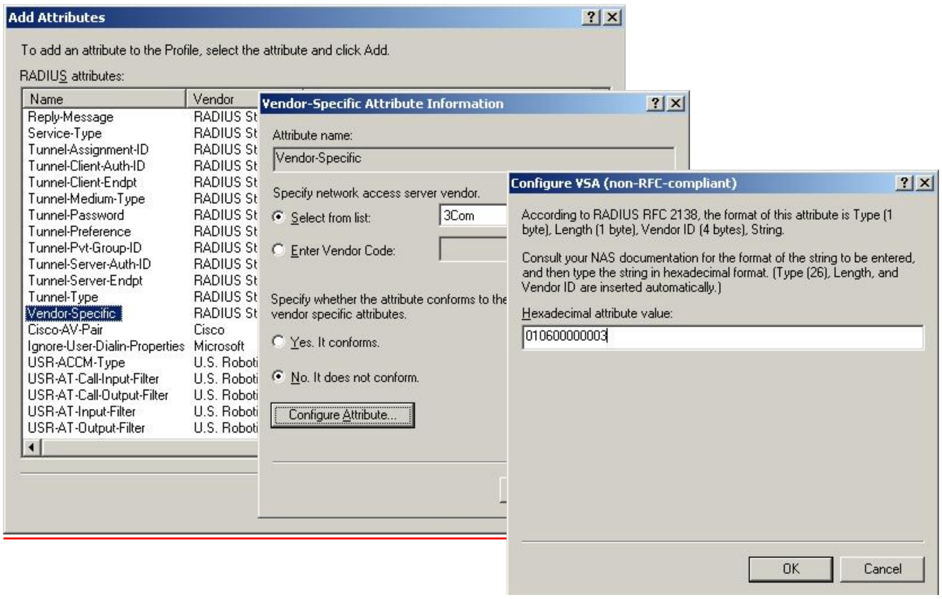


Specify additional connection attributes to be returned to the Remote Access Server.

Parameters:

Name	Vendor	Value
Service-Type	RADIUS Standard	Administrative
Framed-Protocol	RADIUS Standard	PPP

f Add a Vendor specific attribute to indicate the access level that should be provided:



Add Attributes
Vendor-Specific Attribute Information
Configure VSA (non-RFC-compliant)
Configure Attribute...
OK
Cancel

To add an attribute to the Profile, select the attribute and click Add.

RADIUS attributes:

Name	Vendor
Reply-Message	RADIUS St
Service-Type	RADIUS St
Tunnel-Assignment-ID	RADIUS St
Tunnel-Client-Auth-ID	RADIUS St
Tunnel-Client-Endpt	RADIUS St
Tunnel-Medium-Type	RADIUS St
Tunnel-Password	RADIUS St
Tunnel-Preference	RADIUS St
Tunnel-Pvt-Group-ID	RADIUS St
Tunnel-Server-Auth-ID	RADIUS St
Tunnel-Server-Endpt	RADIUS St
Tunnel-Type	RADIUS St
Vendor-Specific	RADIUS St
Cisco-AV-Pair	Cisco
Ignore-User-Dialin-Properties	Microsoft
USR-ACCM-Type	U.S. Roboti
USR-AT-Call-Input-Filter	U.S. Roboti
USR-AT-Call-Output-Filter	U.S. Roboti
USR-AT-Input-Filter	U.S. Roboti
USR-AT-Output-Filter	U.S. Roboti

Attribute name:

Vendor-Specific

Specify network access server vendor.

● Select from list: 3Com

○ Enter Vendor Code:

Specify whether the attribute conforms to the vendor specific attributes.

○ Yes. It conforms.

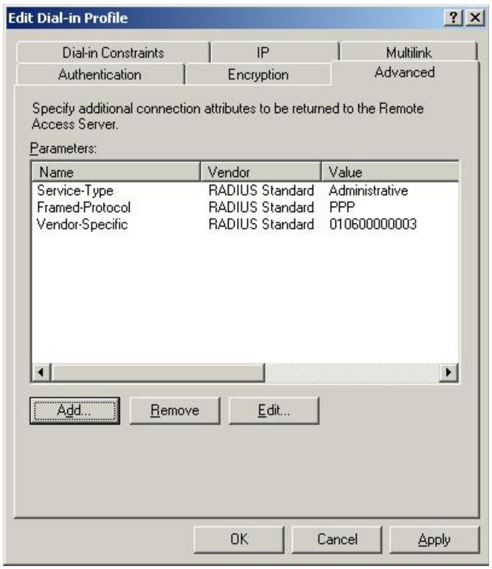
● No. It does not conform.

According to RADIUS RFC 2138, the format of this attribute is Type (1 byte), Length (1 byte), Vendor ID (4 bytes), String.

Consult your NAS documentation for the format of the string to be entered, and then type the string in hexadecimal format. (Type (26), Length, and Vendor ID are inserted automatically.)

Hexadecimal attribute value:

010600000003



Specify additional connection attributes to be returned to the Remote Access Server.

Parameters:

Name	Vendor	Value
Service-Type	RADIUS Standard	Administrative
Framed-Protocol	RADIUS Standard	PPP
Vendor-Specific	RADIUS Standard	010600000003

The Value 010600000003 indicates admin privileges for the switch. 01 at the end indicates monitor and 02 indicates manager access. On the Switch 5500, 00 indicates visitor level.

11 Configure the RADIUS client. Refer to "Setting Up the RADIUS Client" for information on setting up the client.

12 Establish an IEEE 802.1x session, using Microsoft's Internet Authentication Service. When you are prompted to select a certificate (it could be that there are additional active certificates on your client computer), select the certificate that you have installed for this specific Certification Authority server.

If you encounter problems, check the *Event Viewer* and the *System Log* on the server to determine what is what is happening, and possible causes for the problems.

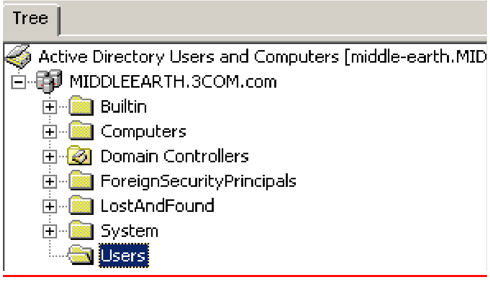
Configuring auto VLAN and QoS membership for Microsoft IAS

VLAN Groups are used by IAS to assign the correct VLAN ID to each user account. One VLAN Group must be created for each VLAN defined on the Switch 5500. The VLAN Groups must be created as Global/Security groups

Follow these steps to set up auto VLAN and QoS for use by Microsoft IAS:

1 Define the VLAN Groups on the Active Directory server and assign the user accounts to each VLAN Group. Go to *Programs > Administrative Tools > Active Directory Users and Computers*

a For example, to create one group that will represent VLAN 4 select the *Users* folder from the domain (see below),



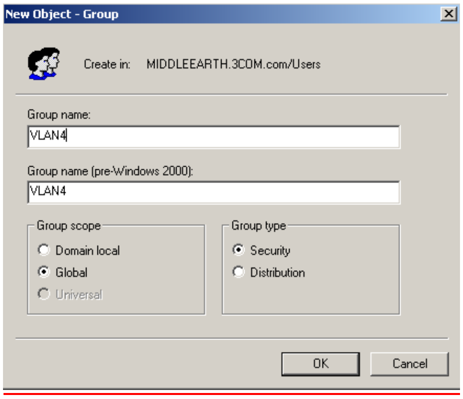
Tree

Active Directory Users and Computers [middle-earth.MID

MIDDLEEARTH.3COM.com

- Builtin
- Computers
- Domain Controllers
- ForeignSecurityPrincipals
- LostAndFound
- System
- Users

b Name the VLAN Group with a descriptive name that describes the function of the VLAN Group, for example *VLAN4.* Check *Global* in the *Group Scope* box and *Security* in the *Group Type* box, click *OK*



New Object - Group

Create in: MIDDLEEARTH.3COM.com/Users

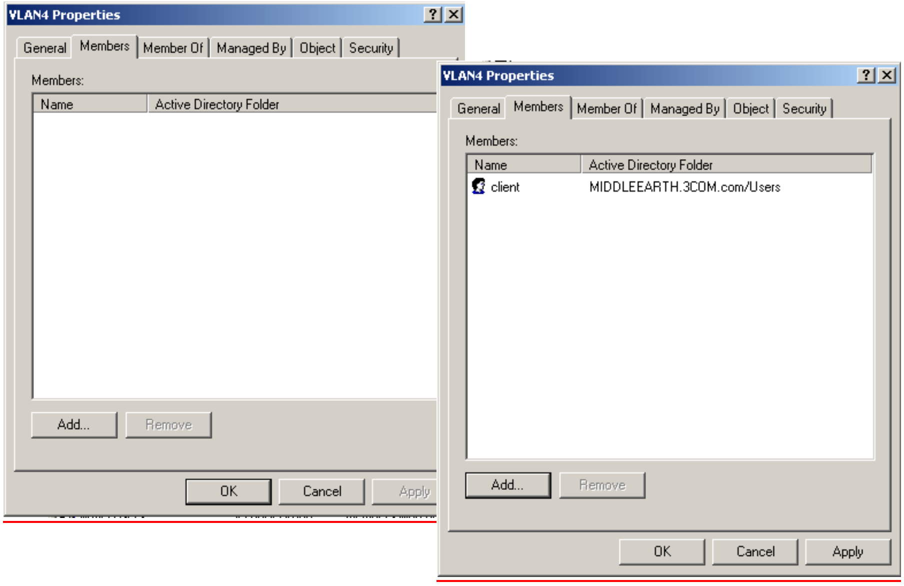
Group name: VLAN4

Group name (pre-Windows 2000): VLAN4

Group scope: ○ Domain local ● Global ○ Universal

Group type: ● Security ○ Distribution

c Select the group, right click and select *Properties*. Select the *Members* tab, add the users that have received the certificate and will use the VLAN functionality.



VLAN4 Properties

General | Members | Member Of | Managed By | Object | Security

Members:

Name	Active Directory Folder

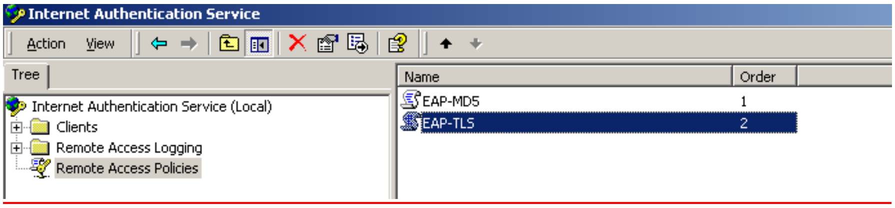
VLAN4 Properties

General | Members | Member Of | Managed By | Object | Security

Members:

Name	Active Directory Folder
client	MIDDLEEARTH.3COM.com/Users

d Go to *Programs* > *Administrative Tools* > *Internet Authentication Service*. and select *Remote Access Policies*. Select the policy that you configured earlier, right-click and select *Properties*.

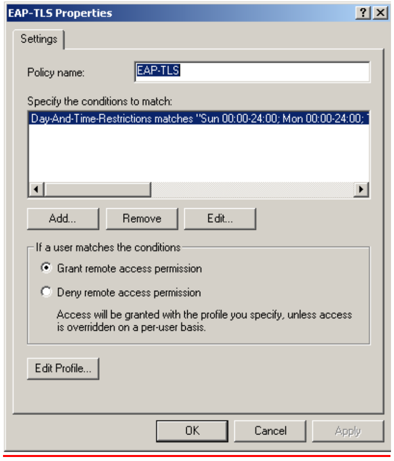


Internet Authentication Service

- Internet Authentication Service (Local)
  - Clients
  - Remote Access Logging
  - Remote Access Policies

Name	Order
EAP-MD5	1
EAP-TLS	2

e Click *Add* to add policy membership.



EAP-TLS Properties

Policy name: EAP-TLS

Specify the conditions to match:

Day-And-Time-Restrictions matches "Sun 00:00-24:00; Mon 00:00-24:00;

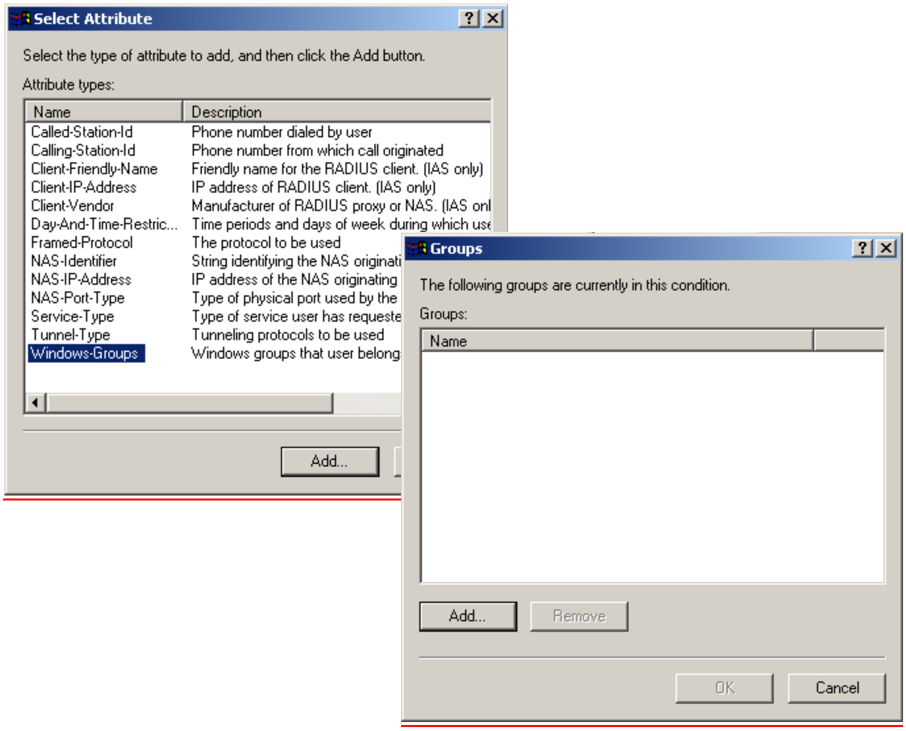
If a user matches the conditions

● Grant remote access permission

○ Deny remote access permission

Access will be granted with the profile you specify, unless access is overridden on a per-user basis.

f Select the *Windows-Groups* attribute type, and select *Add* and *Add* again



Select Attribute

Select the type of attribute to add, and then click the Add button.

Attribute types:

Name	Description
Called-Station-Id	Phone number dialed by user
Calling-Station-Id	Phone number from which call originated
Client-Friendly-Name	Friendly name for the RADIUS client. (IAS only)
Client-IP-Address	IP address of RADIUS client. (IAS only)
Client-Vendor	Manufacturer of RADIUS proxy or NAS. (IAS onl
Day-And-Time-Restric...	Time periods and days of week during which use
Framed-Protocol	The protocol to be used
NAS-Identifier	String identifying the NAS originati
NAS-IP-Address	IP address of the NAS originating
NAS-Port-Type	Type of physical port used by the
Service-Type	Type of service user has requeste
Tunnel-Type	Tunneling protocols to be used
Windows-Groups	Windows groups that user belong

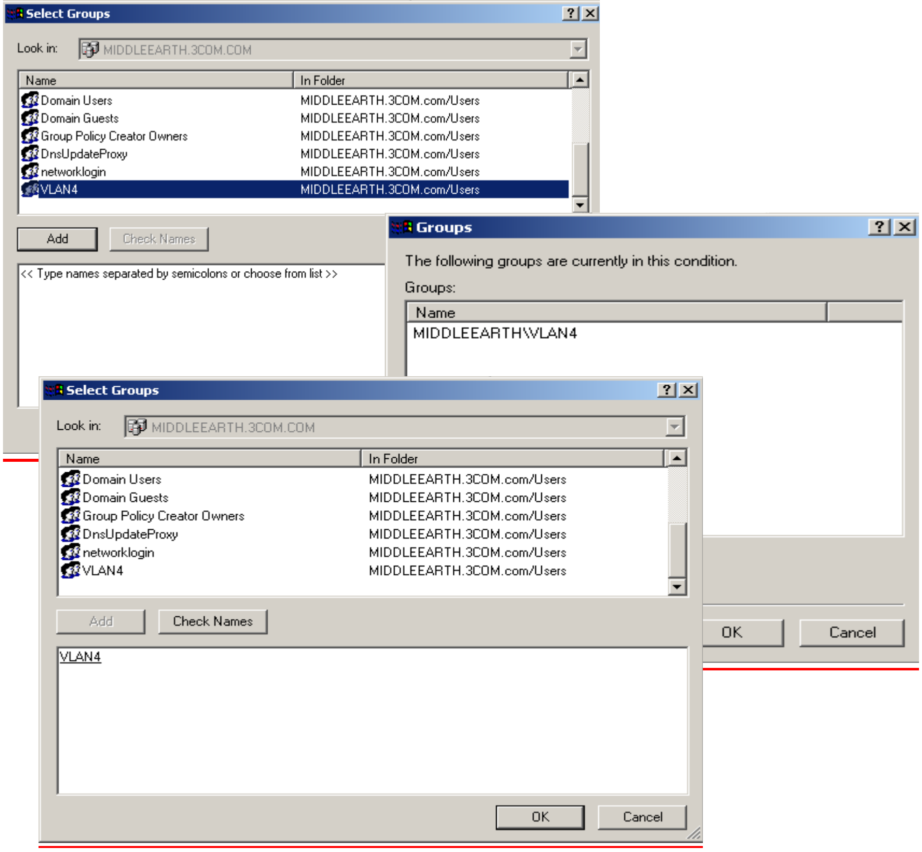
Groups

The following groups are currently in this condition.

Groups:

Name

g Select the VLAN group that you have just created and click *Add* and then *OK* to confirm.



Select Groups

Look in: MIDDLEEARTH.3COM.COM

Name	In Folder
Domain Users	MIDDLEEARTH.3COM.com/Users
Domain Guests	MIDDLEEARTH.3COM.com/Users
Group Policy Creator Owners	MIDDLEEARTH.3COM.com/Users
DnsUpdateProxy	MIDDLEEARTH.3COM.com/Users
networklogin	MIDDLEEARTH.3COM.com/Users
VLAN4	MIDDLEEARTH.3COM.com/Users

<< Type names separated by semicolons or choose from list >>

Groups

The following groups are currently in this condition.

Groups:

Name
MIDDLEEARTH\VLAN4

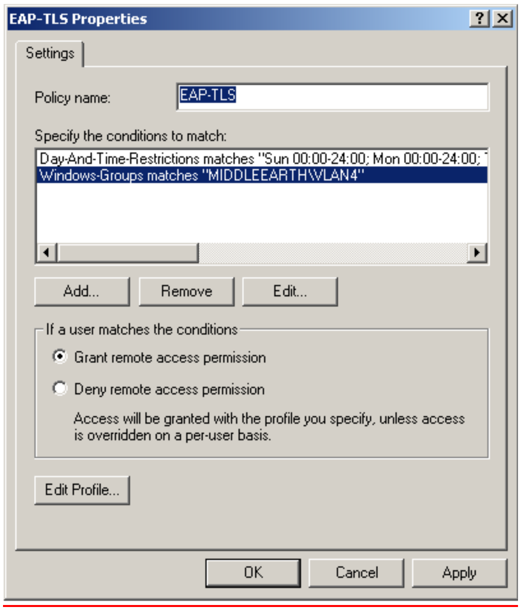
Select Groups

Look in: MIDDLEEARTH.3COM.COM

Name	In Folder
Domain Users	MIDDLEEARTH.3COM.com/Users
Domain Guests	MIDDLEEARTH.3COM.com/Users
Group Policy Creator Owners	MIDDLEEARTH.3COM.com/Users
DnsUpdateProxy	MIDDLEEARTH.3COM.com/Users
networklogin	MIDDLEEARTH.3COM.com/Users
VLAN4	MIDDLEEARTH.3COM.com/Users

VLAN4

h Click *OK* again to return you to the *Security Policy* properties.



EAP-TLS Properties

Settings

Policy name: EAP-TLS

Specify the conditions to match:

Day-And-Time-Restrictions matches "Sun 00:00-24:00; Mon 00:00-24:00;

Windows-Groups matches "MIDDLEEARTH\VLAN4"

If a user matches the conditions

● Grant remote access permission

○ Deny remote access permission

Access will be granted with the profile you specify, unless access is overridden on a per-user basis.

i Click *Edit Profile...* and select the *Advanced* tab. Click *Add*. Refer to Table 686 and Table 687 for the RADIUS attributes to add to the profile.

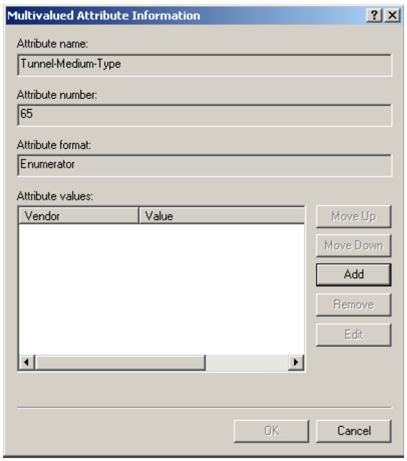
Table 686 Summary of auto VLAN attributes

For Auto VLAN	Return String	Comment
Tunnel-Medium-type	802	
Tunnel-Private-Group-ID	2	VLAN value
Tunnel-Type	VLAN	

Table 687 Summary of QoS attributes

For Auto QoS	Return String	Comment
Filter-id	profile=student	QoS Profile name

j Select *Tunnel-Medium-Type* and click *Add*.



Multivalued Attribute Information

Attribute name: Tunnel-Medium-Type

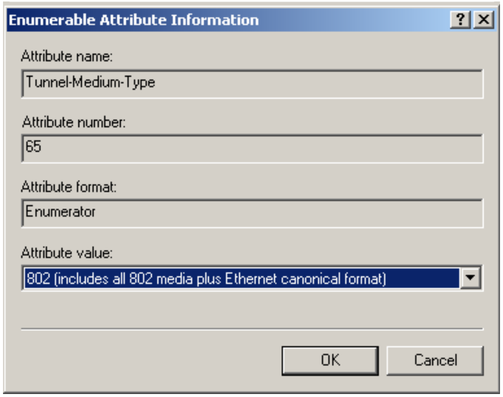
Attribute number: 65

Attribute format: Enumerator

Attribute values:

Vendor	Value

k Ensure that the Attribute value is set to 802 and click *OK*.



Enumerable Attribute Information

Attribute name: Tunnel-Medium-Type

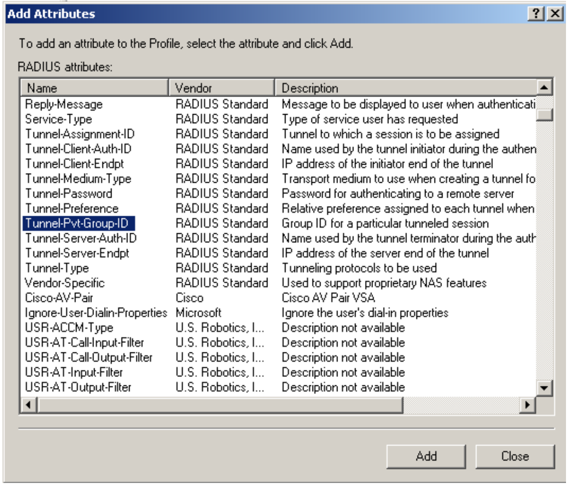
Attribute number: 65

Attribute format: Enumerator

Attribute value: 802 (includes all 802 media plus Ethernet canonical format)

l Click *OK* again on the *Multivalued Attribute Information* screen to return to the Add *Attributes* screen.

m Select the *Tunnel-Pvt-Group-ID* entry and click *Add*.



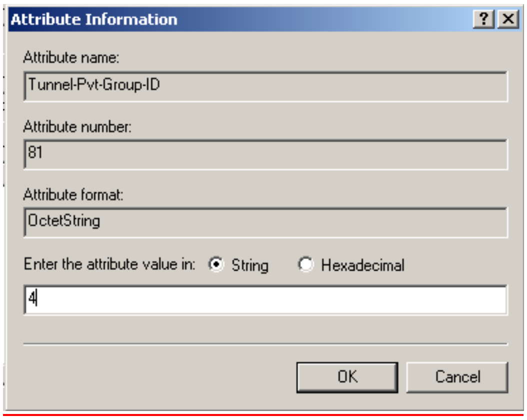
Add Attributes

To add an attribute to the Profile, select the attribute and click Add.

RADIUS attributes:

Name	Vendor	Description
Reply-Message	RADIUS Standard	Message to be displayed to user when authenticati
Service-Type	RADIUS Standard	Type of service user has requested
Tunnel-Assignment-ID	RADIUS Standard	Tunnel to which a session is to be assigned
Tunnel-Client-Auth-ID	RADIUS Standard	Name used by the tunnel initiator during the authen
Tunnel-Client-Endpt	RADIUS Standard	IP address of the initiator end of the tunnel
Tunnel-Medium-Type	RADIUS Standard	Transport medium to use when creating a tunnel fo
Tunnel-Password	RADIUS Standard	Password for authenticating to a remote server
Tunnel-Preference	RADIUS Standard	Relative preference assigned to each tunnel when
Tunnel-Pvt-Group-ID	RADIUS Standard	Group ID for a particular tunneled session
Tunnel-Server-Auth-ID	RADIUS Standard	Name used by the tunnel terminator during the auth
Tunnel-Server-Endpt	RADIUS Standard	IP address of the server end of the tunnel
Tunnel-Type	RADIUS Standard	Tunneling protocols to be used
Vendor-Specific	RADIUS Standard	Used to support proprietary NAS features
Cisco-AV-Pair	Cisco	Cisco AV Pair VSA
Ignore-User-Dialin-Properties	Microsoft	Ignore the user's dial-in properties
USR-ACCM-Type	U.S. Robotics, I...	Description not available
USR-AT-Call-Input-Filter	U.S. Robotics, I...	Description not available
USR-AT-Call-Output-Filter	U.S. Robotics, I...	Description not available
USR-AT-Input-Filter	U.S. Robotics, I...	Description not available
USR-AT-Output-Filter	U.S. Robotics, I...	Description not available

n Click *Add,* ensure that the Attribute value is set to 4 (Attribute value in string format), and click *OK*. This value represents the VLAN ID.



Attribute Information

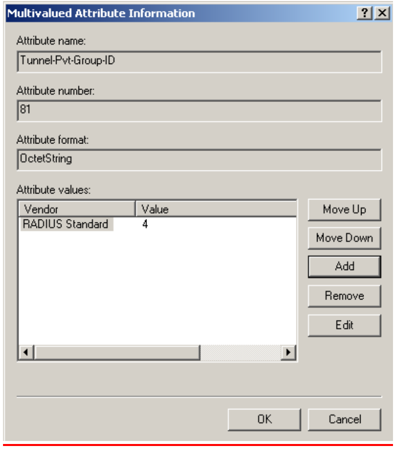
Attribute name: Tunnel-Pvt-Group-ID

Attribute number: 81

Attribute format: OctetString

Enter the attribute value in: ● String ○ Hexadecimal

4



Multivalued Attribute Information

Attribute name: Tunnel-Pvt-Group-ID

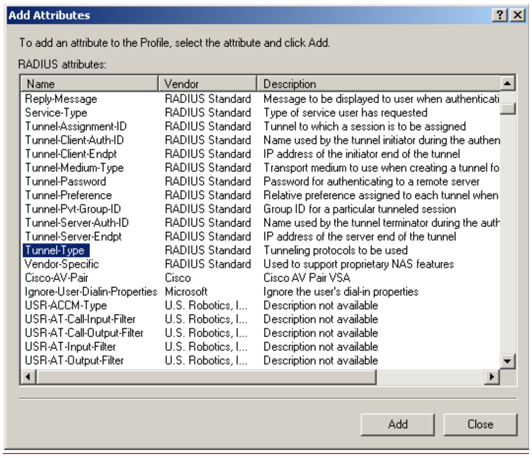
Attribute number: 81

Attribute format: OctetString

Attribute values:

Vendor	Value
RADIUS Standard	4

o Click *OK* again on the *Multivalued Attribute Information* screen to return to the the *Add Attributes* screen. Select the *Tunnel-Type* entry and click *Add*.



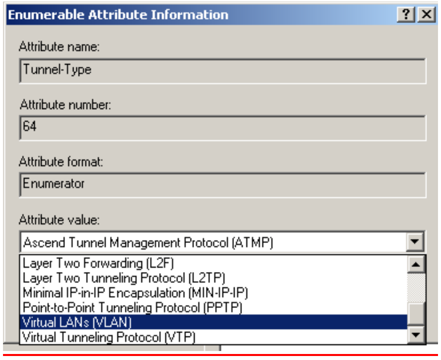
Add Attributes

To add an attribute to the Profile, select the attribute and click Add.

RADIUS attributes:

Name	Vendor	Description
Reply-Message	RADIUS Standard	Message to be displayed to user when authenticati
Service-Type	RADIUS Standard	Type of service user has requested
Tunnel-Assignment-ID	RADIUS Standard	Tunnel to which a session is to be assigned
Tunnel-Client-Auth-ID	RADIUS Standard	Name used by the tunnel initiator during the authen
Tunnel-Client-Endpt	RADIUS Standard	IP address of the initiator end of the tunnel
Tunnel-Medium-Type	RADIUS Standard	Transport medium to use when creating a tunnel fo
Tunnel-Password	RADIUS Standard	Password for authenticating to a remote server
Tunnel-Preference	RADIUS Standard	Relative preference assigned to each tunnel when
Tunnel-Pvt-Group-ID	RADIUS Standard	Group ID for a particular tunneled session
Tunnel-Server-Auth-ID	RADIUS Standard	Name used by the tunnel terminator during the auth
Tunnel-Server-Endpt	RADIUS Standard	IP address of the server end of the tunnel
Tunnel-Type	RADIUS Standard	Tunneling protocols to be used
Vendor-Specific	RADIUS Standard	Used to support proprietary NAS features
Cisco-AV-Pair	Cisco	Cisco AV Pair VSA
Ignore-User-Dialin-Properties	Microsoft	Ignore the user's dial-in properties
USR-ACCM-Type	U.S. Robotics, I...	Description not available
USR-AT-Call-Input-Filter	U.S. Robotics, I...	Description not available
USR-AT-Call-Output-Filter	U.S. Robotics, I...	Description not available
USR-AT-Input-Filter	U.S. Robotics, I...	Description not available
USR-AT-Output-Filter	U.S. Robotics, I...	Description not available

p Click *Add* again. In the pull down menu, select *Virtual LANs* and click *OK*.



Enumerable Attribute Information

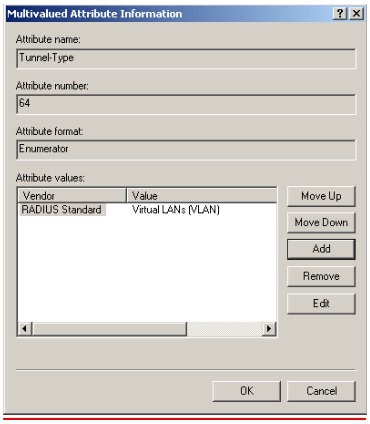
Attribute name: Tunnel-Type

Attribute number: 64

Attribute format: Enumerator

Attribute value: Ascend Tunnel Management Protocol (ATMP)

- Layer Two Forwarding (L2F)
- Layer Two Tunneling Protocol (L2TP)
- Minimal IP-in-IP Encapsulation (MIN-IP-IP)
- Point-to-Point Tunneling Protocol (PPTP)
- Virtual LANs (VLAN)
- Virtual Tunneling Protocol (VTP)



Multivalued Attribute Information

Attribute name: Tunnel-Type

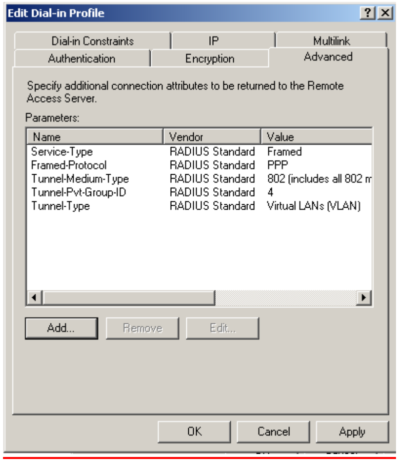
Attribute number: 64

Attribute format: Enumerator

Attribute values:

Vendor	Value
RADIUS Standard	Virtual LANs (VLAN)

q Click *OK* again and to return to the *Add Attributes* screen. Click *Close*. You will now see the added attributes



Edit Dial-in Profile

Specify additional connection attributes to be returned to the Remote Access Server.

Parameters:

Name	Vendor	Value
Service-Type	RADIUS Standard	Framed
Framed-Protocol	RADIUS Standard	PPP
Tunnel-Medium-Type	RADIUS Standard	802 (includes all 802 m
Tunnel-Pvt-Group-ID	RADIUS Standard	4
Tunnel-Type	RADIUS Standard	Virtual LANs (VLAN)

r Click *OK* to close the *Profile* screen and *OK* again to close the *Policy* screen. This completes the configuration of the Internet Authentication Service.

2 To test the configuration, connect the workstation to a port on the Switch 5500 (the port does not have to be a member of VLAN 4). Ensure that there is a DHCP server connected to the switch that resides on a switch port that is an untagged member of VLAN 4. The RADIUS server should reside in the same VLAN as the workstation.

Once authenticated the switch will receive VLAN information from the RADIUS server and will place the switch port in the associated VLAN.

For troubleshooting, you can use the Event Viewer on both the workstation and the RADIUS server.

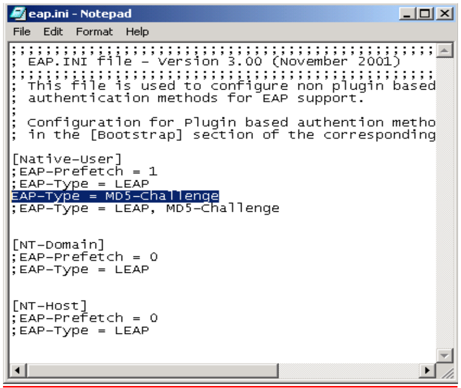
Configuring Funk RADIUS

3Com has successfully installed and tested Funk RADIUS running on a Windows server in a network with Switch 5500 deployed.

Download the Funk Steel-Belted RADIUS Server application from **`www.funk.com`** and install the application. Once installed you have a 30 day license to use it.

To configure Funk RADIUS as a RADIUS server for networks with the Switch 5500, follow these steps:

1 Open file `eap.ini` in `\radius\service` and remove the ";" before the MD5-Challenge Line. This enables the MD5-challenge



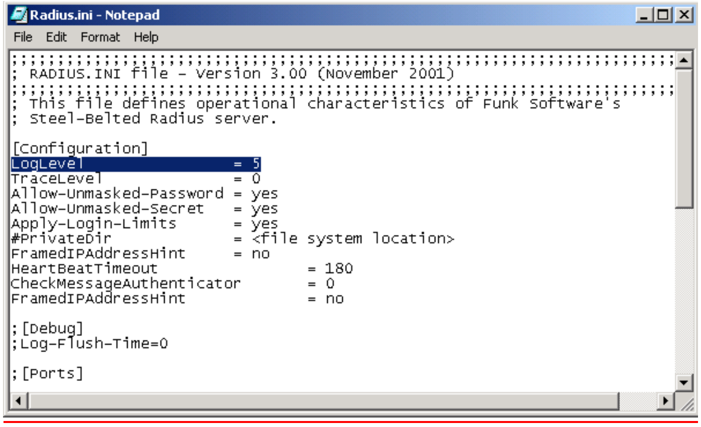
```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; EAP.INI file - Version 3.00 (November 2001)
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; This file is used to configure non plugin based
; authentication methods for EAP support.
;
; Configuration for Plugin based authention metho
; in the [Bootstrap] section of the corresponding

[Native-User]
;EAP-Prefetch = 1
;EAP-Type = LEAP
EAP-Type = MD5-Challenge
;EAP-Type = LEAP, MD5-Challenge


[NT-Domain]
;EAP-Prefetch = 0
;EAP-Type = LEAP


[NT-Host]
;EAP-Prefetch = 0
;EAP-Type = LEAP
```

2 Open file `radius.ini` in `\radius\service` and change the log level to 5.



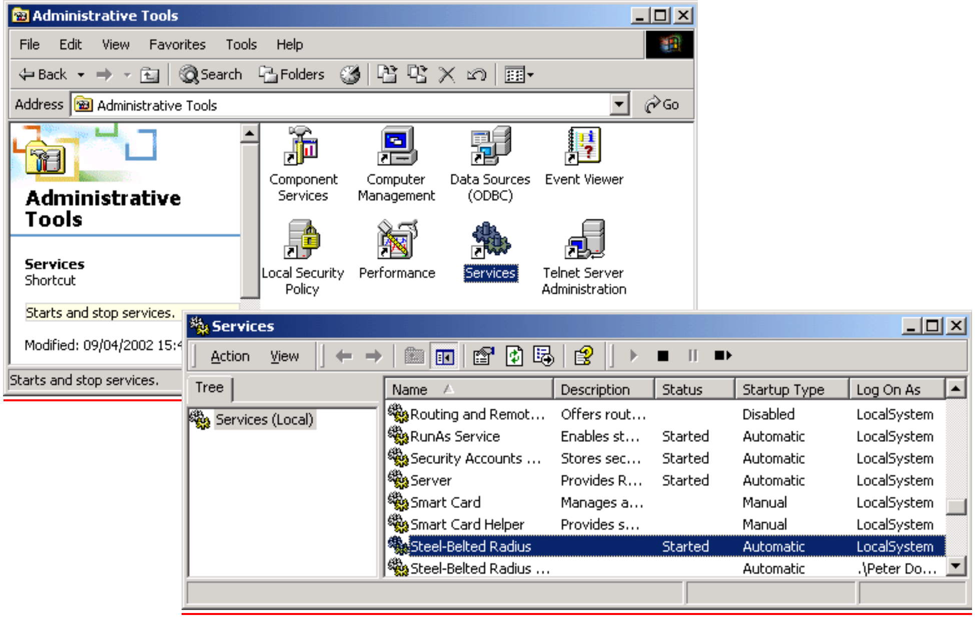
```
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; RADIUS.INI file - Version 3.00 (November 2001)
;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
; This file defines operational characteristics of Funk Software's
; Steel-Belted Radius server.

[Configuration]
LogLevel                 = 5
TraceLevel               = 0
Allow-Unmasked-Password  = yes
Allow-Unmasked-Secret    = yes
Apply-Login-Limits       = yes
#PrivateDir              = <file system location>
FramedIPAddressHint      = no
HeartBeatTimeout                = 180
CheckMessageAuthenticator       = 0
FramedIPAddressHint             = no

;[Debug]
;Log-Flush-Time=0

;[Ports]
```

3 Either re-boot the server or stop then restart the RADIUS service. To stop and restart the Steel-Belted RADIUS service, go to *Control Panel* > *Administrative tools* > *Services*. Scroll down to the Steel-Belted service, stop and restart it.

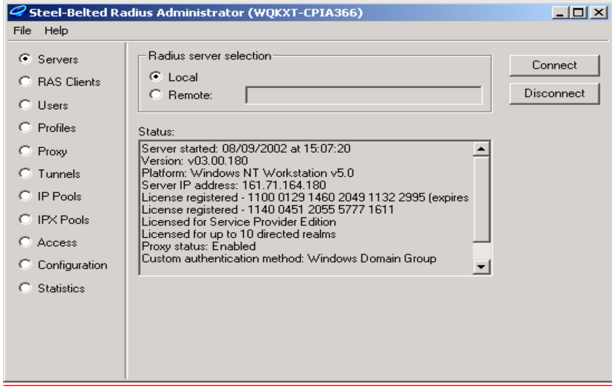


Name	Description	Status	Startup Type	Log On As
Routing and Remot...	Offers rout...		Disabled	LocalSystem
RunAs Service	Enables st...	Started	Automatic	LocalSystem
Security Accounts ...	Stores sec...	Started	Automatic	LocalSystem
Server	Provides R...	Started	Automatic	LocalSystem
Smart Card	Manages a...		Manual	LocalSystem
Smart Card Helper	Provides s...		Manual	LocalSystem
Steel-Belted Radius		Started	Automatic	LocalSystem
Steel-Belted Radius ...			Automatic	.\Peter Do...

Funk RADIUS is now ready to run.

If you intend to use auto VLAN and QoS, you will need to create VLAN and QoS profiles on the 3Com Switch 5500 and follow the instructions in Configuring auto VLAN and QoS for Funk RADIUS.

4 Start the Funk RADIUS program, select *Servers* from the left hand list and select *Local* Radius server. Select *Connect* to start listening for clients.



● Servers

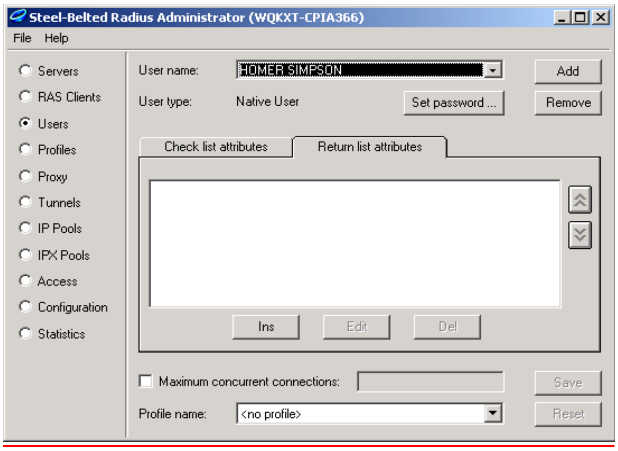
Radius server selection: ● Local ○ Remote:

Status:

```
Server started: 08/09/2002 at 15:07:20
Version: v03.00.180
Platform: Windows NT Workstation v5.0
Server IP address: 161.71.164.180
License registered - 1100 0129 1460 2049 1132 2995 (expires
License registered - 1140 0451 2055 5777 1611
Licensed for Service Provider Edition
Licensed for up to 10 directed realms
Proxy status: Enabled
Custom authentication method: Windows Domain Group
```

5 To add a user, select *Users* from the left hand list, enter the *User name*, Set password and select Add.

Passwords are case sensitive.



User name: HOMER SIMPSON

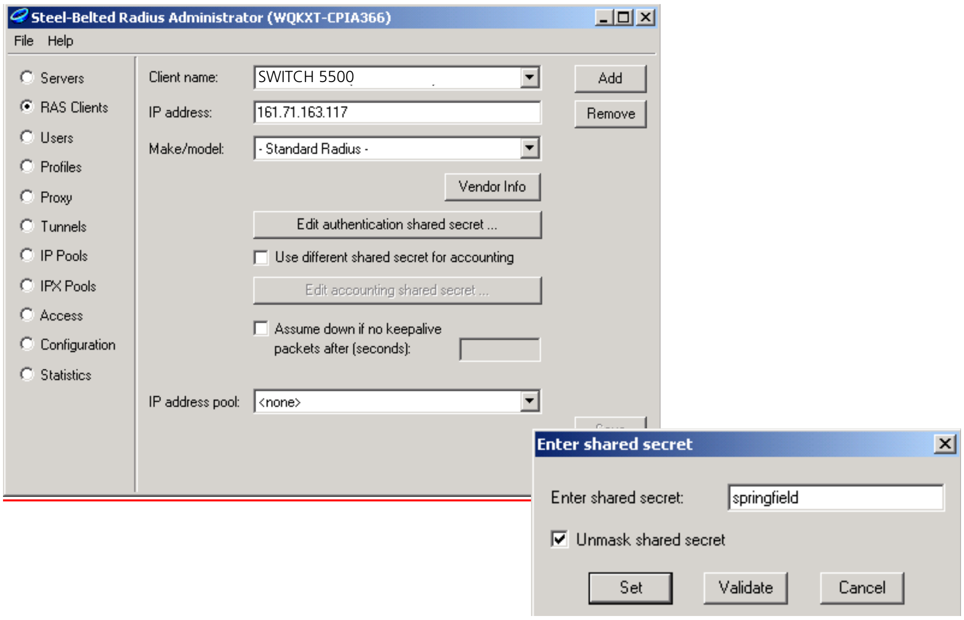
User type: Native User

□ Maximum concurrent connections:

Profile name: <no profile>

6 Enter the shared secret to encrypt the authentication data. The shared secret must be identical on the Switch 5500 and the RADIUS Server

a Select *RAS Clients* from the left hand list, enter a *Client name* , the *IP address* and the *Shared secret*.



Client name: SWITCH 5500

IP address: 161.71.163.117

Make/model: - Standard Radius -

□ Use different shared secret for accounting

□ Assume down if no keepalive packets after (seconds):

IP address pool: <none>

Enter shared secret: springfield

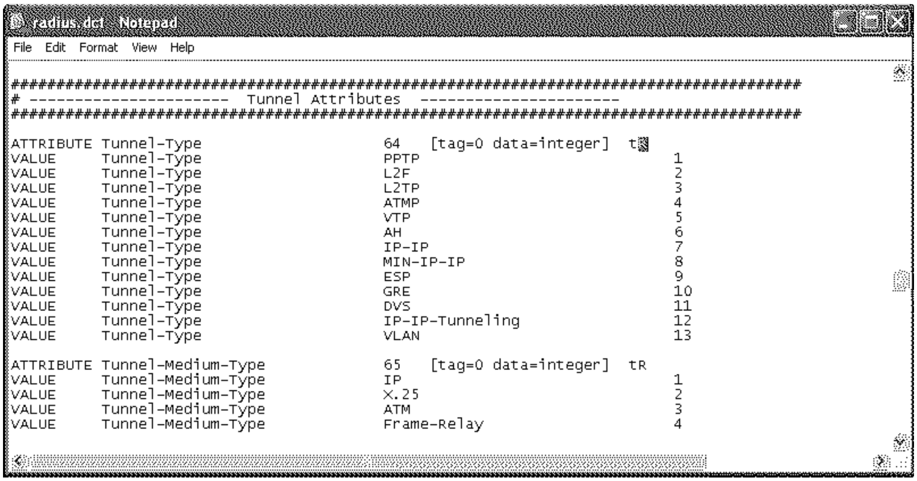
☑ Unmask shared secret

Configuring auto VLAN and QoS for Funk RADIUS

To set up auto VLAN and QoS using Funk RADIUS, follow these steps:

1 Edit the dictionary file `radius.dct` so that Return list attributes from the Funk RADIUS server are returned to the Switch 5500. The changes to make are:

a Add an **R** at the end of the correct attributes in the file, see example below. The attributes will now appear as potential Return list attributes for every user.



```
#########################################################################################
# ----------------------  Tunnel Attributes  ----------------------
#########################################################################################

ATTRIBUTE Tunnel-Type                     64   [tag=0 data=integer]  tR
VALUE     Tunnel-Type                     PPTP                           1
VALUE     Tunnel-Type                     L2F                            2
VALUE     Tunnel-Type                     L2TP                           3
VALUE     Tunnel-Type                     ATMP                           4
VALUE     Tunnel-Type                     VTP                            5
VALUE     Tunnel-Type                     AH                             6
VALUE     Tunnel-Type                     IP-IP                          7
VALUE     Tunnel-Type                     MIN-IP-IP                      8
VALUE     Tunnel-Type                     ESP                            9
VALUE     Tunnel-Type                     GRE                            10
VALUE     Tunnel-Type                     DVS                            11
VALUE     Tunnel-Type                     IP-IP-Tunneling                12
VALUE     Tunnel-Type                     VLAN                           13

ATTRIBUTE Tunnel-Medium-Type              65   [tag=0 data=integer]  tR
VALUE     Tunnel-Medium-Type              IP                             1
VALUE     Tunnel-Medium-Type              X.25                           2
VALUE     Tunnel-Medium-Type              ATM                            3
VALUE     Tunnel-Medium-Type              Frame-Relay                    4
```

2 After saving the edited `radius.dct` file, stop and restart the Funk RADIUS service.

3 To use these return list attributes, they need to be assigned to a user or group. Create a new user and add the return list attributes shown in Table 688.and Table 689

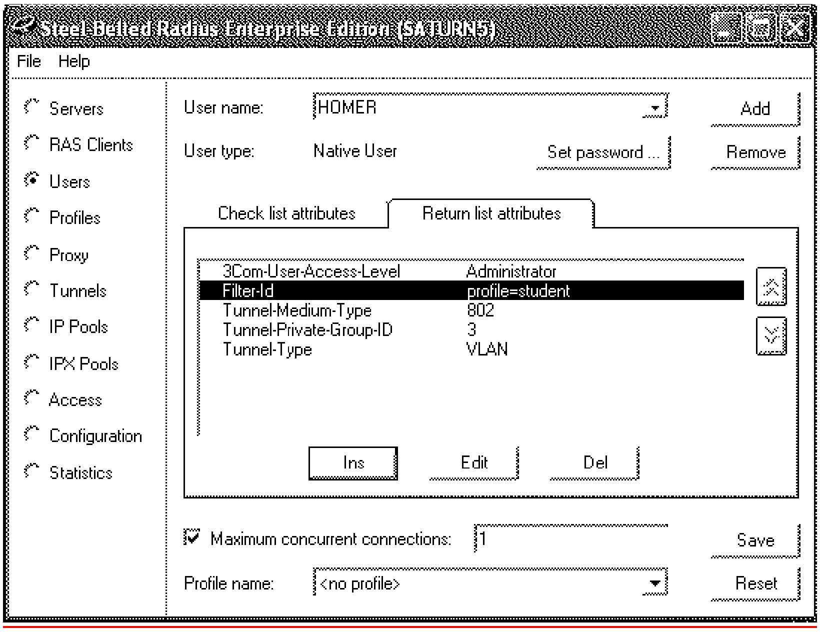
Table 688 Summary of auto VLAN attributes

For Auto VLAN	Return String	Comment
Tunnel-Medium-type	802	
Tunnel-Private-Group-ID	2	VLAN value
Tunnel-Type	VLAN	

Table 689 Summary of QoS attributes

For Auto QoS	Return String	Comment
Filter-id	profile=student	QoS Profile name

The following example shows the User name HOMER with the correct Return list Attributes inserted,



User name: HOMER

User type: Native User

3Com-User-Access-Level	Administrator
Filter-Id	profile=student
Tunnel-Medium-Type	802
Tunnel-Private-Group-ID	3
Tunnel-Type	VLAN

☑ Maximum concurrent connections: 1

Profile name: <no profile>

The VLANs and QoS profiles must also be created on the 3Com Switch 5500.

Configuring FreeRADIUS

3Com has successfully installed and tested FreeRADIUS running on Solaris 2.6 and RedHat Linux servers in networks with the Switch 5500 deployed.

Download FreeRADIUS source files from **`http://www.freeradius.org`** and install the application following the instructions from the website. The following instructions assume that you have installed a standard version of FreeRADIUS.

To configure FreeRADIUS as a RADIUS server for networks with the Switch 5500, follow these steps:

1 Add each Switch 5500 as a RADIUS client to the FreeRADIUS server

a Locate the existing file `clients.conf` in `/usr/local/etc/raddb`

b Add an entry in `clients.conf` for the Switch 5500 you wish to administer. For example:

```
client xxx.xxx.xxx.xxx {
    secret    = a-shared-secret
    shortname = a-short-name
}
```

Where **`xxx.xxx.xxx.xxx`** is the IP address of the 3Com Switch 5500.

2 Update the dictionary for Switch login

a In /usr/local/etc/raddb create a new file called dictionary.3Com containing the following information:

```
VENDOR     3Com                   43
ATTRIBUTE  3Com-User-Access-Level  1             Integer  3Com
VALUE      3Com-User-Access-Level  Monitor       1
VALUE      3Com-User-Access-Level  Manager       2
VALUE      3Com-User-Access-Level  Administrator  3
```

b Edit the existing file dictionary in /usr/local/etc/raddb to add the following line:

```
$INCLUDE dictionary.3Com
```

The new file dictionary.3Com will be used in configuring the FreeRADIUS server

3 Locate the existing file users in /usr/local/etc/raddb and for each user authorized to administer the Switch 5500:

a Add an entry for Switch Login. For example

```
user-name  Auth-Type = System, 3Com-User-Access-Level =
Administrator
```

This indicates that the server should return the 3Com vendor specific attribute 3Com-User-Access-Level in the Access-Accept message for that user.

b Add an entry for Network Login. For example

```
user-name Auth-Type := Local, User-Password == "password"
```

4 Run the FreeRADIUS server with **radiusd**, to turn on debugging. so you can see any problems that may occur with the authentication:

```
cd /usr/local/sbin
./radiusd -sfxxyz -l stdout
```

Setting Up Auto VLAN and QOS using FreeRADIUS

It is slightly more complex to set up auto VLAN and QoS using FreeRADIUS, as the dictionary file needs to be specially updated.

1 Update the dictionary.tunnel file with the following lines:

```
ATTRIBUTE  Tunnel-Type             64   integerhas_tag
ATTRIBUTE  Tunnel-Medium-Type      65   integerhas_tag
ATTRIBUTE  Tunnel-Private-Group-Id 81   stringhas_tag
VALUE      Tunnel-Type    VLAN  13
VALUE      Tunnel-Medium-Type  TMT802  6
```

2 Locate the file users in /usr/local/etc/raddb and add the return list attributes to the user. For example:

```
bob   Auth-Type := Local, User-Password == "bob"
      Tunnel-Medium-Type = TMT802,
      Tunnel-Private-Group-Id = 2,
      Tunnel-Type = VLAN,
      Filter-Id = "profile=student"
```

In the example above, Tunnel-Medium-Type has been set to TMT802, to force FreeRADIUS to treat 802 as a string requiring to be looked up in the dictionary and return integer 6, rather than return integer 802 which would be the case if Tunnel-Medium-Type was set to 802.

Setting Up the RADIUS Client

This section covers the following RADIUS clients:

- Windows 2000 built-in client
- Windows XP built-in client
- Aegis Client Installation

Windows 2000 built-in client

Windows 2000 requires Service Pack 3 and the IEEE 802.1x client patch for Windows 2000.

1 Downloaded the patches if required from:

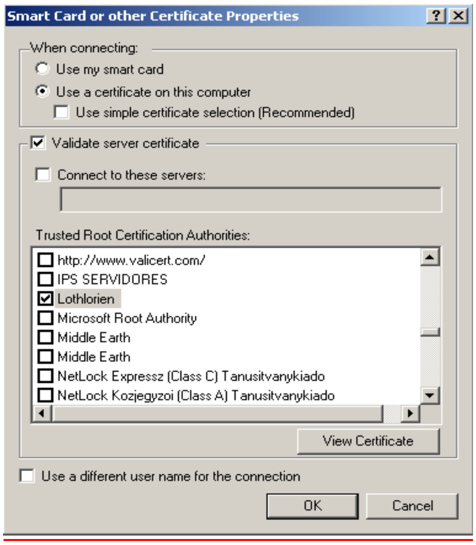
`http://www.microsoft.com/Downloads/details.aspx?displaylang=en&FamilyID=6B78EDBE-D3CA-4880-929F-453C695B9637`

2 After the updates have been installed, start the *Wireless Authentication Service* in *Component Services* on the Windows 2000 workstation (set the service to startup type *Automatic*).

3 Open the *Network and Dial up* connections folder, right-click the desired Network Interface and select *Properties*.

4 Select the *Authentication* tab and check *Enable Network Access Control using IEEE 802.1x*

5 Set *Smart Card or Certificate* as *EAP type* and select the previously imported certificate as shown below.



Smart Card or other Certificate Properties

When connecting:

○ Use my smart card

● Use a certificate on this computer

□ Use simple certificate selection (Recommended)

☑ Validate server certificate

□ Connect to these servers:

Trusted Root Certification Authorities:

□ http://www.valicert.com/
□ IPS SERVIDORES
☑ Lothlorien
□ Microsoft Root Authority
□ Middle Earth
□ Middle Earth
□ NetLock Expressz (Class C) Tanusitvanykiado
□ NetLock Kozjegyzoi (Class A) Tanusitvanykiado

□ Use a different user name for the connection

Windows XP built-in client

The RADIUS client shipped with Windows XP has a security issue which affects the port authentication operation. If the RADIUS client is configured to use EAP-MD5, after a user logs-off, then the next user to log-on will remain authorized with the original user's credentials. This occurs because the Microsoft client does not generate an EAPOL-Logoff message when the user logs-off, which leaves the port authorized. To reduce the impact of this issue, decrease the "session-timeout" return list attribute to force re-authentication of the port more often. Alternatively, use a RADIUS client without this security flaw, for example the Aegis client

A patch for the Windows XP RADIUS client may be available from Microsoft since publishing this guide.

Aegis Client Installation

The Aegis Client is a standards-based implementation of IEEE 802.1x and supports many different encrypted algorithms such as MD5. It works on different Windows and Linux operating systems, such as Win XP, 2000, NT, 98, ME, Mac OSX. Details of the Aegis client can be found at **`http://www.mtghouse.com/`**

Follow these steps to install the Aegis client:

1 Registering the Aegis Client.

When using the Aegis client for the first time, a license key will be requested. To obtain a valid license key, complete an online form on the Meetinghouse website giving the System ID. A license key will then be sent using e-mail. The System ID can be found when running the Aegis Client application for the first time. To apply the license key:

a Run the Aegis Client software.

b Go to *Aegis Client* > *Register* and select *Help* on the menu

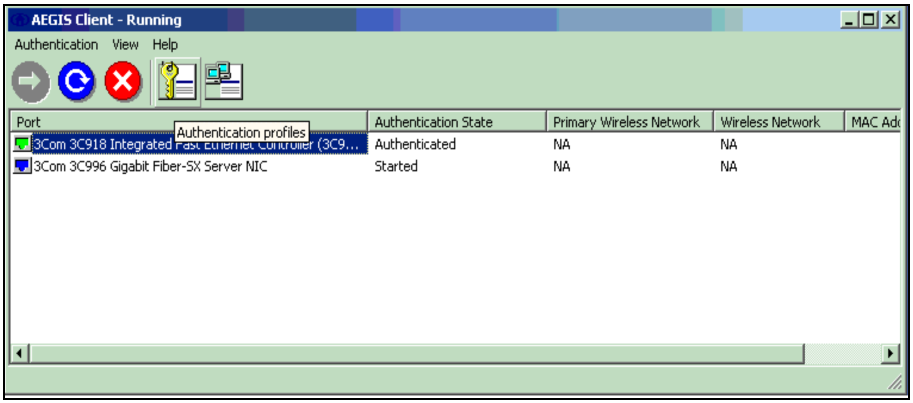
c Copy the License ID indicated at the bottom of the dialog box into the *License ID* field.

d Copy the License Key provided in the e-mail from Meetinghouse into the *License Key* field.

e Press *OK*

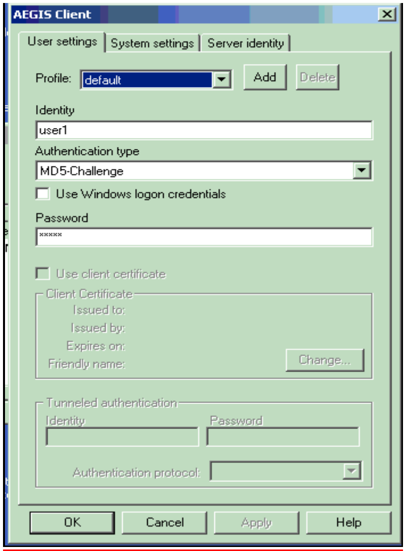
2 Configuring the Aegis Client

a Click the *Key* icon.



Port	Authentication State	Primary Wireless Network	Wireless Network	MAC Adc
3Com 3C918 Integrated Fast Ethernet Controller (3C9...	Authenticated	NA	NA	
3Com 3C996 Gigabit Fiber-SX Server NIC	Started	NA	NA	

b This screen will appear:



Profile: default

Identity
user1

Authentication type
MD5-Challenge

☐ Use Windows logon credentials

Password
*****

☐ Use client certificate

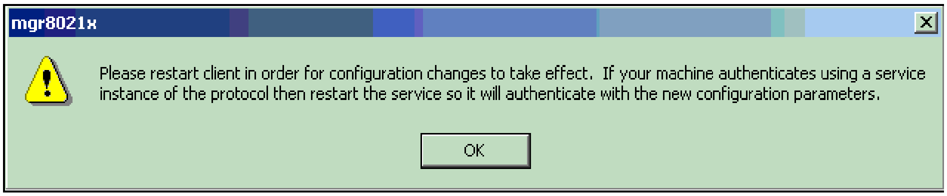
Client Certificate
Issued to:
Issued by:
Expires on:
Friendly name:

Tunneled authentication
Identity
Password
Authentication protocol:

c Leave the *Profile* as *default*. The *Identity* is an account created on the RADIUS Server with the *Password*.

d Click *OK* to finish the configuration.

e Restart the client either by rebooting, or stopping and re-starting the service.



Please restart client in order for configuration changes to take effect. If your machine authenticates using a service instance of the protocol then restart the service so it will authenticate with the new configuration parameters.

f Click the *OK* button, then return to the Aegis Client main interface. To restart the client, press the button with the red-cross. If authentication is successful, the icon will turn green.

C AUTHENTICATING THE SWITCH 5500 WITH CISCO SECURE ACS

This appendix covers the following topics:

- Cisco Secure ACS (TACACS+) and the 3Com Switch 5500
- Setting Up the Cisco Secure ACS (TACACS+) server

Cisco Secure ACS (TACACS+) and the 3Com Switch 5500

Cisco Secure ACS and TACACS+ are proprietary protocols and software created by Cisco, they provide similar functionality to a RADIUS server. Enterprises which contain a Cisco Secure ACS server with TACACS+ to provide centralized control over network and management access, can also deploy the 3Com Switch 5500 on their network.

Although 3Com does not directly support the proprietary TACACS+ protocol, 3Com switches can still be authenticated in networks which use TACACS+ and Cisco Secure ACS. The windows based Cisco Secure ACS server contains a built-in RADIUS server. This RADIUS server integrates seamlessly with the TACACS database allowing 3Com switches to authenticate correctly using the RADIUS protocol. Users that already exist on the TACACS+ server can be authorized using the TACACS+ or RADIUS server, an optional VLAN and QoS profile can be applied to the user. Network administrators can also be authorized using the built in RADIUS server, providing centralized access to 3Com switches.

The remainder of this appendix describes how to setup Cisco Secure ACS (v3.3) to operate using RADIUS with a 3Com switch.

Setting Up the Cisco Secure ACS (TACACS+) server

Configure the Cisco Secure ACS server through the web interface. Log into the web interface from any PC or localhost of the server, using port 2002 . For example:

```
http://TACACS-server:2002
```

The following sections detail the steps required to configure the Cisco Secure ACS (TACACS+) server to authenticate a Switch 5500 on your network and allow any additional users to login to the network:

- Adding a 3Com Switch 5500 as a RADIUS client
- Adding a User for Network Login

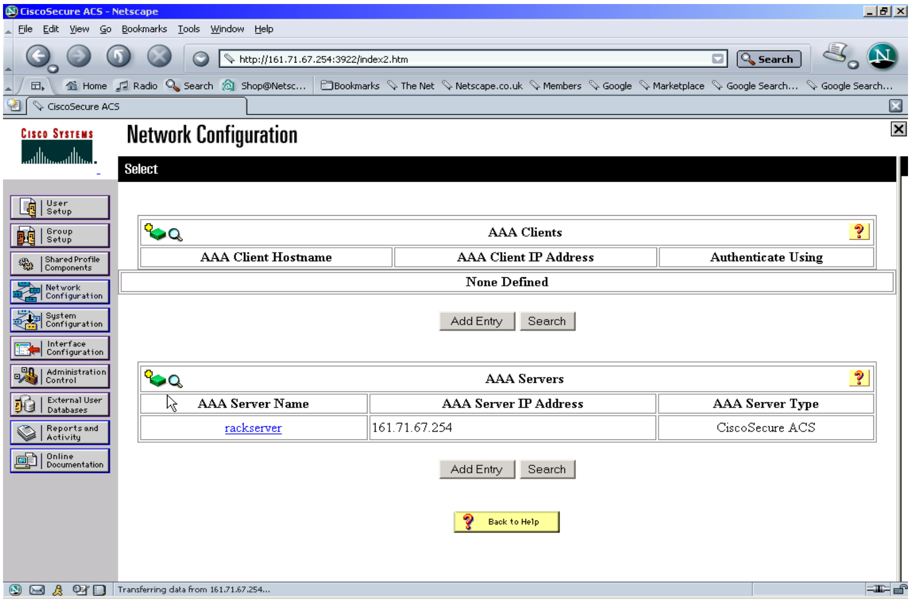
The final section details how to add a User (Network Administrator) for Switch Login to enable centralized management of the switch through the Cisco Secure ACS server.

- Adding a User for Switch Login

Adding a 3Com Switch 5500 as a RADIUS client

Once logged into the Cisco Secure ACS interface, follow these steps:

1 Select *Network Configuration* from the left hand side



CiscoSecure ACS - Netscape
File Edit View Go Bookmarks Tools Window Help
http://161.71.67.254:3922/index2.htm
Search
Home Radio Search Shop@Netsc... Bookmarks The Net Netscape.co.uk Members Google Marketplace Google Search... Google Search...
CiscoSecure ACS
Cisco Systems
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Transferring data from 161.71.67.254...

Network Configuration

Select

AAA Clients

AAA Client Hostname	AAA Client IP Address	Authenticate Using
None Defined		

Add Entry Search

AAA Servers

AAA Server Name	AAA Server IP Address	AAA Server Type
rackserver	161.71.67.254	CiscoSecure ACS

Add Entry Search

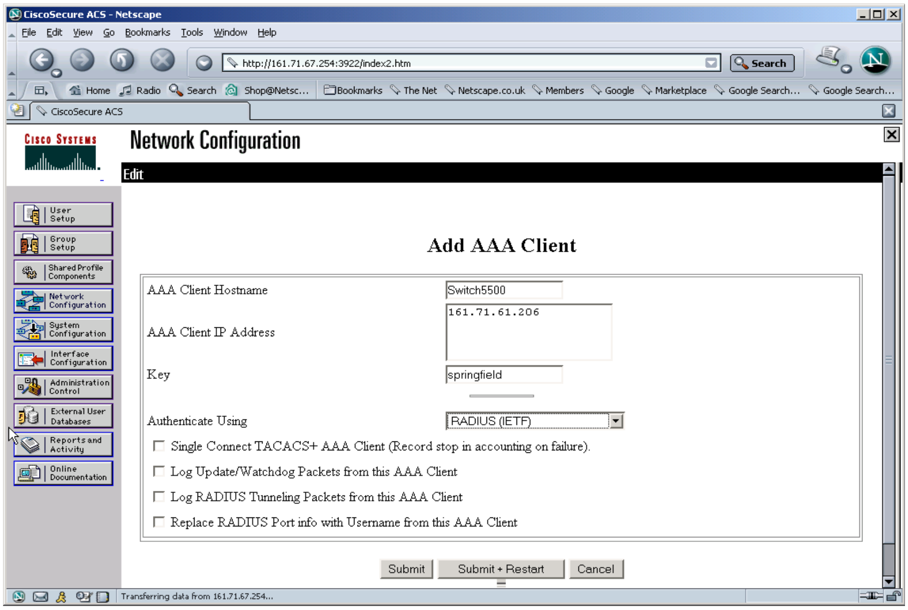
Back to Help

2 Select *Add Entry* from under AAA Clients.

3 Enter the details of the 3Com switch.

Spaces are not permitted in the AAA Client Host name.

An example is shown below



CiscoSecure ACS - Netscape
File Edit View Go Bookmarks Tools Window Help
http://161.71.67.254:3922/index2.htm
Search
Home Radio Search Shop@Netsc... Bookmarks The Net Netscape.co.uk Members Google Marketplace Google Search... Google Search...
CiscoSecure ACS
Cisco Systems
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Transferring data from 161.71.67.254...

Network Configuration

Edit

Add AAA Client

AAA Client Hostname	Switch5500
AAA Client IP Address	161.71.61.206
Key	springfield
Authenticate Using	RADIUS (IETF)

☐ Single Connect TACACS+ AAA Client (Record stop in accounting on failure).

☐ Log Update/Watchdog Packets from this AAA Client

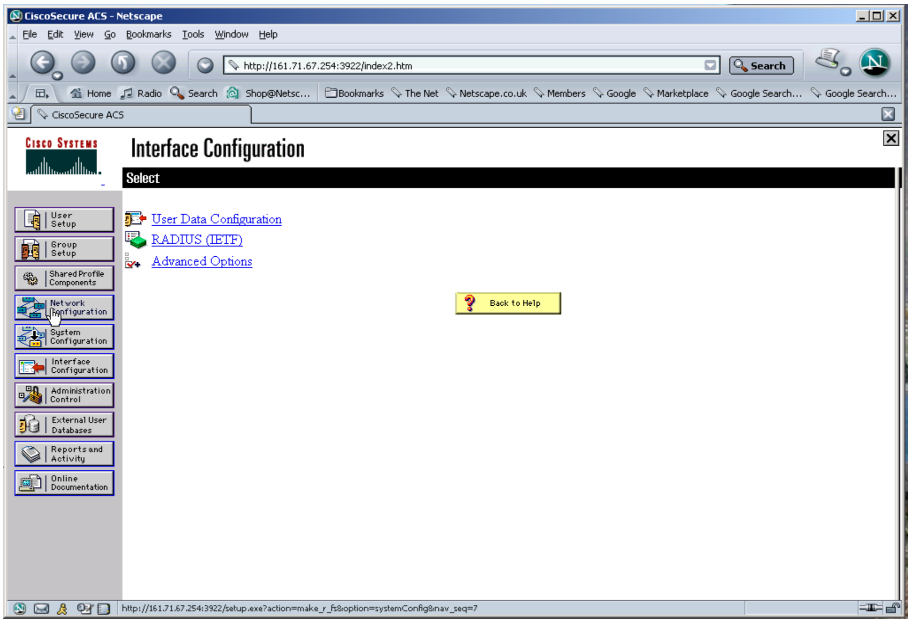
☐ Log RADIUS Tunneling Packets from this AAA Client

☐ Replace RADIUS Port info with Username from this AAA Client

Submit Submit + Restart Cancel

4 Select *Submit*. Do not restart the ACS server at this stage

5 Select *Interface Configuration* from the left hand side.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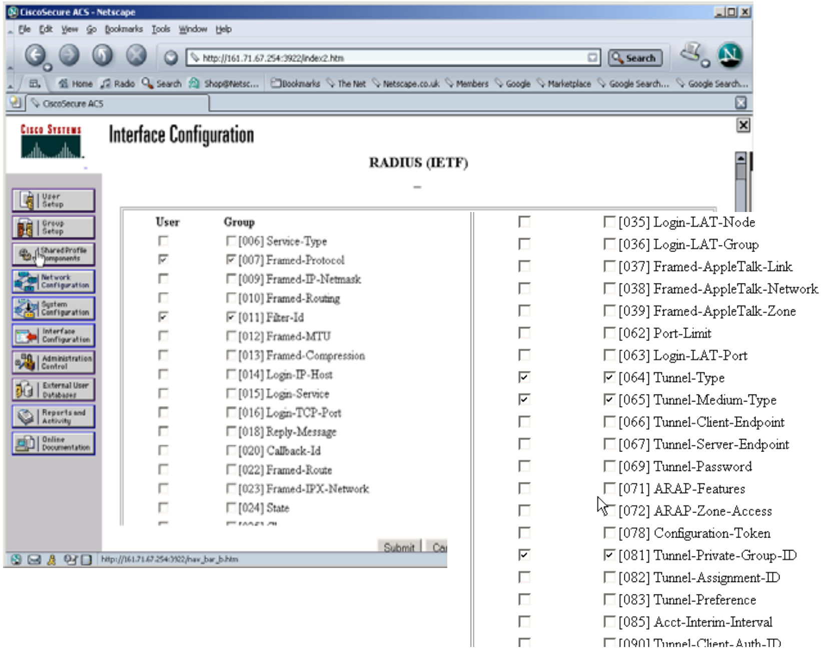
Home Radio Search Shop@Netsc... Bookmarks The Net Netscape.co.uk Members Google Marketplace Google Search... Google Search...
CiscoSecure ACS
Cisco Systems
Interface Configuration
Select
User Data Configuration
RADIUS (IETF)
Advanced Options
Back to Help
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
http://161.71.67.254:3922/setup.exe?action=make_r_fs&option=systemConfig&nav_seq=7

6 Select *RADIUS (IETF)* from the list under *Interface Configuration*.

7 Check the RADIUS attributes that you wish to install.

If you want to use auto VLAN and QoS, ensure that you have the following options selected for both the User and Group:

- Filter-ID
- Tunnel-Type
- Tunnel-Medium-Type
- Tunnel-Private-Group-I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CiscoSecure ACS
Cisco Systems
Interface Configuration
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Submit
Ca
http://161.71.67.254:3922/nav_bar_b.htm

RADIUS (IETF)

User	Group
☐	☐ [006] Service-Type
☑	☑ [007] Framed-Protocol
☐	☐ [009] Framed-IP-Netmask
☐	☐ [010] Framed-Routing
☑	☑ [011] Filter-Id
☐	☐ [012] Framed-MTU
☐	☐ [013] Framed-Compression
☐	☐ [014] Login-IP-Host
☐	☐ [015] Login-Service
☐	☐ [016] Login-TCP-Port
☐	☐ [018] Reply-Message
☐	☐ [020] Callback-Id
☐	☐ [022] Framed-Route
☐	☐ [023] Framed-IPX-Network
☐	☐ [024] State

☐	☐ [035] Login-LAT-Node
☐	☐ [036] Login-LAT-Group
☐	☐ [037] Framed-AppleTalk-Link
☐	☐ [038] Framed-AppleTalk-Network
☐	☐ [039] Framed-AppleTalk-Zone
☐	☐ [062] Port-Limit
☐	☐ [063] Login-LAT-Port
☑	☑ [064] Tunnel-Type
☑	☑ [065] Tunnel-Medium-Type
☐	☐ [066] Tunnel-Client-Endpoint
☐	☐ [067] Tunnel-Server-Endpoint
☐	☐ [069] Tunnel-Password
☐	☐ [071] ARAP-Features
☐	☐ [072] ARAP-Zone-Access
☐	☐ [078] Configuration-Token
☑	☑ [081] Tunnel-Private-Group-ID
☐	☐ [082] Tunnel-Assignment-ID
☐	☐ [083] Tunnel-Preference
☐	☐ [085] Acct-Interim-Interval
☐	☐ [090] Tunnel-Client-Auth-ID

8 Select *Submit*.

9 Repeat step 1 through step 8 for each Switch 5500 on your network. When all of the Switch 5500s have been added as clients to the Cisco Secure ACS server, restart the Secure ACS server by selecting *System Configuration* from the left hand side, then select *Service Control* and click *Restart*.

Adding a User for Network Login

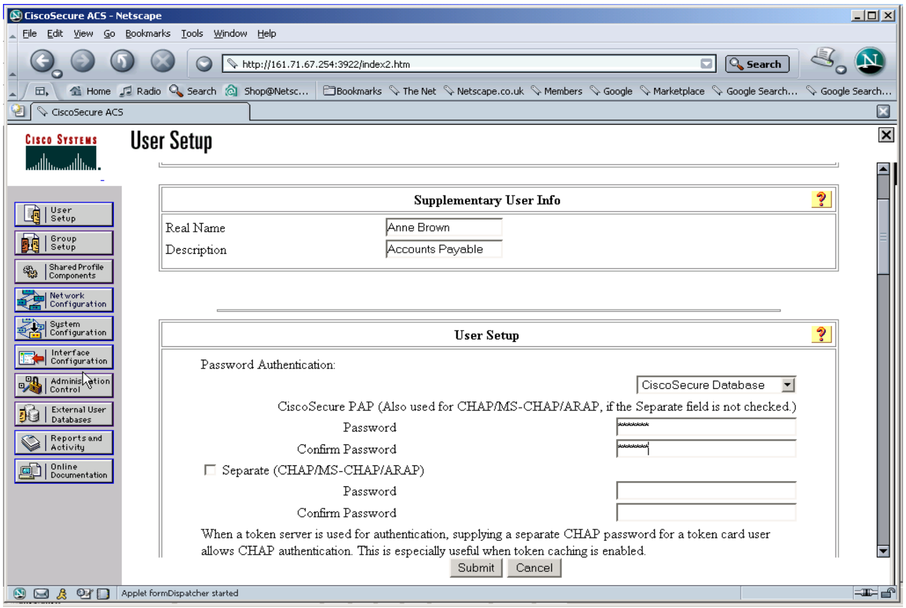
Existing users on a network with a Secure ACS server can be authorized using the TACACS+ or RADIUS server. New users connected through a Switch 5500 to the network need to be authorized using the RADIUS server. An optional VLAN and QoS profile can be applied to the user.

Follow these steps to add a user for Network Login.

1 Select *User Setup* from the left hand side

2 Enter the username, and select *Add/edit*

3 Enter the user information, scroll down to complete the user profile, including specific RADIUS attributes if required.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CiscoSecure ACS
Cisco Systems
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Submit
Cancel

http://161.71.67.254:3922/index2.htm

User Setup

Supplementary User Info

Real Name	Anne Brown
Description	Accounts Payable

User Setup

Password Authentication:

CiscoSecure Database

CiscoSecure PAP (Also used for CHAP/MS-CHAP/ARAP, if the Separate field is not checked.)

Password *******

Confirm Password *******

□ Separate (CHAP/MS-CHAP/ARAP)

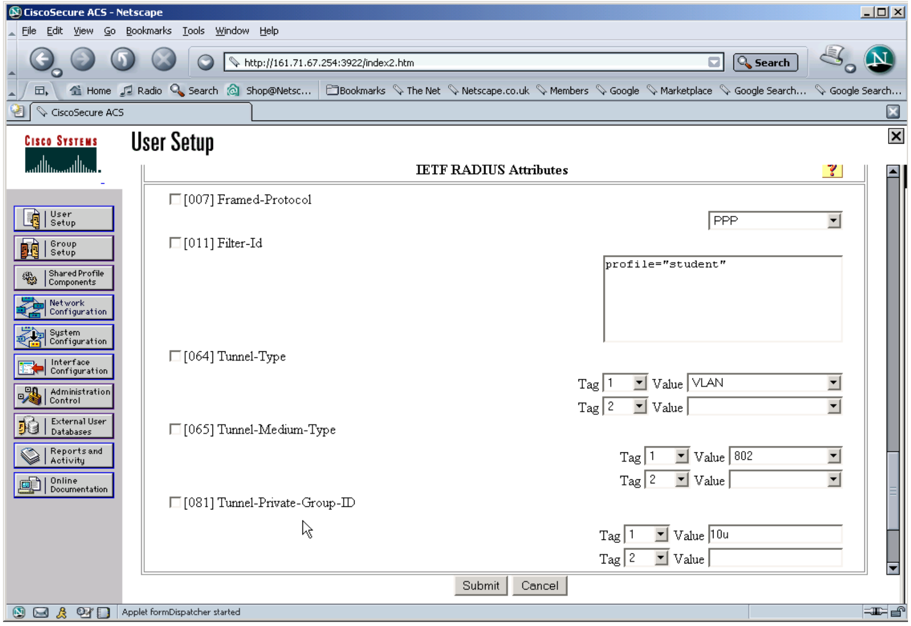
Password

Confirm Password

When a token server is used for authentication, supplying a separate CHAP password for a token card user allows CHAP authentication. This is especially useful when token caching is enabled.

Applet formDispatcher started

The screen below shows specific RADIUS attributes having been selected for the user. The user has the student profile selected and is assigned to VLAN 10 untagged.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Search
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CiscoSecure ACS
Cisco Systems
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Submit
Cancel
Applet formDispatcher started

User Setup

IETF RADIUS Attributes

□ [007] Framed-Protocol — PPP

□ [011] Filter-Id — profile="student"

□ [064] Tunnel-Type
Tag 1 Value VLAN
Tag 2 Value

□ [065] Tunnel-Medium-Type
Tag 1 Value 802
Tag 2 Value

□ [081] Tunnel-Private-Group-ID
Tag 1 Value 10u
Tag 2 Value

The RADIUS attributes need to have already been selected, see step 7 in Adding a 3Com Switch 5500 as a RADIUS client.

The User can now access the network through Network Login.

Adding a User for Switch Login

Adding a user for switch login is slightly more complex, as 3Com specific RADIUS attributes need to be returned to the 3Com Switch 5500. These RADIUS attributes define the access level of the the user to the management interface.

Follow these steps:

1 Add the required RADIUS attributes to the Cisco Secure ACS server, by editing an .ini file and compiling it into the Secure ACS RADIUS server using an application called **`csutil.exe`**.

For example:

a Create 3Com.ini file with the following contents:

```
[User Defined Vendor]
Name=3Com
IETF Code=43
VSA 1=3Com-User-Access-Level

[3Com-User-Access-Level]
Type=INTEGER
Profile=OUT
Enums=3Com-User-Access-Level-Values

[3Com-User-Access-Level-Values]
```

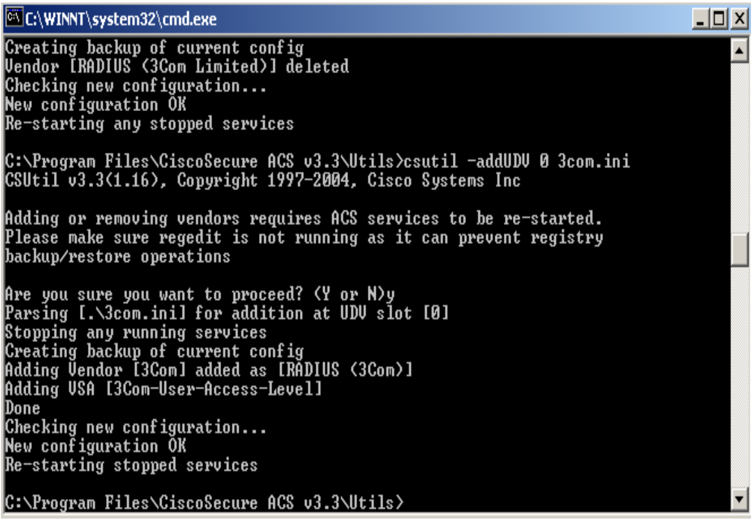
```
1=Monitor
2=Manager
3=Administrator
```

b Locate the application **`csutil.exe`**. in the utils directory of the install path (eg. C:\program files\Cisco Secure ACS\utils\).

c Copy the 3Com.ini file into the utils directory

d At the command prompt enter

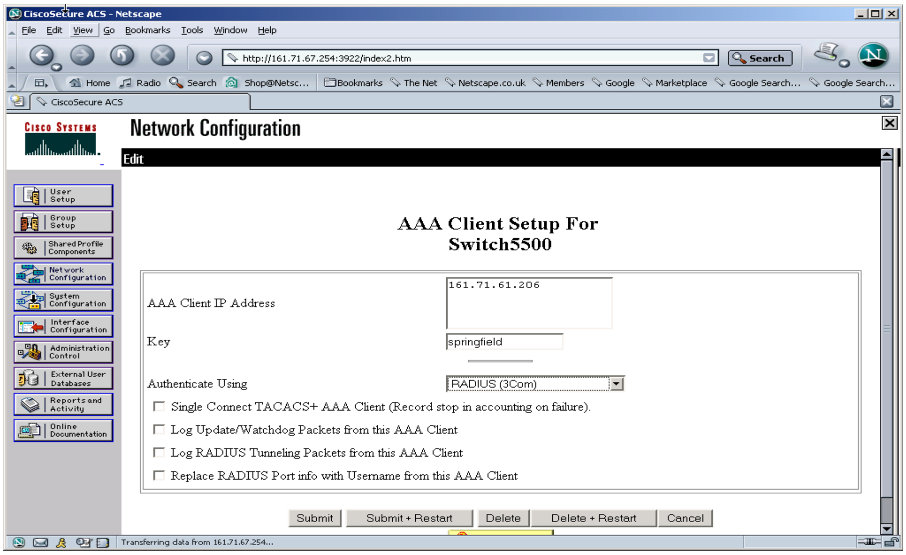
```
csutil -addUDV 0 3Com.ini
```



```
Creating backup of current config
Vendor [RADIUS (3Com Limited)] deleted
Checking new configuration...
New configuration OK
Re-starting any stopped services

C:\Program Files\CiscoSecure ACS v3.3\Utils>csutil -addUDV 0 3com.ini
CSUtil v3.3(1.16), Copyright 1997-2004, Cisco Systems Inc

Adding or removing vendors requires ACS services to be re-started.
Please make sure regedit is not running as it can prevent registry
backup/restore operations

Are you sure you want to proceed? (Y or N)y
Parsing [.\3com.ini] for addition at UDV slot [0]
Stopping any running services
Creating backup of current config
Adding Vendor [3Com] added as [RADIUS (3Com)]
Adding VSA [3Com-User-Access-Level]
Done
Checking new configuration...
New configuration OK
Re-starting stopped services

C:\Program Files\CiscoSecure ACS v3.3\Utils>
```

This will stop the Cisco Secure ACS server, add the RADIUS information (by adding the contents of 3Com.ini to UDV (User Defined Vendor) slot 0),and then restart the server. Once complete, log into the Secure ACS server again and complete step 2 and step 3.

2 To use the new RADIUS attributes, a client needs to be a user of RADIUS (3Com) attributes. Select *Network Configuration* from the left hand side and select an existing device or add a new device. In the *AAA Client Setup* window select *RADIUS (3COM)* from the *Authenticate Using* pull down list. .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CiscoSecure ACS
CISCO SYSTEMS
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Submit
Submit + Restart
Delete
Delete + Restart
Cancel
Transferring data from 161.71.67.254...

Network Configuration

Edit

AAA Client Setup For Switch5500

AAA Client IP Address: 161.71.61.206

Key: springfield

Authenticate Using: RADIUS (3Com)

□ Single Connect TACACS+ AAA Client (Record stop in accounting on failure).

□ Log Update/Watchdog Packets from this AAA Client

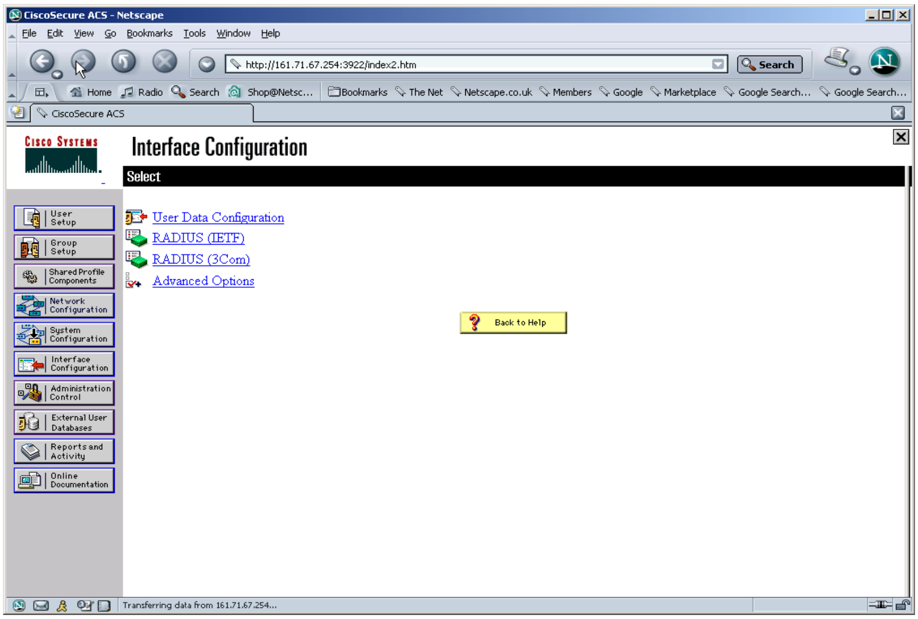
□ Log RADIUS Tunneling Packets from this AAA Client

□ Replace RADIUS Port info with Username from this AAA Client

3 Select *Submit+Restart*

The IETF attributes will still be available to the device, the 3Com attributes are simply appended to them.

4 Select *Interface Configuration*, followed by *RADIUS (3Com)*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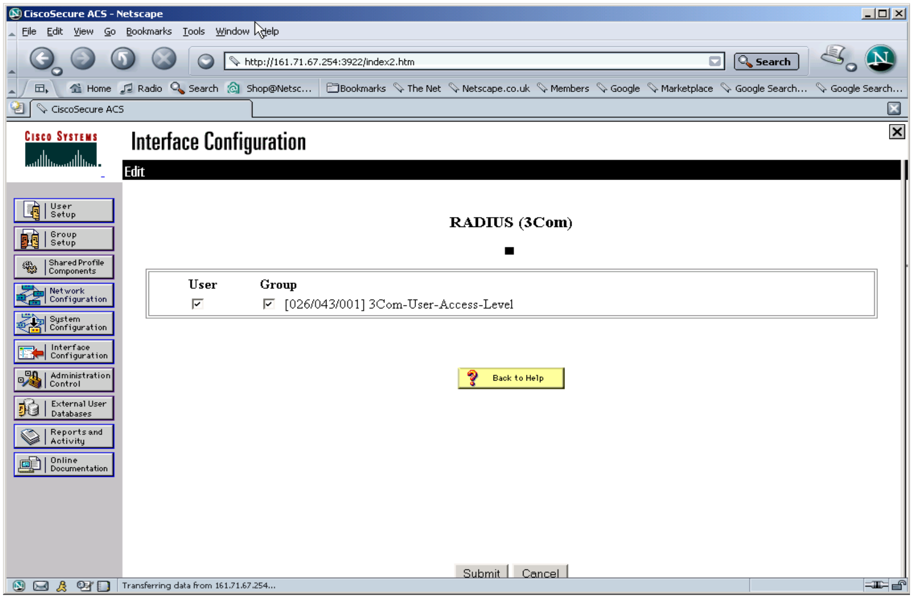
CiscoSecure ACS
CISCO SYSTEMS
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Back to Help
Transferring data from 161.71.67.254...

Interface Configuration

Select

- User Data Configuration
- RADIUS (IETF)
- RADIUS (3Com)
- Advanced Options

5 Ensure that the *3Com-User-Access-Level* option is selected for both *User* and *Group* setup, as shown below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CiscoSecure ACS
CISCO SYSTEMS
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Back to Help
Submit
Cancel
Transferring data from 161.71.67.254...

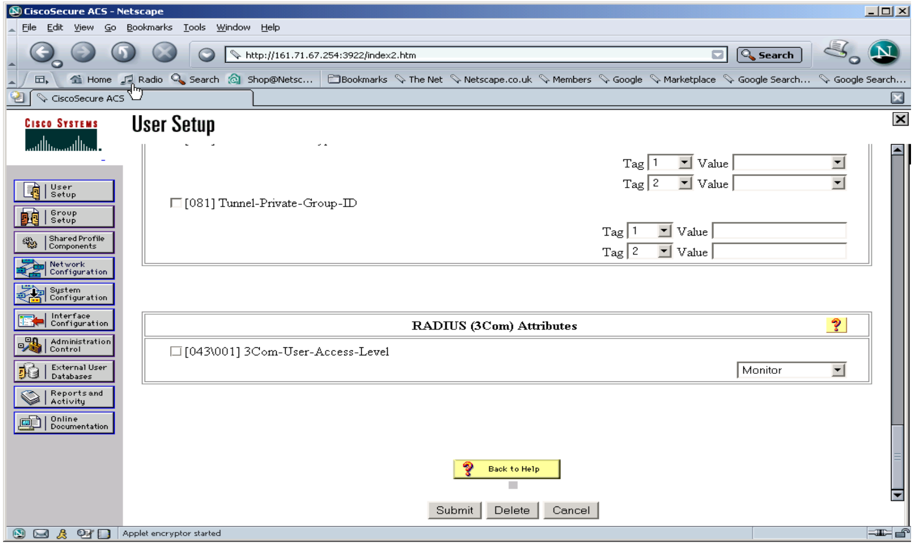
Interface Configuration

Edit

RADIUS (3Com)

User	Group	
☑	☑	[026/043/001] 3Com-User-Access-Level

6 Select *User Setup* and either modify the attributes of an existing user (select *Find* to display the User List in the right hand window) or *Add* a new user (see Adding a User for Network Login). Set the user’s access level to the 3Com Switch 5500 by scrolling to the bottom of the user profile where there should be the option for configuring the access level as shown below:



User Setup

Tag 1 Value
Tag 2 Value

□ [081] Tunnel-Private-Group-ID

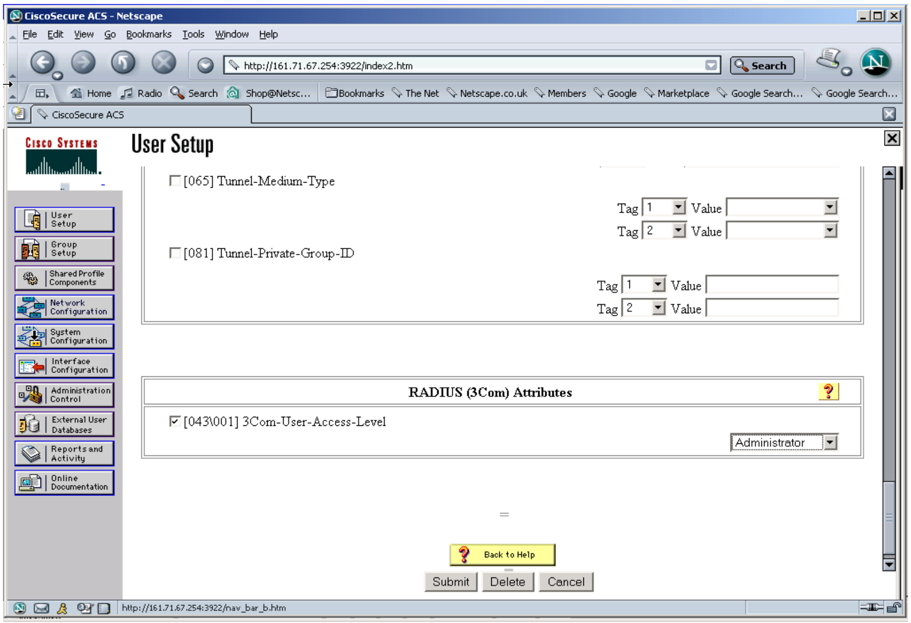
Tag 1 Value
Tag 2 Value

RADIUS (3Com) Attributes

□ [043\001] 3Com-User-Access-Level

Monitor

7 In the *RADIUS (3Com) Attribute* box , check *3Com-User-Access-Level* and select *Administrator* from the pull down list, see below:


CiscoSecure ACS - Netscape
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http://161.71.67.254:3922/index2.htm
Search
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CiscoSecure ACS
Cisco Systems
User Setup
Group Setup
Shared Profile Components
Network Configuration
System Configuration
Interface Configuration
Administration Control
External User Databases
Reports and Activity
Online Documentation
Back to Help
Submit
Delete
Cancel
http://161.71.67.254:3922/nav_bar_b.htm

User Setup

□ [065] Tunnel-Medium-Type

Tag 1 Value
Tag 2 Value

□ [081] Tunnel-Private-Group-ID

Tag 1 Value
Tag 2 Value

RADIUS (3Com) Attributes

☑ [043\001] 3Com-User-Access-Level

Administrator

8 Select *Submit*.

The Switch 5500 can now be managed by the Network Administrator through the CISCO Secure ACS server.

D

3COM XRN

This section explains what 3Com XRN™ (eXpandable Resilient Networking) is and how you can use it to benefit your network. It also explains how to implement XRN on your network.

This chapter contains the following sections:

- What is XRN?
- XRN Terminology
- Benefits of XRN
- XRN Features
- How to Implement XRN—Overview
- Important Considerations and Recommendations
- Network Example using XRN
- Recovering your XRN Network

The sections below provide supplementary information that are not essential reading, but may be of interest to advanced users.

- How XRN Interacts with other 3Com Switches
- How XRN Interacts with other Features
- How a Failure affects the Distributed Fabric

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Command Reference Guide supplied in PDF format on the 3Com Web site at www.3com.com.

What is XRN?

XRN (eXpandable Resilient Network) is a 3Com LAN technology built into the software and hardware of your Switch that offers high availability, scalability, and connectivity.

Supported Switches

XRN is supported by the 3Com Operating System on the following Switches installed with Version 1.0 software or later:

Table 690 3Com Switch 5500 Support for XRN Distributed Fabric

3Com Switch	XRN support
Switch 5500-SI 28-Port (3CR17151-91)	Only supports DDM and DLA*
Switch 5500-SI 52-Port (3CR17152-91)	Only supports DDM and DLA*
Switch 5500-EI 28-Port (3CR17161-91)	Full XRN functionality
Switch 5500-EI 52-Port (3CR17162-91)	Full XRN functionality
Switch 5500-EI PWR 28-Port (3CR17171-91)	Full XRN functionality
Switch 5500-EI PWR 52-Port (3CR17172-91)	Full XRN functionality
Switch 5500-EI 28-Port FX (3CR17181-91)	Full XRN functionality
Switch 5500G-EI 24-Port (3CR17254-91) (no PSU)	Full XRN functionality
Switch 5500G-EI 48-Port (3CR17255-91) (no PSU)	Full XRN functionality
Switch 5500G-EI 24-Port (3CR17250-91) (non-PoE PSU)	Full XRN functionality
Switch 5500G-EI 48-Port (3CR17251-91) (non-PoE PSU)	Full XRN functionality
Switch 5500G-EI 24-Port (3CR17252-91) (PoE PSU)	Full XRN functionality
Switch 5500G-EI 48-Port (3CR17253-91) (PoE PSU)	Full XRN functionality

* Distributed Device Management, Distributed Link Aggregation

XRN is standards based. The 3Com only proprietary technology operates across the Fabric Interconnect ports.

XRN Terminology

This section contains a glossary of the common XRN terminology.

eXpandable Resilient Network (XRN)

XRN is developed by 3Com that allows you to implement fault tolerant, high performance and scalable multilayer networks.

Fabric Interconnect

Fabric Interconnect is the interconnection between XRN Switches that form the Distributed Fabric.

XRN Distributed Fabric (Distributed Fabric)

XRN Distributed Fabric is the term used to describe interconnected devices supporting XRN.

Distributed Device Management (DDM)

DDM allows Switches in the XRN Distributed Fabric to behave as a single managed entity, irrespective of the form factor or Switch deployed. For further information see page 673.

Distributed Link Aggregation (DLA)

DLA is the configuration of Aggregated Links across interconnected devices in the Distributed Fabric. 3Com and non-3Com devices can connect to the XRN Distributed Fabric using DLA. For further information see page 674.

Distributed Resilient Routing (DRR)

DRR provides distributed routing and router resiliency across an XRN Distributed Fabric. For further information see page 673.

Benefits of XRN

The benefits of XRN include:

- Increased environmental resilience provided by:
  - Hardware and Software redundancy per unit or across the Distributed Fabric.
  - Distributed management across the Distributed Fabric.
  - Distributed Link Aggregation across the Distributed Fabric.
  - Distributed Resilient Routing across the Distributed Fabric.
- Increased network performance provided by:
  - Switching capacity that increases as you add a Switch to the Fabric. So network performance and resilience expand as the Fabric grows.
  - Link Aggregation supported across the Distributed Fabric.
- Flexibility provided by:
  - Support across any of the Switches within an individual 3Com Switch 5500 family to create an XRN Distributed Fabric.

XRN Features

This section describes the key features of XRN.

Distributed Device Management (DDM)

DDM provides single IP address management across the interconnected Switches that form the Distributed Fabric. This allows the entire Distributed Fabric to be managed and configured as a single managed entity. In the event of failure in one of the Switches in the Distributed Fabric, management access to the remaining Switch is retained on the same IP address.

DDM allows you to manage the Distributed Fabric using the command line interface (CLI), Web interface, or SNMP.

DDM provides you with the ability to carry out the following:

- Single step Switch software upgrades across the Distributed Fabric (provided the Switches are of the same family).
- Distributed Fabric-wide configuration of all software features.
- Configuration of port-specific software features across the Distributed Fabric using a single management interface.

Distributed Resilient Routing (DRR)

DRR allows the Switches in the Distributed Fabric to act as a single logical router which provides router resiliency in the event of failure in one of the interconnected Switches. With DRR, Switches in the Distributed Fabric are routing, which significantly increases the overall Layer 3 capacity of the core of the network.

DRR can intelligently distribute the routing load across both Switches in the Distributed Fabric, which maximizes routing performance and makes full use of bandwidth capacity.

Switches in the Distributed Fabric provide Layer 3 local forwarding for directly connected hosts and devices.

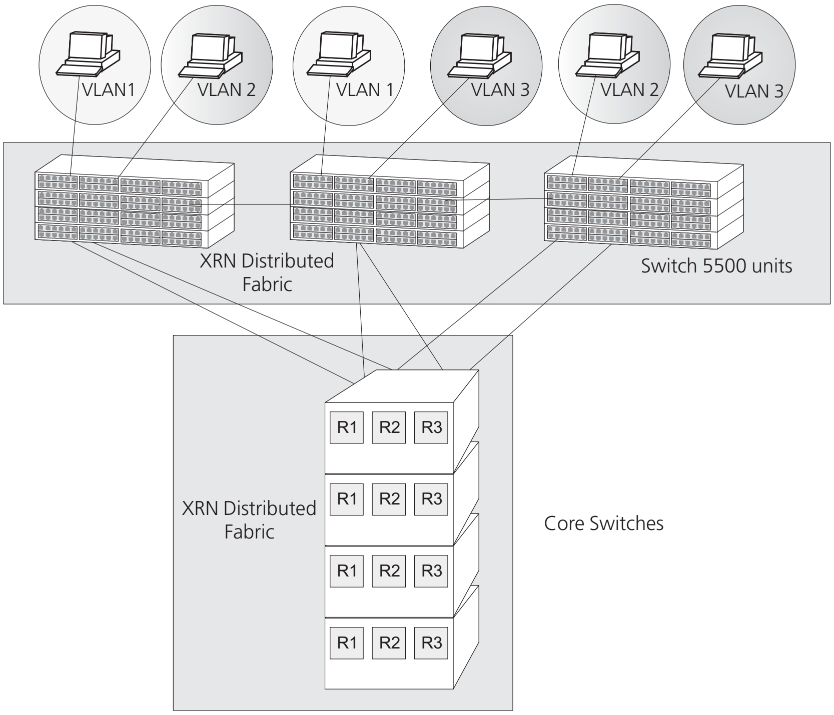
Switch units within the Distributed Fabric provide the same router interfaces and mirror each other's routing tables. This allows each unit to keep the routing local to the unit for locally connected hosts and devices.

In the example shown in Figure 178, there is a single logical router across the XRN Distributed Fabric with router interfaces (R1, R2, and R3) shared by both units.

If there is a loss of a unit in an XRN Distributed Fabric it does not affect routing provided you are using Distributed Link Aggregation or the devices in the wiring closet are multihomed.

DRR is an XRN-specific implementation that only operates on XRN within the Distributed Fabric. However it will interoperate with other routers outside of the XRN Distributed Fabric.

Figure 178 Network Example illustrating Distributed Resilient Routing



Distributed Link Aggregation (DLA)

DLA ensures that all member ports of an aggregated link distribute the traffic flow across the Distributed Fabric. This provides resilience and enhanced performance. Failure in one of the member links in the Aggregated Link will not affect communication to the Distributed Fabric as traffic will be forwarded using the remaining member links. Details of the the number of member links and Aggregated Links supported by the Switches in a Distributed Fabric are listed in Table 691.

Table 691 Aggregated Links and Member Links Supported within a Fabric

Switch Family	Max number of member links	Number of Aggregated Links
Switch 5500-SI Family	8 Fast Ethernet or 4 Gigabit Ethernet	14 (28 port) or 26 (52 port) 8 per stack
Switch 5500-EI Family	8 Fast Ethernet or 4 Gigabit Ethernet	14 (28 port) or 26 (52 port) 8 per stack
Switch 5500G-EI Family	8 Gigabit Ethernet or 4 10Gbps Ethernet	32 per unit/stack

Distributed Link Aggregation Example

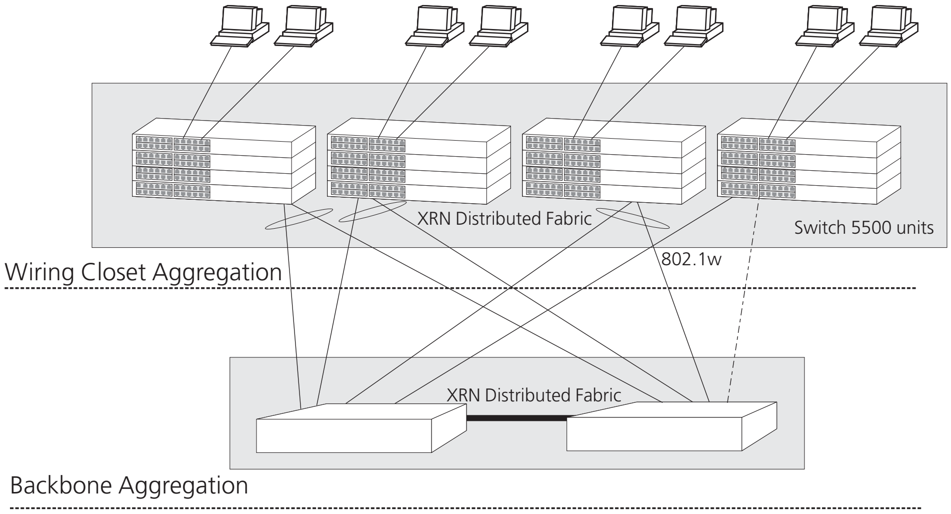
You can also use DLA to create highly resilient network backbones, supporting multihomed links to the wiring closets as shown in Figure 179.

Intelligent local forwarding ensures that each Switch in the XRN Distributed Fabric forwards traffic to local Link Aggregation ports rather than across the Fabric Interconnect, thereby reducing network traffic.

You can also use resilient links or STP/RSTP for resilience, however, this does not provide the bandwidth advantage of link aggregation.

For more information about STP/RSTP refer to Chapter 17 "Network Protocol Operation".

Figure 179 Distributed Link Aggregation at the Network Backbone



How to Implement XRN—Overview

This section provides an overview on how to implement XRN in your network. Following the steps below will ensure that your XRN network operates correctly.

1. Design your network using XRN Distributed Fabrics, taking into account all the important considerations and recommendations (see "Important Considerations and Recommendations" on page 676).
2. Ensure that the Switches you plan to interconnect to create an XRN Distributed Fabric are of the same Family and are running the same version of software.
3. Create the XRN Distributed Fabric as follows:
   - **Switch 5500 Family**—using the two SFP ports (27/28 or 51/52 depending on type of Switch), however, *before* connecting up, enable the Fabric ports on the Switch units using the instructions in the "Creating an XRN Distributed Fabric" chapter in the Getting Started Guide that accompanies your Switch.
   - **Switch 5500G Family—**using the built-in dedicated Fabric ports connected using a stacking cable as described in the "Creating an XRN Distributed Fabric" chapter in the Getting Started Guide that accompanies your Switch.

   Once the Switches are interconnected to create an XRN Distributed Fabric, they behave as if they were one Switch and can be managed using a single IP address.
4. Set up the IP information so you can begin managing and configuring the Switches in the Distributed Fabric.

For more information on setting up IP information for your Switch so it is ready for management, refer to the Getting Started Guide that accompanies your Switch.

5. If VLANs are required (for example, if the network is in a Layer 3 environment), create the VLANs and assign VLAN membership to all ports.
6. Configure the Aggregated Links either manually or automatically using LACP, ensuring they are tagged members of all VLANs.
7. Configure the router IP interfaces.

For detailed descriptions of the web interface operations and the command line interface (CLI) commands that you require to manage the Switch please refer to the Command Guide supplied in PDF format on the CD-ROM that accompanies your Switch or on the 3Com Web site.

Important Considerations and Recommendations

This section contains important points and recommendations that you need to consider or be aware of when designing a network using XRN .

- Bandwidth across the XRN Interconnect is detailed in Table 692. Intelligent Local Forwarding and DRR ensures efficient use of bandwidth across the Fabric Interconnect.

Table 692 Bandwidth across the XRN Interconnect

Switch Model	Bandwidth across the XRN Interconnect
Switch 5500-SI Family	1Gbps, 2 Gbps (full duplex)
Switch 5500-EI Family	1Gbps, 2 Gbps (full duplex)
Switch 5500G-EI Family	48 Gbps, 96 Gbps (full duplex)

- When you create a Distributed Fabric the relevant port-based tables do not double in size, they remain as they were.
- When Switch 5500 units are in an XRN Distributed Fabric their unit IDs are user configurable.
- The maximum number of Switch units that can be interconnected is shown in Table 693.

Table 693 Number of Switch units that can create an XRN Distributed Fabric

Switch Model	Max number of units	Method
Switch 5500-EI Family	8	Loop
Switch 5500G-EI Family	8	Loop

- It is not possible to interconnect a 3Com Switch 5500 with any other 3Com device or mix Enhanced Image (EI) Switch 5500 units with Standard Image (SI) units.
- It is not possible to create an XRN Distributed Fabric with Switches from different 3Com Switch 5500 families, for example, a Switch 5500 EI with a 5500G-EI. You can only use Switches within an individual 3Com Switch 5500 family to create an XRN Distributed Fabric, for example, a Switch 5500-EI 52-Port with a Switch 5500-EI 28-Port.
- 3Com strongly recommends that you upgrade all Switches to be interconnected to the latest software agent.
- 3Com recommends that you initialize a Switch unit that has previously been used elsewhere in your network before you interconnect to an existing unit. If you do not initialize the unit, problems may be caused by conflicting Switch configurations.
- When a port is operating in XRN mode it will no longer be configurable in the normal way, that is, you cannot control port features such as auto-negotiation, VLANs, static addresses, STP, Aggregated Links, Resilient Links, and so on.

Recommendations for Achieving Maximum Resilience

To achieve maximum network-level resilience 3Com recommends that:

- Servers and wiring closets are multihomed. That is, each server or wiring closet is connected to both units within the Distributed Fabric.
- On all multi-homed links you use link aggregation (preferably configured automatically using LACP rather than configured manually) across an XRN Distributed Fabric, and you have STP/RSTP enabled across your network. (See "Legacy Aggregated Links" on page 682 for more information.)

  If you are unable to use link aggregation on multihomed links, then STP/RSTP should be used as the second option, and the last option would be to use resilient links.

  This implementation increases the level of fault tolerance as it also protects against loss of the physical interfaces at the core.
- If you use the Switch 5500 in a Distributed Fabric further resilience can be achieved by utilizing a redundant power source.
- You always have STP/RSTP enabled on your network to prevent the risk of loops occurring if you have links that are multihomed, particularly if you are using link aggregation.

- All multihomed links and alternate paths must carry *all* VLANs, and packets must be tagged.
- The Distributed Fabric is the STP root bridge.
- Individual port members of each aggregated link must have VLAN membership manually configured before the aggregated link is set up. You must not rely on port members inheriting VLAN membership configuration from the aggregated link. (See "VLANs" on page 681 for more information.)
- If you are using resilient links, these must be configured on the remote unit, not on the units within the Distributed Fabric.

If you follow the 3Com recommendations, should there be a unit or interconnect failure within the Distributed Fabric, traffic flow will be maintained at all times. If you want to know more detail about how the Distributed Fabric behaves in certain failure scenarios, see "How a Failure affects the Distributed Fabric" on page 684.

Unit ID Numbering Mechanism

This section outlines the mechanisms that the Switch 5500 Family uses to determine the unit IDs for management purposes.

When a Fabric is created using the Switch 5500 the unit numbering can be determined in two ways.

- You can manually assign unit IDs 1 to 8 to specific units using the `change[self-unit, unit-id] to [1-8, auto-numbering]` command from the System View. If you manually assign unit IDs to a Switch using the `change` command the IDs will be retained after a power cycle.

  If you add a unit to a Fabric that has previously been manually configured with a unit ID and this conflicts with an ID already within the Fabric, then the Switch with the lowest MAC address assumes the ID in question and the other unit will automatically renumber.

3Com recommends that you manually assign the unit IDs within the Fabric if you wish to have predictability of knowing which units have which IDs at all times.

- Fabric topology is 'discovered' and the units auto-number their IDs.

Adding and removing units from the Fabric does not cause any renumbering to occur and the Fabric will continue to work normally. Renumbering only occurs when the Fabric is next power cycled if the units are configured to auto-number.

The unit LEDs will display the unit number in the Fabric, from 1 to 8.

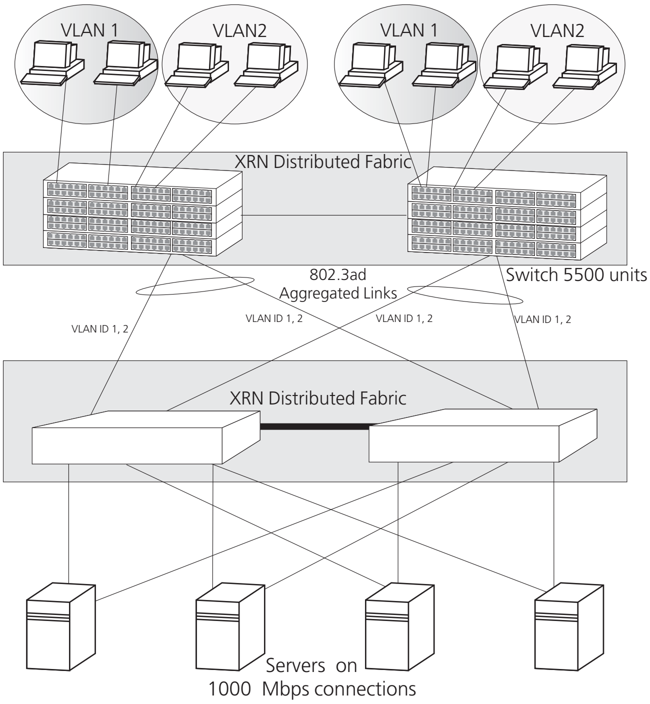
Network Example using XRN

The following example explains how to set up XRN in a network to gain maximum resilience using two Distributed Fabrics. The same process scales for larger networks if you are using multiple XRN Distributed Fabrics.

XRN Distributed Fabric Network

The example in Figure 180 shows a network with two Switches interconnected to create a single XRN Distributed Fabric in the Server Distribution section of the network, this Fabric in turn is connected to a Fabric within the Core of the network. The servers are multi-homed as are the Switch 5500 Fabrics to create a highly resilient network.

Figure 180 A Dual XRN Distributed Fabric Network



How to Set up this Network

This section provides information on how to configure an XRN network as shown in Figure 180. It assumes you have carried out step 1 to step 4 as detailed in "How to Implement XRN—Overview" on page 676.

1 Enable LACP on the required ports, ensuring you have not connected your devices to the Distributed Fabric yet as you must configure your VLANs before the aggregated links are configured. Individual port members of each aggregated link must have VLAN membership explicitly set, that is, manually configured, before the aggregated link is set up. You must not rely on port members inheriting VLAN membership configuration from the aggregated link.

2 Create the VLANs and assign VLAN membership to all ports.

3 Connect up your ports. As LACP was enabled in step 1 the aggregated links will now automatically configure themselves.

4 Configure the router IP interfaces.

5 Ensure that RSTP is enabled across the network.

Legacy aggregated links are not resilient to an interconnect failure. Hence the 3Com recommendation to use IEEE 802.3ad aggregated links (LACP) for maximum resilience.

If an automatic aggregated link (created by LACP) contains ports with different VLAN membership, the aggregated link will inherit the VLAN membership of the first port that comes up in the aggregated link. It will override any pre-defined VLAN membership for the aggregated link.

Recovering your XRN Network

In the event of a failure within your XRN network, 3Com recommends that you follow the recommendations below.

Unit Failure

The steps below outline the procedure to recover your XRN network in the event of a unit failure within your Distributed Fabric.

1. Obtain a Switch and ensure it is installed with the same software version as the failed Switch.
2. Initialize the new Switch so it is operating with its factory default settings.
3. Connect the new Switch to the operational Switch to form the Distributed Fabric.
4. IP interfaces and VLANs will be converged between the Switches, that is, IP interfaces and the creation of the VLANs is done automatically on the new Switch. However, any port-based configuration must be done manually.
5. If any Switch features, for example, IGMP snooping or passwords are not set to default state then these should be reset after the new Distributed Fabric has been formed.

Interconnect Failure

The steps below outline the procedure to recover your XRN network in the event of an interconnect failure within your Distributed Fabric.

1. Obtain a new cable.
2. Install the new cable.

How XRN Interacts with other 3Com Switches

This section provides guidelines on connecting legacy and new 3Com Switches (including non-XRN enabled Switches) to an XRN Distributed Fabric. Table 694 lists the features supported by the Switches that can be used when connecting to a Distributed Fabric.

For detailed information on how the Switch features interact with XRN , refer to the "How XRN Interacts with other Features" on page 681.

Table 694 Features supported by 3Com Switches connecting to an XRN Distributed Fabric

3Com Switch	Resilient Links	STP/ RSTP	MSTP	Manual Link Aggregations	LACP Link Aggregations
3Com Switch 1100 Family	Yes	Yes	No	Yes	No
3Com Switch 3300 Family	Yes	Yes	No	Yes	No
3Com Switch 4200 Family	Yes	Yes	No	Yes	Yes
3Com Switch 4400 Family	Yes	Yes	No	Yes	Yes
3Com Switch 3800 Family	No	Yes	No	Yes	Yes
3Com Switch 4900 Family	Yes	Yes	No	Yes	Yes
3Com Switch 40x0 Family	Yes	Yes	No	Yes	Yes
3Com Switch 4005 Family	No	Yes	No	Yes	Yes
3Com Switch 4007 Family	No	Yes	No	Yes	No
3Com Switch 5500 Family	No	Yes	No	Yes	Yes
3Com Switch 5500G Family	No	Yes	No	Yes	Yes
3Com Switch 7700 Family	No	Yes	Yes	Yes	No
3Com Switch 8800 Family	No	Yes	Yes	Yes	No

How XRN Interacts with other Features

This section provides supplementary information on how XRN interacts with other software features supported by your Switch.

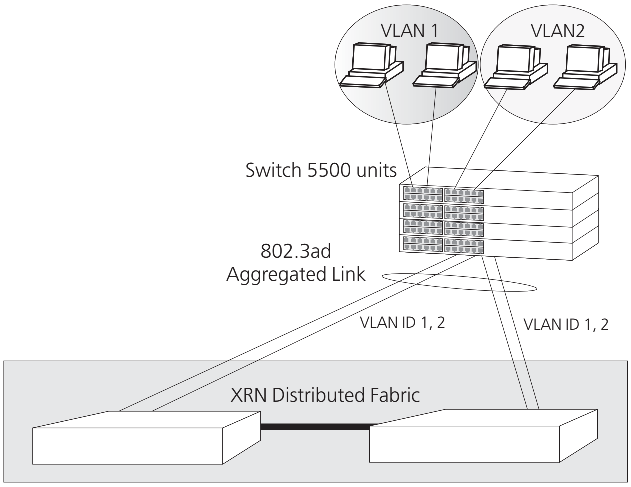
VLANs

Figure 181 shows a single aggregated link, created automatically using LACP, connecting the Switch 5500 stack to the Distributed Fabric. The Distributed Fabric will take its VLAN membership from a port within the Switch 5500 stack .

If the Fabric Interconnect fails the aggregated link will split, creating two separate aggregated links (as shown in Figure 182). If the ports within the Switch 5500 stack each have different VLAN membership, this will mean the two newly formed aggregated links will also have different VLAN membership. This will result in the different VLANs not being able to communicate.

3Com recommends that you set individual ports that are to be members of an aggregated link to the same VLAN membership. This ensures communication between all VLANs at all times.

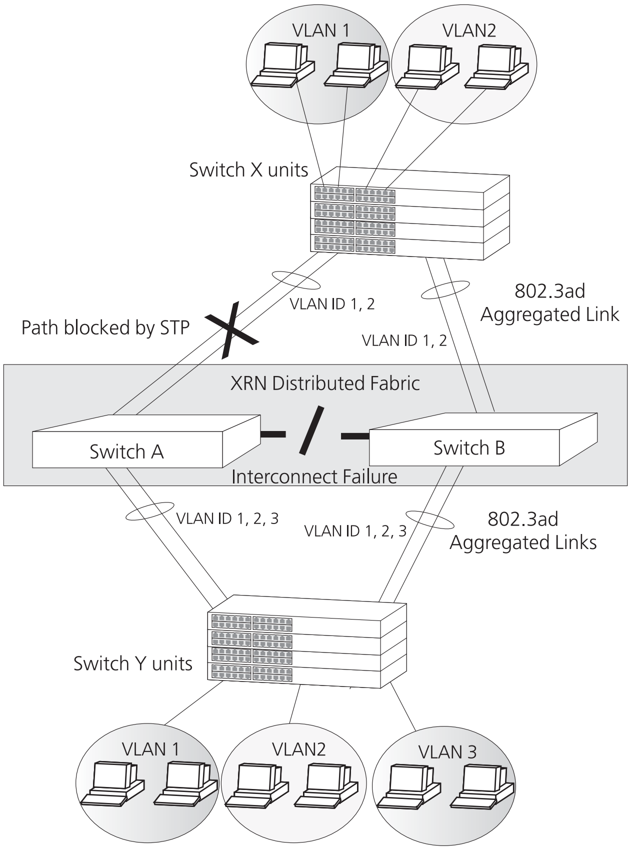
Figure 181 How XRN interacts with VLANs—Example 1



The Distributed Resilient Routing (DRR) feature also requires that all units can communicate with each other on all VLANs. This ensures that on an interconnect failure all units can communicate with each other.

For example in Figure 182 the interconnect has failed and only one of the units in the Distributed Fabric will act as the router. STP will detect a potential loop and block a path of its choosing, in this example it has blocked the path between Switch X units and Switch A. If ports have different VLAN membership as shown here there will be loss of communication between VLANs 1 and 2.

Figure 182 How XRN interacts with VLANs—Example 2



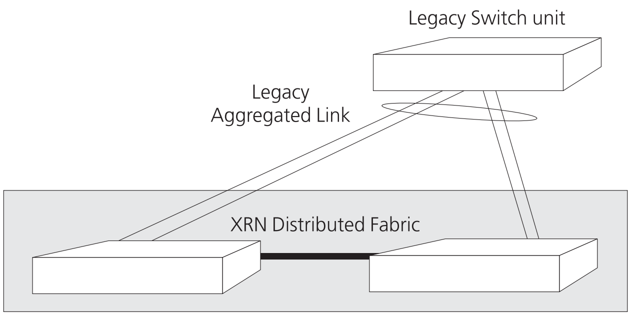
Legacy Aggregated Links

Legacy aggregated links, will react in the normal way if a unit within the Distributed Fabric fails, that is, all traffic will be redirected down the link(s) to the unit that is still operating.

However, in Figure 183, if the interconnect fails, the aggregation is still a single logical entity at the legacy Switch end, but it is now split over both units within the Distributed Fabric. The legacy Switch is not aware that the aggregation has split and will continue to send traffic over both links, resulting in data loss.

Hence the recommendation to use IEEE 802.3ad aggregated links, if possible, as legacy aggregated links are not resilient to an Fabric Interconnect failure.

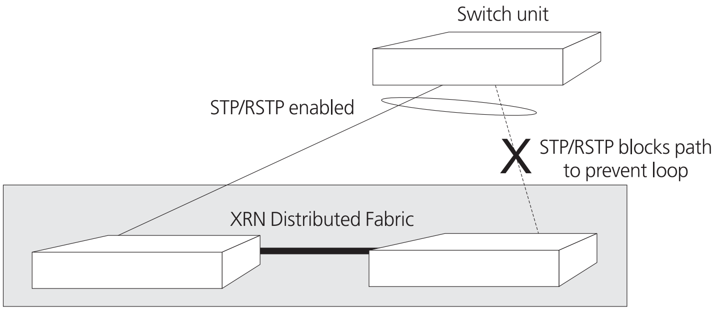
Figure 183 How XRN interacts with legacy aggregated links



STP/RSTP STP/RSTP should be used for multihomed links if you are not able to use aggregated links. Figure 184 shows how STP will prevent a loop occurring on a multihomed link.

STP/RSTP should always be enabled if your multihomed links are aggregated links. Figure 182 shows how, on interconnect failure, STP/RSTP will detect the potential loop caused by the aggregated links splitting and block a path to prevent the loop occurring.

Figure 184 How XRN interacts with STP/RSTP

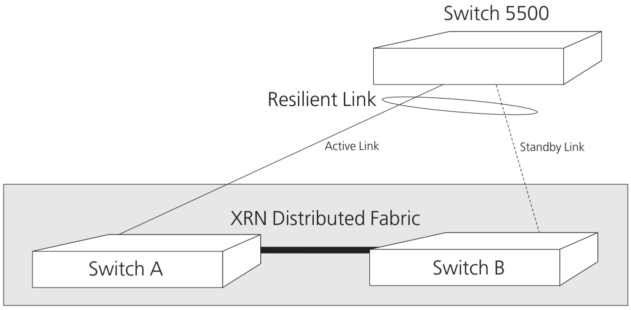


Resilient Links In Figure 185, if Switch A within the Distributed Fabric fails, the Switch 3300 will detect that a link has gone down and will make the standby link to Switch B active and pass all traffic down the link to Switch B.

When using resilient links in a Distributed Fabric network the resilient links must be configured at the remote end rather than at the Distributed Fabric. In a unit failure scenario as described above it would not matter if the resilient links were configured at the Distributed Fabric end. However, on an interconnect failure it would matter.

For example, if the resilient links were configured on Switches A and B, if the interconnect fails, both Switches will detect a failed link to Switch 3300 and both A and B will activate their links to Switch 3300. So both links in the resilient link will be passing traffic, potentially causing a loop in the network.

Figure 185 How XRN interacts with Resilient Links



How a Failure affects the Distributed Fabric

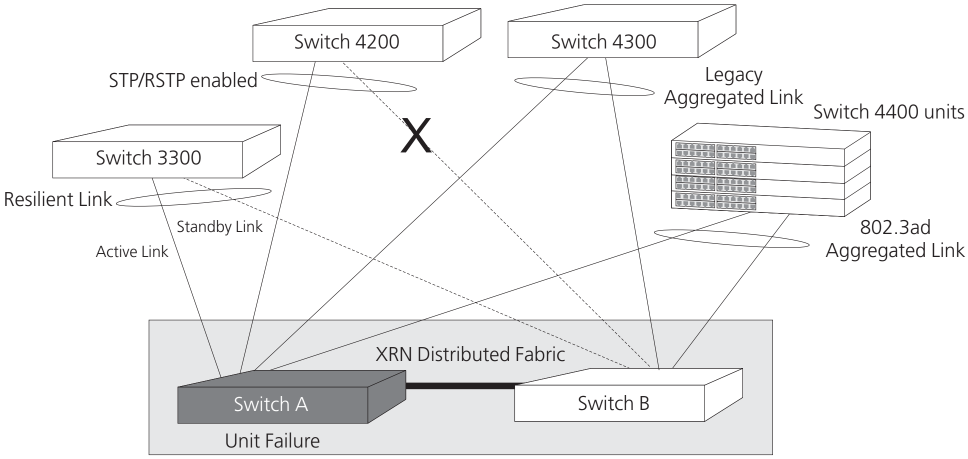
This section provides supplementary information on how the Distributed Fabric and traffic flow is affected by failure of an Fabric Interconnect and of a unit in the Distributed Fabric.

Loss of a Switch within the XRN Distributed Fabric

When a Switch unit in the Distributed Fabric fails, assuming you have followed the recommendations in "Important Considerations and Recommendations" on page 676, your traffic flow should continue through your network.

The way the network reacts depends upon which features are configured on which links. For example, Figure 186 shows an XRN network where all the edge devices are connected to the Distributed Fabric using a range of supported features, some of which are legacy features.

Figure 186 XRN Network reaction on Distributed Fabric unit failure



Should Switch A fail, the network will react in the following way:

LACP (IEEE 802.3ad) and Legacy Aggregated Links

The Switch 4400 and Switch 4300 Aggregated Links will reroute all traffic down the link connected to Switch B.

Legacy STP (IEEE802.1D) and RSTP (IEEE 802.1w)

The Switch 4200 is using legacy STP. STP will reconfigure the network to open the previously blocked link to Switch B. The STP reconfiguration will cause all Switch forwarding databases (MAC address tables) to be fast aged (if using RSTP, they will be flushed).

Resilient Links

The Switch 3300 is using resilient links, which should be set up at the 3300 end of the link. The Switch 3300 will detect the unit failure and activate the link to Switch B

VLANs

Any VLANs will not be affected by unit failure.

Router

Switch B will continue to do all the routing. As it was routing prior to Switch A's failure there will be no change of the router identity, that is, the router interface IP addresses will not change. The router interface MAC addresses may change but this will have no visible impact on your network. Any MAC address change is propagated to your network by the issuing of gratuitous ARP messages.

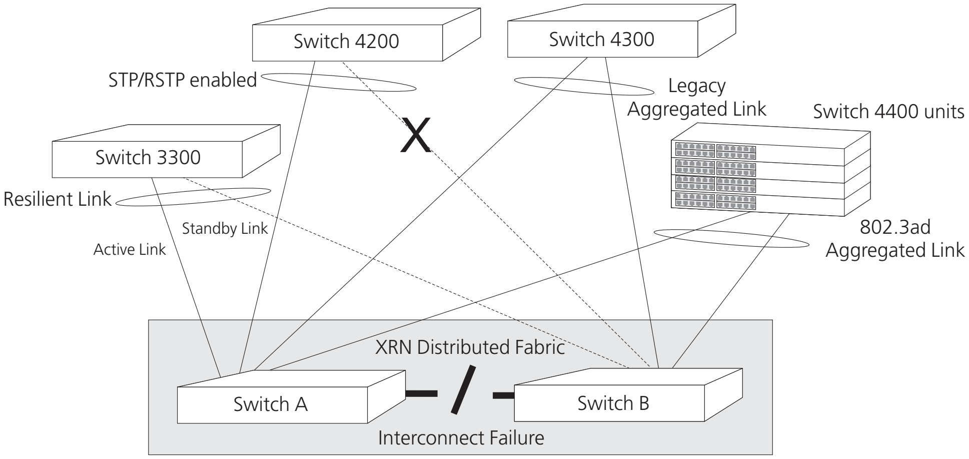
Switch A Recovery

When Switch A recovers and starts to operate again, all links will reconfigure themselves as they were before the failure, according to the protocols used. The routing task will once again be shared between Switches A and B, using the same IP address.

Loss of the Fabric Interconnect

When an interconnect fails between two Switches in the Distributed Fabric, assuming you have STP/RSTP and LACP enabled as recommended in "Important Considerations and Recommendations" on page 676, your traffic flow should continue through your network.

Figure 187 XRN Network reaction on Fabric Interconnect failure



In Figure 187, if the interconnect fails, the network will react in the following way:

LACP (IEEE 802.3ad) and Legacy Aggregated Links

The Switch 4400 automatically configured aggregated link (LACP) will reconfigure itself to create two separate aggregated links.

The Switch 4300 legacy aggregated link will be split between the two Switches in the Distributed Fabric and will no longer operate and will cause network disruption.

Legacy aggregated links are not resilient to an interconnect failure. Hence the 3Com recommendation to use IEEE 802.3ad aggregated links (LACP) for maximum resilience.

IEEE802.1D (Legacy STP) and RSTP

The Switch 4200 is using legacy STP. STP (and RSTP) will reconfigure the network to open the previously blocked link to Switch B. The STP reconfiguration will cause all Switch forwarding databases (MAC address tables) to be fast aged (if using RSTP, they will be flushed). If STP is enabled throughout the network, it will reconfigure the network to ensure that no loops occur due to split aggregated links.

If the Distributed Fabric has been configured to be the root bridge in the network then this will encourage STP to maintain the traffic flow through the shortest paths in the event of an Fabric Interconnect failure.

Resilient Links

The Switch 3300 will continue to send traffic down the active link to Switch A and keep the link to Switch B in standby mode.

VLANs

As all VLANs will have been configured on all links, the traffic will still reach its destination using the paths that remain open.

Router

Initially both Switches continue to route. Simultaneously the Switches attempt to contact each other and carry out a process that determines which Switch will become the Layer 3 router and which Switch will become the Layer 2 bridge. This avoids the scenario of two different and independent routers operating with the same identity.

Interconnect Recovery

When the interconnect recovers and starts to operate again, all links will reconfigure themselves as they were before the failure, according to the protocols used. The routing task will once again be shared between Switches A and B, using the same IP address.