8 Gigabit PoE + 2 100M/1G SFP + 2 100M/1G/2.5G SFP + 2 DI + 2 DO Layer 2 Industrial Ethernet Switch

CLI User Manual

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Preface

Switch CLI user manual has introduced:

- CLI configuration interface login
- CLI configuration rule and method
- Introduction of command lines related to various network management functions

Note

The screenshot reference device in this manual supports 8 Gigabit PoE ports +2 Gigabit SFP+2 2.5G SFP+2 DIs +2 DOs. The configuration of the same function of this series of products is the same. If the model does not have Gigabit SFP or I/O ports, it does not have the corresponding configuration function.

Audience

This manual applies to the following engineers:

- Network administrators responsible for network configuration and maintenance
- On-site technical support and maintenance personnel
- Network engineer

Text Format Convention

Format	Description
" "	Words with “” represent the interface words. Such as: “Port No.”.
>	Multi-level path is separated by ">". For example, open local connection path description: open "Control Panel > Network Connection > Local Connection".
Light Blue Font	It represents the words clicked to achieve hyperlink. Font color as: "Light blue".
About this chapter	The section ‘about this chapter’ provides links to various sections of this chapter, as well as links to the Principles/Operations Section of this chapter.

Icon Convention

Format	Description
Notice	Remind the announcements in the operation, improper operation may result in data loss or equipment damage.
Warning	Pay attention to the notes on the mark, improper operation may cause personal injury.

Format	Description
 Notes	Make a necessary supplementary instruction for operation description.
 Key	Configuration, operation, or tips for device usage.
 Tips	Pay attention to the operation or information to ensure success device configuration or normal working.

Port Convention

The port number in this manual is only an example, and does not represent the actual port with this number on the device. In actual use, the port number existing on the device shall prevail.

Revision Record

Version No.	Date	Revision Description
01	04/08/2025	Product release

Contents

1 Quick Start

This document describes basic usage and configuration of the Industrial Command Line Interface (ICLI). The ICLI is a comprehensive management interface to the device. It is the only management interface accessible on the serial console; even without network connectivity, the device can be managed using a serial connection.
This section describes how to perform the following:

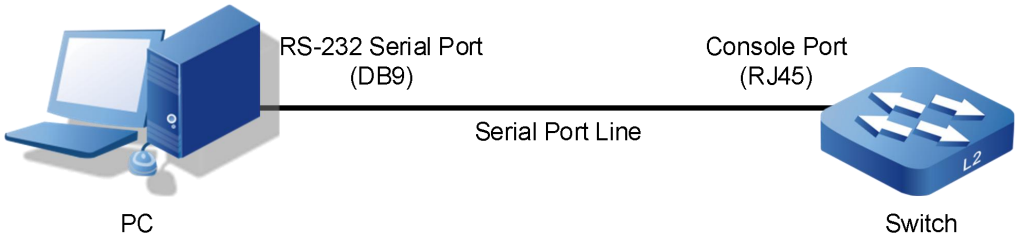
- Log in and reset configuration to factory defaults
- Set device hostname and admin user password
- Set VLAN 1 IP Address
- Verify connectivity using 'ping'
- Display the current configuration and save it to flash storage

The following assumes the device is powered on and has a functional connection to a computer using the serial console port on the device (115200 baud, no parity, 8 data bits, 1 stop bit, no flow control).
Use serial cable to connect computer serial port and Console port of the device, and run terminal emulator, such as TeraTerm or PuTTY on Windows, or Minicom on Linux.

1.1 Login to the Switch via Console Port

The PC can log in to the command line interface of the device by connecting to the Console port of the device.

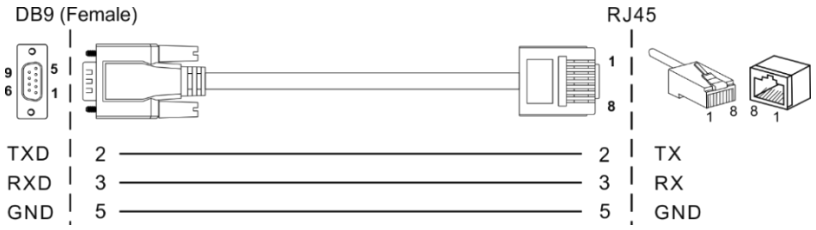
Step 1 Connect the serial port of the computer to the Console port of the device through the serial port line to establish a local configuration environment, as shown in the topology diagram below.



1. Connect DB9 at one end of serial port line to RS-232 serial port of PC.
2. Connect the RJ45 on the other end of the serial line to the Console port of the device.

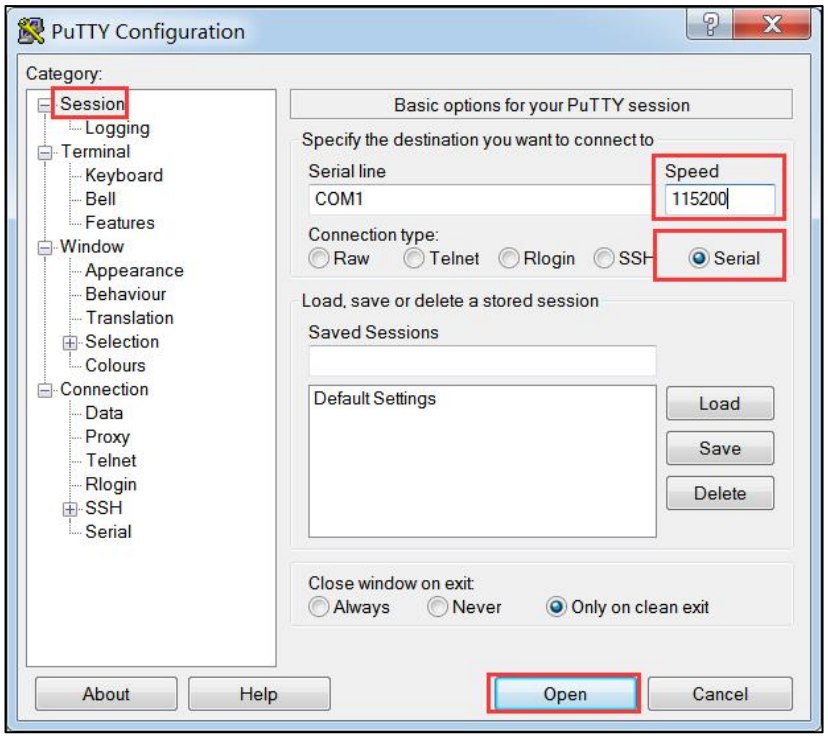
Note:

Diagram of internal connection line of serial port line/communication cable is shown below.



Step 2 Open the terminal simulation software on the PC, create a new connection, and set the interface and communication parameters of the connection. (Using PuTTY as an example here.)

1. Open PuTTY and click “Session” on the menu bar.
2. In the "Basic options for your PuTTY session" input box on the right, do the following:
   - Select "Connection type" to "Serial".
   - Enter "115200" in the "Speed" text box;
   - Click “Open”.



3. The "COM1-PuTTY" command line edit dialog box pops up. Press enter key to enter user name and password. The user name and password of the device are both admin by default, as shown below.

Step 3 End.

1.2 Log in and Reset Configuration to Factory Default

Notice

To ensure the safety of device and network, please keep the password properly and modify it regularly.

After using the device or system initialization for the first time, you need to use the default user name to log in to the CLI configuration interface through the CONSOLE port, and the WEB HTTP service will automatically start after logging in. The default user name and password are “admin”. Press Enter one or more times until the Username: prompt appears. Enter admin and press Enter. At the Password: prompt type admin and press Enter.

After all users or new users successfully log in to the device for the first time, they need to modify the initial password. After the password is set successfully, you will be prompted to re-login, and the prompt' #' will be displayed after successful login. At last, enter "copy running-config startup-config" to save the password configuration.

Notes

The length of the password string must be greater than or equal to 8 and be composed of two or more of uppercase letters, lowercase letters, numbers, and special characters.

```
Press ENTER to get started

Username: admin
Password:



First Login (please change the administrator account password)

Password:
Password (again) :

Password changed successfully!
Press ENTER to get started

Username: admin
Password:
# copy running-config startup-config
Building configuration...
```

```
% Saving 4759 bytes to flash:startup-config
#
```

At this point, the admin user is operating at the highest privilege level, level 15. This means that you have complete control over the device and its configuration, so you can reset the configuration to factory defaults. Enter reload defaults and press Enter. When prompted to return, the system reverts to the factory default values, as shown below.

```
# reload defaults
% Reloading defaults. Please stand by.
#
```

1.3 SSH

SSH is enabled by default. You can use the following command to disable SSH.

```
# configure terminal
(config)# no ip ssh
```

After SSH is disabled, you will not be able to log in to the CLI configuration interface through the network port.
Use the following command to enable SSH.

```
# configure terminal
(config)#ip ssh
```

1.4 Set Device Hostname and Admin User Password

There are several different modes of ICLI. The current mode is called execution mode; It allows users to perform operations related to configuration files, reload default values, display system information, etc., but does not allow users to change detailed configuration items. These operations are performed in configuration mode.
To set the device hostname, first change to configuration mode by typing configuration terminal and pressing Enter, then type hostname mydevice and press Enter, where mydevice is the appropriate name for the device. Finally, type exit and press enter. The order should be as follows.

```
# configure terminal
(config)# hostname mydevice
mydevice(config)# exit
mydevice#
```

The command is executed immediately, so the hostname immediately changes the device hostname.
The command for modifying the user password of current administrator is as follows.

```
mydevice# configure terminal
```

```
mydevice(config)# username admin privilege 15 password unencrypted
very-secret
mydevice(config)# exit
mydevice#
```

The user, admin, now has the password “very-secret.” Other users can add in a similar way.

1.5 Set VLAN 1 IP Address

The purpose is to assign an IP address to a device on VLAN 1. This is often sufficient for small local area networks that use Dynamic Host Configuration Protocol (DHCP) or static IP address allocation.
The system implements a DHCP client that, once enabled, will send out requests for IP address configuration. Those requests are received by a DHCP server on the network (if it exists and was appropriately configured). Then, the server will search its available IP address pool, allocate one, and return it to the DHCP client. The returned information typically includes IP address, netmask, and default gateway, but may also contain other information such as Domain Name Service (DNS) server addresses.
This configuration is similar to that of setting the host name: enter configuration mode, enter and execute configuration commands, and exit configuration mode. The following commands instruct the device to use DHCP to obtain an IP address, or, if DHCP fails, to use a static fallback address. Inclusion of a fallback IP is optional and may be omitted.

```
mydevice# configure terminal
mydevice(config)# interface vlan 1
mydevice(config-if-vlan)# ip address dhcp fallback 172.16.1.2
255.255.0.0
mydevice(config-if-vlan)# exit
mydevice(config)#
```

Notice how the prompt changes; The interface vlan 1 command enters a configuration submode, which allows configuration of IP addresses, etc.
Also note that IP addresses can only be assigned to VLAN interfaces.
After the configuration is completed, you can check the generated IP address. As seen below, the DHCP negotiation succeeded and the device obtained an address:

```
mydevice# show ip interface brief
Vlan        Address          Method           Status
-------     ---------        ------------     ----------
1           172.16.1.17/16   DHCP             UP
mydevice#
```

`show ip interface brief` displays all configured and active IP interfaces. Status should be UP. If not, the reason may be that there is no link on any port.
If DHCP negotiation fails, allocate the backup IP 172.16.1.2/255.255.0.0.

Now the most basic system configuration has been completed. Management connectivity can be verified by issuing a **ping** command to a well-known external IP address:

```
mydevice# ping ip 172.16.1.1
PING server 172.16.1.1, 56 bytes of data.
64 bytes from 172.16.1.1: icmp_seq=0, time=0ms
64 bytes from 172.16.1.1: icmp_seq=1, time=0ms
64 bytes from 172.16.1.1: icmp_seq=2, time=0ms
64 bytes from 172.16.1.1: icmp_seq=3, time=0ms
64 bytes from 172.16.1.1: icmp_seq=4, time=0ms
Sent 5 packets, received 5 OK, 0 bad
mydevice#
```

If the Ping is successful, now you can login to the address 172.16.1.17 (or 172.16.1.2) on the VLAN1 interface via telnet or ssh.

1.6 Set Static ARP

The command to set static ARP is:
ip arp <v_ipv4_abc> <v_mac_addr>
CLI example: set the static ARP to 192.168.1.253 and the MAC address to 00:10:00:00:01:01.

```
# configure terminal
(config)# ip arp 192.168.1.253 00:10:00:00:01:01
```

CLI example: delete static ARP.

```
(config)# no ip arp 192.168.1.253
```

1.7 Display and Save Configuration to Flash

The current configuration of the device can be displayed as a virtual file, which contains a complete set of commands required to create the same configuration. There are some exceptions because some items are not displayed, such as private SSH keys. These files, called running-config, are inherently unstable; It can't survive a reboot. Therefore, it is necessary to save the file to the Flash storage named startup-config, because the file will be read and executed every time it is started, so it is responsible for restoring the running configuration of the system to the saved state. The show running-config command will display the configuration settings shown below. Some details have been deleted for brevity. In addition, the interface set depends on hardware capabilities.

```
# show running-config
Building configuration...
RSA privatekey set 27
wd3gqeUx5cBnT6kGOshVOFTk23h45O87N71tJKpYLw==
```

```
[...]RSA privatekey set 26
S8Rm+cLPYn+oHqkY6mR5Z6HU6Q9yqduOPv4+1w0=
username admin privilege 15 password encrypted
k56kc1Il+61jrPPS3NOjdACwJkB6X6bo5mrb+xIRLQlR5vvqOLdmz8PaFDMHOP
av5uNBAShOE4Jz73Tg3JY00pny9kENLOALhLHbYcFfCPx+fFrOG8tNkNFpxcCH
kYmvR2oL0bwcy/7e+/6fxkUUi51L04T8Np4NDQXKeRrI1d7knx228nWhVrBhz8
79xeOU4tzpq1a0
8Unb7r12id/QIAlBspGpR/DNcYYvWnaFsUieO2yjRXnAntfpXbEy5jvKUybzuG
OxucBLLG1lZ338tkKlRXgpMuFZ6xRCAY02hGOT/HTR1XhgLGMnnXJCj8ywrAkl
3wEinksYLucft0mSew==
!
vlan 1
!
spanning-tree mst name Default revision 0
!
poe management mode class-reserved-power
poe supply 360
!
interface GigabitEthernet 1/1
 poe power limit 30.0
 no spanning-tree
! [...]
interface 2.5GigabitEthernet 1/10
 poe power limit 30.0
 no spanning-tree
!
interface vlan 1
 ip address 192.168.1.254 255.255.255.0
!
mep os-tlv oui 0xC sub-type 0x1 value 0x2
!
spanning-tree aggregation
 no spanning-tree
 spanning-tree link-type point-to-point
!
!
line console 0
!
line vty 0
! [...]
line vty 15
!
```

```
!
end
#
```

Lines that begin with ‘ ’ are comments. The file begins with the **hostname** command and the password for the admin user, followed by VLAN 1 and other items, such as Spanning Tree Protocol (STP). A list of all port interfaces on the device, ordered by switch ID, type, and port number comes next.

All port interfaces are set by default, so nothing will be displayed. Generally speaking, only non-default configurations are displayed, otherwise the output will be large and readability will be affected. There are some exceptions that will be discussed later.

Following the physical interfaces are VLAN interface1. Only the former has an assigned IP address. Finally, the line section is shown. It specifies characteristics for the serial console (line console 0) or network ICLI management connections (line vty x).

The configuration shown above is also saved in startup-config.

```
mydevice# copy running-config startup-config
Building configuration...
% Saving 4759 bytes to flash:startup-config
mydevice # dir
Directory of flash:
   r- 1970-01-01 00:00:00     292 default-config
   rw 1970-01-01 00:01:53    4759 startup-config
2 files, 5051 bytes total.
mydevice# more flash:startup-config
RSA privatekey set 27
wd3gqeUx5cBnT6kGOshVOFTk23h45O87N71tJKpYLw==
[...]
```

The dir command lists the files in the flash file system while more outputs the contents of the designated file.

The skills exercised in this section form the basis for all day-to-day work with the ICLI on the device: logging in, displaying information with the show command, working with configuration files (**show running-config, copy, dir, more**), working with the actual configuration (**configure terminal, exit**), and sub-modes (**interface ...**).

The configuration proceeds in the same manner as setting the hostname: enter configuration mode, enter and execute configuration commands, and exit configuration mode. The following commands instruct the device to use DHCP to obtain an IP address, or, if DHCP fails, to use a static fallback address. Inclusion of a fallback IP is optional and may be omitted.

2 ICLI Basics

The following list shows the key ICLI characteristics:

- It is modal (certain operations are possible or impossible in specific modes)
- It is line-based (there are no screen editing features)
- It executes commands instantly upon end-of-line
- It is privilege-based (certain operations require the user to have a certain privilege level to succeed)
- It implements industrial de-facto behavior for network equipment CLIs (structurally and behaviorally, it resembles CLIs found on other equipment while still possessing unique characteristics in some areas)

The ICLI can be accessed directly using the console port, or over the network through telnet or ssh. In each case, the user has to log in before ICLI commands can be executed. This begins a session that lasts until logout.

Multiple sessions can co-exist at the same time, each providing separate environments: logged-in user ID, privilege level, command history, mode, and session settings. It is therefore perfectly possible for the same user to control several concurrent sessions, such as one serial console session and one ssh session.

The user database is either local or provided by a RADIUS or TACACS+ server. If it is a local user database, password and privilege level will be maintained on the device.

2.1 Command Structure and Syntax

A command is a single line of text consisting of keywords and parameters, for example:

```
mydevice# show vlan id 10
...
mydevice# show vlan id 20
...
```

The keywords are show, vlan and ID; While 10 and 20 are parameters that may contain another value in another command call.

Keywords are case-insensitive, so "show, "SHOW" and "Show" are the same. Conversely, parameters may or may not be case-sensitive, depending on the command and parameters in question.

As long as keywords and some parameters are clear, they can be abbreviated. For example, these commands are identical:

```
mydevice# show interface GigabitEthernet 1/5 capabilities
...
mydevice# sh in g 1/5 c
...
```

This works because:

- Many keywords begin with "s", but only one begins with "sh"
- Several commands start with "show i", but only one starts with "show in"
- The show interface command takes the port type as a parameter. According to the hardware function, the options are: FastEthernet, GigabitEthernet, 2.5GigabitEthernet, 5GigabitEthernet and 10GigabitEthernet. Thus, ‘g’ is a unique abbreviation for GigabitEthernet
- 1/5 means Port 5 of Switch 1. This parameter cannot be abbreviated and must be written completely.
- The show interface GigabitEthernet 1/5 command can output different kinds of information: function, statistics, status and other information. In this case, ‘c’ is a unique abbreviation for capabilities.

With a bit of practice, this allows for highly efficient keyboard entry, in particular when coupled with the context-sensitive help features of the ICLI (see Context-Sensitive Help).

Syntax

A command is described by its syntax, for example:

```
show interface list { status | statistics | capabilities |
switchport | veriphy }
```

and

```
show erps [ detail | statistics ]
```

The semantics are:

- keywords are written in bold.
- parameters are written in italics.
- [...] indicates an optional construct: It may or may not be present.
- { ... } indicates a grouping; the constructs within belong together
- ‘|’ indicates a choice between two or more alternatives, (example, a | b | c which reads as “a or b or c”).

Thus, the first command syntax is simple: First `show`, then `interface`, then a list of interfaces, then exactly one of `status`, `statistics`, `capabilities`, `switchport`, and veriphy.

The second command is a bit more complex: `show` and `erps` are mandatory, but the remaining parameters and keywords are optional: The user may enter group IDs; the user may enter either ‘statistics’ or ‘detail’. For example:

- Show short-form ERPS (Ethernet Ring Protection Switching) information for all instances:

```
mydevice# show erps
...
```

- Show statistics for all instances:

```
mydevice# show erps statistics
...
```

- Show details for all instances:

```
mydevice# show erps detail
...
```

- But it is not allowed to show details and statistics at the same time:

```
mydevice# show erps detail statistics
^
% Invalid word detected at '^' marker.
```

- Show details for specific set of instances:

```
mydevice# show erps 1-6 detail
...
```

This grammar has some slightly complicated features, focusing on optional sequences, such as [a] [b] [c].

- Each of a, b, c may or may not be present (“a c” is valid, as is no input)
- Order is not important (“a c” and “c a” are equivalent)
- Each optional item can be present exactly no times or one time (not repeated)

There are variations:

- Group of options, of which at least one must be present: { [a] [b] [c] }*1
- Group of options, where one or more has fixed position: [a] {[b]} [c]
- This says that ‘b’ is optional, but if it is present then it must follow after ‘a’ (if ‘a’ is present) and it must come before ‘c’ (if ‘c’ is present)

For example, assuming a command with this syntax:

```
a [b] [c] { d | e } {[f] [g]}*1
```

then valid input examples are:

- "a d f", because "b" and "c" are optional, select "e" instead of "d", and "f" is selected in the mandatory option.
- "a d f g", because "b" and "c" are optional, select “d” instead of "e", and "f" and "g" are selected among the options in the last group.
- "a c b e g", because the optional item "b" was not selected, and select “e” instead of "d", and "g" was selected in the mandatory option.

2.2 Name Ethernet Port

An Ethernet interface, or port, is identified by three pieces of information:

- The type (FastEthernet, GigabitEthernet, 2.5GigabitEthernet, 5GigabitEthernet, 10GigabitEthernet)
- The switch it belongs to (for non-stacking systems, this value is always 1)
- The port number within the type and switch (numbering starts with 1 for each type, so a switch may have both GigabitEthernet 1/1 and 2.5GigabitEthernet 1/1)

Many ICLI commands accept interface list. In its simplest form, such a list is a sequence of (type, switch ID, port) information separated by whitespace. For example: GigabitEthernet 1/3 10GigabitEthernet 1/2. This allows a single list to mix different types.

The switch ID and the port numbers can be listed either as single numbers, as lists, or as sequences. A list is a comma-separated set of single port numbers or sequences, whereas a sequence is of the form: from—to.

Some examples:

- GigabitEthernet 1/5 for the single gigabit port number 5 on switch 1
- GigabitEthernet 1/2,4,10-12 for gigabit ports 2, 4, 10, 11, 12 on switch 1
- GigabitEthernet 1-3/2 for gigabit port 2 on switches 1, 2 and 3

It is possible to wildcard the type and/or switch ID and/or ports to mean “all types,” “all switch IDs,” and “all ports,” respectively. A wildcard is written with an asterisk instead of type, switch ID, or port, and some further abbreviations are possible:

- “*” means “ports of all types of all switches”
- Type “*” means “all ports of specified types of all switches”

For clarity, here are some examples. Suppose a stack has two switches, Switch ID 1 and Switch ID 3. Each switch has 9 Gigabit ports and two 2.5Gigabit ports. So:

- interface * （or： interface * * *）
  All ports of all types on all switches: GigabitEthernet 1,3/1-9 2.5GigabitEthernet 1,3/1-2
- interface * 1/2
  Switch 1, port number 2 of all types: GigabitEthernet 1/2 2.5GigabitEthernet 1/2
- interface * */2
  All switches, all types, port number 2: GigabitEthernet 1,3/2 2.5GigabitEthernet 1,3/2
- interface * */4
  All switches, all types, port number 4: GigabitEthernet 1,3/4

There is no 2.5Gigabit port in the result.

- interface GigabitEthernet 3/*
  Switch 3, all gigabit ports: GigabitEthernet 3/1-9
- interface 2.5GigabitEthernet * （or： interface 2.5GigabitEthernet */*）
  All 2.5 gigabit ports on all switches: 2.5GigabitEthernet 1,3/1-2

Wildcards will include the largest possible port set, but if a specific switch identification or port number does not exist, an error message may be output.

For example, these sets are invalid:

- interface * 2/*
  All types and all ports on Switch 2-this is not a number recognized by the stack.
- interface * */100
  On any switch, there is no Port 100 for any type of port.
- interface GigabitEthernet */* 2.5GigabitEthernet 2/*
  Similarly, Switch 2 does not exist, so the whole set is considered invalid.

Validity is determined per set of (type, switch ID, port) containing wildcards: the result for that set is valid if there is at least one port that matches the set. The set table is valid if at least each set in that set table can match a port.

2.3 Use of keyboard

ICLI provides a rich set of keys to help users use the command line. The functionality is divided into:

- Basic line editing
- Command history
- Context-sensitive help
- Long lines and pagination

Basic Line Editing

Basic line editing allows you to enter characters to form a command line, and also allows you to move the cursor and insert/delete characters and words. The following table shows the available editing functions and keys.

Table1 • key of basic line editing

Key	Operation
Left/Right	Move one character to the left/right
Home/Ctrl-A	Move to the beginning of the line
End/Ctrl-E	Move to the end of the line
Del/Ctrl-D	Delete a character at the cursor
Backspace/Ctrl-H	Delete the character to the left of the cursor
Ctrl-N	Delete the entire current line
Ctrl-U/Ctrl-X	Delete all characters to the left of the cursor
Ctrl-K	Delete all characters below and to the right of the cursor
Ctrl-W	Delete from the cursor to the beginning of the left word
TAB	Complete the word at the end of the line

Command History

A session maintains a non-persistent command history of previously entered command lines. The history can be up to 32 lines long. Once full, a new line will push the oldest entry out.

Table 2 • Command History

Key	Operation
Up/Ctrl-P	The previous line in the command history
Down	The last line in the command history

The number of rows retained in the current session history can be configured from 0 to 32, where 0 means that history is completely disabled.

```
mydevice# terminal history size 32
```

The current value is displayed as part of the output from `show terminal`:

```
mydevice# show terminal
Line is con 0.
* You are at this line now.
Alive from Console.
Default privileged level is 2.
Command line editing is enabled
Display EXEC banner is enabled.
Display Day banner is enabled.
Terminal width is 80.
length is 24.
history size is 32.
exec-timeout is 10 min 0 second.
Current session privilege is 15.
Elapsed time is 0 day 0 hour 6 min 20 sec.
```

```
Idle time is 0 day 0 hour 0 min 0 sec.
```

It is possible to list the history:

```
mydevice# show history
show running-config
copy running-config startup-config
dir
show history
mydevice#
```

This list starts with the earliest entry.

Context-Sensitive Help

The ICLI implements several hundred commands ranging from the very simple to the very complex. It is therefore imperative that the user can be assisted in entering syntactically correct commands as well as discovering relevant commands. These objectives are supported by the context sensitive help features.

Table 3 • Context-Sensitive Help Key

Key	Operation
?	Display the next possible input and description
??/Ctrl-Q	Display possible command syntax
TAB	Show next possible input without description or expand current word if it is unambiguous

The context-sensitive help only displays commands that are accessible at the current session privilege level (see Understanding Privilege Levels).

Use Context-Sensitive Help

```
! Show possible next input for a command that begins with 'show
a':
 mydevice# show a?
     aaa          Authentication, Authorization and Accounting
methods
     access        Access management
     access-list    Access list
     aggregation    Aggregation port configuration
   alarmlog      System logging message
! The same, but without descriptions:
mydevice# show a<TAB>
aaa         access      access-list  aggregation  alarmlog
! If the user enters another 'g' the word 'aggregation' is the only
possibility:
mydevice# show ag?
aggregation    Aggregation port configuration
```

```
<cr>
! Pressing <TAB> now expands the word fully:
mydevice# show aggregation
! Possible next input is displayed with a press of '?': mydevice#
show aggregation ?
|    Output modifiers
mode Traffic distribution mode
<cr>
! The syntax is displayed with another press of '?': mydevice# show
aggregation ?
show aggregation [ mode ]
! This shows that there is an optional 'mode' word (square brackets
indicate an option).
! Repeated presses of '?' toggles display between next possible
input and syntax:
mydevice# show aggregation ?
|    Output modifiers
mode Traffic distribution mode
<cr>
mydevice# show aggregation ?
show aggregation [ mode ]
! Finally, the syntax display is also directly available with Ctrl-Q:
mydevice# show aggregation ^Q
show aggregation [ mode ]
```

Long Lines and Pagination

The configuration of the session indicates the width of the terminal in characters and its length in lines. It uses these parameters to control the processing of long input lines and the paging of multi-line output. Please see Understanding Terminal Parameters for details on changing these parameters.

When a line is longer than the terminal width minus its prompt, a long line will appear. In this case, a part of the line will be hidden from display, as shown by the "$" at the beginning and/or end of the visible part of the line.

For example:

```
mydevice# $there is text to the left of what is visible here
mydevice# there is text to the right of what is visible here$
mydevice# $there is text at both ends of what is visible here$
```

The first line scrolls to the left; The second line scrolls to the right; The third line has been scrolled to the middle of a fairly long line.

Pagination occurs whenever the number of lines output exceeds the configured terminal length due to the execution of a command. A typical example is the output of show running-config. After the first several lines have been output, the pagination prompt is presented:

```
! [lines of text]
```

```
-- more --, next page: Space, continue:  g, quit: ^C
```

The following keys control pagination:

Table 4•Paging Keys

Key	Operation
Enter	Show the next line of output
Space	Show the next page of output
G	Display the rest of the output without more paging
Q/Ctrl-C	Show the rest of the output
Other keys	Display the next page of output. Certain terminal keys (arrows, Home, End, etc.) may appear as multiple characters to the ICLI, leading to multiple pages being output in quick succession.

The terminal length (also sometimes called height) can be configured for the current session using the terminal length lines command. If you enter lines = 0, paging is disabled.

```
mydevice# terminal length 0
mydevice# terminal length 25
```

The same is true for setting the terminal width in characters.

Other Special Keys

An extra key is defined as a shortcut key. This key can immediately return to Exec mode from any submode.

Table 5•Special Keys

Key	Operation
Ctrl-Z	Return directly to Exec mode

2.4 Filter Output

In most cases, you can filter the output of the command. You can limit the output to only lines that match/trigger a specific substring. The available filtering is:

- Begin – display the first line that matches and all subsequent lines
- Include – display exactly those lines that match
- Exclude – display exactly those lines that do not match. The string is case-sensitive.

The syntax is:

```
command '|' { begin | include | exclude } string
```

```
! Execute a command that generates some output; no filtering
initially:
mydevice# show users
Line is con 0.
* You are at this line now.
Connection is from Console. User name is admin.
```

```
Privilege is 15.
Elapsed time is 0 day 21 hour 52 min 50 sec.
Idle time is 0 day 0 hour 0 min 0 sec.
! Filter to include specific word:
mydevice# show users | include User name is admin.
! Exclude all lines that contain ‘0’ (zero)
mydevice# show users | exclude 0
* You are at this line now.
Connection is from Console. User name is admin.
Privilege is 15.
! Begin output when specific word is matched:
mydevice# show users | begin Elapsed
Elapsed time is 0 day 21 hour 53 min 29 sec.
Idle time is 0 day 0 hour 0 min 0 sec.
```

2.5 Understanding Modes and Submodes

ICLI implements many modes to control the available command sets. The mode is also affected by the user's permission level; Some modes or commands can only be accessed by administrators, while others do not require permissions other than login. Three main modes: Exec, Privileged Exec and Config. Under Config, there exist several sub-modes. The sub-modes allow configuration of specific VLANs, Ethernet interfaces, etc.

Table 6 • Modes

Mode	Parent Mode	Note
Exec		Minimum privilege mode; Used for basic system monitoring. It is generally not allowed to modify the system. Command: **Disable** Prompt: **hostname>**
Privileged Exec	Exec	Privileged mode; Allows configuration and other modifications to the system. Command: **enable** Prompt: **hostname#**
Config	Priv.Exec	Global configuration mode Command: **configure terminal** Prompt: **hostname(config)#**
VLAN Config	Config	Sub-mode for configuring active VLANs Command: **vlan vlan_id_list** Prompt: **hostname(config-vlan)#**
VLAN Interface Config	Config	Sub-mode for configuring VLAN interfaces Command: **interface vlan vlan_id_list** Prompt: **hostname(config-if-vlan)#**
Interface Config	Config	Sub-mode for configuring Ethernet interfaces Command:**interface type switch_num/port_num** Prompt: **hostname(config-if)#**
Line	Config	Sub-mode for configuring terminal lines Command:**line { con | vty } line_num** Prompt: **hostname(config-line)#**
IPMC Profile Config	Config	Sub-mode for configuring IP Multicast profiles Command: **ipmc profile profile_name** Prompt: **hostname(config-ipmc-profile)#**
SNMP Server Host Config	Config	Configure the submodes of SNMP server host entries Command: **snmp-server host host_name**

Mode	Parent Mode	Note
		Prompt: **hostname(config-snmps-host)#**
DHCP Pool Config	Config	Sub-mode for configuring DHCP client pools Command:**ip dhcp pool pool_name** Prompt: **hostname(config-dhcp-pool)#**
STP Aggregation Config	Config	Configure the submodes of Spanning Tree Protocol aggregation Command: **spanning-tree aggregation** Prompt: **hostname(config-stp-aggr)#**
JSON Notification Host Config	Config	Sub-mode for configuring JSON notification hosts Command: **json notification host host_name** Prompt: **hostname(config-json-notif-host)#**

It is possible for a user to transition between these modes using certain commands, subject to the user's privilege level and the current session privilege level (see Understanding Privilege Levels.).

The initial mode is determined by the privilege level of the logged-in user. If the privilege level is 0 or 1, the user is unprivileged and begins in the (Unprivileged) Exec mode. If the privilege level is high, the session will start in privileged EXEC mode.

If an enable password is configured for this level, users can raise the privilege level of Exec mode to a higher value. This promotion is accomplished by enabling the level command, and the level is a value between 1 and 15. The reverse operation (lowering the privilege level) is achieved with the disable command.

After entering the privileged execution mode, the user can configure the terminal to enter the global configuration mode by inputting commands. Exit the global configuration by typing end or Exit, and then pressing Enter or CTRL-Z..

Access to a configuration sub-mode (for example, Ethernet interfaces) goes through global configuration or another sub-mode. Therefore, for example, VLAN submode can be directly changed into Ethernet interface submode.

Therefore, each mode and submode implements a command range. In each mode, a specific subset of commands is available. To use other commands, users usually have to change the mode/submode. This is necessary because there are commands with the same prefix in different modes. For example, in privileged execution mode, global configuration mode and VLAN interface configuration mode, there are commands starting with "ip".

There are two exceptions to this:

In the configuration submode, as long as there is no ambiguity, the global configuration mode command can be accessed. Execute the global configuration command to exit the submode.

Exec mode commands (whether privileged or unprivileged) are accessible from within global configuration or one of the sub-modes by using the do command.

The do command takes any command line from Exec and executes it. In the following example, the user wants to change the IP address on the VLAN 1 interface and use do to verify the current address in submode.

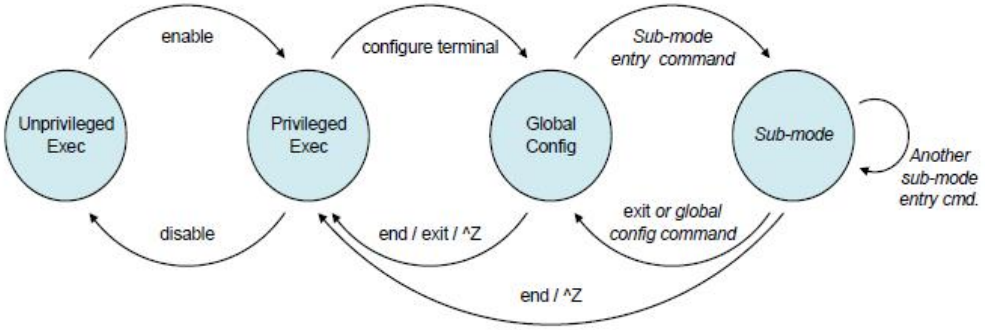
Use "do" in Submode

```
mydevice# configure terminal
mydevice(config)# interface vlan 1
mydevice(config-if-vlan)# do show ip interface brief
Interface       Address            Method   Status
--------------- ------------------- -------- ------
VLAN 1          192.168.1.254/24    Manual   UP mydevice
(config-if-vlan)# end
! When in Exec, no 'do' prefix is needed:
mydevice# show ip interface brief
Vlan Address          Method   Status
1 172.16.1.15/24       DHCP    UP
```

ICLI Mode Transitions:

The following figure shows the possible transition between main modes and submodes, and some related commands.

Figure• ICLI Mode Transitions:



ICLI Mode Transitions:

```
! Initial mode for this example is Unprivileged Exec. Raise level
! (and change mode):
mydevice> enable
Password: *********
mydevice#

! Note how the prompt changed from '>' to '#' to indicate the
privileged exec mode

! Enter global configuration mode:
mydevice# configure terminal

! Now create VLAN 100 and give it a name. This enters the VLAN sub-mode,
as
```

```
! indicated by a new prompt:
mydevice(config)# vlan 100
mydevice(config-vlan)# name MyVlan


! Change directly from VLAN sub-mode into Ethernet interface
sub-mode for
! interface instance 4 on switch 1, and set link speed to 'auto'
mydevice(config-vlan)# interface GigabitEthernet 1/4
mydevice(config-if)# speed auto


! Then enter a command from the global configuration mode; this
leaves Ethernet interface sub-mode
mydevice(config-if)# hostname mydevice


! Exit global configuration mode and go back to Privileged Exec
mydevice(config)# end
! And use 'disable' to go back to Unprivileged Exec:
mydevice# disable
mydevice>
```

2.6 Understand Privilege Level

A privilege level is a number in the range of 0 to 15, inclusive, with 0 being the lowest. It is assigned to a user session to determine access to ICLI commands. Only commands with the same or lower permission level can be accessed.

Every user on the device has a default permission level, which is copied to the permission level of the session when logging in. However, users can change the session permission level by executing the enable or disable command. This can be used, for example, as follows:

- The user account is configured with permission level 0.
- Whenever a user needs to execute a command with higher privilege, the user changes the session priority, executes the necessary command, and then reverts to the default priority.

Access with higher priority must be password-protected by using the global configuration command of enable password or enable secret. The main difference between the two is whether the password is displayed in clear text or encrypted form in running-config and startup-config.

Password input can also be encrypted or clear text. The latter is used when the operator enters a new password, because the operator usually does not know the encrypted form of the password.

Input password is displayed in ciphertext. By default, the administrator user is at level 15, which is the highest privilege level.

Configure Privilege Level keyword

The following example configures a level 15 password using enable secret, inspects the resulting configuration, then removes it again.

```
mydevice# configure terminal

! A secret can either be input in clear text or encrypted form;
! a digit indicates which kind follows on the command line:
mydevice(config)# enable secret ?
0    Specifies an UNENCRYPTED password will follow
5    Specifies an ENCRYPTED secret will follow

! In this case: Unencrypted. Then follows either the level for
! which a password is being configured, or, if no level is given,
! the password for level 15:
mydevice(config)# enable secret 0 ?
<word32>    Password
level       Set exec level password

! Thus, the following two commands are semantically identical:
mydevice(config)# enable secret 0 my-secret
mydevice(config)# enable secret 0 level 15 my-secret

! The running configuration can be inspected to see the encrypted
form:
mydevice(config)# do show running-config | include enable
enable secret 5 level 15 D29441BF847EA2DD5442EA9B1E40D4ED
! To remove the password use the 'no' form (the two are semantically
equivalent for level 15):
mydevice(config)# no enable secret
mydevice(config)# no enable secret level 15
mydevice(config)# do show running-config | include enable
mydevice(config)#
```

2.7 Understanding Terminal Parameters

Each system login creates a session, whether through the serial console, telnet or ssh. The session can be initialized with the configurable settings in the command configuration submode, but most settings can also be changed in Exec mode when

the session is valid. However, this change is not persistent and will be lost when the session is terminated.
The following table lists the available settings and modes that can be configured.
Table 7 • Setting and Modes

Set	Mode	Note
editing	Exec, Line	Enable/disable command line scrolling
exec-banner	Line	Enable/disable display of running execution title (configured in "banner exec ...")
exec-timeout	Exec, Line	Inactive timer; automatically quit after an inactive period. A value of 0 is to turn off automatic exit.
history	Exec, Line	Length of command history buffer
length	Exec, Line	Terminal length in line units, used for paging. 0 means turn off paging.
location	Line	A line of text that describes the terminal location (such as “Server room”)
motd-banner	Line	Enable/disable the display of the information title of the day (configured by "banner motd ...")
privilege	Line	Distribute default priority
width	Exec, Line	Width of character terminal used for pagination

The following table lists the available settings and modes that can be configured.
The system supports 1 serial console session and up to 16 network sessions. The console session is called "console 0" and each network session is called "vty X", where vty is short for Virtual TTY and X is a value between 0 and 15.
The configuration appears near the bottom of running-config as follows:

```
line console 0
exec-timeout 0
!
line vty 0
!
line vty 1
!
line vty 2
! [...]
```

It is possible to specify different settings for each vty, but this is generally not recommended since there is no way to associate an incoming ssh or telnet connection with a specific vty.

Changing Terminal Parameters

```
This example shows how to change some values for the current session,
and for all future console sessions.
! First inspect current settings for this session:
```

```
mydevice# show terminal
Line is con 0.
* You are at this line now. Alive from Console.
Default privileged level is 2.
 Command line editing is enabled
Display EXEC banner is enabled.
Display Day banner is enabled.
Terminal width is 80.
length is 24.
history size is 32.
exec-timeout is 10 min 0 second.

Current session privilege is 15.
Elapsed time is 0 day 0 hour 15 min 42 sec.
Idle time is 0 day 0 hour 0 min 0 sec.

! Then set terminal length to zero to disable pagination, and
exec-timeout to zero to disable automatic logout:
mydevice# terminal length 0
mydevice# terminal exec-timeout 0
mydevice# show terminal
Line is con 0.
* You are at this line now.
Alive from Console.
Default privileged level is 2.
Command line editing is enabled
Display EXEC banner is enabled.
Display Day banner is enabled.
Terminal width is 80.
length is 0.
history size is 32.
exec-timeout is 0 min 0 second.

Current session privilege is 15.
Elapsed time is 0 day 0 hour 16 min 31 sec.
Idle time is 0 day 0 hour 0 min 0 sec.

! Then we do the same, but for all future console sessions.
! Note how the commands have no 'terminal' prefix ('terminal length'
vs. 'length'):
```

```
mydevice# configure terminal
mydevice(config)# line console 0
mydevice(config-line)# exec-timeout 0
mydevice(config-line)# length 0
mydevice(config-line)# end
! Finally save the configuration to startup-config to make it
persistent:
mydevice# copy running-config startup-config
Building configuration...
% Saving 1287 bytes to flash:startup-config
mydevice#
```

Using Title

The system provides three different banners (text that is output as messages to the user):

- The Message Of The Day banner (MOTD), displayed upon connection to the system or when a console login attempt has timed out
- The Login banner, displayed before the first “Username:” login prompt
- The Exec banner, displayed upon successful login

All of these banners are configured in a similar manner, using the `banner` command:

```
banner [ motd | login | exec ] <banner>
```

The title text can be single line or multiple lines. The first character of the text defines a separator; The actual text of the title follows immediately and ends at the first occurrence of the separator. The actual text does not contain delimiters.

Configuring Title

```
! First configure the MOTD banner, which in this case is multi-line.
‘*’ is used as delimiter character, but any printable character
that isn’t used in the message is usable:
mydevice# configure terminal
mydevice(config)# banner motd * This is the Message Of The Day
Banner.
It spans multiple lines.
And one more. But now it ends. *
! Enter TEXT message.   End with the character '*'.
! Then the Login and Exec banners. Both are single-line. Note how
different delimiters are used in each banner:
mydevice(config)# banner login XThis is mydevice.X
mydevice(config)# banner exec “WARNING: Production system. Be
careful.”
mydevice(config)# end

! Inspect configuration:
mydevice# show running-config
```

```
Building configuration...
banner motd "This is the Message Of The Day Banner.
It spans multiple lines.
And one more. But now it ends."
banner exec "WARNING: Production system. Be careful."
banner login "This is mydevice."
hostname mydevice
! [...]
end

! Test it: Log out, then log in again:
mydevice# exit

This is the Message Of The Day Banner.
It spans multiple lines.
And one more. But now it ends.
Press ENTER to get started<ENTER>
This is mydevice.
Username: admin
Password:

WARNING: Production system. Be careful.
mydevice#

! Finally save the configuration to startup-config to make it
persistent:
mydevice# copy running-config startup-config
Building configuration...
% Saving 1461 bytes to flash:startup-config
mydevice#
```

3 Configuring the System

Changes to system configuration can only be made from the global configuration mode and its sub-modes, except when working with configuration files or reloading defaults. This is done in Privileged Exec mode. The following steps outline the sequence.

- Raise privilege level to 15.
- Enters global configuration mode.
- Input appropriate configuration commands. Optionally, enter sub-modes and input appropriate commands there.
- Exit global configuration mode.
- Verify configuration.
- Save Configuration to Flash.

3.1 Configuration Instance

In this example, the host name and the IP address of VLAN 1 have been configured, verified and saved. This example assumes that the session initially has no permissions.

- Raise privilege level:

```
> enable
Password: ***
```

- Enter Configure Mode

```
# configure terminal
```

- Enter configuration command. The IP address is set from the submode of vlan interface.

```
! VLAN interface submode:
(config)# hostname mydevice
mydevice(config)# interface vlan 1
mydevice(config-if-vlan)# ip address dhcp fallback 172.16.1.2
255.255.0.0
mydevice(config-if-vlan)# exit
```

- Leave global configuration mode and go back to Privileged Exec:

```
mydevice(config)# end
```

- Inspect and verify the configuration (some output omitted for brevity):

```
mydevice# show running-config
Building configuration...
[...]
!
vlan 1
!
[...]
!
interface GigabitEthernet 1/1
poe power limit 30.0
 no spanning-tree
[...]
!
interface vlan 1
ip address dhcp fallback 172.16.1.2 255.255.0.0
!
[...]
end
! More verification: Display IP interfaces and assigned IP address
and status:
mydevice# show ip interface brief
Vlan Address      Method   Status
-----------------------------------
1 172.16.1.15/24   DHCP    UP
! An address was obtained from DHCP, so the fallback wasn't used
! Try to inspect hostname:
mydevice# show hostname
^
% Invalid word detected at '^' marker.
! No such command exists, but it is possible to extract a single
line from running-config by using a filter:
mydevice# show running-config | include hostname
hostname mydevice
#
```

- Save Configuration to Flash:

```
mydevice# copy running-config startup-config
Building configuration...
% Saving 1272 bytes to flash:startup-config
```

3.2 Resetting or Removing Configuration with "no”

You can delete specific configuration items or reset them to the default values. Generally speaking, almost every configuration command has a corresponding no form. The ‘no’ form is syntactically similar (but not necessarily identical) to the configuration command, but either resets the parameters to defaults for the configurable item being addressed or removes the item altogether.
In many cases, "no" can be understood as "no" different from the default setting.

Using the form of "no"

The following list shows the tasks accomplished:

- Configure the IP address of VLAN 1 interface to use DHCP.
- Check the configuration
- Remove the IP address on the VLAN 1 interface

‘’no’’ operations can be viewed as reset-to-default, with the defaults being no IP address.

```
mydevice# configure terminal
mydevice(config)# interface vlan 1
mydevice(config-if-vlan)# ip address dhcp
mydevice(config-if-vlan)# exit
(config)# end

mydevice# show ip interface brief
Interface       Address            Method   Status
--------------- ------------------- -------- ------
VLAN 1          192.168.1.254/24    DHCP     UP
mydevice# configure terminal
mydevice(config)# interface vlan 1
mydevice(config-if-vlan)# no ip address
mydevice(config-if-vlan)# end
mydevice# show ip interface brief
Interface       Address            Method   Status
--------------- ------------------- -------- ------
mydevice#
```

Note:
The syntax of configuration command and its "no" form are different; The "no" form usually does not take so many parameters.

This is usually convenient, but in some cases it may produce unexpected results. For example, an OAM MEP instance can configure Continuity Check using ‘mep <num> cc <priority> ...’ and reset it with ‘no mep <num> cc’. However, because MEPs are

removed using the command ‘no mep <num>’, it is possible to unintentionally remove an existing MEP by entering ‘no mep 10 ccc’ – the extra ‘c’ means that the last word isn’t recognized as ‘cc’, leading to a match of the MEP removal command instead of the desired reset-CC command.

4 Manage Users

The following describes local user management on the device. RADIUS and TACACS+ user management is beyond the scope of this document. You can create multiple user accounts on a system. Each user account has a set of configurable attributes:

- User name
- Password
- Privilege Level

All properties are configured with the same username command.

```
username <username> privilege <priv> password encrypted
<encry_password_1> [ <encry_password_2> ]

username <username> privilege <priv> password unencrypted
<password>

no username <username>
```

`No username` would delete the given user account.

4.1 Add, Modify and Delete User

The following example adds two user accounts with different permission levels, checks the configuration, and uses "no username" to delete one account again.

```
! Display current set of local user accounts:

mydevice# show running-config | include username

username admin privilege 15 password encrypted [...]


! Add two accounts, 'operator' and 'monitor'. The passwords are
supplied in unencrypted form:

mydevice# configure terminal

mydevice(config)# username operator privilege 10 password
unencrypted a-secret

mydevice(config)# username monitor privilege 1 password
unencrypted new-secret
```

```
! Verify that the configuration is correct. Note that passwords
are displayed in encrypted form:
mydevice(config)# do show running-config | include username
username admin privilege 15 password encrypted [...]
username operator privilege 10 password encrypted [...]
username monitor privilege 1 password encrypted [...]

! Delete the 'operator' user and verify it is removed from the
configuration:
mydevice(config)# no username operator
mydevice(config)# do show running-config | include username
username admin privilege 15 password encrypted [...]
username monitor privilege 1 password encrypted [...]
```

4.2 Configuring Privilege Level

The privilege level of the user. The allowed range is 0 to 15. If the privilege level value is 15, it can access all groups, that is, that is granted the fully control of the device. But others value need to refer to each group privilege level. User's privilege should be same or greater than the group privilege level to have the access of that group. By default setting, most groups privilege level 5 has the read-only access and privilege level 10 has the read-write access. And the system maintenance (software upload, factory defaults, and so on) need user privilege level 15. Generally, the privilege level 15 can be used for an administrator account, privilege level 10 for a standard user account and privilege level 5 for a guest account.

```
web privilege group <group_name> level { [ configRoPriv
<configRoPriv> ] [ configRwPriv <configRwPriv> ] [ statusRoPriv
<statusRoPriv> ] [ statusRwPriv <statusRwPriv> ] }*1
```

CLI example: view the privilege level of Aggregation.

```
# show web privilege group Aggregation level
Group Name                     Privilege Level
                             CRO CRW SRO SRW
------------------------------ --- --- --- ---
Aggregation                      5  10   5  10
```

CLI example: set the read-only privilege of Aggregation configuration to 3 and the write privilege to 5; Set the read-only privilege of Aggregation status to 3 and the write privilege to 5.

```
# configure terminal
(config)# web privilege group Aggregation level configRoPriv 3
(config)# web privilege group Aggregation level configRwPriv 5
(config)# web privilege group Aggregation level statusRoPriv 3
(config)# web privilege group Aggregation level statusRwPriv 5
```

4.3 View User

```
show users [ myself ]
```

Commands for viewing all CLI online user information.

```
# show users
Line is con 0.
   * You are at this line now.
   Connection is from Console.
   User name is admin.
   Privilege is 15.
   Elapsed time is 0 day 0 hour 38 min 17 sec.
   Idle time is 0 day 0 hour 0 min 0 sec.

Line is vty 0.
   Connection is from 192.168.1.161:22462 by Telnet.
   User name is admin001.
   Privilege is 5.
   Elapsed time is 0 day 0 hour 0 min 3 sec.
   Idle time is 0 day 0 hour 0 min 3 sec.
```

Commands for viewing users' own information.

```
# show users myself
Line is con 0.
   * You are at this line now.
   Connection is from Console.
   User name is admin.
   Privilege is 15.
   Elapsed time is 0 day 0 hour 41 min 51 sec.
   Idle time is 0 day 0 hour 0 min 0 sec.
```

5 Using show Commands

show command is the cornerstone of system monitoring based on ICLI. Most functions implement one or more show commands, which will display related combinations of status and configuration.

Notes:
The exact settings of available commands, parameters and output formats depend on the system configuration and software version, so some of the following commands and examples may not be applicable to all systems.

The show command exists only in two Exec modes and is limited by the session permission level. Therefore, listing the largest possible set of show commands requires a session level of 15.

5.1 Lists All show Commands

The following example is to raise the session permission level to 15. In this example, the activation password has been specified, so you need to enter a password to continue. Then the user inputs show and uses the context-sensitive help feature to list the possible show commands, in this case for a Carrier Ethernet system.

```
Username: admin
Password:
# show ?
   aaa              Authentication, Authorization and Accounting
methods
   access           Access management
   access-list       Access list
   aggregation       Aggregation port configuration
   alarmlog         System logging message
   clock            Configure time-of-day clock
```

```
   dot1x            IEEE Standard for port-based Network Access
Control
   erps             Ethernet Ring Protection Switching
   evc              Ethernet Virtual Connections
   history          Display the session command history
   interface         Interface status and configuration
   io               Configure IO
   ip               Interface Internet Protocol configuration
commands
   ipmc             IPv4/IPv6 multicast configuration
   ipv6             IPv6 configuration commands
   lacp             LACP configuration/status
   line             TTY line information
   lldp             Display LLDP neighbors information.
   loop-protect      Loop protection configuration
   mac              Mac Address Table information
   mep              Maintenance Entity Point
   ntp              Configure NTP
   platform          Platform configuration
   poe              Power Over Ethernet.
   port-security     Port Security status - Port Security is a
module with no
                   direct configuration.
   privilege         Display command privilege
   process          process
   qos              Quality of Service
   radius-server     RADIUS configuration
   relay            Configure relay alarm
   ring             Configure ring
   rmon             RMON statistics
   running-config    Show running system information
   scheduling        Scheduling infomation
   snmp             Display SNMP configurations
   sntp             Configure SNTP
   spanning-tree     STP Bridge
   stpstate         stp state
   switchport        Display switching mode characteristics
   system           system
   systemlog         System logging message
   tacacs-server     TACACS+ configuration
```

```
   terminal         Display terminal configuration parameters
   time             Display current system time
   users            Display information about terminal lines
   version          System hardware and software status
   vlan             VLAN status
   web              Web
   xsq              Configure XSQ
```

5.2 Use Context-Sensitive Help to Find

The context-sensitive help feature for syntax display is also useful for determining the exact command to execute. In the following example, the user discovers the proper command **show ip statistics system** through exploration:

```
# show ip ?
   arp
   dhcp          Dynamic Host Configuration Protocol
   domain        Default domain name
   http          Hypertext Transfer Protocol
   igmp          Internet Group Management Protocol
   interface     IP interface status and configuration
   name-server   Domain Name System
   route         Display the current IP routing table
   ssh           Secure Shell
   statistics    Traffic statistics
# show ip statistics ?
   |           Output modifiers
   icmp        IPv4 ICMP traffic
   icmp-msg    IPv4 ICMP traffic for designated message type
   interface   Select an interface to configure
system      IPv4 system traffic
<cr>

! A repeated press of '?' displays the syntax:
mydevice# show ip statistics ?
show ip statistics [ system ] [ interface vlan <v_vlan_list> ]
[ icmp ] [ icmp-msg <type> ]

mydevice# show ip statistics system
IPv4 statistics:
```

```
Rcvd:  48 total in 27096 bytes
       24 local destination, 0 forwarding
       0 header error, 0 address error, 0 unknown protocol
       0 no route, 0 truncated, 0 discarded
Sent:  48 total in 27096 bytes
       24 generated, 0 forwarded
       0 no route, 0 discarded
Frags: 0 reassemble (0 reassembled, 0 couldn't reassemble)
       0 fragment (0 fragmented, 0 couldn't fragment)
       0 fragment created
Mcast: 0 received in 0 byte
       0 sent in 0 byte
Bcast: 0 received, 0 sent
```

5.3 Display running-config

The virtual file running-config consists of a series of commands, which together produce the currently running system configuration.
This list of commands is usually not 100% identical to the list of commands a user has input to configure the device. Because running-config is a text representation of the system configuration stored in the device memory in binary form.
Due to the huge task of configuring effective devices, running-config only lists the differences between the default settings and the current settings in most cases. This greatly reduces the output and greatly improves the readability of the configuration, but requires readers to know the contents of the default settings.
Use show running-config all-defaults to include default values.

Default and non-default and all defaults

In this example, if the speed and duplex settings of an Ethernet interface are at default values (auto-negotiation), then nothing will be output. If the user subsequently fixes the rate to 1 Gbps, the value is now a non-default value and the rate will be output. Duplex will also be output, because when the rate is fixed at 1 Gbps, it is forced to be "full".

```
! Display current configuration for an interface. All settings are
at default:
mydevice# show running-config interface GigabitEthernet 1/4
Building configuration...
interface GigabitEthernet 1/4
poe power limit 30.0
no spanning-tree
!
end
```

```
! Now set the speed to 1Gbps and display the configuration again:
mydevice# configure terminal
mydevice(config)# interface GigabitEthernet 1/4
mydevice(config-if)# speed 1000
mydevice(config-if)# end

mydevice# show running-config interface GigabitEthernet 1/4
Building configuration...
interface GigabitEthernet 1/4
poe power limit 30.0
no spanning-tree
speed 1000
duplex full
!
end

! Include all default settings for that interface:
mydevice# show running-config interface GigabitEthernet 1/4
all-defaults
Building configuration...
interface GigabitEthernet 1/4
 loop-protect
 no loop-protect action
 loop-protect tx-mode
 switchport mode access
 switchport access vlan 1
 switchport forbidden vlan remove 1-4095
 no ip igmp snooping filter
 no ip igmp snooping max-groups
 no ip igmp snooping mrouter
 no ip igmp snooping immediate-leave
-- more --, next page: Space, continue: g, quit: ^C
```

The output of **`show running-config`** can be restricted to a specific interface. Several such filters are shown below.

```
show running-config [ all-defaults ]
```

This will display the entire currently running system configuration.

```
show running-config feature <feature_name> [ all-defaults ]
```

Only commands related to specific functions are output. The list of features depends on the system configuration and software version. For example:

```
# show running-config feature ?
  <cword>    Valid words are 'access' 'access-list' 'aggregation'
'auth'
             'clock' 'dhcp' 'dhcp-snooping' 'dhcp_server' 'dns'
'dot1x'
             'erps' 'evc' 'http' 'icli' 'io_alarm'
'ip-igmp-snooping'
             'ip-igmp-snooping-port' 'ip-igmp-snooping-vlan'
'ipmc-profile'
             'ipmc-profile-range' 'ipv4' 'ipv6-mld-snooping'
             'ipv6-mld-snooping-port' 'ipv6-mld-snooping-vlan'
             'json_rpc_notification' 'lacp' 'lldp' 'logging'
'loop-protect'
             'mac' 'mep' 'monitor' 'mstp' 'netmanager' 'ntp' 'poe'
'port'
             'port-security' 'qos' 'relay' 'rmon' 'snmp' 'sntp'
'ssh'
             'swring' 'time_range' 'user' 'vlan'
'web-privilege-group-level'
mydevice# show running-config feature vlan
Building configuration...
!
vlan 1
!
!
!
!
interface GigabitEthernet 1/1
!
interface GigabitEthernet 1/2
!
interface GigabitEthernet 1/3
!
... much output omitted for brevity ...
```

The structure of running-config remains unchanged in the output. Sub-modes such as VLANs and Ethernet interfaces are listed, but if the requested function is not related to a specific sub-mode, the output may be empty.

```
show running-config interface ( <port_type> [ <list> ] )
[ all-defaults ]
```

By using this filter, users can view a list of specific Ethernet interfaces. This may contain wildcards, for example:

```
mydevice# show running-config interface 2.5GigabitEthernet *
Building configuration...
interface 2.5GigabitEthernet 1/9
 no spanning-tree
!
interface 2.5GigabitEthernet 1/10
 no spanning-tree
!
end
```

In this example, there is only one VLAN on the system.

```
show running-config interface vlan <list> [ all-defaults ]
```

It is also possible to filter the list of VLAN interface, for example:

```
mydevice# show running-config interface vlan 1-10
Building configuration...
interface vlan 1
ip address 192.168.1.254 255.255.255.0!
end
```

In this example, there is only one VLAN interface on the system.

```
show running-config line { console | vty } <list> [ all-defaults ]
```

This command can be used for the console or list of virtual terminal devices (vty). In the current design, there is only one console device, 0. For example:

```
mydevice# show running-config line console 0
Building configuration...
line console 0
!
End
```

6 Working with Configuration Files

There are four configuration files:

- running-config–A virtual file containing the currently running system configuration.
- startup-config – contains the boot-time configuration. When changing the configuration, you must copy it to startup-config so that it can be applied at the next startup.
- default-config—Restore the read-only file used when the configuration is the default value. If startup-config is missing, the file will also be used. It contains product-specific customizations to the default settings of the device.
- User-defined – configuration files created by the user (up to 31). These are usually used for backups or variants of startup-config.

Except for running-config, all these are stored in the flash file system. The available operations are:

copy source destination

where source and destination can be one of:

```
running-config
startup-config (or flash:startup-config)
flash:filename
dir
```

Lists the contents of the flash file system.

```
#more flash: filename
```

Output the file content to the terminal.

```
#delete flash: filename
```

Delete a specific file.

6.1 Restore to the Default Configuration

It is possible to reset the system to a default configuration in two ways:

- Delete startup-config and restart.
- Instructs the software to abandon the current configuration and reset to the default values without restarting.

Deleting startup-config doesn't change running-config until the system is rebooted, at which time the defaults are loaded.
Conversely, discarding the current configuration does affect running-config, but it does not affect startup-config. If you want to save the configuration, you should save startup-config to running-config.
Rebooting and resetting the default configuration is accomplished with the reload command:

```
#reload cold
#reload defaults [ keep-ip ]
```

Reloading the cold version will restart the system. If the system is stacking, you can also restart a specific switch by providing the switch ID.
The second method loads the configuration default values. If the `keep-ip` keyword is given, then the system attempts to keep the most relevant parts of the VLAN 1 IP setup in order to maintain management connectivity (the IP address setup and the active default route).
There is no guarantee, however, that the above is sufficient for reverting to default configuration: it depends on the actual network properties and the system's total IP configuration. In some cases, it is best to use the "no" command to explicitly cancel the system configuration, or prepare an appropriate configuration and download it to the startup-config of the system, and then restart it.

6.2 Use Configuration Files

The following example assumes a file system that contains an additional file called backup, previously created with a `copy` command.

```
! List files in flash:
mydevice# dir
Directory of flash:
r- 1970-01-01 00:00:00   648 default-config
rw 1970-01-06 03:57:33   1313 startup-config
rw 1970-01-01 19:54:01   1237 backup
3 files, 3198 bytes total.

! Display the contents of the file 'backup' (output is abbreviated):
mydevice# more flash:backup
hostname mydevice
...
end
! Use file 'backup' for the next boot by overwriting startup-config:
mydevice# copy flash:backup startup-config
% Saving 1237 bytes to flash:startup-config

! Verify that the sizes are identical:
```

```
mydevice# dir
Directory of flash:
r- 1970-01-01 00:00:00   648 default-config
rw 1970-01-06 05:30:41   1237 startup-config
rw 1970-01-01 19:54:01   1237 backup
3 files, 3122 bytes total.

! Regret and delete startup-config. Note how 'flash:' is required:
mydevice# delete flash:startup-config
mydevice# dir
Directory of flash:
r- 1970-01-01 00:00:00   648 default-config
rw 1970-01-01 19:54:01   1237 backup
2 files, 1885 bytes total.

! Use the currently running config for next boot:
mydevice# copy running-config startup-config
Building configuration...
% Saving 1271 bytes to flash:startup-config
```

6.3 Using Reload Command

```
! Reload defaults, but try to keep VLAN 1 configuration. First list
current IP
! settings:

# show ip interface brief
Interface       Address            Method   Status
--------------- ------------------- -------- ------
VLAN 1          192.168.1.254/24    Manual   UP
mydevice# reload defaults keep-ip
% Reloading defaults, attempting to keep VLAN 1 IP address. Please
stand by.
# show ip interface brief
Interface       Address            Method   Status
--------------- ------------------- -------- ------
VLAN 1          192.168.1.254/24    Manual   UP
! Contents of flash: are unchanged:
mydevice# dir
Directory of flash:
```

```
r- 1970-01-01 00:00:00   648 default-config
rw 1970-01-06 05:33:18   1237 startup-config
rw 1970-01-01 19:54:01   1237 backup
3 files, 3122 bytes total.

! Reload again, but don't try to keep VLAN 1 settings:
# reload defaults
% Reloading defaults. Please stand by.
! Verify that the default IP settings have been restored:
 # show ip interface brief
lan Address       Method     Status
--------------- ------------------- -------- ------
1 192.0.2.1/24    Manual       UP

! Reboot the system
# reload cold
% Cold reload in progress, please stand by.
! ... bootup output omitted ...
```

6.4 Working with Software Images

The system can store up to two software images in flash. The image selected for bootup is termed the Active image, while the other is termed the Alternate image.
It is possible to swap the Active and the Alternative image, and it is possible to upgrade to a new Active image. A swap simply switches the Active and Alternate designation on each image and reboots the system.
Firmware upgrade requires these steps:

- Download new firmware using HTTPS and verify suitability for the system
- Overwrite the current Alternate image with the newly downloaded image
- Swap Active and Alternate and reboot

The result is that the old Active build becomes the Alternate, and the newly downloaded image Active.
Related configuration commands:

```
show version
firmware swap
show version
! lists various details about the system, including the images in flash.
```

CLI example: use alternate firmware to replace active firmware.

```
# firmware swap
... Erase from 0x41fd0000-0x41fdffff: Low Library.
... Program from 0x87feeffc-0x87ffeffc to 0x41fd0000: Low Library.
```

```
... Program from 0x87fef006-0x87fef008 to 0x41fd000a: Low Library.
Alternate image activated, now rebooting.
! ... much output omitted for brevity
```

7 System

7.1 System Information

CLI example: display system information.

```
# show version
MEMORY          : Total=78804 KBytes, Free=62788 KBytes, Max=62771
KBytes
FLASH           : 0x40000000-0x41ffffff, 512 x 0x10000 blocks
MAC Address      : 00-02-6f-01-02-03
Device Number    : Need to fill in!
Previous Restart : Cold

System Contact   :
System Name      :
System Location  :
System Time      : 1970-01-01T01:19:17+00:00
System Uptime    : 01:19:17

Active Image
------------
Image           :  (primary)
Version         : 5.2.2.B2021070900R1224D20000
Date            : Jul  9 2021 10:24:54 by Jaguar

Alternate Image
---------------
Image           :  (backup)
Version         : 5.2.2.B2021070900R1224D20000
Date            : Jul  9 2021 10:24:54 by Jaguar
```

```
Bootloader
----------
Image           : RedBoot (bootloader)
Version         : version 1.1
Date            : 10:26:58, Jul  9 2021


------------------
SID : 1
------------------
Port Count      : 12
Product         : Managed Switch
Software Version : 5.2.2.B2021070900R1224D20000
Build Date      : Jul  9 2021 10:24:54 by Jaguar


SoftProductID:63
Port count:12
```

CLI example, set the system time to 16: 00 p.m, June 8th, 2021.

```
# configure terminal
(config)# time set 2021/06/08 16:00:00
```

7.2 IP

7.2.1 IP Configuration

Routing or host mode configuration.
Command:

```
ip routing
no ip routing
```

IP Interface

Configure the IP address and DHCP service function of the VLAN interface.
Command:

```
interface vlan <vlist>
ip address { { <address> <netmask> } | { dhcp [ fallback
<fallback_address> <fallback_netmask> [ timeout
<fallback_timeout> ] ] } }
```

Parameters:

- < vlist >: VLAN entry.
- <address>: IPv4 address.
- <netmask>: subnet mask.

- <fallback_address>: fallback IP address
- < fallback_netmask >: fallback subnet mask.
- <fallback_timeout>: fallback timeout

IP Routes

Add IP routes.
Command:

```
ip route <v_ipv4_addr> <v_ipv4_netmask> <v_ipv4_gw>
```

Parameters:

- <v_ipv4_addr>: IPv4 network address.
- <v_ipv4_netmask>: subnet mask.
- <v_ipv4_gw>: gateway.

Static ARP

Static ARP binding.
Command:

```
ip arp <v_ipv4_abc> <v_mac_addr>
```

Parameters:

- <v_ipv4_abc>: IPv4 address.
- <v_mac_addr>: MAC address.

7.2.2 IP Status Monitoring

IP Interface

Displays IP interface information.
Command:

```
show interface vlan [<vlan_list>]
```

IP Routes

Display IP route information.
Command:

```
show ip route
```

Neighbour cache

Display neighbor cache information.
Command:

```
show ip arp
```

7.3 NTP

The Network Time Protocol (NTP) synchronizes the time of day among a set of distributed time servers and clients. This helps users to associate events from system logs with other time-specified events from multiple network devices. NTP uses the

User Datagram Protocol (UDP) as its transport protocol. All NTP communications use Coordinated Universal Time (UTC).
Although NTP version 4 is disabled by default, it has been executed. NTP IPv4 or IPv6 addresses can be configured to support up to five servers.
Enable/Disable NTP Client or Server.
Command:

```
ntp mode { client | server }
no ntp mode { client | server }
```

Configure NTP server IP address.
Command:

```
ntp server <index_var> ip-address <ipv4_var>
```

Parameters:

- <index_var>: the index value ranges from 1 to 5.
- <IPv4 _ var>: IPv4 address format is X.X.X.X.

Instance:
Use CLI commands to configure NTP and server addresses.

```
# configure terminal
! Enable NTP and set server address
(config)# ntp mode client
(config)# ntp server 1 ip-address 217.198.219.102
```

The software allows users to configure the local time zone. The switch must be configured to get the time from the NTP server. The default time zone is configured as None. Acronyms can be selectively assigned to selected time zones.
Show NTP Status.
Command:

```
show ntp mode { client | server } status
show ntp status
```

7.4 Time Zone

Time Zone Configuration.
Command:

```
clock timezone <word_var> <hour_var> [ <minute_var>
[ <subtype_var> ] ]
```

Parameters:

- <word_var>: The acronym can be up to 16 alpha-numeric characters in length, allowing special characters such as, '-' (hyphen), '.'(period) and '_'(underline). Acronyms are case-sensitive.
- <hour _ var>: UTC time zone-12 – 12.

Instance:
CLI example, set the system time zone to (GMT+08: 00) Beijing, Chongqing, Hong Kong, Urumqi, and set the acronym to BJ.

```
(config)# clock timezone BJ 8
```

Timezone.

Command:

```
show clock detail
```

7.5 Log

7.5.1 Configure Log

Log configuration, related commands are as follows:

```
(config)# logging ?
host     host
level    Severity level
on       Enable Switch logging host mode

(config)# logging level ?
   error           Severity 3: Error conditions
   informational    Severity 6: Informational messages
   notice          Severity 5: Normal but significant condition
   warning         Severity 4: Warning conditions
```

CLI example, enable server mode and set the server address to receive logs to 192.168.1.2.

```
# configure ter
(config)# logging  on
(config)# logging host 192.168.1.2
```

7.5.2 Check Alarm Log

The command to view the alarm log:

```
# show alarmlog ?
   |              Output modifiers
   error           Severity 3: Error conditions
   informational    Severity 6: Informational messages
   notice          Severity 5: Normal but significant condition
   warning         Severity 4: Warning conditions
<cr>
```

Example: View the alarm log with the level of "Error”

```
# show alarmlog error
```

8 Port

8.1 Port Configuration

View Port Configuration

You can view port configuration through **show interface ?**.
View port configuration, the following commands can be supported.

```
# show interface GigabitEthernet 1/1 ?
*                  All switches or All ports
GigabitEthernet      1 Gigabit Ethernet Port
2.5GigabitEthernet    2.5 Gigabit Ethernet Port
capabilities         Display capabilities.
description          Description of interface
statistics           Display statistics counters.
status               Display status.
switchport           Show interface switchport information
transceiver          Show interface transceiver
veriphy              Display the latest cable diagnostic results.
```

CLI example: view the Port 1's status.

```
# show interface GigabitEthernet 1/1 status
```

CLI example: view the Port 1's performance parameter.

```
# show interface GigabitEthernet 1/1 capabilities
GigabitEthernet 1/1 Capabilities:
  Model:               CEServices
  Type:                10/100/1000BaseT
  Speed:               10,100,1000,auto
  Duplex:              half,full,auto
  Trunk encap. type:     802.1Q
  Trunk mode:           access,hybrid,trunk
```

```
 Channel:             no
 Broadcast suppression: no
 Flowcontrol:          yes
 Fast Start:           no
 QoS scheduling:       tx-(8q)
 CoS rewrite:          yes
 ToS rewrite:          yes
 UDLD:                no
 Inline power:         yes
 RMirror:             no
 PortSecure:           yes
 Dot1x:               no
```

CLI example: view Port 1's statistical monitoring

```
show interface GigabitEthernet 1/1 statistics
```

Modify Port Configuration

In the config view, ports can be configured, and the supported commands are as follows.

```
(config)# interface GigabitEthernet 1/1
(config-if)# ?
   access-list          Access list
   aggregation          Create an aggregation
   description          Description of the interface
   do                  To run exec commands in the configuration
mode
   duplex               Interface duplex
   end                 Go back to EXEC mode
   evc                 Ethernet Virtual Connections
   excessive-restart    Restart backoff algorithm after 16
collisions (No  excessive-restart means discard frame after 16
collisions)
   exit                Exit from current mode
   flowcontrol          Traffic flow control.
   frame-length-check    Drop frames with mismatch between
EtherType/Length  field and actually payload size.
   help                Description of the interactive help system
   ip                  Interface Internet Protocol configuration
commands
   lacp                Enable LACP on this interface
   mac                 MAC keyword
   media-type           Media type.
```

```
   mtu                 Maximum transmission unit
   no                  Negate a command or set its defaults
   poe                 Power Over Ethernet.
   qos                 Quality of Service
   relay               Port alarm
   shutdown            Shutdown of the interface.
   snmp-server         Set SNMP server's configurations
   spanning-tree       Spanning Tree protocol
  speed               Configures interface speed. If you use 10, 100,
or 1000 keywords with the auto keyword the port will
only advertise the specified speeds.
   switchport          Switching mode characteristics
```

CLI example: set the speed of Port1 to 1Gps.

```
(config-if)# interface GigabitEthernet 1/1
(config-if)# speed 1000
```

CLI example: set Port1 to full duplex mode, enable flow control.

```
(config-if)# interface GigabitEthernet 1/1
 (config-if)# speed 1000
(config-if)# duplex ?
   auto   Auto negotiation of duplex mode.
   full   Forced full duplex.
   half   Forced half duplex.
(config-if)# duplex full
(config-if)# flowcontrol on
```

CLI example: close Port 3 and the closed port will not be accessible.

```
# configure terminal
(config-if)#  interface GigabitEthernet 1/1 GigabitEthernet 1/3
(config-if)# shutdown
```

CLI example: open Port 1 and Port 3.

```
(config)# interface GigabitEthernet 1/1
(config-if)# no shutdown
(config)# interface GigabitEthernet 1/3
(config-if)# no shutdown
```

8.2 DDMI

DDMI can be enabled by the following command.

```
(config)# ddmi
```

CLI example: view DDMIs enabled status.

```
# show DDMI
Current mode: Enabled
```

View DDMI monitoring data

```
# show interface GigabitEthernet 1/11 transceiver

GigabitEthernet 1/11
------------------------------
Tranceiver Information
================================================================
============
Vendor            :
Part Number       :
Serial Number     :
Revision          :
Data Code         :
Transceiver       : NONE

DDMI Information
++ : high alarm, +  : high warning, -  : low warning, -- : low alarm.
Tx: transmit, Rx: receive, mA: milliamperes, mW: milliwatts.
================================================================
============
% SFP module doesn't support DDMI
```

8.3 Relay Alarm

8.3.1 View Relay Status

The relay status of power supply and port could be viewed by the following commands.

```
# show relay
Switch relay alarm is disabled
Switch relay power1 alarm is disabled
Switch relay power2 alarm is disabled
relay is configured on following
GigabitEthernet 1/1 disable
GigabitEthernet 1/2 disable
GigabitEthernet 1/3 disable
GigabitEthernet 1/4 disable
```

```
GigabitEthernet 1/5 disable
GigabitEthernet 1/6 disable
GigabitEthernet 1/7 disable
GigabitEthernet 1/8 disable
GigabitEthernet 1/11 disable
GigabitEthernet 1/12 disable
2.5GigabitEthernet 1/9 disable
2.5GigabitEthernet 1/10 disable
```

CLI example, view Port 1's relay status.

```
# show relay interface GigabitEthernet 1/1
GigabitEthernet 1/1 disable
```

8.3.2 Configure Relay

Enable Relay Alarm

CLI example: enable power supply 1’s relay alarm.

```
# configure terminal
(config)# relay power 1
```

CLI example: enable Port 1’s relay alarm.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# relay
```

Disable Relay Alarm

CLI example: disable power supply 1’s relay alarm.

```
# configure terminal
(config)# no relay power 1
```

CLI example: disable Port 1’s relay alarm.

```
(config-if)# no relay
```

8.4 IO Alarm

Enable/disable IO alarm mode and configure alarm type.
Command:

```
io alarm mode <index_var>
no io alarm mode <index_var>
io alarm type { close | open | both } <index_var>
```

Parameters:

- <index_var>：IO port No.

- { close | open | both }：{ close | open | both }

View IO Status.

Command:

```
show io alarm [ <index_var> ]
```

9 SNMP

9.1 Navigating the SNMP Configuration

The command to view SNMP is as follows.

```
# show snmp ?
   |                 Output modifiers
   access             access configuration
   community           Community
   host               Set SNMP host's configurations
   mib                MIB (Management Information Base)
   security-to-group    security-to-group configuration
   user               User
   view               MIB view configuration
   <cr>
```

CLI example: view the community configuration of SNMP V3.

```
# show SNMP community V3
Community   : public
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0

Community   : private
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0
```

9.2 Configuring SNMP

The related commands of SNMP configuration are as follows.

```
# configure terminal
(config)# snmp ?
   access             access configuration
   community          Set the SNMP community
   contact            Set the SNMP server's contact string
   engine-id          Set SNMP engine ID
   host               Set SNMP host's configurations
   location           Set the SNMP server's location string
   security-to-group   security-to-group configuration
   trap               Set trap's configurations
   user               Set the SNMPv3 user's configurations
   version            Set the SNMP server's version
   view               MIB view configuration
   <cr>
```

CLI example: enable and disable SNMP, and view the configuration results.

```
(config)# snmp
(config)# end
# show snmp

SNMP Configuration
SNMP Mode                  : enabled
SNMP Version               : 3
Read Community             : default
Write Community            : private
Trap Mode                  : disabled

SNMPv3 Communities Table:
Community   : public
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0

Community   : private
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0


SNMPv3 Users Table:
User Name             : default_user
Engine ID             : 800007e5017f000001
```

```
Security Level         : NoAuth, NoPriv
... much output omitted for brevity ...

# configure terminal
(config)# no snmp
(config)# end
# show snmp

SNMP Configuration
SNMP Mode                  : disabled
SNMP Version                : 3
Read Community              : default
Write Community             : private
Trap Mode                  : disabled

SNMPv3 Communities Table:
Community   : public
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0

Community   : private
Source IP   : 0.0.0.0
Source Mask : 0.0.0.0


SNMPv3 Users Table:
User Name             : default_user
Engine ID             : 800007e5017f000001
Security Level         : NoAuth, NoPriv
... much output omitted for brevity ...
```

CLI example: enable and disable SNMP Trap.

```
(config)# snmp-server trap
(config)# no snmp-server trap
```

CLI example: create a new community pub1, and set the original address of SNMP access to 192.168.1.200 and the source mask to 255.255.255.0.

```
(config)# snmp community v3 pub1 192.168.1.200 255.255.255.0
```

CLI example: update the system engine ID of SNMP, note that updating the engine ID will clear all original local users.

```
(config)# snmp engine-id local 800007e5017f000002
```

CLI example: The commands of creating new Trap entries and disabling all Trap entries.

```
(config)# snmp-server host host1
(config-snmps-host)# shutdown
```

CLI example: add community name public3, source IP is 192.168.1.254, and destination address is 255.255.255.0.

```
(config)# snmp community V3 public3 192.168.1.100 255.255.255.0
```

CLI example: create a new user user1, set the user engine to 800007e5017f000001, the authentication mode to md5 and the encryption method to AES, and set authentication password and privacy password.

```
(config)# snmp user user1 engine-id 800007e5017f000001 md5 pri aes
Auth Password Set
   Please enter the new Password:
   Enter the Password again:

Private Password Set
   Please enter the new Password:
   Enter the Password again:
The MD5 and AES protocol has security risks. Please use it caution.
```

Notice

The encryption algorithms adopted by the device include AES, DES, SHA1 and MD5, among which:

- AES and DES encryption algorithms are reversible, SHA1 and MD5 encryption algorithms are irreversible.
- DES / MD5 / SHA1 encryption algorithm has low security and exists security risks.

Therefore, within the range of encryption algorithms supported by the protocol, it is recommended to use more secure encryption algorithms, such as AES.

CLI example: delete the user entry with user name user1 and user engine 800007e5017f000001.

```
(config)# no snmp user user1 engine-id  800007e5017f000001
```

CLI example: create a new View, set the view type to include and MIB word OID to .1.0.1.

```
(config)# snmp view view1 .1.0.1 include
```

CLI example: create a security group with the security name usm-user and the group name ro-group.

```
(config)# snmp security-to-group model v3 name usm-user group
ro-group
```

10 RMON

10.1 Statistics Configuration

Command:

```
rmon collection stats <id>
```

Parameters:

- <id>: statistics ID, 1-65535.

10.2 History Configuration

Command:

```
rmon collection history <id> [ buckets <buckets> ] [ interval
<interval> ]
```

Parameters:

- <id>: history ID, 1-65535.
- <buckets>: the maximum number of sampling entries, 1-65535.
- <interval>: the sampling interval is 1-3600s.

10.3 Alarm Configuration

Command:

```
rmon alarm <id> { ifInOctets | ifInUcastPkts | ifInNUcastPkts |
ifInDiscards | ifInErrors | ifInUnknownProtos | ifOutOctets |
ifOutUcastPkts | ifOutNUcastPkts | ifOutDiscards | ifOutErrors }
<ifIndex> <interval> { absolute | delta } rising-threshold
<rising_threshold> [ <rising_event_id> ] falling-threshold
<falling_threshold> [ <falling_event_id> ] { [ rising | falling
| both ] }
```

Parameters:

- <ID>: 1-65535, alarm entry id.
- <ifIndex>: interface index.
- <interval>: the sampling interval is 1-2147483647.
- <rising_threshold>: rising thresholds value, -2147483648-2147483647.

- <rising_event_id>: rising event ID.
- <Falling_threshold>: falling thresholds value, -2147483648-2147483647.
- <falling_event_id>: falling event ID.

10.4 Link Event Configuration

Command:

```
rmon event <id> [ log ] [ trap <community> ] { [ description
<description> ] }
```

Parameters:

- <id>: event ID.
- <community>: Trap community.
- <description>: description.

10.5 Statistics Monitoring

Command:

```
show rmon statistics [ <id_list> ]
```

Parameters:

- <id_list>: ID entry 1-65535.

10.6 History Monitoring

Command:

```
show rmon history [ <id_list> ]
```

Parameters:

- <id_list>: ID entry 1-65535.

10.7 Alarm Monitoring

Command:

```
show rmon alarm [ <id_list> ]
```

Parameters:

- <id_list>: ID entry 1-65535.

10.8 Event Monitoring

Command:

```
show rmon event [ <id_list> ]
```

Parameters:

- <id_list>: ID entry 1-65535.

11 Ethernet Services

11.1 Port Configuration

Command:

```
interface GigabitEthernet <port_type_list>
evc [ dei { colored | fixed } ] [ tag { inner | outer } ] [ addr
{ source | destination } ]
```

Parameters:

- <port_type_list>: port number.

11.2 L2CP Configuration

Command:

```
interface GigabitEthernet <port_type_list>
evc l2cp (peer | forward ) <l2cp _list>
```

Parameters:

- <port_type_list>: port number.
- <l2cp _ list>: the value of L2CP list is 0-31, where 0-15 is the MAC address of destination BPDU (01-80-C2-00-00-0X), 16-31 is the MAC address of GARP (01-80-C2-00-00-2X), and the value of X is 0-F.

11.3 Bandwidth Limitation Subset

Command:

```
evc policer [ update ] <policer_id> [ { enable | disable } ] [ type
{ mef | single } ] [ mode { coupled | aware } ] [ rate-type { line
| data } ] [ cir <cir> ] [ cbs <cbs> ] [ eir <eir> ] [ ebs <ebs> ]
```

Parameters:

- <policer_ID>: policer ID, 1-256.
- <cir>: committed information rate, 0-10000000kbps.
- <cbs>: committed information size, 0-100,000 bytes.

- <eir>: excess information rate, 0-10000000kbps.
- <ebs>: excess information size, 0-100000bytes.

11.4 EVCs Configuration

Command:

- NNI Port.

```
evc <evc_id> interface ( <port_type> [ <port_list> ] )
```

- EVC Parameters.

```
evc <evc_id> [ name <evc_name> ] { [ vid <evc_vid> ] } [ ivid <ivid> ]
[ learning [ disable ] ]
```

- Inner Tag.

```
evc <evc_id> [ inner-tag add { [ type { none | c-tag | s-tag |
s-custom-tag } ] [ vid-mode { normal | tunnel } ] [ vid <it_add_vid> ]
[ preserve [ disable ] ] [ pcp <it_add_pcp> ] [ dei <it_add_dei> ]
```

- Outer Tag.

```
evc <evc_id> [ outer-tag add vid <ot_add_vid> ]
```

Parameters:

- <evc_id>：EVC ID，1-256。
- <port_type>: port type.
- <port_list>: port number.
- <evc_name >: EVC name, 1-256 characters (A-Z, a-z, 0-9).
- <evc_vid>: EVC VLAN ID, 1-4095.
- <ivid>: internal VLAN ID.
- <it_add_vid>: Inner tag VID.
- <it_add_pcp>: internal tag PCP, 0-7.
- <it_add_dei>: internal tag DEI, 0-1.
- <ot_add_vid>: Outer tag VID.

11.5 ECEs Configuration

Command:

- UNI Port.

```
evc ece <ece_id> [ interface ( <port_type> [ <port_list> ] ) ]
```

- UNI matching - tag type.

```
evc ece <ece_id> [ outer-tag { [ match { [ type { untagged | tagged
| c-tagged | s-tagged | any } ] [ vid { <ot_match_vid> | any } ]
[ pcp { <ot_match_pcp> | any } ] [ dei { <ot_match_dei> | any } ] } ]
[ add { [ mode { enable | disable } ] [ preserve [ disable ] ] [ pcp
<ot_add_pcp> ] [ dei <ot_add_dei> ] } ] } ]
```

- UNI matching - frame type.

```
evc ece <ece_id> [ frame-type { any | { ipv4 [ proto { <pr4> | udp
| tcp | any } ] [ dscp { <dscp4> | any } ] [ sip { <sip4> | any } ]
[ dip { <dip4> | any } ] [ fragment { yes | no | any } ] [ sport
{ <sp4> | any } ] [ dport { <dp4> | any } ] } | { ipv6 [ proto { <pr6>
| udp | tcp | any } ] [ dscp { <dscp6> | any } ] [ sip { <sip6>
```

```
| any } ] [ dip { <dip6> | any } ] [ sport { <sp6> | any } ] [ dport
{ <dp6> | any } ] } } ]
```

- Action.

```
evc ece <ece_id> [ direction { both | uni-to-nni | nni-to-uni } ]
[ evc { <evc_id> | none } ] [ pop <pop> ] [ policy <policy_no> ]
[ cos { <cos> | disable } ]
```

- MAC Parameters.

```
evc ece <ece_id> [ smac { <smac> | any } ] [ dmac { <dmac> | unicast
| multicast | broadcast | any } ]
```

Parameters:

- <ece_id>：ECE ID，1-256。
- <port_type>: port type.
- <port_list>: port number.
- <ot_match_vid>: external matching VID.
- <ot_match_pcp>: external matching PCP, 0-7.
- <ot_match_dei> : external match DEI, 0-1.
- <ot_add_pcp>: egress outer tag PCP, 0-7.
- <ot_add_dei>: egress outer tag DEI, 0-1.
- <pr4>: IP protocol type, 0-255.
- <dscp4>: DSCP filter value or range.
- <sip4>:source IP address.
- <dip4>:destination IP addresses.
- <Sp4>:source port
- <Dp4>:destination Port
- <pop>: PoP tag statistics, 0-2.
- <policy_no>: ACL policy, 0-255.
- <cos>: CoS class of service, 0-7.
- <smac>: source MAC address.
- <dmac>: destination MAC address.

11.6 EVC Statistics Monitoring

Command:

```
show evc statistics [ interface ( <port_type> [ <port_list> ] ) ]
[ cos <cos> ] [ green | yellow | red | discard ]

show evc { [ <evc_id> | all ] } [ ece [ <ece_id> ] ]
```

Parameters:

- <port_type>: port type.
- <port_list>: port number.
- <cos>: CoS class of service, 0-7.
- <evc_id>：ECE ID，1-256。

12 Configure Static Routing

An IP address identifies a device on an IP network. The IP version 4 (IPv4) address is 32 bits long. IPv4 addresses can only be assigned through VLAN interfaces. The address can be set manually (called a static IP) or automatically by using the DHCP protocol. For more information, see Configuring DHCP Client Switch Application Software to Handle Software Static IPv4 Routes.

Traditional Network

Routing includes a TCP/IP host and an IP router. The following figure shows the configuration of a traditional network with two IP networks and a router. Each IP network needs an assigned IP address and a gateway to which packets can be forwarded.

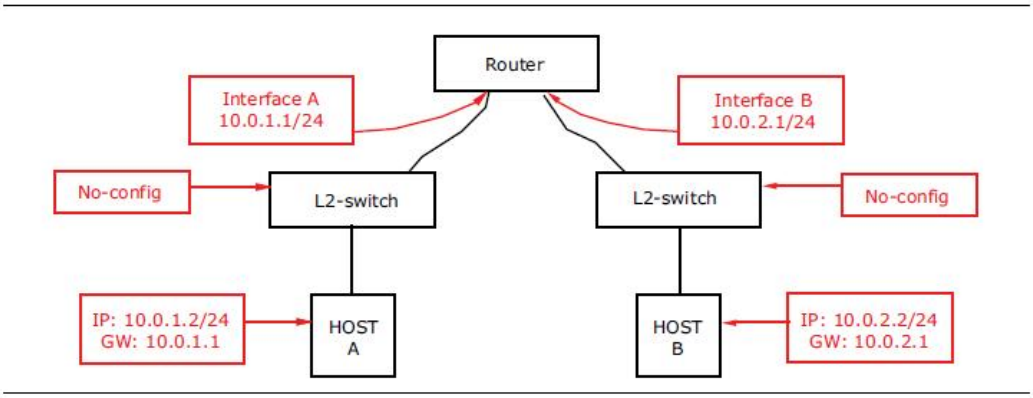


Figure • IP Routing of using Router and L3 Switch

Using a VLAN-Aware Switch

The following illustration shows the same network configured to use a VLAN-aware switch. Using VLAN is a way to separate traffic within the same switch.

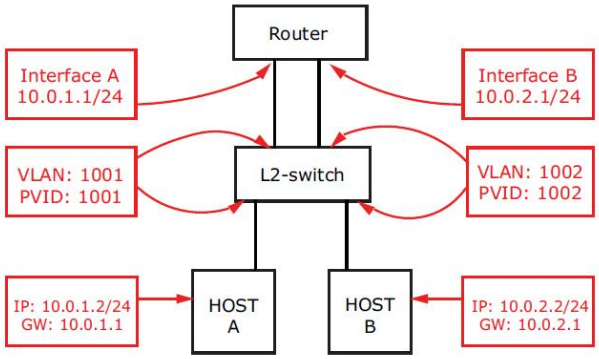


Figure • IP Routing using a Router and VLAN-Aware Switch

Configuration using ICLI

The following steps implement the configurations using the command line interface.

Step 1 Create VLAN 1001 and 1002 to separate two IP networks.

```
Switch# configure terminal
Switch(config)# vlan 1001
Switch(config-vlan)# vlan 1002
Switch(config-vlan)# exit
```

Step 2 Define the port VLAN for each port by using the switchport access vlan command to specify the VLAN for each interface. Then, unlabeled frames are classified into this VLAN.

```
Switch(config)# interface GigabitEthernet 1/1
Switch(config-if)# switchport access vlan 1001
Switch(config-if)# exit
Switch(config)# interface GigabitEthernet 1/2
Switch(config-if)# switchport access vlan 1002
Switch(config-if)# exit
```

Step 3 Use the IP address command to set the primary IP address for the interface, thus configuring router branch A and branch B.

```
Switch(config)# interface vlan 1001
Switch(config-if-vlan)# ip address 10.0.1.1 255.255.255.0
Switch(config-if-vlan)# exit
Switch(config)# interface vlan 1002
Switch(config-if-vlan)# ip address 10.0.2.1 255.255.255.0
Switch(config-if-vlan)# end
```

13 Layer 2 Protocol Configuration

This document describes how to configure switch to perform Layer 2 functions such as Link Aggregation (LAG), Link Aggregation Control Protocol (LACP), Virtual LANs (VLANs), Mirroring and Multiple Spanning Tree Protocol (MSTP). Configuration examples are provided for the command line interface (CLI).

13.1 Link Aggregation

Aggregation supports the parallel use of multiple ports, thus increasing the link speed beyond the limit of a single port and increasing redundancy for higher availability. If the system has 6 ports, the maximum aggregation group is 3 (6 divided by 2).

Add Port to Aggregation Group

CLI example: Add the first Gigabit port into group 1

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# aggregation ?
group   Create an aggregation group
(config-if)# aggregation group ?
<uint> The aggregation group id
(config-if)# aggregation group 1
```

Configure Aggregation Mode

The aggregation function uses the following keys to calculate the destination port of the frame. The default methods are the source MAC address, IP address and TCP/UDP port number. By default, Destination MAC Address is not used.
CLI example: Change aggregation mode to dmac, ip, port, and smac

```
# configure terminal
(config)# aggregation mode ?
Dmac    Destination MAC affects the distribution
ip      IP address affects the distribution
port IP port affects the distribution
```

```
smac Source MAC affects the distribution
<cr>
(config)# aggregation mode dmac ip port smac
(config)# do show aggregation mode
Aggregation Mode:

SMAC : Enabled
DMAC : Enabled
IP : Enabled
Port : Enabled
```

You can use the show aggregation mode command to view the current aggregation mode.

```
# show aggregation mode
Aggregation Mode:

SMAC : Enabled
DMAC : Disabled
IP : Enabled
Port : Enabled
```

13.2 LACP

Link Aggregation Control Protocol (LACP) is an IEEE 802.3ad standard protocol that allows bundling several physical ports together to form a single logical port.

Enable LACP

When the lacp command is used on a port to start LACP, it will form an aggregation with two or more ports connected to the same aggregation. The default value is Disabled.

CLI example: Enable LACP on the first Gigabit port

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# lacp
```

CLI example: Disable LACP on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# no lacp
```

Configure Keyword

The port's LACP key ranges from 1-65535. The Auto setting sets the key according to the physical link speed, 10 Mb = 1, 100 Mb = 2, 1 Gb = 3. With a specific setting a user-defined value can be entered. Ports with the same Key value can participate in

the same aggregation group, while ports with different keys cannot. The default value is automatic.
CLI example: Set the LACP key of the first Gigabit port to 3.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# lacp key ?
<1-65535>  Key value
auto Choose a key based on port speed
(config-if)# lacp key 3
```

Configure Roles

LACP role shows the activity status. The active role transmits LACP packets every second, while the passive role waits for LACP packets from peers, also known as the "reply" role. The default value is active.
CLI example: Set LACP Role to Passive on the first Gigabit port

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# lacp role ?
active  Transmit LACP BPDUs continously
passive Wait for neighbour LACP BPDUs before transmitting
(config-if)# lacp role passive
```

Configuration Timeout

Timeout controls the period between BPDU transmissions. Fast transmits LACP packets every second, while Slow waits for 30 seconds before sending LACP packets. The default value is Fast.
CLI example: Set LACP Timeout to slow on the first Gigabit port

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# lacp timeout ?
Fast   Transmit BPDU each second (fast timeout)
slow   Transmit BPDU each 30th second (slow timeout)
(config-if)# lacp timeout slow
```

Configure Priority

Priority controls the priority of the port. If the LACP partner wants to form a larger group than is supported by this device, then this parameter controls which ports will be active and which ports will be in a backup role. Lower number means greater priority. The default value is 32768.
CLI example: Set LACP priority to 1000 on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# lacp port-priority ?
```

```
<1-65535>  Priority value, lower means higher priority
(config-if)# lacp port-priority 1000
```

Display State

The current LACP mode can be viewed with the show lacp command, as follows:

```
# show lacp ?
internal   Internal LACP configuration
neighbour  Neighbour LACP status
statistics Internal LACP statistics
system-id  LACP system id
```

13.3 MAC Address Table

The exchange is based on the DMAC address contained in the frame. The switch builds up a table that maps MAC addresses to switch ports for knowing which ports the frames should go to. The table contains static and dynamic entries. If the administrator wants a fixed mapping between the DMAC address and the switch port, the static entry is configured by the network administrator.
The frames also contain a source MAC address (SMAC address), which shows the MAC address of the equipment sending the frame. Switches use SMAC addresses to automatically update MAC tables with these dynamic MAC addresses. If no frame with the corresponding SMAC address appears after the configurable aging time, the dynamic entry is deleted from the MAC table.
The MAC address table related configuration commands are as follows:

- Set MAC aging time
- Set automatic MAC address learning:
  - Automatic MAC address learning of VLAN
  - Automatic MAC address learning of port
- Add static MAC address for VLAN

```
mydevice(config)# mac address-table?
   aging-time    Mac address aging time
   learning      Mac Learning
static       Static MAC address
mydevice(config)# mac address-table learning ?
vlan    VLAN
mydevice(config)#  interface GigabitEthernet 1/6
mydevice(config-if)# mac address-table learning
```

Setting the Aging Time

By default, dynamic entries are removed from the MAC table after 300 seconds. This removal is also called aging.
CLI example: Change the aging time to 600 seconds

```
# configure terminal
(config)# mac address-table aging-time ?
```

```
<0,10-1000000>Aging time in seconds, 0 disables aging
(config)# mac address-table aging-time 600
```

Adding a Static MAC Address Entry

CLI example: Add static MAC address: 00:00:00:00:00:01 in VLAN 2 on the first Gigabit port

```
# configure terminal
(config)# mac address-table ?
   aging-time    Mac address aging time
   learning      Mac Learning
static        Static MAC address
(config)# mac address-table static 00:00:00:00:00:01 vlan 2
interface GigabitEthernet 1/1
```

Display MAC Address Table

The current MAC address table can be viewed with the show mac address-table command as follows:

```
# show mac address-table
```

13.4 VLAN

The following figure shows an example of VLAN configuration.

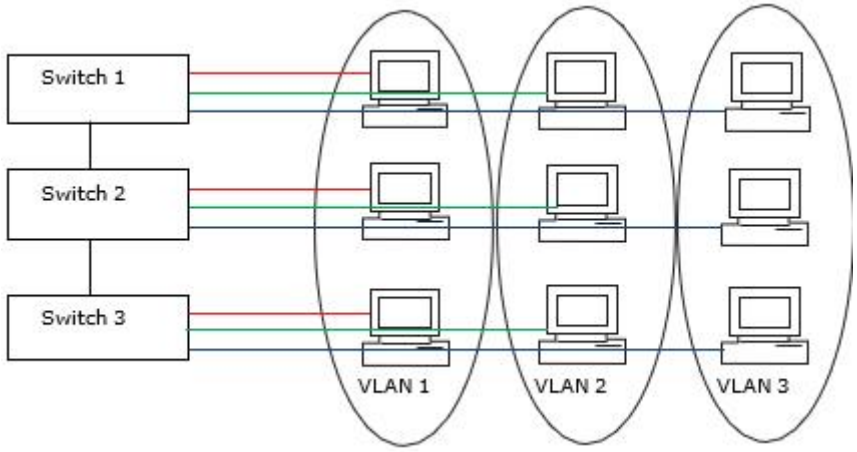


Figure • example of VLAN rapid configuration

Because VLAN 1 is created by default, one need only add VLAN 2 and 3, as follows:

```
# configure terminal
(config)# vlan 2
(config)# vlan 3
```

Set access port. It is assumed that ports 1 to 3 are connected to a PC. The PVID of each port is different.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
```

```
(config-if)# switchport mode access
(config-if)# switchport access vlan 1
(config)# exit
(config)# interface GigabitEthernet 1/2
(config-if)# switchport mode access
(config-if)# switchport access vlan 2
(config)# exit
(config)# interface GigabitEthernet 1/3
(config-if)# switchport mode access
(config-if)# switchport access vlan 3
(config)# exit
```

Set the Trunk port. Assume that port 4 is connected to another switch. Set the received VLAN to 1-3.

```
# configure terminal
(config)# interface GigabitEthernet 1/4
(config-if)# switchport mode trunk
(config-if)# switchport trunk allowed vlan 1-3
Configure the port such that frames are always transmitted with
a tag on port 4.
(config-if)# switchport trunk vlan tag native
```

Global Configuration

Current VLAN

CLI example: Add VLAN 2

```
# configure terminal
(config)# vlan 2
```

CLI example: Delete VLAN 2

```
# configure terminal
(config)# no vlan 2
```

CLI example: Show existing VLAN

```
# show vlan brief
VLAN    Name    Interfaces
1    default    Gi 1/1-6
2    VLAN0002
```

The VLAN field that allows access only affects ports that are configured as Access. Other port modes can access all VLAN members specified in the Allowed VLAN field. By default, only VLAN 1 is enabled. Use the following syntax to create more VLAN.

```
# configure terminal
(config)# vlan1,10-13,200,300
```

Individual elements are separated by commas, and ranges are separated by dashes. Spaces are allowed in between the delimiters. This example creates VLAN 1, 10, 11, 12, 13, 200, and 300.

VLAN Naming

CLI example: Set VLAN2's name to test

```
# configure terminal
(config)# vlan 2
(config-vlan)# name test
```

13.4.1 Port-Based Configuration

Port Mode

The port mode determines the basic behavior of the port. The port can be in one of three modes, in which Access is the default mode.

Access

Access ports are normally used to connect to end stations. Access ports have the following characteristics:

- Members of only one VLAN (port LAN or access VLAN), which is 1 by default.
- Accepts unmarked frames and C-marked frames.
- Discards all frames not classified to the accessVLAN.
- All frames at the egress will not be marked.

Trunk

Trunk ports can carry traffic on multiple VLANs simultaneously, and are normally used to connect to other switches. Trunk ports have the following characteristics:

- Member of all existing VLANs by default (limited by the use of allowed VLANs).
- All frames except those classified to the Port VLAN or Native VLAN get tagged on egress by default (frames classified to the Port VLAN do not get C-tagged on egress)
- Egress tagging can be changed to tag all frames, in which case only tagged frames are accepted on ingress

Hybrid：

Hybrid ports resemble trunk ports in many ways, but add additional port configuration features. In addition to the characteristics described for trunk ports, hybrid ports have these abilities:

- Ingress filtering can be controlled
- Ingress acceptance of frames and configuration of egress tagging can be configured independently

CLI example: Configure as Access port on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport mode access
```

CLI example: Configure as Trunk port on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport mode trunk
```

CLI example: Configure as Hybrid port on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport mode hybrid
```

Port VLAN

The port VLAN determines the VLAN ID or PVID of the port. Allowed VLANs are in the range 1 through 4095, default being 1.
On ingress, frames get classified to the Port VLAN if the port is configured as VLAN unaware, the frame is untagged, or VLAN awareness is enabled on the port, but the frame is priority tagged (VLAN ID = 0).
On egress, frames classified to the Port VLAN do not get tagged if Egress Tagging is set to untag Port VLAN.
The Port VLAN is called an "Access VLAN" for ports in Access mode and Native VLAN for ports in Trunk or Hybrid mode.
CLI example: Set Port VLAN to 2 on the first Gigabit port (configured as access mode)

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport access vlan ?
   <vlan_id>  VLAN ID of the native VLAN when this port is in trunk
mode
(config-if)# switchport access vlan 2
```

CLI example: Set port VLAN to 2 on the first Gigabit port (configured as trunk mode)

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport trunk native vlan 2
```

CLI example: Set port VLAN to 2 on the first Gigabit port (configured as hybrid mode)

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport hybrid native vlan 2
```

Ingress Filtering

Hybrid ports allow for changing ingress filtering. Access and Trunk ports always have ingress filtering enabled.
If ingress filtering is enabled, frames that are not members of VLAN ports will be dropped.
If ingress filtering is disabled, frames that are not members of VLAN ports are accepted and forwarded to the switch engine. However, the port will never transmit frames classified to VLANs that it is not a member of.
CLI example: Set ingress filtering on the first Gigabit port

```
# configure terminal
```

```
(config)# interface GigabitEthernet 1/1
(config-if)# switchport hybrid ?
acceptable-frame-type    Set acceptable frame type on a port
allowed                  Set allowed VLAN characteristics when
interface is in hybrid mode
egress-tag               Egress VLAN tagging configuration
ingress-filtering        VLAN Ingress filter configuration
native                   Set native VLAN
```

Ingress Acceptance

Hybrid ports allow for changing the type of frames that are accepted on ingress.

Tagged or Untagged

Both tagged and untagged frames are accepted.

Tagged Frame Only

Only tagged frames are accepted on ingress. Discard unmarked frames.

Untagged Frame Only

Only untagged frames are accepted on ingress. Discard marked frames.
CLI example: Configure ingress filtering on the first Gigabit port

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport hybrid acceptable-frame-type ?
all     Allow all frames
tagged  Allow only tagged frames
untagged   Allow only untagged frames
```

Egress Tagging

Ports in Trunk and Hybrid modes can control the marking of egress frames.

Untag Port VLAN

Frames classified to the Port VLAN are transmitted untagged. Other frames are transmitted with related tags.

Tag All

All frames, whether classified into port VLAN or not, are transmitted with tags.

Untag All

All frames, whether classified to the Port VLAN or not, are transmitted without a tag. This option is only available for ports in Hybrid mode.
CLI example: Set egress tagging on the first Gigabit port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport hybrid egress-tag ?
```

```
all     Tag all frames
none    No egress tagging
```

Allowed VLANs

Ports in Trunk and Hybrid mode may control which VLANs they are allowed to become members of. An Access port can only be a member of an Access VLAN.
The field's syntax is identical to the syntax used in the existing VLAN field. By default, a port may become a member of all possible VLANs, and is therefore set to 1-4095.
This field may be empty, which means that the port will not be a member of any existing VLAN.
CLI example: Set port VLAN to 2 on the first Gigabit port (configured as trunk mode)

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport trunk allowed vlan ?
<vlan_list>    VLAN IDs of the allowed VLANs when this port is
in hybrid mode
add            Add VLANs to the current list
all            All VLANs
except         All VLANs except the following
none           No VLANs
remove         Remove VLANs from the current list
```

CLI example: Set port VLAN to 2 on the first Gigabit port (configured as hybrid mode)

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# switchport hybrid allowed vlan ?
<vlan_list>    VLAN IDs of the allowed VLANs when this port is in
hybrid mode
add            Add VLANs to the current list
all            All VLANs
except         All VLANs except the following
none           No VLANs
remove         Remove VLANs from the current list
```

Forbidden VLANs

A port can be configured to never be a member of one or more VLAN. This is particularly useful when dynamic VLAN protocols such as MVRP and GVRP must be prevented from dynamically adding ports to VLANs.
The trick is to mark such VLANs as forbidden on the port in question. The syntax is the same as that used in the existing VLAN field.
By default, the field is left blank, which means that the port may become a member of all possible VLANs.
CLI example: Configure forbidden VLAN on the first Gigabit port.

```
# configure terminal
```

```
(config)# interface GigabitEthernet 1/1
(config-if)# switchport forbidden vlan ?
add         Add to existing list.
remove      Remove from existing list.
```

Display VLAN Status

CLI example

```
# show vlan ?
brief       VLAN summary information
id          VLAN status by VLAN id
ip-subnet   Show VLAN ip-subnet entries.
mac         Show VLAN MAC entries.
name        VLAN status by VLAN name
protocol    Protocol-based VLAN status
status      Show the VLANs configured for each interface.
<cr>
```

13.4.2 Configure MAC-based /Protocol based /IP Subnet-based VLAN

Supported commands for Configuring MAC-based /Protocol based /IP Subnet-based VLAN are as follows:

```
mydevice# configure ter
(config)# interface GigabitEthernet 1/1
mydevice(config-if)# switchport vlan ?
   ip-subnet    VCL IP Subnet-based VLAN configuration.
   mac          MAC-based VLAN commands
protocol     Protocol-based VLAN commands
(config-if)# exit

mydevice(config)# vlan protocol ?
   eth2    Ethernet-based VLAN commands
   llc     LLC based VLAN group
snap    SNAP-based VLAN group

mydevice(config-if)# switchport vlan ip-subnet ?
   <ipv4_subnet>    Source IP address and mask (Format:
                    xx.xx.xx.xx/mm.mm.mm.mm).
id               Specify an index for the IP subnet entry
```

```
 (deprecated).


mydevice(config-if)# switchport vlan mac ?
   <mac_ucast>    48 bit unicast MAC address: xx:xx:xx:xx:xx:xx
mydevice(config-if)# switchport vlan protocol?
   group    Protocol-based VLAN group commands
mydevice(config-if)# switchport vlan protocol group ?
   <word16>    Group Name (Range: 1 - 16 characters)
mydevice(config-if)# switchport vlan protocol group 1 ?
vlan    VLAN keyword
```

CLI example: configure the subnet 192.168.1.0/255.255.255.0 as VLAN1.

```
mydevice(config-if)# switchport vlan ip-subnet
192.168.1.0/255.255.255.0 vlan 1
```

CLI example: configure the MAC address 00:00:00:00:00:01 as VLAN1.

```
mydevice(config-if)# switchport vlan mac 00:00:00:00:00:01 vlan
1
```

CLI example: divide the data flow of arp protocol of Port 1 into VLAN1

```
mydevice(config)# vlan protocol eth2 arp group 1
mydevice(config)# interface GigabitEthernet 1/1
mydevice(config-if)# switchport vlan protocol group 1 vlan 1
```

13.5 Port Mirroring

Note

This function is only used for network traffic monitoring and fault location, and does not involve any operations related to collecting user data.

Local Mirror

In order to debug network problems or monitor network traffic, the switch system can be configured to mirror frames from multiple ports to a mirrored port.

Mirror the Traffic of Port X to Port Y

1. Mirror the traffic (both rx and tx) of the first Gigabit port

```
(config)# monitor source interface GigabitEthernet 1/1 both
```

2. Configure the mirror destination port to Gigabit port 6.

```
(config)# monitor destination interface GigabitEthernet 1/6
```

13.6 Multiple Spanning Tree Protocol

Bridge Settings

ICLI Command for Basic Settings

The following ICLI commands apply to basic settings.
The protocol version is set by the ICLI command:

```
(config)# spanning-tree mode [mstp|rstp|stp]
```

Set bridge priority:

```
(config)# spanning-tree mst 0 priority ?
<0-61440>   bridge priority in increments 0f 4096 (Lower
Priority indicates greater likelihood of becoming
            root)
```

The bridge priority should be set to a multiple of 4096, that is, one of 4096*i, where i=0, …, 15.
The forward delay is set by:

```
(config)# spanning-tree mst forward-time <4-30>
```

<4-30> is one of the numbers 4,5, …, 30.
The max age is set by:

```
(config)# spanning-tree mst max-age <6-40>
```

The max hop is set by:

```
(config)# spanning-tree mst max-hop <6-40>
```

The transmit hold count is set by:

```
(config)# spanning-tree transmit hold-count <1-10>
```

ICLI Command for Advanced Settings

The following ICLI commands apply to advanced settings.
The edge port BPDU filtering is enabled with the ICLI command:

```
(config)# [no] spanning-tree edge bpdu-filter
```

The edge port BPDU guard is enabled with the ICLI command:

```
(config)# [no] spanning-tree edge bpdu-guard
```

The port error recovery and port error recovery timeout is set by one ICLI command:

```
(config)# [no] spanning-tree recovery interval <30-86400>
```

This will both enable and set the value. “No” to disable it.

MSTI Configuration

By default, all VLAN IDs are mapped to the Common and Internal Spanning Tree (CIST). If the protocol version is set to MSTP, then a VLAN ID can be mapped to one out of 8 spanning trees, where CIST is one. The other seven are called MSTI1, …, MSTI7. The MSTI configuration also has a name and version. All these values must

be the same on the switches in the network. Otherwise, the configuration will not take effect.
The identifier is configured as follows.

```
(config)# spanning-tree mst name <ConfigurationName> revision
<RevisionNumber>
```

where <ConfigurationName> is a string of maximum length 32 characters, and <RevisionNumber> is an integer in the range 0,…,65535.
Add VLAN to MSTI1 and MIST2 with the following command.

```
(config)# [no] spanning-tree mst 1 vlan 10-15
(config)# [no] spanning-tree mst 2 vlan 16,18
```

The form of "no" will delete all problematic VLAN in MSTI.

MSTI Priority

Each MSTI and CIST can have priority. The lower the priority numeric values, the higher priority.
The bridge identifier is constructed according to the bridge priority numbers CIST, MSTI1, …, MSTI7. This is connected to the MAC address of the switch. In this way, the bridge identifier is unique.
The lower the bridge identifier, the higher the priority. High priority means that the switch is often the root of the spanning tree. If two switches have the same bridge priority, for example, setting the MSTI1 priority higher or setting the MSTI2 priority lower will make one switch lean towards the root switch.

STP CIST Port Configuration

STP is based on port configuration.
Except for path cost and priority, all parameters are specific to ports, not CIST. These two parameters can be set for each MSTI, but other parameters cannot, because they apply to ports. If, for example, spanning tree is disabled (as it is for port 3), it applies to the CIST and all the MSTIs.
When using ICLI, execute CIST convergence port Configuration command at the config mode prompt, as shown below.

```
(config)#
```

Execute the CIST standard port configuration command at the interface configuration mode prompt as shown below.

```
(config-if)#
```

The following command takes the user in interface config mode as an example.

STP Enable

Using the following command, you can enable or disable the port participation spanning tree protocol individually.

```
(config-if)# [no] spanning-tree
```

Path Cost and Priority

The path cost and priority are set by the following commands:

```
(config-if)# spanning-tree mst 0 cost <Cost>
```

```
(config-if)# spanning-tree mst 0 port-priority <Priority>
```

<Cost> is a number between 1 and 200000000 or it may be auto. If set to auto, then the path cost will be set to some value appropriate for the physical link speed, using IEEE 802.1D recommended values.
<Priority> is a number in the range 0 to 240 and a multiple of 16. If it is not a multiple of 16 then it will be set to 0.
The path cost is used by STP when selecting ports. Low cost is chosen in favor of high cost. And if two ports have the same cost, then priority is used as a tie breaker.

Admin Edge and Auto Edge

This two features are activated by the following ICLI command.

```
(config-if)# [no] spanning-tree edge
(config-if)# [no] spanning-tree auto-edge
```

The first command changes the field Admin Edge, and the second command changes Auto Edge. These two values control how the port is declared as an edge port. An edge port is a port that is not connected to a bridge.
If automatic edge is enabled, the port determines whether it is an edge port by registering whether BPDUs is received on the port. The admin edge determines what the port should start as, being edge or not, until auto edge if enabled, then change.
You can see this decision by selecting Monitor > Spanning Tree > Bridge Status, and then clicking CIST. Then the edge field shows the decision.

Restricting Roles and TCN

This two features are activated by the following ICLI command.

```
(config-if)# [no] spanning-tree restricted-role
(config-if)# [no] spanning-tree restricted-tcn
```

If the restricted role is enabled, even if the port has the best spanning tree priority vector, it will not be selected as the root port of CIST or any MSTI. After selecting the root port, such a port will be selected as the backup port. If set, it can cause lack of spanning tree connectivity. It can be set by a network administrator to prevent bridges external to a core region of the network influence the spanning tree active topology, possibly because those bridges are not under the full control of the administrator. This feature is also called root protection.
If restricted TCN is enabled it causes the port not to propagate received topology change notifications and topology changes to other ports. If set it can cause temporary loss of connectivity after changes in a spanning tree's active topology as a result of persistently incorrect learned station location information. It is set by a network administrator to prevent bridges external to a core region of the network, causing address flushing in that region, possibly because those bridges are not under the full control of the administrator or the physical link state of the attached LANs transits frequently.

BPDU Guard

This feature is activated by the following ICLI command.

```
(config-if)# [no] spanning-tree bpdu-guard
```

If enabled it causes the port to disable itself upon receiving valid BPDU's. Contrary to the similar bridge setting, the port Edge status does not effect this setting.

Point-to-Point

This feature is activated by the following ICLI command.

```
(config-if)# [no] spanning-tree link-type
{auto|point-to-point|shared}
```

Where the no form is equivalent to setting it to auto.
Set the link to point-to-point and display it as "Forced True". Set it to share and it will be displayed as "Force False". Set it to Auto and it will be displayed as "auto".

MSTI Port

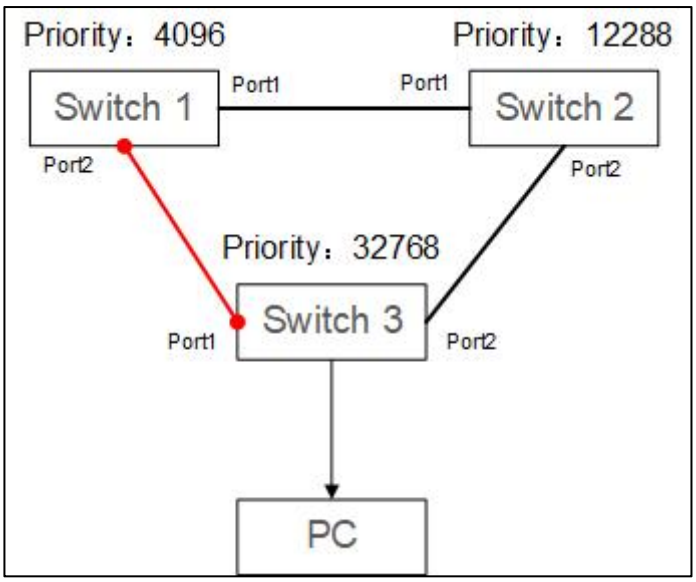
The ICLI commands for setting the path cost and priority is the same as for CIST, but with the change that the MSTI is not 0 (MSTI0 is CIST), but a number from 1 to 7.

```
(config-if)# spanning-tree mst <MSTI> cost <Cost>
(config-if)# spanning-tree mst <MSTI> port-priority <Priority>
```

Here <MSTI> is the number of MSTI, ranging from 1 to 7. Other parameters are the same as CIST.
<Cost> is a number between 1 and 200000000 or it may be auto. If set to auto, then the path cost will be set to some value appropriate for the physical link speed, using IEEE 802.1D recommended values.
<Priority> is a number in the range 0 to 240 and a multiple of 16. Note that if it is not a multiple of 16 then it will be set to 0.
The path cost is used by STP when selecting ports. Low cost is chosen in favor of high cost. And if two ports have the same cost, then priority is used as a tie breaker.

Single Ring Configuration Instance

Use three switches for single ring configuration experiment. Set the version of the spanning tree to STP, and configure the global priority of the spanning tree as shown in the following figure.



The port roles of each switch in the single ring are as follows:

- The highest priority of Switch 1 is the root bridge, Port 1 is the designated port, and Port 2 is the blocked port;
- Port 1 of Switch 2 is the root port and Port 2 is the designated port;
- Port 1 of Switch 3 is the root port and Port 2 is the blocked port.

Configuration Command of Switch 1 is as follows:

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# spanning-tree
(config-if)#exit
(config)# interface GigabitEthernet 1/2
(config-if)# spanning-tree
(config-if)#exit
(config)# spanning-tree mode stp
(config)# spanning-tree mst 0 priority 4096
```

Configuration command of Switch 2 is as follows:

```
(config)# interface GigabitEthernet 1/1
(config-if)# spanning-tree
(config-if)#exit
(config)# interface GigabitEthernet 1/2
(config-if)# spanning-tree
(config-if)#exit
(config)#spanning-tree mode stp
(config)#spanning-tree mst 0 priority 12288
```

Configuration command of Switch 3 is as follows:

```
(config)# interface GigabitEthernet 1/1
(config-if)# spanning-tree
(config-if)#exit
(config)# interface GigabitEthernet 1/2
(config-if)# spanning-tree
(config-if)#exit
(config)spanning-tree mode stp
(config)spanning-tree mst 0 priority 32768
```

View the spanning tree activity status of Switch 1, and you can see that Switch 1 is a root bridge. The MAC address of Switch 1 used in the example is 00-22-6F-01-B1-20.

```
# show spanning-tree active
CIST Bridge STP Status
Bridge ID   : 4096.00-22-6F-01-B1-20
Root ID     : 4096.00-22-6F-01-B1-20
Root Port   : -
Root PathCost: 0
Regional Root: 4096.00-22-6F-01-B1-20
Int. PathCost: 0
Max Hops    : 20
```

```
TC Flag     : Steady
TC Count    : 0
TC Last     : -
Port      Port Role      State      Pri  PathCost  Edge  P2P
Uptime
--------  -------------  ---------  ---  --------  ----  ---
-------------
Gi 1/1    DesignatedPort  Learning   128    20000  No    Yes  0d
00:00:32
Port      Port Role      State      Pri  PathCost  Edge  P2P
Uptime
```

View the port status of Switch 1: Port 1 is in forwarding status and Port 2 is in blocking status.

```
# show stpstate
Port  StpState      LinkState
1     Forwarding    Link
2     Blocking      Down
3     Blocking      Down
4     Blocking      Down
5     Blocking      Down
6     Blocking      Down
7     Blocking      Down
8     Forwarding    Link
9     Blocking      Down
10    Blocking      Down
11    Blocking      Down
12    Blocking      Down
```

View the spanning tree activity status of Switch 2.

```
#   show spanning-tree active
CIST Bridge STP Status
Bridge ID   : 12288.00-22-6F-00-00-66
Root ID     : 4096.00-22-6F-01-B1-20
Root Port   : 1
Root PathCost: 20000
Regional Root: 12288.00-22-6F-00-00-66
Int. PathCost: 0
Max Hops    : 20
TC Flag     : Steady
TC Count    : 129
TC Last     :   0d 00:03:50
```

```
Port      Port Role      State      Pri  PathCost  Edge  P2P
Uptime
--------  -------------  ---------  ---  --------  ----  ---
-------------
Gi 1/1    RootPort       Forwarding  128    20000  No    Yes  0d
00:41:04
Gi 1/2    DesignatedPort  Forwarding  128    20000  No    Yes  0d
00:33:53
```

View the port status of Switch 2: Ports 1 and 2 are in forwarding status.

```
# show stpstate
Port  StpState      LinkState
1     Forwarding    Link
2     Forwarding    Link
3     Blocking      Down
4     Blocking      Down
5     Blocking      Down
6     Blocking      Down
7     Blocking      Down
8     Forwarding    Down
9     Blocking      Down
10    Blocking      Down
11    Blocking      Down
12    Blocking      Down
```

View the spanning tree activity status of Switch 3.

```
#  show spanning-tree active
CIST Bridge STP Status
Bridge ID   : 32768.00-22-6F-00-00-0C
Root ID     : 4096.00-22-6F-01-B1-20
Root Port   : 2
Root PathCost: 40000
Regional Root: 32768.00-22-6F-00-00-0C
Int. PathCost: 0
Max Hops    : 20
TC Flag     : Steady
TC Count    : 0
TC Last     : -
Port      Port Role      State      Pri  PathCost  Edge  P2P
Uptime
--------  -------------  ---------  ---  --------  ----  ---
-------------
```

```
Gi 1/2    RootPort       Learning    128    20000  No    Yes  0d
00:00:20
```

View the port status of Switch 3: Port 1 is in blocking status and Port 2 is in forwarding status.

```
# show stpstate
Port  StpState      LinkState
1     Blocking      Down
2     Forwarding    Link
3     Blocking      Down
4     Blocking      Down
5     Blocking      Down
6     Blocking      Down
7     Forwarding    Down
8     Blocking      Down
9     Blocking      Down
10    Blocking      Down
11    Blocking      Down
12    Blocking      Down
```

13.7 LLDP Configuration

This document provides step-by-step guidance on how to use ICLI command to set up LLDP, LLDP-MED, and CDP for discovering connected network equipment managed by a management platform, which may be a computer running an IP-capable operating system such as FeeBSD, Linux, or Windows.
Using ICLI as the management interface requires a serial console connection between the device and management platform. No network connection is required to use ICLI, but the terminal emulator software needs to be installed.
It is recommended that the target audience of this document be familiar with IP/HTTP technology and have experience in setting up operating system application services.

13.7.1 LLDP, LLDP-MED and CDP

LLDP is used for information exchange between network devices by publishing information about themselves to link partners on each interface. Link partners are called neighbors or remote devices. LLDP is defined in IEEE 802.1AB
LLDP-MED is an extension of LLDP standard defined in TIA1057. LLDP-MED-enabled devices can communicate their functions and configurations to their neighbors, so as to ensure the consistency of the same media service or application in the network.
CDP is a proprietary protocol that runs over Layer 2 (the data link layer) to automatically discover and learn about other devices connected to the network. When

CDP awareness is enabled, CDP frames are transformed into LLDP information and added to the neighbor entries table. LLDP will not actively send CDP PDU.

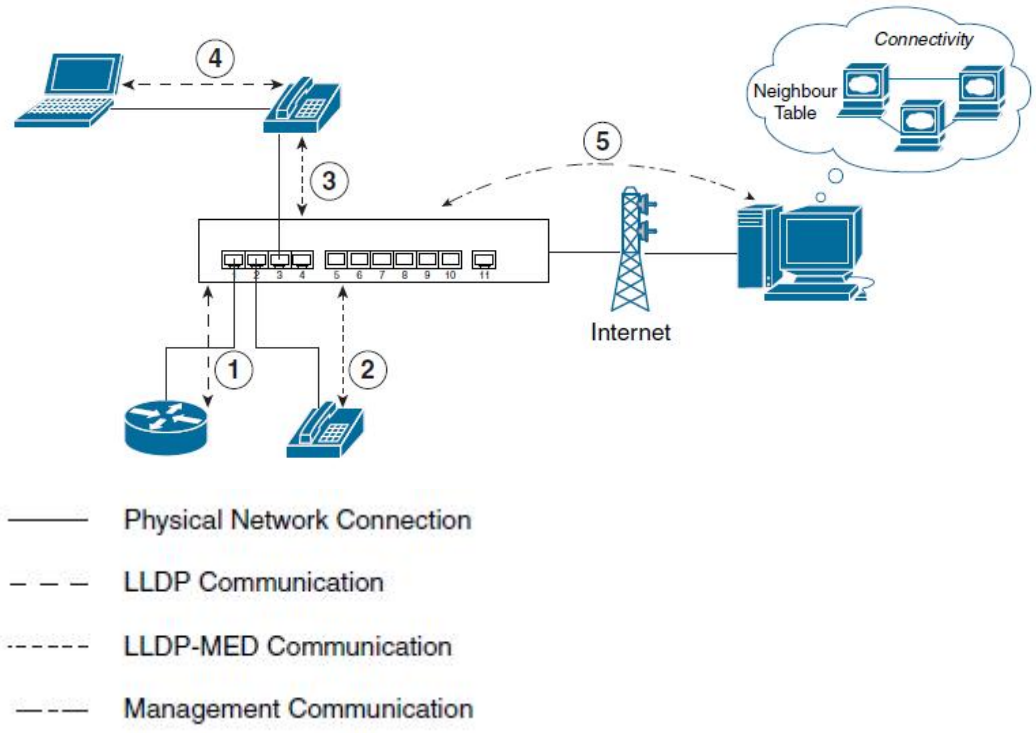
13.7.2 LLDP Operation and Configuration

LLDP enables directly connected devices to discover each other's information. It announces the information of the device itself on each interface, allowing other devices in the LAN to know all the information of their peer devices. Common deployed applications that use the information conveyed by LLDP include the following:

- Network topology-A schematic diagram in which the network management system can accurately represent the network topology.
- Emergency service-not only determine the location of the equipment, but also set the ELIN for emergency calls. According to the collected information, the public resources of emergency services can be coordinated.
- VLAN configuration-The device can tell peers which VLANs can be used for streaming media services.
- Power negotiation-When the device also supports PoE, the connected device and terminal can negotiate the expected power consumption.

With this function in the network, automatic device discovery is very beneficial to network management and convenient for the deployment of streaming media applications. The following figure illustrates the basic concept of LLDP operation.

Figure 1 LLDP operation



Use LLDP to reduce network management by simply connecting network devices. In the above figure, a VoIP phone and a laptop computer are connected into a chain, sharing the same port on LLDP-enabled devices, while another VoIP phone and a network device are connected to other ports on the same device.

1 When a network device is connected, LLDP communication begins, and it is identified as a neighbor providing network capability.

2 When an IP phone is connected, LLDP recognizes that this neighbor can run VoIP applications by exchanging LLDP-MED information. Further, the switch might then be able to reserve power (PoE) if the corresponding setting is configured on both IP phone and switch.
3 LLDP recognizes that another IP phone is connected and records its information in the neighbor table.
4 When the laptop is connected to the phone, LLDP starts to switch between the laptop and the phone at the same time, even though they may not be physically adjacent.
5 Management systems, whether local or remote, can now query devices to explore the actual network topology.

LLDP also provides configurable parameters for transmitting LLDP protocol data units containing multiple TLVs. The following table shows the basic LLDP parameters and their corresponding descriptions.

Table 1 • LLDP Parameters

Parameters	**Note**
Tx Interval	The switch periodically transmits LLDP frames to its neighbors for having the network discovery information up-to-date. The interval between each LLDP frame is determined by this value, and the unit is seconds.
Tx Hold	Each LLDP frame contains information about how long time the information in the LLDP frame shall be considered valid. The LLDP information valid period is set to Tx Hold multiplied by Tx Interval seconds.
Tx Delay	If the system configuration is changed (e.g. the IP address) a new LLDP frame is transmitted, but the time between the LLDP frames will always be at least the value of Tx Delay seconds. Tx Delay cannot be larger than 1/4 of the Tx Interval value.
Tx Re-Initialization	When a interface is disabled, LLDP is disabled or the switch is rebooted, a LLDP shutdown frame is transmitted to the neighboring units, signaling that the LLDP information isn't valid anymore. Tx Re-Initialization controls the amount of seconds between the shutdown frame and a new LLDP initialization.
Port Description	Optional TLV: Port description will be included in LLDP information transmitted.
System Name	Optional TLV: System name will be included in LLDP information transmitted.
System Description	Optional TLV: System description will be included in LLDP information transmitted.
System Capability	Optional TLV: System capability will be included in LLDP information transmitted.
Management Address	Optional TLV: Management address will be included in LLDP information transmitted.

In addition to basic system information about network devices, optional information about specific applications can be distributed by LLDP devices that support "configuring LLDP-MED".

Configure LLDP

LLDP is enabled by default (doing both Tx and Rx for LLDPDU) on all the switch ports. Therefore, LLDP settings are limited to ensuring that LLDP parameters and system TLV are configured as expected. The following is a quick summary of the steps.

1 Enable LLDP on a specific port.
2 If necessary, set up each LLDP system TLV to be advertised.
3 If necessary, set the global LLDP transmission parameters.
4 If necessary, save the configuration.

The following table shows the default LLDP settings and their configurable value range.

Table 2 • Default LLDP Settings and Configurable Value Range

Parameters	**Default**	**Configurable range**
Tx Interval	30s	5 - 32768s
Tx Hold	4 times	2-10次
Tx Delay	2s	1-8192s
Tx Re-Initialization	2s	1 - 10s
Port LLDP Administration	Tx and RX	Send, receive, send and receive, neither receive nor send.
Port Tx Port Description	Right	Right or wrong
Port Tx System Name	Right	Right or wrong
Port Tx System Description	Right	Right or wrong
Port Tx System Capability	Right	Right or wrong
Port Tx Management Address	Right	Right or wrong

LLDP Setup using ICLI

The following table shows the steps of establishing LLDP using ICLI.

Table 3• Set LLDP by using ICLI

Steps	**Action**	**Purpose**
1	Configure terminal. Example **# configure terminal** **(config)#**	Enter Configure Mode
2	**interface interface-id** Example **(config)# interface * (config-if)#**	Specify the interface for configuring LLDP, and enter the interface configuration mode.
3	**lldp transmit** Example **(config-if)# lldp transmit** **(config-if)#**	Enable/disable LLDP frame transmission.

Steps	Action	Purpose
4	**lldp receive** Example **(config-if)# lldp receive** **(config-if)#**	Enable/disable decoding of received LLDP frames.
5	**lldp tlv-select {management-address | port-description | system-capabilities | system-description | system-name}** Example **(config-if)# lldp tlv-select system-name** **(config-if)#**	Enable/disable transmission of optional system TLV.
6	**exit** Example **(config-if)# exit** **(config)#**	Exit interface configuration mode and return to global configuration mode.
7	**lldp timer seconds** Example **(config)# lldp timer 30** **(config)#**	Sets LLDP Tx interval (The time between each LLDP frame transmitted in seconds).
8	**lldp holdtime seconds** Example **(config)# lldp holdtime 4 (config)#**	Sets LLDP hold time (The neighbor switch will discard the LLDP information after hold time multiplied by timer seconds).
9	**lldp transmission-delay seconds** Example **(config)# lldp transmission-delay 2** **(config)#**	LLDP transmission delay (the amount of time that the transmission of LLDP frames will delayed after LLDP configuration has changed) in seconds.
10	**lldp reinit seconds** Example **(config)# lldp reinit 2 (config)#**	LLDP Tx re-initialization delay in seconds.
11	**End time** Example **(config)# end** **#**	Return to privileged EXEC mode.
12	**copy running-config startup-config** Example: **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file

13.7.3 LLDP-MED Operation and Configuration

LLDP-MED provides devices with additional capabilities to serve specific applications. According to the LLDP-MED operation mode of each interface, the device acts as a connection device or an endpoint device on the specified port. The difference between network connection device and endpoint device is to initialize LLDP-MED TLV transmission. The network connection device will not start LLDP-MED TLV transmission until it detects the endpoint device as a neighbor. The endpoint device immediately starts LLDP-MED TLV transmission.

In order to realize these related properties, LLDP-MED defines the LLDP-MED quick start interaction between the protocol and the application layer above the protocol. Initially, the network connection device will only transmit LLDP TLV in LLDPDU. Only when the LLDPE-MED endpoint device is detected will the network connection device supporting LLDPE-MED begin to advertise LLDP-MED TLV in the outgoing LLDPDUs on the relevant port. In order to share LLDPE-MED information as quickly as possible, LLDPE-MED applications will temporarily speed up the transmission of LLDPDU within one second after detecting new LLDPE-MED neighbors.

Because there is a risk of an LLDP frame being lost during transmission between neighbors, it is recommended to repeat the fast start transmission multiple times to increase the possibility of the neighbors receiving the LLDP frame. By quick start repeat count, you can specify the number of repetitions of quick start transmission.

LLDP-MED and LLDP-MED Quick Start are only used to run on the link between LLDP-MED network connection devices and endpoint devices, so they are not applicable to the link between LAN infrastructure elements, including network connection devices or other types of links.

LLDP-MED supports the following four main additional functions.

1 Feature discovery-Enables endpoints to determine the features supported by connected devices. It can also be used to indicate the type of connected device (telephone, switch, wireless router, etc.).

2 Location identification discovery-enables network devices (mainly IP phones) to know their location information, which can be used in location-based applications, especially emergency services.

3 Network Policy Discovery-Provides a mechanism for switches to inform connected devices of the VLAN identification that the device should use. The device can plug into any switch, get its VLAN ID, and then start communication.

4 Power Discovery-When introducing PoE, two directly connected devices can transmit power information, because the switches with PoE function supply power to the connected devices.

The following table shows the optional TLV of location identification supported by LLDP-MED.

Table 4 Location Identification Optional TLV Supported by LLDP-MED

Optional TLV	**Note**
ELIN Address	ELIN identifier of emergency call service, which is used during setting emergency call to traditional CAMA or PSAP based on ISDN relay.
Country Code	ISO 3166 country code, containing two letters, expressed in uppercase ASCII letters.
State	National subdivisions (state, canton, region, province,

Optional TLV	Note
	prefecture).
County	County, parish, district
City	City, township, shi (Japan).
City District	City division, borough, city district, ward, chou (Japan).
Block (Neighborhood)	Neighborhood, block.
Street	Street
Street Direction	Leading street direction
Trailing Street	Street end direction suffix
Street Suffix	Street suffix
House No.	House number
House No. Suffix	House no. suffix.
Landmark	Landmark or vanity address.
Additional	Location Info. Additional Location Info.
Name	Name (domicile and office occupant).
Zip Code	Zip code
Building	Building (structure).
Apartment	Unit (apartment).
Floor	Floor.
Room No.	Room number.
Place Type	Place type.
Postal Community Name	Postal community name.
P.O. Box	P.O. Box
Additional	CodeAdditional code.

The following table shows the optional TLV of network policy supported by LLDP-MED.

Table 5•Optional top-level domain names supported by LLDP-MED for network policies

Optional TLV	Note
Datum	Specify the geodetic system to be used: WGS84, NAD83/NAVD88 and NAD83/MLLW.
Latitude	Latitude (within 0-90 degrees) north or south of the equator.
Longitude	Longitude (within 0-180 degrees) east of the prime meridian or west of the prime meridian.
Altitude	Height value based on height type (meter or layer).
ELIN Address	ELIN identifier of emergency call service, which is used during setting emergency call to traditional CAMA or PSAP based on ISDN relay.
Country Code	ISO 3166 country code, containing two letters, expressed in uppercase ASCII letters.
State	National subdivisions (state, canton, region, province,

Optional TLV	Note
	prefecture).
County	County, parish, district
City	City, township, shi (Japan).
City District	City division, borough, city district, ward, chou (Japan).
Block (Neighborhood)	Neighborhood, block.
Street	Street
Street Direction	Leading street direction
Trailing Street	Street end direction suffix
Street Suffix	Street suffix
House No.	House number
House No. Suffix	House no. suffix.
Landmark	Landmark or vanity address.
Additional Location Info.	Additional Location Info.
Name	Name (domicile and office occupant).
Zip Code	Zip code
Building	Building (structure).
Apartment	Unit (apartment).
Floor	Floor.
Room No.	Room number.
Place Type	Place type.
Postal Community Name	Postal Community Name
P.O. Box	P.O. Box
Additional	CodeAdditional code.

The following table shows the optional TLV of network policy supported by LLDP-MED.

Table 6•Optional TLV supported by LLDP-MED for network policies

Optional TLV	Note
Media Application Type	The specific application types handled are as follows: Voice, Guest Voice, Softphone Voice, Video Conferencing, Streaming Video and Control / Signaling (conditionally support a separate network policy for the media types above).
VLAN ID	VLAN identifier (VID) for the port as defined in IEEE 802.1Q. It is valid only when policy is using a ‘tagged’ VLAN.
Tag	Tag indicating whether the specified application type is using a ‘tagged’ or an ‘untagged’ VLAN.
L2 Priority	802.1p CoS value, which is used to determine the priority of the specified application.

Optional TLV	Note
DCP	DSCP value used to provide differentiated service node behavior for a specific application.

Network policies are intended for applications with specific real-time network policy requirements, such as interactive voice and/or video services. It may be advertised and associated with multiple groups of application types supported on a given port.

Configuring LLDP-MED

The default value of LLDP-MED supports four discovery options: Function, location identification, network strategy and power supply. They also default to the transmission capacity, network policy and location TLV in LLDP-MED information exchange. Before setting up LLDP-MED, LLDP needs the ability to process protocol messages. The following is a quick summary of the steps, assuming that LLDP is enabled and working normally. For information about LLDP configuration, see LLDP-MED Operation and Configuration.

Function discovery

1 Enable function discovery on the specific interface(s).
2 If necessary, configure the LLDP-MED device type for each interface.
3 If necessary, save the configuration.

Location recognition discovery

1 Configure fast start repeat count for LLDP-MED.
2 Configure geodetic system settings.
3 If necessary, configure the ELIN address of the emergency service.
4 Configure location information settings.
5 Enable location identity discovery on a specific interface.
6 If necessary, set the LLDP-MED device type for each interface.
7 If necessary, save the configuration.

Network policy discovery

1 Create a network policy for the expected application type.
2 Associate the created network policy with the selected interface.
3 Enable network policy discovery on a specific interface.
4 If necessary, configure the LLDP-MED device type for each interface.
5 If necessary, save the configuration.

Power supply discovery

PoE should be able to cooperate with LLDP-MED.
1 Enable power discovery on the specific interface(s).
2 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default LLDP-MED settings and their configurable value ranges.
Table 7 Default LLDP-MED Settings and Configurable Value Range

Parameters	Default	Configurable range

Parameters	Default	Configurable range
Fast Start Repeat Count	4	1 – 10
Transmit TLVs	Function network-policy & location	capabilities, network-policy and location
Map Datum Type	WGS84	WGS84,NAD83/NAVD88 and NAD83/MLLW
Latitude Type	North	North or south
Latitude	0	0.0000 – 90.0000
Longitude Type	East	East or west
Longitude	0	0.0000 – 180.0000
Altitude Type	Meter	Meter or floor
Altitude	0	-2097151.9 to 2097151.9
ELIN Address	Null string	A string of 0–25 characters
Country Code	Null string	String in 0 – 2 characters
State	Null string	A string of 0–250 characters
County	Null string	A string of 0–250 characters
City	Null string	A string of 0–250 characters
City District	Null string	A string of 0–250 characters
Block (Neighborhood)	Null string	A string of 0–250 characters
Street	Null string	A string of 0–250 characters
Street Direction	Null string	A string of 0–250 characters
Trailing Street	Null string	A string of 0–250 characters
Street Suffix	Null string	A string of 0–250 characters
House No.	Null string	A string of 0–250 characters
House No. Suffix	Null string	A string of 0–250 characters
Landmark	Null string	A string of 0–250 characters
Additional Location Info.	Null string	A string of 0–250 characters
Name	Null string	A string of 0–250 characters
Zip Code	Null string	A string of 0–250 characters
Building	Null string	A string of 0–250 characters
Apartment	Null string	A string of 0–250 characters
Floor	Null string	A string of 0–250 characters
Room No.	Null string	A string of 0–250 characters
Place Type	Null string	A string of 0–250 characters
Postal Community	Null string	A string of 0–250 characters
P.O. Box	Null string	A string of 0–250 characters
Additional Code	Null string	A string of 0–250 characters
Network Policy ID	N/A	0 – 31

Parameters	Default	Configurable range
Media Application Type	voice	voice Voice signal guest-voice guest-voice signaling soft phone-voice Video conference video stream Video signal
VLAN ID	1	1 – 4095
Tag	Tagged	Tagged or untagged
L2 Priority	0	0 – 7
DSCP	0	0 – 63
Port MED Device Type	Connectivity	Connection or endpoint
Port MED Optional TLV	Capability & Location & Network Strategy &poe	Functional location network-policy poe
Port Policy List	N/A	Created network policy ID

Setting up LLDP-MED with ICLI

The following table shows the steps of establishing LLDP-MED using ICLI.

Table 8• Setting LLDP-MED with ICLI

Steps	Action	Purpose
1	**configure terminal** Example **# configure terminal (config)#**	Enter Configure Mode
2	**lldp med fast counts** Example **(config)# lldp med fast 4 (config)#**	Specify the fast start repeat count for LLDP-MED.
3	**lldp med datum {nad83-mllw | nad83-navd88 | wgs84}** Example **(config)# lldp med datum wgs84 (config)#**	Specifies the geodetic system type.
4	**lldp med location-tlv** **{** **elin-addr string |** **latitude {north | south} degrees |** **longitude {east | west} degrees |** **altitude {meters | floors} values** **}** Example **(config)# lldp med location-tlv altitude meters 0** **(config)#**	Assign geographic coordinate values to devices. In addition, you can specify the ELIN identity.

Steps	Action	Purpose
5	**lldp med location-tlv civic-addr** **{** **additional-code string |** **additional-info string | apartment string |** **block string | building string | city string** **| country string | county string |** **district string | floor string |** **house-no string | house-no-suffix string |** **landmark string |** **leading-street-direction string |** **name string |** **p-o-box string | place-type string |** **postal-community-name string |** **room-number string |** **state string | street string |** **street-suffix string |** **trailing-street-suffix string |** **zip-code string** **}** Example **(config)# lldp med location-tlv civic-addr country TW (config)# lldp med location-tlv civic-addr zip-code 30055 (config)# lldp med location-tlv civic-addr house-no-suffix 23F, 2B (config)#**	Specify city location information.
6	**lldp med media-vlan-policy policy-id** **{** **guest-voice | guest-voice-signaling | softphone-voice | streaming-video | video-conferencing |** **video-signaling | voice |** **voice-signaling** **}** **{** **tagged vlan-id [l2-priority cos] | untagged** **}** **[dscp dscp]** Example **(config)# lldp med media-vlan-policy 0 streaming-video untagged (config)# lldp med media-vlan-policy 1 voice tag 1 23 l2-priority 3 dscp 21 (config)#**	Create a network policy that can be assigned to an interface of a specific type of application.

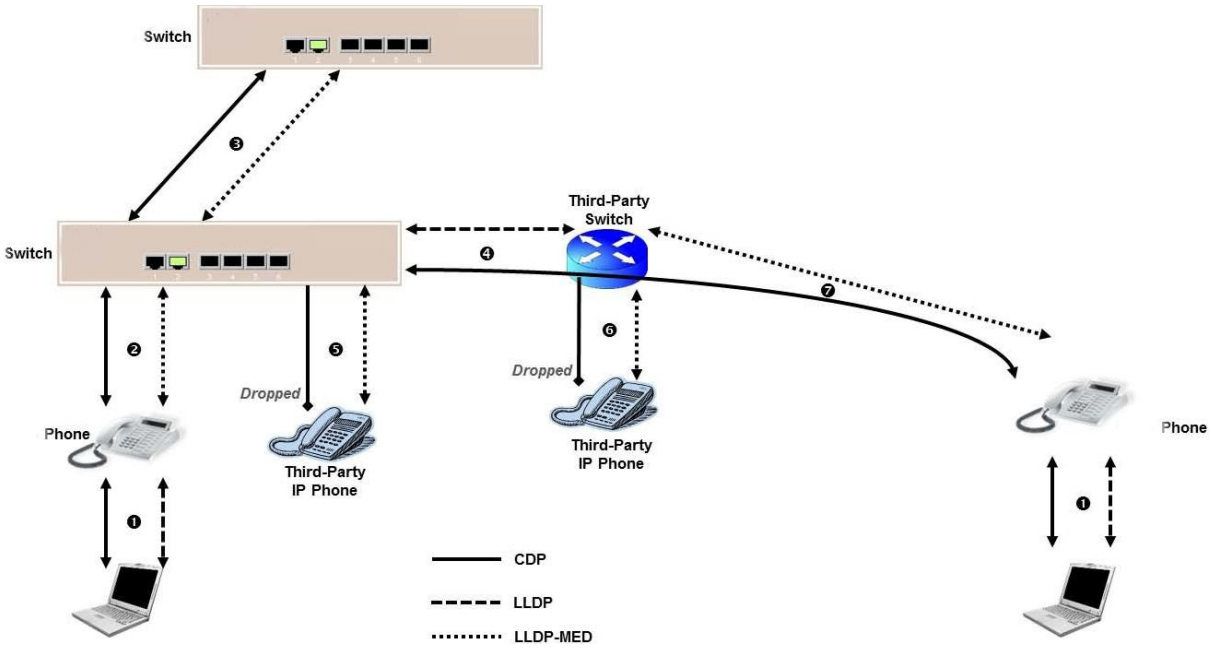
Steps	Action	Purpose
7	**interface interface-id** Example **(config)# interface 10GigabitEthernet 1/2 (config-if)#**	Specify the interface for setting LLDP-MED, and enter the interface configuration mode.
8	**lldp med type {connectivity | end-point}** Example **(config-if)# lldp med type connectivity (config-if)#**	Select the network connection device or endpoint device as the interface role. 端点设备作为接口角色。
9	**lldp med transmit-tlv {capabilities | location | network-policy | poe}** Example **(config-if)# lldp med transmit-tlv capabilities location network-policy poe (config-if)#**	Specifies the optional TLV to be transmitted.
10	**lldp med media-vlan policy-list policy-range** Example **(config-if)# lldp med media-vlan policy-list 0-1 (config-if)#**	Specifies the media policy that the interface will apply.
11	**End time** Example **(config-if)# end** **#**	Return to privileged EXEC mode.
12	**copy running-config startup-config** Example **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file

13.7.4 CDP Operation and Configuration

CDP is an L2 proprietary discovery protocol for all CDP devices (routers, bridges, access servers, and switches). It provides a concept similar to LLDP usage, which is used for network management applications to discover devices adjacent to known devices. For more information, see the documentation for current CDP features.

LLDP can recognize CDP. It only recognizes devices connected to devices and makes them neighbors. The diagram in the following technical white paper illustrates how CDP works.

Figure CDP operation



The following steps describe how CDP works.

1 A laptop connected to a phone can support CDP. Some applications running on that PC (example VT Advantage) also support CDP. Therefore, mobile phones use CDP to support these applications.

2 Switches and telephones exchange CDP messages.

3 Both switches exchange CDP and LLDP messages.

4 Switches exchange LLDP messages with third-party switches, but still advertise CDP messages. In this case, third-party switches usually ignore CDP messages and flood them to other interfaces, which means that devices connected to third-party switches receive CDP messages from the switches as if they were directly connected to the switches. It is recommended to close CDP on the port connected to the third-party switch, which can ensure the function of the application to some extent.

5 The third-party phone discards CDP messages from the switch, but exchanges LLDP-MED messages with the switch.

6 The third-party phone discards CDP messages flooded by the third-party switch and only exchanges LLDP-MED messages with the third-party switch.

7 A phone can generate both CDP messages and LLDP-MED messages. Third-party switches ignore CDP messages again and flood them to other interfaces. However, third-party switches still exchange LLDP-MED messages with connected phones. Similarly, it is recommended to turn off CDP on switch ports connected to third-party switches.

Configuration CDP

LLDP only knows the existence of the device when it receives CDP message. CDP operations are limited to decoding incoming CDP frames, and CDP frames are decoded only when LLDP is enabled on the port.

If all ports have CDP awareness disabled, the device forwards CDP frames received from neighbor devices. If CDP identification is enabled on at least one port, the device will terminate all CDP frames.

Only CDP TLVs that can be mapped to a corresponding field in the LLDP neighbors table are decoded. All other TLVs are discarded (Unrecognized CDP TLVs and

discarded CDP frames are not shown in the LLDP statistics.). CDP TLVs are mapped into LLDP neighbors table, as follows:

- CDP TLV Device ID is mapped to the LLDP Chassis ID field.
- CDP TLV "Address" is mapped to the LLDP "Management Address" field. The CDP address TLV can contain multiple addresses, but only the first address is shown in the LLDP neighbors table.
- CDP TLV Port ID is mapped to the LLDP Port ID field.
- CDP TLV Version and Platform is mapped to the LLDP System Description field.
- Both the CDP and LLDP support system capabilities, but the CDP capabilities cover capabilities that are not part of the LLDP. These capabilities are shown as others in the LLDP neighbors table.

  Note:

  When CDP awareness on an interface is disabled, the CDP information is not removed immediately, but gets removed when the hold time is exceeded.

The following steps summarize the process of configuring CDP.

1 Enable LLDP on a specific interface.

2 Enable CDP awareness for the specific interface(s).

3 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default CDP settings and their configurable value range.

Table 9 • Default CDP Settings and Configurable Value Range

Parameters	Default	Configurable range
Per Port LLDP Administration	Tx and RX	Send, receive, send and receive, neither receive nor send
CDP Awareness	Error	Right or wrong

CDP Setup using ICLI

The following table shows the steps of setting up CDP proxy using ICLI.

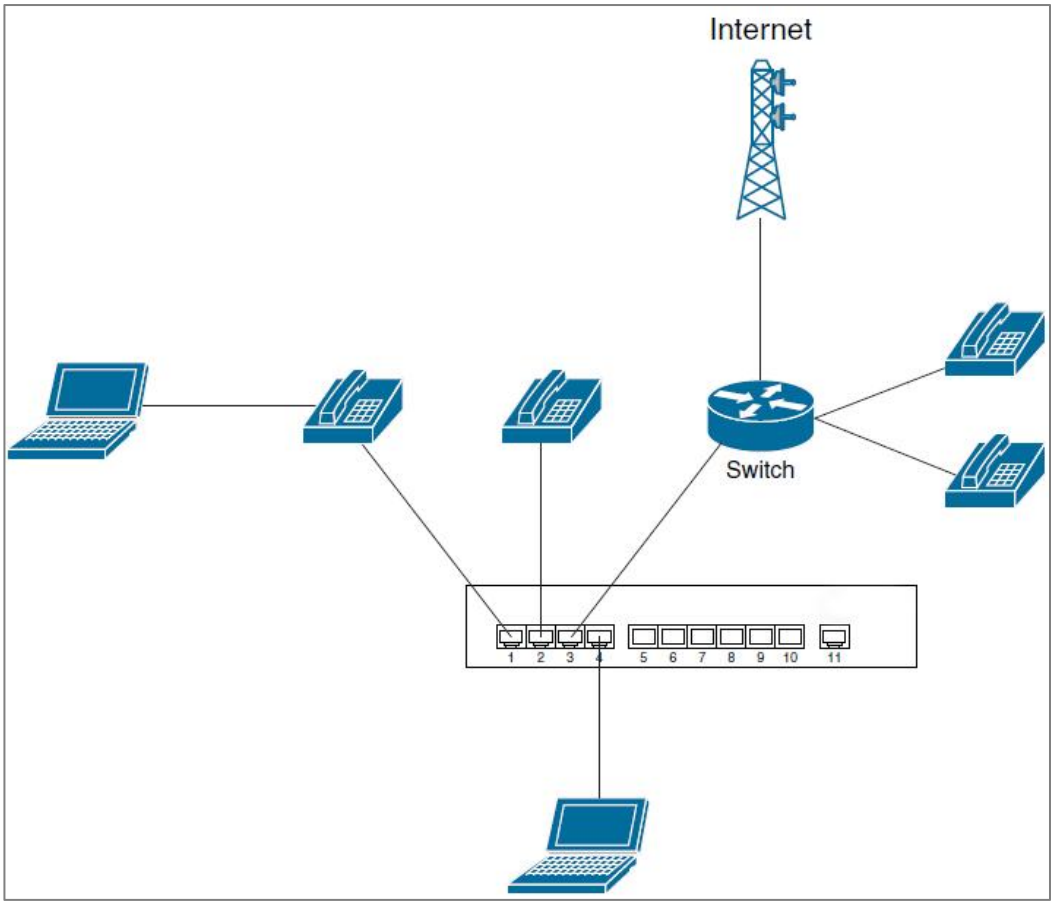
Table 10• Set CDP by using ICLI

Steps	**Action**	**Purpose**
1	**configure terminal** Example **# configure terminal** **(config)#**	Enter Configure Mode
2	**interface interface-id** Example **(config)# interface *** **(config-if)#**	Specify the interface that enables LLDP, and enter the interface configuration mode.
3	**lldp cdp-aware** Example **(config-if)# lldp cdp-aware** **(config-if)#**	Specifies if the interface is CDP aware.
4	Example **(config-if)# end**	Return to privileged EXEC mode.

5	**copy running-config startup-config** Example **# copy running-config startup-config #**	(Optional) Saves settings in the configuration file

13.7.5 Topology Example

The following topology diagram is used to demonstrate the example, assuming that the device is started in the default configuration.
Graph topology example



Deploying IP telephone network with ICLI

The main goal of establishing IP telephone network is to give priority to voice data among telephones, software or hardware.

```
# configure terminal
(config)# lldp med media-vlan-policy 0 voice tagged 111 l2-priority 7 dscp 5
(config)# lldp med media-vlan-policy 1 softphone-voice untagged dscp 5
(config)# interface GigabitEthernet 1/1-4
(config-if)# lldp med type connectivity
```

```
(config-if)# lldp med transmit-tlv capabilities network-policy
(config-if)# interface GigabitEthernet 1/1-3
(config-if)# lldp med media-vlan policy-list 0
(config-if)# interface GigabitEthernet 1/4
(config-if)# lldp med media-vlan policy-list 1
(config-if)# end
#
```

13.8 Ring

Ring is a private protocol that can't realize communication with other manufacturers' devices. Ring is an Ethernet Ring network algorithm developed and designed for highly reliable industrial control network applications that require link redundancy backup. Its design concept is completely in accordance with international standards (STP and RSTP) implementation, and do the necessary for industrial control application optimization, with Ethernet link redundancy, fault fast automatic recovery ability.

Ring adopts the design of no master station. The devices running the Ring protocol discover the loop in the network by exchanging information with each other, and block a certain port. Finally, the ring network structure is trimmed into a tree network structure without loop, thus preventing messages from circulating continuously in the ring network, and avoiding the reduction of processing capacity caused by repeated reception of the same message. In a multi-Ring network composed of 250 switches, when the network is interrupted or fails, the ring can ensure that the user network automatically resumes link communication within 20 ms.

Global Configuration

Enable the Ring network.

```
# configure terminal
(config)# ring
```

Disable the Ring network.

```
# configure terminal
(config)# no ring
```

Ring Configuration

Single ring Configuration

```
# configure terminal
(config)# ring group <group-id> <ring-id> single <port1> <port2>
<hello-time> (master | slave)
```

In a single Ring, Ring supports master/slave and no master configuration to meet various network environment requirements. When all devices are configured in Slave mode, the single ring has no master station structure, that is, there is no designated backup link. When a device is designated to be configured in master mode, the device serves as the master device, and the single-ring network in which it is located has a

master station structure; Other single-ring devices need to be configured in Slave mode and serves as the slave device
Link / coupling ring / dual homing network configuration.

```
# configure terminal
(config)# ring group <group-id> <ring-id> (chain | couple |
dualhoming) <port1> <port2> <hello-time>
```

Network ID

When multiple switches form a ring, the current ring ID would be network ID. Different ring network has different ID. The ring network identification must remain the same in one ring network.

Ring Port

Port that can be used for the formation of ring network in switch. In a coupling ring, the coupling port is the port connected to the different network identifiers, and the control port is the port in the link where the two rings meet.

hello-time

The sending cycle of hello-time packet, ranging from 0-300(*100ms), and 0 means not to send.

13.9 Loop Protection

Loop protection periodically sends a detection message from the interface to check whether the message is returned to the device, and then determines whether there are loops between the interface, the device's underlying network or the device, or between the two interfaces of the device. After a loop is detected, the device sends a trap to the NMS and records a log, and takes a preconfigured action on the looped interface (the interface is shut down by default) to minimize impact of the loop on the device and entire network.

Global Configuration

Enable loop protection.

```
# configure terminal
(config)# loop-protect
```

Disable loop protection.

```
# configure terminal
(config)# no loop-protect
```

Transmission Time

The time interval of transmitting loop detection packet, unit: second.

```
# configure terminal
(config)# loop-protect transmit-time <1-10>
```

Shutdown Time

After detecting the loop, enable the loop protection and disable the port time, unit: second. 0 means disabling the port.

```
# configure terminal
(config)# loop-protect shutdown-time  <0-604800>
```

Port Configuration

Enable port loop protection.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# loop-protect
```

Disable port loop protection.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# no loop-protect
```

Action

The processing methods of the interface after the loop is detected, such as log alarm and close the port.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# loop-protect action ?
   log        Generate log
   shutdown    Shutdown port
```

Active Protection

Controls whether the port is actively generating loop protection PDU's, or whether it is just passively looking for looped PDU's.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# loop-protect tx-mode
```

13.10 DHCP Server

A DHCP server assigns IP addresses from specified address pools to DHCP clients. It can also manage these clients and provide network parameters such as the default gateway address, Domain Name System (DNS) server address, and Windows Internet Name Service (WINS) server address. A DHCP server can accept broadcasts from locally attached LAN segments or DHCP requests forwarded by DHCP relay agents within the network.

Global Configuration

Enable DHCP Server.

```
# configure terminal
(config)# ip dhcp server
```

Enable DHCP server on VLAN interface.

```
# configure terminal
(config)# interface vlan 1
(config-if-vlan)# ip dhcp server
```

Reserve IP Address Configuration

DHCP server will not allocate these excluded IP addresses to DHCP client.

```
# configure terminal
(config)# ip dhcp excluded-address <ipv4_addr>
```

Address Pool

According to the DHCP pool, DHCP server will allocate IP address and deliver configuration parameters to DHCP client.

```
# configure terminal
(config)# ip dhcp pool 1
(config-dhcp-pool)# ?
   broadcast            Broadcast address in use on the client's
subnet
   client-identifier     Client identifier
   client-name          Client host name
   default-router        Default routers
   dns-server           DNS servers
   do                  To run exec commands in the configuration
mode
   domain-name           Domain name
   end                 Go back to EXEC mode
   exit                Exit from current mode
   file                Boot file name (option 67)
   hardware-address      Client hardware address
   help                Description of the interactive help system
   host                Client IP address and mask
   lease               Address lease time
   netbios-name-server    NetBIOS (WINS) name servers
   netbios-node-type     NetBIOS node type
   netbios-scope         NetBIOS scope
   network              Network number and mask
```

```
nis-domain-name       NIS domain name
nis-server            Network information servers
no                   Negate a command or set its defaults
ntp-server            NTP servers
option               DHCP option parameters field.
sname                Optional server host name (option 66)
vendor               Vendor configuration
```

13.11 DHCP Snooping

DHCP Snooping is a security feature of DHCP (Dynamic Host Configuration Protocol) that ensures that DHCP clients receive IP addresses from valid DHCP servers and records the corresponding relationship between IP address of DHCP client and MAC address to prevent DHCP attack on network.

Snooping Mode

Enable DHCP snooping mode operation. When DHCP snooping mode operation is enabled, the DHCP request messages will be forwarded to trusted ports and only allow reply packets from trusted ports.

```
# configure terminal
(config)# ip dhcp snooping
```

Port Mode Configuration

Trusted: Configures the port as trusted source of the DHCP messages.

```
# configure terminal
(config)# interface GigabitEthernet 1/1
(config-if)# ip dhcp snooping trust
```

13.12 DHCP Relay

DHCP relay agent forwards DHCP messages between a DHCP server and DHCP clients, and helps the DHCP server to dynamically allocate network parameters to the DHCP clients.

When a DHCP client broadcasts request messages with the destination IP address 255.255.255.255, only the DHCP server on the same network segment as the DHCP server can receive the request messages. If a DHCP server is on a different network segment from the DHCP client, the DHCP server can not receive request messages from the DHCP client, a DHCP relay agent must be deployed to forward DHCP messages to the DHCP server. Different from traditional IP message forwarding, the DHCP relay agent modifies the format of a message to generate a new DHCP message and then forwards it after receiving DHCP request or respond message.

Relay Mode

When DHCP relay mode operation is enabled, the agent forwards and transfers DHCP messages between the clients and the server when they are not in the same subnet domain. And the DHCP broadcast message won't be flooded for security considerations.

```
# configure terminal
(config)# ip dhcp relay
```

Relay Information Mode

When DHCP relay information mode operation is enabled, the agent inserts specific information (option 82) into a DHCP message when forwarding to DHCP server and removes it from a DHCP message when transferring to DHCP client.

```
# configure terminal
(config)# ip dhcp relay information option
```

Relay Information Policy

When DHCP relay information mode operation is enabled, if the agent receives a DHCP message that already contains relay agent information it will enforce the policy.

- Replace: Replace the original relay information when a DHCP message that already contains it is received.
- Keep: Keep the original relay information when a DHCP message that already contains it is received.
- Drop: Drop the package when a DHCP message that already contains relay information is received.

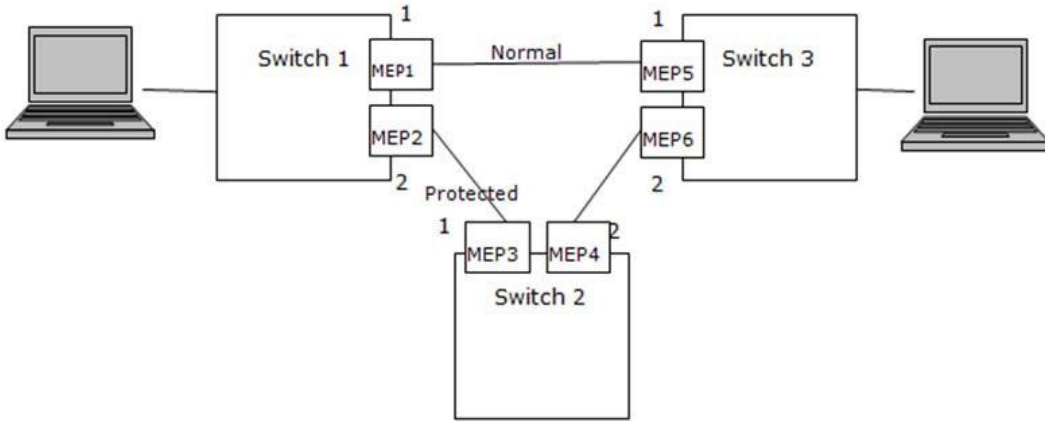
```
# configure terminal
(config)# ip dhcp relay information policy ?
   drop      Drop the package when receive a DHCP message that
already contains relay information
   keep      Keep the original relay information when receive a
DHCP message that already contains it
   replace    Replace the original relay information when receive
a DHCP message that already contains it
```

14 Ethernet Ring Protection Switching Configuration

14.1 Introduction

This document shows how to configure the Ethernet Ring Protection Switching (ERPS) for switches using the ICLI commands. The following figure builds a simple network of 3 switches to demonstrate these functions.

Figure Ethernet Ring Protection Switching (ERPS) Model



14.2 Configuring ERPS from the ICLI

Initial switch configuration

The following command disables STP.

```
#Configure port 1-2
(config)# interface GigabitEthernet 1/1-2
(config-if)#switchport mode hybrid
#disable Spanning Tree Protocol
(config-if)#no spanning-tree
```

Configuring MEP and ERPS on Switch 1 (RPL Owner)

```
#create mep 1 on port 1
(config)# mep 1 down domain port flow 1 level 0 interface
GigabitEthernet 1/1
#set vlan for MEP traffic
(config)# mep 1 vid 3001
#set id of peer mep mep 1 peer-mep-id 5
#enable ccm, default is 1FPS mep 1 cc 0
#enable RAPS
(config)# mep 1 aps 0 raps
(config)# mep 2 down domain port flow 2 level 0 interface
GigabitEthernet 1/2
(config)# mep 2 mep-id 2
(config)# mep 2 vid 3001
(config)# mep 2 peer-mep-id 3
(config)# mep 2 cc 0
(config)# mep 2 aps 0 raps
#create erps on port 1 and port 2
(config)# erps 1 major port0 interface GigabitEthernet 1/1 port1
interface GigabitEthernet 1/2
#set MEP ID for the corresponding port
(config)# erps 1 mep port0 sf 1 aps 1 port1 sf 2 aps 2
#set to RPL owner
(config)# erps 1 rpl owner port1
#set protected VLAN
(config)# erps 1 vlan 1
```

Configuring MEP and ERPS on Switch 2 (RPL Neighbor)

```
(config)# mep 1  down domain  port flow 1 level 0 interface
GigabitEthernet 1/1
(config)# mep 1  mep-id 3
(config)# mep 1  vid 3001
(config)# mep 1  peer-mep-id  2
(config)# mep 1  cc 0
(config)# mep 1  aps 0 raps
(config)# mep 2  down domain  port flow 2 level 0 interface
GigabitEthernet 1/2
(config)# mep 2  mep-id 4
```

```
(config)# mep 2  vid 3001
(config)# mep 2  peer-mep-id  6
(config)# mep 2  cc 0
(config)# mep 2  aps 0 raps
(config)# erps 1 major port0 interface GigabitEthernet 1/1 port1
interface GigabitEthernet 1/2
(config)# erps 1 mep port0 sf 1 aps 1 port1 sf 2 aps 2
#set to RPL neighbour
(config)# erps 1 rpl neighbor port0
(config)# erps 1 vlan 1
```

Configuring MEP and ERPS on Switch 3

```
(config)# mep 1  down domain  port flow 1 level 0 interface
GigabitEthernet 1/1
(config)# mep 1  mep-id 5
(config)# mep 1  vid 3001
(config)# mep 1  peer-mep-id  1
(config)# mep 1  cc 0
(config)# mep 1  aps 0 raps
(config)# mep 2  down domain  port flow 2 level 0 interface
GigabitEthernet 1/2
(config)# mep 2  mep-id 6
(config)# mep 2  vid 3001
(config)# mep 2  peer-mep-id  4
(config)# mep 2  cc 0
(config)# mep 2  aps 0 raps
(config)# erps 1 major port0 interface GigabitEthernet 1/1 port1
interface GigabitEthernet 1/2
(config)# erps 1 mep port0 sf 1 aps 1 port1 sf 2 aps 2
(config)# erps 1 vlan 1
```

Note:

On SWITCH. To set the CCM rate to 100FPS or 300FPS, the peer MAC address must be known as shown here as shown below: Or set it to lower rate first, until the peer MAC address is learned, and then change it to a higher rate.

```
(config)# mep 1 peer-mep-id <peer mep id> mac <peer mac address>
mep 1 cc 0 fr300s
```

Finally, you can use the show erps command to check the status of erps.

15 Configure Network Access Servers and Access Control Lists

This document describes how to configure the network access server and access control list functions in the switch application software. Configuration can be performed by means of the Industrial Command Line Interface (ICLI).

15.1 Access Control Table

The access control list (ACL) is controlled with the ICLI command access-list in the config- and interface config mode. For more information about config and interface config patterns, see Understanding Modes and Submodes. The basic configuration commands are as follows:

```
(config)# access-list …
```

and

```
(config-if)# access-list …
```

The following sections describe the three ACL configuration categories: port, rate limiter and access control list.

Port

For each port, you can configure a rule to determine how egress packets should be handled. For the rule on the port to take effect, the problematic packet must be associated with a policy ID. Now, we will assume that the policy ID is 0. If not changed, this is the value associated with the packet. For information about the policy ID, see "ECE Configuration Policy ID".
Action can be Permit or Deny. Permit means that the packet received on this port is forwarded normally, while Deny means that the packet is rejected. Therefore, if we set the Action of port 1 with PolicyID=0 to Deny, no packets in the system will be exchanged.
The Rate Limiter ID can be Disabled or a number in the range of 1-16, which points to one of the 16 rate limiter instances. The rate limiter ID maps to the number of packets per second, which defines the rate. For more information see "Rate Limiters".

Port Redirect specifies that packets that match the rule in question are redirected to a given port, or if Disabled, they should be forwarded in the normal way, in which case port redirection is disabled.
Logging specifies that packets matching the rule are logged. You can display packets by using the following ICLI command.

```
# show logging
```

This shows the log of one item per event. Use the following command to display all the information of event 46.

```
# show logging 46
```

Shutdown specifies that the port will be closed when the rule is hit.
State specifies whether the port is enabled or disabled. Change it to Disable and close the port. If Shutdown is enabled and the rule is hit, the system changes the value to Disable. Re-Enable the port by changing it to enable. It will remain enabled until the next rule hit.
Counter tells how many times this rule has been hit.
Use the following ICLI command to set these rules from the interface-config mode.

```
(config-if)# access-list policy <PolicyID>
(config-if)# access-list action <deny | permit>
(config-if)# access-list rate-limit <1-16>
(config-if)# access-list redirect interface gi 1/2
(config-if)# [no] access-list logging
(config-if)# [no] access-list shutdown
(config-if)# access-list port-state
```

This command cannot be used to give multiple parameters in one line. Use the no command to disable Logging and shutdown.
The last command is not in the network GUI. They are used to enable ports that are closed when shutdown is enabled.

Rate Limiters

Rate limiters map rate limiter IDs to a rate. The rate can be in any of the following formats.

- Packets per second
- 100 pps (100 packets per second)
- 100 kbps (100 kilobits per second)

The rate limit ID is a number between 1 and 16.
The ICLI command for setting the rate limit can be one of the following:

```
(config)# access-list rate-limiter <1-16> pps <0-3276700>
(config)# access-list rate-limiter <1-16> 100kbps <0-10000>
```

Where <1-16> represents a number from 1 to 16. The rate is the last number multiplied by the unit.

Access Control Table

The port part above defines a list of rules and related operations, one rule for each port. This section will describe more complex rules.

In this example, the selected source MAC should be 00-00-00-00-12, and the destination MAC address will be broadcast. The Ethernet type should also be 0x9876. VLAN identification should be 2, with priority 2 or 3. So if an ingress packet on any port (since the Ingress Port is set to All) has these attributes, then it will match this rule. After matching, the above operation will be performed.
The ICLI order makes this rule as follows. For clarity, each element is placed in a separate line, but it can be written in one line.

```
(config)# access-list ace 1
vid 2
tag-priority 2-3
dmac-type broadcast
frame etype
etype-value 0x9876
smac 00-00-00-00-00-12
logging
```

The number of the ACE entity is 1. This number is called the AceId, which can be in the range of 1-256.

```
(config)# access-list ace <AceId> …
```

Elements in a command can be in any order, except that ace <AceId > must come first.
When more than one rule is added (which is likely to be the case), the rules will be parsed in some order. When a rule similar to the above is added, it will be placed at the end of the list. So this will be the last rule to check before adding another rule.
You can specify where the rule is inserted in the hierarchy. This is done by specifying the next rule. Assume that the ACL list is empty, as shown below.

```
(config)# access-list ace 20 vid 100
(config)# access-list ace 15 vid 101
(config)# access-list ace 25 vid 102 next 15
```

The first command will insert aceID 20 into an empty list. It is the first and only element. The aceID 15 is then inserted at the end of the list to lead to the order 20, 15. The next 15 field in the third aceID inserts it before rule 15. The final rule ordering is 20, 25 and 15.

ECE Configuration Policy ID

In the port (ignore) and access control lists, the Policy ID is set to 0.
An ECE rule goes into the IS1, before the IS2 where the ACL rule resides. Therefore when the Policy ID in the Actions table is given some value for an ECE, that value can be used in ACLs.
The ICLI command is:

```
(config)# evc ece <EceId> policy <Policy ID> …
```

15.2 Network Access Server

NAS Type

This feature provides port-based access control. There are two types of authentication, namely IEEE 802.1X and MAC-based authentication. The 802.1X provide the following three kinds:

- Port based 802.1X
- Single 802.1X
- Multi 802.1X

The following three terms are used in the 802.1X context:

- Supplicant, client (PC) with some 801.1X software
- Authenticator, switch
- Authentication servers, such as RADIUS servers.

Therefore, the requester/client is connected to the authenticator/switch on a certain port, and the authenticator can reach the authentication server.

The idea is that the supplicant wants access to the port, so it sends an Extensible Authentication Protocol over LAN (EAPoL) message to the authenticator, which in turn asks the authenticator server, if this supplicant can be accepted. If so, then the authenticator opens the port for the requester and the communication can proceed. Depending on the configuration of the authenticator, the process runs in different ways.

Port Based 802.1X

According to this method, if the requester S is on the network N and the network N is connected to the authenticator on a certain port A, then if the requester S opens the port A, everyone on the network N can access it.

Single 802.1X

This mode is similar to port-based 802.1X, but in this case, only the requester who opens the authenticator port is allowed to send and receive packets. This is done through the MAC address of the requester.

Multi 802.1X

This mode is similar to single 802.1X except that multiple requesters can be registered on the port. One advantage here is that multicast packets are not sent from the switch to the requester.

MAC-based Authentication

If the requester is considered to be composed of a client and a requester component, when the client sends the first data packet, the requester component is responsible for negotiating port opening, and MAC-based authentication is considered as multi 802.1X, in which the requester component is moved to the authenticator/switch. Then, this embedded requester component uses the MAC address of the client as the user name and password in the format of aa-bb-cc-dd-ee-ff. The advantage of this is that the client does not have to own the requester software.

Port Configuration

Four configurations have been described above. The other two are Force Authorized and Force Unauthorized. The first is the default value, which means that the port is open. The second means that it cannot be accessed.
The ICLI commands for changing admin state options are as follows:

```
(config-if)# dot1x port-control auto |
force-authorized |
force-unauthorized |
mac-based |
multi |
single
```

Note:
"Auto" means port-based 802.1X, as described in the following section.

System Configuration

After setting the management status for the port, the NAS function must be enabled on the switch or authenticator.

Mode

Mode enables global NAS functionality. The corresponding ICLI command is as follows:

```
(config)# [no] dot1x system-auth-control
```

Re-authentication Enable

Re-authentication is enabled by the following ICLI command:

```
(config)# [no] dot1 re-authentication
```

The no variable can disable it. This means that the requester is periodically re-authenticated. This cycle is a recertification cycle.
This parameter affects ports with port based 801.1X, single 802.1X, or multi 802.1X admin states.
If the requester does not re-authenticate, the authenticator releases the related resources.
Note:
For MAC-based authentication, the aging period provides a similar function.

Re-authentication Period

The re-authentication period is set by the following ICLI command:

```
(config)# [no] dot1x authentication timer re-authenticate <1-3600>
```

Where <1-3600> is the time in seconds. The no variant sets it to the default, which is 3600 seconds. This property is associated with the property of re-authentication enabled.

EAPOL Timeout

The EAPOL timeout is set by the following ICLI command:

```
(config)# [no] dot1x timeout tx-period <1-65535>
```

The no variant sets it to the default, which is 30 seconds.
This parameter affects ports with port based 801.1X, single 802.1X, or multi 802.1X admin states.
EAPoL timeout is the retransmission time of EAPOL frame requesting identity from authenticator to requester.

Aging Time

The aging period is set by the following ICLI command:

```
(config)# [no] dot1x authentication timer inactivity <10-1000000>
```

Default value is 300 seconds.
This parameter affects ports with single 801.1x, multi 802.1x, or MAC based authentication. In these cases, if enabled, reauthentication works with port-based 802.1X to handle timeouts.
Aging is a timeout of MAC-based authentication. If the client has registered by this method and has not received the message after the expiration period, the validator will release the resources associated with it.

Hold Time

The hold time is set by the following ICLI command:

```
(config)# [no] dot1x timeout quite-period <10-1000000>
```

The no variant sets the hello time to the default, which is 10 seconds.
This parameter affects ports with single 801.1x, multi 802.1x, or MAC based authentication.
If the requester or client is denied access, it will be in an unauthorized state for the holding time.

RADIUS

The RADIUS assigned QoS is globally enabled by the following ICLI command:

```
(config)# [no] dot1x feature radius-qos
```

The RADIUS assigned VLAN feature is enabled by the following ICLI command:

```
(config)# [no] dot1x feature radius-vlan
```

Both can be enabled by the following ICLI command:

```
(config)# [no] dot1x feature radius-qos radius-vlan
```

Guest VLAN Enabled

The Guest vlan feature is enabled by the following ICLI command:

```
(config)# [no] dot1x feature guest-vlan
```

Any combination of the features guest-vlan, radius-qos, and radius-vlan can be enabled by the following ICLI command:

```
(config)# [no] dot1x feature guest-vlan radius-qos radius-vlan
```

QoS Assigned by RADIUS

The port has this feature enabled. For more information, see System Configuration. It can also be enabled by the following ICLI command:

```
(config-if)# [no] dot1x radius-qos
```

In which it is disabled with the no variable command.
The feature takes effect when globally enabled by checking the RADIUS-Assigned QoS Enabled option, or by means of the following ICLI command:

```
(config)# [no] dot1x radius-qos
```

On the RADIUS server and entry (per RFC 4675), say:

```
User-Priority-Table = 55555555
```

For the problematic 802.1X entry, it must exist. In this case, the user is assigned QoS 5. The valid values are 0,..., 7. The value on the right must contain eight identical numbers.
If the FreeRADIUS (http://freeradius.org) is used, then a username entry with password would appear in the user's file.

```
mememe  Cleartext-password := “itsasecret”
User-Priority-Table = 55555555
```

The port state table displays the admin state used, the port authorized, and the QoS class (5), as it was configured on the RADIUS server.
The show dot1x ICLI command also displays status and statistics.

```
# show dot1x status
# show dot1x status interface gi 1/3
The latter shows status to the interface specified:
# show dot1x status interface GigabitEthernet 1/3 GigabitEthernet
1/3 :
----------------------
Admin State           Port State       Last Source      Last ID
-------------------   ---------------  --------------   --------
Port-based 802.1X     Authorized    00-23-5a-a8-05-eb    mememe
Current Radius QOS    Current Radius VLAN Current Guest VLAN
------------------    -------------------  ------------------
5                     -                       -
```

VLAN Assigned by RADIUS

The port has this feature enabled. For more information, see System Configuration. It can also be enabled by the following ICLI command:

```
(config-if)# [no] dot1x radius-vlan
```

In which it is disabled with the no variable.
The feature takes effect when globally enabled by checking the RADIUS-Assigned VLAN Enabled option, or by means of the following ICLI command:

```
(config)# [no] dot1x radius-vlan
```

On the RADIUS server and entry, say:

```
Tunnel-Medium-Type = 6             i.e., IEEE-802
Tunnel-Type = 13                   i.e., VLAN
Tunnel-Private-Group-Id = ”123”    i.e., VID=123
```

For the problematic 802.1X entry, it must exist. In this case, the user is assigned VLAN 123. Refer to RFC 2868, RADIUS Attributes for Tunnel Protocol Support and RFC 3580, IEEE 802.1X Remote Authentication Dial In User Service (RADIUS), Usage Guidelines for further reference.
If the FreeRADIUS (http://freeradius.org) is used, then a username entry with password would appear in the user's file.

```
mememe  Cleartext-password := “itsasecret”
User-Priority-Table = 55555555,
Tunnel-Medium = 6,
Tunnel-Type = 13,
Tunnel-Private-Group-ID = 123
```

QoS= 5 remains in the previous section.
The port status table shows that the port VLAN has been assigned by RADIUS server. The show dot1x ICLI command also displays status information.

```
# show dot1x status interface GigabitEthernet 1/3
GigabitEthernet 1/3 :
----------------------
Admin State           Port State    Last Source          Last ID
-------------------   -----------   ------------------   -------
Port-based 802.1X     Authorized    00-23-5a-a8-05-eb    mememe
Current Radius QOS    Current Radius VLAN Current Guest VLAN
-------------------    ------------------  -------------------
5                     123                 -
```

VID 123 reappears here.

Guest VLAN Enabled

Guest VLAN is a VLAN in which the authentication process failed and the client can be put. This applies to situations where the management status is single 801.1X, multi 802.1X or MAC-based authentication.
If the Guest VLAN Enabled option is selected, a port will be enabled to enter the GuestVLAN. For more information, see System Configuration. It can also be enabled by the following ICLI command:

```
(config-if)# [no] dot1x guest-vlan
```

The command parameters are related to the last four options.

- Guest VLAN enable
- Guest VLAN ID
- Max. Reauth. Count
- Allow Guest VLAN if EAPoL Seen

The ICLI commands for these parameters are as follows:

```
(config)# [no] dot1x feature guest-vlan
(config)# dot1x guest-vlan 44
(config)# dot1x max-reauth-req 33
(config)# [no] dot1x guest-vlan supplicant
```

This command enables the guest vlan globally, sets the VLAN ID to 44, and sets Max. Reauth. Count is 33, and if EAPOL is seen, the allowed Guest VLAN is enabled.
The criteria for entering the guest VLAN is as follows:
After establishing the link on the port, the authenticator begins to send EAPoL packets to the requester. If Max. Reauth. Count packets are transmitted without receiving an EAPoL packet, then the port will enter the guest VLAN using the following logic:

- If EAPOL Seen is enabled, the guest VLAN is allowed.

or

- If EAPOL Seen is not enabled, the guest VLAN is allowed.
  - If EAPoL packets have been seen on this port, then continue transmitting EAPoL packets and do not enter guest VLAN
  - If EAPoL packets have not been seen on this port, then enter guest VLAN.

16 QoS Configuration

This document gives examples on how to set up Quality of Service (QoS) using the Industrial Command Line Interface (ICLI). The examples used in this document pertain to switch engine.

16.1 Understanding QoS

All ingress frames are classified to a QoS level. QoS class is used in the queue system when assigning resources, in the arbitration from ingress to egress queues, and in the egress scheduler when selecting the next frame for transmission.

- Bandwidth control in the queues can be done by using Policers or Shapers.
- Apart from Shapers and Policers, different scheduling mechanisms can be configured on how the different priority queues in the QOS system are handled.
- Weighted Random Early Detection (WRED) can be configured globally to avoid congestion and drop the Yellow Frames (frames with Drop Probability (DP) set to 1) when the queues are filled.
- For controlling the amount of flooded frames entering the switch Storm Policers can be used at the global level.

QoS Classification

There are two methods of classification to a QoS Class (CoS): Basic and Advanced.

Basic QoS Classification

Basic QoS classification enables predefined schemes for handling Priority Code Points (PCP), Drop Eligible Indicator (DEI), and Differentiated Service Code Points (DSCP):

- QoS classification based on PCP and DEI for tagged frames. The mapping table of PCP and DEI to QoS class of each port is programmable.
- QoS classification based on DSCP values.
- DSCP Translation.
- DSCP Remarking based on QOS class.
- Per Port QOS class configuration for untagged and non IP Frames.

Advanced QoS Classification

Advanced QoS classification uses the QoS Control Lists (QCLs), which provide a flexible classification:

- Higher layer protocol fields (Layer 2 through Layer 4) for rule matching.

- Actions include mapping to QOS class and translation of PCP, DEI and DSCP values.

Policers

Policers limit the bandwidth of received frames exceeding the configurable rates. Policers can be configured at queue level or at a port level. There is also a provision to add policers at the EVC level, although this provision is not discussed in this document.

Shapers

Egress traffic shaping can be achieved using bandwidth shapers. Shapers can be configured at queue level or at a port level.

Scheduling Algorithm

Two types of scheduling are possible on the switch at a port level, Strict Priority and Deficit Weighted Round Robin (DWRR).
Strict priority: All queues follow strict priority scheduling.
DWRR: Scheduling is based on the weights configured for each queue. Configuration is present to select the number of queues which can be under DWRR. It is possible to include from 2 to all 8 queues in DWRR mode.
When the number of queues selected for DWRR is less than 8 then the lowest priority queues are put in DWRR and higher priority queues are put in Strict Priority. For example, if number of Queues is 2 for DWRR then Queue 0 and 1 are set in DWRR mode and remaining Queues 2 to 8 are set in Strict Priority.
Weighted Random Early Detection (WRED) can be configured globally to avoid congestion and drop the Yellow Frames (frames with Drop Probability (DP) set to 1) when the queues are filled. For controlling the amount of flooded frames entering the switch Storm Policers can be used at the global level.

Weighted Random Early Detection (WRED)

Congestion can be avoided in the queue system by enabling and configuring the Weighted Random Early Detection Function (WRED). WRED can discard the frames with Drop Probability set to 1.
Configuration includes enabling WRED per queue (Global settings and not per port) and setting the Minimum and Maximum Threshold. Minimum threshold is the queue fill level at which the WRED. starts discarding the Frames. Maximum threshold can be configured either as Drop Probability or Fill Level. When the Unit is Drop Probability the mentioned threshold would be the Drop Probability with the queue fill level is just about 100%. When the Unit is Fill level, then it represents the Queue fill level where Drop probability is 100%.

Storm Policing

Storm Policers restrict the amount of flooded frames (Frames coming with SMAC which is not learnt earlier) entering the switch. The configurations are global per switch and not per port. Storm policer can be applied separately on Unicast, Multicast, or Broadcast packets.
CLI example: configure the broadcast rate to 128fps, multicast rate to 256fps and unicast rate to 512bps.

```
(config)# qos storm broadcast fps 128
```

```
(config)# qos storm multicast fps 256
(config)# qos storm unicast fps 512
(config)# exit
# show qos storm
qos storm:
==========
Unicast  :  enabled     fps 512
Multicast:  enabled     fps 256
Broadcast:  enabled     fps 128
```

16.2 QoS Configuration Examples

This section provides ICLI configuration examples according to different quality of service classifications.


Notes:
To configure the following example, first use the following command to restore the system defaults.

```
# reload defaults
#
```

Port Classification

Each port can be configured with basic QoS classification. Ingress traffic coming on each port can be assigned to a CoS, PCP, Drop Precedence Level (DPL), and DEI.

Example

All traffic coming on port 1 is mapped to CoS 2 and PCP is set as 1.
The equivalent ICLI commands are as follows:

```
# configure terminal
(config)# interface GigabitEthernet 1/1
! Set Cos to 2 and PCP to 1
(config-if)# qos cos 2
(config-if)# qos pcp 1
(config-if)# end
```

Tagged Frame Classification for Each Port

Egress port tag can be classified based on PCP and DEI values received on input packets. This is achieved by enabling tag classification for this port.

Example

On port 2, map PCP 0 and DEI 0 to QoS Class 2 and PCP 0 and DEI 1 to QoS Class 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
(config)# interface GigabitEthernet 1/2
! Enable Tag Classification
(config-if)# qos trust tag
! Map PCP 0 and DEI 0 to Qos Class 2
(config-if)# qos map tag-cos pcp 0 dei 0 cos 2 dpl 0
! Map PCP 0 and DEL 1 to Qos Class 3
(config-if)# qos map tag-cos pcp 0 dei 1 cos 3 dpl 1
(config-if)# end
```

Tag Comments for Each Port

Tag comment on the egress frame can be completed in the following three ways.

4 Classified: PCP and DEI values on the egress frames are updated with the classified values at the ingress. By default, PCP and DEI values are set as classification values.

5 Default: PCP and DEI values on the egress frames are updated to default values defined per port.

6 Mapped: PCP and DEI values on the egress frames are updated based on the tag remarking QoS/DPL to PCP/DEI Mapping per port.

PCP and DEI values sent on egress frames can be mapped to QoS levels and DPL values. This configuration can be done through each port.

Example 1

Set Default PCP to 5 and DEI to 0 on port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
(config)# interface GigabitEthernet 1/3
! Set Default PCP to 5 and DEI to 0
(config-if)# qos tag-remark pcp 5 dei 0
(config-if)# end
```

Example 2

Map QoS Class 2 and DPL 0 to PCP 3 and DEI 0. Map QoS Class 3 and DPL 1 to PCP 4 and DEI 1.
The equivalent ICLI commands are as follows:

```
# configure terminal
(config)# interface GigabitEthernet 1/2
! Set Tag Remarking to Mapped
(config-if)# qos tag-remark mapped
```

```
! Map QoS Class 2 and DPL 0 to PCP 3 and DEI 0
(config-if)# qos map cos-tag cos 2 dpl 0 pcp 3 dei 0
! Map QoS Class 3 and DPL 1 to PCP 4 and DEI 1
(config-if)# qos map cos-tag cos 3 dpl 1 pcp 4 dei 1
(config-if)# end
```

DSCP Configuration

The following DSCP Configuration settings are present per port for ingress and egress.

7 DSCP based QoS classification
8 Selection of trusted DSCP values used for QoS classification
9 DSCP Translation: DSCP translation is done based on the DSCP translation table
10 Classify (For rewriting if enabled):
- No DSCP classification
- Classify only DSCP=0
- Classify only selected (trusted) DSCP values based on the DSCP classification table
- Classify all DSCP

11 Rewrite (on egress):
- No egress rewrite
- Rewrite enabled without remapping
- Remap DSCP with DP unaware
- Remap DSCP with DP aware

Example 1

DSCP (only trusted) to QoS class / DPL classification at ingress on port 2.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP Trust for DSCP at Port 2.
(config)# interface GigabitEthernet 1/2
(config-if)# qos trust dscp
(config-if)# exit
! Map DSCP Values 4 and 5 to QoS Class 6.
(config)# qos map dscp-cos 4 cos 6 dpl 0
(config)# qos map dscp-cos 5 cos 6 dpl 0
(config)# end
```

Example 2

Translate DSCP at ingress on port 2 and rewrite enabled on port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP Translate at ingress on Port 2
(config)# interface GigabitEthernet 1/2
(config-if)# qos trust dscp
```

```
(config-if)# qos dscp-translate
(config-if)# exit
! Enable DSCP Remark at egress on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos trust dscp
(config-if)# qos dscp-remark rewrite
(config-if)# exit
! Create Ingress DSCP Translation Map
(config)# qos map dscp-ingress-translation 1 to 5
(config)# qos map dscp-ingress-translation 2 to 6
(config)# end
```

Example 3

Classify only DSCP = 0 at ingress on port 2 and rewrite enabled on port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP=0 Classification and Translation at ingress on Port
2
(config)# interface GigabitEthernet 1/2
(config-if)# qos trust dscp
(config-if)# qos dscp-classify zero
(config-if)# qos dscp-translate
(config-if)# exit
! Create Ingress DSCP Translation Map.
(config)# qos map dscp-ingress-translation 0 to 7
(config)# qos map dscp-ingress-translation 1 to 5
! Note: Only DSCP=0 will be rewritten as these are only classified.
! Enable DSCP Remark at egress on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos trust dscp
(config-if)# qos dscp-remark rewrite
(config-if)# exit
(config)# end
```

Example 4

Classify Selected DSCP at ingress on port 2, DSCP rewrite enabled on port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP classification for selected DSCP values at ingress
Port 2
(config)# interface GigabitEthernet 1/2
```

```
(config-if)# qos trust dscp
(config-if)# qos dscp-classify selected
(config-if)# exit
(config)# qos map dscp-classify 0
(config)# qos map dscp-classify 1
(config)# qos map dscp-classify 2
! Create Ingress DSCP Translation Map.
(config)# qos map dscp-ingress-translation 0 to 7
(config)# qos map dscp-ingress-translation 1 to 5
(config)# qos map dscp-ingress-translation 2 to 8
! Enable DSCP Remark at egress on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos trust dscp
(config-if)# qos dscp-remark rewrite
(config-if)# exit
(config-if)# end
```

Example 5

Classify all DSCP values at ingress on port 2, rewrite enabled on port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP classification for all DSCP values at ingress Port
2
(config)# interface GigabitEthernet 1/2
(config-if)# qos trust dscp
(config-if)# qos dscp-classify any
(config-if)# exit
! Enable DSCP Remark at egress on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos trust dscp
(config-if)# qos dscp-remark rewrite
(config-if)# exit
(config)# end
```

Example 6

QoS/DP to DSCP Classification enabled. Rewrite DSCP with DP Aware at egress on port 3.

Notes

To execute this example PCP/DEI on the incoming packets can be used to direct packets to a particular QoS class and DP value.

The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable DSCP Classification on all DSCP values on port 2.
(config)# interface GigabitEthernet 1/2
(config-if)# qos trust dscp
(config-if)# qos dscp-classify any
(config-if)# exit
! Map QoS Class 5, DP = 0 to DSCP 4, QoS Class 5, DP = 1 to DSCP
5
(config)# qos map cos-dscp 5 dpl 0 dscp 4
(config)# qos map cos-dscp 5 dpl 1 dscp 5
! Remap DSCP 4, DP = 0 to DSCP = 8 and DSCP 5, DP = 1 to DSCP =9
on Egress
(config)# qos map dscp-egress-translation 4 0 to 8
(config)# qos map dscp-egress-translation 5 0 to 9
! Enable DSCP rewrite with DSCP Remap DP Aware on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos dscp-remark remap-dp
(config-if)# end
```

QCLs

Advanced QoS classification can be accomplished by examining the fields from Layer 2 to Layer 4 and mapping them to PCP/DEI, QoS classes and DSCP values.

Example 1

Match a specific target MAC on port 2 and map it to QoS class 5.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Set the Address mode to Destination on Port 2
(config)# interface GigabitEthernet 1/2
(config-if)# qos qce addr destination
(config-if)# exit
! Create QCL rule for matching particular destination MAC on Port
2
(config)# qos qce 1 interface GigabitEthernet 1/2 dmac
00-00-00-00-00-23 action cos 5
(config-if)# end
```

Example 2

Match on a particular VLAN Tag and PCP range on port 2 and map these to QoS class 6. Also map these frames to PCP = 6 and DEI = 0.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Create QCL rule for matching particular VLAN ID and range of PCP
values.
(config)# qos qce 1 interface GigabitEthernet 1/2 tag vid 10 pcp
4-5 action cos 6 pcp-dei 6 (config)# end
```

Example 3

Match a specific Dest MAC, source IP, UDP Sport number on port 2. Map these to QoS Class 7, DP = 1 and DSCP value = 9.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Set the QCE address mode to MAC and IP address on Port 2.
(config)# interface GigabitEthernet 1/2
(config-if)# qos qce key mac_ip_addr
(config-if)# exit
! Create QCL rule for matching DMAC, SIP, UDP Sport on Port 2.
(config)# qos qce 1 interface GigabitEthernet 1/2 dmac
00-00-00-00-00-23 frame-type ipv4 proto (config)# end
```

Policers

Port Policer

Enable policies at the port level of a specific port.

Example 1

Enable the policer on port 2 and set the policer rate to 2000 Kbps. For better performance, you can also choose to enable flow control if the regulated traffic is TCP traffic.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable Policer on Port 2 with a rate set to 2000Kbps
(config)# interface GigabitEthernet 1/2
(config-if)# qos policer 2000 flowcontrol
(config-if)# end
```

Example 2

Enable the policer on port 2 and set the policer rate to 200fps. The unit is frames per second.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable Policer on Port 2 with a rate set to 200fps
(config)# interface GigabitEthernet 1/2
(config-if)# qos policer 200 fps (config-if)
# end
```

Queue Policer

Example

Enable the policer on queue 2 of port 2. Set the monitoring rate to 20mbps.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable Policer on Queue 2 at Port 2 with a rate set to 20 Mbps
(config)# interface GigabitEthernet 1/2
(config-if)# qos queue-policer queue 2 20000
(config-if)# end
```

Shapers

Port Shaper

Enable port-level shapers to shape the egress traffic.

Example

Enable the shaper on port 3 and set the shaper rate to 4000 Kbps.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable Shaper on Port 3 and set the rate to 4000 Kbps
(config)# interface GigabitEthernet 1/3
(config-if)# qos shaper 4000
(config-if)# end
```

Queue Shaper

Example

Shaping is enabled at different rates on Queue 3 and Queue 4 of Port 3.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Enable Queue Shaper on Queues 3 and 4 on Port 3 and set the rate
to 4000 and 8000 Kbps
(config)# interface GigabitEthernet 1/3
(config-if)# qos queue-shaper queue 3 4000
(config-if)# qos queue-shaper queue 4 8000
(config-if)# end
```

Scheduler

DWRR

Example

Set the scheduling mode to DWRR (for 6 queues) on Port 3 with the following weights: Queues 0-40, 1-40, 2-20, 3-20, 4-20 and 5-20.
The equivalent ICLI commands are as follows:

```
# configure terminal
! Set Scheduler mode to DWRR Priority on Port 3
(config)# interface GigabitEthernet 1/3
(config-if)# qos wrr 40 40 20 20 20 20
(config-if)# end
```

Weighted Random Early Detection (WRED)

Example 1

Configuring WRED on Queue 4 with a Minimum Threshold as 10% and Maximum Threshold as 50%. The maximum threshold unit is the discard probability.
The equivalent ICLI commands are as follows:

```
# configure terminal
!Set Minimum threshold as 10 and Maximum Threshold as 50 on Queue
4. (config)# qos wred queue 4 min-fl 10 max 50
```

Example 2

Configuring WRED on Queue 5 with a Minimum Threshold as 10% and Maximum Threshold as 90%. The maximum threshold unit is the filling level.
The equivalent ICLI commands are as follows:

```
# configure terminal
!Set Minimum threshold as 10 and Maximum Threshold as 90 on Queue
5.
(config)# qos wred queue 5 min-fl 10 max 90 fill-level
```

Storm Policing

Example

Apply 1K fps storm strategy on unicast frame type.
The equivalent CLI Command is:

```
# configure terminal
(config)# qos storm unicast kfps 1
```

17 Configure the DHCP Client

This document describes basic usage of Industrial Command Line Interface (ICLI) to configure the DHCP client with a switch.
ICLI is an integrated management interface on the device. This is the only accessible management interface on the serial console. Even if there is no network connection, you can use a serial connection to manage devices. The following commands assume that the device is powered on and the serial port has a functional connection to a computer console. Serial port setting should be as follows:

- 115200 baud rate
- No parity
- 8 data bits
- 1 Stop Bit
- No Flow Control

Use serial cable to connect computer serial port and Console port of the device, and run terminal emulator, such as TeraTerm or PuTTY on Windows, or Minicom on Linux.
"#" indicates the user prompt.

```
# configure terminal
(config)# hostname Switch
Switch(config)# end
```

17.1 DHCP Client

When enabled, the DHCP client in the switch application software will issue an IP address configuration request. When the DHCP server on the network receives the request, the server will search its available IP address pool, allocate one, and return it to the DHCP client. The returned information typically includes IP address, netmask, and default gateway, but may also contain other information such as Domain Name Service (DNS) server addresses.


Notes
IP addresses can only be assigned to VLAN interfaces.

Interface configuration mode is used to configure the parameters of an interface or a series of interfaces. Interfaces can be physical ports, VLAN or other virtual interfaces. According to the interface type, the interface configuration mode is further distinguished. The command prompt of each interface is slightly different.
The VLAN interface configuration mode is used to configure the parameters of the VLAN interface. The following sections describe the commands to access the VLAN interface configuration mode

Static IP Address

In application software, VLAN 1 is often used to manage VLAN. The purpose is to assign an IP address to a device on VLAN 1. The following static settings are also the default settings.

```
Switch# configure terminal
Switch(config)# interface vlan 1
Switch(config-if-vlan)# ip address 192.0.2.1 255.255.255.0
Switch(config-if-vlan)# end
```

DHCP Address

The application software includes a DHCP client, which must be enabled to automatically obtain an IP address from a DHCP server on the network.

```
Switch# configure terminal
Switch(config)# interface vlan 1
Switch(config-if-vlan)# ip address dhcp
Switch(config-if-vlan)# end
```

Bring back the DHCP Address

It is a good practice to default to an IP address after a timeout period for those instances where there is no DHCP server on the network.

```
Switch# configure terminal
Switch(config)# interface vlan 1
Switch(config-if-vlan)# ip address dhcp fallback 192.0.2.1
255.255.255.0
Switch(config-if-vlan)# end
```

Display IP Address

After setting the static address, the following output will be displayed.

```
Switch# show ip interface brief
Interface      Address          Method        Status
---------      ------------     -------       ------
VLAN 1         192.0.2.1/24     Manual        UP
Switch#
```

When DHCP negotiation is successful, the following response will be displayed.

```
Switch# show ip interface brief
```

```
Interface      Address           Method        Status
---------      ------------      -------       ------
VLAN 1         10.10.132.82/23   DHCP          UP
Switch#
```

Use the show ip interface command to briefly display the configured and active IP interfaces. The active interface should display "UP" status. If you don't see this status, there may be no link on any port. If DHCP negotiation fails, 192.0.2.1's backup IP will be allocated. The following command displays DHCP session statistics.

```
Switch# show ip dhcp detailed statistics client
GigabitEthernet 1/1 Statistics:
-------------------------------
Rx Discover:                    0   Tx Discover:            4
Rx Offer:                       1   Tx Offer:               0
Rx Request:                     0   Tx Request:             17
Rx Decline:                     0   Tx Decline:             0
Rx ACK:                         17  Tx ACK:                 0
Rx NAK:                         0   Tx NAK:                 0
Rx Release:                     0   Tx Release:             0
Rx Inform:                      0   Tx Inform:              0
Rx Lease Query:                 0   Tx Lease Query:         0
Rx Lease Unassigned:            0   Tx Lease Unassigned:    0
Rx Lease Unknown:               0   Tx Lease Unknown:       0
Rx Lease Active:                0   Tx Lease Active:        0
Rx Lease Active:                0   Tx Lease Active:        0
Rx Discarded checksum error:    0
Switch#
```

Another way to display the IP address is to display the actual VLAN.

```
Switch# show interface vlan 1
VLAN1
  LINK: 00-22-6f-01-01-10 Mtu:1500 <UP BROADCAST RUNNING
MULTICAST>
IPv4: 192.168.1.254/24 192.168.1.255
```

Using the Obtained Network Connection

After completing the basic system configuration, you can verify management connectivity by issuing a ping command to a known external IP address.

```
Switch# ping ip 10.10.130.66
PING server 10.10.130.66, 56 bytes of data.
64 bytes from 10.10.130.66: icmp_seq=0, time=10ms
64 bytes from 10.10.130.66: icmp_seq=1, time=10ms
```

```
64 bytes from 10.10.130.66: icmp_seq=2, time=0ms
64 bytes from 10.10.130.66: icmp_seq=3, time=0ms
64 bytes from 10.10.130.66: icmp_seq=4, time=0ms
Sent 5 packets, received 5 OK, 0 bad
Switch#
```

If the ping is successful, network logins can now be performed using ssh to the address on VLAN interface 1.

Save Configuration to Flash

The current configuration of the device cannot remain unchanged after a reboot. Use the following command to save running-config in FLASH under the name of startup-config.

```
Switch# copy running-config startup-config Building
configuration...
% Saving 1223 bytes to flash:startup-config
Switch#
```

The startup-config file is read and executed every time it is started. It is also used to restore the running configuration of the system to the last saved state.

Specify MAC Address

When two switches have the same MAC address, the IP address will not be obtained successfully. The MAC address must be unique because the DHCP server binds the MAC address and the IP address. Use the following steps to specify a unique MAC address to obtain an IP address from the network.

```
Switch# platform debug allow
Switch# debug board
Board MAC Address: 00-22-6f-01-01-10
Board ID        : 1234
Board Type Conf  : 0
Board Type Active : Luton26 (5)
Product Type     : IES6300-8GT2HS
Product hwrev    : Need to fill in!
Switch# debug board mac 00-22-6F-00-b1-20
Board set operation success
```

18 PoE

18.1 Navigating the PoE Configuration

Commands related to PoE query are:

```
#  show poe ?
   |              Output modifiers
   auto-checking    auto-checking configuration
   interface
primary
<cr>
```

Check each port's PoE status monitoring.

```
# show poe
POE Primary Power Supply 360 [W].
Interface             PD Class  Port Status
Power Used [W]   Current Used [mA]
----------------------  --------
----------------------------------------  ---------------
-----------------
GigabitEthernet 1/1 does not have PoE support
GigabitEthernet 1/2 does not have PoE support
GigabitEthernet 1/3 does not have PoE support
GigabitEthernet 1/4 does not have PoE support
GigabitEthernet 1/5 does not have PoE support
GigabitEthernet 1/6 does not have PoE support
GigabitEthernet 1/7 does not have PoE support
GigabitEthernet 1/8 does not have PoE support
2.5GigabitEthernet 1/9 does not have PoE support
2.5GigabitEthernet 1/10 does not have PoE support
GigabitEthernet 1/11 does not have PoE support
```

```
GigabitEthernet 1/12 does not have PoE support
```

The command to check the automatic PoE detection configuration of each port is as follows.

```
#  show poe auto-checking

Port    Ping IP address StartupTime    IntervalTime
RetryTimeFailureError   FailureTotal   FailureAction
RebootTime

1       0.0.0.0         60             30             3
0              0              reboot          15

2       0.0.0.0         60             30             3
0              0              reboot          15

3       0.0.0.0         60             30             3
0              0              reboot          15

4       0.0.0.0         60             30             3
0              0              reboot          15

5       0.0.0.0         60             30             3
0              0              reboot          15

6       0.0.0.0         60             30             3
0              0              reboot          15

7       0.0.0.0         60             30             3
0              0              reboot          15

8       0.0.0.0         60             30             3
0              0              reboot          15

2.5GigabitEthernet 1/9 does not have PoE support

2.5GigabitEthernet 1/10 does not have PoE support

GigabitEthernet 1/11 does not have PoE support

GigabitEthernet 1/12 does not have PoE support

poe auto-checking disable
```

Check the power supply status of Port 1.

```
# show poe interface GigabitEthernet 1/1

Interface             PD Class  Port Status
Power Used [W]   Current Used [mA]

----------------------  --------
----------------------------------------  ---------------
-----------------

GigabitEthernet 1/1     -        No PD detected
0.0            0
```

Check the maximum power supply of PoE of the device.

```
# show poe primary power supply

POE Primary Power Supply 360 [W].
```

18.2 Configure PoE

Global Configuration

The command that supports PoE global configuration is as follows:

```
(config)# poe ?
   auto-checking     Setting poe auto-checking
   capacitor-detect   Enable or disable capacitor detection
management         Use management mode to configure PoE
power management method.
supply             Use PoE supply to specify the maximum
powerthe power supply can deliver.
```

CLI example: enable PoE auto-check and capacitor detection.

```
(config)# poe auto-checking enable
(config)# poe capacitor-detect
```

CLI example: disable PoE auto-check and capacitor detection.

```
(config)# poe auto-checking disable
(config)# no poe capacitor-detect
```

CLI example: set the “Reserved Power Determined by” to "class" and the “Power Management Mode” to "Actual Consumption".

```
(config)# poe management mode class-consumption
```

CLI example: set the “Reserved Power Determined by” to "class" and the “Power Management Mode” to "Reserved Power".

```
(config)# poe management mode class-reserved-power
```

CLI example: set the “Reserved Power Determined by” to "Allocation" and the “Power Management Mode” to "Actual Consumption".

```
(config)# poe management mode allocation-consumption
```

CLI example: set the “Reserved Power Determined by” to "Allocation" and the “Power Management Mode” to "Reserved Power".

```
(config)# poe management mode allocation-reserved-power
```

Policy Configuration

The CLI Command for PoE policy configuration is as follows:

```
(config)#   scheduling  name ?
<word32>    Scheduling name in 32 characters
(config)#   scheduling  name sch1
(config-time-range-name)# ?
   absolute   Configure absolute time
   do         To run exec commands in the configuration mode
   end        Go back to EXEC mode
```

```
   exit       Exit from current mode
   help       Description of the interactive help system
   no         Negate a command or set its defaults
periodic
Configure periodic time
```

Power Supply Delay

CLI example: enable PoE power supply delay of Port 1 and set the delay time to 10s.

```
(config)# interface GigabitEthernet 1/1
(config-if)# poe delay
(config-if)# poe delay time 10
```

CLI example: disable power supply delay.

```
(config-if)# no poe delay
```

19 IP Multicast Configuration

This document provides the steps of deploying IPMC configuration files, IGMP/MLD monitoring and proxy, and MVR using ICLI command to manage IPMC traffic forwarding. It needs to be familiar with IP/HTTP technology and experience in setting up operating system application services.
A network equipment device running software is managed on a platform that may be a computer running an IP-capable OS (for example, FreeBSD®, Linux® or WINDOWS®).
To use ICLI as a management interface, it is necessary to establish a serial console connection between the device and the management platform. No network connection is required to use ICLI, but terminal emulator software must be installed.

19.1 IGMP/MLD Snooping

IP multicast reduces the burden of IP broadcast data traffic by forwarding data frames only to those network devices that expect the specified frames to put forward group registration. It is commonly deployed for triple play services (data, voice, and video) such as network conference system and video on demand.
SWITCH IPMC, which includes IGMP and MLD protocol support, manages the IP multicast group registration. Snooping works at the Layer2 MAC level but it actually handles (Layer3) IP IGMP control messages to dedicate Layer2 MAC forwarding table.
For IPMC monitoring, the system needs to be in router mode, in which the following two roles are defined.

- Queriers transmit IPMC queries and are responsible for triggering multicast address determination.
- Non-querier routers are not selected as queriers in the same broadcast domain, such as VLAN.

19.2 IGMP/MLD Agent

To be an IPMC proxy, the system acts as a Host/Node in reporting the joins or leaves of multicast groups towards routers. On the other hand, the system acts as a router and collects expected multicast group registration information from connected

hosts/nodes. In this manner IPMC control messages restrict and manage loading of the connected routers in running protocol control.

19.3 IPMC Profile

In addition to multicast group registration driven by IGMP/MLD control messages, IPMC also provides IPMC configuration files, that is, access control during registration. IPMC profile manages permissions in multicast registration for group tables.
An IPMC profile provides the rules for specific group addresses to decide whether or not the multicast registration should happen. The concept of an IPMC profile is similar to that of an ACL that gives permission by checking the given rules in a specific order. An IPMC profile is constructed with address range rules where the first matching condition takes effect.

19.4 IPMC Traffic Forwarding

By using IPMC snooping or proxy, SWITCH is able to do IPv4 and/or IPv6 multicast forwarding that saves bandwidth across the network. It is also able to do access management on multicast registration by deploying the IPMC profile either in filtering utility or in throttling control. MVR deployment selects the expected group address dedicated by the IPMC profile when it is expected to restrict and prioritize certain multicast streams as they are forwarded in a proprietary VLAN trunk.
IPMC monitor/proxy and MVR can coexist to provide IPv4 and/or IPv6 multicast group registration service. However, choosing the registered group address between IPMC monitor/proxy and MVR has priority.
MVR has higher priority in choosing the group address for registration because MVR should be treated as a static VLAN deployment in which the user administration must get involved. When MVR obtains a group address, the control message about the specific group address will not be announced in the IPMC listening/proxy VLAN.

Limitations for IPMC Snooping, Proxy and Profile

1 IP and MAC hash: By using the MAC address table for forwarding IP multicast data, it is possible that two different IPMC group addresses map to the same MAC forwarding entry.
2 Unregistered Flooding Control: When the group table is full, unregistered multicast data traffic will be blocked by the unregistered flooding setting. Keep the unregistered flooding control enabled to deal with this situation.
3 Proxy for IGMPv3/MLDv2: transmits IGMPv1/IGMPv2/MLDv1 control messages upstream while the proxy is enabled. Downstream, however, it can completely handle the IPMC group registration when it receives the control messages of IGMPv1/IGMPv2/IGMPv3/MLDv1/MLDv2. SWITCH does not yet fully support IGMPv3/MLDv2 in IPMC proxy.
4 Not all platforms support SSM forwarding: To consider the access control resources used in chip forwarding, SSM registration information is valid on software level only.

19.5 IGMP/MLD Monitoring Operation and Configuration

IPMC (IGMP/MLD) snooping is used to perform generic IP multicast group registration upon receiving IGMP/MLD control messages. The implementation of IPMC protocol conforms to the standards of IGMPv3 and MLDv2, and can handle all types of IPMC control messages from connected network devices.
To start snooping, both the global and per (IP) VLAN interface administrative controls have to be enabled. According to the query election results on VLAN, active queries start advertising query control messages. The host/node then responds with a join message containing the expected group address. After the join messages are received, routers/ switches program the group table according to the collected information with a proper forwarding map. When a multicast data stream is broadcast, devices with IPMC monitoring capability only forward data frames to registered group members.

IPMC Snooping

Each multicast listener reports the expected joining group when it receives the query from the inquirer. Then, the device senses the destination port interface associated with the registered group address. When broadcasting multicast data from the server, the device only forwards specific frames assigned to a known group of registered members.
The SWITCH supports both the IPv4 (IGMP) and IPv6 (MLD) multicast group registration protocols, as described in the following sections.

IGMP Snooping

IGMP is a protocol for IPv4 multicast group registration. IGMP snooping provides global administrative control and per (IP) VLAN interface management. You need to create an IGMP VLAN and enable a specific IGMP VLAN to start listening to IGMP control messages. The following are additional configurable IGMP VLAN interface settings for protocol control.

- Querier Election defined in IGMP. When this option is disabled, the device will always be a non-querying device.
- Querier Address IPv4 address defined as the source address used in the IP header for IGMP Querier election. If the inquirer address is not set, the system will use the IPv4 management address of the IP interface associated with this VLAN. When the IPv4 management address is not set, the system uses the first available IPv4 management address. Otherwise, the system uses a default value, 192.0.2.1.
- Compatibility is maintained by hosts and routers taking appropriate actions depending on the versions of IGMP operating on hosts and routers within a network.
- Priority of interface indicates the IGMP control frame priority level generated by the device. It can be used to prioritize different types of traffic.
- Robustness variables allow adjustment for expected packet loss on the network.
- Query interval is the interval between general queries sent by inquirers.
- QRI maximum response delay is used to calculate the maximum response code inserted into a regular general query. This depends on the given maximum response code. The connected host/node has to respond within this interval.

- The last member query interval of LMQI is used to ensure that the group is deregistered, and no more hosts/nodes need a specific multicast address. It is also used as a contributor to the built-in quick leave mechanism of the protocol.
- URI The unsolicited report interval is the time between repetitions of a host's initial report of membership in a group. It is used to suppress the join/report sent by the host/node.

The following table shows the basic IGMP snooping parameters and their corresponding descriptions.

Table 1•IGMP monitoring parameters

Parameters	Note
Global IGMP Snooping	Enable/Disable the global IGMP snooping. System starts to receive IGMP control frame when the global IGMP snooping is enabled.
Unregistered Flooding	Enable/Disable the flooding of frame destined to unregistered IPv4 group address. The flooding control takes effect only when IGMP snooping is globally enabled. When IGMP snooping is disabled, unregistered traffic flooding is always active in spite of this setting.
IGMP SSM Range	Allows the SSM-aware hosts and routers to run the SSM service model for the groups in the address range. Group addresses within SSM range are not allowed to be advertised by excluding/blocking registration messages.
VLAN ID	ID of the specific IGMP VLAN interface.
VLAN IGMP Snooping	Enable/Disable per (IP) VLAN IGMP snooping. When the IGMP monitoring of each VLAN IGMP enabled, the system enables IGMP and maintains the group table.
Join Querier Election	Enable/Disable to join the IGMP querier election of the specific IGMP VLAN interface.
Querier Address	Set the IP address used as the source address in the frame generated by the device itself.
Compatibility	Specify the IGMP VLAN interface's compatibility. The options are: IGMP-Auto, Forced IGMPv1, Forced IGMPv2, and Forced IGMPv3.
Priority	Specify the CoS priority for IGMP VLAN tagged control frame.
RV	Used as the tolerance for IGMP control frame loss.
QI	Used for the routers sending periodical general query message.
QRI	Time limit for the host to respond to query messages.
LMQI	The router determines whether any hosts need this group of addresses by sending specific query messages during this time.
URI	Used for the hosts not sending too many join/report messages in this period of time.

Once the default parameters are enabled globally using the created and enabled VLAN interface, IGMP monitoring can work well. Other functions follow the protocol to realize group registration and forwarding table programming.

SWITCH IGMP snooping is disabled by default without any IGMP VLAN interface. Create and enable the IGMP VLAN interface and global administrative control to start IGMP snooping. Because IGMP snooping logical interface relies on the existing physical VLAN setting to receive and transmit protocol frames, it is important to properly configure the associated VLAN. IGMP behavior is configured by protocol parameters. Modifying these parameters requires familiarity with the IGMP standard. The following is a quick summary of the steps.

1 Confirm that unregistered flood control is set as expected.
2 If you want to run IGMPv3 snooping on SSM-enabled services, please confirm the SSM address range.
3 Create an IGMP VLAN interface and enable this interface.
4 Configure Querier Address if needed.
5 Set up Compatibility and/or Join Querier Election to force IGMP snooping in static operation (IGMPv1/IGMPv2/ IGMPv3 and/or Non-Querier) mode.
6 Set up protocol attributes (RV / QI / QRI / LMQI / URI) for IGMP to adjust protocol behaviors.
7 If necessary, assign a CoS priority to the control frame that sends the flag.
8 Repeat steps 3 to 7 for IGMP VLAN interface management.
9 Set up global IGMP snooping administrative control, if needed.
10 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default IGMP snooping settings and their configurable value range.

Table 2• IGMP Snooping Settings

Configuration	Default Value	Configurable value range
Global IGMP Snooping	Disabled	Enabled or Disabled
Unregistered Flooding	Enable	Enabled or Disabled
IGMP SSM Range	232.0.0.0 / 8	Valid IPv4 multicast prefix and prefix length
VLAN ID for IGMP Interface	空	1 ~ 4095 VLAN ID. At maximum 32 IGMP VLAN interface can be created.
VLAN IGMP Snooping	Disabled	Enabled or Disabled
Join Querier Election	Enable	Enabled or Disabled When Disabled, the specific interface always acts as Non-Querier.
Querier Address	0.0.0.0.	Valid IPv4 multicast address.
Compatibility	Auto	Auto / IGMPv1 / IGMPv2 / IGMPv3 Auto: Compatible with IGMPv1/IGMPv2/IGMPv3 IGMPv1：Forced IGMPv1 IGMPv2：Forced IGMPv2 IGMPv3：Forced IGMPv3
Priority	0	0 ~ 7 CoS value.
RV	2	Packet loss tolerance count from 1 to 255

Configuration	Default Value	Configurable value range
QI	125	1 - 31744s
QRI	100	one tenth of 0-31744s
LMQI	10	one tenth of 0-31744s
URI	1	0 - 31744s

IGMP Snooping Setup Using ICLI

The following table shows the steps used to set up IGMP snooping using ICLI.

Table 3• Setting up IGMP Snooping Using ICLI

Steps	Command or operation	Purpose
1	**configure terminal** Example **# configure terminal** **(config)#**	Enter Configure Mode
2	**ip igmp { ssm-range <ipv4_mcast> | unknown-flooding }** Example **(config)# ip igmp unknown-flooding** **(config)#**	(Optional) Sets up unknown flooding or SSM range or IPv4 multicast data forwarding.
3	**ip igmp snooping vlan <vlan_list>** Example **(config)# ip igmp snooping vlan 1** **(config)#**	Creates IGMP VLAN interface(s) with specific VLAN ID or list.
4	**interface vlan <vlan_list>** Example **(config)# interface vlan 1** **(config-if-vlan)#**	Enter (IP)VLAN interface configuration mode with a specific VLAN ID or list.
5	**ip igmp snooping** Example **(config-if-vlan)# ip igmp snooping** **(config-if-vlan)#**	Enable the designated (IP) VLAN interface MLD snooping function.

Steps	Command or operation	Purpose
6	**ip igmp snooping** **{** **compatibility { auto | v1 | v2 | v3 }** **| last-member-query-interval** **<0-31744> |** **priority <0-7> |** **querier address <ipv4_ucast> |** **querier election |** **query-interval <1-31744> |** **query-max-response-time <0-31744> |** **robustness-variable <1-255> |** **unsolicited-report-interval** **<0-31744>** **}** Example **(config-if-vlan)# ip igmp snooping** **querier election** **(config-if-vlan)#**	(Optional) Sets up IGMP VLAN interface specific configurations.
7	**exit** Example **(config-if-vlan)# exit** **(config)#**	Exit interface configuration mode and return to global configuration mode.
8	**ip igmp snooping** Example **(config)# ip igmp snooping** **(config)#**	Enables the global MLD snooping function.
9	**end** Example **(config)# end** **#**	Return to privileged EXEC mode
10	**copy running-config startup-config** Example **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file

MLD Snooping

MLD is a protocol for IPv6 multicast group registration. MLD snooping provides global administrative control and per (IP) VLAN interface management. It is almost the same as "IGMP monitoring" except for the address of the querier.

The querier address used in MLD is always the IPv6 link local address of a specific (IP)VLAN interface, because MLD is a local range protocol registered for IPv6 multicast groups. If the corresponding IP interface is not configured in the system, the MLD listener uses EUI-64 to determine the source address in the IP header for generating the MLD control message.

The following table shows the basic MLD search parameters and their corresponding descriptions.

Table 4 • MLD Snooping Parameters

Parameters	Note
Global MLD Snooping	Enable/Disable the global MLD snooping. System starts to receive MLD control frame when the global MLD snooping is enabled.
Unregistered Flooding	Enable/Disable the flooding of frame destined to unregistered IPv6 group address. The flooding control takes effect only when MLD snooping is globally enabled. When MLD snooping is disabled, unregistered traffic flooding is always active in spite of this setting.
MLD SSM Range	Allows the SSM-aware hosts and routers to run the SSM service model for the groups in the address range.
VLAN ID	ID of the specific MLD VLAN interface.
VLAN MLD Snooping	Enable/Disable per (IP) VLAN MLD snooping. When the MLD monitoring of each VLAN MLD enabled, the system enables IGMP and maintains the group table.
Join Querier Election	Enable/Disable to join the MLD querier election of the specific MLD VLAN interface.
Compatibility	Specify the MLD VLAN interface's compatibility. The options are: MLD-Auto, Forced MLDv1, and Forced MLDv2.
Priority	Specify the CoS priority for MLD VLAN tagged control frame.
RV	Used as the tolerance for MLD control frame loss.
QI	Used for the routers sending periodical general query message.
QRI	Time limit for the host to respond to query messages.
LMQI	The router determines whether any hosts need this group of addresses by sending specific query messages during this time.
URI	Used for the hosts not sending too many join/report messages in this period of time.

Once the default parameters are enabled globally using the created and enabled VLAN interface, MLD monitoring can work well. Other functions follow the protocol to realize group registration and forwarding table programming.

Unregistered Flooding control needs to always be enabled for MLD listening, because IPv6 relies on multicast message exchange for interface initialization. If these important messages are filtered (not submerged), the connected IPv6 nodes will not work normally.

By default, MLD listening is disabled without any MLD VLAN interface. Create and enable the MLD VLAN interface and global administrative control to start MLD snooping. Because MLD snooping logical interface relies on the existing physical VLAN setting to receive and transmit protocol frames, it is important to properly

configure the associated VLAN. MLD behavior is configured by protocol parameters. Modifying these parameters requires familiarity with the MLD standard.
The following is a quick summary of the steps.

1 Confirm that unregistered flood control is set as expected. It is strongly recommended to enable unregistered flooding control for IPv6 multicast traffic.
2 If you want to run MLDv2 snooping on SSM-enabled services, please confirm the SSM address range.
3 Create an MLD VLAN interface and enable this interface.
4 Set up Compatibility and/or Join Querier Election to force MLD snooping in static operation (MLDv1/MLDv2 and/or Non-Querier) mode.
5 Set up protocol attributes (RV / QI / QRI / LLQI / URI) for MLD to adjust protocol behaviors.
6 If necessary, assign a CoS priority to the control frame that sends the flag.
7 Repeat steps 3 to 6 for MLD VLAN interface management.
8 Set up global MLD snooping administrative control, if needed.
9 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default MLD snooping settings and their configurable value range.
Table 5• Default MLD Snooping Settings

Configuration	Default Value	Configurable value range
Global MLD Snooping	Disabled	Enabled or Disabled
VLAN ID for MLD Interface	Enable	Enabled or Disabled
MLD SSM Range	ff3e：：/ 96	Valid IPv6 multicast prefix and prefix length
VLAN ID for MLD Interface	Null	1 ~ 4095 VLAN ID. At maximum 32 MLD VLAN interface can be created.
VLAN MLD Snooping	Disabled	Enabled or Disabled
Join Querier Election	Enable	Enabled or Disabled When Disabled, the specific interface always acts as Non-Querier.
Compatibility	Auto	Auto / MLDv1 / MLDv2 Auto: Compatible with MLDv1/MLDv2MLDv1: Forced MLDv1 MLDv2：Forced MLDv2
Priority	0	0 ~ 7 CoS value.
RV	2	Packet loss tolerance count from 1 to 255
QI	125	1 - 31744s
QRI	100	one tenth of 0-31744s
LLQI	10	one tenth of 0-31744s
URI	1	0 - 31744s

MLD Snooping Setup Using ICLI

The following table shows the steps used to set up MLD snooping using ICLI.

Table 6• Setting up MLD Snooping Using ICLI

Steps	Command or operation	Purpose
1	**configure terminal** Example **# configure terminal (config)#**	Enter Configure Mode
2	**ipv6 mld { ssm-range <ipv6_mcast> | unknown-flooding }** Example **(config)# ipv6 mld unknown-flooding** **(config)#**	(Optional) Sets up unknown flooding or SSM range or IPv6 multicast data forwarding.
3	**ipv6 mld snooping vlan <vlan_list>** Example **(config)# ipv6 mld snooping vlan 1** **(config)#**	Creates MLD VLAN interface(s) with specific VLAN ID or list.
4	**interface vlan <vlan_list>** Example **(config)# interface vlan 1** **(config-if-vlan)#**	Enter (IP)VLAN interface configuration mode with a specific VLAN ID or list.
5	ipv6 mld snooping Example **(config-if-vlan)# ipv6 mld snooping** **(config-if-vlan)#**	Enable the designated (IP) VLAN interface MLD snooping function.
6	**ipv6 mld snooping** **{** **compatibility { auto | v1 | v2 } |** **last-member-query-interval <0-31744> |** **priority <0-7> |** **querier election |** **query-interval <1-31744> |** **query-max-response-time <0-31744> |** **robustness-variable <1-255> |** **unsolicited-report-interval <0-31744>** **}** Example **(config-if-vlan)# ipv6 mld snooping querier election** **(config-if-vlan)#**	(Optional) Sets up MLD VLAN interface specific configurations.

Steps	Command or operation	Purpose
7	**exit** Example **(config-if-vlan)# exit** **(config)#**	Exit interface configuration mode and return to global configuration mode.
8	**ipv6 mld snooping** Example **(config)# ipv6 mld snooping** **(config)#**	Enables the global MLD snooping function.
9	**end** Example **(config)# end** **#**	Return to privileged EXEC mode
10	复制running-config startup-config Example **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file file

19.6 IGMP/MLD Proxy Operation and Configuration

IPMC (IGMP/MLD) proxy is used to reduce message exchanges from the IPMC control plane. The IPMC agent represents a group of hosts in the reporting group, and it communicates with the hosts as a general IPMC router to collect group registration information. The core idea of proxy operation is that the device will only actively report the first registered (new) connection of the group, but only the last cancelled (deleted) connection of the group. The following tasks start the IPMC proxy operation.

- Enable global and expected (IP)VLAN interface listening.
- Enable agent management control.
- Turn off the Join Querier Election function on the (IP)VLAN interface.

At startup, the device collects the group registration and reports the entries in the group table when the timer of the latest event report expires or the device receives the query message from the inquirer. In other words, the device acts as both a host and a router. The following steps describe the protocol message exchange.

1 When 1 is started, it reports the connections of 225.5.5.5 and 228.8.8.8 to register them in the group table of the device. After a short time, the device sends the connection of 225.5.5.5 and 228.8.8.8.8.

2 Suppose 2 and 3 start almost at the same time, but the message from 2 appears first. Register new groups with collection addresses of 226.6.6 and 227.7.7.7 and register them in the group table of the device. When the message from 3 arrives, the device will update the existing group registration. After a period of time, the device only sends the connection of 226.6.6 and 227.7.7.7.

3 When 4 boots up and it sends join messages, the device updates only the existing group registrations and does not advertise the reports for join.

4 When 5 boots up and it sends join messages, the device updates only the existing group registrations and does not advertise the reports for join.

5 When the general query timer (QI) expires on a querier all the hosts receive the general query frame and respond with reports of join. The device handles connections received by connected listeners, but filters them by not forwarding control frames. The device also reports the connections of the groups (225.5.5, 226.6.6, 227.7.7.7 and 228.8.8) recorded in the local database.

IGMP Proxy

The IGMP proxy delegates IPv4 multicast group registration, provides global administrative controls, and cooperates with IGMP Snooping.
The following table shows the basic IGMP proxy parameters and their corresponding descriptions.
Table 7 • IGMP Proxy Parameters

Parameters	Note
IGMP Host Proxy	Enable/Disable the global IGMP proxy. The system stops forwarding control messages to upstream directly, but when the IGMP proxy is enabled, it actively sends the group address report instead.
IGMP Leave Proxy	Enable/Disable the IGMP proxy only for group de-registration. This function is only applicable to IGMPv2 that provides the LEAVE message type.

Note:
When global IGMP proxy is enabled, the system does proxy for both group registration and de-registration regardless of the setting for IGMP leave proxy.

MLD Proxy

The MLD proxy delegates IPv6 multicast group registration, provides global administrative controls, and cooperates with MLD Snooping. The following table shows the basic MLD proxy parameters and their corresponding descriptions.
Table 8 • MLD Proxy Parameters

Parameters	Note
MLD Host Proxy	Enable/Disable the global MLD proxy. The system stops forwarding control messages to upstream directly, but when the MLD proxy is enabled, it actively sends the group address report instead.
MLD DONE Proxy	Enable/Disable the MLD proxy only for group de-registration. This function is only applicable to MLDv1 that provides the DONE message type.

Note:
When global MLD proxy is enabled, the system does proxy for both group registration and de-registration regardless of the setting for MLD leave proxy.

Configure IGMP/MLD agent

Set up IPMC Snooping before turning on IGMP/MLD proxy on SWITCH. The following options are available for IGMP/MLD proxy:

- Apply for Leave Proxy proxy of IGMP/MLD leave messages only.
- Host Proxy proxy for various IGMP/MLD control messages.

When the host proxy is selected, the leaving proxy will be overwritten, but it will remain in the configuration even if the leaving agent becomes redundant.
The following is a quick summary of the steps.

1 Determine whether IGMP or MLD proxy is required.
2 If IGMP proxy is expected, set up IGMP snooping first. If MLD proxy is expected, set up MLD snooping first.
3 Select preferred proxy option: host proxy or leave proxy.
4 Enable specific proxy management controls.
5 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default IGMP/MLD proxy settings and their configurable value range.

Table 9 • IGMP/ MLD proxy setting

Configuration	Default Value	Configurable value range
IGMP Host Proxy	Disabled	Enabled or Disabled
IGMP Leave Proxy	Disabled	Enabled or Disabled
MLD Host Proxy	Disabled	Enabled or Disabled
MLD Leave Proxy	Disabled	Enabled or Disabled

IGMP/MLD Proxy Setup Using ICLI

The following table shows the steps used to set up IGMP/MLD proxy using ICLI.

Table 10• Setting up IGMP/MLD Proxy Using ICLI

Steps	Command	Purpose
1	**Configure terminal.** Example **# configure terminal** **(config)#**	Enter Configure Mode
2	**ip igmp host-proxy [leave-proxy]** Example **(config)# ip igmp host-proxy leave-proxy** **(config)#**	(Optional) Enables IGMP host proxy or leave proxy.
3	**ipv6 mld host-proxy [leave-proxy]** Example **(config)# ipv6 mld host-proxy** **(config)#**	(Optional) Enables MLD host proxy or leave proxy.
4	**end** Example **(config)# end** **#**	Return to privileged EXEC mode.
5	**copy running-config startup-config** Example **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file

19.7 IPMC Profile Operation and Configuration

IPMC analyzes the management forwarding mapping used for IP multicast. When the group address does not match any rules in the IPMC configuration file, it will be deleted from the multicast registration. Therefore, it is very important to determine the expected group of registration in advance.

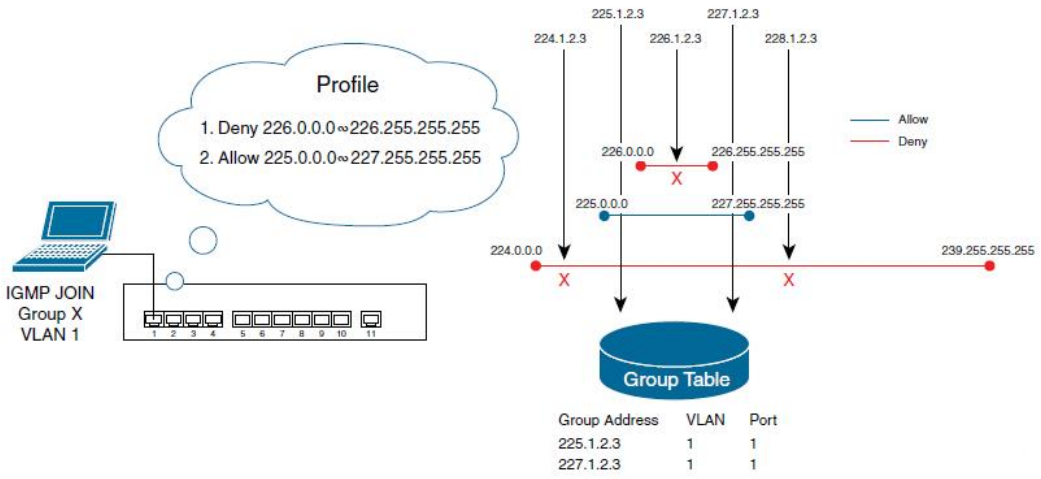
IPMC profile configuration includes profile settings and address ranges. The configuration file contains filtering rules that reference the selected address range. Address ranges that may belong to different profiles provide a set of continuous IP multicast groups for address matching.

To start using IPMC profile, the following conditions have to be met:

- Global IPMC profile management control must be enabled.
- Defines the address range for analysis. An address range can be either IPv4 multicast address or IPv6 multicast address but not a hybrid (IPv4 and IPv6 mixed) multicast address.
- Define rules for a single profile by selecting an existing address range and giving corresponding actions. The smaller the rule index number, the higher the priority of matching. Profiles can perform access control in mixed matching, but will follow the priority order to specify the final filtering results.
- Associate the configuration file with the expected application, IPMC filtering utility, and/or MVR. Overlapping address tolerance depends on the application's design perspective: IPMC filtering utility even allows the same IPMC profile being applied on different ports, but MVR does not allow the different MVR VLANs managing the overlap groups.

When the profile is set and ready to perform filtering, every group registration request (triggered by receiving IPMC control message) starts matching to decide registration result. By checking the rules in the specified configuration file, the first matching result will be the final decision. The following figure shows the IPMC analysis operation for IGMP.

Figure IPMC analysis operation of IGMP



In this example, only group addresses of 225.0.0 to 225.255.255.255 and 227.0.0 to 227.255.255 are allowed for a specific profile. The first rule (index is 1) should deny group address ranges from 226.0.0.0 to 226.255.255.255, and the second rule (index is 2) should permit group address ranges from 225.0.0.0 to 227.255.255.255.

Upon receiving the JOIN message, SWITCH starts matching the input group address with the existing rules, as shown in the following examples.

1 When 224.1.2.3 appears, the two rules do not match, so the group address will not be programmed into the group table.
2 When 225.1.2.3 appears, the first rule does not match, but the second rule does, so the group address is programmed into the group table.
3 When 226.1.2.3 appears, the first rule matches, so the operation stops. The first rule denies registration, so the group address will not be programmed into the group table.
4 When 227.1.2.3 appears, the first rule does not match, but the second rule does. The second rule allows registration, so the group address is programmed into the group table.
5 When 228.1.2.3 appears, the two rules do not match, so the group address is not programmed into the group table.

IPMC profiles provide configurable parameters for managing profiles, profile rules, and address ranges. The following table shows the basic IPMC analysis parameters and their corresponding descriptions.

Table 14• IPMC Profile Parameters

Parameters	Note
Global Profile Mode	Enable/disable the global IPMC profile. Only when global profile mode is enabled will the system start filtering based on profile settings.
Address Range Name	The name of the table used to index address entries, and each entry has a unique name.
Start Address	The starting IPv4/IPv6 Multicast Group Address that will be used as an address range.
End Address	The ending IPv4/IPv6 Multicast Group Address that will be used as an address range.
Profile Name	The name of the index profile table, each entry has a unique name.
Profile Description	Additional instructions about the configuration file.
Rule Entry Name	The name of the address range used to specify the rule. Select only existing address range entries.
Rule Action	Indicates a learning operation when receiving a join/report frame whose group address matches the regular address range. Allowed group addresses that match the range specified in the rule will be learned. Deny group addresses that match the range specified in the rule will be discarded.
Log for Rule	Indicates the logging preference when a join/report frame with a group address matching the address range of the rule is received. Enables recording of information about group addresses that match the range specified in the rule. The corresponding information of the group address that disables the range specified in the matching rule will not be recorded.

Next Rule	Specifies the next rule entry used in the same profile. If the next rule is not specified, the specified rule will be added as the last entry in the configuration file by default. In short, it is used to assign priority order to the rules in the configuration file.

Note:
IPMC configuration file starts to operate passively. It only provides access control when receiving IPMC control messages that depend on monitoring, proxy and MVR management.
If there are no profiles, address ranges and rule entries, the IPMC profile is disabled by default. Create address ranges and profiles, and associate expected ranges with rules used in specific profiles to set up IPMC profiles. When IPMC access control is required, enable the global IPMC profile to start filtering. The following is a quick summary of the steps.

1 Create an address range with the correct entry name.
2 Repeat step 1 for the expected address range management.
3 Create a configuration file with the correct entry name.
4 If necessary, set an additional description for the specified IPMC profile entry.
5 Associates an address range entry with the specified IPMC profile entry as a profile rule.
6 Set action and logging preferences for rules.
7 If necessary, specify the priority of the rules in the specified IPMC profile entry.
8 For profile management, repeat steps 3 to 7.
9 If necessary, set the global IPMC profile management control.
10 If necessary, save the configuration.

Before applying a specific profile, always check the priority of rules in the profile.

Default Setting and Configurable Value Range

The following table shows the default IPMC profile settings and their configurable value ranges.

Table 15•IPMC configuration file settings

Configuration	Default Value	Configurable value range
Global Profile Mode	Disabled	Enabled or Disabled.
Address Range Name	Null string	At maximum 16 printable characters are accepted. The name string must be unique on each system. You can create up to 128 address range entries.
Start Address	Null	A valid IPv4 or IPv6 multicast address. It must be the same version address as the End Address.
End Address	Null	A valid IPv4 or IPv6 multicast address. It must be the same version address as the Start Address.
Profile Name	Null string	At maximum 16 printable characters are accepted. The name string must be unique on each system. You can create up to 64 profile entries.
Profile Description	Null string	At maximum 64 printable characters are

Configuration	Default Value	Configurable value range
		accepted.
Rule Entry Name	Null string	The configured address range in the system.
Rule Action	Deny	Allow or prohibit
Log for Rule	Disabled	Enabled or Disabled
Next Rule	Least priority (Last rule in profile)	Any existing rules in a specific IPMC configuration file.

Setting up IPMC Profile Using ICLI

The following table shows the steps to set up an IPMC configuration file using ICLI.
Table 16• setting IPMC profile using ICLI

Steps	Command	Purpose
1	**Configure terminal.** Example **# configure terminal (config)#**	Enter Configure Mode
2	**ipmc profile** Example **(config)# no ipmc profile** **(config)#**	(Optional) Enables/disables the global IPMC analysis function.
3	**ipmc range range-name start-ip-multicast-address end-ip-multicast-address** Example **(config)# ipmc range Video 227.3.3.3 228.123.123.123** **(config)# ipmc range Data 238.0.0.0 239.255.255.255** **(config)# ipmc range Audio 225.1.1.1 225.222.222.222** **(config)# ipmc range Game 226.0.0.0 226.255.255.255** **(config)#**	Define the expected address range.
4	**ipmc profile profile-name** Example **(config-if)# ipmc profile AN1135** **(config-if)#**	Specify the name of the IPMC profile entry that enables access control, and enter the IPMC profile configuration mode.
5	**description** Example **(config-ipmc-profile)# description Demonstration for Configuration Guides AN1135 (config-ipmc-profile)#**	(Optional) Add additional comments to describe a specific profile.

Steps	Command	Purpose
6	**range range-name {deny | permit} [log] [next range-name]** Example **(config-ipmc-profile)# range Audio permit log (config-ipmc-profile)# range Data permit (config-ipmc-profile)# range Video permit next Data (config-ipmc-profile)#**	Schedule and configure rules for a specific profile.
7	**end** Example **(config-ipmc-profile)# end #**	Return to privileged EXEC mode.
8	**show ipmc profile [profile-name] [detail]** Example **# show ipmc profile IPMC Profile is currently disabled, please enable profile to start filtering. Profile:AN1135 (In IGMP Mode) Description:Demonstration for Configuration Guides AN1135 HEAD-> Audio (Permit the following range and log the matched entry) Start Address:225.1.1.1 End Address:225.222.222.222 NEXT-> Video (Permit the following range) Start Address:227.3.3.3 End Address:228.123.123.123 NEXT-> Data (Permit the following range) Start Address:238.0.0.0 End Address:239.255.255.255 #**	Confirm the configured IPMC profile filter criteria.
9	**copy running-config startup-config** Example **# copy running-config startup-config #**	(Optional) Saves settings in the configuration file.

Notes

Do not use the no command to negate the configured settings. Use the show ipmc profile detail command to display the matching conditions in detail to help understand the filtering results of a specific address.

19.8 IGMP/MLD Utility Operation and Configuration

IPMC provides four additional utilities for static control of "IPMC monitoring".

1 Filter restricted group registrations according to the given analysis access control. Only allowed groups will be registered. For information about configuring access control, see IPMC Profile Operation and Configuration.
2 According to the throttle value, throttle limits the number of registered groups.
3 When the message of leaving the group is received, whether the protocol is confirmed or not, Quick Leave will delete the MAC forwarding entry.
4 A router port statically configures a specific port as an upstream port, which means it is connected to another IPMC router.

The following table shows the basic IPMC utility parameters and their corresponding descriptions.

Table 17• IPMC utility parameters

Parameters	Note
Filtering Profile	Specify the profile to use in filtering group registration.
Throttling Value	Specifies the maximum number of group registrations.
Fast Leave	Delete the MAC forwarding entry immediately after receiving the message of group logout.
Router Port	The specified interface is connected to another IPMC router.

Each utility need to be configured per-port because they are used to enhance IGMP/MLD snooping and IPMC performs Layer2 snooping. The following are some examples of typical use.

- The filtering utility can be used to restrict multicast address forwarding for specific ports.
- The throttling utility can be used to limit the number of multicast address registrations on a specific port to save group table resources.
- The quick leave utility can be used to speed up group cleanup for a better multicast streaming experience.
- The router port utility can be used to manually specify the upstream of the IPMC control plane.

The following is a quick summary of the steps.

1 Define the purpose and investigate the possible results of applying these utilities.
2 First set up the IPMC configuration file to use the filtering utility. For more information, see "IPMC Profile Operation and Configuration".
3 If necessary, associate the IPMC profile that is expected to be filtered with a specific port.

Note:
It is possible to filter from mixed-mode configuration files applied to IGMP or multi-layer listening ports, but not from pure IGMP configuration files applied to multi-layer listening ports, and vice versa.

4 If necessary, assign throttle numbers to limit the number of group registrations on specific ports.
5 If necessary, enable Fast Leave to immediately clear MAC forwarding entries on specific ports.
6 Select the upstream connection (where a multicast router is attached) on a specific port, if required.
7 If necessary, save the configuration.

Default Setting and Configurable Value Range

The following table shows the default IPMC utility settings and their configurable value range.

Table 18• IPMC Utility Settings

Configuration	Default Value	Configurable value range
Filtering Profile	Null	Existing IPMC profile entry.
Throttling Value	Unlimited	Registration number of 1-10 groups
Fast Leave	Disabled	Enabled or Disabled.
Router Port	Disabled	Enabled or Disabled.

IGMP/MLD Utility Setup Using ICLI

The following table shows the steps used to set up IGMP/MLD utilities using ICLI.

Table 19• Setting up IGMP/MLD Utilities Using ICL

Steps	Command	Purpose
1	**configure terminal** Example **# configure terminal (config)#**	Enter Configure Mode
2	**interface interface-id** Example **(config)# interface GigabitEthernet 1/4 (config-if)#**	Specify the interface using the IPMC utility and enter the interface configuration mode.
3	**ip igmp snooping filter <word16>** **ipv6 mld snooping filter <word16>** Example **(config-if)# ip igmp snooping filter AN1135 (config-if)#**	(Optional) Set the filtering function.
4	**ip igmp snooping max-groups <1-10>** **ipv6 mld snooping max-groups <1-10>** Example **(config-if)# ipv6 mld snooping max-groups 3 (config-if)#**	(Optional) Set the throttle function.
5	**ip igmp snooping immediate-leave** **ipv6 mld snooping immediate-leave** Example **(config-if)# ipv6 mld snooping immediate-leave** **(config-if)#**	(Optional) Set the fast leave function.
6	**ip igmp snooping mrouter ipv6 mld snooping mrouter** Example **(config-if)# ip igmp snooping mrouter** **(config-if)# ipv6 mld snooping mrouter** **(config-if)#**	(Optional) Set the router port function

Steps	Command	Purpose
7	**end** Example **(config-if)# end #**	Return to privileged EXEC mode.
8	**copy running-config startup-config** Example **# copy running-config startup-config** **#**	(Optional) Saves settings in the configuration file file.

19.9 IPMC Configuration Instance

Complete the following tasks so that you can start managing IPMC functions.

1 Prepare a computer

Ensure the computer is equipped with a (USB) RS-232 connector and NIC card.

- Install uBuntu LTS version of Linux operating system on this computer. See http://www.ubuntu.com/download/desktop/install-ubuntu-desktop for information on installation steps.
- Add minicom package

```
$ sudo apt-get install minicom
```

- Configure minicom software

```
(Find out the expected group to access the expected serial adapter in the computer. In this case, 'dialout' is the group name and there are at least two serial adapters available:'ttyS0' and ' ttyUSB0'.)

$ ls -alp /dev | grep tty

…

crw-rw----1 root dialout4,64 Nov 13 19:17 ttyS0

…

crw-rw----1 root dialout4,73 Nov 1 15:53 ttyS9 crw-rw----1 root dialout 188, 0 Nov 1 15:53 ttyUSB0

…

(Use command "usermod" to add your Ubuntu user as a member of group 'dialout' if user is not in the specific group. To check whether user belongs to the group 'dialout', use command "id" to identify.)

$ id Switch

uid=2000 gid=1000 groups=1000

$ sudo usermod -a -G dialout Switch

$ id Switch

uid=2000 gid=1000 groups=1000,20(dialout

)
```

```
(Setup USB RS-232 adaptor as minicom's default connection, for
example.)
$ sudo minicom -s
(Select 'Serial port setup' after executing command.)
+-----[configuration]------+
| Filenames and paths|
| File transfer protocols|
| Serial port setup|
| Modem and dialing|
| Screen and keyboard|
| Save setup as dfl|
| Save setup as..|
| Exit|
| Exit from Minicom|
+--------------------------+
(Change the serial port setting as below to meet the serial
configuration.)
+ -------------------------------------------------------
--------+
| A-Serial Device:/dev/ttyUSB0
|
| B -Lockfile Location:/var/lock
|
| C-Callin Program:
|
| D-Callout Program:
|
| E-Bps/Par/Bits:115200 8N1
|
| F -Hardware Flow Control :No
|
| G -Software Flow Control :No
|
|
|
| Change which setting?
|
+ -------------------------------------------------------
--------+
```

```
| Screen and keyboard|
| Save setup as dfl|
| Save setup as..|
| Exit|
| Exit from Minicom|
+--------------------------+


(Select 'Save setup as dfl' after changing serial port setting is
done.)
```

2 Prepare network devices that support IPMC profile/monitor/proxy and MVR.

3 Connect computers and devices with serial cables and network cables, and make sure they are all running.

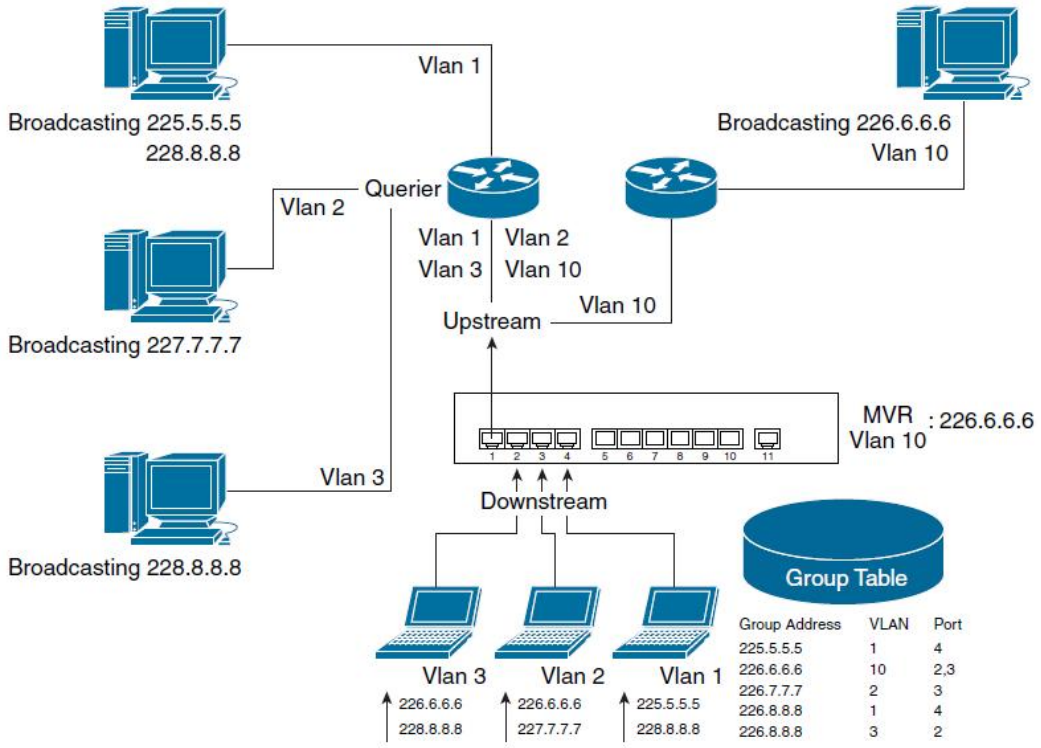
4 Use the minicom application to confirm or set the IP configuration of the device, and then use PING to ensure that the IP communication between the device and the computer is active.
(In this case, the IP address of the computer is '192.0.2.88' while the IP address of the equipment is '192.0.2.1'.)

```
$ ifconfig
eth0Link encap:EthernetHWaddr 00:10:60:76:b4:a5
inet addr:192.0.2.88 Bcast:192.0.2.255Mask:255.255.255.0 inet6
addr:fe80::210:60ff:fe76:b4a5/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500Metric:1
RX packets:793 errors:0 dropped:0 overruns:0 frame:0
TX packets:791 errors:1 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:89148 (89.1 KB) TX bytes:89606 (89.6 KB)
$ minicom
Welcome to minicom 2.7
OPTIONS:I18n
Compiled on Jan 1 2014, 17:13:19. Port /dev/ttyUSB0 Press CTRL-A
Z for help on special keys
Username:admin
Password:
# show interface vlan
VLAN1
LINK:00-22-6f-00-c2-70 Mtu:1500 <UP BROADCAST RUNNING MULTICAST>
IPv4:192.0.2.1/24 192.0.2.255
IPv6:fe80::201:c1ff:fe00:c270/64 <UP RUNNING>
# ping ip 192.0.2.88
PING server 192.0.2.88, 56 bytes of data.
64 bytes from 192.0.2.88:icmp_seq=0, time=10ms
64 bytes from 192.0.2.88:icmp_seq=1, time=0ms
```

```
64 bytes from 192.0.2.88:icmp_seq=2, time=0ms

64 bytes from 192.0.2.88:icmp_seq=3, time=0ms

64 bytes from 192.0.2.88:icmp_seq=4, time=0ms Sent 5 packets,
received 5 OK, 0 bad

#
```

The following topology illustration is used to demonstrate the examples, which assume the device boots up with its default configuration. It also demonstrates the final group registration result after completing the example.

Figure IPMC configuration example topology



Deploy IPMC Configuration Files for Filtering Multimedia Streams

IPMC configuration file is mainly set to provide access control in multicast learning, so as to manage forwarding. Therefore we expect only the address ranges from 225.0.0.0 to 228.255.255.255 will be handled by SWITCH. We will then create an IPMC profile and use this profile for filtering IGMP group registration.

```
# configure terminal

(config)# ipmc range SuperSet 225.0.0.0 228.255.255.255 (config)#
ipmc profile Demonstration

(config-ipmc-profile)# range SuperSet permit log
(config-ipmc-profile)# exit

(config)# ipmc profile

(config)# do show ipmc profile detail

IPMC Profile is now enabled to start filtering.
Profile:Demonstration (In IGMP Mode) Description:
```

```
HEAD-> SuperSet (Permit the following range and log the matched entry) Start Address:225.0.0.0

End Address:228.255.255.255

IGMP will deny matched address between [224.0.0.0 <-> 224.255.255.255] IGMP will permit and log matched address between [225.0.0.0 <-> 228.255.255.255]

IGMP will deny matched address between [229.0.0.0 <-> 239.255.255.255] MLD will deny matched address between [ff00::<-> ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff]

(config)# interface *

(config-if)# ip igmp snooping filter Demonstration

(config-if)# exit

(config)# ip igmp snooping vlan 1 (config)# interface vlan 1
(config-if-vlan)# ip igmp snooping

(config-if-vlan)# exit (config)# ip igmp snooping

(config)# do show ip igmp snooping detail

IGMP Snooping is enabled to start snooping IGMP control plane. Multicast streams destined to unregistered IGMP groups will be flooding.

Switch-1 IGMP Interface Status

IGMP snooping VLAN 1 interface is enabled.

Querier status is ACTIVE (Administrative Control:Join Querier-Election)

Startup Query Interval:25 seconds; Startup Query Count:1

Querier address is not set and will use system's IP address of this int erface. Active IGMP Querier Address is 0.0.0.0

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:10 / URI:1

RX IGMP Query:0 V1Join:0 V2Join:0 V3Join:0 V2Leave:0 TX IGMP Query:0 / (Source) Specific Query:0

IGMP RX Errors:0; Group Registration Count:0

Compatibility:IGMP-Auto / Querier Version:Default / Host Version:Default

Older Version Querier Present Timeout:0 second Older Version Host Present Timeout:0 second (config)# end

#
```

Monitor IPv4 Multicast Registration in Different VLAN

For the convenience of management, it is assumed that the connected hosts are divided into different VLAN. VLAN configuration and IGMP monitoring need to be set at the same time.

```
# configure terminal

(config)# vlan 2

(config-vlan)# exit (config)# vlan 3 (config-vlan)# exit
```

```
(config)# interface GigabitEthernet 1/4 (config-if)# switch mode
access (config-if)# switch access vlan 1

(config-if)# interface GigabitEthernet 1/3 (config-if)# switch
mode access (config-if)# switch access vlan 2

(config-if)# interface GigabitEthernet 1/2 (config-if)# switch
mode access (config-if)# switch access vlan 3

(config-if)# interface GigabitEthernet 1/1 (config-if)# switch
mode trunk (config-if)# switch trunk native vlan 1

(config-if)# swtich trunk allowed vlan 1,2,3 (config-if)# exit

(config)# ip igmp snooping vlan 2 (config)# ip igmp snooping vlan
3 (config)# interface vlan 1-3 (config-if-vlan)# ip igmp snooping
(config-if-vlan)# exit (config)# ip igmp snooping

(config)# do show ip igmp snooping detail

IGMP Snooping is enabled to start snooping IGMP control plane.
Multicast streams destined to unregistered IGMP groups will be
flooding.

Switch-1 IGMP Interface Status

IGMP snooping VLAN 1 interface is enabled.

Querier status is ACTIVE (Administrative Control:Join
Querier-Election

)

Querier Up time:3190 seconds; Query Interval:91 seconds

Querier address is not set and will use system's IP address of this
int erface. Active IGMP Querier Address is 10.9.52.198

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:10 / URI:1

RX IGMP Query:0 V1Join:0 V2Join:0 V3Join:0 V2Leave:0

TX IGMP Query:3 / (Source) Specific Query:0

IGMP RX Errors:0; Group Registration Count:0

Compatibility:IGMP-Auto / Querier Version:Default / Host
Version:Default Older Version Querier Present Timeout:0 second
Older Version Host Present Timeout:0 second IGMP snooping VLAN 2
interface is enabled.

Querier status is ACTIVE (Administrative Control:Join
Querier-Election

)


Startup Query Interval:24 seconds; Startup Query Count:1

Querier address is not set and will use system's IP address of this
int erface. Active IGMP Querier Address is 0.0.0.0

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:10 / URI:1

RX IGMP Query:0 V1Join:0 V2Join:0 V3Join:0 V2Leave:0 TX IGMP Query:1
/ (Source) Specific Query:0

IGMP RX Errors:0; Group Registration Count:0
```

```
Compatibility:IGMP-Auto / Querier Version:Default / Host
Version:Default

Older Version Querier Present Timeout:0 second Older Version Host
Present Timeout:0 second IGMP snooping VLAN 3 interface is enabled.

Querier status is ACTIVE (Administrative Control:Join
Querier-Election

)

Startup Query Interval:24 seconds; Startup Query Count:1

Querier address is not set and will use system's IP address of this
int erface. Active IGMP Querier Address is 0.0.0.0

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:10 / URI:1

RX IGMP Query:0 V1Join:0 V2Join:0 V3Join:0 V2Leave:0 TX IGMP Query:1
/ (Source) Specific Query:0

IGMP RX Errors:0; Group Registration Count:0

Compatibility:IGMP-Auto / Querier Version:Default / Host
Version:Default Older Version Querier Present Timeout:0 second
Older Version Host Present Timeout:0 second (config)# end

#
```

Deploy MVR and IGMP Monitoring at the Same Time

Create another IPMC profile and a new MVR VLAN to deploy an MVR VLAN over the existing network with permitting gaming group in range 226.0.0.0/8 (226.0.0.0 ~ 226.255.255.255). In this example, the MVR VLAN ID is set to 10, and this MVR VLAN only forwards multicast streams in the channel to users.

```
# configure terminal

(config)# ipmc range Game 226.0.0.0 226.255.255.255 (config)# ipmc
profile Game (config-ipmc-profile)# range Game permit log

(config-ipmc-profile)# exit

(config)# ipmc profile

(config)# do show ipmc profile detail


IPMC Profile is now enabled to start filtering. Profile:AN1135 (In
IGMP Mode) Description:Demonstration for Configuration Guides
AN1135

HEAD-> Audio (Permit the following range and log the matched entry)
Start Address:225.1.1.1

End Address :225.222.222.222

NEXT-> Video (Permit the following range) Start Address:227.3.3.3
End Address :228.123.123.123

NEXT-> Data (Permit the following range) Start Address:238.0.0.0
End Address :239.255.255.255

IGMP will deny matched address between [224.0.0.0 <-> 225.1.1.0]

IGMP will permit and log matched address between [225.1.1.1 <->
225.222.222.222]
```

```
IGMP will deny matched address between [225.222.222.223 <->
227.3.3.2] IGMP will permit matched address between [227.3.3.3 <->
228.123.123.123

]

IGMP will deny matched address between [228.123.123.124 <->
237.255.255.255]

IGMP will permit matched address between [238.0.0.0 <->
239.255.255.255

]

MLD will deny matched address between [ff00::<->
ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff]

Profile:Demonstration (In IGMP Mode) Description:

HEAD-> SuperSet (Permit the following range and log the matched
entry) Start Address:225.0.0.0

End Address :228.255.255.255

IGMP will deny matched address between [224.0.0.0 <->
224.255.255.255] IGMP will permit and log matched address between
[225.0.0.0 <-> 228.255.255.255]

IGMP will deny matched address between [229.0.0.0 <->
239.255.255.255] MLD will deny matched address between [ff00::<->
ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff]

Profile:Game (In IGMP Mode) Description:

HEAD-> Game (Permit the following range and log the matched entry)
Start Address:226.0.0.0

End Address :226.255.255.255

IGMP will deny matched address between [224.0.0.0 <->
225.255.255.255] IGMP will permit and log matched address between
[226.0.0.0 <-> 226.255.255.255]

IGMP will deny matched address between [227.0.0.0 <->
239.255.255.255] MLD will deny matched address between [ff00::<->
ffff:ffff:ffff:ffff:ffff:ffff:ffff:ffff]

(config)# mvr vlan 10 name Game (config)# mvr name Game channel
Game (config)# mvr

(config)# do show mvr detail

MVR is now enabled to start group registration. Switch-1 MVR-IGMP
Interface Status

IGMP MVR VLAN 10 (Name is Game) interface is enabled. Querier status
is IDLE ( Forced Non-Querier )

Querier Expiry Time:255 seconds

IGMP address is not set and will use system's IP address of this
interf ace. Control frames will be sent as Tagged

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:5 / URI:1

RX IGMP Query:0 V1Join:0 V2Join:0 V3Join:0 V2Leave:0 TX IGMP Query:0
/ (Source) Specific Query:0

IGMP RX Errors:0; Group Registration Count:0 Port Role Setting:
```

```
Inactive Port:Gi 1/1,Gi 1/2,Gi 1/3,Gi 1/4,Gi 1/5,Gi 1/6,Gi 1/7,Gi
1/8, Gi 1/9,2.5G 1/1,2.5G 1/2

Interface Channel Profile:Game (In IGMP Mode) Description:

HEAD-> Game (Permit the following range and log the matched entry)
Start Address:226.0.0.0

End Address:226.255.255.255 Switch-1 MVR-MLD Interface Status

MLD MVR VLAN 10 (Name is Game) interface is enabled. Querier status
is IDLE ( Forced Non-Querier )

Querier Expiry Time:255 seconds

MLD address will use Link-Local address of this interface. Control
frames will be sent as Tagged

PRI:0 / RV:2 / QI:125 / QRI:100 / LMQI:5 / URI:1

RX MLD Query:0 V1Report:0 V2Report:0 V1Done:0 TX MLD Query:0 /
(Source) Specific Query:0 MLD RX Errors:0; Group Registration
Count:0 Port Role Setting:

Inactive Port:Gi 1/1,Gi 1/2,Gi 1/3,Gi 1/4,Gi 1/5,Gi 1/6,Gi 1/7,Gi
1/8, Gi 1/9,2.5G 1/1,2.5G 1/2

Interface Channel Profile:Game (In IGMP Mode) Description:

HEAD-> Game (Permit the following range and log the matched entry)
Start Address:226.0.0.0

End Address:226.255.255.255 (config)# end

#
```

Notes

In this topology, group addresses sent to addresses outside the superset will be flooded. Data sent from VLAN 1 to 225.5.5.5 will be forwarded to port 4. Data destined to 226.6.6.6 from VLAN 10 will be forwarded to port 2 & 3. Data destined for VLAN 2 will be forwarded to port 3. Data destined to 228.8.8.8 from VLAN 1 will be forwarded to port 4. Data destined to 228.8.8.8 from VLAN 3 will be forwarded to port 2.

20 HTTPS Setting

This document demonstrates how to set up HTTPS for secure communication between an http client (usually a Web browser) and an HTTP server using the ICLI command.
Using ICLI as the management interface requires a serial console connection between the device and management platform. No network connection is required to use ICLI, but terminal emulator software must be installed.
The HTTPS functionality is meant for secure communication between a browser (management console) and a web server (switch). The included self-signed certificate may trigger a browser warning that the certificate is not issued by a trusted source. The certificate upload mechanism in the switch software enables use of a trusted third-party certificate.

20.1 Understanding HTTPS

HTTPS (Hypertext Transfer Protocol Secure) is a method for securing HTTP data transfer over a TCP/IP network. It adds the security capabilities of SSL/TLS to standard HTTP communications between an HTTP client (usually a web browser) and an HTTP server (usually a web server). The main motivation for HTTPS is to prevent man-in-the-middle attacks or eavesdropping.

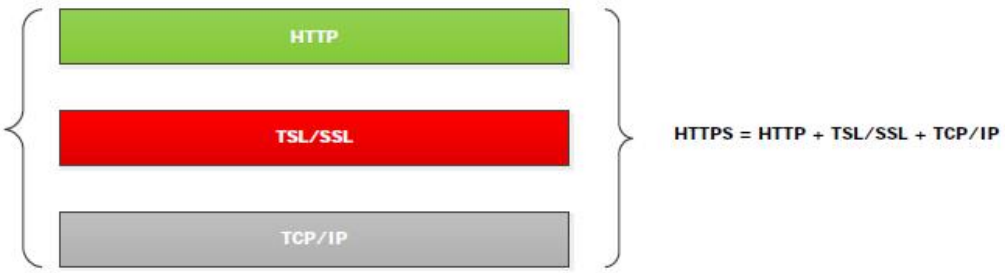
Restrictions for HTTPS

Per HTTP communication models, the host (web server) addresses and port numbers are necessarily part of the underlying TCP/IP protocols. HTTPS cannot protect their disclosure but encrypts the content of the HTTP data (payload)- that means an eavesdropper can infer the IP address, domain name, and port number of the web server but not the content of the applications.

HTTPS Working Model

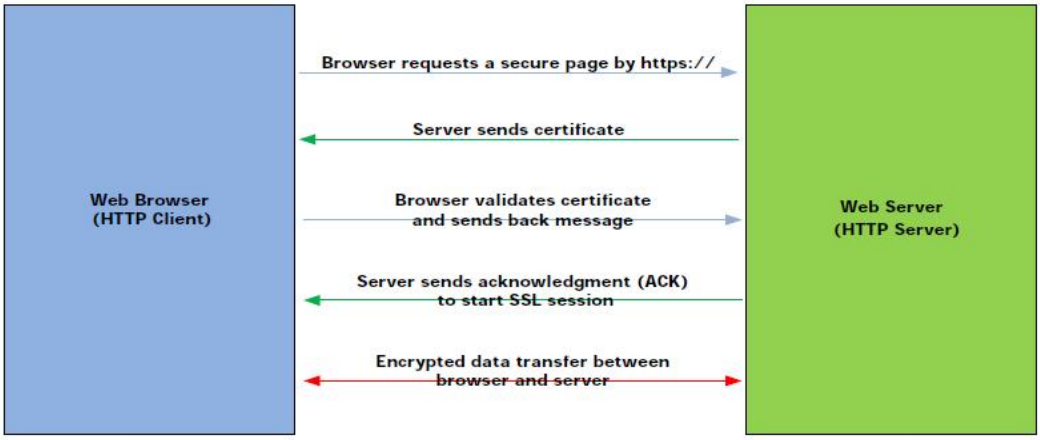
- Protocol layering: HTTPS is a mechanism to layer HTTP on top of SSL/TLS and to add securities capabilities to HTTP application.

Figure 1 • Protocol Layering



- Authentication: The web browser requires a server certificate from the web server before an SSL/TLS connection is established. An SSL/TSL connection is required before HTTPS data transfer can commence.
- Encryption: Once an SSL connection is established, data transfer is encrypted with a public key provided by a security certificate.

Figure 2 • Encryption



20.2 Configuration Prerequisites

This section lists the prerequisites for configuring and/or monitoring operations on devices using the management platform.

- Computer with (USB) RS-232 connector and NIC card
- Terminal emulator software that supports the serial port
- Serial port parameters, as follows:
  - Baud rate 115200
  - Data bit: 8 bits
  - Stop bit: 1 bit
  - Flow control: deny
  - parity check: no

20.3 Configuring HTTPS

HTTPS is enabled by default in SWITCH. A web browser can access a switch at https://ip-address-of-switch/. This section provides guidelines for changing the switch startup configuration using the default settings.

If you want to configure HTTPS using ICLI, please connect the serial RS-232 cable to the switch when running the terminal console software on the host.

HTTPS Default Setting and Configurable Value Range

The following table provides details of the default settings and configurable value ranges for HTTPS.

Table 1• Default Settings and Configurable Value Range of HTTPS

Configuration	Default Value	Configurable value
Mode	Enable	Enabled, disabled
Automatic Redirect	Disabled	Enabled, disabled
Certificate Maintain	None	None, Delete, Upload, Generate
Certificate Algorithm	RSA	RSA
PassPhrase	None	Serial Mode
Certificate Upload	Browser	Browser, URL
Certificate Status	N/A	Not configurable

HTTPS Setup using ICLI

As mentioned above, setting up HTTPS is a multi-step process.

Enable HTTPS

```
! Enters global configuration mode
!  configure terminal
! Enables the HTTPS
(config)# ip http secure-server
HTTPS mode is enabled and the browser can request a secure data
via https://
```

Automatically redirect the Web browser to HTTPS mode

```
Enters global configuration mode
# configure terminal
Enables automatic redirect
(config)# ip http secure-redirect
HTTPS automatic redirect is enabled
```

Maintenance certificate

```
Disable HTTPS
(config)# no ip http secure-server
Delete HTTPS certificate
(config)# ip http secure-certificate delete
HTTPS certificate is now deleted
```

Generate a new certificate to replace the current certificate

```
Disable HTTPS
(config)# no ip http secure-server
```

```
Generate HTTPS certificate with RSA or DSA
To generate certificate with RSA algorithm:
(config)# ip http secure-certificate generate RSA
or
To generate certificate with DSA algorithm.
(config)# ip http secure-certificate generate DSA
HTTPS certificate is now generated
```

Upload a third-party certificate externally to replace the current certificate

```
Disable HTTPS
(config)# no ip http secure-server
Upload certificate from tftp or http servers, below is an example
for uploading a named 3rd-party certificate,
https_server_certificate.pem from tftp server whose IP address is
10.0.0.123
(config)# ip http secre-certificate upload \
tftp://10.0.0.123/https_server_certificate.pem
 HTTPS certificate is now uploaded
```

Notes

Turn off the HTTPS protocol before uploading, generating or deleting certificates. Enable HTTPS after the process is completed.

21 Appendix One: Safety Reinforcement Configuration

21.1 Storm Suppression

Risk Statement

The switch receives all data frames on the network segment, learns according to the source MAC addresses in the data frames, builds a MAC address table, and stores the corresponding relationship between MAC addresses and ports. For the received data frames, if the switch can find the destination MAC address in the MAC address table, it will forward the frames at Layer 2 based on the destination MAC address, thus isolating the collision. If the destination address is not in the MAC address table, the switch will send broadcast to all ports except the receiving port, which may lead to broadcast storm in the network.

Solution

In most scenarios of Layer 2 networks, unicast traffic should be much larger than broadcast traffic, which is also a prerequisite for using switches for networking. However, if broadcast traffic is not restricted, when broadcast traffic exists in large quantities, it will consume a lot of network bandwidth, resulting in the decline of network performance and even communication interruption. If the broadcast traffic generated is restricted in the switch, it can still ensure that the device can leave a part of bandwidth for ordinary unicast forwarding when the broadcast traffic surges.

Configuration Instance

Set the suppression value of broadcast, multicast and unknown unicast to 16kfps.

```
(config)# qos storm broadcast fps 16
(config)# qos storm multicast fps 16
(config)# qos storm unicast fps 16
```

Save configuration

```
(config)# exit
# copy running-config startup-config
```

21.2 Rate Limit of Reported CPU Message

Risk Statement

In the network, there will be a large number of messages that need to be sent to the CPU for processing, some of which are malicious attack messages against the CPU; When the network loop causes broadcast storm, some layer 2 protocol messages form storm in the network, and these protocol messages need to be reported to CPU for processing. Too many messages are reported to CPU, which will lead to high CPU occupancy rate, performance degradation and affect normal services. Malicious attack messages against CPU (frequently sending messages) will lead to CPU overload, which will affect the normal operation of other services and even lead to system interruption.

Solution

Filter the reported messages and limit its rate to avoid CPU overload. Discard the messages that do not conform to the rules, and limit the speed of protocol messages that conform to the rules on the CPU interface (such as port speed limit and speed limit of queue level). At the same time, ACL can be used to finely control some special protocol flows, thus ensuring the CPU's processing of normal services.

Configuration Instance

The corresponding rate and flow control has been configured by default on the CPU interface and its 8 queues by reported CPU messages, and no manual configuration is required; For encryption and decryption protocol messages (HTTPS, SSH, etc.) that require CPU to perform extra high-burden calculation, traffic control can be performed through ACL.

Configure the rate of rate-limiter 1 to 500pps.

```
(config)# access-list rate-limiter 1 pps 500
```

ace1 limits the https message rate to 500pps.

```
(config)# access-list ace 1 frame-type ipv4-tcp dip
192.168.1.254/32 dport 443 rate-limiter 1
```

Save configuration

```
(config)# exit

# copy running-config startup-config
```

21.3 Isolate the Management Plane From the User Plane

Risk Statement

In order to improve compatibility and management convenience, the user plane and management plane of the switch are not isolated by default. Users can log in and manage devices through the service interface, which objectively increases the

possibility of being attacked, and attackers can easily try to attack the management plane through the service interface.

Solution

Users can isolate the user plane and the management plane by configuring ACL to protect the management plane from external attacks.

Configuration Instance

Isolation between in-band management and user plane can be realized by ACL configuration:

- For in-band management VLAN: only management data (HTTPS, SSH, SNMP) are allowed to access by configuring ACL entries, while other data are denied access.
- For the user plane VLAN: configure ACL entries to deny the user VLAN access to the management data of the device (HTTPS, SSH, SNMP).

for example: The management plane is VLAN 1, the device management IP is 192.168.1.254, and the user plane is VLAN 2.

- Complete the following configurations in order: configure VLAN 1 to access devices via HTTPS
- Configure VLAN 1 to access devices via SSH
- Configure VLAN 1 to access devices via SNMP.
- Configure other data of VLAN 1 not to access devices.
- Configure VLAN 2 not to access devices via HTTPS.
- Configure VLAN 2 not to access devices via SSH.
- Configure VLAN 2 not to access devices via SNMP.
- Save configuration

```
(config)# access-list rate-limiter 1 100kbps 5

(config)# access-list ace 1 next 2 vid 1 frame-type ipv4-tcp dport
443

(config)# access-list ace 2 next 3 vid 1 frame-type ipv4-tcp dport
22

(config)# access-list ace 3 next 4 vid 1 frame-type ipv4-udp dport
161

(config)# access-list ace 4 next 5 vid 1 action deny

(config)# access-list ace 5 next 6 vid 2 frame-type ipv4-tcp dip
192.168.1.254/32 dport 443 action deny

(config)# access-list ace 6 next 7 vid 2 frame-type ipv4-tcp dip
192.168.1.254/32 dport 22 action deny

(config)# access-list ace 7 vid 2 frame-type ipv4-udp dip
192.168.1.254/32 dport 161 action deny

(config)# exit

# copy running-config startup-config
```


Notice

According to ACL priority, the location of entry that deny access by VLAN1 should be arranged after the entires of HTTPS, SSH and SNMP that allow access by VLAN1.

21.4 SNMP

Risk Statement

The management protocols of plaintext transmission, such as SNMPv1 and SNMPv2, have the risk of information leakage in use.

Solution

Use the secure encryption management protocol SNMPv3.

Security Configuration

SNMP is a protocol used for network device management. Only SNMP v3 version is currently supported. SNMPv3 supports the security mechanism of USM (User-based Security Model). By authenticating and encrypting the communication data, SNMP v3 can prevent messages from being disguised, tampered and leaked. For security reasons, it is recommended to configure authenticated and encrypted v3 users and use v3 authentication encryption to manage switches. The access right of users are restricted by associating ACL and MIB views with users.

Notes

The length of the authentication password and privacy password string must be greater than or equal to 8 and be composed of two or more of uppercase letters, lowercase letters, numbers and special characters.

Configuration Instance

Step 1 Create V3 user user1; Set the authentication mode to MD5 and the authentication password to admin123; Set the encryption mode to AES and the privacy password to admin345

```
mydevice(config)# snmp user user2 engine-id 800007e5017f000003 md5
priv aes


Auth Password Set
    Please enter the new Password:
    Enter the Password again:


Private Password Set
    Please enter the new Password:
    Enter the Password again:
The MD5 and AES protocol has security risks. Please use it caution.
```

Step 2 Create V3 user group, as shown in the following figure.

```
(config)# snmp  security-to-group model v3 name user1 group group1
```

Step 3 Create the view node view1.

```
(config)# snmp view  view1 .1.3.6.1 include
```

Step 4 Configure V3 user group access view, as shown in the following figure.

```
(config)# snmp access group1 model v3 level priv read view1 write
view1
```

Step 5 Save configuration

```
(config)# end
# copy running-config startup-config
Building configuration...
% Saving 5615 bytes to flash:startup-config
```

Step 6 End.

21.5 Login to Switch via WEB Network Management

Risk Statement

As a management protocol for plaintext transmission, HTTP has the risk of information leakage when users use this protocol.

Solution

Use the secure encryption management protocol HTTPS.

Security Configuration

Device provides secure transmission services to prevent the transmitted data from being intercepted. Due to the security risk of HTTP, this device does not support logging in to the WEB network management through HTTP. A switch only supports logging in to the Web management via secure HTTP (that is HTTPS), but does not support logging in to the Web management via HTTP. The HTTPS server receives login connection requests from all interfaces by default, which poses security risks. It is recommended to use access management to restrict access to customers. After successfully specifying the access IP of HTTPS server, only the specified IP address is allowed to log in to the device, and the access of other addresses will be rejected.

Configuration Instance: Access Control Configuration

According to the access control configuration, the IP address of the client accessing the device is restricted to 192.168.1.100-192.168.1.110, and the client can access the device through HTTPS, SNMP, SSH, etc.

```
(config)# access management 1 1 192.168.1.100 to 192.168.1.110 all
(config)# end
# copy running-config startup-config
Building configuration...
% Saving 5615 bytes to flash:startup-config
```

Configuration Instance: Enable HTTPS

Enable HTTPS with the following command.

```
(config)# ip http secure-server
```

Save configuration with the following command.

```
(config)# exit
```

```
# copy running-config startup-config
Building configuration...
% Saving 5376 bytes to flash:startup-config
```