HP 5500 EI & 5500 SI Switch Series

ACL and QoS

Configuration Guide

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Contents

Configuring ACLs

- Unless otherwise stated, ACLs refer to both IPv4 and IPv6 ACLs throughout this document.
- The term "interface" in the routing features refers to VLAN interfaces, bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports. You can set an Ethernet port to operate in route mode by using the **port link-mode route** command (see *Layer 2—LAN Switching Configuration Guide*). HP 5500 SI Switch Series does not support Layer 3 Ethernet ports.

Overview

An access control list (ACL) is a set of rules (or permit or deny statements) for identifying traffic based on criteria such as source IP address, destination IP address, and port number.

ACLs are primarily used for packet filtering. A packet filter drops packets that match a deny rule and permits packets that match a permit rule. ACLs are also used by many modules, QoS and IP routing for example, for traffic classification and identification.

Applications on the switch

An ACL is implemented in hardware or software, depending on the module that uses it. If the module, the packet filter or QoS module for example, is implemented in hardware, the ACL is applied to hardware to process traffic. If the module, the routing or user interface access control module (Telnet, SNMP, or web) for example, is implemented in software, the ACL is applied to software to process traffic.

The user interface access control module denies packets that do not match any ACL. Some modules, QoS for example, ignore the permit or deny action in ACL rules and do not base their drop or forwarding decisions on the action set in ACL rules. See the specified module for information about ACL application.

ACL categories

Category	ACL number	IP version	Match criteria
Basic ACLs	2000 to 2999	IPv4	Source IPv4 address
		IPv6	Source IPv6 address
Advanced ACLs	3000 to 3999	IPv4	Source IPv4 address, destination IPv4 address, packet priority, protocols over IPv4, and other Layer 3 and Layer 4 header fields
		IPv6	Source IPv6 address, destination IPv6 address, packet priority, protocols over IPv6, and other Layer 3 and Layer 4 header fields
Ethernet frame header ACLs	4000 to 4999	IPv4 and IPv6	Layer 2 header fields, such as source and destination MAC addresses, 802.1p priority, and link layer protocol type

Numbering and naming ACLs

Each ACL category has a unique range of ACL numbers. When creating an ACL, you must assign it a number. In addition, you can assign the ACL a name for ease of identification. After creating an ACL with a name, you cannot rename it or delete its name.

For an Ethernet frame header ACL, the ACL number and name must be globally unique. For an IPv4 basic or advanced ACLs, its ACL number and name must be unique among all IPv4 ACLs, and for an IPv6 basic or advanced ACL, its ACL number and name must be unique among all IPv6 ACLs. You can assign an IPv4 ACL and an IPv6 ACL the same number and name.

Match order

The rules in an ACL are sorted in a specific order. When a packet matches a rule, the device stops the match process and performs the action defined in the rule. If an ACL contains overlapping or conflicting rules, the matching result and action to take depend on the rule order.

The following ACL match orders are available:

- **config**—Sorts ACL rules in ascending order of rule ID. A rule with a lower ID is matched before a rule with a higher ID. If you use this approach, carefully check the rules and their order.
- **auto**—Sorts ACL rules in depth-first order. Depth-first ordering guarantees that any subset of a rule is always matched before the rule. Table 1 lists the sequence of tie breakers that depth-first ordering uses to sort rules for each type of ACL.

Table 1 Sort ACL rules in depth-first order

ACL category	Sequence of tie breakers
IPv4 basic ACL	1. VPN instance 2. More 0s in the source IP address wildcard (more 0s means a narrower IP address range) 3. Rule configured earlier
IPv4 advanced ACL	1. VPN instance 2. Specific protocol type rather than IP (IP represents any protocol over IP) 3. More 0s in the source IP address wildcard mask 4. More 0s in the destination IP address wildcard 5. Narrower TCP/UDP service port number range 6. Rule configured earlier
IPv6 basic ACL	1. VPN instance 2. Longer prefix for the source IP address (a longer prefix means a narrower IP address range) 3. Rule configured earlier
IPv6 advanced ACL	1. VPN instance 2. Specific protocol type rather than IP (IP represents any protocol over IPv6) 3. Longer prefix for the source IPv6 address 4. Longer prefix for the destination IPv6 address 5. Narrower TCP/UDP service port number range 6. Rule configured earlier

ACL category	Sequence of tie breakers
Ethernet frame header ACL	1. More 1s in the source MAC address mask (more 1s means a smaller MAC address) 2. More 1s in the destination MAC address mask 3. Rule configured earlier

A wildcard mask, also called an inverse mask, is a 32-bit binary and represented in dotted decimal notation. In contrast to a network mask, the 0 bits in a wildcard mask represent "do care" bits, and the 1 bits represent "don't care" bits. If the "do care" bits in an IP address are identical to the "do care" bits in an IP address criterion, the IP address matches the criterion. All "don't care" bits are ignored. The 0s and 1s in a wildcard mask can be noncontiguous. For example, 0.255.0.255 is a valid wildcard mask

NOTE:

Only HP 5500 EI Switch Series supports VPN instance configuration in an ACL rule. .

ACL rule comments and rule range remarks

You can add a comment about an ACL rule to make it easy to understand. The rule comment appears below the rule statement.

You can also add a rule range remark to indicate the start or end of a range of rules created for the same purpose. A rule range remark always appears above the specified ACL rule. If the specified rule has not been created yet, the position of the comment in the ACL is as follows:

- If the match order is config, the remark is inserted into the ACL in descending order of rule ID.
- If the match order is auto, the remark is placed at the end of the ACL. After you create the rule, the remark appears above the rule.

For more information about how to use rule range remarks, see the **rule remark** command in *ACL and QoS Command Reference* for your device.

ACL rule numbering

What is the ACL rule numbering step

If you do not assign an ID to the rule you are creating, the system automatically assigns it a rule ID. The rule numbering step sets the increment by which the system automatically numbers rules. For example, the default ACL rule numbering step is 5. If you do not assign IDs to rules you are creating, they are automatically numbered 0, 5, 10, 15, and so on. The wider the numbering step, the more rules you can insert between two rules.

By introducing a gap between rules rather than contiguously numbering rules, you have the flexibility of inserting rules in an ACL. This feature is important for a config order ACL, where ACL rules are matched in ascending order of rule ID.

Automatic rule numbering and renumbering

The ID automatically assigned to an ACL rule takes the nearest higher multiple of the numbering step to the current highest rule ID, starting with 0.

For example, if the numbering step is 5 (the default), and there are five ACL rules numbered 0, 5, 9, 10, and 12, the newly defined rule is numbered 15. If the ACL does not contain any rule, the first rule is numbered 0.

Whenever the step changes, the rules are renumbered, starting from 0. For example, if there are five rules numbered 5, 10, 13, 15, and 20, changing the step from 5 to 2 causes the rules to be renumbered 0, 2, 4, 6, and 8.

Fragments filtering with ACLs

Traditional packet filtering matches only first fragments of packets, and allows all subsequent non-first fragments to pass through. Attackers can fabricate non-first fragments to attack networks.

To avoid the risks, the H3C ACL implementation:

- Filters all fragments by default, including non-first fragments.
- Allows for matching criteria modification, for example, filters non-first fragments only.

ACL configuration task list

Task	Remarks
Configuring a time range	Optional Applicable to IPv4 and IPv6 ACLs.
Configuring a basic ACL	Required Configure at least one task. Applicable to IPv4 and IPv6 except that simple ACLs are for IPv6.
Configuring an advanced ACL	
Configuring an Ethernet frame header ACL	
Copying an ACL	Optional Applicable to IPv4 and IPv6.
Configuring packet filtering with ACLs	Optional Applicable to IPv4 and IPv6.

Configuring a time range

You can implement ACL rules based on the time of day by applying a time range to them. A time-based ACL rule only takes effect in any time periods specified by the time range.

The following basic types of time range are available:

- **Periodic time range**—Recurs periodically on a day or days of the week.
- **Absolute time range**—Represents only a period of time and does not recur.

You can create a maximum of 256 time ranges, each with a maximum of 32 periodic statements and 12 absolute statements. The active period of a time range is calculated as follows:

1. Combining all periodic statements.
2. Combining all absolute statements.
3. Taking the intersection of the two statement sets as the active period of the time range.

To configure a time range:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A

Step		Command	Remarks
2.	Configure a time range.	**time-range** *time-range-name* { *start-time* **to** *end-time* *days* [**from** *time1* *date1*] [**to** *time2* *date2*] | **from** *time1* *date1* [**to** *time2* *date2*] | **to** *time2* *date2* }	By default, no time range exists. Repeat this command with the same time range name to create multiple statements for a time range.

Configuring a basic ACL

Configuring an IPv4 basic ACL

IPv4 basic ACLs match packets based only on source IP addresses.

To configure an IPv4 basic ACL:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Create an IPv4 basic ACL and enter its view.	**acl number** *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]	By default, no ACL exists. IPv4 basic ACLs are numbered in the range of 2000 to 2999. You can use the **acl name** *acl-name* command to enter the view of a named IPv4 ACL.
3.	Configure a description for the IPv4 basic ACL.	**description** *text*	Optional. By default, an IPv4 basic ACL has no ACL description.
4.	Set the rule numbering step.	**step** *step-value*	Optional. The default setting is 5.
5.	Create or edit a rule.	**rule** [*rule-id*] { **deny** | **permit** } [**counting** | **fragment** | **logging** | **source** { *sour-addr* *sour-wildcard* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *	By default, an IPv4 basic ACL does not contain any rule. The **vpn-instance** *vpn-instanced-name* option is not available on an HP 5500 SI switch. If the ACL is for QoS traffic classification or packet filtering, do not specify the **vpn-instance** keyword. This keyword can cause ACL application failure. The **logging** and **counting** keywords (even if specified) do not take effect for QoS policies.
6.	Add or edit a rule comment.	**rule** *rule-id* **comment** *text*	Optional. By default, no rule comments are configured.
7.	Add or edit a rule range remark.	**rule** [*rule-id*] **remark** *text*	Optional. By default, no rule range remarks are configured.
8.	Enable counting ACL rule matches performed in hardware.	**hardware-count enable**	Optional. Disabled by default. When the ACL is referenced by a QoS policy, this command does not take effect.

Configuring an IPv6 basic ACL

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Create an IPv6 basic ACL view and enter its view.	**acl ipv6 number** *acl6-number* [**name** *acl6-name*] [**match-order** { **auto** | **config** }]	By default, no ACL exists. IPv6 basic ACLs are numbered in the range of 2000 to 2999. You can use the **acl ipv6 name** *acl6-name* command to enter the view of a named IPv6 ACL.
3.	Configure a description for the IPv6 basic ACL.	**description** *text*	Optional. By default, an IPv6 basic ACL has no ACL description.
4.	Set the rule numbering step.	**step** *step-value*	Optional. The default setting is 5.
5.	Create or edit a rule.	**rule** [*rule-id*] { **deny** | **permit** } [**counting** | **fragment** | **logging** | **routing** [**type** *routing-type*] | **source** { *ipv6-address prefix-length* | *ipv6-address/prefix-length* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *	By default, an IPv6 basic ACL does not contain any rule. The **vpn-instance** *vpn-instance-name* option is not available on an HP 5500 SI switch. If the ACL is for QoS traffic classification or packet filtering, do not specify the **fragment**, **routing**, and **vpn-instance** keywords. The keywords can cause ACL application failure. The **logging** and **counting** keywords (even if specified) do not take effect for QoS.
6.	Add or edit a rule comment.	**rule** *rule-id* **comment** *text*	Optional. By default, no rule comments are configured.
7.	Add or edit a rule range remark.	**rule** [*rule-id*] **remark** *text*	Optional. By default, no rule range remarks are configured.
8.	Enable counting ACL rule matches performed in hardware.	**hardware-count enable**	Optional. Disabled by default. When the ACL is referenced by a QoS policy, this command does not take effect.

Configuring an advanced ACL

Configuring an IPv4 advanced ACL

IPv4 advanced ACLs match packets based on source IP addresses, destination IP addresses, packet priorities, protocols over IP, and other protocol header information, such as TCP/UDP source and destination port numbers, TCP flags, ICMP message types, and ICMP message codes.

Compared to IPv4 basic ACLs, IPv4 advanced ACLs allow more flexible and accurate filtering.

To configure an IPv4 advanced ACL:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Create an IPv4 advanced ACL and enter its view.	**acl number** *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]	By default, no ACL exists. IPv4 advanced ACLs are numbered in the range of 3000 to 3999. You can use the **acl name** *acl-name* command to enter the view of a named IPv4 ACL.
3.	Configure a description for the IPv4 advanced ACL.	**description** *text*	Optional. By default, an IPv4 advanced ACL has no ACL description.
4.	Set the rule numbering step.	**step** *step-value*	Optional. The default setting is 5.
5.	Create or edit a rule.	**rule** [*rule-id*] { **deny** | **permit** } *protocol* [{ { **ack** *ack-value* | **fin** *fin-value* | **psh** *psh-value* | **rst** *rst-value* | **syn** *syn-value* | **urg** *urg-value* } * | **established** } | **counting** | **destination** { *dest-addr dest-wildcard* | **any** } | **destination-port** *operator port1* [*port2*] | **dscp** *dscp* | **fragment** | **icmp-type** { *icmp-type* [*icmp-code*] | *icmp-message* } | **logging** | **precedence** *precedence* | **source** { *sour-addr sour-wildcard* | **any** } | **source-port** *operator port1* [*port2*] | **time-range** *time-range-name* | **tos** *tos* | **vpn-instance** *vpn-instance-name*] *	By default, an IPv4 advanced ACL does not contain any rule. The **vpn-instance** *vpn-instance-name* option is not available on an HP 5500 SI switch. If an IPv4 advanced ACL is for QoS traffic classification or packet filtering: • Do not specify the **vpn-instance** keyword. • Do not specify **neq** for the *operator* argument. • The **logging** and **counting** keywords (even if specified) do not take effect for QoS traffic classification.
6.	Add or edit a rule comment.	**rule** *rule-id* **comment** *text*	Optional. By default, no rule comments are configured.
7.	Add or edit a rule range remark.	**rule** [*rule-id*] **remark** *text*	Optional. By default, no rule range remarks are configured.
8.	Enable counting ACL rule matches performed in hardware.	**hardware-count enable**	Optional. Disabled by default. When the ACL is referenced by a QoS policy, this command does not take effect.

Configuring an IPv6 advanced ACL

IPv6 advanced ACLs match packets based on the source IPv6 addresses, destination IPv6 addresses, packet priorities, protocols carried over IPv6, and other protocol header fields such as the TCP/UDP source port number, TCP/UDP destination port number, ICMPv6 message type, and ICMPv6 message code.

Compared to IPv6 basic ACLs, IPv6 advanced ACLs allow more flexible and accurate filtering.

Configuration restrictions and guidelines

When the *protocol* argument takes 43, 44, 51, or 60, the ACL cannot function on for the outbound QoS application.

Configuration procedure

To configure an IPv6 advanced ACL:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create an IPv6 advanced ACL and enter its view.	**acl ipv6 number** *acl6-number* [**name** *acl6-name*] [**match-order** { **auto** | **config** }]	By default, no ACL exists. IPv6 advanced ACLs are numbered in the range of 3000 to 3999. You can use the **acl ipv6 name** *acl6-name* command to enter the view of a named IPv6 ACL.
3. Configure a description for the IPv6 advanced ACL.	**description** *text*	Optional. By default, an IPv6 advanced ACL has no ACL description.
4. Set the rule numbering step.	**step** *step-value*	Optional. 5 by default.
5. Create or edit a rule.	**rule** [*rule-id*] { **deny** | **permit** } *protocol* [{ { **ack** *ack-value* | **fin** *fin-value* | **psh** *psh-value* | **rst** *rst-value* | **syn** *syn-value* | **urg** *urg-value* } * | **established** } | **counting** | **destination** { *dest dest-prefix* | *dest/dest-prefix* | **any** } | **destination-port** *operator port1* [*port2*] | **dscp** *dscp* | **flow-label** *flow-label-value* | **fragment** | **icmp6-type** { *icmp6-type icmp6-code* | *icmp6-message* } | **logging** | **routing** [**type** *routing-type*] | **source** { *source source-prefix* | *source/source-prefix* **|** **any** } | **source-port** *operator port1* [*port2*] | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *	By default IPv6 advanced ACL does not contain any rule. The **vpn-instance** *vpn-instance-name* option is not available on an HP 5500 SI switch. If an IPv6 advanced ACL is for QoS traffic classification or packet filtering: • Do not specify the **fragment** or **routing** keyword. • Do not specify the **vpn-instance** keyword. • Do not specify **neq** for the *operator* argument. • Do not specify the **flow-label** keyword if the ACL is for outbound QoS traffic classification or outbound packet filtering on an HP 5500 EI switch • The **logging** and **counting** keywords (even if specified) do not take effect when the ACL is used for traffic classification.
6. Add or edit a rule comment.	**rule** *rule-id* **comment** *text*	Optional. By default, no rule comments are configured.
7. Add or edit a rule range remark.	**rule** [*rule-id*] **remark** *text*	Optional. By default, no rule range remarks are configured.

Step	Command	Remarks
8. Enable counting ACL rule matches performed in hardware.	**hardware-count enable**	Optional. Disabled by default. When the ACL is referenced by a QoS policy, this command does not take effect.

Configuring an Ethernet frame header ACL

Ethernet frame header ACLs, also called "Layer 2 ACLs," match packets based on Layer 2 protocol header fields, such as source MAC address, destination MAC address, 802.1p priority (VLAN priority), and link layer protocol type.

To configure an Ethernet frame header ACL:

Step	Command	Remarks
1. Enter system view.	system-view	N/A
2. Create an Ethernet frame header ACL and enter its view.	**acl number** *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]	By default, no ACL exists. Ethernet frame header ACLs are numbered in the range of 4000 to 4999. You can use the **acl name** *acl-name* command to enter the view of a named Ethernet frame header ACL.
3. Configure a description for the Ethernet frame header ACL.	**description** *text*	Optional. By default, an Ethernet frame header ACL has no ACL description.
4. Set the rule numbering step.	**step** *step-value*	Optional. The default setting is 5.
5. Create or edit a rule.	**rule** [*rule-id*] { **deny** | **permit** } [**cos** *vlan-pri* | **counting** | **dest-mac** *dest-addr dest-mask* | { **lsap** *lsap-type lsap-type-mask* | **type** *protocol-type protocol-type-mask* } | **source-mac** *sour-addr source-mask* | **time-range** *time-range-name*] *	By default, an Ethernet frame header ACL does not contain any rule. If the ACL is for QoS traffic classification or packet filtering, to use the **lsap** keyword, the *lsap-type* argument must be AAAA, and the *lasp-type-mask* argument must be FFFF. Otherwise, the ACL cannot be function normally.
6. Add or edit a rule comment.	**rule** *rule-id* **comment** *text*	Optional. By default, no rule comments are configured.
7. Add or edit a rule range remark.	**rule** [*rule-id*] **remark** *text*	Optional. By default, no rule range remarks are configured.

Step	Command	Remarks
8. Enable counting ACL rule matches performed in hardware.	**hardware-count enable**	Optional. Disabled by default. When the ACL is referenced by a QoS policy, this command does not take effect.

Copying an ACL

You can create an ACL by copying an existing ACL (source ACL). The new ACL (destination ACL) has the same properties and content as the source ACL, but not the same ACL number and name.

To successfully copy an ACL, make sure that:

- The destination ACL number is from the same category as the source ACL number.
- The source ACL already exists but the destination ACL does not.

Copying an IPv4 ACL

Step	Command
1. Enter system view.	**system-view**
2. Copy an existing IPv4 ACL to create a new IPv4 ACL.	**acl copy** { *source-acl-number* | **name** *source-acl-name* } **to** { *dest-acl-number* | **name** *dest-acl-name* }

Copying an IPv6 ACL

Step	Command
1. Enter system view.	**system-view**
2. Copy an existing IPv6 ACL to generate a new one of the same category.	**acl ipv6 copy** { *source-acl6-number* | **name** *source-acl6-name* } **to** { *dest-acl6-number* | **name** *dest-acl6-name* }

Configuring packet filtering with ACLs

You can use an ACL to filter incoming or outgoing IPv4 or IPv6 packets. You can apply one IPv4 ACL, one IPv6 AL, and one Ethernet frame header ACL at most to filter packets in the same direction of an interface.

With a basic or advanced ACL, you can log filtering events by specifying the **logging** keyword in the ACL rules and enabling the counting function. To enable counting for rule matches performed in hardware, configure the **hardware-count enable** command for the ACL or specify the **counting** keyword in the ACL rules.

You can set the packet filter to periodically send packet filtering logs to the information center as informational messages. The interval for generating and outputting packet filtering logs is configurable. The log information includes the number of matching packets and the ACL rules used in an interval. For more information about the information center, see *Network Management and Monitoring Configuration Guide*.

NOTE:

ACLs on VLAN interfaces filter only packets forwarded at Layer 3.

Applying an IPv4 or Ethernet frame header ACL for packet filtering

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view.	**interface** *interface-type interface-number*	N/A
3. Apply an IPv4 basic, IPv4 advanced, or Ethernet frame header ACL to the interface to filter packets.	**packet-filter** { *acl-number* | **name** *acl-name* } { **inbound** | **outbound** }	By default, no ACL is applied to any interface.
4. Exit to system view.	**quit**	N/A
5. Set the interval for generating and outputting IPv4 packet filtering logs.	**acl logging frequence** *frequence*	By default, the interval is 0. No IPv4 packet filtering logs are generated.

Applying an IPv6 ACL for packet filtering

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view.	**interface** *interface-type interface-number*	N/A
3. Apply an IPv6 basic or IPv6 advanced ACL to the interface to filter IPv6 packets.	**packet-filter ipv6** { *acl6-number* | **name** *acl6-name* } { **inbound** | **outbound** }	By default, no IPv6 ACL is applied to the interface.
4. Exit to system view.	**quit**	N/A
5. Set the interval for generating and outputting IPv6 packet filtering logs.	**acl ipv6 logging frequence** *frequence*	The default interval is 0. No IPv6 packet filtering logs are generated.

Displaying and maintaining ACLs

Task	Command	Remarks
Display configuration and match statistics for one or all IPv4 ACLs.	**display acl** { *acl-number* | **all** | **name** *acl-name* } [**slot** *slot-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display configuration and match statistics for one or all IPv6 ACLs.	**display acl ipv6** { *acl6-number* | **all** | **name** *acl6-name* } [**slot** *slot-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view

Task	Command	Remarks
Display the usage of ACL rules.	**display acl resource** [**slot** *slot-number*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display the application status of packet filtering ACLs on interfaces.	**display packet-filter** { { **all** | **interface** *interface-type interface-number* } [**inbound** | **outbound**] | **interface vlan-interface** *vlan-interface-number* [**inbound** | **outbound**] [**slot** *slot-number*] } [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display the configuration and status of one or all time ranges.	**display time-range** { *time-range-name* | **all** } [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Clear statistics for one or all IPv4 ACLs.	**reset acl counter** { *acl-number* | **all** | **name** *acl-name* }	Available in user view
Clear statistics for one or all IPv6 basic and advanced ACLs.	**reset acl ipv6 counter** { *acl6-number* | **all** | **name** *acl6-name* }	Available in user view

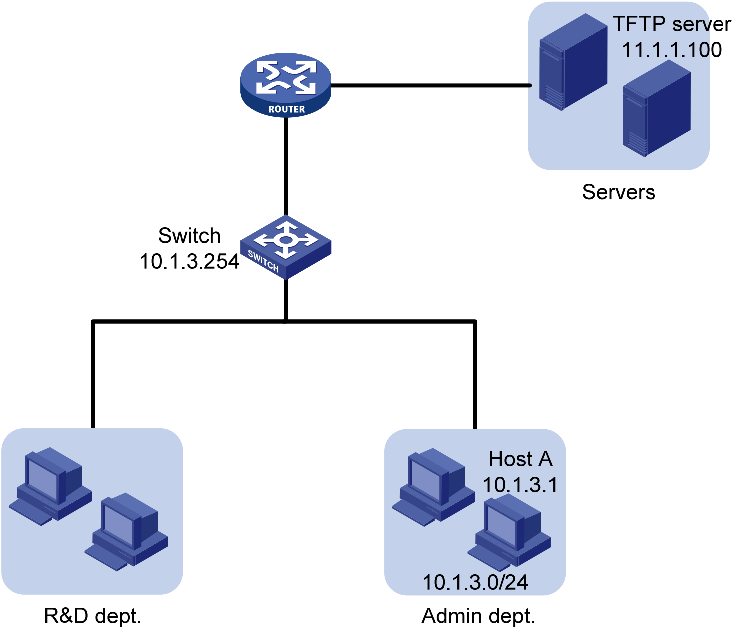
Configuration example of using ACL for device management

Network requirements

As shown in Figure 1, configure ACLs so that:

- Host A can telnet to the switch only during the working time (8:30 to 18:00 of every working day).
- As a TFTP client, the switch can get files from only the server 11.1.1.100. This makes sure that the switch saves only authorized files.
- As an FTP server, the switch accepts the login requests from only the NMS.

Figure 1 Network diagram



Configuration procedure

1. Limit the telnet login requests:

   # Create a time range named **telnet** to cover 8:30 to 18:00 of every working day.

   ```
   <Switch> system-view
   [Switch] time-range telnet 8:30 to 18:00 working-day
   ```

   # Create IPv4 basic ACL 2000, and configure a rule for the ACL to permit the packets sourced from 10.1.3.1 during only the time specified by time range **telnet**.

   ```
   [Switch] acl number 2000
   [Switch-acl-basic-2000] rule permit source 10.1.3.1 0 time-range telnet
   [Switch-acl-basic-2000] quit
   ```

   # Apply ACL 2000 to the inbound traffic of all telnet user interfaces to limit the telnet login requests.

   ```
   [Switch] user-interface vty 0 4
   [Switch-ui-vty0-4] acl 2000 inbound
   ```

2. Limit the access to the TFTP server:

   # Create IPv4 basic ACL 2001, and configure a rule for the ACL to permit only the packets sourced from 11.1.1.100.

   ```
   [Switch] acl number 2001
   [Switch-acl-basic-2001] rule permit source 11.1.1.100 0
   [Switch-acl-basic-2001] quit
   ```

   # Use ACL 2001 to control the switch's access to a specific TFTP server.

   ```
   [Switch] tftp-server acl 2001
   ```

3. Limit the FTP login requests:

   # Create IPv4 basic ACL 2002, and configure a rule for the ACL to permit only the packets sourced from 10.1.3.1.

   ```
   [Switch] acl number 2002
   ```

```
[Switch-acl-basic-2001] rule permit source 10.1.3.1 0
[Switch-acl-basic-2001] quit
```

# Enable the FTP server on the switch.

```
[Switch] ftp server enable
```

# Use ACL 2001 to control FTP clients' access to the FTP server.

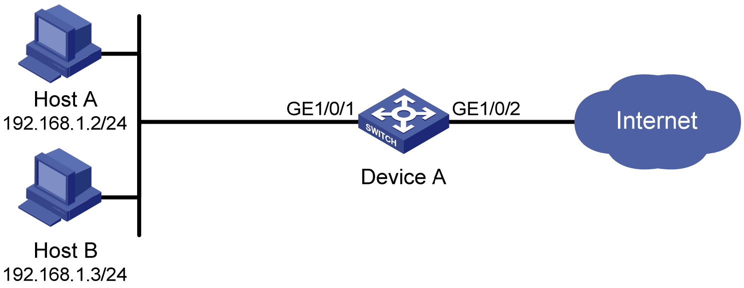
```
[Switch] ftp server acl 2002
```

IPv4 packet filtering configuration example

Network requirements

As shown in Figure 2, apply an ACL to the inbound direction of interface GigabitEthernet 1/0/1 on Device A so that every day from 08:00 to 18:00 the interface allows only packets sourced from Host A to pass. Configure Device A to output IPv4 packet filtering logs to the console at 10-minute intervals.

Figure 2 Network diagram



Configuration procedure

# Create a time range from 08:00 to 18:00 every day.

```
<DeviceA> system-view
[DeviceA] time-range study 8:00 to 18:00 daily
```

# Create IPv4 ACL 2009, and configure two rules in the ACL. One rule permits packets sourced from Host A and the other denies packets sourced from any other host during the time range **study**. Enable logging for the permit rule.

```
[DeviceA] acl number 2009
[DeviceA-acl-basic-2009] rule permit source 192.168.1.2 0 time-range study logging
[DeviceA-acl-basic-2009] rule deny source any time-range study
[DeviceA-acl-basic-2009] quit
```

# Enable the device to generate and output IPv4 packet filtering logs at 10-minute intervals.

```
[DeviceA] acl logging frequence 10
```

# Configure the device to output informational log messages to the console.

```
[DeviceA] info-center source default channel 0 log level informational
```

# Apply IPv4 ACL 2009 to filter incoming packets on GigabitEthernet 1/0/1.

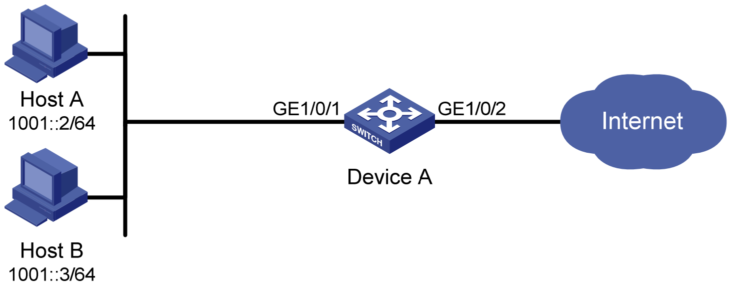
```
[DeviceA] interface gigabitethernet 1/0/1
[DeviceA-GigabitEthernet1/0/1] packet-filter 2009 inbound
[DeviceA-GigabitEthernet1/0/1] quit
```

IPv6 packet filtering configuration example

Network requirements

As shown in Figure 3, apply an IPv6 ACL to the incoming traffic of GigabitEthernet 1/0/1 on Device A so that every day from 08:00 to 18:00 the interface allows only packets from Host A to pass through. Configure Device A to output IPv4 packet filtering logs to the console at 10-minute intervals.

Figure 3 Network diagram



Configuration procedure

# Create a time range from 08:00 to 18:00 every day.

```
<DeviceA> system-view
[DeviceA] time-range study 8:0 to 18:0 daily
```

# Create IPv6 ACL 2009, and configure two rules for the ACL. One permits packets sourced from Host A and the other denies packets sourced from any other host during the time range **study**. Enable logging for the permit rule.

```
[DeviceA] acl ipv6 number 2009
[DeviceA-acl6-basic-2009] rule permit source 1001::2 128 time-range study logging
[DeviceA-acl6-basic-2009] rule deny source any time-range study
[DeviceA-acl6-basic-2009] quit
```

# Configure the device to collect and output IPv6 packet filtering logs at 10-minute intervals.

```
[DeviceA] acl ipv6 logging frequence 10
```

# Configure the device to output informational log messages to the console.

```
[DeviceA] info-center source default channel 0 log level informational
```

# Apply IPv6 ACL 2009 to filter incoming packets on GigabitEthernet 1/0/1.

```
[DeviceA] interface gigabitethernet 1/0/1
[DeviceA-GigabitEthernet1/0/1] packet-filter ipv6 2009 inbound
[DeviceA-GigabitEthernet1/0/1] quit
```

QoS overview

In data communications, Quality of Service (QoS) is a network's ability to provide differentiated service guarantees for diversified traffic in terms of bandwidth, delay, jitter, and drop rate.

Network resources are scarce. The contention for resources requires that QoS prioritize important traffic flows over trivial ones. For example, in the case of fixed bandwidth, if a traffic flow gets more bandwidth, the other traffic flows will get less bandwidth and may be affected. When making a QoS scheme, you must consider the characteristics of various applications to balance the interests of diversified users and to utilize network resources.

The following section describes some typical QoS service models and widely used, mature QoS techniques.

QoS service models

Best-effort service model

The best-effort model is a single-service model and also the simplest service model. In this service model, the network does its best to deliver packets, but does not guarantee delivery or control delay.

The best-effort service model is the default model in the Internet and applies to most network applications. It uses the first in first out (FIFO) queuing mechanism.

IntServ model

The integrated service (IntServ) model is a multiple-service model that can accommodate diverse QoS requirements. This service model provides the most granularly differentiated QoS by identifying and guaranteeing definite QoS for each data flow.

In the IntServ model, an application must request service from the network before it sends data. IntServ signals the service request with the Resource Reservation Protocol (RSVP). All nodes receiving the request reserve resources as requested and maintain state information for the application flow.

The IntServ model demands high storage and processing capabilities because it requires all nodes along the transmission path to maintain resource state information for each flow. This model is suitable for small-sized or edge networks, but not large-sized networks, for example, the core layer of the Internet, where billions of flows are present.

DiffServ model

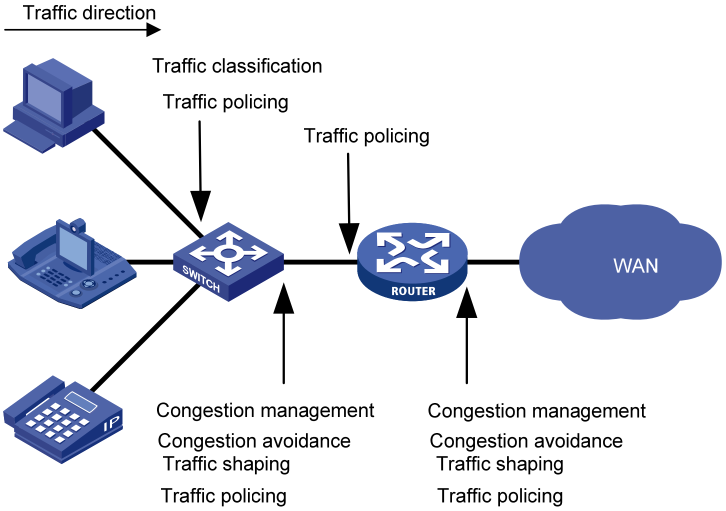
The differentiated service (DiffServ) model is a multiple-service model that can satisfy diverse QoS requirements. It is easy to implement and extend. DiffServ does not signal the network to reserve resources before sending data, as IntServ does.

All QoS techniques in this document are based on the DiffServ model.

QoS techniques

The QoS techniques include traffic classification, traffic policing, traffic shaping, rate limit, congestion management, and congestion avoidance. They address problems that arise at different positions of a network.

Figure 4 Placement of the QoS techniques in a network



As shown in Figure 4, traffic classification, traffic shaping, traffic policing, congestion management, and congestion avoidance mainly implement the following functions:

- **Traffic classification**—Uses certain match criteria to assign packets with the same characteristics to a class. Based on classes, you can provide differentiated services.
- **Traffic policing**—Polices flows entering or leaving a device, and imposes penalties on traffic flows that exceed the pre-set threshold to prevent aggressive use of network resources. You can apply traffic policing to both incoming and outgoing traffic of a port.
- **Traffic shaping**—Proactively adapts the output rate of traffic to the network resources available on the downstream device to eliminate packet drops. Traffic shaping usually applies to the outgoing traffic of a port.
- **Congestion management**—Provides a resource scheduling policy to determine the packet forwarding sequence when congestion occurs. Congestion management usually applies to the outgoing traffic of a port.
- **Congestion avoidance**—Monitors the network resource usage, and is usually applied to the outgoing traffic of a port. When congestion worsens, congestion avoidance reduces the queue length by dropping packets.

QoS configuration approaches

You can configure QoS in these approaches:

- MQC approach
- Non-MQC approach

Some features support both approaches, but some support only one.

MQC approach

In modular QoS configuration (MQC) approach, you configure QoS service parameters by using QoS policies (see "Configuring a QoS policy").

Non-MQC approach

In non-MQC approach, you configure QoS service parameters without using a QoS policy. For example, you can use the rate limit feature to set a rate limit on an interface without using a QoS policy.

Configuring a QoS policy

Overview

A QoS policy is a set of class-behavior associations and defines the shaping, policing, or other QoS actions to take on different classes of traffic.

A class is a set of match criteria for identifying traffic and it uses the AND or OR operator:

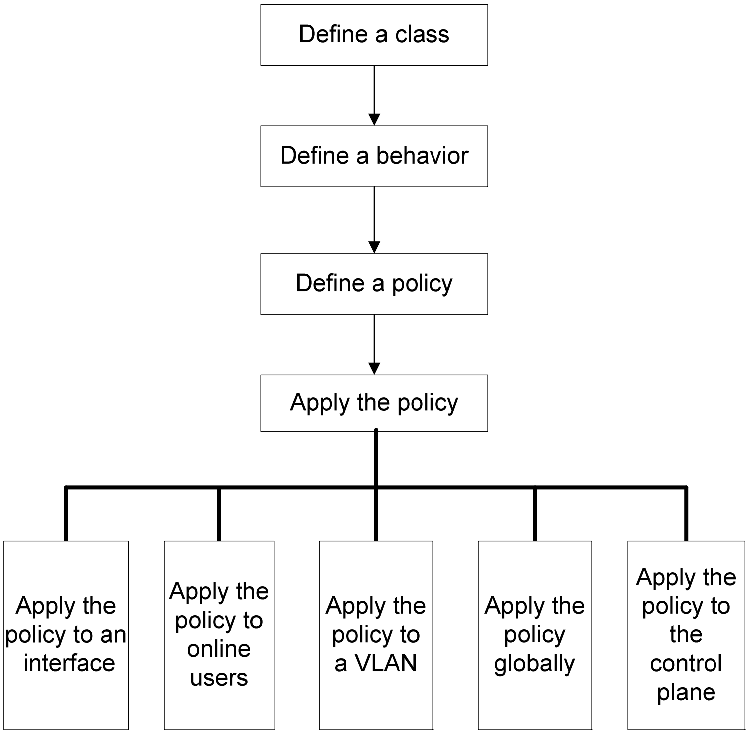
- **AND**—A packet must match all the criteria to match the class.
- **OR**—A packet matches the class if it matches any of the criteria in the class.

A traffic behavior defines a set of QoS actions to take on packets, such as priority marking and redirect.

By associating a traffic behavior with a class in a QoS policy, you apply the specific set of QoS actions to the class of traffic.

Figure 5 shows how to configure a QoS policy.

Figure 5 QoS policy configuration procedure


Define a class
Define a behavior
Define a policy
Apply the policy
Apply the policy to an interface
Apply the policy to online users
Apply the policy to a VLAN
Apply the policy globally
Apply the policy to the control plane

Defining a class

To define a class, specify its name and then configure the match criteria in class view.

Configuration restrictions and guidelines

- If a class that uses the AND operator has multiple **if-match acl**, **if-match acl ipv6**, **if-match customer-vlan-id** or **if-match service-vlan-id** clauses, a packet that matches any of the clauses matches the class.
- To successfully execute the traffic behavior associated with a traffic class that uses the AND operator, define only one **if-match** clause for any of the following match criteria and input only one value for any of the following *list* arguments. To create multiple **if-match** clauses for these match criteria or specify multiple values for the *list* arguments, specify the operator of the class as OR and use the **if-match** command multiple times.
    - **customer-dot1p** *8021p-list*
    - **destination-mac** *mac-address*
    - **dscp** *dscp-list*
    - **ip-precedence** *ip-precedence-list*
    - **service-dot1p** *8021p-list*
    - **source-mac** *mac-address*
    - **system-index** *index-value-list*

Configuration procedure

To define a class:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	By default, the operator of a class is AND. The operator of a class can be AND or OR: • **AND**—A packet is assigned to a class only when the packet matches all the criteria in the class. • **OR**—A packet is assigned to a class if it matches any of the criteria in the class.
3. Configure match criteria.	**if-match** *match-criteria*	N/A

match-criteria: Match criterion.

Table 2 The value range for the *match-criteria* argument

Option	Description
acl [**ipv6**] { *acl-number* | **name** *acl-name* }	Matches an ACL. The *acl-number* argument ranges from 2000 to 3999 for an IPv4 ACL, 2000 to 3999 for an IPv6 ACL, and 4000 to 4999 for an Ethernet frame header ACL. The *acl-name* argument is a case-insensitive string of 1 to 63 characters, which must start with an alphabetic letter from a to z (or A to Z), and to avoid confusion, cannot be **all**.
any	Matches all packets.

Option	Description
dscp *dscp-list*	Matches DSCP values. The *dscp-list* argument is a list of up to eight DSCP values. A DSCP value can be a number from 0 to 63 or any keyword in Table 12.
destination-mac *mac-address*	Matches a destination MAC address.
customer-dot1p *8021p-list*	Matches the 802.1p priority of the customer network. The *8021p-list* argument is a list of up to eight 802.1p priority values. An 802.1p priority ranges from 0 to 7.
service-dot1p *8021p-list*	Matches the 802.1p priority of the service provider network. The *8021p-list* argument is a list of up to eight 802.1p priority values. An 802.1p priority ranges from 0 to 7.
ip-precedence *ip-precedence-list*	Matches IP precedence. The *ip-precedence-list* argument is a list of up to eight IP precedence values. An IP precedence ranges from 0 to 7.
protocol *protocol-name*	Matches a protocol. The *protocol-name* argument can be IP or IPv6.
source-mac *mac-address*	Matches a source MAC address.
customer-vlan-id { *vlan-id-list* | *vlan-id1* **to** *vlan-id2* }	Matches the VLAN IDs of customer networks. The *vlan-id-list* argument is a list of up to eight VLAN IDs. The *vlan-id1* **to** *vlan-id2* specifies a VLAN ID range, where the *vlan-id1* must be smaller than the *vlan-id2*. A VLAN ID ranges from 1 to 4094.
service-vlan-id { *vlan-id-list* | *vlan-id1* **to** *vlan-id2* }	Matches the VLAN IDs of ISP networks. The *vlan-id-list* is a list of up to eight VLAN IDs. The *vlan-id1* **to** *vlan-id2* specifies a VLAN ID range, where the *vlan-id1* must be smaller than the *vlan-id2*. A VLAN ID ranges from 1 to 4094.
system-index *index-value-list*	Matches a pre-defined match criterion (system-index) for packets sent to the control plane. The *index-value-list* argument specifies a list of up to eight system indexes. The system index ranges from 1 to 128.

Defining a traffic behavior

A traffic behavior is a set of QoS actions (such as traffic filtering, shaping, policing, and priority marking) to take on a class of traffic. To define a traffic behavior, first create it and then configure QoS actions, such as priority marking and traffic redirecting, in traffic behavior view.

To define a traffic behavior:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a traffic behavior and enter traffic behavior view.	**traffic behavior** *behavior-name*	N/A
3. Configure actions in the traffic behavior.	See the subsequent chapters, depending on the purpose of the traffic behavior: traffic policing, traffic filtering, traffic redirecting, priority marking, traffic accounting, and so on.	

Defining a policy

You associate a behavior with a class in a QoS policy to perform the actions defined in the behavior for the class of packets.

Configuration restrictions and guidelines

- If an ACL is referenced by a QoS policy for defining traffic match criteria, packets matching the ACL are organized as a class and the behavior defined in the QoS policy applies to the class regardless of whether the action in the rule is **deny** or **permit**.
- In a QoS policy with multiple class-to-traffic-behavior associations, if the action of creating an outer VLAN tag, setting customer network VLAN ID, or setting service provider network VLAN ID is configured in a traffic behavior, do not configure any other action in this traffic behavior; otherwise, the QoS policy may not function as expected after it is applied. For more information about the action of setting customer network VLAN ID or service provider network VLAN ID, see *Layer 2—LAN Switching Configuration Guide*.

Configuration procedure

To associate a class with a behavior in a policy:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
3. Associate a class with a behavior in the policy.	**classifier** *tcl-name* **behavior** *behavior-name* [**mode dot1q-tag-manipulation**]	Repeat this step to create more class-behavior associations.

The **dot1q-tag-manipulation** keyword is only for VLAN mapping purposes. For more information about VLAN mapping, see *Layer 2—LAN Switching Configuration Guide*.

Applying the QoS policy

You can apply a QoS policy to the following occasions:

- **An interface**—The policy takes effect on the traffic sent or received on the interface.
- **A user profile**—The policy takes effect on the traffic sent or received by the online users of the user profile.
- **A VLAN**—The policy takes effect on the traffic sent or received on all ports in the VLAN.
- **Globally**—The policy takes effect on the traffic sent or received on all ports.
- **Control plane**—The policy takes effect on the traffic received on the control plane.

The QoS policies applied to ports, to VLANs, and globally are in the descending priority order. If the system finds a matching QoS policy for the incoming/outgoing traffic, the system stops matching the traffic against QoS policies.

You can modify classes, behaviors, and class-behavior associations in a QoS policy applied to an interface, VLAN, or inactive user profile, or globally. If a class references an ACL for traffic classification, you can delete or modify the ACL (such as add rules to, delete rules from, and modify rules of the ACL).

If a QoS policy has been applied to an active user profile, you cannot modify classes, behaviors, and class-behavior associations of the QoS policy, or delete the QoS policy.

Applying the QoS policy to an interface

Both bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports support QoS policies. The term "interface" in this section collectively refers to these types of ports. You can use the **port link-mode** command to set an Ethernet port to operate in bridge or route mode (see *Layer 2—LAN Switching Configuration Guide*).

The HP 5500 SI Switch Series does not support Layer 3 Ethernet ports.

A policy can be applied to multiple interfaces, but only one policy can be applied in one direction (inbound or outbound) of an interface.

The QoS policy applied to the outgoing traffic of a port does not regulate local packets, which are critical protocol packets sent by the device for maintaining the normal operation of the device. The most common local packets include link maintenance packets, STP, LDP, and RSVP packets.

To apply the QoS policy to an interface:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view or port group view.	- Enter interface view: **interface** *interface-type interface-number* - Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Apply the policy to the interface or port group.	**qos apply policy** *policy-name* { **inbound** | **outbound** }	The **outbound** keyword is not available on the HP 5500 SI Switch Series.

Applying the QoS policy to online users

You can apply a QoS policy to multiple online users. In one direction of each online user, only one policy can be applied. To modify a QoS policy already applied in a certain direction, remove the QoS policy application first.

Configuration restrictions and guidelines

- The QoS policy applied to a user profile supports only the **remark**, **car**, and **filter** actions.
- Do not apply a null policy to a user profile. The user profile using a null policy cannot be activated.
- The authentication methods available for online users include 802.1X and Portal.

Configuration procedure

To apply the QoS policy to online users:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter user profile view.	**user-profile** *profile-name*	The configuration made in user profile view takes effect when the user profile is activated and the users of the user profile are online. For more information about user profiles, see *Security Configuration Guide*.
3. Apply the QoS policy.	**qos apply policy** *policy-name* { **inbound** | **outbound** }	Use the **inbound** keyword to apply the QoS policy to the incoming traffic of the device (traffic sent by the online users). Use the **outbound** keyword to apply the QoS policy to the outgoing traffic (traffic received by the online users). The **outbound** keyword is not available on the HP 5500 SI Switch Series.
4. Return to system view.	**quit**	N/A
5. Activate the user profile.	**user-profile** *profile-name* **enable**	By default, a user profile is inactive.

Applying the QoS policy to a VLAN

You can apply a QoS policy to a VLAN to regulate traffic of the VLAN.

QoS policies cannot be applied to dynamic VLANs, such as VLANs created by GVRP.

To apply the QoS policy to a VLAN:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Apply the QoS policy to VLANs.	**qos vlan-policy** *policy-name* **vlan** *vlan-id-list* { **inbound** | **outbound** }	The **outbound** keyword is not available on the HP 5500 SI Switch Series.

Applying the QoS policy globally

You can apply a QoS policy globally to the inbound or outbound direction of all ports.

To apply the QoS policy globally:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Apply the QoS policy globally.	**qos apply policy** *policy-name* **global** { **inbound** | **outbound** }	The **outbound** keyword is not available on the HP 5500 SI Switch Series.

Applying the QoS policy to the control plane

A device provides the data plane and the control plane.

- The data plane has units responsible for receiving, transmitting, and switching (forwarding) packets, such as various dedicated forwarding chips. They deliver super processing speeds and throughput.
- The control plane has processing units running most routing and switching protocols and responsible for protocol packet resolution and calculation, such as CPUs. Compared with data plane units, the control plane units allow for great packet processing flexibility, but have lower throughput.

When the data plane receives packets that it cannot recognize or process, it transmits them to the control plane. If the transmission rate exceeds the processing capability of the control plane, which very likely occurs at times of DoS attacks, the control plane will be busy handling undesired packets and fail to handle legitimate packets correctly or timely. As a result, protocol performance is affected.

To address this problem, apply a QoS policy to the control plane to take QoS actions, such as traffic filtering or rate limiting, on inbound traffic. This action ensures that the control plane can receive, transmit, and process packets properly.

Configuration restrictions and guidelines

- By default, devices are configured with pre-defined control plane policies, which take effect on the control planes by default. A pre-defined control plane QoS policy uses the system-index to identify the type of packets sent to the control plane. You can reference system-indexes in **if-match** commands in class view for traffic classification and then re-configure traffic behaviors for these classes as required. You can use the **display qos policy control-plane pre-defined** command to display them.
- In a QoS policy for control planes, if a system index classifier is configured, the associated traffic behavior can contain only the **car** action or the combination of **car** and **accounting packet** actions. In addition, if the CAR action is configured, only its CIR setting can be applied.
- In the QoS policy for a control plane, if a system index classifier is not configured, the associated traffic behaviors also take effect on the data traffic of the device where the control plane resides.

Configuration procedure

To apply the QoS policy to the control plane:

Step		Command
1.	Enter system view.	**system-view**
2.	Enter control plane view.	**control-plane slot** *slot-number*
3.	Apply the QoS policy to the control plane.	**qos apply policy** *policy-name* **inbound**

Displaying and maintaining QoS policies

IMPORTANT:

The **outbound** keyword is not available on the HP 5500 SI Switch Series.

Task	Command	Remarks
Display traffic class configuration.	**display traffic classifier user-defined** [*tcl-name*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display traffic behavior configuration.	**display traffic behavior user-defined** [*behavior-name*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display user-defined QoS policy configuration.	**display qos policy user-defined** [*policy-name* [**classifier** *tcl-name*]] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display QoS policy configuration on the specified or all interfaces.	**display qos policy interface** [*interface-type interface-number*] [**inbound** | **outbound**] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display VLAN QoS policy configuration.	**display qos vlan-policy** { **name** *policy-name* | **vlan** *vlan-id* } [**slot** *slot-number*] [**inbound** | **outbound**] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display information about QoS policies applied globally.	**display qos policy global** [**slot** *slot-number*] [**inbound** | **outbound**] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display information about QoS policies applied to a control plane.	**display qos policy control-plane slot** *slot-number* [**inbound**] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display information about pre-defined QoS policies applied to a control plane.	**display qos policy control-plane pre-defined** [**slot** *slot-number*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Clear VLAN QoS policy statistics.	**reset qos vlan-policy** [**vlan** *vlan-id*] [**inbound** | **outbound**]	Available in user view
Clear the statistics for a QoS policy applied globally.	**reset qos policy global** [**inbound** | **outbound**]	Available in user view
Clear the statistics for the QoS policy applied to a control plane.	**reset qos policy control-plane slot** *slot-number* [**inbound**]	Available in user view

Configuring priority mapping

Both bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports support the priority mapping function. The term "interface" in this chapter collectively refers to these types of ports. You can use the **port link-mode** command to set an Ethernet port to operate in bridge or route mode (see *Layer 2—LAN Switching Configuration Guide*).

The HP 5500 SI Switch Series does not support Layer 3 Ethernet ports.

Overview

When a packet enters a device, depending on your configuration, the device assigns a set of QoS priority parameters to the packet based on either a certain priority field carried in the packet or the port priority of the incoming port. This process is called "priority mapping". During this process, the device can modify the priority of the packet depending on device status. The set of QoS priority parameters decides the scheduling priority and forwarding priority of the packet.

Priority mapping is implemented with priority mapping tables and involves priorities such as 802.1p priority, DSCP, IP precedence, local precedence, and drop precedence.

Types of priorities

Priorities fall into the following types: priorities carried in packets, and priorities locally assigned for scheduling only.

The packet-carried priorities include 802.1p priority, DSCP precedence, IP precedence, and so on. These priorities have global significance and affect the forwarding priority of packets across the network. For more information about these priorities, see "Appendix B Packet precedences."

The locally assigned priorities only have local significance. They are assigned by the device for scheduling only. These priorities include the local precedence and drop precedence, as follows:

- **Local precedence**—Local precedence is used for queuing. A local precedence value corresponds to an output queue. A packet with higher local precedence is assigned to a higher priority output queue to be preferentially scheduled.
- **Drop precedence**—Drop precedence is used for making packet drop decisions. Packets with the highest drop precedence are dropped preferentially.

Priority mapping tables

Priority mapping is implemented with priority mapping tables. By looking up a priority mapping table, the device decides which priority value to assign to a packet for subsequent packet processing. The switch provides the following priority mapping tables:

- **dot1p-dp**—802.1p-to-drop priority mapping table.
- **dot1p-lp**—802.1p-to-local priority mapping table.
- **dscp-dot1p**—DSCP-to-802.1p priority mapping table, which is applicable to only IP packets.
- **dscp-dp**—DSCP-to-drop priority mapping table, which is applicable to only IP packets.
- **dscp-dscp**—DSCP-to-DSCP priority mapping table, which is applicable to only IP packets.

The default priority mapping tables (see "Appendix A Default priority mapping tables") are available for priority mapping. In most cases, they are adequate for priority mapping. If a default priority mapping table cannot meet your requirements, you can modify the priority mapping table as required.

Priority trust mode on a port

The priority trust mode on a port decides which priority is used for priority mapping table lookup. Port priority was introduced to use for priority mapping in addition to priority fields carried in packets. The Switch Series provides the following priority trust modes:

- Using the 802.1p priority carried in packets for priority mapping.

Table 3 Priority mapping results of trusting the 802.1p priority (when the default dot1p-lp priority mapping table is used)

802.1p priority carried in packets	Local precedence	Queue ID
0	2	2
1	0	0
2	1	1
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7

NOTE:

When the 802.1p priority carried in packets is trusted, the port priority is used for priority mapping for packets which do not carry VLAN tags (namely, do not carry 802.1p priorities.) The priority mapping results are the same as not trusting packet priority, as shown in Table 5.

- Using the DSCP carried in packets for priority mapping.

Table 4 Priority mapping results of trusting the DSCP (when the default dscp-dot1p and dot1p-lp priority mapping tables are used)

DSCP value carried in packets	Local precedence	Queue ID
0 to 7	2	2
8 to 15	0	0
16 to 23	1	1
24 to 31	3	3
32 to 39	4	4
40 to 47	5	5
48 to 55	6	6
56 to 63	7	7

- Using the port priority as the 802.1p priority for priority mapping. The port priority is user configurable.

Table 5 Priority mapping results of not trusting packet priority (when the default dot1p-lp priority mapping table is used)

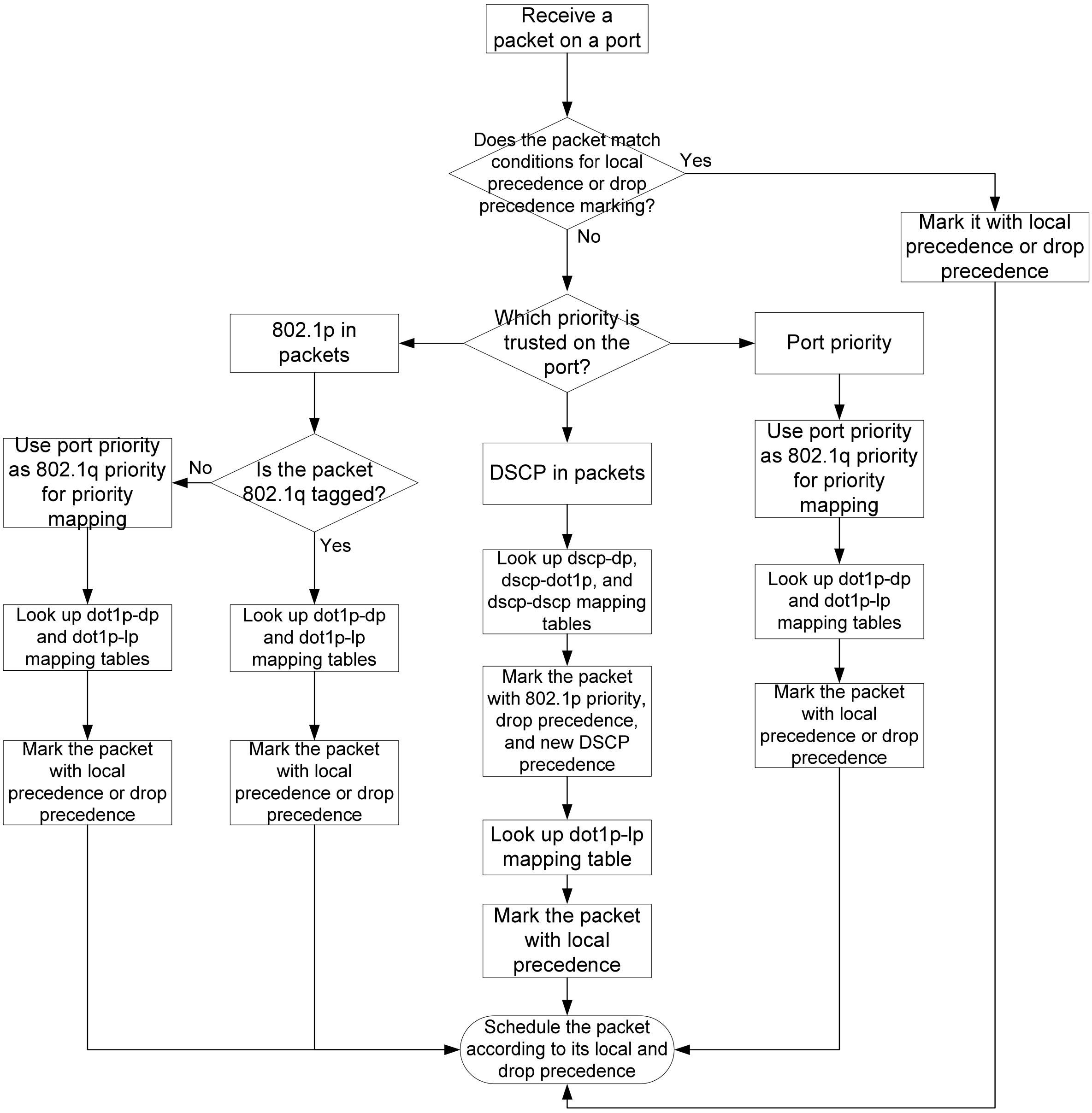
Port priority	Local precedence	Queue ID
0 (default)	2	2
1	0	0
2	1	1
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7

The priority mapping procedure varies with the priority modes. For more information, see the subsequent section.

Priority mapping procedure

On receiving an Ethernet packet on a port, the switch marks the scheduling priorities (local precedence and drop precedence) for the Ethernet packet. This procedure is done according to the priority trust mode of the receiving port and the 802.1q tagging status of the packet, as shown in Figure 6.

Figure 6 Priority mapping procedure for an Ethernet packet



Receive a packet on a port
Does the packet match conditions for local precedence or drop precedence marking?
Yes
No
Mark it with local precedence or drop precedence
Which priority is trusted on the port?
802.1p in packets
Port priority
DSCP in packets
Is the packet 802.1q tagged?
No
Yes
Use port priority as 802.1q priority for priority mapping
Look up dot1p-dp and dot1p-lp mapping tables
Mark the packet with local precedence or drop precedence
Look up dot1p-dp and dot1p-lp mapping tables
Mark the packet with local precedence or drop precedence
Look up dscp-dp, dscp-dot1p, and dscp-dscp mapping tables
Mark the packet with 802.1p priority, drop precedence, and new DSCP precedence
Look up dot1p-lp mapping table
Mark the packet with local precedence
Use port priority as 802.1q priority for priority mapping
Look up dot1p-dp and dot1p-lp mapping tables
Mark the packet with local precedence or drop precedence
Schedule the packet according to its local and drop precedence

Configuration guidelines

You can modify priority mappings by modifying priority mapping tables, priority trust mode on a port, and port priority.

H3C recommends planning QoS throughout the network before making your QoS configuration.

Configuring a priority mapping table

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A

Step		Command	Remarks
2.	Enter priority mapping table view.	**qos map-table** { **dot1p-dp** | **dot1p-lp** | **dscp-dot1p** | **dscp-dp** | **dscp-dscp** }	N/A
3.	Configure the priority mapping table.	**import** *import-value-list* **export** *export-value*	Newly configured mappings overwrite the old ones.

Configuring a port to trust packet priority for priority mapping

When you configure the trusted packet priority type on an interface or port group, use the following priority trust modes:

- **dot1p**—Uses the 802.1p priority of received packets for mapping.
- **dscp**—Uses the DSCP precedence of received IP packets for mapping.
- **untrust**—Uses port priority as the 802.1p priority for priority mapping.

To configure the trusted packet priority type on an interface or port group:

Step		Command	Remarks
1.	Enter system view	**system-view**	N/A
2.	Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3.	Configure the trusted packet priority type for the interface.	• Trust the DSCP priority in packets: **qos trust dscp** • Trust the 802.1p priority in packets: **qos trust dot1p** • Trust the port priority: **undo qos trust**	Use either command. By default, the device trusts the port priority.

Changing the port priority of an interface

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A

Step	Command	Remarks
2. Enter interface view or port group view.	- Enter interface view: **interface** *interface-type interface-number* - Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Set the port priority of the interface.	**qos priority** *priority-value*	The default port priority is 0.

Displaying priority mappings

Task	Command	Remarks
Display priority mapping table configuration.	**display qos map-table** [**dot1p-dp** | **dot1p-lp** | **dscp-dot1p** | **dscp-dp** | **dscp-dscp**] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display the trusted packet priority type on a port.	**display qos trust interface** [*interface-type interface-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view

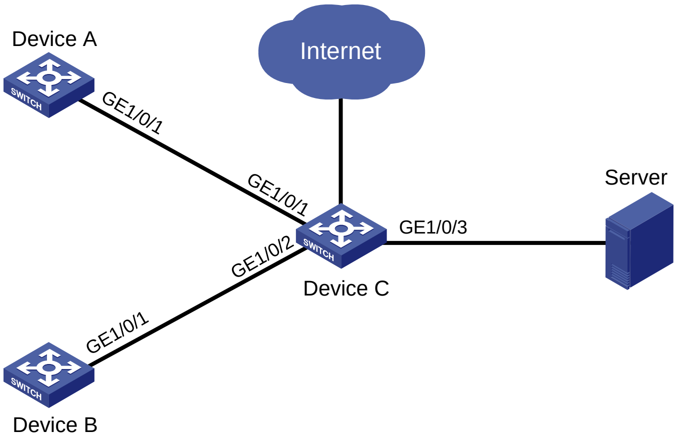
Priority trust mode configuration example

Network requirements

As shown in Figure 7, Device A is connected to GigabitEthernet 1/0/1 of Device C, Device B is connected to GigabitEthernet 1/0/2 of Device C, and the packets from Device A and Device B to Device C are not VLAN tagged.

Make configurations to have Device C preferentially process packets from Device A to Server when GigabitEthernet 1/0/3 of Device C is congested.

Figure 7 Network diagram



Configuration procedure

# Assign port priority to GigabitEthernet 1/0/1 and GigabitEthernet 1/0/2. Make sure that the priority of GigabitEthernet 1/0/1 is higher than that of GigabitEthernet 1/0/2, and no trusted packet priority type is configured on GigabitEthernet 1/0/1 or GigabitEthernet 1/0/2.

```
<DeviceC> system-view
[DeviceC] interface gigabitethernet 1/0/1
[DeviceC-GigabitEthernet1/0/1] qos priority 3
[DeviceC-GigabitEthernet1/0/1] quit
[DeviceC] interface gigabitethernet 1/0/2
[DeviceC-GigabitEthernet1/0/2] qos priority 1
[DeviceC-GigabitEthernet1/0/2] quit
```

Priority mapping table and priority marking configuration example

Network requirements

As shown in Figure 8, the company's enterprise network interconnects all departments through Device. The network is described as follows:

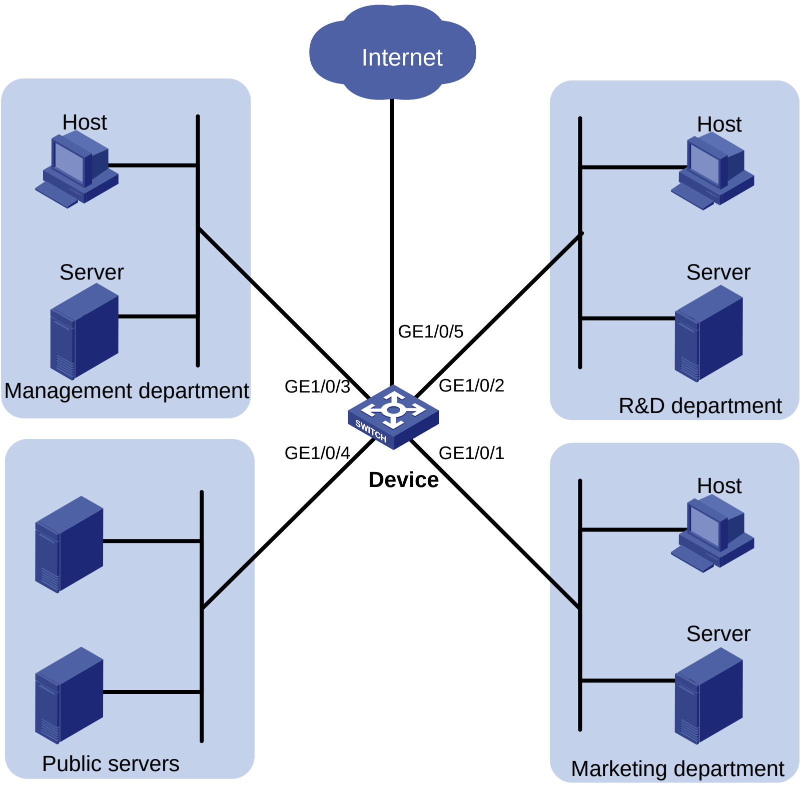
- The marketing department connects to GigabitEthernet 1/0/1 of Device, which sets the 802.1p priority of traffic from the marketing department to 3.
- The R&D department connects to GigabitEthernet 1/0/2 of Device, which sets the 802.1p priority of traffic from the R&D department to 4.
- The management department connects to GigabitEthernet 1/0/3 of Device, which sets the 802.1p priority of traffic from the management department to 5.

Configure port priority, 802.1p-to-local mapping table, and priority marking to implement the plan as described in Table 6.

Table 6 Configuration plan

Traffic destination	Traffic priority order	Queuing plan		
		Traffic source	**Output queue**	**Queue priority**
Public servers	R&D department > management department > marketing department	R&D department	6	High
		Management department	4	Medium
		Marketing department	2	Low
Internet	Management department > marketing department > R&D department	R&D department	2	Low
		Management department	6	High
		Marketing department	4	Medium

Figure 8 Network diagram



Configuration procedure

1. Configure trusting port priority:

   # Set the port priority of GigabitEthernet 1/0/1 to 3.

   ```
   <Device> system-view
   [Device] interface gigabitethernet 1/0/1
   [Device-GigabitEthernet1/0/1] qos priority 3
   [Device-GigabitEthernet1/0/1] quit
   ```

   # Set the port priority of GigabitEthernet 1/0/2 to 4.

   ```
   [Device] interface gigabitethernet 1/0/2
   [Device-GigabitEthernet1/0/2] qos priority 4
   [Device-GigabitEthernet1/0/2] quit
   ```

   # Set the port priority of GigabitEthernet 1/0/3 to 5.

   ```
   [Device] interface gigabitethernet 1/0/3
   [Device-GigabitEthernet1/0/3] qos priority 5
   [Device-GigabitEthernet1/0/3] quit
   ```

2. Configure the 802.1p-to-local mapping table to map 802.1p priority values 3, 4, and 5 to local precedence values 2, 6, and 4.

   This guarantees the R&D department, management department, and marketing department decreased priorities to access the public server.

   ```
   [Device] qos map-table dot1p-lp
   [Device-maptbl-dot1p-lp] import 3 export 2
   [Device-maptbl-dot1p-lp] import 4 export 6
   ```

```
[Device-maptbl-dot1p-lp] import 5 export 4
[Device-maptbl-dot1p-lp] quit
```

3. Configure priority marking:

   # Mark the HTTP traffic of the management department, marketing department, and R&D department to the Internet with 802.1p priorities 4, 5, and 3, respectively. Use the priority mapping table you have configured to map the 802.1p priorities to local precedence values 6, 4, and 2, respectively, for differentiated traffic treatment.

   # Create ACL 3000 to match HTTP traffic.

   ```
   [Device] acl number 3000
   [Device-acl-adv-3000] rule permit tcp destination-port eq 80
   [Device-acl-adv-3000] quit
   ```

   # Create class **http** and reference ACL 3000 in the class.

   ```
   [Device] traffic classifier http
   [Device-classifier-http] if-match acl 3000
   [Device-classifier-http] quit
   ```

   # Configure a priority marking policy for the management department, and apply the policy to the incoming traffic of GigabitEthernet 1/0/3.

   ```
   [Device] traffic behavior admin
   [Device-behavior-admin] remark dot1p 4
   [Device-behavior-admin] quit
   [Device] qos policy admin
   [Device-qospolicy-admin] classifier http behavior admin
   [Device-qospolicy-admin] quit
   [Device] interface gigabitethernet 1/0/3
   [Device-GigabitEthernet1/0/3] qos apply policy admin inbound
   ```

   # Configure a priority marking policy for the marketing department, and apply the policy to the incoming traffic of GigabitEthernet 1/0/1.

   ```
   [Device] traffic behavior market
   [Device-behavior-market] remark dot1p 5
   [Device-behavior-market] quit
   [Device] qos policy market
   [Device-qospolicy-market] classifier http behavior market
   [Device-qospolicy-market] quit
   [Device] interface gigabitethernet 1/0/1
   [Device-GigabitEthernet1/0/1] qos apply policy market inbound
   ```

   # Configure a priority marking policy for the R&D department, and apply the policy to the incoming traffic of GigabitEthernet 1/0/2.

   ```
   [Device] traffic behavior rd
   [Device-behavior-rd] remark dot1p 3
   [Device-behavior-rd] quit
   [Device] qos policy rd
   [Device-qospolicy-rd] classifier http behavior rd
   [Device-qospolicy-rd] quit
   [Device] interface gigabitethernet 1/0/2
   [Device-GigabitEthernet1/0/2] qos apply policy rd inbound
   ```

Configuring traffic policing, traffic shaping, and rate limit

Both bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports support the traffic shaping and rate limit functions. The term "interface" in this chapter collectively refers to these types of ports. You can use the **port link-mode** command to set an Ethernet port to operate in bridge or route mode (see *Layer 2—LAN Switching Configuration Guide*).

The HP 5500 SI Switch Series does not support Layer 3 Ethernet ports.

Overview

Traffic policing, traffic shaping, and rate limit are QoS technologies that help assign network resources, such as assign bandwidth. They increase network performance and user satisfaction. For example, you can configure a flow to use only the resources committed to it in a certain time range. This avoids network congestion caused by burst traffic.

Traffic policing, generic traffic shaping (GTS), and rate limit control the traffic rate and resource usage according to traffic specifications. Once a particular flow exceeds its specifications, such as assigned bandwidth, the flow is shaped or policed to make sure that it is under the specifications. You can use token buckets for evaluating traffic specifications.

Traffic evaluation and token buckets

A token bucket is analogous to a container that holds a certain number of tokens. Each token represents a certain forwarding capacity. The system puts tokens into the bucket at a constant rate. When the token bucket is full, the extra tokens cause the token bucket to overflow.

Evaluating traffic with the token bucket

A token bucket mechanism evaluates traffic by looking at the number of tokens in the bucket. If the number of tokens in the bucket is enough for forwarding the packets, the traffic conforms to the specification, and is called "conforming traffic". Otherwise, the traffic does not conform to the specification, and is called "excess traffic".

A token bucket has the following configurable parameters:

- Mean rate at which tokens are put into the bucket, which is the permitted average rate of traffic. It is usually set to the committed information rate (CIR).
- Burst size or the capacity of the token bucket. It is the maximum traffic size permitted in each burst. It is usually set to the committed burst size (CBS). The set burst size must be greater than the maximum packet size.

Each arriving packet is evaluated. In each evaluation, if the number of tokens in the bucket is enough, the traffic conforms to the specification and the tokens for forwarding the packet are taken away; if the number of tokens in the bucket is not enough, the traffic is excessive.

Complicated evaluation

You can set two token buckets, bucket C and bucket E, to evaluate traffic in a more complicated environment and achieve more policing flexibility. For example, traffic policing uses the following parameters:

- **CIR**—Rate at which tokens are put into bucket C. It sets the average packet transmission or forwarding rate allowed by bucket C.
- **CBS**—Size of bucket C, which specifies the transient burst of traffic that bucket C can forward.
- **Peak information rate (PIR)**—Rate at which tokens are put into bucket E, which specifies the average packet transmission or forwarding rate allowed by bucket E.
- **Excess burst size (EBS)**—Size of bucket E, which specifies the transient burst of traffic that bucket E can forward.

CBS is implemented with bucket C, and EBS with bucket E. In each evaluation, packets are measured against the following bucket scenarios:

- If bucket C has enough tokens, packets are colored green.
- If bucket C does not have enough tokens but bucket E has enough tokens, packets are colored yellow.
- If neither bucket C nor bucket E has sufficient tokens, packets are colored red.

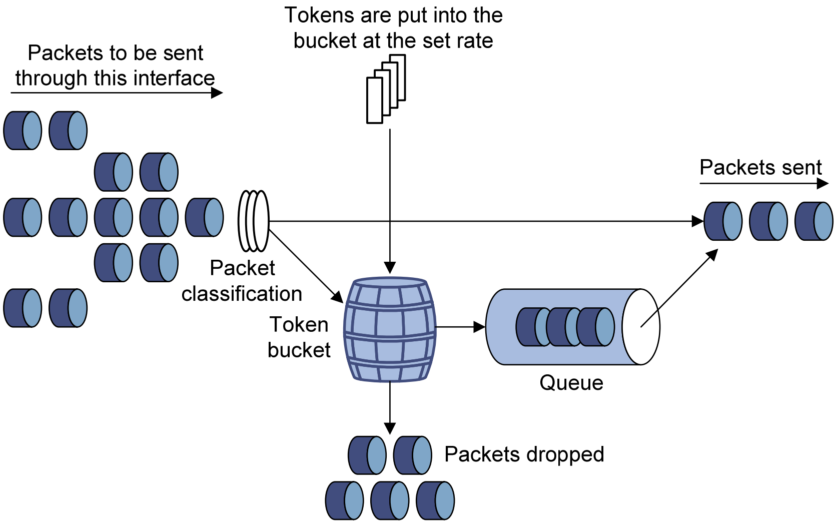
Traffic policing

IMPORTANT:

The HP 5500 EI switch supports policing the inbound traffic and the outbound traffic, and the HP 5500 SI supports policing only the incoming traffic.

A typical application of traffic policing is to supervise the specification of certain traffic entering a network and limit it within a reasonable range, or to "discipline" the extra traffic to prevent aggressive use of network resources by a certain application. For example, you can limit bandwidth for HTTP packets to less than 50% of the total. If the traffic of a certain session exceeds the limit, traffic policing can drop the packets or reset the IP precedence of the packets. Figure 9 shows an example of policing outbound traffic on an interface.

Figure 9 Traffic policing


Tokens are put into the bucket at the set rate
Packets to be sent through this interface
Packets sent
Packet classification
Token bucket
Queue
Packets dropped

Traffic policing is widely used in policing traffic entering the networks of internet service providers (ISPs). It can classify the policed traffic and take pre-defined policing actions on each packet depending on the evaluation result:

- Forwarding the packet if the evaluation result is "conforming"
- Dropping the packet if the evaluation result is "excess"
- Forwarding the packet with its DSCP precedence re-marked if the evaluation result is "conforming"

Traffic shaping

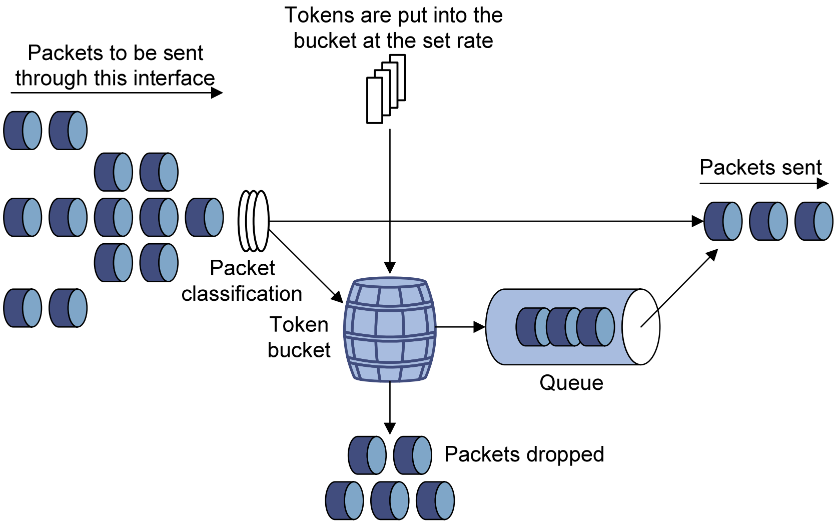
IMPORTANT:

Traffic shaping shapes the outbound traffic.

Traffic shaping limits the outbound traffic rate by buffering exceeding traffic. You can use traffic shaping to adapt the traffic output rate on a device to the input traffic rate of its connected device to avoid packet loss.

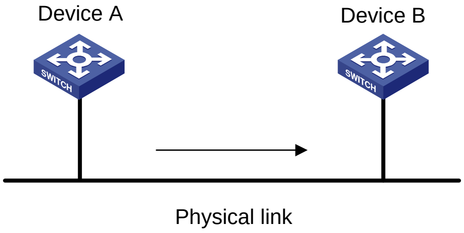
The difference between traffic policing and GTS is that packets to be dropped with traffic policing are retained in a buffer or queue with GTS, as shown in Figure 10. When enough tokens are in the token bucket, the buffered packets are sent at an even rate. Traffic shaping can result in additional delay and traffic policing does not.

Figure 10 GTS


Tokens are put into the bucket at the set rate
Packets to be sent through this interface
Packets sent
Packet classification
Token bucket
Queue
Packets dropped

For example, in Figure 11, Device B performs traffic policing on packets from Device A and drops packets exceeding the limit. To avoid packet loss, you can perform traffic shaping on the outgoing interface of Device A so packets exceeding the limit are cached in Device A. Once resources are released, traffic shaping takes out the cached packets and sends them out.

Figure 11 GTS application



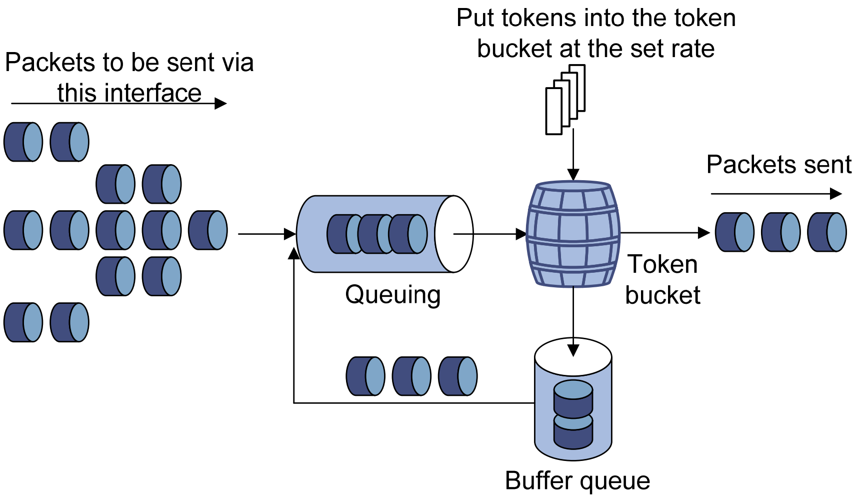
Rate limit

Rate limit supports controlling the rate of the outbound traffic.

The rate limit of a physical interface specifies the maximum rate for forwarding packets (including critical packets).

Rate limit also uses token buckets for traffic control. With rate limit configured on an interface, all packets to be sent through the interface are handled by the token bucket at the set rate limit value. If enough tokens are in the token bucket, packets can be forwarded. Otherwise, packets are put into QoS queues for congestion management. In this way, the traffic passing the physical interface is controlled.

Figure 12 Rate limit implementation


Put tokens into the token bucket at the set rate
Packets to be sent via this interface
Packets sent
Queuing
Token bucket
Buffer queue

The token bucket mechanism limits traffic rate when accommodating bursts. It allows bursty traffic to be transmitted if enough tokens are available. If tokens are scarce, packets cannot be transmitted until efficient tokens are generated in the token bucket. It restricts the traffic rate to the rate for generating tokens.

Rate limit can only limit traffic rate on a physical interface, and traffic policing can limit the rate of a flow on an interface. To limit the rate of all the packets on interfaces, using rate limit is easier.

Configuring traffic policing

Configuration restrictions and guidelines

In a traffic behavior, do not configure traffic policing with any priority marking action (including local precedence, drop precedence, 802.1p priority, DSCP value, and IP precedence marking actions) in the same traffic behavior. Otherwise, you will fail to apply the QoS policy successfully.

Configuration procedure

To configure traffic policing:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	N/A
3. Configure match criteria.	**if-match** *match-criteria*	N/A
4. Return to system view.	**quit**	N/A
5. Create a behavior and enter behavior view.	**traffic behavior** *behavior-name*	N/A

Step	Command	Remarks
6. Configure a traffic policing action.	**car cir** *committed-information-rate* [**cbs** *committed-burst-size* [**ebs** *excess-burst-size*]] [**pir** *peak-information-rate*] [**green** *action*] [**yellow** *action*] [**red** *action*]	N/A
7. Return to system view.	**quit**	N/A
8. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
9. Associate the class with the traffic behavior in the QoS policy.	**classifier** *tcl-name* **behavior** *behavior-name*	N/A
10. Return to system view.	**quit**	N/A
11. Apply the QoS policy.	• Applying the QoS policy to an interface • Applying the QoS policy to online users • Applying the QoS policy to a VLAN • Applying the QoS policy globally • Applying the QoS policy to the control plane	Choose one application destination as needed.

Configuring GTS

The Switch Series supports queue-based GTS, which shapes traffic of a specific queue.

To configure GTS:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Configure GTS for a queue.	**qos gts queue** *queue-number* **cir** *committed-information-rate* [**cbs** *committed-burst-size*]	N/A

Configuring the rate limit

The rate limit of a physical interface specifies the maximum rate of outgoing packets.

To configure the rate limit:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view or port group view.	- Enter interface view: **interface** *interface-type interface-number* - Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Configure the rate limit for the interface or port group.	**qos lr outbound cir** *committed-information-rate* [**cbs** *committed-burst-size*]	N/A

Displaying and maintaining traffic policing, GTS, and rate limit

On the Switch Series, you can configure traffic policing in MQC approach. For more information about the displaying and maintaining commands, see "Displaying and maintaining QoS policies."

Task	Command	Remarks
Display interface GTS configuration information.	**display qos gts interface** [*interface-type interface-number*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display interface rate limit configuration information.	**display qos lr interface** [*interface-type interface-number*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view

Traffic policing configuration example

Network requirements

As shown in Figure 13:

- GigabitEthernet 1/0/3 of Device A is connected to GigabitEthernet1/0/1 of Device B.
- Server, Host A, and Host B can access the Internet through Device A and Device B.

Perform traffic control on GigabitEthernet 1/0/1 of Device A for traffic received from Server and Host A, respectively, to satisfy the following requirements:

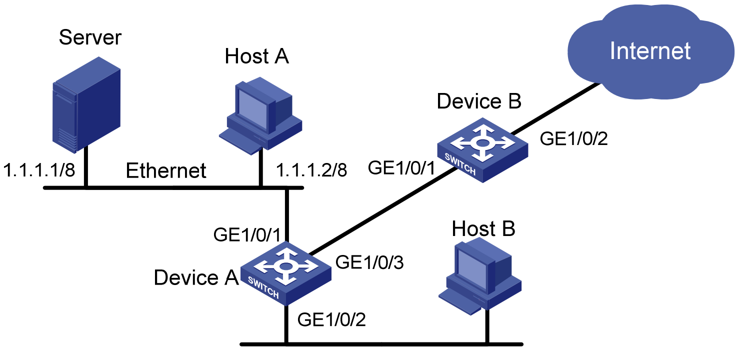
- Limit the rate of traffic from Server to 1024 kbps: transmit the conforming traffic normally, and mark the excess traffic with DSCP value 0 and then transmit the traffic.
- Limit the rate of traffic from Host A to 256 kbps: transmit the conforming traffic normally, and drop the excess traffic.

Perform traffic control on GigabitEthernet 1/0/1 and GigabitEthernet 1/0/2 of Device B to satisfy the following requirements:

- Limit the total incoming traffic rate of GigabitEthernet 1/0/1 to 2048 kbps, and drop the excess traffic.

- Limit the outgoing HTTP traffic (traffic accessing the Internet) rate of GigabitEthernet 1/0/2 to 1024 kbps, and drop the excess traffic.

Figure 13 Network diagram



Configuration procedures

1. Configure Device A:

# Configure ACL 2001 and ACL 2002 to match traffic from Server and Host A, respectively.

```
<DeviceA> system-view
[DeviceA] acl number 2001
[DeviceA-acl-basic-2001] rule permit source 1.1.1.1 0
[DeviceA-acl-basic-2001] quit
[DeviceA] acl number 2002
[DeviceA-acl-basic-2002] rule permit source 1.1.1.2 0
[DeviceA-acl-basic-2002] quit
```

# Create a class named **server**, and use ACL 2001 as the match criterion. Create a class named **host**, and use ACL 2002 as the match criterion.

```
[DeviceA] traffic classifier server
[DeviceA-classifier-server] if-match acl 2001
[DeviceA-classifier-server] quit
[DeviceA] traffic classifier host
[DeviceA-classifier-host] if-match acl 2002
[DeviceA-classifier-host] quit
```

# Create a behavior named **server**, and configure the CAR action for the behavior as follows: set the CIR to 1024 kbps, and mark the excess packets (red packets) with DSCP value 0 and transmit them.

```
[DeviceA] traffic behavior server
[DeviceA-behavior-server] car cir 1024 red remark-dscp-pass 0
[DeviceA-behavior-server] quit
```

# Create a behavior named **host**, and configure the CAR action for the behavior as follows: set the CIR to 256 kbps.

```
[DeviceA] traffic behavior host
[DeviceA-behavior-host] car cir 256
[DeviceA-behavior-host] quit
```

# Create a QoS policy named **car**, and associate class **server** with behavior **server** and class **host** with behavior **host**.

```
[DeviceA] qos policy car
```

```
[DeviceA-qospolicy-car] classifier server behavior server
[DeviceA-qospolicy-car] classifier host behavior host
[DeviceA-qospolicy-car] quit
```

# Apply QoS policy **car** to the incoming traffic of port GigabitEthernet 1/0/1.

```
[DeviceA] interface GigabitEthernet 1/0/1
[DeviceA-GigabitEthernet1/0/1] qos apply policy car inbound
```

2. Configure Device B:

# Configure advanced ACL 3001 to match HTTP traffic.

```
<DeviceB> system-view
[DeviceB] acl number 3001
[DeviceB-acl-adv-3001] rule permit tcp destination-port eq 80
[DeviceB-acl-adv-3001] quit
```

# Create a class named **http**, and use ACL 3001 as the match criterion.

```
[DeviceB] traffic classifier http
[DeviceB-classifier-http] if-match acl 3001
[DeviceB-classifier-http] quit
```

# Create a class named **class**, and configure the class to match all packets.

```
[DeviceB] traffic classifier class
[DeviceB-classifier-class] if-match any
[DeviceB-classifier-class] quit
```

# Create a behavior named **car_inbound**, and configure the CAR action for the behavior as follows: set the CIR to 2048 kbps.

```
[DeviceB] traffic behavior car_inbound
[DeviceB-behavior-car_inbound] car cir 2048
[DeviceB-behavior-car_inbound] quit
```

# Create a behavior named **car_outbound**, and configure a CAR action for the behavior as follows: set the CIR to 1024 kbps.

```
[DeviceB] traffic behavior car_outbound
[DeviceB-behavior-car_outbound] car cir 1024
[DeviceB-behavior-car_outbound] quit
```

# Create a QoS policy named **car_inbound**, and associate class **class** with traffic behavior **car_inbound** in the QoS policy.

```
[DeviceB] qos policy car_inbound
[DeviceB-qospolicy-car_inbound] classifier class behavior car_inbound
[DeviceB-qospolicy-car_inbound] quit
```

# Create a QoS policy named **car_outbound**, and associate class **http** with traffic behavior **car_outbound** in the QoS policy.

```
[DeviceB] qos policy car_outbound
[DeviceB-qospolicy-car_outbound] classifier http behavior car_outbound
[DeviceB-qospolicy-car_outbound] quit
```

# Apply QoS policy **car_inbound** to the incoming traffic of port GigabitEthernet 1/0/1.

```
[DeviceB] interface GigabitEthernet 1/0/1
[DeviceB-GigabitEthernet1/0/1] qos apply policy car_inbound inbound
```

# Apply QoS policy **car_outbound** to the outgoing traffic of port GigabitEthernet 1/0/2.

```
[DeviceB] interface GigabitEthernet 1/0/2
[DeviceB-GigabitEthernet1/0/2] qos apply policy car_outbound outbound
```

Configuring congestion management

Both bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports support the congestion management function. The term "interface" in this chapter collectively refers to these types of ports. You can use the **port link-mode** command to set an Ethernet port to operate in bridge or route mode (see *Layer 2—LAN Switching Configuration Guide*).

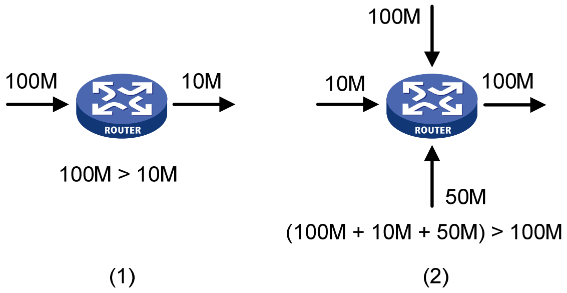
The HP 5500 SI Switch Series does not support Layer 3 Ethernet ports.

Overview

Network congestion degrades service quality on a traditional network. Congestion is a situation where the forwarding rate decreases due to insufficient resources, resulting in extra delay.

Congestion is more likely to occur in complex packet switching circumstances. Figure 14 shows two common cases:

Figure 14 Traffic congestion causes



Congestion can bring the following negative results:

- Increased delay and jitter during packet transmission
- Decreased network throughput and resource use efficiency
- Network resource (memory, in particular) exhaustion and system breakdown

Congestion is unavoidable in switched networks and multi-user application environments. To improve the service performance of your network, you must take proper measures to address the congestion issues.

The key to congestion management is defining a dispatching policy for resources to decide the order of forwarding packets when congestion occurs.

Congestion management techniques

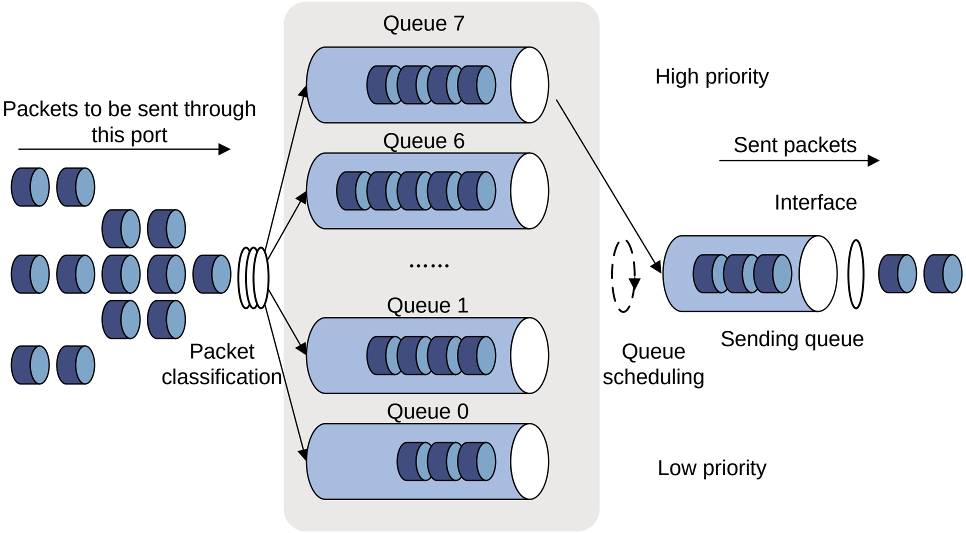
Congestion management uses queuing and scheduling algorithms to classify and sort traffic leaving a port. Each queuing algorithm addresses a particular network traffic problem, and has a different impact on bandwidth resource assignment, delay, and jitter.

Queue scheduling processes packets by their priorities, preferentially forwarding high-priority packets. The following section describes Strict Priority (SP) queuing, Weighted Fair Queuing (WFQ), Weighted Round Robin (WRR) queuing, SP+WRR queuing, and SP+WFQ queuing.

SP queuing

SP queuing is designed for mission-critical applications that require preferential service to reduce the response delay when congestion occurs.

Figure 15 SP queuing



In Figure 15, SP queuing classifies eight queues on a port into eight classes, numbered 7 to 0 in descending priority order.

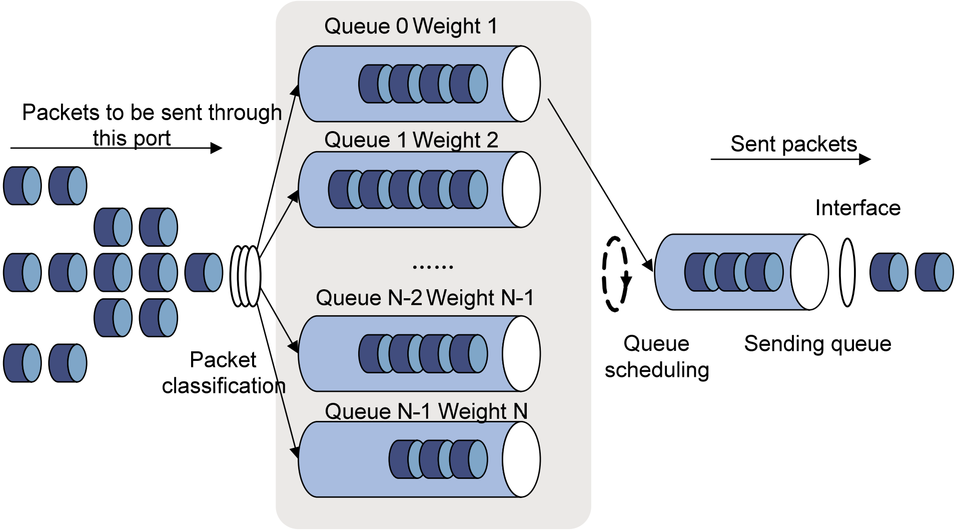
SP queuing schedules the eight queues in the descending order of priority. SP queuing sends packets in the queue with the highest priority first. When the queue with the highest priority is empty, it sends packets in the queue with the second highest priority, and so on. You can assign mission-critical packets to the high priority queue to make sure that they are always served first, and assign common service packets to the low priority queues and transmitted when the high priority queues are empty.

The disadvantage of SP queuing is that packets in the lower priority queues cannot be transmitted if packets exist in the higher priority queues. This may cause lower priority traffic to starve to death.

WRR queuing

WRR queuing schedules all the queues in turn to ensure every queue is served for a certain time, as shown in Figure 16.

Figure 16 WRR queuing



Assume a port provides eight output queues. WRR assigns each queue a weight value (represented by w7, w6, w5, w4, w3, w2, w1, or w0) to decide the proportion of resources assigned to the queue.

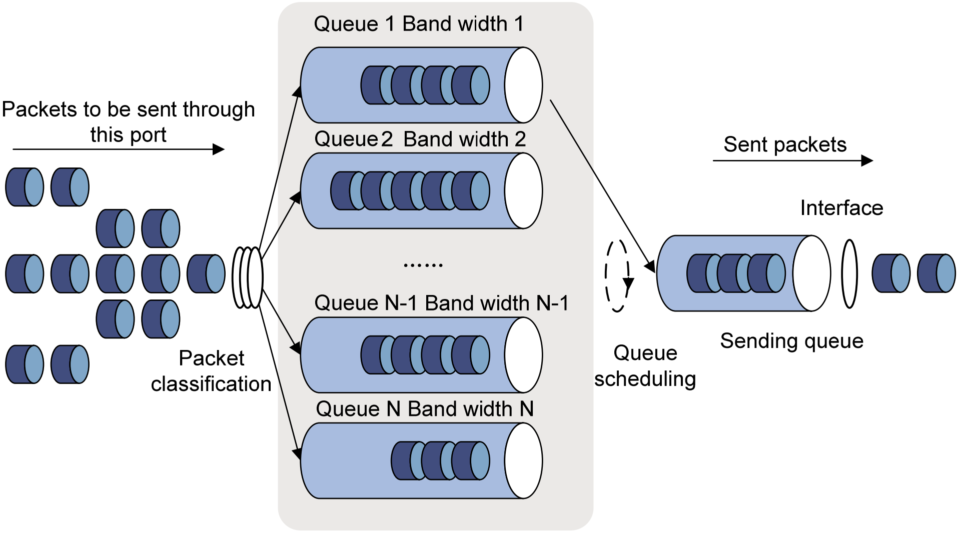
- The HP 5500 SI switch supports byte-count weight, which determines the weight by the number of bytes scheduled in a cycle.
- The HP 5500 EI switch supports byte-count weight (which determines the weight by the number of bytes scheduled in a cycle) or packet-based weight (which determines the weight by the number of packets scheduled in a cycle).

Take the byte-count weight as an example. On a 1000 Mbps port, you can configure the weight values of WRR queuing to 5, 5, 3, 3, 1, 1, 1, and 1 (corresponding to w7, w6, w5, w4, w3, w2, w1, and w0, respectively). In this way, the queue with the lowest priority can get a minimum of 50 Mbps of bandwidth. WRR avoids the disadvantage of SP queuing, where packets in low-priority queues can fail to be served for a long time.

Another advantage of WRR queuing is that when the queues are scheduled in turn, the service time for each queue is not fixed. If a queue is empty, the next queue will be scheduled immediately. This improves bandwidth resource use efficiency.

WFQ queuing

Figure 17 WFQ queuing



WFQ is similar to WRR. You can use WFQ as an alternative to WRR.

Compared with WRR, WFQ can work with the minimum guaranteed bandwidth as follows:

- By setting the minimum guaranteed bandwidth, you can make sure that each WFQ queue is assured of certain bandwidth.
- The assignable bandwidth is allocated based on the weight of each queue (assignable bandwidth = total bandwidth – the sum of minimum guaranteed bandwidth of each queue).

For example, assume the total bandwidth of a port is 10 Mbps, and the port has eight queues, with weights as 1, 1, 1, 1, 3, 3, 5, and 5 and the minimum guaranteed bandwidth as 128 kbps for each queue.

- The assignable bandwidth = 10 Mbps – 128 kbps x 8 = 9 Mbps.
- The total assignable bandwidth quota is the sum of the weights of all queues, 1 + 1 + 1 + 1 + 3 + 3+ 5 + 5 = 20.
- The bandwidth percentage assigned to each queue is weight of the flow/total assignable bandwidth quota. The bandwidth percentages for the queues are 1/20, 1/20, 1/20, 1/20, 3/20, 3/20, 5/20, and 5/20, respectively.
- The bandwidth assigned to a queue = the minimum guaranteed bandwidth + the bandwidth allocated to the queue from the assignable bandwidth.

SP+WRR queuing

You can assign some queues on a port to the SP scheduling group and the others to the WRR scheduling group (group 1) to implement SP + WRR queue scheduling. The switch schedules packets in the SP scheduling group preferentially, and when the SP scheduling group is empty, schedules the packets in the WRR scheduling group. Queues in the SP scheduling group are scheduled with the SP queue scheduling algorithm. Queues in the WRR scheduling group are scheduled with WRR.

SP+WFQ queuing

SP+WFQ queuing is similar to SP+WRR queuing. You can assign some queues on a port to the SP scheduling group and the others to the WFQ scheduling group to implement SP + WFQ queue scheduling. The switch schedules packets of queues in the WFQ group based on their minimum guaranteed bandwidth settings, then uses SP queuing to schedule the queues in the SP scheduling group, and at last uses WFQ to schedule the queues in the WFQ scheduling group in a round robin fashion according to their weights

Configuring SP queuing

Configuration procedure

To configure SP queuing:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter interface view or port group view.	- Enter interface view: **interface** *interface-type interface-number* - Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3.	Configure SP queuing.	**qos sp**	The default queuing algorithm on an interface is WRR queuing.
4.	Display SP queuing configuration.	**display qos sp interface** [*interface-type interface-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Optional. Available in any view

Configuration example

Network requirements

Configure GigabitEthernet 1/0/1 to use SP queuing.

Configuration procedure

# Enter system view

```
<Sysname> system-view
```

# Configure GigabitEthernet1/0/1 to use SP queuing.

```
[Sysname] interface gigabitethernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos sp
```

Configuring WRR queuing

Configuration procedure

To configure WRR queuing:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Enable byte-count or packet-based WRR queuing.	**qos wrr** [**byte-count** | **weight**]	Optional. The default queuing algorithm on an interface is WRR. Only the HP 5500 EI switch supports the **byte-count** and **weight** keywords.
4. Configure the scheduling weight for a queue.	• For a byte-count WRR queue: **qos wrr** *queue-id* **group** *group-id* **byte-count** *schedule-value* • For a packet-based WRR queue: **qos wrr** *queue-id* **group** *group-id* **weight** *schedule-value*	Select an approach according to the WRR queuing type. Only the HP 5500 SI switch supports packet-based WRR queue configuration. By default, packet-based WRR is used, and the weights of queues 0 through 7 are 1, 2, 3, 4, 5, 9, 13, and 15.
5. Display WRR queuing configuration information on interfaces.	**display qos wrr interface** [*interface-type interface-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Optional. Available in any view

NOTE:

To guarantee successful WRR configuration, make sure that the scheduling weight type (byte-count or packet-based) is the same as the WRR queuing type (byte-count or packet-based) when you configure the scheduling weight for a WRR queue.

Configuration example

WRR queuing configuration example on an HP 5500 EI switch

1. Network requirements
   - Configure byte-count WRR on GigabitEthernet 1/0/1.
   - Assign all queues to the WRR group, with the weights of 1, 2, 4, 6, 8, 10, 12, and 14.

2. Configuration procedures

# Enter system view.

```
<Sysname> system-view
```

# Configure WRR queuing on port GigabitEthernet 1/0/1.

```
[Sysname] interface GigabitEthernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos wrr byte-count
[Sysname-GigabitEthernet1/0/1] qos wrr 0 group 1 byte-count 1
[Sysname-GigabitEthernet1/0/1] qos wrr 1 group 1 byte-count 2
[Sysname-GigabitEthernet1/0/1] qos wrr 2 group 1 byte-count 4
[Sysname-GigabitEthernet1/0/1] qos wrr 3 group 1 byte-count 6
[Sysname-GigabitEthernet1/0/1] qos wrr 4 group 1 byte-count 8
[Sysname-GigabitEthernet1/0/1] qos wrr 5 group 1 byte-count 10
[Sysname-GigabitEthernet1/0/1] qos wrr 6 group 1 byte-count 12
[Sysname-GigabitEthernet1/0/1] qos wrr 7 group 1 byte-count 14
```

WRR queuing configuration example on an HP 5500 SI switch

1. Network requirements
   - Configure WRR queuing on port GigabitEthernet 1/0/1.
   - Assign all queues to the WRR group, with the weights of 1, 2, 4, 6, 8, 10, 12, and 14.
2. Configuration procedures

# Enter system view.

```
<Sysname> system-view
```

# Configure WRR queuing on port GigabitEthernet 1/0/1.

```
[Sysname] interface GigabitEthernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos wrr
[Sysname-GigabitEthernet1/0/1] qos wrr 0 group 1 weight 1
[Sysname-GigabitEthernet1/0/1] qos wrr 1 group 1 weight 2
[Sysname-GigabitEthernet1/0/1] qos wrr 2 group 1 weight 4
[Sysname-GigabitEthernet1/0/1] qos wrr 3 group 1 weight 6
[Sysname-GigabitEthernet1/0/1] qos wrr 4 group 1 weight 8
[Sysname-GigabitEthernet1/0/1] qos wrr 5 group 1 weight 10
[Sysname-GigabitEthernet1/0/1] qos wrr 6 group 1 weight 12
[Sysname-GigabitEthernet1/0/1] qos wrr 7 group 1 weight 14
```

Configuring WFQ queuing

Configuration procedure

To configure WFQ queuing:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A

2. Enter interface view or port group view.	- Enter interface view: **interface** *interface-type interface-number* - Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Enable byte-count or packet-based WFQ queuing.	**qos wfq** [**byte-count** | **weight**]	The default queuing algorithm on an interface is WRR.
4. Configure the scheduling weight for a queue.	- For a byte-count WFQ queue: **qos wfq** *queue-id* **group** *group-id* **byte-count** *schedule-value* - For a packet-based WFQ queue: **qos wfq** *queue-id* **group** *group-id* **weight** *schedule-value*	Select a command according to the WFQ type (byte-count or packet-based) you have enabled. If you have enabled WFQ on the port, byte-count WRR applies by default, and the default scheduling weight is 1 for each queue.
5. Configure the minimum guaranteed bandwidth for a WFQ queue.	**qos bandwidth queue** *queue-id* **min** *bandwidth-value*	Optional. 64 kbps by default for each queue.
6. Display WFQ queuing configuration.	**display qos wfq interface** [*interface-type interface-number*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Optional. Available in any view

NOTE:

To guarantee successful WFQ configuration, make sure that the scheduling weight type (byte-count or packet-based) is the same as the WFQ queuing type (byte-count or packet-based) when you configure the scheduling weight for a WFQ queue.

Configuration example

Network requirements

Configure WFQ queues on an interface and assign the scheduling weight 2, 5, 10, 10, and 10 to queue 1, queue 3, queue 4, queue 5, and queue 6, respectively.

Configuration procedure

# Enter system view.

```
<Sysname> system-view
```

# Configure WFQ queues on GigabitEthernet 1/0/1.

```
[Sysname] interface gigabitethernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos wfq
[Sysname-GigabitEthernet1/0/1] qos wfq 1 weight 2
[Sysname-GigabitEthernet1/0/1] qos wfq 3 weight 5
[Sysname-GigabitEthernet1/0/1] qos wfq 4 weight 10
[Sysname-GigabitEthernet1/0/1] qos wfq 5 weight 10
[Sysname-GigabitEthernet1/0/1] qos wfq 6 weight 10
```

Configuring SP+WRR queuing

Configuration procedure

To configure SP + WRR queuing:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3.	Enable byte-count or packet-based WRR queuing.	**qos wrr** [**byte-count** | **weight**]	Optional. By default, all ports use WRR queuing. Only the HP 5500 EI switch supports the **byte-count** and **weight** keywords.
4.	Configure SP queue scheduling.	**qos wrr** *queue-id* **group sp**	By default, all the queues of a WRR-enabled port use the WRR queue scheduling algorithm.
5.	Assign a queue to a WRR group and configure the scheduling weight for the queue.	**qos wrr** *queue-id* **group** *group-id* { **weight** | **byte-count** } *schedule-value*	By default, on a WRR-enabled port, packet-based WRR is enabled, and the weights of queues 0 through 7 are 1, 2, 3, 4, 5, 9, 13, and 15. The HP 5500 SI switch supports only the **weight** keyword.

NOTE:

To guarantee successful WRR configuration, make sure that the scheduling weight type (byte-count or packet-based) is the same as the WRR queuing type (byte-count or packet-based) when you configure the scheduling weight for a WRR queue.

Configuration example

Network requirements

- Configure SP+WRR queue scheduling algorithm on GigabitEthernet 1/0/1, and use packet-based WRR.
- Configure queue 0, queue 1, queue 2, and queue 3 on GigabitEthernet 1/0/1 to be in SP queue scheduling group.
- Configure queue 4, queue 5, queue 6, and queue 7 on GigabitEthernet 1/0/1 to use WRR queuing, with the weight 2, 4, 6, and 8, respectively.

Configuration procedure

# Enter system view.

```
<Sysname> system-view
```

# Enable the SP+WRR queue scheduling algorithm on GigabitEthernet1/0/1.

```
[Sysname] interface GigabitEthernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos wrr weight
[Sysname-GigabitEthernet1/0/1] qos wrr 0 group sp
[Sysname-GigabitEthernet1/0/1] qos wrr 1 group sp
[Sysname-GigabitEthernet1/0/1] qos wrr 2 group sp
[Sysname-GigabitEthernet1/0/1] qos wrr 3 group sp
[Sysname-GigabitEthernet1/0/1] qos wrr 4 group 1 weight 2
[Sysname-GigabitEthernet1/0/1] qos wrr 5 group 1 weight 4
[Sysname-GigabitEthernet1/0/1] qos wrr 6 group 1 weight 6
[Sysname-GigabitEthernet1/0/1] qos wrr 7 group 1 weight 8
```

Configuring SP+WFQ queuing

Configuration procedure

To configure SP + WFQ queuing:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
3. Enable byte-count or packet-based WFQ queuing.	**qos wfq** [**byte-count** | **weight**]	By default, WRR queuing is enabled.
4. Configure SP queue scheduling.	**qos wfq** *queue-id* **group sp**	By default, all the queues of a WFQ-enabled port use are in the WFQ group.
5. Configure the scheduling weight for a queue.	**qos wfq** *queue-id* **group** *group-id* { **weight** | **byte-count** } *schedule-value*	By default, the scheduling weight is 1 for each queue of a WFQ-enabled port.
6. Configure the minimum guaranteed bandwidth for a queue.	**qos bandwidth queue** *queue-id* **min** *bandwidth-value*	Optional. 64 kbps for each queue by default.

NOTE:

To guarantee successful WFQ configuration, make sure that the scheduling weight type (byte-count or packet-based) is the same as the WFQ queuing type (byte-count or packet-based) when you configure the scheduling weight for a WFQ queue.

Configuration example

Network requirements

- Configure SP+WFQ queuing on GigabitEthernet 1/0/1, and use packet-based WFQ scheduling weights.
- Configure queue 0, queue 1, queue 2, and queue 3 on GigabitEthernet 1/0/1 to be in SP queue scheduling group.
- Configure queue 4, queue 5, queue 6, and queue 7 on GigabitEthernet 1/0/1 to use WFQ queuing, with the weight 2, 4, 6, and 8 and the minimum guaranteed bandwidth 128 kbps.

Configuration procedure

# Enter system view.

```
<Sysname> system-view
```

# Enable the SP+WFQ queue scheduling algorithm on GigabitEthernet1/0/1.

```
[Sysname] interface GigabitEthernet 1/0/1
[Sysname-GigabitEthernet1/0/1] qos wfq weight
[Sysname-GigabitEthernet1/0/1] qos wfq 0 group sp
[Sysname-GigabitEthernet1/0/1] qos wfq 1 group sp
[Sysname-GigabitEthernet1/0/1] qos wfq 2 group sp
[Sysname-GigabitEthernet1/0/1] qos wfq 3 group sp
[Sysname-GigabitEthernet1/0/1] qos wfq 4 group 1 weight 2
[Sysname-GigabitEthernet1/0/1] qos bandwidth queue 4 min 128
[Sysname-GigabitEthernet1/0/1] qos wfq 5 group 1 weight 4
[Sysname-GigabitEthernet1/0/1] qos bandwidth queue 5 min 128
[Sysname-GigabitEthernet1/0/1] qos wfq 6 group 1 weight 6
[Sysname-GigabitEthernet1/0/1] qos bandwidth queue 6 min 128
[Sysname-GigabitEthernet1/0/1] qos wfq 7 group 1 weight 8
[Sysname-GigabitEthernet1/0/1] qos bandwidth queue 7 min 128
```

Configuring congestion avoidance (available only on the HP 5500 EI)

Both bridge mode (Layer 2) and route mode (Layer 3) Ethernet ports support the congestion avoidance function. The term "interface" in this chapter collectively refers to these types of ports. You can use the **port link-mode** command to set an Ethernet port to operate in bridge or route mode (see *Layer 2—LAN Switching Configuration Guide*).

Overview

Avoiding congestion before it occurs is a proactive approach to improving network performance. As a flow control mechanism, congestion avoidance actively monitors network resources (such as queues and memory buffers), and drops packets when congestion is expected to occur or deteriorate.

Compared with end-to-end flow control, this flow control mechanism controls the load of more flows in a device. When dropping packets from a source end, it cooperates with the flow control mechanism (such as TCP flow control) at the source end to regulate the network traffic size. The combination of the local packet drop policy and the source-end flow control mechanism helps maximize throughput and network use efficiency and minimize packet loss and delay.

Tail drop

Congestion management techniques drop all packets that are arriving at a full queue. This tail drop mechanism results in global TCP synchronization. If packets from multiple TCP connections are dropped, these TCP connections go into the state of congestion avoidance and slow start to reduce traffic, but traffic peak occurs later. Consequently, the network traffic jitters all the time.

RED and WRED

You can use random early detection (RED) or weighted random early detection (WRED) to avoid global TCP synchronization.

Both RED and WRED avoid global TCP synchronization by randomly dropping packets. When the sending rates of some TCP sessions slow down after their packets are dropped, other TCP sessions remain at high sending rates. Link bandwidth is efficiently used, because TCP sessions at high sending rates always exist.

The RED or WRED algorithm sets an upper threshold and lower threshold for each queue, and processes the packets in a queue as follows:

- When the queue size is shorter than the lower threshold, no packet is dropped;
- When the queue size reaches the upper threshold, all subsequent packets are dropped;
- When the queue size is between the lower threshold and the upper threshold, the received packets are dropped at random. The drop probability in a queue increases along with the queue size under the maximum drop probability.

NOTE:

The Switch Series does not support the upper threshold configuration.

Introduction to WRED configuration

On the Switch Series, WRED is implemented with WRED tables. WRED tables are created globally in system view and then applied to interfaces.

Before configuring WRED, determine the following parameters:

- **Lower threshold**—When the average queue length is below the lower threshold, no packet is dropped. When the average queue length exceeds the lower threshold, the switch drops packets at the user-configured drop probability.
- **Drop precedence**—A parameter used in packet drop. Value 0 represents green packets, 1 represents yellow packets, and 2 represents red packets. Red packets are preferentially dropped.
- **Denominator**—Denominator for drop probability calculation. A greater denominator means a lower drop probability. Table 7 shows the denominator and the drop probability dependencies.

Table 7 Denominator and the drop probability dependencies

Denominator	Drop probability
0	100%
1 to 8	1/8
9 to 16	1/16
17 to 32	1/32
33 to 64	1/64
65 to 128	1/128

Configuring WRED

In a WRED table, drop parameters are configured on a per queue basis because WRED regulates packets on a per queue basis.

A WRED table can be applied to multiple interfaces. For a WRED table already applied to an interface, you can modify the values of the WRED table, but you cannot remove the WRED table.

Configuration procedure

To configure and apply a queue-based WRED table:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Create a WRED table and enter its view.	**qos wred queue table** *table-name*	N/A

3.	Configure the other WRED parameters.	**queue** *queue-value* [**drop-level** *drop-level*] **low-limit** *low-limit* [**discard-probability** *discard-prob*]	Optional. By default, *low-limit* is 10, and *discard-prob* is 10.
4.	Enter interface view or port group view.	• Enter interface view: **interface** *interface-type interface-number* • Enter port group view: **port-group manual** *port-group-name*	Use either command. Settings in interface view take effect on the current interface. Settings in port group view take effect on all ports in the port group.
5.	Apply the WRED table to the interface or port group.	**qos wred apply** *table-name*	N/A

Configuration examples

Apply a WRED table to Layer 2 port GigabitEthernet 1/0/1. Set the *low-limit* to 30 and *discard-prob* to 20 for queue 1.

# Enter system view.

```
<Sysname> system-view
```

# Create a queue-based WRED table named **queue-table1**, and configure the drop parameters.

```
[Sysname] qos wred queue table queue-table1
[Sysname-wred-table-queue-table1] queue 1 low-limit 30 discard-probability 20
[Sysname-wred-table-queue-table1] quit
```

# Enter port view.

```
[Sysname] interface gigabitethernet 1/0/1
```

# Apply the WRED table to GigabitEthernet 1/0/1.

```
[Sysname-GigabitEthernet1/0/1] qos wred apply queue-table1
```

Displaying and maintaining WRED

Task	Command	Remarks
Display WRED configuration information on the interface or all interfaces.	**display qos wred interface** [*interface-type interface-number*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view
Display configuration information about a WRED table or all WRED tables.	**display qos wred table** [*table-name*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Available in any view

Configuring traffic filtering

Traffic filtering filters traffic matching certain criteria. For example, you can filter packets sourced from a specific IP address according to network status.

Configuration procedure

To configure traffic filtering:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	N/A
3. Configure match criteria.	**if-match** *match-criteria*	N/A
4. Return to system view.	**quit**	N/A
5. Create a behavior and enter behavior view.	**traffic behavior** *behavior-name*	N/A
6. Configure the traffic filtering action.	**filter** { **deny** | **permit** }	• **deny**—Drops packets. • **permit**—Permits packets to pass through.
7. Return to system view.	**quit**	N/A
8. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
9. Associate the class with the traffic behavior in the QoS policy.	**classifier** *tcl-name* **behavior** *behavior-name*	N/A
10. Return to system view.	**quit**	N/A
11. Apply the QoS policy.	• Applying the QoS policy to an interface • Applying the QoS policy to online users • Applying the QoS policy to a VLAN • Applying the QoS policy globally • Applying the QoS policy to the control plane	Choose one application destination as needed.
12. Display the traffic filtering configuration.	**display traffic behavior user-defined** [*behavior-name*] [| { **begin** | **exclude** | **include** } *regular-expression*]	Optional. Available in any view

NOTE:

With **filter deny** configured for a traffic behavior, the other actions (except class-based accounting and traffic mirroring) in the traffic behavior do not take effect.

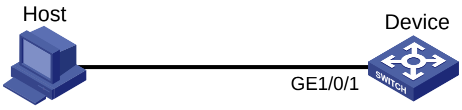
Traffic filtering configuration example

Network requirements

As shown in Figure 18, Host is connected to GigabitEthernet 1/0/1 of Device.

Configure traffic filtering to filter the packets with source port not being 21, and received on GigabitEthernet 1/0/1.

Figure 18 Network diagram



Configuration procedure

# Create advanced ACL 3000, and configure a rule to match packets whose source port number is not 21.

```
<DeviceA> system-view
[DeviceA] acl number 3000
[DeviceA-acl-adv-3000] rule 0 permit tcp source-port neq 21
[DeviceA-acl-adv-3000] quit
```

# Create a class named **classifier_1**, and use ACL 3000 as the match criterion in the class.

```
[DeviceA] traffic classifier classifier_1
[DeviceA-classifier-classifier_1] if-match acl 3000
[DeviceA-classifier-classifier_1] quit
```

# Create a behavior named **behavior_1**, and configure the traffic filtering action to drop packets.

```
[DeviceA] traffic behavior behavior_1
[DeviceA-behavior-behavior_1] filter deny
[DeviceA-behavior-behavior_1] quit
```

# Create a policy named **policy**, and associate class **classifier_1** with behavior **behavior_1** in the policy.

```
[DeviceA] qos policy policy
[DeviceA-qospolicy-policy] classifier classifier_1 behavior behavior_1
[DeviceA-qospolicy-policy] quit
```

# Apply the policy named **policy** to the incoming traffic of GigabitEthernet 1/0/1.

```
[DeviceA] interface gigabitethernet 1/0/1
[DeviceA-GigabitEthernet1/0/1] qos apply policy policy inbound
```

Configuring priority marking

Priority marking sets the priority fields or flag bits of packets to modify the priority of traffic. For example, you can use priority marking to set IP precedence or DSCP for a class of IP traffic to change its transmission priority in the network.

Priority marking can be used together with priority mapping. For more information about priority mapping, see "Configuring priority mapping."

Color-based priority marking

Coloring a packet

The switch colors a packet to indicate its transmission priority after evaluating the status of processing resources and the priority of the packet.

The switch can color a packet by using one of the following approaches:

- Uses the token bucket mechanism (bucket C and bucket E) of traffic policing:
    - If bucket C has enough tokens, the packet is colored green.
    - If bucket C does not have enough tokens but bucket E has enough tokens, the packet is colored yellow.
    - If neither bucket C nor bucket E has enough tokens, the packet is colored red.
- If traffic policing is not configured, looks up the 802.1p priority of a packet in the 802.1p-to-drop priority mapping table, allocates drop precedence to the packet, and colors the packet according to the drop precedence.
    - Drop precedence 0 represents green packets.
    - Drop precedence 1 represents yellow packets.
    - Drop precedence 2 represents red packets.

For more information about traffic policing function, see "Configuring traffic policing, traffic shaping, and rate limit." For more information about priority mapping tables, see "Configuring priority mapping."

Marking packets based on their colors

Color-based priority marking supports re-marking DSCP precedence.

You can configure color-based marking in the following ways:

- To mark packets based on a color set during traffic policing, configure a priority marking action for the color in the traffic policing action **car**. For more information, see "Configuring traffic policing."
- To mark packets based on their drop precedence, configure a priority marking action for a color by using the **remark** command as described in the subsequent section.

IMPORTANT:

Do not use the **remark** command together with the **car** command in a traffic behavior to perform color-based marking.

Configuration procedure

To configure priority marking:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	N/A
3. Configure match criteria.	**if-match** *match-criteria*	N/A
4. Return to system view.	**quit**	N/A
5. Create a behavior and enter behavior view.	**traffic behavior** *behavior-name*	N/A
6. Set the DSCP value for packets.	**remark** [**green** | **red** | **yellow**] **dscp** *dscp-value*	Optional.
7. Set the 802.1p priority for packets or configure the inner-to-outer tag priority copying function.	**remark dot1p** { *8021p* | **customer-dot1p-trust** }	Optional.
8. Set the drop precedence for packets.	**remark drop-precedence** *drop-precedence-value*	Optional. Applicable to only the outbound direction.
9. Set the IP precedence for packets.	**remark ip-precedence** *ip-precedence-value*	Optional.
10. Set the local precedence for packets.	**remark local-precedence** *local-precedence*	Optional.
11. Return to system view.	**quit**	N/A
12. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
13. Associate the class with the traffic behavior in the QoS policy.	**classifier** *tcl-name* **behavior** *behavior-name*	N/A
14. Return to system view.	**quit**	N/A
15. Apply the QoS policy.	• Applying the QoS policy to an interface • Applying the QoS policy to online users • Applying the QoS policy to a VLAN • Applying the QoS policy globally • Applying the QoS policy to the control plane	Choose one application destination as needed.
16. Display the priority marking configuration.	**display traffic behavior user-defined** [*behavior-name*] [**|** { **begin** | **exclude** | **include** } *regular-expression*]	Optional. Available in any view

The following table shows the support for priority marking actions in the inbound and outbound directions.

Table 8 Support for priority marking actions in the inbound and outbound directions

Action	inbound	outbound
802.1p priority marking	Yes	Yes
Drop precedence marking	Yes	No
DSCP marking	Yes	Yes
IP precedence marking	Yes	Yes
Local precedence marking	Yes	No

Local precedence re-marking configuration example

Network requirements

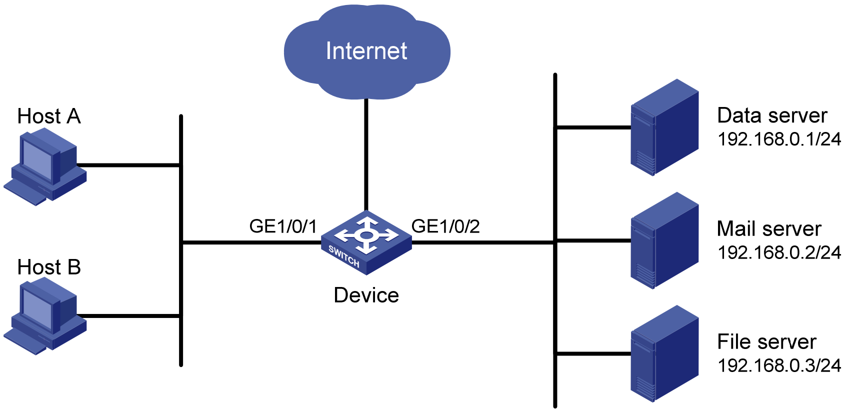
As shown in Figure 19, the company's enterprise network interconnects hosts with servers through Device. The network is described as follows:

- Host A and Host B are connected to GigabitEthernet 1/0/1 of Device.
- The data server, mail server, and file server are connected to GigabitEthernet 1/0/2 of Device.

Configure priority marking on Device to satisfy the following requirements:

Traffic source	Destination	Processing priority
Host A, B	Data server	High
Host A, B	Mail server	Medium
Host A, B	File server	Low

Figure 19 Network diagram



Configuration procedure

# Create advanced ACL 3000, and configure a rule to match packets with destination IP address 192.168.0.1.

```
<Device> system-view
[Device] acl number 3000
[Device-acl-adv-3000] rule permit ip destination 192.168.0.1 0
[Device-acl-adv-3000] quit
```

# Create advanced ACL 3001, and configure a rule to match packets with destination IP address 192.168.0.2.

```
[Device] acl number 3001
[Device-acl-adv-3001] rule permit ip destination 192.168.0.2 0
[Device-acl-adv-3001] quit
```

# Create advanced ACL 3002, and configure a rule to match packets with destination IP address 192.168.0.3.

```
[Device] acl number 3002
[Device-acl-adv-3002] rule permit ip destination 192.168.0.3 0
[Device-acl-adv-3002] quit
```

# Create a class named **classifier_dbserver**, and use ACL 3000 as the match criterion in the class.

```
[Device] traffic classifier classifier_dbserver
[Device-classifier-classifier_dbserver] if-match acl 3000
[Device-classifier-classifier_dbserver] quit
```

# Create a class named **classifier_mserver**, and use ACL 3001 as the match criterion in the class.

```
[Device] traffic classifier classifier_mserver
[Device-classifier-classifier_mserver] if-match acl 3001
[Device-classifier-classifier_mserver] quit
```

# Create a class named **classifier_fserver**, and use ACL 3002 as the match criterion in the class.

```
[Device] traffic classifier classifier_fserver
[Device-classifier-classifier_fserver] if-match acl 3002
[Device-classifier-classifier_fserver] quit
```

# Create a behavior named **behavior_dbserver**, and configure the action of setting the local precedence value to 4.

```
[Device] traffic behavior behavior_dbserver
[Device-behavior-behavior_dbserver] remark local-precedence 4
[Device-behavior-behavior_dbserver] quit
```

# Create a behavior named **behavior_mserver**, and configure the action of setting the local precedence value to 3.

```
[Device] traffic behavior behavior_mserver
[Device-behavior-behavior_mserver] remark local-precedence 3
[Device-behavior-behavior_mserver] quit
```

# Create a behavior named **behavior_fserver**, and configure the action of setting the local precedence value to 2.

```
[Device] traffic behavior behavior_fserver
[Device-behavior-behavior_fserver] remark local-precedence 2
[Device-behavior-behavior_fserver] quit
```

# Create a policy named **policy_server**, and associate classes with behaviors in the policy.

```
[Device] qos policy policy_server
[Device-qospolicy-policy_server] classifier classifier_dbserver behavior
behavior_dbserver
```

```
[Device-qospolicy-policy_server] classifier classifier_mserver behavior
behavior_mserver
[Device-qospolicy-policy_server] classifier classifier_fserver behavior
behavior_fserver
[Device-qospolicy-policy_server] quit
```

# Apply the policy named **policy_server** to the incoming traffic of GigabitEthernet 1/0/1.

```
[Device] interface gigabitethernet 1/0/1
[Device-GigabitEthernet1/0/1] qos apply policy policy_server inbound
[Device-GigabitEthernet1/0/1] quit
```

Configuring traffic redirecting

Traffic redirecting is the action of redirecting the packets matching the specific match criteria to a certain location for processing.

The following redirect actions are supported:

- **Redirecting traffic to the CPU**—redirects packets that require processing by the CPU to the CPU.
- **Redirecting traffic to an interface**—redirects packets that require processing by an interface to the interface. Note that this action applies to only Layer 2 packets, and the target interface must be a Layer 2 interface.
- **Redirecting traffic to the next hop**—redirects packets that require processing by an interface to the interface. This action can be used to implement policy-based routing. For more information about policy-based routing, see *Layer 3—IP Routing Configuration Guide*.

IMPORTANT:

The HP 5500 SI switch does not support redirecting traffic to the next hop.

Configuration restrictions and guidelines

- The actions of redirecting traffic to the CPU, redirecting traffic to an interface, and redirecting traffic to the next hop are mutually exclusive with each other in the same traffic behavior.
- A QoS policy with traffic redirecting actions can be applied to only the inbound direction of a port, VLAN, or all ports.
- The default of the **fail-action** keyword is **forward**.
- You can use the **display traffic behavior user-defined** command to view the traffic redirecting configuration.

Configuration procedure

To configure traffic redirecting:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	N/A
3.	Configure match criteria.	**if-match** *match-criteria*	N/A
4.	Return to system view.	**quit**	N/A
5.	Create a behavior and enter behavior view.	**traffic behavior** *behavior-name*	N/A

Step	Command	Remarks
6. Configure a traffic redirecting action.	**redirect** { **cpu** | **interface** *interface-type interface-number* | **next-hop** { *ipv4-add1* [*ipv4-add2*] | *ipv6-add1* [*interface-type interface-number*] [*ipv6-add2* [*interface-type interface-number*]] } [**fail-action** { **discard** | **forward** }] }	The HP 5500 SI switch does not support the **next-hop** or **fail-action** keyword.
7. Return to system view.	**quit**	N/A
8. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
9. Associate the class with the traffic behavior in the QoS policy.	**classifier** *tcl-name* **behavior** *behavior-name*	N/A
10. Return to system view.	**quit**	N/A
11. Apply the QoS policy.	• Applying the QoS policy to an interface • Applying the QoS policy to a VLAN • Applying the QoS policy globally • Applying the QoS policy to the control plane	Choose one application destination as needed.

Redirect-to-next hop configuration example

Network requirements

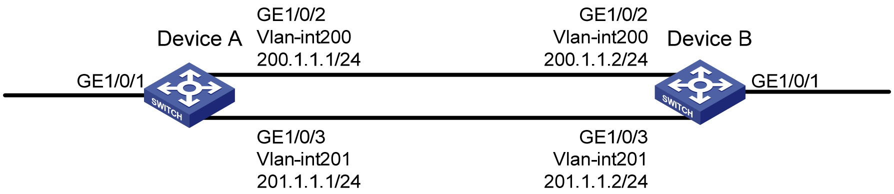
As shown in Figure 20, the network is described as follows:

- Device A is connected to Device through two links. At the same time, Device A and Device B are each connected to other devices.
- GigabitEthernet 1/0/2 of Device A and GigabitEthernet 1/0/2 of Device B belong to VLAN 200.
- Ethernet 1/3 of Device A and Ethernet 1/3 of Device B belong to VLAN 201.
- On Device A, the IP address of VLAN-interface 200 is 200.1.1.1/24, and that of VLAN-interface 201 is 201.1.1.1/24.
- On Device B, the IP address of VLAN-interface 200 is 200.1.1.2/24, and that of VLAN-interface 201 is 201.1.1.2/24.

Configure the actions of redirecting traffic to the next hop to implement policy-based routing and satisfy the following requirements:

- Packets with source IP address 2.1.1.1 received on GigabitEthernet 1/0/1 of Device A are forwarded to IP address 200.1.1.2.
- Packets with source IP address 2.1.1.2 received on GigabitEthernet 1/0/1 of Device A are forwarded to IP address 201.1.1.2.
- Other packets received on GigabitEthernet 1/0/1 of Device A are forwarded according to the routing table.

Figure 20 Network diagram



Configuration procedure

# Create basic ACL 2000, and configure a rule to match packets with source IP address 2.1.1.1.

```
<DeviceA> system-view
[DeviceA] acl number 2000
[DeviceA-acl-basic-2000] rule permit source 2.1.1.1 0
[DeviceA-acl-basic-2000] quit
```

# Create basic ACL 2001, and configure a rule to match packets with source IP address 2.1.1.2.

```
[DeviceA] acl number 2001
[DeviceA-acl-basic-2001] rule permit source 2.1.1.2 0
[DeviceA-acl-basic-2001] quit
```

# Create a class named **classifier_1**, and use ACL 2000 as the match criterion in the class.

```
[DeviceA] traffic classifier classifier_1
[DeviceA-classifier-classifier_1] if-match acl 2000
[DeviceA-classifier-classifier_1] quit
```

# Create a class named **classifier_2**, and use ACL 2001 as the match criterion in the class.

```
[DeviceA] traffic classifier classifier_2
[DeviceA-classifier-classifier_2] if-match acl 2001
[DeviceA-classifier-classifier_2] quit
```

# Create a behavior named **behavior_1**, and configure the action of redirecting traffic to the next hop 200.1.1.2.

```
[DeviceA] traffic behavior behavior_1
[DeviceA-behavior-behavior_1] redirect next-hop 200.1.1.2
[DeviceA-behavior-behavior_1] quit
```

# Create a behavior named **behavior_2**, and configure the action of redirecting traffic to the next hop 200.1.1.2.

```
[DeviceA] traffic behavior behavior_2
[DeviceA-behavior-behavior_2] redirect next-hop 201.1.1.2
[DeviceA-behavior-behavior_2] quit
```

# Create a policy named **policy**, associate class **classifier_1** with behavior **behavior_1**, and associate class **classifier_2** with behavior **behavior_2** in the policy.

```
[DeviceA] qos policy policy
[DeviceA-qospolicy-policy] classifier classifier_1 behavior behavior_1
[DeviceA-qospolicy-policy] classifier classifier_2 behavior behavior_2
[DeviceA-qospolicy-policy] quit
```

# Apply the policy named **policy** to the incoming traffic of GigabitEthernet 1/0/1.

```
[DeviceA] interface gigabitethernet 1/0/1
```

```
[DeviceA-GigabitEthernet1/0/1] qos apply policy policy inbound
```

Configuring class-based accounting

Class-based accounting collects statistics (in packets or bytes) on a per-traffic class basis. For example, you can define the action to collect statistics for traffic sourced from a certain IP address. By analyzing the statistics, you can determine whether anomalies have occurred and what action to take. The HP 5500 SI/EI switch supports only collecting statistics in packets.

Configuration procedure

To configure class-based accounting:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Create a class and enter class view.	**traffic classifier** *tcl-name* [**operator** { **and** | **or** }]	N/A
3. Configure match criteria.	**if-match** *match-criteria*	N/A
4. Return to system view.	**quit**	N/A
5. Create a behavior and enter behavior view.	**traffic behavior** *behavior-name*	N/A
6. Configure the accounting action.	**accounting**	N/A
7. Return to system view.	**quit**	N/A
8. Create a policy and enter policy view.	**qos policy** *policy-name*	N/A
9. Associate the class with the traffic behavior in the QoS policy.	**classifier** *tcl-name* **behavior** *behavior-name*	N/A
10. Return to system view.	**quit**	N/A
11. Apply the QoS policy.	• Applying the QoS policy to an interface • Applying the QoS policy to a VLAN • Applying the QoS policy globally • Applying the QoS policy to the control plane	Choose one application destination as needed.

Displaying and maintaining traffic accounting

You can verify the configuration with the **display qos policy global**, **display qos policy interface**, or **display qos vlan-policy** command depending on the occasion where the QoS policy is applied.

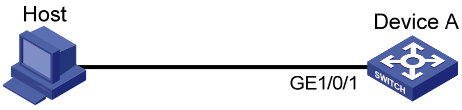
Class-based accounting configuration example

Network requirements

As shown in Figure 21, Host is connected to GigabitEthernet 1/0/1 of Device A.

Configure class-based accounting to collect statistics for traffic sourced from 1.1.1.1/24 and received on GigabitEthernet 1/0/1.

Figure 21 Network diagram



Configuration procedure

# Create basic ACL 2000, and configure a rule to match packets with source IP address 1.1.1.1.

```
<DeviceA> system-view
[DeviceA] acl number 2000
[DeviceA-acl-basic-2000] rule permit source 1.1.1.1 0
[DeviceA-acl-basic-2000] quit
```

# Create a class named **classifier_1**, and use ACL 2000 as the match criterion in the class.

```
[DeviceA] traffic classifier classifier_1
[DeviceA-classifier-classifier_1] if-match acl 2000
[DeviceA-classifier-classifier_1] quit
```

# Create a behavior named **behavior_1**, and configure the traffic accounting action.

```
[DeviceA] traffic behavior behavior_1
[DeviceA-behavior-behavior_1] accounting
[DeviceA-behavior-behavior_1] quit
```

# Create a policy named **policy**, and associate class **classifier_1** with behavior **behavior_1** in the policy.

```
[DeviceA] qos policy policy
[DeviceA-qospolicy-policy] classifier classifier_1 behavior behavior_1
[DeviceA-qospolicy-policy] quit
```

# Apply the policy named **policy** to the incoming traffic of GigabitEthernet 1/0/1.

```
[DeviceA] interface gigabitethernet 1/0/1
[DeviceA-GigabitEthernet1/0/1] qos apply policy policy inbound
[DeviceA-GigabitEthernet1/0/1] quit
```

# Display traffic statistics to verify the configuration.

```
[DeviceA] display qos policy interface gigabitethernet 1/0/1

  Interface: GigabitEthernet1/0/1

  Direction: Inbound

  Policy: policy
   Classifier: classifier_1
```

```
Operator: AND
Rule(s) : If-match acl 2000
Behavior: behavior_1
 Accounting Enable:
   28529 (Packets)
```

Configuring the data buffer

Overview

Data buffer

The Switch Series provides the data buffer to buffer packets to be sent out ports to avoid packet loss when bursty traffic causes congestion.

The switch controls how a port uses the data buffer by allocating the cell resource and packet resource (called "buffer resources").

- The cell resource is the physical storage space in cells for the data buffer. The cell resource allocated to a port indicates the maximum buffer space that the port can occupy in the buffer.
- The packet resource is the logical buffering space in packets. A packet is counted as one regardless of its length. A packet in the packet resource uses a certain amount of cell resources in the cell resource, depending on its length. The packet resource allocated to a port indicates the maximum number of packets that the port can store in the buffer.

Set independently, the packet resource and the cell resource work simultaneously to regulate data buffering. A packet can be buffered only when both resources are adequate.

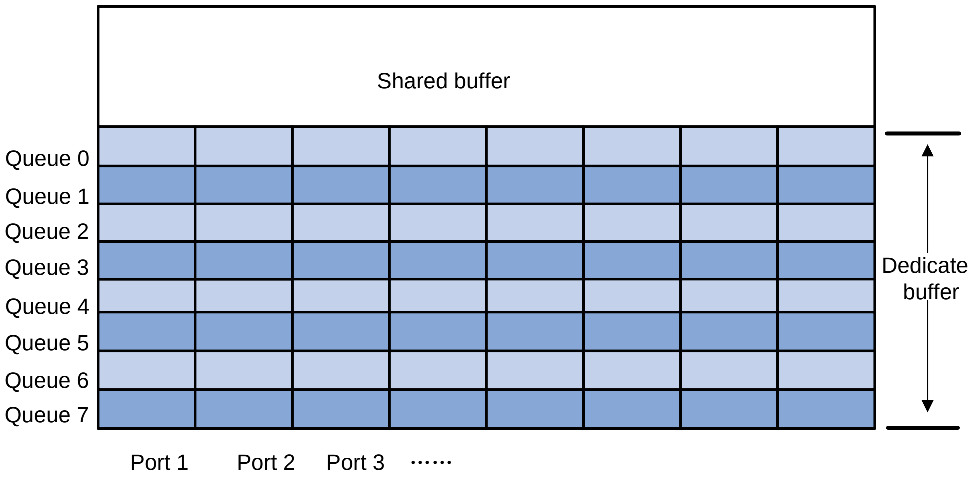
Data buffer allocation

Cell resource allocation

The cell resource is divided into a shared resource and a dedicated resource. You can manually set the percentage of the shared resource to the total buffer, and the remaining buffer becomes the dedicated resource automatically.

On an HP 5500 SI/EI switch, the cell resource is allocated as shown in Figure 22.

Figure 22 Cell resource allocation on the HP 5500 SI/EI switch



The dedicated resource is allocated following these rules:

- **On a per-port basis**—As illustrated by the vertical lines in Figure 22, the switch automatically divides the dedicated resource among all ports evenly.
- **On a per-queue basis**—As illustrated by the horizontal lines in Figure 22, the dedicated resource of each port is proportionately allocated among the queues on it and all ports use the same allocation scheme. The percentage of the resource allocated to a queue is called the minimum guaranteed resource percentage of the queue.

The shared buffer in the cell resource can buffer the bursty traffic on ports. The shared resource is shared by all queues of all ports. When a certain queue of a port is congested because its dedicated cell resource gets full, it can use a certain portion of the shared resource of the cell resource. The maximum shared resource size available for a queue is defined as a percentage of the shared resource. After the bursty traffic is transmitted, the shared resource used by the bursty traffic is released for other ports or queues to use. For example, you can configure port 1 to use 30% of the shared buffer of the cell resource.

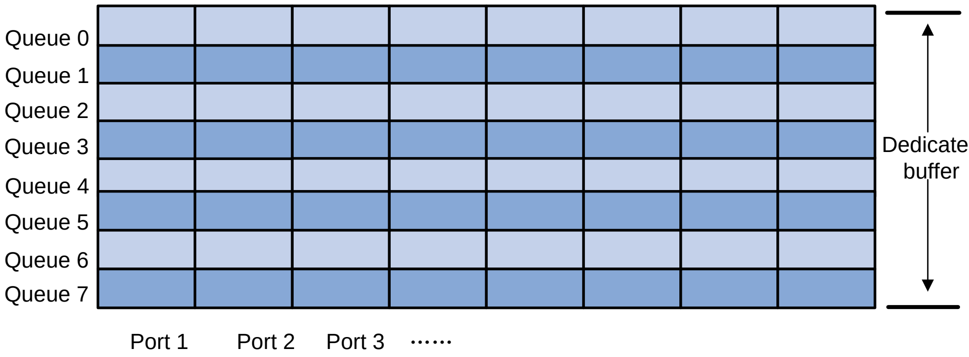
You can perform the following parameters for the cell resource:

- Configure the shared resource size
- Configure the minimum guaranteed resource size for a queue
- Configure the maximum shared resource size for a port

Packet resource allocation

Different from the cell resource, the packet resource does not have a shared resource, and the whole buffer is evenly allocated to ports, as shown in Figure 23.

Figure 23 Packet resource allocation on the HP 5500 SI/EI switch



Like the packet resource, the cell resource is also allocated on a per-port basis and on a per-queue basis. Because the packet resource does not have the shared resource, you can adjust only the percentage of the queue buffer to the port buffer, which is called the minimum guaranteed buffer percentage.

Data buffer configuration approaches

You can configure the data buffer on the HP 5500 SI/EI Switch Series in one of the following approaches:

- Using the burst function to configure the data buffer setup
- Manually configuring the data buffer setup

NOTE:

The two approaches are mutually exclusive. If the data buffer setup has been configured in one approach, you must remove the present configuration first before you use the other approach.

Using the burst function to configure the data buffer setup

The burst function allows the switch to automatically determine the shared resource size, the minimum guaranteed resource size for each queue, the maximum shared resource size for each queue, and the maximum shared resource size per port.

The burst function helps optimize packet buffering to ameliorate forwarding performance in the following scenarios:

- Broadcast or multicast traffic is dense and bursts of traffic are usually large.
- High-speed traffic is forwarded over low-speed links or traffic received from multiple ports is forwarded through a port operating at the same speed.

To use the burst function to configure the data buffer:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Enable the burst function.	**burst-mode enable**	By default, the burst function is disabled.

Manually configuring the data buffer setup

Data buffer configuration is complicated and has significant impacts on the forwarding performance of a device. H3C does not recommend modifying the data buffer parameters unless you are sure that your device will benefit from the change. If a larger buffer is needed, H3C recommends that you enable the burst function to allocate the buffer automatically.

Manually configuring the data buffer task list

Task		Remarks
Configuring the cell resource	Configuring the shared resource size	Optional
	Configuring the minimum guaranteed resource size for a queue	Optional
	Configuring the maximum shared resource size for a port	Optional
Configuring the packet resource	Configuring the minimum guaranteed resource size for a queue	Optional
Applying the data buffer settings		Required

Configuring the cell resource

Configuring the shared resource size

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A

Step	Command	Remarks
2. Configure the shared resource area of the cell resource in percentage.	**buffer egress** [slot *slot-number*] **cell total-shared ratio** *ratio*	Optional. By default, the shared resource area of the cell resource is 60%.

Configuring the minimum guaranteed resource size for a queue

When configuring the minimum guaranteed resource size for a queue, follow these guidelines:

- Modifying the minimum guaranteed resource size for a queue can affect those of the other queues, because the dedicated resource of a port is shared by eight queues. The system will automatically allocate the remaining dedicated resource space among all queues that are not manually assigned a minimum guaranteed resource space. For example, if you set the minimum guaranteed resource size to 30% for a queue, the remaining seven queues will each share 10% of the dedicated resource of the port.
- The minimum guaranteed resource settings of a queue apply to the queue with the same number on each port.

To configure the minimum guaranteed resource size for a queue:

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Configure the minimum guaranteed cell resource size for a queue as a percentage of the dedicated cell resource per port.	**buffer egress** [slot *slot-number*] **cell queue** *queue-id* **guaranteed ratio** *ratio*	Optional. By default, the minimum guaranteed resource size for a queue is 12% of the dedicated resource of the port in the cell resource.

Configuring the maximum shared resource size for a port

Step	Command	Remarks
1. Enter system view.	**system-view**	N/A
2. Configure the maximum shared cell resource size for a queue as a percentage of the shared cell resource.	**buffer egress** [slot *slot-number*] **cell shared ratio** *ratio*	Optional. By default, a queue can use up to 50% of the shared cell resource.

NOTE:

The maximum shared resource settings for a queue apply to the queue with the same number on each port.

Configuring the packet resource

Configuring the minimum guaranteed resource size for a queue

When configuring the minimum guaranteed resource size for a queue, follow these guidelines:

- Modifying the minimum guaranteed resource size for a queue can affect those of the other queues, because the dedicated resource of a port is shared by eight queues. The system will automatically allocate the remaining dedicated resource space among all queues that are not manually assigned a minimum guaranteed resource space. For example, if you set the minimum guaranteed resource size to 30% for a queue, the remaining seven queues will each share 10% of the dedicated resource of the port.

- The minimum guaranteed resource settings of a queue apply to the queue with the same number on each port.

To configure the minimum guaranteed resource size for a queue:

Step		Command	Remarks
1.	Enter system view.	**system-view**	N/A
2.	Configure the minimum guaranteed packet resource size for a queue as a percentage of the dedicated packet resource per port.	**buffer egress** [slot *slot-number*] **packet queue** *queue-id* **guaranteed ratio** *ratio*	Optional. By default, the minimum guaranteed resource size for queue 2 is 51% of the dedicated resource of the port in the packet resource, and that for any other queue is 7%.

Applying the data buffer settings

After manually configuring data buffer, you should execute the following steps to make the manual data buffer configurations take effect.

To apply the data buffer settings:

Step		Command
1.	Enter system view.	**system-view**
2.	Apply the data buffer settings.	**buffer apply**

Appendix A Default priority mapping tables

Uncolored priority mapping tables

For the default **dscp-dscp** mapping table, an input value yields a target value equal to it.

Table 9 Default dot1p-lp and dot1p-dp priority mapping tables

Input priority value	dot1p-lp mapping	dot1p-dp mapping
802.1p priority (dot1p)	**Local precedence (lp)**	**Drop precedence (dp)**
0	2	0
1	0	0
2	1	0
3	3	0
4	4	0
5	5	0
6	6	0
7	7	0

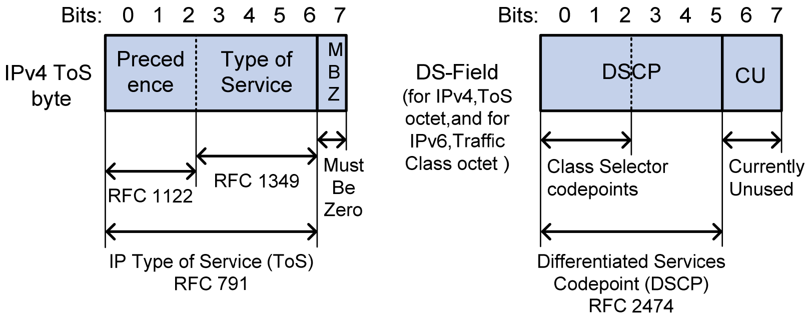
Table 10 Default dscp-dp and dscp-dot1p priority mapping tables

Input priority value	dscp-dp mapping	dscp-dot1p mapping
DSCP	**Drop precedence (dp)**	**802.1p priority (dot1p)**
0 to 7	0	0
8 to 15	0	1
16 to 23	0	2
24 to 31	0	3
32 to 39	0	4
40 to 47	0	5
48 to 55	0	6
56 to 63	0	7

Appendix B Packet precedences

IP precedence and DSCP values

Figure 24 ToS and DS fields


Bits: 0 1 2 3 4 5 6 7
IPv4 ToS byte
Preced ence
Type of Service
M B Z
RFC 1122
RFC 1349
Must Be Zero
IP Type of Service (ToS) RFC 791
Bits: 0 1 2 3 4 5 6 7
DS-Field (for IPv4,ToS octet,and for IPv6,Traffic Class octet)
DSCP
CU
Class Selector codepoints
Currently Unused
Differentiated Services Codepoint (DSCP) RFC 2474

As shown in Figure 24, the ToS field in the IPv4 header contains eight bits, where the first three bits (0 to 2) represent IP precedence from 0 to 7; the Traffic Classes field in the IPv6 header contains eight bits, where the first three bits (0 to 2) represent IP precedence from 0 to 7. According to RFC 2474, the ToS field in the IPv4 header or the Traffic Classes field in the IPv6 header is redefined as the differentiated services (DS) field, where a DSCP value is represented by the first six bits (0 to 5) and is in the range 0 to 63. The remaining two bits (6 and 7) are reserved.

Table 11 Description on IP precedence

IP precedence (decimal)	IP precedence (binary)	Description
0	000	Routine
1	001	priority
2	010	immediate
3	011	flash
4	100	flash-override
5	101	critical
6	110	internet
7	111	network

Table 12 Description on DSCP values

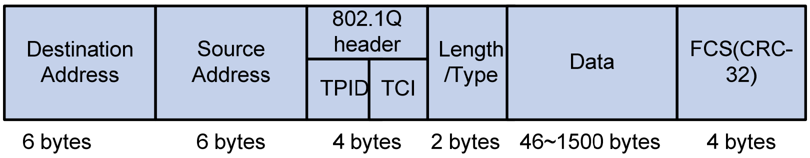
DSCP value (decimal)	DSCP value (binary)	Description
46	101110	ef
10	001010	af11
12	001100	af12
14	001110	af13
18	010010	af21

DSCP value (decimal)	DSCP value (binary)	Description
20	010100	af22
22	010110	af23
26	011010	af31
28	011100	af32
30	011110	af33
34	100010	af41
36	100100	af42
38	100110	af43
8	001000	cs1
16	010000	cs2
24	011000	cs3
32	100000	cs4
40	101000	cs5
48	110000	cs6
56	111000	cs7
0	000000	be (default)

802.1p priority

802.1p priority lies in the Layer 2 header and applies to occasions where Layer 3 header analysis is not needed and QoS must be assured at Layer 2.

Figure 25 An Ethernet frame with an 802.1Q tag header



As shown in Figure 25, the four-byte 802.1Q tag header consists of the tag protocol identifier (TPID, two bytes in length), whose value is 0x8100, and the tag control information (TCI, two bytes in length). Figure 26 shows the format of the 802.1Q tag header. The Priority field in the 802.1Q tag header is called the "802.1p priority", because its use is defined in IEEE 802.1p. Table 13 shows the values for 802.1p priority.

Figure 26 802.1Q tag header

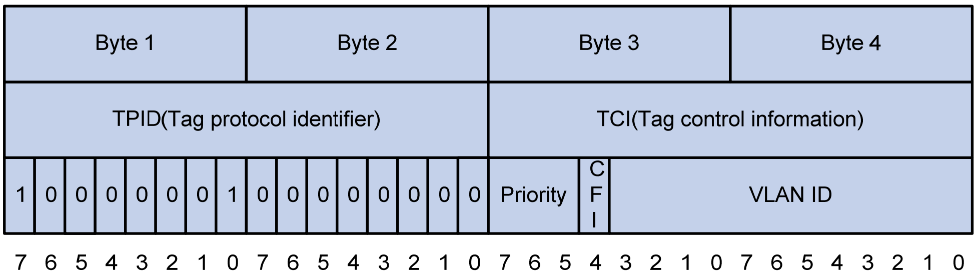


Table 13 Description on 802.1p priority

802.1p priority (decimal)	802.1p priority (binary)	Description
0	000	best-effort
1	001	background
2	010	spare
3	011	excellent-effort
4	100	controlled-load
5	101	video
6	110	voice
7	111	network-management

Support and other resources

Contacting HP

For worldwide technical support information, see the HP support website:

http://www.hp.com/support

Before contacting HP, collect the following information:

- Product model names and numbers
- Technical support registration number (if applicable)
- Product serial numbers
- Error messages
- Operating system type and revision level
- Detailed questions

Subscription service

HP recommends that you register your product at the Subscriber's Choice for Business website:

http://www.hp.com/go/wwalerts

After registering, you will receive email notification of product enhancements, new driver versions, firmware updates, and other product resources.

Related information

Documents

To find related documents, browse to the Manuals page of the HP Business Support Center website:

http://www.hp.com/support/manuals

- For related documentation, navigate to the Networking section, and select a networking category.
- For a complete list of acronyms and their definitions, see *HP FlexNetwork Technology Acronyms*.

Websites

- HP.com http://www.hp.com
- HP Networking http://www.hp.com/go/networking
- HP manuals http://www.hp.com/support/manuals
- HP download drivers and software http://www.hp.com/support/downloads
- HP software depot http://www.software.hp.com
- HP Education http://www.hp.com/learn

Conventions

This section describes the conventions used in this documentation set.

Command conventions

Convention	Description
Boldface	**Bold** text represents commands and keywords that you enter literally as shown.
Italic	*Italic* text represents arguments that you replace with actual values.
[ ]	Square brackets enclose syntax choices (keywords or arguments) that are optional.
{ x | y | ... }	Braces enclose a set of required syntax choices separated by vertical bars, from which you select one.
[x | y | ...]	Square brackets enclose a set of optional syntax choices separated by vertical bars, from which you select one or none.
{ x | y | ... } *	Asterisk-marked braces enclose a set of required syntax choices separated by vertical bars, from which you select at least one.
[x | y | ...] *	Asterisk-marked square brackets enclose optional syntax choices separated by vertical bars, from which you select one choice, multiple choices, or none.
&<1-n>	The argument or keyword and argument combination before the ampersand (&) sign can be entered 1 to n times.
#	A line that starts with a pound (#) sign is comments.

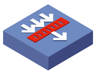
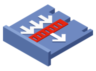
GUI conventions

Convention	Description
Boldface	Window names, button names, field names, and menu items are in bold text. For example, the **New User** window appears; click **OK**.
>	Multi-level menus are separated by angle brackets. For example, **File** > **Create** > **Folder**.

Symbols

Convention	Description
⚠ WARNING	An alert that calls attention to important information that if not understood or followed can result in personal injury.
△ CAUTION	An alert that calls attention to important information that if not understood or followed can result in data loss, data corruption, or damage to hardware or software.
ⓘ IMPORTANT	An alert that calls attention to essential information.
NOTE	An alert that contains additional or supplementary information.
💡 TIP	An alert that provides helpful information.

Network topology icons

	Represents a generic network device, such as a router, switch, or firewall.
	Represents a routing-capable device, such as a router or Layer 3 switch.
	Represents a generic switch, such as a Layer 2 or Layer 3 switch, or a router that supports Layer 2 forwarding and other Layer 2 features.
	Represents an access controller, a unified wired-WLAN module, or the switching engine on a unified wired-WLAN switch.
	Represents an access point.
	Represents a security product, such as a firewall, a UTM, or a load-balancing or security card that is installed in a device.
	Represents a security card, such as a firewall card, a load-balancing card, or a NetStream card.

Port numbering in examples

The port numbers in this document are for illustration only and might be unavailable on your device.

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