H3C S6850 & S9850 Switch Series

ACL and QoS Configuration Guide

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Preface

This configuration guide describes the ACL and QoS fundamentals and configuration procedures.

This preface includes the following topics about the documentation:

- Audience.
- Conventions.
- Documentation feedback.

Audience

This documentation is intended for:

- Network planners.
- Field technical support and servicing engineers.
- Network administrators working with the S6850 & S9850 switch series.

Conventions

The following information describes the conventions used in the documentation.

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 a minimum of 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 Boldface. For example, the **New User** window opens; 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

Convention	Description
	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 access controller engine on a unified wired-WLAN switch.
	Represents an access point.
	Represents a wireless terminator unit.
	Represents a wireless terminator.
	Represents a mesh access point.
	Represents omnidirectional signals.
	Represents directional signals.
	Represents a security product, such as a firewall, UTM, multiservice security gateway, or load balancing device.
	Represents a security module, such as a firewall, load balancing, NetStream, SSL VPN, IPS, or ACG module.

Examples provided in this document

Examples in this document might use devices that differ from your device in hardware model, configuration, or software version. It is normal that the port numbers, sample output, screenshots, and other information in the examples differ from what you have on your device.

Documentation feedback

You can e-mail your comments about product documentation to info@h3c.com.

We appreciate your comments.

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Configuring ACLs

About ACLs

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

ACLs are primarily used for packet filtering. You can also use ACLs in QoS, security, routing, and other modules for identifying traffic. The packet drop or forwarding decisions depend on the modules that use ACLs.

Numbering and naming ACLs

When creating an ACL, you must assign it a number or name for identification. You can specify an existing ACL by its number or name. Each ACL type has a unique range of ACL numbers.

For basic or advanced ACLs with the same number, you must use the **`ipv6`** keyword to distinguish them. For ACLs with the same name, you must use the **`ipv6`**, **`mac`**, and **`user-defined`** keywords to distinguish them.

ACL types

Type	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, protocol number, and other Layer 3 and Layer 4 header fields.
		IPv6	Source IPv6 address, destination IPv6 address, packet priority, protocol number, and other Layer 3 and Layer 4 header fields.
Layer 2 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.
User-defined ACLs	5000 to 5999	IPv4 and IPv6	User specified matching patterns in protocol headers.

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 method, check the rules and their order carefully.

NOTE:

The match order of user-defined ACLs can only be **config**.

- **auto**—Sorts ACL rules in depth-first order. Depth-first ordering makes sure 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 type	Sequence of tie breakers
IPv4 basic ACL	**1.** VPN instance. **2.** More 0s in the source IPv4 address wildcard (more 0s means a narrower IPv4 address range). **3.** Rule configured earlier.
IPv4 advanced ACL	**4.** VPN instance. **5.** Specific protocol number. **6.** More 0s in the source IPv4 address wildcard mask. **7.** More 0s in the destination IPv4 address wildcard. **8.** Narrower TCP/UDP service port number range. **9.** Rule configured earlier.
IPv6 basic ACL	**10.** VPN instance. **11.** Longer prefix for the source IPv6 address (a longer prefix means a narrower IPv6 address range). **12.** Rule configured earlier.
IPv6 advanced ACL	**13.** VPN instance. **14.** Specific protocol number. **15.** Longer prefix for the source IPv6 address. **16.** Longer prefix for the destination IPv6 address. **17.** Narrower TCP/UDP service port number range. **18.** Rule configured earlier.
Layer 2 ACL	**19.** More 1s in the source MAC address mask (more 1s means a smaller MAC address). **20.** More 1s in the destination MAC address mask. **21.** Rule configured earlier.

A wildcard mask, also called an inverse mask, is a 32-bit binary number 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.

Rule numbering

ACL rules can be manually numbered or automatically numbered. This section describes how automatic ACL rule numbering works.

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.

The rule numbering step sets the increment by which the system numbers rules automatically. If you do not specify a rule ID when creating an ACL rule, the system automatically assigns it a rule ID. This rule ID is the nearest higher multiple of the numbering step to the current highest rule ID, starting from the start rule ID. For example, if the rule numbering step is 5 and the current highest rule ID is 12, the rule is numbered 15.

The wider the numbering step, the more rules you can insert between two rules. Whenever the step or start rule ID changes, the rules are renumbered, starting from the start rule ID. For example, if there are five rules numbered 0, 5, 9, 10, and 15, changing the step from 5 to 2 causes the rules to be renumbered 0, 2, 4, 6, and 8.

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 step is 5, and there are five rules numbered 0, 5, 9, 10, and 12, the newly defined rule is numbered 15. If the ACL does not contain a rule, the first rule is numbered 0.

Whenever the step changes, the rules are renumbered, starting from 0. For example, changing the step from 5 to 2 renumbers rules 5, 10, 13, and 15 as rules 0, 2, 4, and 6.

For an ACL of the match order **auto**, rules are sorted in depth-first order, and are renumbered based on the match order. For example, rules are in the match order of 0, 10, and 5. Changing the numbering step to 2 renumbers rules 0, 10, and 5 (not 0, 5, and 10) as rules 0, 2, 4.

Fragment 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 risks, the ACL feature is designed as follows:

- Filters all fragments by default, including non-first fragments.
- Allows for matching criteria modification for efficiency. For example, you can configure the ACL to filter only non-first fragments.

Restrictions and guidelines: ACL configuration

- If you create a numbered ACL, you can enter the view of the ACL by using either of the following commands:
  - **acl** [**ipv6**] **number** *acl-number*.
  - **acl** { [**ipv6**] { **advanced** | **basic** } | **mac** | **user-defined** } *acl-number*.
- If you create a ACL by using the **acl** [**ipv6**] **number** *acl-number* **name** *acl-name* command, you can enter the view of the ACL by using either of the following commands:
  - **acl** [**ipv6**] **name** *acl-name* (for only basic ACLs and advanced ACLs).
  - **acl** [**ipv6**] **number** *acl-number* [**name** *acl-name*].
  - **acl** { [**ipv6**] { **advanced** | **basic** } | **mac** | **user-defined** } **name** *acl-name*.
- If you create a named ACL by using the **acl** { [**ipv6**] { **advanced** | **basic** } | **mac** | **user-defined** } **name** *acl-name* command, you can enter the view of the ACL by using either of the following commands:
  - **acl** [**ipv6**] **name** *acl-name* (for only basic ACLs and advanced ACLs).

- **acl** { [**ipv6**] { **advanced** | **basic** } | **mac** | **user-defined** } **name** *acl-name*.

- Matching packets are forwarded through slow forwarding if an ACL rule contains match criteria or has functions enabled in addition to the following match criteria and functions:
  - Source and destination IP addresses.
  - Source and destination ports.
  - Transport layer protocol.
  - ICMP or ICMPv6 message type, message code, and message name.
  - VPN instance.
  - Logging.
  - Time range.

  Slow forwarding requires packets to be sent to the control plane for forwarding entry calculation, which affects the device forwarding performance.

ACL tasks at a glance

To configure an ACL, perform the following tasks:

- Configure ACLs according to the characteristics of the packets to be matched
  - Configuring a basic ACL
  - Configuring an advanced ACL
  - Configuring a Layer 2 ACL
  - Configuring a user-defined ACL
- (Optional.) Copying an ACL
- (Optional.) Configuring the QoS and ACL resource hardware mode
- (Optional.) Configuring packet filtering with ACLs

Configuring a basic ACL

About basic ACLs

Basic ACLs match packets based only on source IP addresses.

Configuring an IPv4 basic ACL

1. Enter system view.

   system-view
2. Create an IPv4 basic ACL and enter its view. Choose one option as needed:
   - Create an IPv4 basic ACL by specifying an ACL number.

     acl number *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]
   - Create an IPv4 basic ACL by specifying the **basic** keyword.

     acl basic { *acl-number* | **name** *acl-name* } [**match-order** { **auto** | **config** }]
3. (Optional.) Configure a description for the IPv4 basic ACL.

   description *text*

   By default, an IPv4 basic ACL does not have a description.

4. (Optional.) Set the rule numbering step.

   step *step-value* [**start** *start-value*]

   By default, the rule numbering step is 5 and the start rule ID is 0.

5. Create or edit a rule.

   rule [*rule-id*] { **deny** | **permit** } [**counting** | **fragment** | **logging**| **source** { *source-address source-wildcard* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *

   The **logging** keyword takes effect only when the module (for example, packet filtering) that uses the ACL supports logging.

6. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Configuring an IPv6 basic ACL

1. Enter system view.

   system-view

2. Create an IPv6 basic ACL view and enter its view. Choose one option as needed:
   - Create an IPv6 basic ACL by specifying an ACL number.

     acl ipv6 number *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]
   - Create an IPv6 basic ACL by specifying the **basic** keyword.

     acl ipv6 basic { *acl-number* | **name** *acl-name* } [**match-order** { **auto** | **config** }]

3. (Optional.) Configure a description for the IPv6 basic ACL.

   description *text*

   By default, an IPv6 basic ACL does not have a description.

4. (Optional.) Set the rule numbering step.

   step *step-value* [**start** *start-value*]

   By default, the rule numbering step is 5 and the start rule ID is 0.

5. Create or edit a rule.

   rule [*rule-id*] { **deny** | **permit** } [**counting** | **fragment** | **logging**| **routing** [**type** *routing-type*] | **source** { *source-address source-prefix* | *source-address*/*source-prefix* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *

   The **logging** keyword takes effect only when the module (for example, packet filtering) that uses the ACL supports logging.

6. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Configuring an advanced ACL

About advanced ACLs

Advanced ACLs match packets based on the following criteria:

- Source IP addresses.
- Destination IP addresses.
- Packet priorities.
- Local QoS IDs.
- Protocol types.
- Other protocol header information, such as TCP/UDP source and destination port numbers, TCP flags, ICMP message types, and ICMP message codes.
- Encapsulation types.
- Inner source IPv4 addresses.
- Inner destination IPv4 addresses.
- Inner protocol types.
- Other inner protocol header information, such as inner TCP/UDP source and destination port numbers.

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

Configuring an IPv4 advanced ACL

1. Enter system view.

   system-view
2. Create an IPv4 advanced ACL and enter its view. Choose one option as needed:
   - Create a numbered IPv4 advanced ACL by specifying an ACL number.

     acl number *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]
   - Create an IPv4 advanced ACL by specifying the **advanced** keyword.

     acl advanced { *acl-number* | **name** *acl-name* } [**match-order** { **auto** | **config** }]
3. (Optional.) Configure a description for the IPv4 advanced ACL.

   description *text*

   By default, an IPv4 advanced ACL does not have a description.
4. (Optional.) Set the rule numbering step.

   step *step-value* [**start** *start-value*]

   By default, the rule numbering step is 5 and the start rule ID is 0.
5. Create or edit a rule.
   - Create or edit a rule for matching non-encapsulated packets.

     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-address dest-wildcard* | **any** } | { { **precedence** *precedence* | **tos** *tos* } * | { **precedence** *precedence* | **ecn** *ecn* } * | { **dscp** *dscp* | **ecn** *ecn* } * } | **fragment** | **icmp-type** { *icmp-type* [*icmp-code*] | *icmp-message* } | **logging** | **qos-local-id** *local-id-value* | **source** { *source-address source-wildcard* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *
   - Create or edit a rule for matching encapsulated packets.

     rule [*rule-id*] { **deny** | **permit** } **vxlan** [**destination** { *dest-address dest-wildcard* | **any** } | **source** { *source-address source-wildcard* | **any** } | **source-port** *operator port1* [*port2*] | **vxlan-id** *vxlan-id*] *

inner-protocol *inner-protocol* [**counting** | **inner-destination** { *dest-address dest-wildcard* | **any** } | **inner-established** | **inner-source** { *source-address source-wildcard* | **any** } | **logging** | **time-range** *time-range-name*] *

Parameter	Description
vxlan	Matches VXLAN packets by both outer and inner packet information.

The **logging** keyword takes effect only when the module (for example, packet filtering) that uses the ACL supports logging.

6. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Configuring an IPv6 advanced ACL

1. Enter system view.

   system-view

2. Create an IPv6 advanced ACL and enter its view. Choose one option as needed:
   - Create a numbered IPv6 advanced ACL by specifying an ACL number.

     acl ipv6 number *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]
   - Create an IPv6 advanced ACL by specifying the **advanced** keyword.

     acl ipv6 advanced { *acl-number* | **name** *acl-name* } [**match-order** { **auto** | **config** }]

3. (Optional.) Configure a description for the IPv6 advanced ACL.

   description *text*

   By default, an IPv6 advanced ACL does not have a description.

4. (Optional.) Set the rule numbering step.

   step *step-value* [**start** *start-value*]

   By default, the rule numbering step is 5 and the start rule ID is 0.

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-address dest-prefix* | *dest-address/dest-prefix* | **any** } | | { **dscp** *dscp* | **ecn** *ecn-value* } * | **flow-label** *flow-label-value* | **fragment** | **icmp6-type** { *icmp6-type icmp6-code* | *icmp6-message* } | **logging**| **qos-local-id** *local-id-value* | **routing** [**type** *routing-type*] | **hop-by-hop** [**type** *hop-type*] | **source** { *source-address source-prefix* | *source-address/source-prefix* | **any** } | **time-range** *time-range-name* | **vpn-instance** *vpn-instance-name*] *

   The **logging** keyword takes effect only when the module (for example, packet filtering) that uses the ACL supports logging.

6. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Configuring a Layer 2 ACL

About Layer 2 ACLs

Layer 2 ACLs, also called Ethernet frame header ACLs, match packets based on Layer 2 Ethernet header fields, such as:

- Source MAC address.
- Destination MAC address.
- 802.1p priority (VLAN priority).
- Link layer protocol type.
- Encapsulation type.
- Inner source MAC address.
- Inner destination MAC address.
- Inner link layer protocol type.

Procedure

1. Enter system view.

   system-view

2. Create a Layer 2 ACL and enter its view. Choose one option as needed:
   - Create a Layer 2 ACL by specifying an ACL number.

     acl number *acl-number* [**name** *acl-name*] [**match-order** { **auto** | **config** }]
   - Create a Layer 2 ACL by specifying the **mac** keyword.

     acl mac { *acl-number* | **name** *acl-name* } [**match-order** { **auto** | **config** }]
3. (Optional.) Configure a description for the Layer 2 ACL.

   description *text*

   By default, a Layer 2 ACL does not have a description.
4. (Optional.) Set the rule numbering step.

   step *step-value* [**start** *start-value*]

   By default, the rule numbering step is 5 and the start rule ID is 0.
5. Create or edit a rule.

   rule [*rule-id*] { **deny** | **permit** } [**cos** *dot1p* | **counting** | **dest-mac** *dest-address dest-mask* | { **lsap** *lsap-type lsap-type-mask* | **type** *protocol-type protocol-type-mask* } | **source-mac** *source-address source-mask* | **time-range** *time-range-name*] *
6. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Configuring a user-defined ACL

About user-defined ACLs

User-defined ACLs allow you to customize rules based on information in protocol headers. You can define a user-defined ACL to match packets. A specific number of bytes after an offset (relative to the specified header) are compared against a match pattern after being ANDed with a match pattern mask.

Procedure

1. Enter system view.

   system-view

2. Create a user-defined ACL and enter its view. Choose one option as needed:
   - Create a user-defined ACL by specifying an ACL number.

     acl number *acl-number* [**name** *acl-name*]
   - Create a user-defined ACL by specifying the **user-defined** keyword.

     acl user-defined { *acl-number* | **name** *acl-name* }

3. (Optional.) Configure a description for the user-defined ACL.

   description *text*

   By default, a user-defined ACL does not have a description.

4. Create or edit a rule.

   Command set 1:

   rule [*rule-id*] { **deny** | **permit** } [{ { **ipv4** | **l2** | **l4** }*rule-string rule-mask offset* }&<1-8>] [**counting** | **time-range** *time-range-name*] *

   Command set 2:

   rule [*rule-id*] { **deny** | **permit** } [**ipv6-protocol**] *protocol* [**destination** { *dest-address dest-wildcard* | **any** } | **destination-port** { *operator port1* [*port2*] } | **dscp** *dscp* | **source** { *source-address source-wildcard* | **any** } | **source-port** { *operator port1* [*port2*] } | *udf-format*] * [{ { **ipv4** | **l2** | **l4** | **l5** } *rule-string rule-mask offset* }&<1-8>] [**counting** | **time-range** *time-range-name*] *

5. (Optional.) Add or edit a rule comment.

   rule *rule-id* **comment** *text*

   By default, no rule comment is configured.

Copying an ACL

About 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 uses a different number or name than the source ACL.

Restrictions and guidelines

To successfully copy an ACL, make sure:

- The destination ACL is the same type as the source ACL.
- The source ACL already exists, but the destination ACL does not.

Procedure

1. Enter system view.

   system-view

2. Copy an existing ACL to create a new ACL.

   acl [**ipv6** | **mac** | **user-defined**] **copy** { *source-acl-number* | **name** *source-acl-name* } **to** { *dest-acl-number* | **name** *dest-acl-name* }

Configuring the QoS and ACL resource hardware mode

About this task

Different chips produce different packet matching results for QoS and ACL resources. Perform this task to enhance matching capabilities of QoS and ACL resources.

Restrictions and guidelines

This feature is supported only in Release 6555P02 and later.

This feature occupies more QoS and ACL resources when an ACL is applied.

Procedure

1. Enter system view.
   system-view
2. Configure the QoS and ACL resource hardware mode.
   qos-acl resource hardware-mode *hardware-mode-value*
   By default, no QoS and ACL resource hardware mode is configured.

Configuring packet filtering with ACLs

About packet filtering with ACLs

This section describes procedures for using an ACL to filtering packets. For example, you can apply an ACL to an interface to filter incoming or outgoing packets.

Applying an ACL to an interface for packet filtering

Restrictions and guidelines

To the same direction of an interface, you can apply a maximum of four ACLs: one IPv4 ACL, one IPv6 ACL, one Layer 2 ACL, and one user-defined ACL.

You can use the **packet-filter** command in VLAN interface view or use the **packet-filter vlan-interface** command in system view to configure packet filtering in one direction of a VLAN interface. You cannot configure both of them in the same direction of a VLAN interface.

The term "interface" in this section collectively refers to Layer 2 Ethernet interfaces, Layer 2 aggregate interfaces, Layer 3 Ethernet interfaces, Layer 3 Ethernet subinterfaces, Layer 3 aggregate interfaces, VLAN interfaces, and VSI interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

For information about VSI interfaces, see *VXLAN Configuration Guide*.

You cannot apply an ACL to the outbound direction of a Layer 2 aggregate interface, Layer 3 aggregate interface, or VSI interface.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.

interface *interface-type interface-number*

3. Apply an ACL to the interface to filter packets.

   packet-filter [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* } { **inbound** | **outbound** } [**hardware-count**] [**share-mode**] [**vxlan-inner**]

   By default, an interface does not filter packets.

Applying an ACL to a list of VLAN interfaces for packet filtering

Restrictions and guidelines

You can apply only one ACL to the same direction of VLAN interfaces.

Do not enable the packet filtering continuous mode after applying an ACL to a list of VLAN interfaces. If you enable the packet filtering continuous mode, packet filtering on the list of VLAN interfaces becomes invalid.

You can use the **packet-filter** command in VLAN interface view or use the **packet-filter vlan-interface** command in system view to configure packet filtering in one direction of a VLAN interface. You cannot configure both of them in the same direction of a VLAN interface.

Repeating this command with one ACL for the same direction adds new VLAN interfaces to the list of VLAN interfaces:

- If you specify the **hardware-count** keyword the first time you configure this command, you must specify this keyword when repeating this command.
- If you do not specify the **hardware-count** keyword the first time you configure this command, do not specify this keyword when repeating this command.

Procedure

1. Enter system view.

   system-view

2. Apply an ACL to a list of VLAN interfaces to filter packets.

   packet-filter [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* } **vlan-interface** *vlan-interface-list* { **inbound** | **outbound** } [**hardware-count**]

   By default, the system does not filter packets on a VLAN interface.

Applying an ACL to an Ethernet service instance for packet filtering

Restrictions and guidelines

For information about configuring Ethernet service instances, see *VXLAN Configuration Guide*.

Procedure

1. Enter system view.

   system-view

2. Enter interface view.
   - Enter Layer 2 Ethernet interface view.

     interface *interface-type interface-number*
   - Enter Layer 2 aggregate interface view.

interface bridge-aggregation *interface-number*

3. Create an Ethernet service instance and enter Ethernet service instance view.
   service-instance *instance-id*
4. Apply an ACL to the Ethernet service instance.
   packet-filter [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* } { **inbound** | **outbound** } [**hardware-count**]
   By default, the system does not filter packets on an Ethernet service instance.

Configuring the applicable scope of packet filtering on a VLAN interface

About applicable scope of packet filtering on a VLAN interface

You can configure the packet filtering on a VLAN interface to filter the following packets:

- Packets forwarded at Layer 3 by the VLAN interface.
- All packets, including packets forwarded at Layer 3 by the VLAN interface and packets forwarded at Layer 2 by the physical ports associated with the VLAN interface.

Procedure

1. Enter system view.
   system-view
2. Create a VLAN interface and enter its view.
   interface vlan-interface *vlan-interface-id*
   If the VLAN interface already exists, you directly enter its view.
   By default, no VLAN interface exists.
3. Specify the applicable scope of packet filtering on the VLAN interface.
   packet-filter filter [**route** | **all**]
   By default, the packet filtering filters packets forwarded at Layer 3.

Configuring logging and SNMP notifications for packet filtering

About configuring logging and SNMP notifications for packet filtering

You can configure the ACL module to generate log entries or SNMP notifications for packet filtering and output them to the information center or SNMP module at the output interval. The log entry or notification records the number of matching packets and the matched ACL rules. When the first packet of a flow matches an ACL rule, the output interval starts, and the device immediately outputs a log entry or notification for this packet. When the output interval ends, the device outputs a log entry or notification for subsequent matching packets of the flow.

For more information about the information center and SNMP, see *Network Management and Monitoring Configuration Guide.*

Procedure

1. Enter system view.
   system-view
2. Set the interval for outputting packet filtering logs or notifications.
   acl { **logging** | **trap** } **interval** *interval*

The default setting is 0 minutes. By default, the device does not generate log entries or SNMP notifications for packet filtering.

Setting the packet filtering default action

1. Enter system view.
   system-view
2. Set the packet filtering default action to deny.
   packet-filter default deny
   By default, the packet filter permits packets that do not match any ACL rule to pass.

Enabling hardware-count for the packet filtering default action on an interface

About hardware-count for the packet filtering default action

When you enable hardware-count for the packet filtering default action on an interface, the interface counts how many times the packet filtering default action is performed.

To enable the hardware-count feature for the packet filtering default action on an interface, make sure you have applied ACLs to the interface for packet filtering.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Enable hardware-count for the packet filtering default action on the interface.
   packet-filter default { **inbound** | **outbound** } **hardware-count**
   By default, hardware-count is disabled for the packet filtering default action.

Enabling hardware-count for the packet filtering default action for an Ethernet service instance

About hardware-count for the packet filtering default action

When you enable hardware-count for the packet filtering default action on an Ethernet service instance, the Ethernet service instance counts how many times the packet filtering default action is performed.

To enable the hardware-count feature for the packet filtering default action on an Ethernet service instance, make sure you have applied ACLs to the Ethernet service instance for packet filtering.

Restrictions and guidelines

For information about configuring Ethernet service instances, see *VXLAN Configuration Guide* or *EVPN Configuration Guide*.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.

- Enter Layer 2 Ethernet interface view.
  interface *interface-type interface-number*
- Enter Layer 2 aggregate interface view.
  interface bridge-aggregation *interface-number*

3. Create an Ethernet service instance and enter Ethernet service instance view.
   service-instance *instance-id*
4. Enable hardware-count for the packet filtering default action for the Ethernet service instance.
   packet-filter default { **inbound** | **outbound** } **hardware-count**
   By default, hardware-count is disabled for the packet filtering default action.

Ignoring the permit flag added by packet filtering

About ignoring the permit flag added by packet filtering

Packets matching an ACL permit statement in a packet filter are permitted to pass through and marked with a permit flag. Packets with a permit flag are not dropped by a discard action in a QoS policy (for example, a CAR discard action).

This feature allows the device to drop packets with a permit flag by using a discard action in a QoS policy.

Restrictions and guidelines

The permit flag is effective only on the local device.

Procedure

1. Enter system view.
   system-view
2. Ignore the permit flag added by packet filtering.
   packet-filter permit-flag ignore
   By default, the permit flag added by packet filtering is not ignored.

Display and maintenance commands for ACL

Execute **display** commands in any view and **reset** commands in user view.

Task	Command
Display ACL configuration and match statistics.	**display acl** [**ipv6** | **mac** | **user-defined**] { *acl-number* | **all** | **name** *acl-name* }
Display ACL application information for packet filtering.	**display packet-filter** { **interface** [*interface-type interface-number*] | **l2vpn-ac** [**interface** *interface-type interface-number* [**service-instance** *instance-id*]] | **vlan-interface** } [**inbound** | **outbound**] [**slot** *slot-number*]
Display match statistics for packet filtering ACLs.	**display packet-filter statistics** { **interface** *interface-type interface-number* | **l2vpn-ac interface** *interface-type interface-number* **service-instance** *instance-id* | **vlan-interface** } { **inbound** | **outbound** } [**default** | [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* }]

Task	Command
	[**brief**]
Display the accumulated statistics for packet filtering ACLs.	**display packet-filter statistics sum** { **inbound** | **outbound** } [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* } [**brief**]
Display detailed ACL packet filtering information.	**display packet-filter verbose** { **interface** *interface-type interface-number* | **l2vpn-ac interface** *interface-type interface-number* **service-instance** *instance-id* | **vlan-interface** } { **inbound** | **outbound** } [[**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* }] [**slot** *slot-number*]
Display QoS and ACL resource usage.	**display qos-acl resource** [**advanced-mode**] [**slot** *slot-number*]
Clear ACL statistics.	**reset acl** [**ipv6** | **mac** | **user-defined**] **counter** { *acl-number* | **all** | **name** *acl-name* }
Clear match statistics for packet filtering ACLs.	**reset packet-filter statistics** { **interface** [*interface-type interface-number*] | **l2vpn-ac** [**interface** *interface-type interface-number* **service-instance** *instance-id*] | **vlan-interface** } { **inbound** | **outbound** } [**default** | [**ipv6** | **mac** | **user-defined**] { *acl-number* | **name** *acl-name* }]

ACL configuration examples

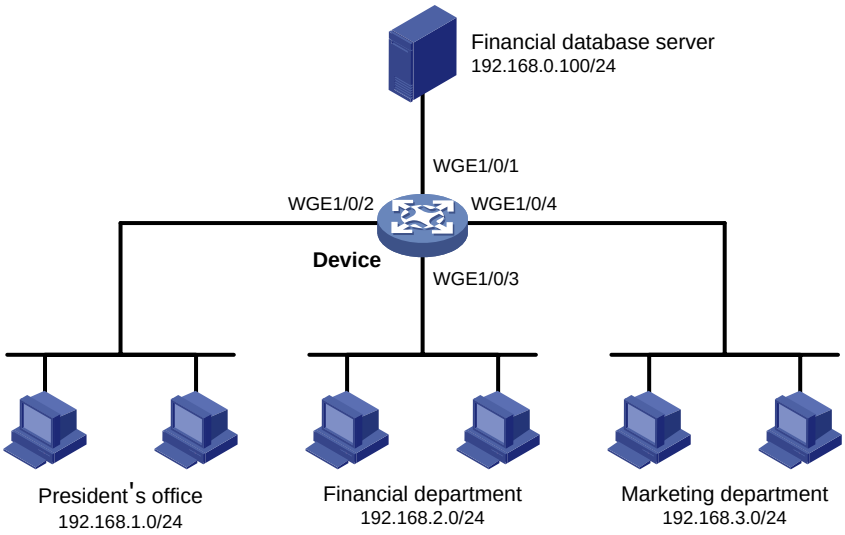
Example: Configuring interface-based packet filter

Network configuration

A company interconnects its departments through the device. Configure a packet filter to:

- Permit access from the President's office at any time to the financial database server.
- Permit access from the Finance department to the database server only during working hours (from 8:00 to 18:00) on working days.
- Deny access from any other department to the database server.

Figure 1 Network diagram



Procedure

Create a periodic time range from 8:00 to 18:00 on working days.

```
<Device> system-view
[Device] time-range work 08:0 to 18:00 working-day
```

Create an IPv4 advanced ACL numbered 3000.

```
[Device] acl advanced 3000
```

Configure a rule to permit access from the President's office to the financial database server.

```
[Device-acl-ipv4-adv-3000] rule permit ip source 192.168.1.0 0.0.0.255 destination
192.168.0.100 0
```

Configure a rule to permit access from the Finance department to the database server during working hours.

```
[Device-acl-ipv4-adv-3000] rule permit ip source 192.168.2.0 0.0.0.255 destination
192.168.0.100 0 time-range work
```

Configure a rule to deny access to the financial database server.

```
[Device-acl-ipv4-adv-3000] rule deny ip source any destination 192.168.0.100 0
[Device-acl-ipv4-adv-3000] quit
```

Apply IPv4 advanced ACL 3000 to filter outgoing packets on interface Twenty-FiveGigE 1/0/1.

```
[Device] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] packet-filter 3000 outbound
[Device-Twenty-FiveGigE1/0/1] quit
```

Verifying the configuration

Verify that a PC in the Finance department can ping the database server during working hours. (All PCs in this example use Windows XP).

```
C:\> ping 192.168.0.100

Pinging 192.168.0.100 with 32 bytes of data:

Reply from 192.168.0.100: bytes=32 time=1ms TTL=255
Reply from 192.168.0.100: bytes=32 time<1ms TTL=255
Reply from 192.168.0.100: bytes=32 time<1ms TTL=255
```

```
Reply from 192.168.0.100: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.0.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Verify that a PC in the Marketing department cannot ping the database server during working hours.

```
C:\> ping 192.168.0.100

Pinging 192.168.0.100 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.0.100:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Display configuration and match statistics for IPv4 advanced ACL 3000 on the device during working hours.

```
[Device] display acl 3000
Advanced IPv4 ACL 3000, 3 rules,
ACL's step is 5
 rule 0 permit ip source 192.168.1.0 0.0.0.255 destination 192.168.0.100 0
 rule 5 permit ip source 192.168.2.0 0.0.0.255 destination 192.168.0.100 0 time-range work (Active)
 rule 10 deny ip destination 192.168.0.100 0
```

The output shows that rule 5 is active. Rule 5 and rule 10 have been matched four times as the result of the ping operations.

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QoS overview

In data communications, Quality of Service (QoS) provides differentiated service guarantees for diversified traffic in terms of bandwidth, delay, jitter, and drop rate, all of which can affect QoS.

QoS manages network resources and prioritizes traffic to balance system resources.

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

QoS service models

This section describes several typical QoS service models.

Best-effort service model

The best-effort model is a single-service model. The best-effort model is not as reliable as other models and does not guarantee delay-free delivery.

The best-effort service model is the default model for 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 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. However, it is not suitable for 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 meet 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.

QoS techniques in a network

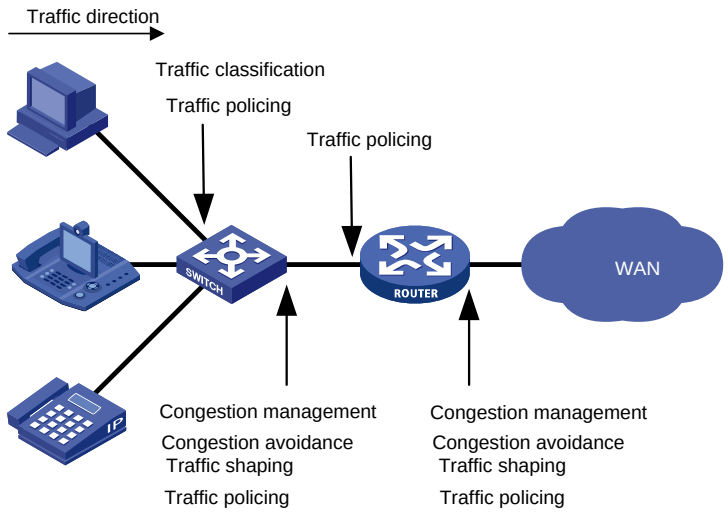
The QoS techniques include the following features:

- Traffic classification.
- Traffic policing.
- Traffic shaping.
- Rate limit.
- Congestion management.
- Congestion avoidance.

The following section briefly introduces these QoS techniques.

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

Figure 1 Position of the QoS techniques in a network



As shown in Figure 1, traffic classification, traffic shaping, traffic policing, congestion management, and congestion avoidance mainly implement the following functions:

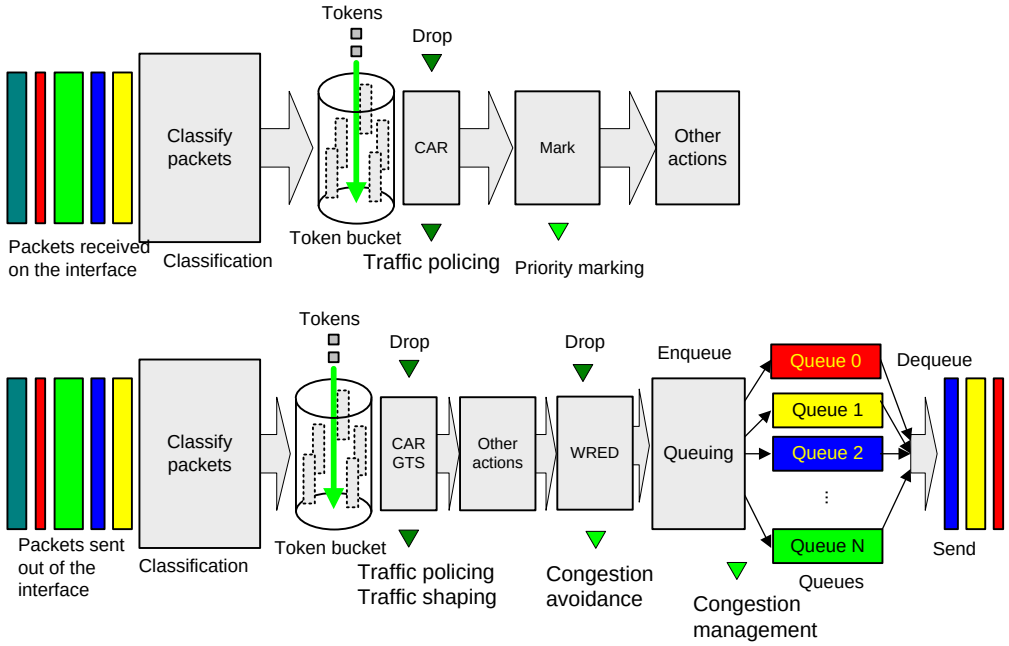
- **Traffic classification**—Uses match criteria to assign packets with the same characteristics to a traffic class. Based on traffic classes, you can provide differentiated services.
- **Traffic policing**—Polices flows and imposes penalties to prevent aggressive use of network resources. You can apply traffic policing to both incoming and outgoing traffic of a port.
- **Traffic shaping**—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. It is usually applied to the outgoing traffic of a port. When congestion worsens, congestion avoidance reduces the queue length by dropping packets.

QoS processing flow in a device

Figure 2 briefly describes how the QoS module processes traffic.

1. Traffic classifier identifies and classifies traffic for subsequent QoS actions.
2. The QoS module takes various QoS actions on classified traffic as configured, depending on the traffic processing phase and network status. For example, you can configure the QoS module to perform the following operations:
   - Traffic policing for incoming traffic.
   - Traffic shaping for outgoing traffic.
   - Congestion avoidance before congestion occurs.
   - Congestion management when congestion occurs.

Figure 2 QoS processing flow



QoS configuration approaches

You can configure QoS by using the MQC approach or non-MQC approach.

In the modular QoS configuration (MQC) approach, you configure QoS service parameters by using QoS policies. A QoS policy defines QoS actions to take on different classes of traffic and can be applied to an object (such as an interface) to control traffic.

In the 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.

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

Configuring a QoS policy

About QoS policies

A QoS policy has the following components:

- **Traffic class**—Defines criteria to match packets.
- **Traffic behavior**—Defines QoS actions to take on matching packets.

By associating a traffic class with a traffic behavior, a QoS policy can perform the QoS actions on matching packets.

A QoS policy can have multiple class-behavior associations.

Restrictions and guidelines: QoS policy configuration

The switch supports the following QoS policy types:

- **Generic**—Can be applied to all supported destinations and can contain all actions.
- **Accounting**—Can be applied to only interfaces or globally and can contain only class-based accounting actions.
- **Mirroring**—Can be applied to only interfaces or globally and can contain only class-based mirroring actions.
- **Marking**—Can be applied to only interfaces or globally and can contain only class-based marking actions.

If you do not specify the **`accounting`**, **`mirroring`**, **`remarking`**, or **`tap`** keyword when creating a QoS policy, a generic QoS policy is created.

QoS policies of different types cannot have the same policy name.

A maximum of four QoS policies (one for each type) can be applied to one direction of an interface. Different actions can be taken on the same traffic class if QoS policies of different types are applied to an interface.

Only one generic QoS policy can be applied to the outbound direction of an interface.

A QoS policy that contains an action of mirroring packets to the INT processor can only be applied to the inbound direction of an interface and does not support the **`share-mode`** keyword.

QoS policy tasks at a glance

To configure a QoS policy, perform the following tasks:

1. Defining a traffic class
2. Defining a traffic behavior
3. Defining a QoS policy
4. Applying the QoS policy
    - Applying the QoS policy to an Ethernet service instance
    - Applying the QoS policy to an interface
    - Applying the QoS policy to VLANs
    - Applying the QoS policy globally

- Applying the QoS policy to a control plane
- Applying the QoS policy to a user profile

Defining a traffic class

Restrictions and guidelines

In a QoS policy applied to the outbound direction of an interface, a match criterion without IPv6 attributes cannot match IPv6 packets. For example, a source MAC address or Layer 2 ACL match criterion cannot match IPv6 packets.

Procedure

1. Enter system view.
   system-view
2. Create a traffic class and enter traffic class view.
   traffic classifier *classifier-name* [**operator** { **and** | **or** }]
3. (Optional.) Configure a description for the traffic class.
   description *text*
   By default, no description is configured for a traffic class.
4. Configure a match criterion.
   if-match *match-criteria*
   By default, no match criterion is configured.
   For more information, see the **if-match** command in *ACL and QoS Command Reference*.

Defining a traffic behavior

1. Enter system view.
   system-view
2. Create a traffic behavior and enter traffic behavior view.
   traffic behavior *behavior-name*
3. Configure an action in the traffic behavior.
   By default, no action is configured for a traffic behavior.
   For more information about configuring an action, see the subsequent chapters for traffic policing, traffic filtering, priority marking, class-based accounting, and so on.

Defining a QoS policy

1. Enter system view.
   system-view
2. Create a QoS policy and enter QoS policy view.
   qos [**ipv6-matching** | { **accounting**|**mirroring**|**remarking** }] **policy** *policy-name*

Parameter	Description
ipv6-matching	Represents an IPv6-matching QoS policy. This keyword is supported only in Release 6555P01 and later.

Parameter	Description
accounting	Represents an accounting-type QoS policy.
mirroring	Represents a mirroring-type QoS policy.
remarking	Represents a marking-type QoS policy.

3. Associate a traffic class with a traffic behavior to create a class-behavior association in the QoS policy.

   classifier *classifier-name* **behavior** *behavior-name* [**mode** { **dcbx** | **qppb-manipulation** } | **insert-before** *before-classifier-name*]

   By default, a traffic class is not associated with a traffic behavior.

   Repeat this step to create more class-behavior associations.

Parameter	Description
dcbx	Specifies that a class-behavior association applies only to DCBX. For more information about DCBX, see *Layer 2—LAN Switching Configuration Guide*.
qppb-manipulation	Specifies that a class-behavior association applies only to matching the **apply qos-local-id** command configuration in a BGP routing policy. For more information, see *Layer 3—IP Routing Configuration Guide*.

Applying the QoS policy

Application destinations

You can apply a QoS policy to the following destinations:

- **Ethernet service instance**—The QoS policy takes effect on the traffic sent or received on the Ethernet service instance.
- **Interface**—The QoS policy takes effect on the traffic sent or received on the interface.
- **VLAN**—The QoS policy takes effect on the traffic sent or received on all ports in the VLAN.
- **Globally**—The QoS policy takes effect on the traffic sent or received on all ports.
- **Control plane**—The QoS policy takes effect on the traffic received on the control plane.
- **User profile**—The QoS policy takes effect on the traffic sent or received by the online users of the user profile.

Restrictions and guidelines for applying a QoS policy

You can modify traffic classes, traffic behaviors, and class-behavior associations in a QoS policy even after it is applied (except that it is applied to a user profile). If a traffic class uses an ACL for traffic classification, you can delete or modify the ACL.

Applying the QoS policy to an Ethernet service instance

Restrictions and guidelines

For configuration commands for Ethernet service instances, see *VXLAN Command Reference*.

Procedure

1. Enter system view.
   system-view
2. Enter Layer 2 Ethernet interface view or Layer 2 aggregate interface view.
   - Enter Layer 2 Ethernet interface view:
     interface *interface-type interface-number*
   - Enter Layer 2 aggregate interface view:
     interface bridge-aggregation *interface-number*
3. Create an Ethernet service instance and enter Ethernet service instance view.
   service-instance *instance-id*
4. Apply the QoS policy to the Ethernet service instance.
   qos apply policy *policy-name* { **inbound** | **outbound** }
   By default, no QoS policy is applied to an Ethernet service instance.

Applying the QoS policy to an interface

Restrictions and guidelines

A QoS policy can be applied to multiple interfaces. However, only one QoS policy of the same type can be applied to one direction (inbound or outbound) of an interface.

A maximum of five QoS policies (one for each type) can be applied to the inbound direction of an interface. Different actions can be taken on the same traffic class if QoS policies of different types are applied to an interface.

A maximum of two QoS policies can be applied to the outbound direction of an interface: one generic and one IPv6-matching.

The IPv6-matching QoS policy is supported only in Release 6555P01 and later.

When a QoS policy is applied to the outgoing traffic, a Layer 2 ACL rule matching the MAC addresses of packets in a class cannot match IPv6 packets.

The QoS policy applied to the outgoing traffic on an interface does not regulate local packets. Local packets refer to critical protocol packets sent by the local system for operation maintenance. The most common local packets include link maintenance, RIP, LDP, and SSH packets.

The term "interface" in this section collectively refers to Layer 2 Ethernet interfaces, Layer 2 aggregate interfaces, Layer 3 Ethernet interfaces, Layer 3 aggregate interfaces, Layer 3 Ethernet subinterfaces, and VSI interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see Ethernet interface configuration in *Layer 2—LAN Switching Configuration Guide*).

You cannot apply a QoS policy to the outbound direction of a Layer 2 or Layer 3 Ethernet interface.

For information about VSI interfaces, see *VXLAN Configuration Guide*.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Apply the QoS policy to the interface.
   qos apply [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy** *policy-name* { **inbound** | **outbound** [**share-mode**]
   By default, no QoS policy is applied to an interface.

The **ipv6-matching** keyword is supported only in Release 6555P01 and later.

Applying the QoS policy to VLANs

About QoS policy application to VLANs

You can apply a QoS policy to VLANs to regulate the traffic on all ports of the VLANs.

Restrictions and guidelines

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

When you apply a QoS policy to VLANs, the QoS policy is applied to the specified VLANs on all IRF member devices. If the hardware resources of an IRF member device are insufficient, applying a QoS policy to VLANs might fail on the IRF member device. The system does not automatically roll back the QoS policy configuration already applied to other IRF member devices. To ensure consistency, use the **undo qos vlan-policy vlan** command to manually remove the QoS policy configuration applied to them.

Procedure

1. Enter system view.
   system-view
2. Apply the QoS policy to VLANs.
   qos vlan-policy *policy-name* **vlan** *vlan-id-list* { **inbound** | **outbound** }
   By default, no QoS policy is applied to a VLAN.

Applying the QoS policy globally

About global QoS policy application

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

Restrictions and guidelines

A maximum of five QoS policies (one for each type) can be applied to one direction globally.

The IPv6-matching QoS policy is supported only in Release 6555P01 and later.

If the hardware resources of an IRF member device are insufficient, applying a QoS policy globally might fail on the IRF member device. The system does not automatically roll back the QoS policy configuration already applied to other IRF member devices. To ensure consistency, you must use the **undo qos apply policy global** command to manually remove the QoS policy configuration applied to them.

Procedure

1. Enter system view.
   system-view
2. Apply the QoS policy globally.
   qos apply [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy** *policy-name* **global** { **inbound** | **outbound**
   By default, no QoS policy is applied globally.
   The **ipv6-matching** keyword is supported only in Release 6555P01 and later.

Applying the QoS policy to a control plane

About the data plane and control plane

A device provides the data plane and the control plane.

- **Data plane**—The units at the data plane are responsible for receiving, transmitting, and switching (forwarding) packets, such as various dedicated forwarding chips. They deliver super processing speeds and throughput.
- **Control plane**—The units at the control plane are processing units running most routing and switching protocols. They are 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, the control plane will be busy handling undesired packets. As a result, the control plane will 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 traffic policing, on inbound traffic. This ensures that the control plane can correctly receive, transmit, and process packets.

A predefined control plane QoS policy uses the protocol type or protocol group type to identify the type of packets sent to the control plane. You can use protocol types or protocol group types in **if-match** commands in traffic class view for traffic classification. Then you can reconfigure traffic behaviors for these traffic classes as required. You can use the **display qos policy control-plane pre-defined** command to display predefined control plane QoS policies.

Procedure

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**

   By default, no QoS policy is applied to a control plane.

Applying the QoS policy to a user profile

About QoS policy application to a user profile

When a user profile is configured, you can perform traffic policing based on users. After a user passes authentication, the authentication server sends the name of the user profile associated with the user to the device. The QoS policy configured in user profile view takes effect only when users come online.

Restrictions and guidelines

You can apply a QoS policy to multiple user profiles. In one direction of each user profile, only one policy can be applied. To modify a QoS policy already applied to a direction, first remove the applied QoS policy.

Procedure

1. Enter system view.

   system-view
2. Enter user profile view.

user-profile *profile-name*

3. Apply the QoS policy to the user profile.
   qos apply policy *policy-name* { **inbound** | **outbound** }
   By default, no QoS policy is applied to a user profile.

Parameter	Description
inbound	Applies a QoS policy to the traffic received by the device from the user profile.
outbound	Applies a QoS policy to the traffic sent by the device to the user profile.

Display and maintenance commands for QoS policies

IMPORTANT:
The **ipv6-matching** keyword is supported only in Release 6555P01 and later.

Execute **display** commands in any view and **reset** commands in user view.

Task	Command
Display QoS policy configuration.	**display qos policy user-defined** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] [*policy-name* [**classifier** *classifier-name*]] [**slot** *slot-number*]
Display information about QoS policies applied to the control plane.	**display qos policy control-plane slot** *slot-number*
Display information about the predefined QoS policy applied to the control plane.	**display qos policy control-plane pre-defined** [**slot** *slot-number*]
Display diagnostic information about QoS policies applied to a control plane.	**display qos policy diagnosis control-plane slot** *slot-number*
Display diagnostic information about QoS policies applied globally.	**display qos** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy diagnosis global** [**slot** *slot-number*] [**inbound** | **outbound**]
Display diagnostic information about QoS policies applied to interfaces.	**display qos** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy diagnosis interface** [*interface-type interface-number*] [**slot** *slot-number*] [**inbound** | **outbound**]
Display diagnostic information about QoS policies applied to Ethernet service instances.	**display qos policy diagnosis l2vpn-ac** [**interface** *interface-type interface-number* [**service-instance** *instance-id*] [**slot** *slot-number*]] **inbound**
Display diagnostic information about QoS	**display qos policy diagnosis user-profile** [**name** *profile-name*] [**user-id** *user-id*] [**slot**

Task	Command
policies applied to user profiles.	*slot-number*] [**inbound** | **outbound**]
Display information about QoS policies applied globally.	**display qos** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy global** [**slot** *slot-number*] [**inbound** | **outbound**]
Display information about QoS policies applied to interfaces.	**display qos** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy interface** [*interface-type interface-number*] [**slot** *slot-number*] [**inbound** | **outbound**]
Display information about QoS policies applied to Ethernet service instances.	**display qos policy l2vpn-ac** [**interface** *interface-type interface-number* [**service-instance** *instance-id*] [**slot** *slot-number*]] [**inbound**]
Display information about QoS policies applied to user profiles.	**display qos policy user-profile** [**name** *profile-name*] [**user-id** *user-id*] [**slot** *slot-number*] [**inbound** | **outbound**]
Display information about QoS policies applied to VLANs.	**display qos vlan-policy** { **name** *policy-name* | **vlan** [*vlan-id*] } [**slot** *slot-number*] [**inbound** | **outbound**]
Display diagnostic information about QoS policies applied to VLANs.	**display qos vlan-policy diagnosis** { **name** *policy-name* | **vlan** [*vlan-id*] } [**slot** *slot-number*] [**inbound** | **outbound**]
Display QoS and ACL resource usage.	**display qos-acl resource** [**slot** *slot-number*]
Display traffic behavior configuration.	**display traffic behavior user-defined** [*behavior-name*] [**slot** *slot-number*]
Display traffic class configuration.	**display traffic classifier user-defined** [*classifier-name*] [**slot** *slot-number*]
Clear the statistics for a QoS policy applied globally.	**reset qos** [**ipv6-matching** | { **accounting** | **mirroring** | **remarking** }] **policy global** [**inbound** | **outbound**]
Clear the statistics for the QoS policy applied to the control plane.	**reset qos policy control-plane slot** *slot-number*
Clear the statistics of the QoS policy applied in a certain direction of a VLAN.	**reset qos vlan-policy** [**vlan** *vlan-id*] [**inbound** | **outbound**]

QoS policy configuration examples

Example: Applying multiple QoS policies to the inbound direction of an interface

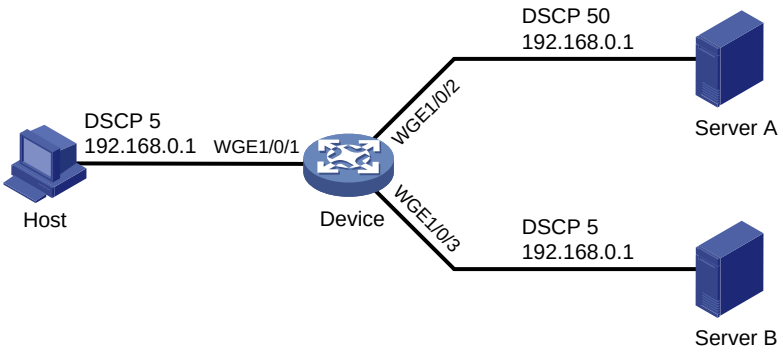
Network configuration

As shown in Figure 3, the source IP address of packets from the host to Server A is 192.168.0.1, and the DSCP field is 5.

Configure multiple QoS policies to meet the following requirements:

- Perform accounting on the packets from the host to Server A.
- Mirror the packets from the host to Server A to Twenty-FiveGigE 1/0/3.
- Mark the packets from the host to Server A with DSCP 50.
- Limit the incoming traffic rate on Twenty-FiveGigE 1/0/1 to 10 Mbps.

Figure 3 Network diagram



Procedure

Configure ACL 2000 to match the packets with source IP address 192.168.0.1.

```
<Device> system-view
[Device] acl basic 2000
[Device-acl-ipv4-basic-2000] rule permit source 192.168.0.1 0
[Device-acl-ipv4-basic-2000] quit
```

Create a traffic class named **host**, and use ACL 2000 as the match criterion.

```
[Device] traffic classifier host
[Device-classifier-host] if-match acl 2000
[Device-classifier-host] quit
```

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

```
[Device] traffic classifier any
[Device-classifier-any] if-match any
[Device-classifier-any] quit
```

Create a traffic behavior named **a**, and configure an accounting action.

```
[Device] traffic behavior a
[Device-behavior-a] accounting packet
[Device-behavior-a] quit
```

Create a traffic behavior named **m**, and configure an action of mirroring traffic to Twenty-FiveGigE 1/0/3.

```
[Device] traffic behavior m
[Device-behavior-m] mirror-to interface twenty-fivegige 1/0/3
[Device-behavior-m] quit
```

Create a traffic behavior named **r**, and configure an action of marking traffic with DSCP 50.

```
[Device] traffic behavior r
[Device-behavior-r] remark dscp 50
[Device-behavior-r] quit
```

Create a traffic behavior named **c**, and configure a traffic policing action (CIR 10240 kbps and CBS 102400 bytes).

```
[Device] traffic behavior c
[Device-behavior-c] car cir 10240 cbs 102400 green pass yellow pass red discard
[Device-behavior-c] quit
```

Create an accounting-type QoS policy named **policy_a**, and associate traffic class **host** with traffic behavior **a** in the QoS policy.

```
[Device] qos accounting policy policy_a
[Device-qospolicy-policy_a] classifier host behavior a
[Device-qospolicy-policy_a] quit
```

Create a mirroring-type QoS policy named **policy_m**, and associate traffic class **host** with traffic behavior **m** in the QoS policy.

```
[Device] qos mirroring policy policy_m
[Device-qospolicy-policy_m] classifier host behavior m
[Device-qospolicy-policy_m] quit
```

Create a marking-type QoS policy named **policy_r**, and associate traffic class **host** with traffic behavior **r** in the QoS policy.

```
[Device] qos remarking policy policy_r
[Device-qospolicy-policy_r] classifier host behavior r
[Device-qospolicy-policy_r] quit
```

Create a generic QoS policy named **policy_g**, and associate traffic class **any** with traffic behavior **c** in the QoS policy.

```
[Device] qos policy policy_g
[Device-qospolicy-policy_g] classifier any behavior c
[Device-qospolicy-policy_g] quit
```

Apply the four QoS policies to the inbound direction of Twenty-FiveGigE 1/0/1.

```
[DeviceA] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] qos apply accounting policy policy_a inbound
[Device-Twenty-FiveGigE1/0/1] qos apply mirroring policy policy_m inbound
[Device-Twenty-FiveGigE1/0/1] qos apply remarking policy policy_r inbound
[Device-Twenty-FiveGigE1/0/1] qos apply policy policy_g inbound
[Device-Twenty-FiveGigE1/0/1] quit
```

Configuring priority mapping

About priority mapping

When a packet arrives, a device assigns a set of QoS priority parameters to the packet based on either of the following:

- A priority field carried in the packet.
- 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 according to the priority mapping rules. The set of QoS priority parameters decides the scheduling priority and forwarding priority of the packet.

Priority mapping is implemented with priority maps and involves the following priorities:

- 802.11e priority.
- 802.1p priority.
- DSCP.
- EXP.
- IP precedence.
- Local precedence.
- Drop priority.

About priorities

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

Packet-carried priorities include 802.1p priority, DSCP precedence, IP precedence, and EXP. These priorities have global significance and affect the forwarding priority of packets across the network. For more information about these priorities, see "Appendixes."

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

- **Local precedence**—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 priority**—Used for making packet drop decisions. Packets with the highest drop priority are dropped preferentially.
- **User priority**—Precedence that the device automatically extracts from a priority field of the packet according to its forwarding path. It is a parameter for determining the scheduling priority and forwarding priority of the packet. The user priority represents the following items:
  - The 802.1p priority for Layer 2 packets.
  - The IP precedence for Layer 3 packets.
  - The EXP for MPLS packets.

The device supports only local precedence and drop priority for scheduling.

Priority maps

The device provides various types of priority maps. By looking through a priority map, the device decides which priority value to assign to a packet for subsequent packet processing.

The default priority maps (as shown in Appendix B Default priority maps) are available for priority mapping. They are adequate in most cases. If a default priority map cannot meet your requirements, you can modify the priority map as required.

Priority mapping configuration methods

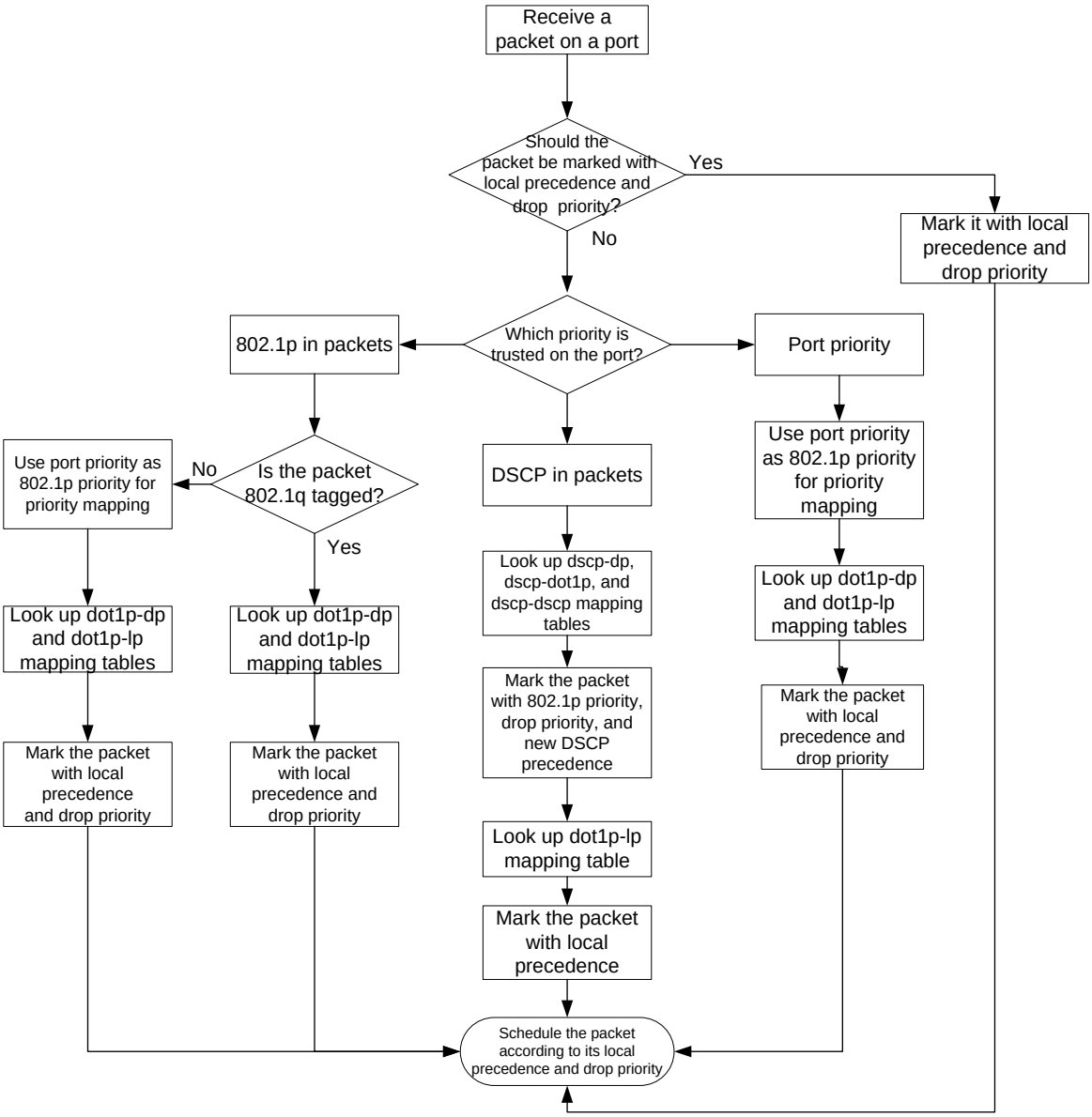
You can configure priority mapping by using any of the following methods:

- **Configuring priority trust mode**—In this method, you can configure a port to look up a trusted priority type (802.1p, for example) in incoming packets in the priority maps. Then, the system maps the trusted priority to the target priority types and values.
- **Changing port priority**—If no packet priority is trusted, the port priority of the incoming port is used. By changing the port priority of a port, you change the priority of the incoming packets on the port.

Priority mapping process

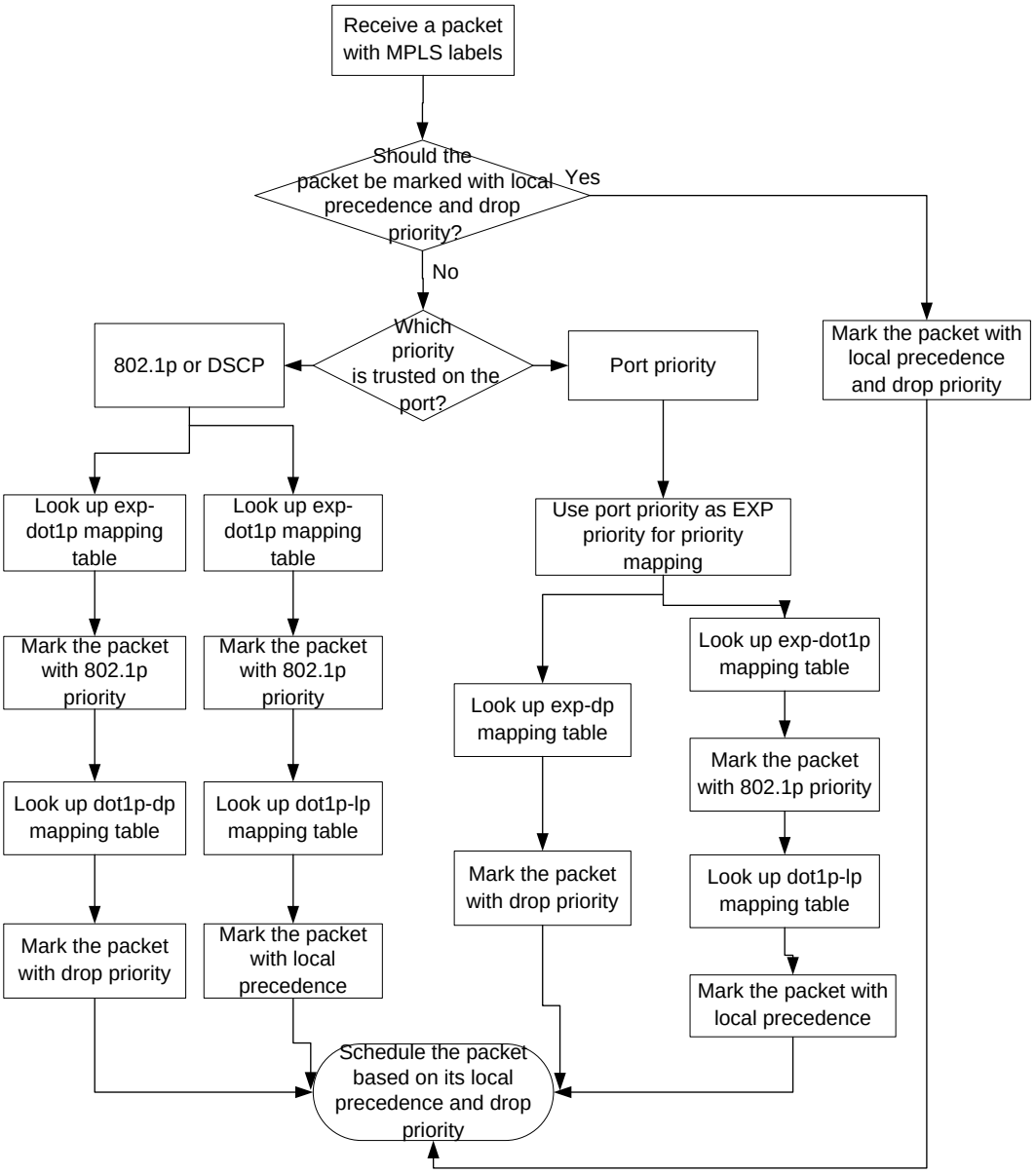
On receiving an Ethernet packet on a port, the switch marks the scheduling priorities (local precedence and drop precedence) for the Ethernet packet. This procedure is done according to the priority trust mode of the receiving port and the 802.1Q tagging status of the packet, as shown in Figure 4.

Figure 4 Priority mapping process for an Ethernet packet



The switch marks a received MPLS packet with a scheduling priority based on the priority trust mode and the packet EXP value, as shown in Figure 5.

Figure 5 Priority mapping process for an MPLS packet



For information about priority marking, see "Configuring priority marking."

Priority mapping tasks at a glance

To configure priority mapping, perform the following tasks:

1. (Optional.) Configuring a priority map
2. Configure a priority mapping method:
   - Configuring a port to trust packet priority for priority mapping
   - Changing the port priority of an interface

Configuring a priority map

1. Enter system view.

system-view

2. Enter priority map view.

   qos map-table { **dot1p-dp** | **dot1p-exp** | **dot1p-lp** | **dscp-dot1p** | **dscp-dp** | **dscp-dscp** | **exp-dot1p** }

3. Configure mappings for the priority map.

   import *import-value-list* **export** *export-value*

   By default, the default priority maps are used. For more information, see "Appendix B Default priority maps."

   If you execute this command multiple times, the most recent configuration takes effect.

Configuring a port to trust packet priority for priority mapping

About configuring a port to trust packet priority

You can configure the device to trust a particular priority field carried in packets for priority mapping on ports or globally. When you configure the trusted packet priority type on an interface, use the following available keywords:

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

Restrictions and guidelines

For a VXLAN tunnel interface to trust the DSCP priority in the outer IP header of VXLAN packets, you must configure both of the following commands:

- **qos trust tunnel-dscp** (in system view).
- **qos trust dscp** (in interface view for the physical interface of the VXLAN tunnel interface).

For a VXLAN tunnel interface to trust the 802.1p priority in the outer Ethernet header of VXLAN packets, you must configure both of the following commands:

- **qos trust tunnel-dot1p** (in system view).
- **qos trust dot1p** (in interface view for the physical interface of the VXLAN tunnel interface).

For PFC to take effect on an overlay network, configure the **qos trust tunnel-dot1p** command on all VTEPs. For information about overlay networks, see *VXLAN Configuration Guide*. For information about PFC, see Ethernet interface configuration in *Layer 2—LAN Switching Configuration Guide*.

The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

Procedure

1. Enter system view.

   system-view

2. Enter interface view.

   interface *interface-type interface-number*

3. Configure the trusted packet priority type.

   qos trust { **dot1p** | **dscp** }

   By default, an interface does not trust any packet priority and uses the port priority as the 802.1p priority for mapping.

4. Return to system view.
   quit
5. (Optional.) Configure the global priority trust mode for VXLAN packets.
   qos trust { **tunnel-dot1p** | **tunnel-dscp** }
   By default, the global priority trust mode for VXLAN packets is not configured.

Changing the port priority of an interface

About port priority

If an interface does not trust any packet priority, the device uses its port priority to look for priority parameters for the incoming packets. By changing port priority, you can prioritize traffic received on different interfaces.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Set the port priority of the interface.
   qos priority [**dscp**] *priority-value*
   The default setting is 0.

Display and maintenance commands for priority mapping

Execute **display** commands in any view.

Task	Command
Display priority map configuration.	**display qos map-table** [**dot1p-dp** | **dot1p-exp** | **dot1p-lp** | **dscp-dot1p** | **dscp-dp** | **dscp-dscp** | **exp-dot1p**]
Display the trusted packet priority type on a port.	**display qos trust interface** [*interface-type interface-number*]

Priority mapping configuration examples

Example: Configuring a priority trust mode

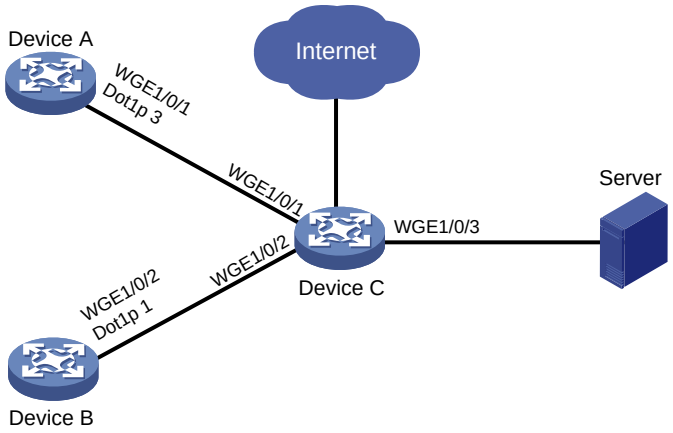
Network configuration

As shown in Figure 6:

- The 802.1p priority of traffic from Device A to Device C is 3.
- The 802.1p priority of traffic from Device B to Device C is 1.

Configure Device C to preferentially process packets from Device A to the server when Twenty-FiveGigE 1/0/3 of Device C is congested.

Figure 6 Network diagram



Procedure

(Method 1) Configure Device C to trust packet priority

Configure Twenty-FiveGigE 1/0/1 and Twenty-FiveGigE 1/0/2 to trust the 802.1p priority for priority mapping.

```
<DeviceC> system-view
[DeviceC] interface twenty-fivegige 1/0/1
[DeviceC-Twenty-FiveGigE1/0/1] qos trust dot1p
[DeviceC-Twenty-FiveGigE1/0/1] quit
[DeviceC] interface twenty-fivegige 1/0/2
[DeviceC-Twenty-FiveGigE1/0/2] qos trust dot1p
[DeviceC-Twenty-FiveGigE1/0/2] quit
```

(Method 2) Configure Device C to trust port priority

Assign port priority to Twenty-FiveGigE 1/0/1 and Twenty-FiveGigE 1/0/2. Make sure the following requirements are met:

- The priority of Twenty-FiveGigE 1/0/1 is higher than that of Twenty-FiveGigE 1/0/2.
- No trusted packet priority type is configured on Twenty-FiveGigE 1/0/1 or Twenty-FiveGigE 1/0/2.

```
<DeviceC> system-view
[DeviceC] interface twenty-fivegige 1/0/1
[DeviceC-Twenty-FiveGigE1/0/1] qos priority 3
[DeviceC-Twenty-FiveGigE1/0/1] quit
[DeviceC] interface twenty-fivegige 1/0/2
[DeviceC-Twenty-FiveGigE1/0/2] qos priority 1
[DeviceC-Twenty-FiveGigE1/0/2] quit
```

Example: Configuring priority mapping tables and priority marking

Network configuration

As shown in Figure 7:

- The Marketing department connects to Twenty-FiveGigE 1/0/1 of Device, which sets the 802.1p priority of traffic from the Marketing department to 3.

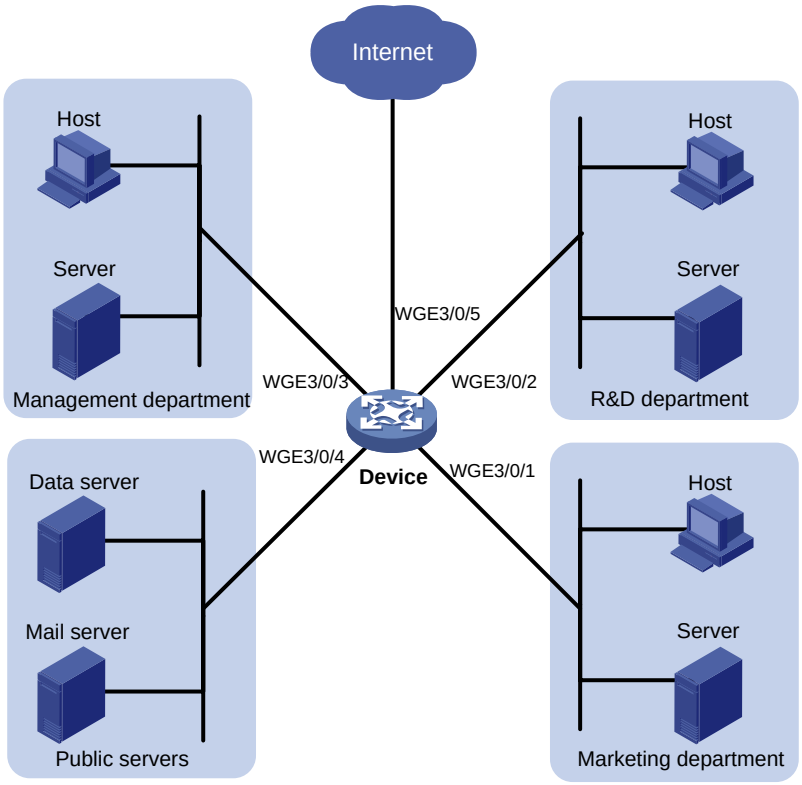
- The R&D department connects to Twenty-FiveGigE 1/0/2 of Device, which sets the 802.1p priority of traffic from the R&D department to 4.
- The Management department connects to Twenty-FiveGigE 1/0/3 of Device, which sets the 802.1p priority of traffic from the Management department to 5.

Configure port priority, 802.1p-to-local mapping table, and priority marking to implement the plan as described in Table 1.

Table 1 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 7 Network diagram



Procedure

1. Configure trusting port priority:

   # Set the port priority of Twenty-FiveGigE 1/0/1 to 3.

   ```
   <Device> system-view
   [Device] interface twenty-fivegige 1/0/1
   ```

```
[Device-Twenty-FiveGigE1/0/1] qos priority 3
[Device-Twenty-FiveGigE1/0/1] quit
```

Set the port priority of Twenty-FiveGigE 1/0/2 to 4.

```
[Device] interface twenty-fivegige 1/0/2
[Device-Twenty-FiveGigE1/0/2] qos priority 4
[Device-Twenty-FiveGigE1/0/2] quit
```

Set the port priority of Twenty-FiveGigE 1/0/3 to 5.

```
[Device] interface twenty-fivegige 1/0/3
[Device-Twenty-FiveGigE1/0/3] qos priority 5
[Device-Twenty-FiveGigE1/0/3] 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 servers.

```
[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 to mark the packets from Management department, Marketing department, and R&D department to the Internet with 802.1p priority values 4, 5, and 3.

This guarantees the Management department, Marketing department, and R&D department decreased priorities to access the Internet.

Create ACL 3000, and configure a rule to match HTTP packets.

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

Create a traffic class named **http**, and use ACL 3000 as a match criterion.

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

Create a traffic behavior named **admin**, and configure a marking action for the Management department.

```
[Device] traffic behavior admin
[Device-behavior-admin] remark dot1p 4
[Device-behavior-admin] quit
```

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

```
[Device] qos policy admin
[Device-qospolicy-admin] classifier http behavior admin
[Device-qospolicy-admin] quit
```

Apply QoS policy **admin** to the inbound direction of Twenty-FiveGigE 1/0/3.

```
[Device] interface twenty-fivegige 1/0/3
[Device-Twenty-FiveGigE1/0/3] qos apply policy admin inbound
```

Create a traffic behavior named **market**, and configure a marking action for the Marketing department.

```
[Device] traffic behavior market
[Device-behavior-market] remark dot1p 5
```

```
[Device-behavior-market] quit
```

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

```
[Device] qos policy market
[Device-qospolicy-market] classifier http behavior market
[Device-qospolicy-market] quit
```

Apply QoS policy **market** to the inbound direction of Twenty-FiveGigE 1/0/1.

```
[Device] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] qos apply policy market inbound
```

Create a traffic behavior named **rd**, and configure a marking action for the R&D department.

```
[Device] traffic behavior rd
[Device-behavior-rd] remark dot1p 3
[Device-behavior-rd] quit
```

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

```
[Device] qos policy rd
[Device-qospolicy-rd] classifier http behavior rd
[Device-qospolicy-rd] quit
```

Apply QoS policy **rd** to the inbound direction of Twenty-FiveGigE 1/0/2.

```
[Device] interface twenty-fivegige 1/0/2
[Device-Twenty-FiveGigE1/0/2] qos apply policy rd inbound
```

Configuring traffic policing, GTS, and rate limit

About traffic policing, GTS, and rate limit

Traffic limit helps assign network resources (including bandwidth) and increase network performance. 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. You can use token buckets for evaluating traffic specifications.

Traffic evaluation and token buckets

Token bucket features

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 (called conforming traffic).
- The corresponding tokens are taken away from the bucket.

Otherwise, the traffic does not conform to the specification (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.

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. The following are main mechanisms used for complicated evaluation:

- **Single rate two color**—Uses one token bucket and 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.

  When a packet arrives, the following rules apply:
  - If bucket C has enough tokens to forward the packet, the packet is colored green.
  - Otherwise, the packet is colored red.
- **Single rate three color**—Uses two token buckets and 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.
- **EBS**—Size of bucket E minus size of bucket C, which specifies the transient burst of traffic that bucket E can forward. The EBS cannot be 0. The size of E bucket is the sum of the CBS and EBS.

When a packet arrives, the following rules apply:

- 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 sufficient tokens, the packet is colored red.

- **Two rate three color**—Uses two token buckets and 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.
  - **PIR**—Rate at which tokens are put into bucket E, which specifies the average packet transmission or forwarding rate allowed by bucket E.
  - **EBS**—Size of bucket E, which specifies the transient burst of traffic that bucket E can forward.

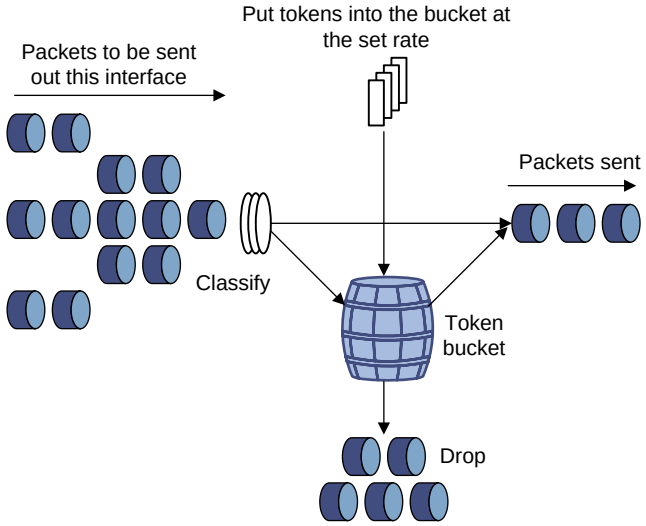
  When a packet arrives, the following rules apply:
  - If bucket C has enough tokens, the packet is colored green.
  - If bucket C does not have enough tokens but bucket E has enough tokens, the packet is colored yellow.
  - If neither bucket C nor bucket E has sufficient tokens, the packet is colored red.

Traffic policing

Traffic policing supports policing the inbound traffic and the outbound traffic.

A typical application of traffic policing is to supervise the specification of traffic entering a network and limit it within a reasonable range. Another application is to "discipline" the extra traffic to prevent aggressive use of network resources by an application. For example, you can limit bandwidth for HTTP packets to less than 50% of the total. If the traffic of a session exceeds the limit, traffic policing can drop the packets or reset the IP precedence of the packets. Figure 8 shows an example of policing outbound traffic on an interface.

Figure 8 Traffic policing



Traffic policing is widely used in policing traffic entering the ISP networks. It can classify the policed traffic and take predefined 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 precedence re-marked if the evaluation result is "conforming."
- Delivering the packet to next-level traffic policing with its precedence re-marked if the evaluation result is "conforming."
- Entering the next-level policing (you can set multiple traffic policing levels, each focused on objects at different levels).

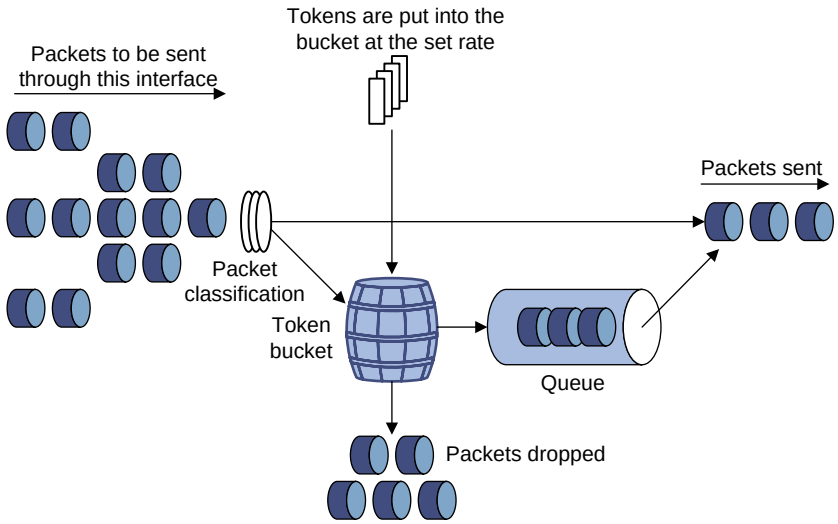
GTS

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

The differences between traffic policing and GTS are as follows:

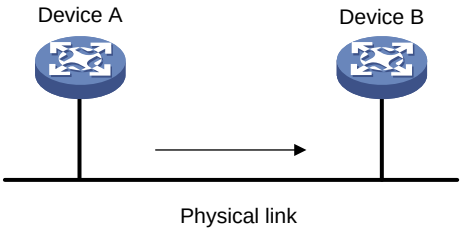
- Packets to be dropped with traffic policing are retained in a buffer or queue with GTS, as shown in Figure 9. When enough tokens are in the token bucket, the buffered packets are sent at an even rate.
- GTS can result in additional delay and traffic policing does not.

Figure 9 GTS



For example, in Figure 10, Device B performs traffic policing on packets from Device A and drops packets exceeding the limit. To avoid packet loss, you can perform GTS on the outgoing interface of Device A so that packets exceeding the limit are cached in Device A. Once resources are released, GTS takes out the cached packets and sends them out.

Figure 10 GTS application



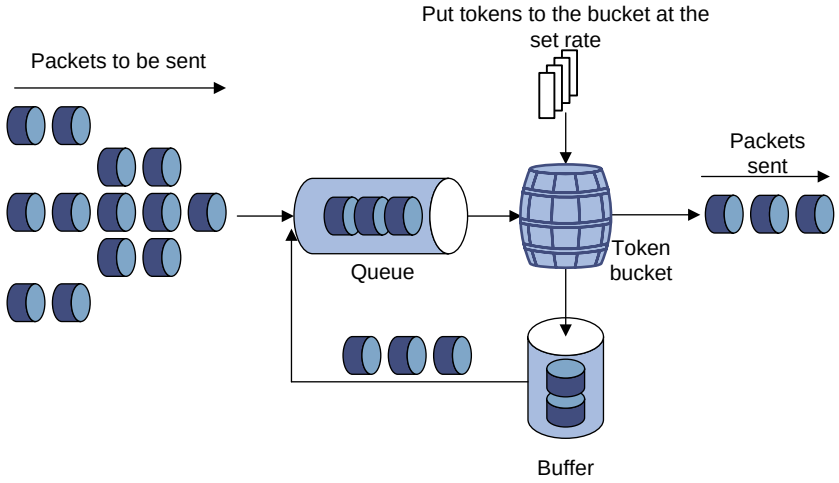
Rate limit

Rate limit controls the rate of inbound and outbound traffic. The outbound traffic is taken for example.

The rate limit of an interface specifies the maximum rate for forwarding packets (excluding critical packets).

Rate limit also uses token buckets for traffic control. When rate limit is configured on an interface, a token bucket handles all packets to be sent through the interface for rate limiting. 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 interface is controlled.

Figure 11 Rate limit implementation



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 controls the total rate of all packets on an interface. It is easier to use than traffic policing in controlling the total traffic rate.

Restrictions and guidelines: Traffic policing, GTS, and rate limit configuration

The specified CIR does not take traffic transmitted in interframe gaps into account, and the actually allowed rate on an interface is greater than the specified CIR.

An interframe gap is a time interval for transmitting 12 bits between frames. This gap serves the following roles:

- Allows the device to differentiate one frame from another.
- Allows for time for the device to process the current frame and to prepare for receiving the next frame.

Configuring traffic policing

Restrictions and guidelines

The device supports the following application destinations for traffic policing:

- Ethernet service instance.
- Interface.
- VLANs.
- Globally.
- Control plane.
- User profile.

If you both configure traffic policing by using the MQC approach and apply a queue scheduling profile on an interface, the device performs queue scheduling before traffic policing. In other words,

the red packets to be dropped by traffic policing will also be processed by the queue scheduling profile.

Procedure

1. Enter system view.

   system-view

2. Define a traffic class.

   a. Create a traffic class and enter traffic class view.

      traffic classifier *classifier-name* [**operator** { **and** | **or** }]

   b. Configure a match criterion.

      if-match *match-criteria*

      By default, no match criterion is configured.

      For more information about the **if-match** command, see *ACL and QoS Command Reference*.

   c. Return to system view.

      quit

3. Define a traffic behavior.

   a. Create a traffic behavior and enter traffic behavior view.

      traffic behavior *behavior-name*

   b. Configure a traffic policing action.

      car cir [**pps**] *committed-information-rate* [**cbs** *committed-burst-size* [**ebs** *excess-burst-size*]] [**green** *action* | **red** *action* | **yellow** *action*] *

      car cir [**pps**] *committed-information-rate* [**cbs** *committed-burst-size*] **pir** [**pps**] *peak-information-rate* [**ebs** *excess-burst-size*] [**green** *action* | **red** *action* | **yellow** *action*] *

      By default, no traffic policing action is configured.

   c. Return to system view.

      quit

4. Define a QoS policy.

   a. Create a QoS policy and enter QoS policy view.

      qos policy *policy-name*

   b. Associate the traffic class with the traffic behavior in the QoS policy.

      classifier *classifier-name* **behavior** *behavior-name*

      By default, a traffic class is not associated with a traffic behavior.

   c. Return to system view.

      quit

5. Apply the QoS policy.

   For more information, see "Applying the QoS policy."

   By default, no QoS policy is applied.

Configuring GTS

Restrictions and guidelines

The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

Procedure

1. Enter system view.

   system-view
2. Enter interface view.

   interface *interface-type interface-number*
3. Configure GTS for a queue.

   qos gts queue *queue-id* **cir** *committed-information-rate* [**cbs** *committed-burst-size*]

   undo qos gts queue *queue-id*

   By default, GTS is not configured on an interface.

Configuring the rate limit

Restrictions and guidelines

The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

Procedure

1. Enter system view.

   system-view
2. Enter interface view.

   interface *interface-type interface-number*
3. Configure the rate limit for the interface.

   qos lr outbound cir *committed-information-rate* [**cbs** *committed-burst-size*]

   By default, no rate limit is configured on an interface.

Display and maintenance commands for traffic policing, GTS, and rate limit

Execute **display** commands in any view.

Task	Command
Display GTS configuration and statistics for interfaces.	**display qos gts interface** [*interface-type interface-number*]
Display rate limit configuration and statistics.	**display qos lr interface** [*interface-type interface-number*]

Task	Command
Display QoS and ACL resource usage.	**display qos-acl resource** [**slot** *slot-number*]
Display traffic behavior configuration.	**display traffic behavior user-defined** [*behavior-name*]

Traffic policing, GTS, and rate limit configuration examples

Example: Configuring traffic policing and GTS

Network requirements

As shown in Figure 12:

- The server, Host A, and Host B can access the Internet through Device A and Device B.
- The server, Host A, and Twenty-FiveGigE 1/0/1 of Device A are in the same network segment.
- Host B and Twenty-FiveGigE 1/0/2 of Device A are in the same network segment.

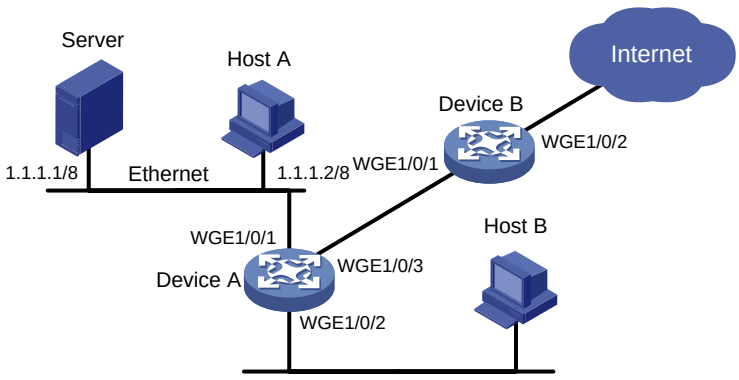
Perform traffic control for the packets that Twenty-FiveGigE 1/0/1 of Device A receives from the server and Host A using the following guidelines:

- Limit the rate of packets from the server to 10240 kbps. When the traffic rate is below 10240 kbps, the traffic is forwarded. When the traffic rate exceeds 10240 kbps, the excess packets are marked with DSCP value 0 and then forwarded.
- Limit the rate of packets from Host A to 2560 kbps. When the traffic rate is below 2560 kbps, the traffic is forwarded. When the traffic rate exceeds 2560 kbps, the excess packets are dropped.

Perform traffic control on Twenty-FiveGigE 1/0/1 and Twenty-FiveGigE 1/0/2 of Device B using the following guidelines:

- Limit the incoming traffic rate on Twenty-FiveGigE 1/0/1 to 20480 kbps, and the excess packets are dropped.
- Limit the outgoing traffic rate on Twenty-FiveGigE 1/0/2 to 10240 kbps, and the excess packets are dropped.

Figure 12 Network diagram



Configuration procedure

1. Configure Device A:

Configure ACL 2001 and ACL 2002 to permit the packets from the server and Host A, respectively.

```
[DeviceA] acl basic 2001
[DeviceA-acl-ipv4-basic-2001] rule permit source 1.1.1.1 0
[DeviceA-acl-ipv4-basic-2001] quit
[DeviceA] acl basic 2002
[DeviceA-acl-ipv4-basic-2002] rule permit source 1.1.1.2 0
[DeviceA-acl-ipv4-basic-2002] quit
```

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

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

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

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

Create a traffic behavior named **server**, and configure a traffic policing action (CIR 10240 kbps).

```
[DeviceA] traffic behavior server
[DeviceA-behavior-server] car cir 10240 red remark-dscp-pass 0
[DeviceA-behavior-server] quit
```

Create a traffic behavior named **host**, and configure a traffic policing action (CIR 2560 kbps).

```
[DeviceA] traffic behavior host
[DeviceA-behavior-host] car cir 2560
[DeviceA-behavior-host] quit
```

Create a QoS policy named **car**, and associate traffic classes **server** and **host** with traffic behaviors **server** and **host** in QoS policy **car**, respectively.

```
[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 inbound direction of Twenty-FiveGigE 1/0/1.

```
[DeviceA] interface twenty-fivegige 1/0/1
[DeviceA-Twenty-FiveGigE1/0/1] qos apply policy car inbound
```

2. Configure Device B:

Create ACL 3001, and configure a rule to match HTTP packets.

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

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

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

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

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

Create a traffic behavior named **car_inbound**, and configure a traffic policing action (CIR 20480 kbps).

```
[DeviceB] traffic behavior car_inbound
[DeviceB-behavior-car_inbound] car cir 20480
[DeviceB-behavior-car_inbound] quit
```

Create a traffic behavior named **car_outbound**, and configure a traffic policing action (CIR 10240 kbps).

```
[DeviceB] traffic behavior car_outbound
[DeviceB-behavior-car_outbound] car cir 10240
[DeviceB-behavior-car_outbound] quit
```

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

```
[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 traffic class **http** with traffic behavior **car_outbound** in QoS policy **car_outbound**.

```
[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 inbound direction of Twenty-FiveGigE 1/0/1.

```
[DeviceB] interface twenty-fivegige 1/0/1
[DeviceB-Twenty-FiveGigE1/0/1] qos apply policy car_inbound inbound
```

Apply QoS policy **car_outbound** to the outbound direction of Twenty-FiveGigE 1/0/2.

```
[DeviceB] interface twenty-fivegige 1/0/2
[DeviceB-Twenty-FiveGigE1/0/2] qos apply policy car_outbound outbound
```

Configuring congestion management

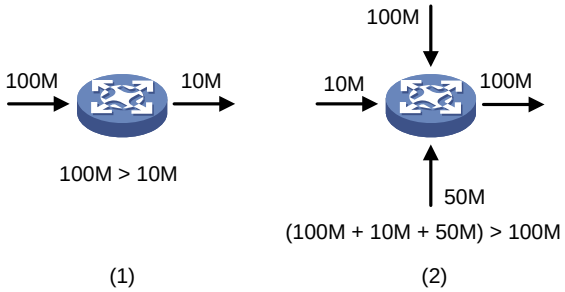
About congestion management

Cause, negative results, and countermeasure of congestion

Congestion occurs on a link or node when traffic size exceeds the processing capability of the link or node. It is typical of a statistical multiplexing network and can be caused by link failures, insufficient resources, and various other causes.

Figure 13 shows two typical congestion scenarios.

Figure 13 Traffic congestion scenarios



Congestion produces 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 even system breakdown.

Congestion is unavoidable in switched networks and multiuser application environments. To improve the service performance of your network, take measures to manage and control it.

The key to congestion management is defining a resource dispatching policy to prioritize packets for forwarding when congestion occurs.

Congestion management methods

Congestion management uses queuing and scheduling algorithms to classify and sort traffic leaving a port.

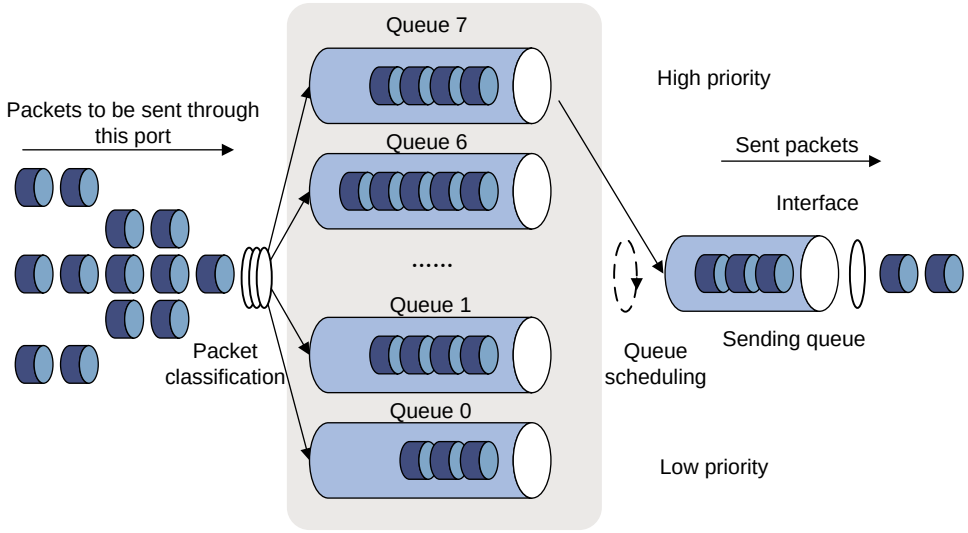
The device supports the following queuing mechanisms:

- SP.
- WRR.
- WFQ.

SP queuing

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

Figure 14 SP queuing



In Figure 14, SP queuing classifies eight queues on a port into eight classes, numbered 7 to 0 in descending priority order.

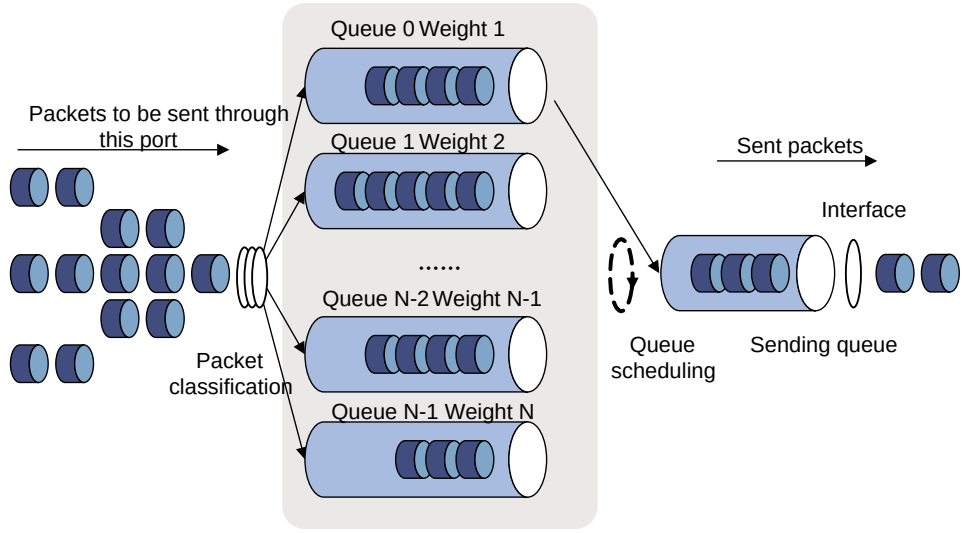
SP queuing schedules the eight queues in the descending order of priority. SP queuing sends packets in the queue with the highest priority first. When the queue with the highest priority is empty, it sends packets in the queue with the second highest priority, and so on. You can assign mission-critical packets to a high priority queue to make sure they are always served first. Common service packets can be assigned to low priority queues to be transmitted when 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. In the worst case, lower priority traffic might never get serviced.

WRR queuing

WRR queuing schedules all the queues in turn to ensure that every queue is served for a certain time, as shown in Figure 15.

Figure 15 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). The weight value of a queue decides the proportion of resources assigned to the queue. On a 100 Mbps port, you can set the weight values to 50, 30, 10, 10, 50, 30, 10, and 10 for w7 through w0. In this way, the queue with the lowest priority can get a minimum of 5 Mbps of bandwidth. WRR solves the problem that SP queuing might fail to serve packets in low-priority queues 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.

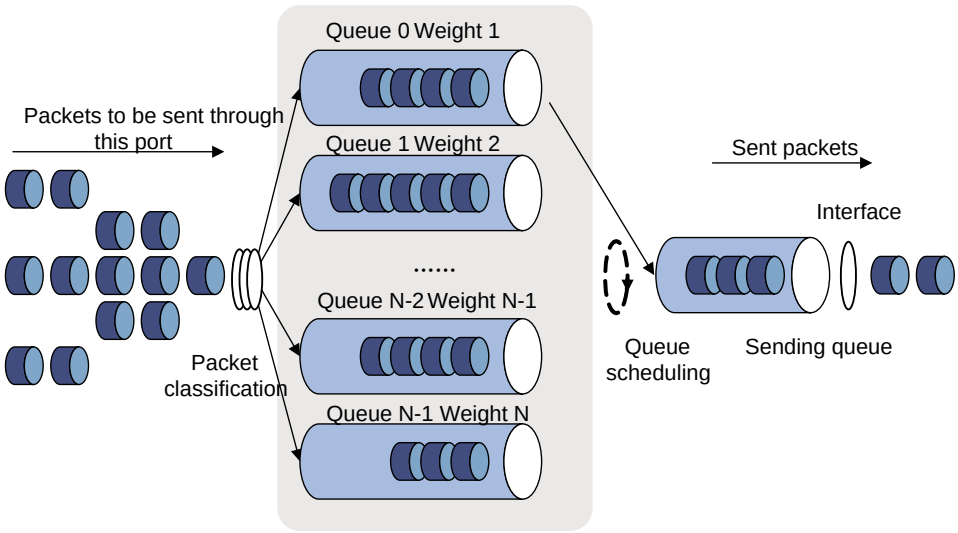
WRR queuing includes the following types:

- **Basic WRR queuing**—Contains multiple queues. You can set the weight for each queue, and WRR schedules these queues based on the user-defined parameters in a round robin manner.
- **Group-based WRR queuing**—All the queues are scheduled by WRR. You can divide output queues to WRR priority queue group 1 and WRR priority queue group 2. Round robin queue scheduling is performed for group 1 first. If group 1 is empty, round robin queue scheduling is performed for group 2. Only WRR priority queue group 1 is supported in the current software version.

On an interface enabled with group-based WRR queuing, you can assign queues to the SP group. Queues in the SP group are scheduled with SP. The SP group has higher scheduling priority than the WRR groups.

WFQ queuing

Figure 16 WFQ queuing



WFQ is similar to WRR. WFQ queuing includes basic WFQ queuing and group-based WFQ queuing. Only WFQ group 1 is supported in the current software version.

On an interface with group-based WFQ queuing enabled, you can also assign queues to the SP group. The difference is that WFQ enables you to set guaranteed bandwidth that a WFQ queue can get during congestion.

SP+WFQ queuing schedules traffic in the following order:

1. Schedules the traffic conforming to the minimum guaranteed bandwidth of each queue in the WFQ group.
2. Schedules the queues in the SP group based on their priorities.
3. Schedules the traffic in each queue in the WFQ group according to the configured weights when all queues in the SP group are empty.

Congestion management tasks at a glance

To configure congestion management, perform the following tasks:

- Configuring queuing on an interface
  - Configuring SP queuing
  - Configuring WRR queuing
  - Configuring WFQ queuing
  - Configuring SP+WRR queuing
  - Configuring SP+WFQ queuing
- Configuring a queue scheduling profile

Configuring queuing on an interface

Restrictions and guidelines for queuing configuration

The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

Configuring SP queuing

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Configure SP queuing.
   qos sp
   By default, an interface uses byte-count WRR queuing.

Configuring WRR queuing

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Enable WRR queuing.
   qos wrr { **byte-count** | **weight** }
   By default, an interface uses byte-count WRR queuing.
4. Assign a queue to a WRR group, and configure scheduling parameters for the queue.
   qos wrr *queue-id* **group 1** { **byte-count** | **weight** } *schedule-value*
   By default, all queues on a WRR-enabled interface are in WRR group 1, and queues 0 through 7 have a weight of 1, 2, 3, 4, 5, 9, 13, and 15, respectively.

Configuring WFQ queuing

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Enable WFQ queuing.
   qos wfq { **byte-count** | **weight** }
   By default, an interface uses byte-count WRR queuing.
4. Assign a queue to a WFQ group, and configure scheduling parameters for the queue.
   qos wfq *queue-id* **group 1** { **byte-count** | **weight** } *schedule-value*
   By default, all queues on a WFQ-enabled interface are in WFQ group 1 and have a weight of 1.

Configuring SP+WRR queuing

Restrictions and guidelines

To configure the scheduling weight, you must specify the same scheduling unit as specified when enabling WRR queuing.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Enable byte-count or packet-count WRR queuing.
   qos wrr { **byte-count** | **weight** }
   By default, an interface uses byte-count WRR queuing.
4. Assign a queue to the SP group.
   qos wrr *queue-id* **group sp**
   By default, all queues on a WRR-enabled interface are in WRR group 1.
5. Assign a queue to a WRR group, and configure a scheduling weight for the queue.
   qos wrr *queue-id* **group 1** { **byte-count** | **weight** } *schedule-value*
   By default, all queues on a WRR-enabled interface are in WRR group 1, and queues 0 through 7 have a weight of 1, 2, 3, 4, 5, 9, 13, and 15, respectively.

Configuring SP+WFQ queuing

Restrictions and guidelines

To configure the scheduling weight, you must specify the same scheduling unit as specified when enabling WFQ queuing.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*

3. Enable byte-count or packet-count WFQ queuing.

   qos wfq [**byte-count** | **weight**]

   By default, an interface uses byte-count WRR queuing.

4. Assign a queue to the SP group.

   qos wfq *queue-id* **group sp**

   By default, all queues on a WFQ-enabled interface are in WFQ group 1.

5. Assign a queue to a WFQ queue scheduling group, and configure a scheduling weight for the queue.

   qos wfq *queue-id* **group 1** { **byte-count** | **weight** } *schedule-value*

   By default, all queues on a WFQ-enabled interface are in WFQ group 1 and have a weight of 1.

6. (Optional.) Set the minimum guaranteed bandwidth for a queue.

   qos bandwidth queue *queue-id* **min** *bandwidth-value*

   The default setting is 64 kbps.

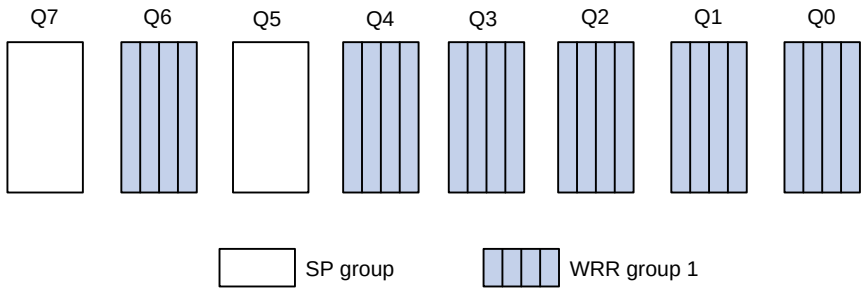
Configuring a queue scheduling profile

About queue scheduling profiles

In a queue scheduling profile, you can configure scheduling parameters for each queue. By applying the queue scheduling profile to an interface, you can implement congestion management on the interface.

Queue scheduling profiles support three queue scheduling algorithms: SP, WRR, and WFQ. In a queue scheduling profile, you can configure SP + WRR or SP + WFQ. For information about each scheduling algorithm, see "About congestion management." When SP and WRR groups are configured in a queue scheduling profile, Figure 17 shows the scheduling order.

Figure 17 Queue scheduling profile configured with both SP and WRR



- Queue 7 has the highest priority in the SP group. Its packets are sent preferentially.
- Queue 5 has the second highest priority in the SP group. Packets in queue 5 are sent when queue 7 is empty.
- All queues in WRR group 1 are scheduled according to their weights. When queue 7 and queue 5 are empty, WRR group 1 is scheduled.

Restrictions and guidelines for queue scheduling profile configuration

When you configure a queue scheduling profile, follow these restrictions and guidelines:

- The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).
- Only one queue scheduling profile can be applied to an interface.
- You can modify the scheduling parameters in a queue scheduling profile already applied to an interface.
- If you both configure traffic policing by using the MQC approach and apply a queue scheduling profile on an interface, the device performs queue scheduling before traffic policing. In other words, the red packets to be dropped by traffic policing will also be processed by the queue scheduling profile.

Configuring a queue scheduling profile

1. Enter system view.

   system-view
2. Create a queue scheduling profile and enter queue scheduling profile view.

   qos qmprofile *profile-name*
3. (Optional.) Configure queue scheduling parameters.
   - Configure a queue to use SP.

     queue *queue-id* **sp**
   - Configure a queue to use WRR.

     queue *queue-id* **wrr group** *group-id* { **weight** | **byte-count** } *schedule-value*
   - Configure a queue to use WFQ.

     queue *queue-id* **wfq** { **weight** | **byte-count** } *schedule-value*

   By default, all queues in a queue scheduling profile use packet-count WRR queuing, and the weights of queues 0 through 7 are 1, 2, 3, 4, 5, 9, 13, and 15, respectively.
4. (Optional.) Set the minimum guaranteed bandwidth for a WFQ queue.

   bandwidth queue *queue-id* **min** *bandwidth-value*

   The default setting is 64 kbps.

Applying a queue scheduling profile

1. Enter system view.

   system-view
2. Enter queue scheduling profile view.

   qos qmprofile *profile-name*
3. Execute the following commands in sequence to apply the queue scheduling profile to the outbound direction of an interface:

   interface *interface-type interface-number*

   qos apply qmprofile *profile-name*

   By default, no queue scheduling profile is applied to an interface.

Example: Configuring a queue scheduling profile

Network configuration

Configure a queue scheduling profile to meet the following requirements on Twenty-FiveGigE 1/0/1:

- Queue 7 has the highest priority, and its packets are sent preferentially.
- Queue 0 through queue 6 are in the WRR group and are scheduled according to their packet-count weights, which are 2, 1, 2, 4, 6, 8, and 10, respectively. When queue 7 is empty, the WRR group is scheduled.

Procedure

Enter system view.

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

Create a queue scheduling profile named **qm1**.

```
[Sysname] qos qmprofile qm1
[Sysname-qmprofile-qm1]
```

Configure queue 7 to use SP queuing.

```
[Sysname-qmprofile-qm1] queue 7 sp
```

Assign queue 0 through queue 6 to WRR group 1, with their packet-count weights as 2, 1, 2, 4, 6, 8, and 10, respectively.

```
[Sysname-qmprofile-qm1] queue 0 wrr group 1 weight 2
[Sysname-qmprofile-qm1] queue 1 wrr group 1 weight 1
[Sysname-qmprofile-qm1] queue 2 wrr group 1 weight 2
[Sysname-qmprofile-qm1] queue 3 wrr group 1 weight 4
[Sysname-qmprofile-qm1] queue 4 wrr group 1 weight 6
[Sysname-qmprofile-qm1] queue 5 wrr group 1 weight 8
[Sysname-qmprofile-qm1] queue 6 wrr group 1 weight 10
[Sysname-qmprofile-qm1] quit
```

Apply queue scheduling profile **qm1** to Twenty-FiveGigE 1/0/1.

```
[Sysname] interface twenty-fivegige 1/0/1
[Sysname-Twenty-FiveGigE1/0/1] qos apply qmprofile qm1
```

After the configuration is completed, Twenty-FiveGigE 1/0/1 performs queue scheduling as specified in queue scheduling profile **qm1**.

Display and maintenance commands for congestion management

Execute **display** commands in any view.

Task	Command
Display the configuration of queue scheduling profiles.	**display qos qmprofile configuration** [*profile-name*] [**slot** *slot-number*]
Display the queue scheduling profiles applied to interfaces.	**display qos qmprofile interface** [*interface-type interface-number*]
Display outbound queue-based traffic statistics	**display qos queue-statistics interface outbound**

Task	Command
for interfaces.	
Display SP queuing configuration.	**display qos queue sp interface** [*interface-type interface-number*]
Display WFQ queuing configuration.	**display qos queue wfq interface** [*interface-type interface-number*]
Display WRR queuing configuration.	**display qos queue wrr interface** [*interface-type interface-number*]

Configuring congestion avoidance

About congestion avoidance

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).
- Drops packets when congestion is expected to occur or deteriorate.

When dropping packets from a source end, congestion avoidance cooperates with the flow control mechanism 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 implements the following functions:

- Maximizes throughput and network use efficiency.
- Minimizes 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. However, 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.

If the current queue size is compared with the upper threshold and lower threshold to determine the drop policy, burst traffic is not fairly treated. To solve this problem, WRED compares the average queue size with the upper threshold and lower threshold to determine the drop probability.

The average queue size reflects the queue size change trend but is not sensitive to burst queue size changes, and burst traffic can be fairly treated.

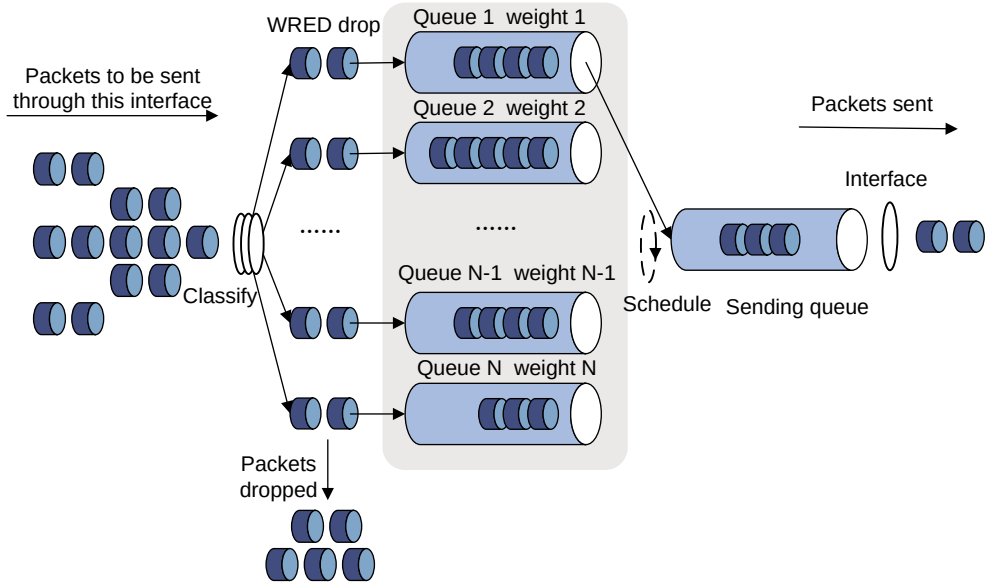
When WFQ queuing is used, you can set the following parameters for packets with different precedence values to provide differentiated drop policies:

- Exponent for average queue size calculation.
- Upper threshold.
- Lower threshold.

- Drop probability.

Relationship between WRED and queuing mechanisms

Figure 18 Relationship between WRED and queuing mechanisms



Through combining WRED with WFQ, the flow-based WRED can be realized. Each flow has its own queue after classification.

- A flow with a smaller queue size has a lower packet drop probability.
- A flow with a larger queue size has a higher packet drop probability.

In this way, the benefits of the flow with a smaller queue size are protected.

ECN

By dropping packets, WRED alleviates the influence of congestion on the network. However, the network resources for transmitting packets from the sender to the device which drops the packets are wasted. When congestion occurs, it is a better idea to perform the following actions:

- Inform the sender of the congestion status.
- Have the sender proactively slow down the packet sending rate or decrease the window size of packets.

This better utilizes the network resources.

RFC 2482 defined an end-to-end congestion notification mechanism named Explicit Congestion Notification (ECN). ECN uses the DS field in the IP header to mark the congestion status along the packet transmission path. An ECN-capable terminal can determine whether congestion occurs on the transmission path according to the packet contents. Then, it adjusts the packet sending speed to avoid deteriorating congestion. ECN defines the last two bits (ECN field) in the DS field of the IP header as follows:

- Bit 6 indicates whether the sending terminal device supports ECN, and is called the ECN-Capable Transport (ECT) bit.
- Bit 7 indicates whether the packet has experienced congestion along the transmission path, and is called the Congestion Experienced (CE) bit.

For more information about the DS field, see "Appendixes."

In actual applications, the following packets are considered as packets that an ECN-capable endpoint transmits:

- Packets with ECT set to 1 and CE set to 0.
- Packets with ECT set to 0 and CE set to 1.

After you enable ECN on a device, congestion management processes packets as follows:

- When the average queue size is below the lower threshold, no packet is dropped, and the ECN fields of packets are not identified or marked.
- When the average queue size is between the lower threshold and the upper threshold, the device performs the following operations:
  a. Picks out packets to be dropped according to the drop probability.
  b. Examines the ECN fields of these packets and determines whether to drop these packets.
  - If the ECN field shows that the packet is sent out of ECN-capable terminal, the device performs the following operations:
    - Sets both the ECT bit and the CE bit to 1.
    - Forwards the packet.
  - If both the ECT bit and the CE bit are 1 in the packet, the device forwards the packet without modifying the ECN field. The combination of ECT bit 1 and CE bit 1 indicates that the packet has experienced congestion along the transmission path.
  - If both the ECT bit and the CE bit is 0 in the packet, the device drops the packet.
- When the average queue size exceeds the upper threshold, the device drops the packet, regardless of whether the packet is sent from an ECN-capable terminal.

WRED parameters

Determine the following parameters before configuring WRED:

- **Upper threshold and lower threshold**—When the average queue size is smaller than the lower threshold, packets are not dropped. When the average queue size is between the lower threshold and the upper threshold, the packets are dropped at random. The longer the queue, the higher the drop probability. When the average queue size exceeds the upper threshold, subsequent packets are dropped.
- **Drop precedence**—A parameter used for packet drop. The value 0 corresponds to green packets, the value 1 corresponds to yellow packets, and the value 2 corresponds to red packets. Red packets are dropped preferentially.
- **Exponent for average queue size calculation**—The greater the exponent, the less sensitive the average queue size is to real-time queue size changes. The formula for calculating the average queue size is:

  Average queue size = (previous average queue size x $(1 – 2^{–n})$) + (current queue size x $2^{–n}$), where n is the exponent.
- **Drop probability**—Drop probability in percentage. The greater the value, the higher the drop probability. (Applicable when you configure a WRED table on an interface.)

Configuring and applying a queue-based WRED table

Restrictions and guidelines

By using a WRED table, WRED randomly drops packets during congestion based on the queues that hold packets.

One WRED table can be applied to multiple interfaces. You can modify the parameters of a WRED table applied to an interface, but you cannot delete the WRED table.

The term "interface" in this section collectively refers to Layer 2 and Layer 3 Ethernet interfaces. You can use the **port link-mode** command to configure an Ethernet port as a Layer 2 or Layer 3 interface (see *Layer 2—LAN Switching Configuration Guide*).

Procedure

1. Enter system view.
   system-view
2. Create a WRED table and enter its view.
   qos wred queue table *table-name*
3. (Optional.) Set the WRED exponent for average queue size calculation.
   queue *queue-id* **weighting-constant** *exponent*
   The default setting is 9.
4. (Optional.) Configure the other WRED parameters.
   queue *queue-id* [**drop-level** *drop-level*] **low-limit** *low-limit* **high-limit** *high-limit* [**discard-probability** *discard-prob*]
   By default, the lower limit is 100, the higher limit is 1000, and the drop probability is 10%.
5. (Optional.) Enable ECN for a queue.
   queue *queue-id* **ecn**
   By default, ECN is disabled for a queue.
6. Return to system view.
   quit
7. Enter interface view.
   interface *interface-type interface-number*
8. Apply the WRED table to the interface.
   qos wred apply [*table-name*]
   By default, no WRED table is applied to an interface, and tail drop is used on an interface.

Example: Configuring and applying a queue-based WRED table

Network configuration

Apply a WRED table to Twenty-FiveGigE 1/0/2, so that the packets are dropped as follows when congestion occurs:

- For the interface to preferentially forward higher-priority traffic, set a lower drop probability for a queue with a greater queue number. Set different drop parameters for queue 0, queue 3, and queue 7.
- Drop packets according to their colors.
  - In queue 0, set the drop probability to 25%, 50%, and 75% for green, yellow, and red packets, respectively.
  - In queue 3, set the drop probability to 5%, 10%, and 25% for green, yellow, and red packets, respectively.
  - In queue 7, set the drop probability to 1%, 5%, and 10% for green, yellow, and red packets, respectively.

- Enable ECN for queue 7.

Procedure

Configure a queue-based WRED table, and set different drop parameters for packets with different drop levels in different queues.

```
<Sysname> system-view
[Sysname] qos wred queue table queue-table1
[Sysname-wred-table-queue-table1] queue 0 drop-level 0 low-limit 128 high-limit 512
discard-probability 25
[Sysname-wred-table-queue-table1] queue 0 drop-level 1 low-limit 128 high-limit 512
discard-probability 50
[Sysname-wred-table-queue-table1] queue 0 drop-level 2 low-limit 128 high-limit 512
discard-probability 75
[Sysname-wred-table-queue-table1] queue 3 drop-level 0 low-limit 256 high-limit 640
discard-probability 5
[Sysname-wred-table-queue-table1] queue 3 drop-level 1 low-limit 256 high-limit 640
discard-probability 10
[Sysname-wred-table-queue-table1] queue 3 drop-level 2 low-limit 256 high-limit 640
discard-probability 25
[Sysname-wred-table-queue-table1] queue 7 drop-level 0 low-limit 512 high-limit 1024
discard-probability 1
[Sysname-wred-table-queue-table1] queue 7 drop-level 1 low-limit 512 high-limit 1024
discard-probability 5
[Sysname-wred-table-queue-table1] queue 7 drop-level 2 low-limit 512 high-limit 1024
discard-probability 10
[Sysname-wred-table-queue-table1] queue 7 ecn
[Sysname-wred-table-queue-table1] quit
```

Apply the queue-based WRED table to Twenty-FiveGigE 1/0/2.

```
[Sysname] interface twenty-fivegige 1/0/2
[Sysname-Twenty-FiveGigE1/0/2] qos wred apply queue-table1
[Sysname-Twenty-FiveGigE1/0/2] quit
```

Display and maintenance commands for WRED

Execute **display** commands in any view.

Task	Command
Display WRED configuration and statistics for an interface.	**display qos wred interface** [*interface-type interface-number*]
Display the configuration of a WRED table or all WRED tables.	**display qos wred table** [**name** *table-name*] [**slot** *slot-number*]

Configuring traffic filtering

About traffic filtering

You can filter in or filter out traffic of a class by associating the class with a traffic filtering action. For example, you can filter packets sourced from an IP address according to network status.

Restrictions and guidelines: Traffic filtering configuration

The device supports the following application destinations for traffic filtering:

- Ethernet service instance.
- Interface.
- VLANs.
- Globally.
- Control plane.
- User profile.

Procedure

1. Enter system view.
   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.
      traffic classifier *classifier-name* [**operator** { **and** | **or** }]
   b. Configure a match criterion.
      if-match *match-criteria*
      By default, no match criterion is configured.
      For more information about configuring match criteria, see *ACL and QoS Command Reference*.
   c. Return to system view.
      quit
3. Define a traffic behavior.
   a. Create a traffic behavior and enter traffic behavior view.
      traffic behavior *behavior-name*
   b. Configure the traffic filtering action.
      filter { **deny** | **none** | **permit** }
      By default, no traffic filtering action is configured.
      If a traffic behavior has the **filter deny** action, all other actions in the traffic behavior except class-based accounting do not take effect.
      If the **filter none** command is configured in a traffic behavior, the permitted packets will not be processed by any other class-behavior associations in the same QoS policy.

If the **filter permit** command is configured in a traffic behavior, the permitted packets can be processed by other class-behavior associations in the same QoS policy.

c. Return to system view.

quit

4. Define a QoS policy.

a. Create a QoS policy and enter QoS policy view.

qos policy *policy-name*

b. Associate the traffic class with the traffic behavior in the QoS policy.

classifier *classifier-name* **behavior** *behavior-name*

By default, a traffic class is not associated with a traffic behavior.

c. Return to system view.

quit

5. Apply the QoS policy.

For more information, see "Applying the QoS policy."

By default, no QoS policy is applied.

6. (Optional.) Display the traffic filtering configuration.

display traffic behavior user-defined [*behavior-name*]

This command is available in any view.

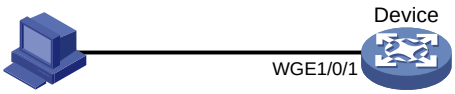
Traffic filtering configuration examples

Example: Configuring traffic filtering

Network configuration

As shown in Figure 19, configure traffic filtering on Twenty-FiveGigE 1/0/1 to deny the incoming packets with a source port number other than 21.

Figure 19 Network diagram



Procedure

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

```
<Device> system-view
[Device] acl advanced 3000
[Device-acl-ipv4-adv-3000] rule 0 permit tcp source-port neq 21
[Device-acl-ipv4-adv-3000] quit
```

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

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

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

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

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

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

Apply QoS policy **policy** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[Device] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] qos apply policy policy inbound
```

Example: Configuring traffic filtering with the none action

Network configuration

As shown in Figure 20, configure traffic filtering and traffic mirroring to mirror the incoming packets matching the following conditions on Twenty-FiveGigE 1/0/2 to Twenty-FiveGigE 1/0/1:

- DSCP priority is 34.
- UDP destination port number is 4791.
- The two bytes after the 8th byte starting from the Layer 4 header are not all-0s or all-1s.

Figure 20 Network diagram

Procedure

Create user-defined ACL 5000, and configure rules to match packets with the following attributes:

- The DSCP value is 34.
- The UDP destination port number is 4791.
- The two bytes after the 8th byte starting from the Layer 4 header are all-0s or all-1s.

```
<Device> system-view
[Device] acl user-defined 5000
[Device-acl-user-5000] rule 0 permit udp dscp 34 destination-port eq 4791 l4 00 ff 8
[Device-acl-user-5000] rule 5 permit udp dscp 34 destination-port eq 4791 l4 ff ff 8
[Device-acl-user-5000] quit
```

Create a traffic class named **classifier_1**, and use ACL 5000 as the match criterion.

```
[Device] traffic classifier classifier_1
[Device-classifier-classifier_1] if-match acl user-defined 5000
[Device-classifier-classifier_1] quit
```

Create a traffic behavior named **behavior_1**, and configure the traffic filtering action as **none**. The packets permitted by the **none** action will not be processed by any other class-behavior associations in the same QoS policy.

```
[Device] traffic behavior behavior_1
```

```
[Device-behavior-behavior_1] filter none
[Device-behavior-behavior_1] quit
```

Create user-defined ACL 5001, and configure rules to match packets with DSCP value 34 and UDP destination port number 4791.

```
<Device> system-view
[Device] acl user-defined 5001
[Device-acl-user-5001] rule 0 permit udp dscp 34 destination-port eq 4791
[Device-acl-user-5001] quit
```

Create a traffic class named **classifier_2**, and use ACL 5001 as the match criterion.

```
[Device] traffic classifier classifier_2
[Device-classifier-classifier_2] if-match acl user-defined 5001
[Device-classifier-classifier_2] quit
```

Create a traffic behavior named **behavior_2**, and configure the action of mirroring traffic to Twenty-FiveGigE 1/0/1.

```
[Device] traffic behavior behavior_2
[Device-behavior-behavior_2] mirror-to interface twenty-fivegige 1/0/1
[Device-behavior-behavior_2] quit
```

Create a QoS policy named **policy**, and associate traffic classes **classifier_1** and **classifier_2** with traffic behaviors **behavior_1** and **behavior_2**, respectively.

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

Apply QoS policy **policy** to the incoming traffic of Twenty-FiveGigE 1/0/2.

```
[Device] interface twenty-fivegige 1/0/2
[Device-Twenty-FiveGigE1/0/2] qos apply policy policy inbound
```

Configuring priority marking

About priority marking

Priority marking sets the priority fields or flag bits of packets to modify the priority of packets. For example, you can use priority marking to set IP precedence or DSCP for a class of IP packets to control the forwarding of these packets.

To configure priority marking to set the priority fields or flag bits for a class of packets, perform the following tasks:

1. Configure a traffic behavior with a priority marking action.
2. Associate the traffic class with the traffic behavior.

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

Configuring priority marking

Restrictions and guidelines

The device supports the following application destinations for priority marking:

- Ethernet service instance.
- Interface.
- VLANs.
- Globally.
- Control plane.
- User profile.

Procedure

1. Enter system view.
   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.
      traffic classifier *classifier-name* [**operator** { **and** | **or** }]
   b. Configure a match criterion.
      if-match *match-criteria*
      By default, no match criterion is configured.
      For more information about the **if-match** command, see *ACL and QoS Command Reference*.
   c. Return to system view.
      quit
3. Define a traffic behavior.
   a. Create a traffic behavior and enter traffic behavior view.
      traffic behavior *behavior-name*
   b. Configure a priority marking action.
      For configurable priority marking actions, see the **remark** commands in *ACL and QoS Command Reference*.

c. Return to system view.
   quit

4. Define a QoS policy.
   a. Create a QoS policy and enter QoS policy view.
      qos policy *policy-name*
   b. Associate the traffic class with the traffic behavior in the QoS policy.
      classifier *classifier-name* **behavior** *behavior-name*
      By default, a traffic class is not associated with a traffic behavior.
   c. Return to system view.
      quit
5. Apply the QoS policy.
   For more information, see "Applying the QoS policy."
   By default, no QoS policy is applied.
6. (Optional.) Display the priority marking configuration.
   display traffic behavior user-defined [*behavior-name*]
   This command is available in any view.

Priority marking configuration examples

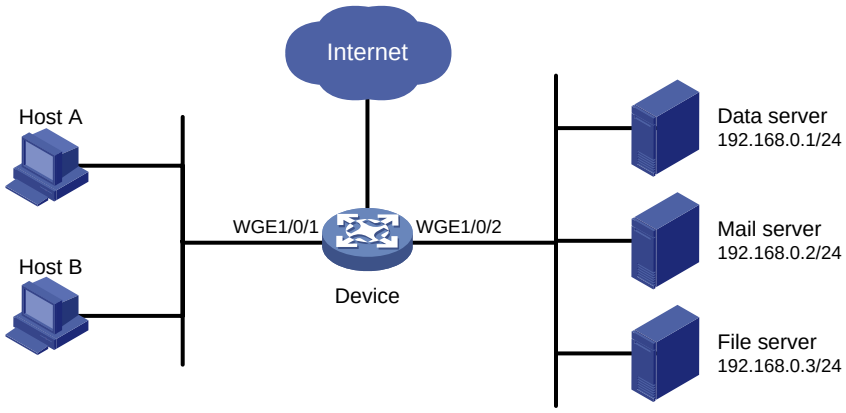
Example: Configuring priority marking

Network configuration

As shown in Figure 21, configure priority marking on the device to meet 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 21 Network diagram



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 advanced 3000
[Device-acl-ipv4-adv-3000] rule permit ip destination 192.168.0.1 0
[Device-acl-ipv4-adv-3000] quit
```

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

```
[Device] acl advanced 3001
[Device-acl-ipv4-adv-3001] rule permit ip destination 192.168.0.2 0
[Device-acl-ipv4-adv-3001] quit
```

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

```
[Device] acl advanced 3002
[Device-acl-ipv4-adv-3002] rule permit ip destination 192.168.0.3 0
[Device-acl-ipv4-adv-3002] quit
```

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

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

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

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

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

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

Create a traffic 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 traffic 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 traffic 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 QoS policy named **policy_server**, and associate traffic classes with traffic behaviors in the QoS 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 QoS policy **policy_server** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[Device] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] qos apply policy policy_server inbound
[Device-Twenty-FiveGigE1/0/1] quit
```

Configuring nesting

About nesting

Nesting adds a VLAN tag to the matching packets to allow the VLAN-tagged packets to pass through the corresponding VLAN. For example, you can add an outer VLAN tag to packets from a customer network to a service provider network. This allows the packets to pass through the service provider network by carrying a VLAN tag assigned by the service provider.

Restrictions and guidelines: Nesting configuration

The device supports the following application destinations in the inbound direction for nesting:

- Interface.
- VLANs.
- Globally.

Procedure

1. Enter system view.
   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.
      traffic classifier *classifier-name* [**operator** { **and** | **or** }]
   b. Configure a match criterion.
      if-match *match-criteria*
      By default, no match criterion is configured for a traffic class.
      For more information about the match criteria, see the **if-match** command in *ACL and QoS Command Reference*.
   c. Return to system view.
      quit
3. Define a traffic behavior.
   a. Create a traffic behavior and enter traffic behavior view.
      traffic behavior *behavior-name*
   b. Configure an outer VLAN tag adding action.
      nest top-most vlan *vlan-id*
      By default, no outer VLAN tag adding action is configured for a traffic behavior.
   c. Return to system view.
      quit
4. Define a QoS policy.
   a. Create a QoS policy and enter QoS policy view.
      qos policy *policy-name*
   b. Associate the traffic class with the traffic behavior in the QoS policy.
      classifier *classifier-name* **behavior** *behavior-name*

By default, a traffic class is not associated with a traffic behavior.

c. Return to system view.

quit

5. Apply the QoS policy.

For more information, see "Applying the QoS policy."

By default, no QoS policy is applied.

6. (Optional.) Display the nesting configuration.

display traffic behavior user-defined [*behavior-name*]

This command is available in any view.

Nesting configuration examples

Example: Configuring nesting

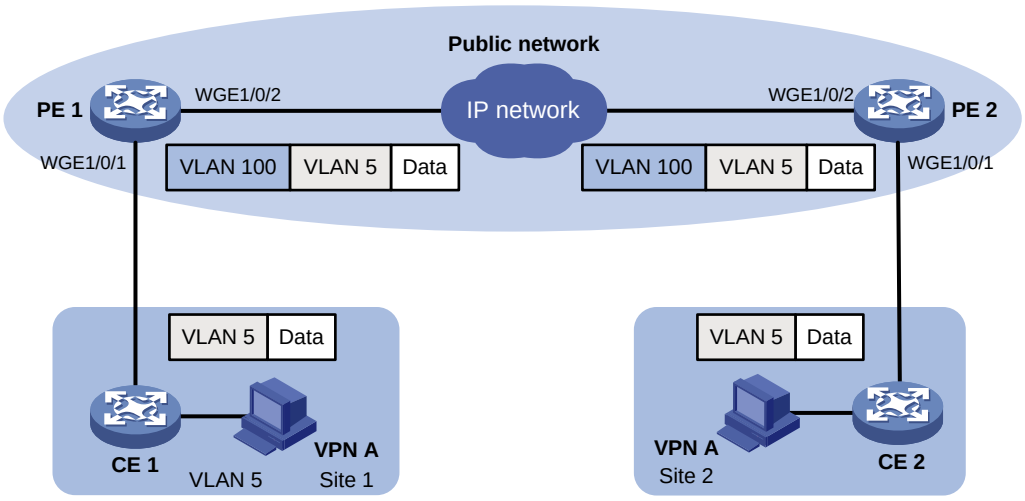
Network configuration

As shown in Figure 22:

- Site 1 and Site 2 in VPN A are two branches of a company. They use VLAN 5 to transmit traffic.
- Because Site 1 and Site 2 are located in different areas, the two sites use the VPN access service of a service provider. The service provider assigns VLAN 100 to the two sites.

Configure nesting, so that the two branches can communicate through the service provider network.

Figure 22 Network diagram



Procedure

1. Configuring PE 1:

Create a traffic class named **test** to match traffic with VLAN ID 5.

```
<PE1> system-view
[PE1] traffic classifier test
[PE1-classifier-test] if-match service-vlan-id 5
[PE1-classifier-test] quit
```

Configure an action to add outer VLAN tag 100 in traffic behavior **test**.

```
[PE1] traffic behavior test
```

```
[PE1-behavior-test] nest top-most vlan 100
[PE1-behavior-test] quit
```

Create a QoS policy named **test**, and associate class **test** with behavior **test** in the QoS policy.

```
[PE1] qos policy test
[PE1-qospolicy-test] classifier test behavior test
[PE1-qospolicy-test] quit
```

Configure the downlink port (Twenty-FiveGigE 1/0/1) as a hybrid port, and assign the port to VLAN 100 as an untagged member.

```
[PE1] interface twenty-fivegige 1/0/1
[PE1-Twenty-FiveGigE1/0/1] port link-type hybrid
[PE1-Twenty-FiveGigE1/0/1] port hybrid vlan 100 untagged
```

Apply QoS policy **test** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[PE1-Twenty-FiveGigE1/0/1] qos apply policy test inbound
[PE1-Twenty-FiveGigE1/0/1] quit
```

Configure the uplink port (Twenty-FiveGigE 1/0/2) as a trunk port, and assign it to VLAN 100.

```
[PE1] interface twenty-fivegige 1/0/2
[PE1-Twenty-FiveGigE1/0/2] port link-type trunk
[PE1-Twenty-FiveGigE1/0/2] port trunk permit vlan 100
[PE1-Twenty-FiveGigE1/0/2] quit
```

2. Configuring PE 2:

Configure PE 2 in the same way PE 1 is configured.

Configuring traffic redirecting

About traffic redirecting

Traffic redirecting redirects packets matching the specified match criteria to a location for processing.

You can redirect packets to the following destinations:

- CPU.
- Interface.

Restrictions and guidelines: Traffic redirecting configuration

- The device supports the following application destinations in the inbound direction for traffic redirecting:
  - Ethernet service instance
  - Interface.
  - VLANs.
  - Globally.
  - Control plane.
  - User profile.
- If you execute the **redirect** command multiple times, the most recent configuration takes effect.
- For traffic redirecting to an Ethernet interface, the switch does not display the redirecting action after the interface expansion card that hosts the interface is removed. After the interface module or interface expansion card is reinserted, the switch can display the redirecting action.

Procedure

1. Enter system view.
   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.
      traffic classifier *classifier-name* [**operator** { **and** | **or** }]
   b. Configure a match criterion.
      if-match *match-criteria*
      By default, no match criterion is configured for a traffic class.
      For more information about the match criteria, see the **if-match** command in *ACL and QoS Command Reference*.
   c. Return to system view.
      quit
3. Define a traffic behavior.
   a. Create a traffic behavior and enter traffic behavior view.

traffic behavior *behavior-name*

b. Configure a traffic redirecting action.

redirect { **cpu** | **interface** *interface-type interface-number* }

By default, no traffic redirecting action is configured for a traffic behavior.

c. Return to system view.

quit

4. Define a QoS policy.

a. Create a QoS policy and enter QoS policy view.

qos policy *policy-name*

b. Associate the traffic class with the traffic behavior in the QoS policy.

classifier *classifier-name* **behavior** *behavior-name*

By default, a traffic class is not associated with a traffic behavior.

c. Return to system view.

quit

5. Apply the QoS policy.

For more information, see "Applying the QoS policy."

By default, no QoS policy is applied.

6. (Optional.) Display traffic redirecting configuration.

display traffic behavior user-defined [*behavior-name*]

This command is available in any view.

Traffic redirecting configuration examples

Example: Configuring traffic redirecting

Network configuration

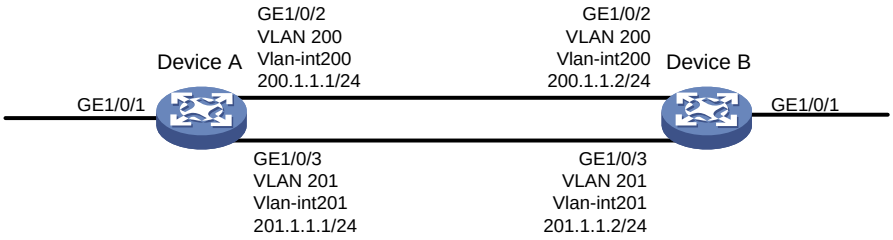
As shown in Figure 23:

- Device A is connected to Device B through two links. Device A and Device B are each connected to other devices.
- Twenty-FiveGigE 1/0/1 of Device A is a trunk port and belongs to VLAN 200 and VLAN 201.
- Twenty-FiveGigE 1/0/2 of Device A and Twenty-FiveGigE 1/0/2 of Device B belong to VLAN 200.
- Twenty-FiveGigE 1/0/3 of Device A and Twenty-FiveGigE 1/0/3 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 an interface to meet the following requirements:

- Packets with source IP address 2.1.1.1 received on Twenty-FiveGigE 1/0/1 of Device A are forwarded to Twenty-FiveGigE 1/0/2.
- Packets with source IP address 2.1.1.2 received on Twenty-FiveGigE 1/0/1 of Device A are forwarded to Twenty-FiveGigE 1/0/3.
- Other packets received on Twenty-FiveGigE 1/0/1 of Device A are forwarded according to the routing table.

Figure 23 Network diagram



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 basic 2000
[DeviceA-acl-ipv4-basic-2000] rule permit source 2.1.1.1 0
[DeviceA-acl-ipv4-basic-2000] quit
```

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

```
[DeviceA] acl basic 2001
[DeviceA-acl-ipv4-basic-2001] rule permit source 2.1.1.2 0
[DeviceA-acl-ipv4-basic-2001] quit
```

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

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

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

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

Create a traffic behavior named **behavior_1**, and configure the action of redirecting traffic to Twenty-FiveGigE 1/0/2.

```
[DeviceA] traffic behavior behavior_1
[DeviceA-behavior-behavior_1] redirect interface twenty-fivegige 1/0/2
[DeviceA-behavior-behavior_1] quit
```

Create a traffic behavior named **behavior_2**, and configure the action of redirecting traffic to Twenty-FiveGigE 1/0/3.

```
[DeviceA] traffic behavior behavior_2
[DeviceA-behavior-behavior_2] redirect interface twenty-fivegige 1/0/3
[DeviceA-behavior-behavior_2] quit
```

Create a QoS policy named **policy**.

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

Associate traffic class **classifier_1** with traffic behavior **behavior_1** in the QoS policy.

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

Associate traffic class **classifier_2** with traffic behavior **behavior_2** in the QoS policy.

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

Apply QoS policy **policy** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[DeviceA] interface twenty-fivegige 1/0/1
[DeviceA-Twenty-FiveGigE1/0/1] qos apply policy policy inbound
```

Configuring global CAR

About global CAR

Global committed access rate (CAR) is an approach to policing traffic flows globally. It adds flexibility to common CAR where traffic policing is performed only on a per-traffic class or per-interface basis. In this approach, CAR actions are created in system view and each can be used to police multiple traffic flows as a whole.

Global CAR provides the following CAR actions: aggregate CAR and hierarchical CAR.

Aggregate CAR

An aggregate CAR action is created globally. It can be directly applied to interfaces or used in the traffic behaviors associated with different traffic classes to police multiple traffic flows as a whole. The total rate of the traffic flows must conform to the traffic policing specifications set in the aggregate CAR action.

Hierarchical CAR

A hierarchical CAR action is created globally. It must be used in conjunction with a common CAR or aggregate CAR action. With a hierarchical CAR action, you can limit the total traffic of multiple traffic classes.

A hierarchical CAR action can be used in the common or aggregate CAR action for a traffic class in either AND mode or OR mode.

- In AND mode, the rate of the traffic class is strictly limited under the common or aggregate CAR. This mode applies to flows that must be strictly rate limited.
- In OR mode, the traffic class can use idle bandwidth of other traffic classes associated with the hierarchical CAR. This mode applies to high priority, bursty traffic like video.

By using the two modes appropriately, you can improve bandwidth efficiency.

For example, suppose two flows exist: a low priority data flow and a high priority, bursty video flow. Their total traffic rate cannot exceed 4096 kbps and the video flow must be assured of at least 2048 kbps bandwidth. You can perform the following tasks:

- Configure common CAR actions to set the traffic rate to 2048 kbps for the two flows.
- Configure a hierarchical CAR action to limit their total traffic rate to 4096 kbps.
- Use the action in AND mode in the common CAR action for the data flow.
- Use the action in OR mode in the common CAR action for the video flow.

The video flow is assured of 2048 kbps bandwidth and can use idle bandwidth of the data flow.

In a bandwidth oversubscription scenario, the uplink port bandwidth is lower than the total downlink port traffic rate. You can use hierarchical CAR to meet the following requirements:

- Limit the total rate of downlink port traffic.
- Allow each downlink port to forward traffic at the maximum rate when the other ports are idle.

For example, you can perform the following tasks:

- Use common CAR actions to limit the rates of Internet access flow 1 and flow 2 to both 128 kbps.
- Use a hierarchical CAR action to limit their total traffic rate to 192 kbps.

- Use the hierarchical CAR action for both flow 1 and flow 2 in AND mode.

When flow 1 is not present, flow 2 is transmitted at the maximum rate, 128 kbps. When both flows are present, the total rate of the two flows cannot exceed 192 kbps. As a result, the traffic rate of flow 2 might drop below 128 kbps.

Configuring aggregate CAR

1. Enter system view.

   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.

      traffic classifier *classifier-name* [**operator** { **and** | **or** }]

   b. Configure a match criterion.

      if-match *match-criteria*

      By default, no match criterion is configured.

      For configurable match criteria, see the **if-match** command in *ACL and QoS Command Reference*.

   c. Return to system view.

      quit
3. Configure an aggregate CAR action.

   qos car *car-name* **aggregative cir** *committed-information-rate* [**cbs** *committed-burst-size* [**ebs** *excess-burst-size*]] [**green** *action* | **red** *action* | **yellow** *action*] *

   qos car *car-name* **aggregative cir** *committed-information-rate* [**cbs** *committed-burst-size*] **pir** *peak-information-rate* [**ebs** *excess-burst-size*] [**green** *action* | **red** *action* | **yellow** *action*] *

   By default, no aggregate CAR action is configured.
4. Define a traffic behavior.
   a. Enter traffic behavior view.

      traffic behavior *behavior-name*

   b. Use the aggregate CAR in the traffic behavior.

      car name *car-name*

      By default, no aggregate CAR action is used in a traffic behavior.
5. Apply the QoS policy.

   For more information, see "Applying the QoS policy."

   By default, no QoS policy is applied.

Display and maintenance commands for global CAR

Execute **display** commands in any view and **reset** commands in user view.

Task	Command
Display statistics for global CAR actions.	**display qos car name** [*car-name*]

Task	Command
Clear statistics for global CAR actions.	**reset qos car name** [*car-name*]

Configuring class-based accounting

About class-based accounting

Class-based accounting collects statistics 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.

Restrictions and guidelines: Class-based accounting configuration

The device supports the following application destinations for class-based accounting:

- Ethernet service instance.
- Interface.
- VLANs.
- Globally.
- Control plane.
- User profile.

Procedure

1. Enter system view.
   system-view
2. Define a traffic class.
   a. Create a traffic class and enter traffic class view.
      traffic classifier *classifier-name* [**operator** { **and** | **or** }]
   b. Configure a match criterion.
      if-match *match-criteria*
      By default, no match criterion is configured.
      For more information about the **if-match** command, see *ACL and QoS Command Reference*.
   c. Return to system view.
      quit
3. Define a traffic behavior.
   a. Create a traffic behavior and enter traffic behavior view.
      traffic behavior *behavior-name*
   b. Configure an accounting action.
      accounting [**byte** | **packet**] *
      By default, no traffic accounting action is configured.
   c. Return to system view.
      quit
4. Define a QoS policy.

a. Create a QoS policy and enter QoS policy view.
   qos policy *policy-name*
b. Associate the traffic class with the traffic behavior in the QoS policy.
   classifier *classifier-name* **behavior** *behavior-name*
   By default, a traffic class is not associated with a traffic behavior.
c. Return to system view.
   quit

5. Apply the QoS policy.
   For more information, see "Applying the QoS policy."
   By default, no QoS policy is applied.
6. (Optional.) Display the class-based accounting configuration.
   display traffic behavior user-defined [*behavior-name*]

Class-based accounting configuration examples

Example: Configuring class-based accounting

Network configuration

As shown in Figure 24, configure class-based accounting on Twenty-FiveGigE 1/0/1 to collect statistics for incoming traffic from 1.1.1.1/24.

Figure 24 Network diagram

Procedure

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

```
<Device> system-view
[Device] acl basic 2000
[Device-acl-ipv4-basic-2000] rule permit source 1.1.1.1 0
[Device-acl-ipv4-basic-2000] quit
```

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

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

Create a traffic behavior named **behavior_1**, and configure the class-based accounting action.

```
[Device] traffic behavior behavior_1
[Device-behavior-behavior_1] accounting packet
[Device-behavior-behavior_1] quit
```

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

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

Apply QoS policy **policy** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[Device] interface twenty-fivegige 1/0/1
[Device-Twenty-FiveGigE1/0/1] qos apply policy policy inbound
[Device-Twenty-FiveGigE1/0/1] quit
```

Display traffic statistics to verify the configuration.

```
[Device] display qos policy interface twenty-fivegige 1/0/1
Interface: Twenty-FiveGigE1/0/1
  Direction: Inbound
  Policy: policy
   Classifier: classifier_1
     Operator: AND
     Rule(s) :
      If-match acl 2000
     Behavior: behavior_1
      Accounting enable:
        28529 (Packets)
```

Configuring QPPB

About QPPB

The QoS Policy Propagation Through the Border Gateway Protocol (QPPB) feature enables you to classify IP packets based on the following attributes:

- BGP community lists.
- Prefix lists.
- BGP AS paths.

Application scenarios

QPPB minimizes the QoS policy configuration and management efforts on the BGP route receiver when the network topology changes. It is suitable for a large-scaled complex network.

The QPPB feature is implemented as follows:

- The BGP route sender preclassifies routes before advertising them.
- The BGP route receiver performs the following operations:
  - Sets the IP precedence and local QoS ID for the routes.
  - Takes appropriate QoS actions on the packets that match the routes.

QPPB is used in the following scenarios:

- Traffic classification based on destination IP addresses.
- Traffic classification based on IBGP and EBGP within an autonomous system or across multiple autonomous systems.

QPPB fundamentals

QPPB works on the BGP receiver by applying a QoS policy to BGP routes with the same local QoS ID. It depends on the BGP route sender to preclassify routes.

The BGP route sender uses a routing policy to set route attributes for BGP routes before advertising them.

The BGP receiver performs the following operations:

- Uses a routing policy to match routes based on these route attributes.
- Sets the local QoS ID for the matching routes.

The BGP receiver performs the following operations:

1. Compares the routes with the incoming route policy based on their BGP AS path, prefix, or community attributes.
2. Applies the local QoS ID to the matching routes.
3. Adds the BGP routes and their associated local QoS ID to the routing table.
4. Applies the local QoS ID to the packets destined to the IP address in the route.
5. Takes QoS actions on the packets according to the QoS priority settings.

QPPB tasks at a glance

To configure QPPB, perform the following tasks:

1. Configuring the route sender
   a. Configuring basic BGP functions
   b. (Optional.) Creating a routing policy
2. Configuring the route receiver
   a. Configuring basic BGP functions
   b. Configuring a routing policy
   c. Enabling QPPB on the route receiving interface

Configuring the route sender

Configure the BGP route sender to set route attributes for routes before advertising them.

Configuring basic BGP functions

For more information, see *Layer 3—IP Routing Configuration Guide*.

Creating a routing policy

Configure a routing policy to classify routes and set route attributes for the route classes. For more information, see *Layer 3—IP Routing Configuration Guide*.

Configuring the route receiver

Configuring basic BGP functions

For more information, see *Layer 3—IP Routing Configuration Guide*.

Configuring a routing policy

Configure a routing policy to perform the following operations:

- Match the route attributes set by the route sender.
- Set the l ocal QoS ID for the matching routes.

For more information, see *Layer 3—IP Routing Configuration Guide*.

Enabling QPPB on the route receiving interface

Restrictions and guidelines

For QPPB to work correctly, you must configure the QoS policy as follows:

- Use the local QoS ID set in the routing policy to match packets.
- Specify the **`mode qppb-manipulation`** keyword when associating a traffic behavior with a traffic class.

For more information about QoS policies, see "

Configuring a QoS policy."

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Enable QPPB on the interface.
   bgp-policy destination ip-qos-map }
   By default, QPPB is disabled.
   This command applies only to incoming traffic.
4. Apply a QoS policy to the interface.
   qos apply policy *policy-name* { **inbound** | **outbound** }
   By default, no QoS policy is applied to an interface.

QPPB configuration examples

Example: Configuring QPPB in an IPv4 network

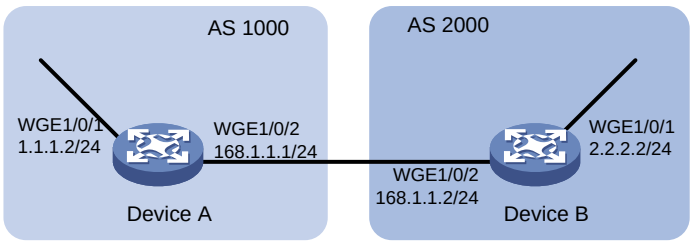
Network configuration

As shown in Figure 25, all devices run BGP.

Configure QPPB so that Device B can perform the following operations:

- Receive routes.
- Set local QoS IDs according to the routing policy.
- Use the QoS policy to limit the traffic rate to 512000 kbps.

Figure 25 Network diagram



Procedure

1. Configure IP addresses for each interface. (Details not shown.)
2. Configure a BGP connection to Device B, and add the network 1.1.1.0/8 to the BGP routing table on Device A.

```
<DeviceA> system-view
[DeviceA] bgp 1000
[DeviceA-bgp] peer 168.1.1.2 as-number 2000
[DeviceA-bgp] peer 168.1.1.2 connect-interface twenty-fivegige 1/0/2
[DeviceA-bgp] address-family ipv4
[DeviceA-bgp-ipv4] import-route direct
[DeviceA-bgp-ipv4] peer 168.1.1.2 enable
```

```
[DeviceA-bgp-ipv4] quit
[DeviceA-bgp] quit
```

3. Configure Device B:

Configure a BGP connection to Device A.

```
<DeviceB> system-view
[DeviceB] bgp 2000
[DeviceB-bgp] peer 168.1.1.1 as-number 1000
[DeviceB-bgp] peer 168.1.1.1 connect-interface twenty-fivegige 1/0/2
[DeviceB-bgp] address-family ipv4
[DeviceB-bgp-ipv4] peer 168.1.1.1 enable
[DeviceB-bgp-ipv4] peer 168.1.1.1 route-policy qppb import
[DeviceB-bgp-ipv4] quit
[DeviceB-bgp] quit
```

Configure the routing policy **qppb**.

```
[DeviceB] route-policy qppb permit node 0
[DeviceB-route-policy-qppb-0] apply qos-local-id 3
[DeviceB-route-policy-qppb-0] quit
```

Enable QPPB on Twenty-FiveGigE 1/0/2.

```
[DeviceB] interface twenty-fivegige 1/0/2
[DeviceB-Twenty-FiveGigE1/0/2] bgp-policy destination ip-qos-map
[DeviceB-Twenty-FiveGigE1/0/2] quit
```

Configure a QoS policy.

```
[DeviceB] traffic classifier qppb
[DeviceB-classifier-qppb] if-match qos-local-id 3
[DeviceB-classifier-qppb] quit
[DeviceB] traffic behavior qppb
[DeviceB-behavior-qppb] car cir 512000 green pass red discard
[DeviceB-behavior-qppb] quit
[DeviceB] qos policy qppb
[DeviceB-qospolicy-qppb] classifier qppb behavior qppb mode qppb-manipulation
[DeviceB-qospolicy-qppb] quit
```

Apply the QoS policy to incoming traffic on Twenty-FiveGigE 1/0/2.

```
[DeviceB] interface twenty-fivegige 1/0/2
[DeviceB-Twenty-FiveGigE1/0/2] qos apply policy qppb inbound
[DeviceB-Twenty-FiveGigE1/0/2] quit
```

Verifying the configuration

Verify that the related route on Device B takes effect.

```
[DeviceB] display ip routing-table 1.1.1.0 24 verbose

Summary Count : 1

Destination: 1.1.1.0/24
   Protocol: BGP             Process ID: 0
  SubProtID: 0x2                    Age: 00h00m33s
       Cost: 0              Preference: 255
      IpPre: 1              QosLocalID: 3
        Tag: 0                   State: Active Adv
```

```
  OrigTblID: 0x0                OrigVrf: default-vrf
    TableID: 0x2                 OrigAs: 1000
      NibID: 0x15000000          LastAs: 1000
     AttrID: 0x0                Neighbor: 168.1.1.1
      Flags: 0x10060         OrigNextHop: 168.1.1.1
      Label: NULL            RealNextHop: 168.1.1.1
    BkLabel: NULL              BkNextHop: N/A
  Tunnel ID: Invalid           Interface: Twenty-FiveGigE1/0/2
BkTunnel ID: Invalid         BkInterface: N/A
   FtnIndex: 0x0            TrafficIndex: N/A
  Connector: N/A               VpnPeerId: N/A
       Dscp: N/A
```

Display the QoS policy configuration on Twenty-FiveGigE1/0/2 of Device B.

```
[DeviceB] display qos policy interface twenty-fivegige 1/0/2
Interface: Twenty-FiveGigE1/0/2
  Direction: Inbound
  Policy: qppb
   Classifier: qppb
         Mode: qppb-manipulation
     Operator: AND
     Rule(s) :
      If-match qos-local-id 3
     Behavior: qppb
      Committed Access Rate:
        CIR 512000 (kbps), CBS 32000000 (Bytes), EBS 0 (Bytes)
        Green action  : pass
        Yellow action : pass
        Red action    : discard
        Green packets : 0 (Packets) 0 (Bytes)
        Yellow packets: 0 (Packets) 0 (Bytes)
        Red packets   : 0 (Packets) 0 (Bytes)
```

Example: Configuring QPPB in an MPLS L3VPN

Network configuration

As shown in Figure 26, all devices run BGP.

Configure QPPB so that Device C can perform the following operations:

- Receive routes.
- Set the QPPB local QoS IDs.
- Use the QoS policy to limit the traffic rate to 200000 kbps in each direction.

Figure 26 Network diagram

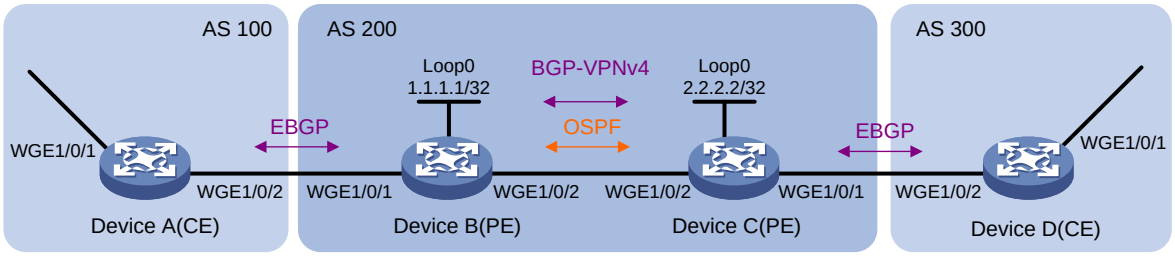


Table 2 Interfaces and IP address assignment

Device	Interface	IP address	Device	Interface	IP address
Device A	WGE1/0/1	192.168.1.2/24	Device B	WGE1/0/1	167.1.1.2/24
	WGE1/0/2	167.1.1.1/24		WGE1/0/2	168.1.1.2/24
Device C	WGE1/0/1	169.1.1.2/24	Device D	WGE1/0/2	169.1.1.1/24
	WGE1/0/2	168.1.1.1/24		WGE1/0/1	192.168.3.2/24

Procedure

1. Configure IP addresses for each interface. (Details not shown.)
2. Configure a BGP connection on Device A.

```
<DeviceA> system-view
[DeviceA] bgp 100
[DeviceA-bgp] peer 167.1.1.2 as-number 200
[DeviceA-bgp] peer 167.1.1.2 connect-interface twenty-fivegige 1/0/2
[DeviceA-bgp] address-family ipv4
[DeviceA-bgp-ipv4] import-route direct
[DeviceA-bgp-ipv4] peer 167.1.1.2 enable
[DeviceA-bgp-ipv4] quit
[DeviceA-bgp] quit
```

3. Configure Device B:

   # Configure a VPN instance.

```
<DeviceB> system-view
[DeviceB] ip vpn-instance vpn1
[DeviceB-vpn-instance-vpn1] route-distinguisher 200:1
[DeviceB-vpn-instance-vpn1] vpn-target 200:1 export-extcommunity
[DeviceB-vpn-instance-vpn1] vpn-target 200:1 import-extcommunity
[DeviceB-vpn-instance-vpn1] quit
```

   # Configure a BGP connection.

```
[DeviceB] router id 1.1.1.1
[DeviceB] bgp 200
[DeviceB-bgp] peer 2.2.2.2 as-number 200
[DeviceB-bgp] peer 2.2.2.2 connect-interface loopback 0
[DeviceB-bgp] ip vpn-instance vpn1
[DeviceB-bgp-vpn1] peer 167.1.1.1 as-number 100
[DeviceB-bgp-vpn1] address-family ipv4
[DeviceB-bgp-ipv4-vpn1] peer 167.1.1.1 enable
[DeviceB-bgp-ipv4-vpn1] quit
[DeviceB-bgp] address-family vpnv4
```

```
[DeviceB-bgp-vpnv4] peer 2.2.2.2 enable
[DeviceB-bgp-vpnv4] quit
[DeviceB-bgp] quit
```

Configure MPLS.

```
[DeviceB] mpls lsr-id 1.1.1.1
[DeviceB] mpls ldp
[DeviceB-mpls-ldp] quit
```

Configure OSPF.

```
[DeviceB] ospf
[DeviceB-ospf-1] area 0
[DeviceB-ospf-1-area-0.0.0.0] network 1.1.1.1 0.0.0.0
[DeviceB-ospf-1-area-0.0.0.0] network 168.1.1.0 0.0.0.255
[DeviceB-ospf-1-area-0.0.0.0] quit
[DeviceB-ospf-1] quit
```

Bind Twenty-FiveGigE 1/0/1 to VPN instance **vpn1**.

```
[DeviceB] interface twenty-fivegige 1/0/1
[DeviceB-Twenty-FiveGigE1/0/1] ip binding vpn-instance vpn1
[DeviceB-Twenty-FiveGigE1/0/1] ip address 167.1.1.2 24
[DeviceB-Twenty-FiveGigE1/0/1] quit
```

Enable MPLS on Twenty-FiveGigE 1/0/2.

```
[DeviceB] interface twenty-fivegige 1/0/2
[DeviceB-Twenty-FiveGigE1/0/2] mpls enable
[DeviceB-Twenty-FiveGigE1/0/2] mpls ldp enable
[DeviceB-Twenty-FiveGigE1/0/2] quit
```

4. Configure Device C:

Configure a VPN instance.

```
<DeviceC> system-view
[DeviceC] ip vpn-instance vpn1
[DeviceC-vpn-instance-vpn1] route-distinguisher 200:1
[DeviceC-vpn-instance-vpn1] vpn-target 200:1 export-extcommunity
[DeviceC-vpn-instance-vpn1] vpn-target 200:1 import-extcommunity
[DeviceC-vpn-instance-vpn1] quit
```

Configure a BGP connection.

```
[DeviceC] router id 2.2.2.2
[DeviceC] bgp 200
[DeviceC-bgp] peer 1.1.1.1 as-number 200
[DeviceC-bgp] peer 1.1.1.1 connect-interface loopback 0
[DeviceC-bgp] ip vpn-instance vpn1
[DeviceC-bgp-vpn1] peer 169.1.1.1 as-number 300
[DeviceC-bgp-vpn1] address-family ipv4
[DeviceC-bgp-ipv4-vpn1] peer 169.1.1.1 enable
[DeviceC-bgp-ipv4-vpn1] peer 169.1.1.1 route-policy qppb import
[DeviceC-bgp-ipv4-vpn1] quit
[DeviceC-bgp-vpn1] quit
[DeviceC-bgp] address-family vpnv4
[DeviceC-bgp-vpnv4] peer 1.1.1.1 enable
[DeviceC-bgp-vpnv4] peer 1.1.1.1 route-policy qppb import
[DeviceC-bgp-vpnv4] quit
```

```
[DeviceC-bgp] quit
```

Configure a routing policy.

```
[DeviceC] route-policy qppb permit node 0
[DeviceC-route-policy-qppb-0] apply qos-local-id 3
[DeviceC-route-policy-qppb-0] quit
```

Configure MPLS.

```
[DeviceC] mpls lsr-id 2.2.2.2
[DeviceC] mpls ldp
[DeviceC-mpls-ldp] quit
```

Configure OSPF.

```
[DeviceC] ospf
[DeviceC-ospf-1] area 0
[DeviceC-ospf-1-area-0.0.0.0] network 2.2.2.2 0.0.0.0
[DeviceC-ospf-1-area-0.0.0.0] network 168.1.1.0 0.0.0.255
[DeviceC-ospf-1-area-0.0.0.0] quit
[DeviceC-ospf-1] quit
```

Configure a QoS policy.

```
[DeviceC] traffic classifier qppb
[DeviceC-classifier-qppb] if-match qos-local-id 3
[DeviceC-classifier-qppb] quit
[DeviceC] traffic behavior qppb
[DeviceC-behavior-qppb] car cir 200000 green pass red discard
[DeviceC-behavior-qppb] quit
[DeviceC] qos policy qppb
[DeviceC-qospolicy-qppb] classifier qppb behavior qppb mode qppb-manipulation
[DeviceC-qospolicy-qppb] quit
```

Enable MPLS on Twenty-FiveGigE 1/0/2.

```
[DeviceC] interface twenty-fivegige 1/0/2
[DeviceC-Twenty-FiveGigE1/0/2] mpls enable
[DeviceC-Twenty-FiveGigE1/0/2] mpls ldp enable
```

Enable QPPB on Twenty-FiveGigE 1/0/1 and Twenty-FiveGigE 1/0/2.

```
[DeviceC-Twenty-FiveGigE1/0/2] bgp-policy destination ip-qos-map
[DeviceC-Twenty-FiveGigE1/0/2] quit
[DeviceC] interface twenty-fivegige 1/0/1
[DeviceC-Twenty-FiveGigE1/0/1] bgp-policy destination ip-qos-map
[DeviceC-Twenty-FiveGigE1/0/1] quit
```

Bind Twenty-FiveGigE 1/0/1 to VPN instance **vpn1**.

```
[DeviceC] interface twenty-fivegige 1/0/1
[DeviceC-Twenty-FiveGigE1/0/1] ip binding vpn-instance vpn1
[DeviceC-Twenty-FiveGigE1/0/1] ip address 169.1.1.2 24
```

Apply QoS policy **qppb** to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[DeviceC-Twenty-FiveGigE1/0/1] qos apply policy qppb inbound
[DeviceC-Twenty-FiveGigE1/0/1] quit
```

Apply QoS policy **qppb** to the incoming traffic of Twenty-FiveGigE 1/0/2.

```
[DeviceC] interface twenty-fivegige 1/0/2
[DeviceC-Twenty-FiveGigE1/0/2] qos apply policy qppb inbound
```

5. Configure a BGP connection on Device D.

```
<DeviceD> system-view
[DeviceD] bgp 300
[DeviceD-bgp] peer 169.1.1.2 as-number 200
[DeviceD-bgp] peer 169.1.1.2 connect-interface twenty-fivegige 1/0/2
[DeviceD-bgp] address-family ipv4
[DeviceD-bgp-ipv4] peer 169.1.1.2 enable
[DeviceD-bgp-ipv4] import-route direct
[DeviceD-bgp-ipv4] quit
```

Verifying the configuration

Verify that the related routes on Device A take effect.

```
[DeviceA] display ip routing-table

Destinations : 18        Routes : 18

Destination/Mask    Proto  Pre  Cost         NextHop         Interface
0.0.0.0/32          Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/8         Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0            127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0            127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
167.1.1.0/24        Direct 0    0            167.1.1.1       WGE1/0/2
167.1.1.0/32        Direct 0    0            167.1.1.1       WGE1/0/2
167.1.1.1/32        Direct 0    0            127.0.0.1       InLoop0
167.1.1.255/32      Direct 0    0            167.1.1.1       WGE1/0/2
169.1.1.0/24        BGP    255  0            167.1.1.2       WGE1/0/2
192.168.1.0/24      Direct 0    0            192.168.1.2     WGE1/0/1
192.168.1.0/32      Direct 0    0            192.168.1.2     WGE1/0/1
192.168.1.2/32      Direct 0    0            127.0.0.1       InLoop0
192.168.1.255/32    Direct 0    0            192.168.1.2     WGE1/0/1
192.168.3.0/24      BGP    255  0            167.1.1.2       WGE1/0/2
224.0.0.0/4         Direct 0    0            0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0            0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
```

Verify that the related routes on Device B take effect.

```
[DeviceB] display ip routing-table

Destinations : 14        Routes : 14

Destination/Mask    Proto  Pre  Cost         NextHop         Interface
0.0.0.0/32          Direct 0    0            127.0.0.1       InLoop0
1.1.1.1/32          Direct 0    0            127.0.0.1       InLoop0
2.2.2.2/32          OSPF   10   1            168.1.1.1       WGE1/0/2
127.0.0.0/8         Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0            127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0            127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
168.1.1.0/24        Direct 0    0            168.1.1.2       WGE1/0/2
168.1.1.0/32        Direct 0    0            168.1.1.2       WGE1/0/2
```

```
168.1.1.2/32        Direct 0    0           127.0.0.1       InLoop0
168.1.1.255/32      Direct 0    0           168.1.1.2       WGE1/0/2
224.0.0.0/4         Direct 0    0           0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0           0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0           127.0.0.1       InLoop0
[DeviceB] display ip routing-table vpn-instance vpn1

Destinations : 16        Routes : 16

Destination/Mask    Proto  Pre  Cost        NextHop         Interface
0.0.0.0/32          Direct 0    0           127.0.0.1       InLoop0
127.0.0.0/8         Direct 0    0           127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0           127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0           127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0           127.0.0.1       InLoop0
167.1.1.0/24        Direct 0    0           167.1.1.2       WGE1/0/1
167.1.1.0/32        Direct 0    0           167.1.1.2       WGE1/0/1
167.1.1.2/32        Direct 0    0           127.0.0.1       InLoop0
167.1.1.255/32      Direct 0    0           167.1.1.2       WGE1/0/1
169.1.1.0/24        BGP    255  0           2.2.2.2         WGE1/0/2
192.168.1.0/24      BGP    255  0           167.1.1.1       WGE1/0/1
192.168.2.0/24      BGP    255  0           167.1.1.1       WGE1/0/1
192.168.3.0/24      BGP    255  0           2.2.2.2         WGE1/0/2
224.0.0.0/4         Direct 0    0           0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0           0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0           127.0.0.1       InLoop0
```

Verify that the related routes on Device C take effect.

```
[DeviceC] display ip routing-table

Destinations : 14        Routes : 14

Destination/Mask    Proto  Pre  Cost        NextHop         Interface
0.0.0.0/32          Direct 0    0           127.0.0.1       InLoop0
1.1.1.1/32          OSPF   10   1           168.1.1.2       WGE1/0/2
2.2.2.2/32          Direct 0    0           127.0.0.1       InLoop0
127.0.0.0/8         Direct 0    0           127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0           127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0           127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0           127.0.0.1       InLoop0
168.1.1.0/24        Direct 0    0           168.1.1.1       WGE1/0/2
168.1.1.0/32        Direct 0    0           168.1.1.1       WGE1/0/2
168.1.1.1/32        Direct 0    0           127.0.0.1       InLoop0
168.1.1.255/32      Direct 0    0           168.1.1.1       WGE1/0/2
224.0.0.0/4         Direct 0    0           0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0           0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0           127.0.0.1       InLoop0
[DeviceC] display ip routing-table vpn-instance vpn1
```

```
Destinations : 16        Routes : 16

Destination/Mask    Proto  Pre  Cost         NextHop         Interface
0.0.0.0/32          Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/8         Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0            127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0            127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
167.1.1.0/24        BGP    255  0            1.1.1.1         WGE1/0/2
169.1.1.0/24        Direct 0    0            169.1.1.2       WGE1/0/1
169.1.1.0/32        Direct 0    0            169.1.1.2       WGE1/0/1
169.1.1.2/32        Direct 0    0            127.0.0.1       InLoop0
169.1.1.255/32      Direct 0    0            169.1.1.2       WGE1/0/1
192.168.1.0/24      BGP    255  0            1.1.1.1         WGE1/0/2
192.168.2.0/24      BGP    255  0            169.1.1.1       WGE1/0/1
192.168.3.0/24      BGP    255  0            169.1.1.1       WGE1/0/1
224.0.0.0/4         Direct 0    0            0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0            0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
```

Verify that the related routes on Device D take effect.

```
[DeviceD] display ip routing-table

Destinations : 18        Routes : 18

Destination/Mask    Proto  Pre  Cost         NextHop         Interface
0.0.0.0/32          Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/8         Direct 0    0            127.0.0.1       InLoop0
127.0.0.0/32        Direct 0    0            127.0.0.1       InLoop0
127.0.0.1/32        Direct 0    0            127.0.0.1       InLoop0
127.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
167.1.1.0/24        BGP    255  0            169.1.1.2       WGE1/0/2
169.1.1.0/24        Direct 0    0            169.1.1.1       WGE1/0/2
169.1.1.0/32        Direct 0    0            169.1.1.1       WGE1/0/2
169.1.1.1/32        Direct 0    0            127.0.0.1       InLoop0
169.1.1.255/32      Direct 0    0            169.1.1.1       WGE1/0/2
192.168.1.0/24      BGP    255  0            169.1.1.2       WGE1/0/2
192.168.3.0/24      Direct 0    0            192.168.3.2     WGE1/0/1
192.168.3.0/32      Direct 0    0            192.168.3.2     WGE1/0/1
192.168.3.2/32      Direct 0    0            127.0.0.1       InLoop0
192.168.3.255/32    Direct 0    0            192.168.3.2     WGE1/0/1
224.0.0.0/4         Direct 0    0            0.0.0.0         NULL0
224.0.0.0/24        Direct 0    0            0.0.0.0         NULL0
255.255.255.255/32  Direct 0    0            127.0.0.1       InLoop0
```

Display the QoS policy configuration in the inbound direction on Device C.

```
[DeviceC] display qos policy interface inbound
Interface: Twenty-FiveGigE1/0/1
  Direction: Inbound
  Policy: qppb
```

```
   Classifier: default-class
         Mode: qppb-manipulation
     Matched : 312 (Packets) 18916 (Bytes)
     5-minute statistics:
      Forwarded: 0/24 (pps/bps)
      Dropped  : 0/0 (pps/bps)
     Operator: AND
     Rule(s) :
      If-match any
     Behavior: be
      -none-
   Classifier: qppb
         Mode: qppb-manipulation
     Matched : 0 (Packets) 0 (Bytes)
     5-minute statistics:
      Forwarded: 0/0 (pps/bps)
      Dropped  : 0/0 (pps/bps)
     Operator: AND
     Rule(s) :
      If-match qos-local-id 3
     Behavior: qppb
      Committed Access Rate:
        CIR 200000 (kbps), CBS 1250000 (Bytes), EBS 0 (Bytes)
        Green action  : pass
        Yellow action : pass
        Red action    : discard
        Green packets : 0 (Packets) 0 (Bytes)
        Yellow packets: 0 (Packets) 0 (Bytes)
        Red packets   : 0 (Packets) 0 (Bytes)

Interface: Twenty-FiveGigE1/0/2
  Direction: Inbound
  Policy: qppb
   Classifier: default-class
         Mode: qppb-manipulation
     Matched : 311 (Packets) 23243 (Bytes)
     5-minute statistics:
      Forwarded: 0/24 (pps/bps)
      Dropped  : 0/0 (pps/bps)
     Operator: AND
     Rule(s) :
      If-match any
     Behavior: be
      -none-
   Classifier: qppb
         Mode: qppb-manipulation
     Matched : 0 (Packets) 0 (Bytes)
     5-minute statistics:
```

```
 Forwarded: 0/0 (pps/bps)
 Dropped  : 0/0 (pps/bps)
Operator: AND
Rule(s) :
 If-match qos-local-id 3
Behavior: qppb
 Committed Access Rate:
   CIR 200000 (kbps), CBS 12500480 (Bytes), EBS 0 (Bytes)
   Green action  : pass
   Yellow action : pass
   Red action    : discard
   Green packets : 0 (Packets) 0 (Bytes)
   Yellow packets: 0 (Packets) 0 (Bytes)
   Red packets   : 0 (Packets) 0 (Bytes)
```

Example: Configuring QPPB in an IPv6 network

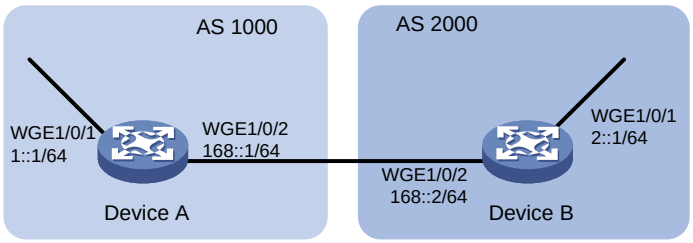
Network configuration

As shown in Figure 27, all devices run BGP.

Configure QPPB so that Device B can perform the following operations:

- Receive routes.
- Set the local QoS ID.
- Use the QoS policy to limit the rate of matching traffic to 512000 kbps.

Figure 27 Network diagram



Procedure

1. Configure IPv6 addresses for each interface. (Details not shown.)
2. Configure BGP on Device A.

```
<DeviceA> system-view
[DeviceA] bgp 1000
[DeviceA] peer 168::2 as-number 2000
[DeviceA] peer 168::2 connect-interface twenty-fivegige 1/0/2
[DeviceA-bgp] address-family ipv6
[DeviceA-bgp-ipv6] peer 168::2 enable
[DeviceA-bgp-ipv6] import-route direct
[DeviceA-bgp-ipv6] quit
[DeviceA-bgp] quit
```

3. Configure Device B:

   # Configure BGP.

```
<DeviceB> system-view
[DeviceB] bgp 2000
[DeviceB] peer 168::1 as-number 1000
[DeviceB] peer 168::1 connect-interface twenty-fivegige 1/0/2
[DeviceB-bgp] address-family ipv6
[DeviceB-bgp-ipv6] peer 168::1 enable
[DeviceB-bgp-ipv6] peer 168::1 route-policy qppb import
[DeviceB-bgp-ipv6] quit
[DeviceB-bgp] quit
```

Configure a routing policy.

```
[DeviceB] route-policy qppb permit node 0
[DeviceB-route-policy-qppb-0] apply qos-local-id 4
[DeviceB-route-policy-qppb-0] quit
```

Enable QPPB on Twenty-FiveGigE 1/0/1.

```
[DeviceB] interface twenty-fivegige 1/0/1
[DeviceB-Twenty-FiveGigE1/0/1] bgp-policy destinationip-qos-map
```

Configure a QoS policy.

```
[DeviceB] traffic classifier qppb
[DeviceB-classifier-qppb] if-match qos-local-id 4
[DeviceB-classifier-qppb] quit
[DeviceB] traffic behavior qppb
[DeviceB-behavior-qppb] car cir 512000 red discard
[DeviceB-behavior-qppb] quit
[DeviceB] qos policy qppb
[DeviceB-qospolicy-qppb] classifier qppb behavior qppb mode qppb-manipulation
[DeviceB-qospolicy-qppb] quit
```

Apply the QoS policy to the incoming traffic of Twenty-FiveGigE 1/0/1.

```
[DeviceB] interface twenty-fivegige 1/0/1
[DeviceB-Twenty-FiveGigE1/0/1] qos apply policy qppb inbound
[DeviceB-Twenty-FiveGigE1/0/1] quit
```

Verifying the configuration

Verify that the related routes on Device A take effect.

```
[DeviceA] display ipv6 routing-table

Destinations : 7        Routes : 7

Destination: ::1/128                                    Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0

Destination: 1::/64                                     Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : GE1/0/1                                    Cost      : 0

Destination: 1::1/128                                   Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0
```

```
Destination: 168::/64                                   Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : GE1/0/2                                    Cost      : 0

Destination: 168::1/128                                 Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0

Destination: FE80::/10                                  Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : NULL0                                      Cost      : 0

Destination: FF00::/8                                   Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : NULL0                                      Cost      : 0
```

Verify that the related routes on Device B take effect.

```
[DeviceB] display ipv6 routing-table

Destinations : 9 Routes : 9

Destination: ::1/128                                    Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0

Destination: 1::/64                                     Protocol  : BGP4+
NextHop    : 168::1                                     Preference: 255
Interface  : GE1/0/2                                    Cost      : 0

Destination: 2::/64                                     Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : GE1/0/1                                    Cost      : 0

Destination: 2::1/128                                   Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0

Destination: 2::2/128                                   Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0

Destination: 168::/64                                   Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : GE1/0/2                                    Cost      : 0

Destination: 168::2/128                                 Protocol  : Direct
NextHop    : ::1                                        Preference: 0
Interface  : InLoop0                                    Cost      : 0
```

```
Destination: FE80::/10                                  Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : NULL0                                      Cost      : 0

Destination: FF00::/8                                   Protocol  : Direct
NextHop    : ::                                         Preference: 0
Interface  : NULL0                                      Cost      : 0
```

Display the configuration and statistics for the QoS policy applied to Twenty-FiveGigE 1/0/1 on Device C.

```
[DeviceC] display qos policy interface twenty-fivegige 1/0/1
Interface: Twenty-FiveGigE1/0/1
  Direction: Inbound
  Policy: qppb
   Classifier: default-class
         Mode: qppb-manipulation
     Matched : 0 (Packets) 0 (Bytes)
     5-minute statistics:
      Forwarded: 0/0 (pps/bps)
      Dropped  : 0/0 (pps/bps)
     Operator: AND
     Rule(s) :
      If-match any
     Behavior: be
      -none-
   Classifier: qppb
         Mode: qppb-manipulation
     Matched : 0 (Packets) 0 (Bytes)
     5-minute statistics:
      Forwarded: 0/0 (pps/bps)
      Dropped  : 0/0 (pps/bps)
     Operator: AND
     Rule(s) :
      If-match qos-local-id 4
     Behavior: qppb
      Committed Access Rate:
        CIR 512000 (kbps), CBS 32000000 (Bytes), EBS 0 (Bytes)
        Green action  : pass
        Yellow action : pass
        Red action    : discard
        Green packets : 0 (Packets) 0 (Bytes)
        Yellow packets: 0 (Packets) 0 (Bytes)
        Red packets   : 0 (Packets) 0 (Bytes)
```

Configuring packet-drop logging for control plane protocols

About packet-drop logging for control plane protocols

A device provides the data plane and the control plane.

- **Data plane**—The units at the data plane are responsible for receiving, transmitting, and switching (forwarding) packets, such as various dedicated forwarding chips. They deliver super processing speeds and throughput.
- **Control plane**—The units at the control plane are processing units running most routing and switching protocols. They are 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.

If protocol packets sent to the control plane are dropped, the protocol operation will be affected. You can configure control plane packet-drop logging. The device regularly generates and sends logs to the information center. For information about configuring the information center, see *Network Management and Monitoring Configuration Guide*.

Procedure

1. Enter system view.

   system-view

2. Enable packet-drop logging for control plane protocols.

   qos control-plane logging protocol { *protocol-name*&<1-8> | **all** } **enable**

   By default, packet-drop logging is disabled for all control plane protocols.

3. (Optional.) Set the interval for sending packet-drop logs.

   qos control-plane logging interval *interval*

   The default setting is 5 seconds.

Appendixes

Appendix A Acronyms

Table 3 Appendix A Acronyms

Acronym	Full spelling
AF	Assured Forwarding
BE	Best Effort
BQ	Bandwidth Queuing
CAR	Committed Access Rate
CBS	Committed Burst Size
CBQ	Class Based Queuing
CE	Congestion Experienced
CIR	Committed Information Rate
CQ	Custom Queuing
DCBX	Data Center Bridging Exchange Protocol
DiffServ	Differentiated Service
DSCP	Differentiated Services Code Point
EBS	Excess Burst Size
ECN	Explicit Congestion Notification
EF	Expedited Forwarding
FIFO	First in First out
FQ	Fair Queuing
GMB	Guaranteed Minimum Bandwidth
GTS	Generic Traffic Shaping
INT	Inband Network Telemetry
IntServ	Integrated Service
ISP	Internet Service Provider
LLQ	Low Latency Queuing
LSP	Label Switched Path
MPLS	Multiprotocol Label Switching
PE	Provider Edge
PIR	Peak Information Rate
PQ	Priority Queuing
QoS	Quality of Service
QPPB	QoS Policy Propagation Through the Border Gateway Protocol
RED	Random Early Detection

Acronym	Full spelling
RSVP	Resource Reservation Protocol
RTP	Real-Time Transport Protocol
SP	Strict Priority
ToS	Type of Service
VoIP	Voice over IP
VPN	Virtual Private Network
WFQ	Weighted Fair Queuing
WRED	Weighted Random Early Detection
WRR	Weighted Round Robin

Appendix B Default priority maps

For the default **dot1p-exp**, **dscp-dscp**, and **exp-dot1p** priority maps, an input value yields a target value equal to it.

Table 4 Default dot1p-lp and dot1p-dp priority maps

Input priority value	dot1p-lp map	dot1p-dp map
dot1p	**lp**	**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 5 Default dscp-dp and dscp-dot1p priority maps

Input priority value	dscp-dp map	dscp-dot1p map
dscp	**dp**	**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

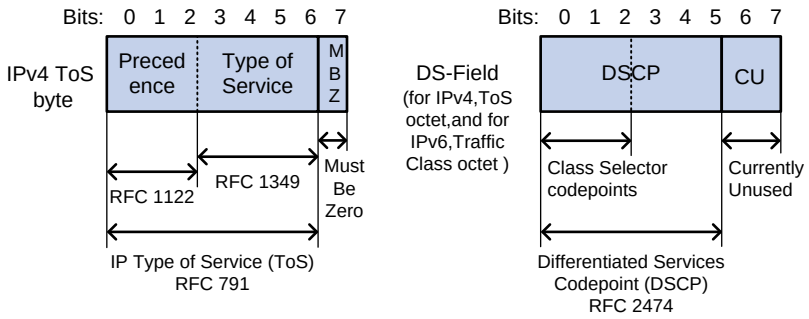
Table 6 Default port priority-local priority map

Port priority	Local precedence
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

Appendix C Introduction to packet precedence

IP precedence and DSCP values

Figure 28 ToS and DS fields



As shown in Figure 28, the ToS field in the IP header contains 8 bits. The first 3 bits (0 to 2) represent IP precedence from 0 to 7. According to RFC 2474, the ToS field is redefined as the differentiated services (DS) field. A DSCP value is represented by the first 6 bits (0 to 5) of the DS field and is in the range 0 to 63. The remaining 2 bits (6 and 7) are reserved.

Table 7 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

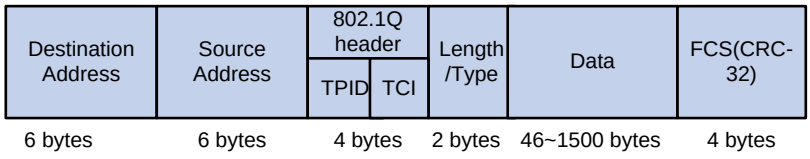
Table 8 DSCP values

DSCP value (decimal)	DSCP value (binary)	Description
46	101110	ef
10	001010	af11
12	001100	af12
14	001110	af13
18	010010	af21
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. It applies to occasions where Layer 3 header analysis is not needed and QoS must be assured at Layer 2.

Figure 29 An Ethernet frame with an 802.1Q tag header



As shown in Figure 29, the 4-byte 802.1Q tag header contains the 2-byte tag protocol identifier (TPID) and the 2-byte tag control information (TCI). The value of the TPID is 0x8100. Figure 30 shows the format of the 802.1Q tag header. The Priority field in the 802.1Q tag header is called 802.1p priority, because its use is defined in IEEE 802.1p. Table 9 shows the values for 802.1p priority.

Figure 30 802.1Q tag header

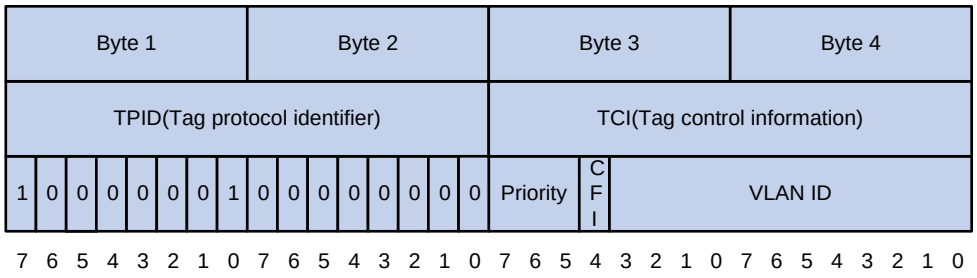


Table 9 Description on 802.1p priority

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

EXP values

The EXP field is in MPLS labels for MPLS QoS purposes. As shown in Figure 31, the EXP field is 3-bit long and is in the range of 0 to 7.

Figure 31 MPLS label structure

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Configuring data buffers

About data buffers

Data buffer types

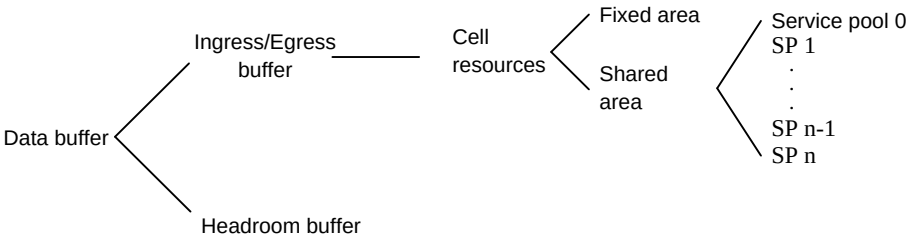
Data buffers temporarily store packets to avoid packet loss.

The following data buffers are available:

- **Ingress buffer**—Stores incoming packets when the CPU is busy.
- **Egress buffer**—Stores outgoing packets when network congestion occurs.
- **Headroom buffer**—Stores packets when the ingress buffer or egress buffer is used up.

Figure 1 shows the structure of ingress and egress buffers.

Figure 1 Data buffer structure



Cell resources

A buffer uses cell resources to store packets based on packet sizes. A cell resource provides 208 bytes. The buffer allocates one cell resource to a 128-byte packet and two cell resources to a 300-byte packet.

Fixed area and shared area

The cell resources have a fixed area and a shared area.

- **Fixed area**—Partitioned into queues, each of which is equally divided by all the interfaces on a card, as shown in Figure 2. When congestion occurs or the CPU is busy, the following rules apply:

  a. An interface first uses the relevant queues of the fixed area to store packets.

  b. When a queue is full, the interface uses the corresponding queue of the shared area.

  c. When the queue in the shared area is also full, the interface discards subsequent packets.

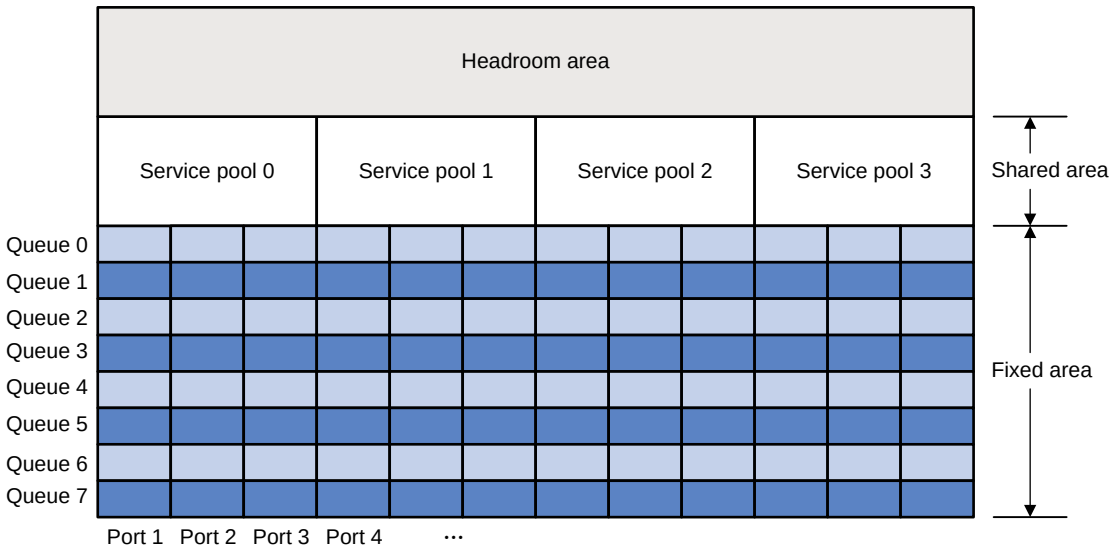
  The system allocates the fixed area among queues as specified by the user. Even if a queue is not full, other queues cannot preempt its space. Similarly, the share of a queue for an interface cannot be preempted by other interfaces even if it is not full.

- **Shared area**—Partitioned into queues, each of which is not equally divided by the interfaces, as shown in Figure 2. The system determines the actual shared-area space for each queue according to user configuration and the number of packets actually received and sent. If a queue is not full, other queues can preempt its space.

  The system puts packets received or sent on all interfaces into a queue in the order they arrive. When the queue is full, subsequent packets are dropped.

The shared area is also divided into service pools based on application services. You can map a queue to a service pool, and this queue can only use the resources of that service pool. By default, all of the shared area belongs to service pool 0.

Figure 2 Fixed area and shared area



Restrictions and guidelines: Data buffer configuration

You can configure data buffers either manually or automatically by enabling the Burst feature. If you have configured data buffers in one way, delete the configuration before using the other way. Otherwise, the new configuration does not take effect.

Inappropriate data buffer changes can cause system problems. Before manually changing data buffer settings, make sure you understand its impact on your device. As a best practice, use the **`burst-mode enable`** command if the system requires large buffer spaces.

Data buffer tasks at a glance

To configure the data buffer, perform the following tasks:

- Enabling the Burst feature
- Configuring data buffers manually
- Setting the buffer ratio or size for a queue in interface view
  - Setting the fixed-area ratio or size for a queue
  - Setting the maximum shared-area ratio or size for a queue
- Mapping a queue to a service pool
- (Optional.) Configuring data buffer monitoring
- (Optional.) Configuring data buffer alarms
  - Configuring alarm thresholds for the ingress or egress buffer
  - Configuring alarm thresholds for the Headroom buffer
  - Configuring packet-drop alarms

Enabling the Burst feature

About the Burst feature

The Burst feature enables the device to automatically allocate cell and packet resources. It is well suited to the following scenarios:

- Broadcast or multicast traffic is intensive, resulting in bursts of traffic.
- Traffic comes in and goes out in one of the following ways:
  - Enters a device from a high-speed interface and goes out of a low-speed interface.
  - Enters from multiple same-rate interfaces at the same time and goes out of an interface with the same rate.

The default data buffer settings are changed after the Burst feature is enabled. You can display the data buffer settings by using the **`display buffer`** command.

Procedure

1. Enter system view.

   `system-view`
2. Enable the Burst feature.

   `burst-mode enable`

   By default, the Burst feature is disabled.

Configuring data buffers manually

About manual data buffer configuration

Each type of resources of a buffer, packet or cell, has a fixed size. After you set the shared-area size for a type of resources, the rest is automatically assigned to the fixed area.

By default, all queues have an equal share of the shared area and the fixed area. You can change the maximum shared-area space and the fixed-area for a queue. The unconfigured queues use the default settings.

Procedure

1. Enter system view.

   `system-view`
2. Configure buffer assignment rules. Choose the options to configure as needed:
   - Set the total shared-area ratio.

     `buffer egress` [**`slot`** *`slot-number`*] **`cell total-shared ratio`** *`ratio`*

     The default setting is 100%.
   - Set the maximum shared-area ratio for a queue.

     `buffer egress` [**`slot`** *`slot-number`*] **`cell queue`** *`queue-id`* **`shared ratio`** *`ratio`*

     The default setting is 20%.

     The actual maximum shared-area space for each queue is determined based on your configuration and the number of packets to be received and sent.
   - Set the fixed-area ratio for a queue.

     `buffer egress` [**`slot`** *`slot-number`*] **`cell queue`** *`queue-id`* **`guaranteed ratio`** *`ratio`*

The sum of fixed-area ratios configured for all queues cannot exceed the total fixed-area ratio. Otherwise, the configuration fails.

- Set the fixed-area ratio or size for a service pool.

  buffer { **egress** | **ingress** } **slot** *slot-number* **cell service-pool** *sp-id* **shared ratio** *ratio*

  By default, all of the shared area is reserved for service pool 0.

3. Apply buffer assignment rules.

   buffer apply

   You cannot directly modify the applied configuration. To modify the configuration, you must cancel the application, reconfigure data buffers, and reapply the configuration.

Setting the buffer ratio or size for a queue in interface view

Setting the fixed-area ratio or size for a queue

About setting the fixed-area ratio for a queue

The fixed area is partitioned into queues, each of which is equally divided by all the interfaces. Even if a queue is not full, other queues cannot preempt its space. After you set the fixed-area ratio for a queue, the other queues have an equal share of the remaining part.

Restrictions and guidelines

The sum of the fixed-area ratios configured for all queues cannot exceed 100%. The queue that causes the sum of the fixed-area ratios to exceed 100% fails to be configured and still uses the default setting.

The fixed-area ratio setting in interface view has higher priority than the fixed-area ratio setting in system view. If it is configured in both views, the setting in interface view takes effect.

Procedure

1. Enter system view.

   system-view

2. Enter interface view.

   interface *interface-type interface-number*

3. Set the fixed-area ratio or size for a queue.

   buffer egress cell queue *queue-id* **guaranteed ratio** *ratio*

   The default setting is 13%.

Setting the maximum shared-area ratio or size for a queue

About setting the maximum shared-area ratio or size for a queue

The shared area is partitioned into queues. If a queue is not full, other queues can preempt its space.. After you set the maximum shared-area ratio for a queue, the other queues use the default setting. The system determines the actual shared-area space for each queue according to user configuration and the number of packets actually received and sent.

Restrictions and guidelines

The maximum shared-area ratio setting in interface view has higher priority than the maximum shared-area setting in system view. If it is configured in both views, the setting in interface view takes effect.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Set the maximum shared-area ratio or size for a queue.
   buffer egress cell queue *queue-id* **shared ratio** *ratio*
   The default setting is 20 %.

Mapping a queue to a service pool

About mapping a queue to a service pool

A queue mapped to a service pool can only use that service pool to store packets and does not affect other service pools.

For the ingress buffer, the queue ID specified represents the 802.1p priority in packets.

Prerequisites

Before performing this task, use the **buffer service-pool shared** command to set the maximum shared-area ratio for the service pool.

Procedure

1. Enter system view.
   system-view
2. Enter interface view.
   interface *interface-type interface-number*
3. Map a queue to a service pool.
   buffer { **egress** | **ingress** } **queue** *queue-id* **map-to service-pool** *sp-id*
   By default, all queues are mapped to service pool 0.

Configuring data buffer monitoring

About data buffer monitoring

The data buffer on a switch is shared by all interfaces for buffering packets during periods of congestion.

This feature allows you to identify the interfaces that use an excessive amount of data buffer space. Then, you can diagnose those interfaces for anomalies.

You can set a per-interface buffer usage threshold. The buffer usage threshold for a queue is the same as the per-interface threshold value. The switch automatically records buffer usage for each interface. When a queue on an interface uses more buffer space than the set threshold, the system counts one threshold violation for the queue.

Procedure

1. Enter system view.

system-view

2. Set a per-interface buffer usage threshold.

   buffer usage threshold slot *slot-number* **ratio** *ratio*

   The default setting is 70%.

Configuring data buffer alarms

About data buffer alarms

This feature works with a network management system (such as IMC). Data buffer alarms include threshold-crossing alarms and packet drop alarms. The device reports these alarms to the network management system for displaying the data buffer usage.

Configuring alarm thresholds for the ingress or egress buffer

1. Enter system view.

   system-view

2. Configure the alarm thresholds. Choose the options to configure as needed:

   - Configure the global alarm threshold for a queue.

     buffer { **egress** | **ingress** } **usage threshold slot** *slot-number* **queue** *queue-id* **ratio** *ratio*

     The default setting is 100%.

   - Execute the following commands in sequence to configure the alarm threshold for a queue on an interface:

     interface *interface-type interface-number*

     buffer { **egress** | **ingress** } **usage threshold queue** *queue-id* **ratio** *ratio*

     The default setting is 100%.

3. Enable threshold-crossing alarms.

   buffer threshold alarm { **egress** | **ingress** } **enable**

   By default, threshold-crossing alarms are disabled.

4. (Optional.) Set the interval for sending threshold-crossing alarms.

   buffer threshold alarm { **egress** | **ingress** } **interval** *interval*

   By default, the global alarm threshold is used.

The alarm threshold and the threshold sending interval take effect only when threshold-crossing alarms are enabled.

Configuring alarm thresholds for the Headroom buffer

1. Enter system view.

   system-view

2. Configure the alarm thresholds. Choose the options to configure as needed:

   - Configure the global per-queue alarm threshold.

     buffer usage threshold headroom slot *slot-number* **ratio** *ratio*

     The default setting is 100%.

- Execute the following commands in sequence to configure the alarm threshold for a queue on an interface:

  interface *interface-type interface-number*

  buffer usage threshold headroom queue *queue-id* **ratio** *ratio*

  By default, the global per-queue alarm threshold is used.

3. Enable threshold-crossing alarms.

   buffer threshold alarm headroom enable

   By default, threshold-crossing alarms are disabled.

4. (Optional.) Set the interval for sending threshold-crossing alarms.

   buffer threshold alarm headroom interval *interval*

   The default setting is 5 seconds.

The alarm threshold and the threshold sending interval take effect only when threshold-crossing alarms are enabled.

Configuring packet-drop alarms

About packet drop alarms

This feature allows the device to periodically send packet-drop information to the NMS.

Restrictions and guidelines

This feature does not take effect on the Headroom buffer.

Procedure

1. Enter system view.

   system-view

2. Enable packet-drop alarms.

   buffer packet-drop alarm enable

   By default, packet-drop alarms are disabled.

3. (Optional.) Set the interval for sending packet-drop alarms.

   buffer packet-drop alarm interval *interval*

   The default setting is 5 seconds.

   This command takes effect only when packet-drop alarms are enabled.

Display and maintenance commands for data buffers

Execute **display** commands in any view.

Task	Command
Display buffer size settings.	**display buffer** [**slot** *slot-number*] [**queue** [*queue-id*]]
Display data buffer usage.	**display buffer usage** [**slot** *slot-number*]

Task	Command
Display buffer usage statistics for interfaces.	**display buffer usage interface** [*interface-type* [*interface-number*]] [**verbose**]

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Configuring time ranges

About time ranges

You can implement a service based on the time of the day by applying a time range to it. A time-based service takes effect only in time periods specified by the time range. For example, you can implement time-based ACL rules by applying a time range to them.

The following basic types of time ranges 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.

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.

Restrictions and guidelines: Time range configuration

When you configure the ACL hardware mode, follow these restrictions and guidelines:

- If a time range does not exist, the service based on the time range does not take effect.
- You can create a maximum of 1024 time ranges, each with a maximum of 32 periodic statements and 12 absolute statements.

Procedure

1. Enter system view.

   system-view

2. Create or edit 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* }

   If an existing time range name is provided, this command adds a statement to the time range.

Display and maintenance commands for time ranges

Execute the **display** command in any view.

Task	Command
Display time range configuration and status.	**display time-range** { *time-range-name* | **all** }

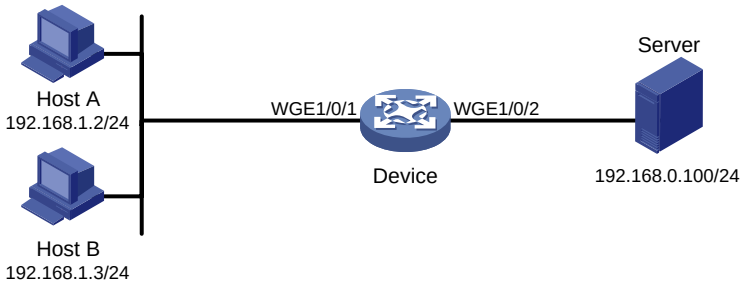
Time range configuration examples

Example: Configuring a time range

Network configuration

As shown in Figure 1, configure an ACL on the device to allow Host A to access the server only during 8:00 and 18:00 on working days from June 2015 to the end of the year.

Figure 1 Network diagram



Procedure

Create a periodic time range during 8:00 and 18:00 on working days from June 2015 to the end of the year.

```
<Device> system-view
[Device] time-range work 8:0 to 18:0 working-day from 0:0 6/1/2015 to 24:00 12/31/2015
```

Create an IPv4 basic ACL numbered 2001, and configure a rule in the ACL to permit packets only from 192.168.1.2/32 during the time range **work**.

```
[Device] acl basic 2001
[Device-acl-ipv4-basic-2001] rule permit source 192.168.1.2 0 time-range work
[Device-acl-ipv4-basic-2001] rule deny source any time-range work
[Device-acl-ipv4-basic-2001] quit
```

Apply IPv4 basic ACL 2001 to filter outgoing packets on Twenty-FiveGigE 1/0/2.

```
[Device] interface twenty-fivegige 1/0/2
[Device-Twenty-FiveGigE1/0/2] packet-filter 2001 outbound
[Device-Twenty-FiveGigE1/0/2] quit
```

Verifying the configuration

Verify that the time range **work** is active on the device.

```
[Device] display time-range all
Current time is 13:58:35 6/19/2015 Friday

Time-range : work (Active)
 08:00 to 18:00 working-day
 from 00:00 6/1/2015 to 00:00 1/1/2016
```