Configuring QoS

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://www.cisco.com/go/cfn. An account on Cisco.com is not required.

Related Topics

Feature History and Information for Troubleshooting Software Configuration

Prerequisites for QoS

Before configuring standard QoS, you must have a thorough understanding of these items:

- The types of applications used and the traffic patterns on your wired or wireless network.

- Traffic characteristics and needs of your wired or wireless network. For example, is the traffic on your network bursty? Do you need to reserve bandwidth for voice and video streams?
- Bandwidth requirements and speed of the wired or wireless network.
- Location of congestion points in the wired or wireless network.

Restrictions for QoS on Wired Targets

A target is an entity where a policy is applied. You can apply a policy to either a wired or wireless target. A wired target can be either a port, client, or VLAN. A wireless target can be either a port, SSID, client, or radio. Wireless QoS policies for port, SSID, client, and radio are applied in the downstream direction. That is, when traffic is flowing from the switch to wireless client.

Note For information about the restrictions for QoS on wireless targets, see Restrictions for Wireless QoS.

The following are restrictions for applying QoS features on the switch the wired target:

- A maximum of 8 queuing classes are supported on the switch port for the wired target.
- A maximum of 63 policers are supported per policy on the wired port for the wired target.
- A maximum of 1600 policies are supported on the switch.
- No more than two levels are supported in a QoS hierarchy.
- In a hierarchical policy, overlapping actions between parent and child are not allowed, except for the case where a policy has the port-shaper in the parent and queueing features in the child policy.
- Policing in both the parent and child is not supported in a QoS hierarchy.
- Marking in both the parent and child is not supported in a QoS hierarchy.
- A mixture of queue-limit and queue-buffer in the same policy is not supported.

  Note The queue-limit percent is not supported on the switch because the queue-buffer command handles this functionality. Queue-limit is only supported with the DSCP and CoS extensions.

- The classification sequence for all wired queuing-based policies should be the same across all wired upstream ports (10-Gigabit Ethernet), and the same for all downstream wired ports (1-Gigabit Ethernet).
- Empty classes are not supported.
- The **match vlan** class-map configuration command supports either a VLAN range or a single VLAN.
- The actions under a policer within a policy-map have the following restrictions:
  - The conform action must be transmit.
  - The exceed/violate action for markdown type can only be cos2cos, prec2prec, dscp2dscp.
  - The markdown types must be the same within a policy.

- Table maps have the following specific restrictions:
    - Only one table map per direction per target is supported.
    - Table maps must be configured under the class-default, table maps are unsupported for a user-defined class.

- Hierarchical policies are required for the following:
    - Port-shapers
    - Aggregate policers
    - PV policy
    - Parent queueing with child marking

Note Any "on-the-fly" change (modifying a policy while it is attached to a target) is not permitted for wired hierarchical policies.

- For ports with wired targets, these are the only supported hierarchical policies:
    - Police chaining in the same policy is unsupported, except for wireless client.
    - Hierarchical queueing is unsupported in the same policy (port shaper is the exception).
    - In a parent class, all filters must have the same type. The child filter type must match the parent filter type with the following exceptions:
        - If the parent class is configured to match IP, then the child class can be configured to match the ACL.
        - If the parent class is configured to match CoS, then the child class can be configured to match the ACL.

- Modification to a policy *name* on a wired port is not recommended, please remove and reapply the policies if any unexpected behavior is seen.

The following are restrictions for applying QoS features on the VLAN to the wired target:

- For a flat or nonhierarchical policy, only marking or a table map is supported.

The following are restrictions for applying QoS features on the EtherChannel member links to the wired target:

- QoS is unsupported.

Related Topics

Restrictions for Wireless QoS

Information About QoS

QoS Overview

By configuring the quality of service (QoS), you can provide preferential treatment to specific types of traffic at the expense of other traffic types. Without QoS, the switch offers best-effort service to each packet, regardless of the packet contents or size. The switch sends the packets without any assurance of reliability, delay bounds, or throughput.

The following are specific features provided by QoS:

- Low latency
- Bandwidth guarantee
- Buffering capabilities and dropping disciplines
- Traffic policing
- Enables the changing of the attribute of the frame or packet header
- Relative services

Modular QoS Command-Line Interface

With the switch, QoS features are enabled through the Modular QoS command-line interface (MQC). The MQC is a command-line interface (CLI) structure that allows you to create traffic policies and attach these policies to interfaces. A traffic policy contains a traffic class and one or more QoS features. A traffic class is used to classify traffic, whereas the QoS features in the traffic policy determine how to treat the classified traffic. One of the main goals of MQC is to provide a platform-independent interface for configuring QoS across Cisco platforms.

QoS and IPv6

The switch supports IPv6-based QoS policies. You can configure IPv6 ACLs as a match criteria and then set the traffic class of the packet or police the stream. You can also match on DSCP values (traffic class for IPv6) and perform the action. Unless a policy has an IPv4 ACL or specifically has following match criterion, it also matches IPv6 traffic.

Note The class default always matches IPv6 traffic, in addition to IPv4 and MAC.

Wired Access Features for QoS

The following table describes the supported QoS features for wired access.

Table 1: QoS Wired Access Features

Feature	Description
Supported targets	• Gigabit Ethernet • 10-Gigabit Ethernet • VLAN
Configuration sequence	QoS policy installed using the **service-policy** command.
Supported number of queues at port level	Up to 8 queues supported on a port. No Approximate Fair Dropping or Discard (AFD) support for wired targets.
Supported classification mechanism	• DSCP • IP precedence • CoS • QoS-group • ACL membership including: ◦ IPv4 ACLs ◦ IPv6 ACLS ◦ MAC ACLs

Hierarchical QoS

The switch supports hierarchical QoS (HQoS). HQoS allows you to perform:

- Hierarchical classification— Traffic classification is based upon other classes.
- Hierarchical policing—The process of having the policing configuration at multiple levels in a hierarchical policy.
- Hierarchical shaping—Shaping can also be configured at multiple levels in the hierarchy.

Note Hierarchical shaping is only supported for the port shaper, where for the parent you only have a configuration for the class default, and the only action for the class default is shaping.

Related Topics

Examples: Hierarchical Classification, on page 73

QoS Implementation

Typically, networks operate on a best-effort delivery basis, which means that all traffic has equal priority and an equal chance of being delivered in a timely manner. When congestion occurs, all traffic has an equal chance of being dropped.

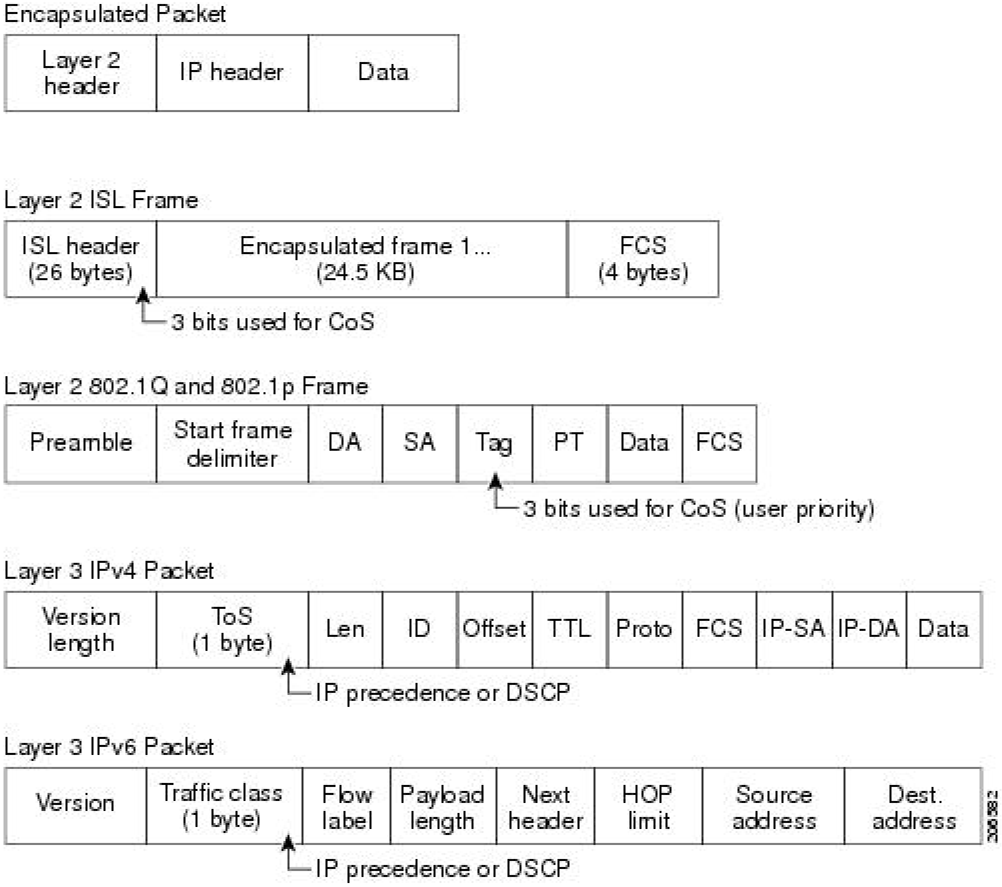
When you configure the QoS feature, you can select specific network traffic, prioritize it according to its relative importance, and use congestion-management and congestion-avoidance techniques to provide preferential treatment. Implementing QoS in your network makes network performance more predictable and bandwidth utilization more effective.

The QoS implementation is based on the Differentiated Services (Diff-Serv) architecture, a standard from the Internet Engineering Task Force (IETF). This architecture specifies that each packet is classified upon entry into the network.

The classification is carried in the IP packet header, using 6 bits from the deprecated IP type of service (ToS) field to carry the classification (*class*) information. Classification can also be carried in the Layer 2 frame.

The special bits in the Layer 2 frame or a Layer 3 packet are shown in the following figure:

Figure 1: QoS Classification Layers in Frames and Packets



Layer 2 Frame Prioritization Bits

Layer 2 Inter-Switch Link (ISL) frame headers have a 1-byte User field that carries an IEEE 802.1p class of service (CoS) value in the three least-significant bits. On ports configured as Layer 2 ISL trunks, all traffic is in ISL frames.

Layer 2 802.1Q frame headers have a 2-byte Tag Control Information field that carries the CoS value in the three most-significant bits, which are called the User Priority bits. On ports configured as Layer 2 802.1Q trunks, all traffic is in 802.1Q frames except for traffic in the native VLAN.

Other frame types cannot carry Layer 2 CoS values.

Layer 2 CoS values range from 0 for low priority to 7 for high priority.

Layer 3 Packet Prioritization Bits

Layer 3 IP packets can carry either an IP precedence value or a Differentiated Services Code Point (DSCP) value. QoS supports the use of either value because DSCP values are backward-compatible with IP precedence values.

IP precedence values range from 0 to 7. DSCP values range from 0 to 63.

End-to-End QoS Solution Using Classification

All switches and routers that access the Internet rely on the class information to provide the same forwarding treatment to packets with the same class information and different treatment to packets with different class information. The class information in the packet can be assigned by end hosts or by switches or routers along the way, based on a configured policy, detailed examination of the packet, or both. Detailed examination of the packet is expected to occur closer to the edge of the network, so that the core switches and routers are not overloaded with this task.

Switches and routers along the path can use the class information to limit the amount of resources allocated per traffic class. The behavior of an individual device when handling traffic in the Diff-Serv architecture is called per-hop behavior. If all devices along a path provide a consistent per-hop behavior, you can construct an end-to-end QoS solution.

Implementing QoS in your network can be a simple task or complex task and depends on the QoS features offered by your internetworking devices, the traffic types and patterns in your network, and the granularity of control that you need over incoming and outgoing traffic.

Packet Classification

Packet classification is the process of identifying a packet as belonging to one of several classes in a defined policy, based on certain criteria. The Modular QoS CLI (MQC) is a policy-class based language. The policy class language is used to define the following:

- Class-map template with one or several match criteria
- Policy-map template with one or several classes associated to the policy map

The policy map template is then associated to one or several interfaces on the switch.

Packet classification is the process of identifying a packet as belonging to one of the classes defined in the policy map. The process of classification will exit when the packet being processed matches a specific filter in a class. This is referred to as first-match exit. In other words, if a packet matches multiple classes in a policy, irrespective of the order of classes in the policy map, it would still exit the classification process after matching the first class.

If a packet does not match any of the classes in the policy, it would be classified into the default class in the policy. Every policy map has a default class, which is a system defined class to match packets that do not match any of the user-defined classes.

Packet classification can be categorized into the following types:

- Classification based on information that is propagated with the packet
- Classification based on information that is switch specific
- Hierarchical classification

Classification Based on Information That is Propagated with the Packet

Classification that is based on information that is part of the packet and propagated either end-to-end or between hops, typically includes the following:

- Classification based on Layer 3 or 4 headers
- Classification based on Layer 2 information

Classification Based on Layer 3 or Layer 4 Header

This is the most common deployment scenario. Numerous fields in the Layer 3 and Layer 4 headers can be used for packet classification.

At the most granular level, this classification methodology can be used to match an entire flow. For this deployment type, an access control list (ACLs) can be used. ACLs can also be used to match based on various subsets of the flow (for example, source IP address only, or destination IP address only, or a combination of both).

Classification can also be done based on the precedence or DSCP values in the IP header. The IP precedence field is used to indicate the relative priority with which a particular packet needs to be handled. It is made up of three bits in the IP header's type of service (ToS) byte.

The following table shows the different IP Precedence bit values and their names:

Note IP Precedence is not supported for wireless QoS.

Table 2: IP Precedence Values and Names

IP Precedence Value	IP Precedence Bits	IP Precedence Names
0	000	Routine
1	001	Priority
2	010	Immediate
3	011	Flash
4	100	Flash Override
5	101	Critical
6	110	Internetwork control
7	111	Network control

Note All routing control traffic in the network uses IP Precedence value 6 by default. IP Precedence value 7 also is reserved for network control traffic. Therefore, the use of IP Precedence values 6 and 7 is not recommended for user traffic.

The DSCP field is made up of 6 bits in the IP header and is being standardized by the Internet Engineering Task Force (IETF) Differentiated Services Working Group. The original ToS byte contained the DSCP bits has been renamed the DSCP byte. The DSCP field is part of the IP header, similar to IP Precedence. In fact, the DSCP field is a super set of the IP Precedence field. Therefore, the DSCP field is used and is set in ways similar to what was described with respect to IP Precedence.

Note The DSCP field definition is backward-compatible with the IP Precedence values.

Classification Based on Layer 2 Header

A variety of methods can be used to perform classification based on the Layer 2 header information. The most common methods include the following:

- MAC address-based classification (only for access groups)—Classification is based upon the source MAC address (for policies in the input direction) and destination MAC address (for policies in the output direction).
- Class-of-Service—Classification is based on the 3 bits in the Layer 2 header based on the IEEE 802.1p standard. This usually maps to the ToS byte in the IP header.
- VLAN ID—Classification is based on the VLAN ID of the packet.

Note Some of these fields in the Layer 2 header can also be set using a policy.

Classification Based on Information that is Device Specific (QoS Groups)

The switch also provides classification mechanisms that are available where classification is not based on information in the packet header or payload.

At times there may be a requirement to aggregate traffic coming from multiple input interfaces into a specific class in the output interface. For example, there could be multiple customer edge routers going into the same access switch on different interfaces. The service provider might want to police all the aggregate voice traffic going into the core to a specific rate. However, the voice traffic coming in from the different customers could have a different ToS settings. QoS group-based classification is a feature that is useful in these scenarios.

Policies configured on the input interfaces would set the QoS group to a specific value, which can then be used to classify packets in the policy enabled on output interface.

The QoS group is a field in the packet data structure internal to the switch. It is important to note that a QoS group is an internal label to the switch and is not part of the packet header.

Hierarchical Classification

The switch permits you to perform a classification based on other classes. Typically, this action may be required when there is a need to combine the classification mechanisms (that is, filters) from two or more classes into a single class map.

QoS Wired Model

To implement QoS, the switch must perform the following tasks:

- Traffic classification—Distinguishes packets or flows from one another.
- Traffic marking and policing—Assigns a label to indicate the given quality of service as the packets move through the switch, and then make the packets comply with the configured resource usage limits.

- Queuing and scheduling—Provides different treatment in all situations where resource contention exists.
- Shaping—Ensures that traffic sent from the switch meets a specific traffic profile.

Ingress Port Activity

The following activities occur at the ingress port of the switch:

- Classification—Classifying a distinct path for a packet by associating it with a QoS label. For example, the switch maps the CoS or DSCP in the packet to a QoS label to distinguish one type of traffic from another. The QoS label that is generated identifies all future QoS actions to be performed on this packet.
- Policing—Policing determines whether a packet is in or out of profile by comparing the rate of the incoming traffic to the configured policer. The policer limits the bandwidth consumed by a flow of traffic. The result is passed to the marker.
- Marking—Marking evaluates the policer and configuration information for the action to be taken when a packet is out of profile and determines what to do with the packet (pass through a packet without modification, mark down the QoS label in the packet, or drop the packet).

Note Applying polices on the wireless ingress port is not supported on the switch.

Egress Port Activity

The following activities occur at the egress port of the switch:

- Policing—Policing determines whether a packet is in or out of profile by comparing the rate of the incoming traffic to the configured policer. The policer limits the bandwidth consumed by a flow of traffic. The result is passed to the marker.
- Marking—Marking evaluates the policer and configuration information for the action to be taken when a packet is out of profile and determines what to do with the packet (pass through a packet without modification, mark down the QoS label in the packet, or drop the packet).
- Queueing—Queueing evaluates the QoS packet label and the corresponding DSCP or CoS value before selecting which of the egress queues to use. Because congestion can occur when multiple ingress ports simultaneously send data to an egress port, Weighted Tail Drop (WTD) differentiates traffic classes and subjects the packets to different thresholds based on the QoS label. If the threshold is exceeded, the packet is dropped.

Classification

Classification is the process of distinguishing one kind of traffic from another by examining the fields in the packet. Classification is enabled only if QoS is enabled on the switch. By default, QoS is enabled on the switch.

During classification, the switch performs a lookup and assigns a QoS label to the packet. The QoS label identifies all QoS actions to be performed on the packet and from which queue the packet is sent.

Access Control Lists

You can use IP standard, IP extended, or Layer 2 MAC ACLs to define a group of packets with the same characteristics (class). You can also classify IP traffic based on IPv6 ACLs.

In the QoS context, the permit and deny actions in the access control entries (ACEs) have different meanings from security ACLs:

- If a match with a permit action is encountered (first-match principle), the specified QoS-related action is taken.
- If a match with a deny action is encountered, the ACL being processed is skipped, and the next ACL is processed.
- If no match with a permit action is encountered and all the ACEs have been examined, no QoS processing occurs on the packet, and the switch offers best-effort service to the packet.
- If multiple ACLs are configured on a port, the lookup stops after the packet matches the first ACL with a permit action, and QoS processing begins.

Note When creating an access list, note that by default the end of the access list contains an implicit deny statement for everything if it did not find a match before reaching the end.

After a traffic class has been defined with the ACL, you can attach a policy to it. A policy might contain multiple classes with actions specified for each one of them. A policy might include commands to classify the class as a particular aggregate (for example, assign a DSCP) or rate-limit the class. This policy is then attached to a particular port on which it becomes effective.

You implement IP ACLs to classify IP traffic by using the **access-list** global configuration command; you implement Layer 2 MAC ACLs to classify non-IP traffic by using the **mac access-list extended** global configuration command.

Class Maps

A class map is a mechanism that you use to name a specific traffic flow (or class) and isolate it from all other traffic. The class map defines the criteria used to match against a specific traffic flow to further classify it. The criteria can include matching the access group defined by the ACL or matching a specific list of DSCP or IP precedence values. If you have more than one type of traffic that you want to classify, you can create another class map and use a different name. After a packet is matched against the class-map criteria, you further classify it through the use of a policy map.

You create a class map by using the **class-map** global configuration command or the **class** policy-map configuration command. You should use the **class-map** command when the map is shared among many ports. When you enter the **class-map** command, the switch enters the class-map configuration mode. In this mode, you define the match criterion for the traffic by using the **match** class-map configuration command.

You can create a default class by using the **class class-default** policy-map configuration command. The default class is system-defined and cannot be configured. Unclassified traffic (traffic that does not meet the match criteria specified in the traffic classes) is treated as default traffic.

Related Topics

Creating a Traffic Class, on page 28

Examples: Classification by Access Control Lists, on page 71

Policy Maps

A policy map specifies which traffic class to act on. Actions can include the following:

- Setting a specific DSCP or IP precedence value in the traffic class
- Setting a CoS value in the traffic class
- Setting a QoS group
- Setting a wireless LAN (WLAN) value in the traffic class
- Specifying the traffic bandwidth limitations and the action to take when the traffic is out of profile

Before a policy map can be effective, you must attach it to a port.

You create and name a policy map using the **policy-map** global configuration command. When you enter this command, the switch enters the policy-map configuration mode. In this mode, you specify the actions to take on a specific traffic class by using the **class** or **set** policy-map configuration and policy-map class configuration commands.

The policy map can also be configured using the **police** and **bandwidth** policy-map class configuration commands, which define the policer, the bandwidth limitations of the traffic, and the action to take if the limits are exceeded. In addition, the policy-map can further be configured using the **priority** policy-map class configuration command, to schedule priority for the class or the queueing policy-map class configuration commands, **queue-buffers** and **queue-limit**.

To enable the policy map, you attach it to a port by using the **service-policy** interface configuration command.

Related Topics

Creating a Traffic Policy, on page 31

Policy Map on Physical Port

You can configure a nonhierarchical policy map on a physical port that specifies which traffic class to act on. Actions can include setting a specific DSCP or IP precedence value in the traffic class, specifying the traffic bandwidth limitations for each matched traffic class (policer), and taking action when the traffic is out of profile (marking).

A policy map also has these characteristics:

- A policy map can contain multiple class statements, each with different match criteria and policers.
- A policy map can contain a predefined default traffic class explicitly placed at the end of the map.

  When you configure a default traffic class by using the **class class-default** policy-map configuration command, unclassified traffic (traffic that does not meet the match criteria specified in the traffic classes) is treated as the default traffic class (**class-default**).
- A separate policy-map class can exist for each type of traffic received through a port.

Related Topics

Attaching a Traffic Policy to an Interface, on page 40

Policy Map on VLANs

The switch supports a VLAN QoS feature that allows the user to perform QoS treatment at the VLAN level (classification and QoS actions) using the incoming frame's VLAN information. In VLAN-based QoS, a service policy is applied to an SVI interface. All physical interfaces belonging to a VLAN policy map then need to be programmed to refer to the VLAN-based policy maps instead of the port-based policy map.

Although the policy map is applied to the VLAN SVI, any policing (rate-limiting) action can only be performed on a per-port basis. You cannot configure the policer to take account of the sum of traffic from a number of physical ports. Each port needs to have a separate policer governing the traffic coming into that port.

Related Topics

Classifying, Policing, and Marking Traffic on SVIs by Using Policy Maps, on page 45

Examples: Policer VLAN Configuration, on page 77

Policing

After a packet is classified and has a DSCP-based, CoS-based, or QoS-group label assigned to it, the policing and marking process can begin.

Policing involves creating a policer that specifies the bandwidth limits for the traffic. Packets that exceed the limits are *out of profile* or *nonconforming*. Each policer decides on a packet-by-packet basis whether the packet is in or out of profile and specifies the actions on the packet. These actions, carried out by the marker, include passing through the packet without modification, dropping the packet, or modifying (marking down) the assigned DSCP or CoS value of the packet and allowing the packet to pass through.

Marked-down packets use the same queues as the original QoS label to prevent packets in a flow from getting out of order.

Note All traffic, regardless of whether it is bridged or routed, is subjected to a policer, if one is configured. As a result, bridged packets might be dropped or might have their DSCP or CoS fields modified when they are policed and marked.

You can configure policing on a physical port or an SVI.

After you configure the policy map and policing actions, attach the policy to an ingress port or SVI by using the **service-policy** interface configuration command.

Related Topics

Configuring Police, on page 57

Examples: Policing Action Configuration, on page 77

Token-Bucket Algorithm

Policing uses a token-bucket algorithm. As each frame is received by the switch, a token is added to the bucket. The bucket has a hole in it and leaks at a rate that you specify as the average traffic rate in bits per second. Each time a token is added to the bucket, the switch verifies that there is enough room in the bucket. If there is not enough room, the packet is marked as nonconforming, and the specified policer action is taken (dropped or marked down).

How quickly the bucket fills is a function of the bucket depth (burst-byte), the rate at which the tokens are removed (rate-bps), and the duration of the burst above the average rate. The size of the bucket imposes an upper limit on the burst length and limits the number of frames that can be transmitted back-to-back. If the burst is short, the bucket does not overflow, and no action is taken against the traffic flow. However, if a burst is long and at a higher rate, the bucket overflows, and the policing actions are taken against the frames in that burst.

You configure the bucket depth (the maximum burst that is tolerated before the bucket overflows) by using the burst-byte option of the **police** policy-map class configuration command. You configure how fast (the average rate) that the tokens are removed from the bucket by using the rate option of the **police** policy-map class configuration command.

Related Topics

Configuring Police, on page 57

Examples: Policing Units, on page 78

Marking

Marking is used to convey specific information to a downstream device in the network, or to carry information from one interface in a switch to another.

Marking can be used to set certain field/bits in the packet headers, or marking can also be used to set certain fields in the packet structure that is internal to the switch. Additionally, the marking feature can be used to define mapping between fields. The following marking methods are available for QoS:

- Packet header
- Device (switch) specific information
- Table maps

Packet Header Marking

Marking on fields in the packet header can be classified into two general categories:

- IPv4/v6 header bit marking
- Layer 2 header bit marking

The marking feature at the IP level is used to set the precedence or the DSCP in the IP header to a specific value to get a specific per-hop behavior at the downstream device (switch or router), or it can also be used to aggregate traffic from different input interfaces into a single class in the output interface. The functionality is currently supported on both the IPv4 and IPv6 headers.

Marking in the Layer 2 headers is typically used to influence dropping behavior in the downstream devices (switch or router). It works in tandem with the match on the Layer 2 headers. The bits in the Layer 2 header that can be set using a policy map are class of service.

Switch Specific Information Marking

This form of marking includes marking of fields in the packet data structure that are not part of the packets header, so that the marking can be used later in the data path. This is not propagated between the switches. Marking of QoS-group falls into this category. This form of marking is only supported in policies that are enabled on the input interfaces. The corresponding matching mechanism can be enabled on the output interfaces on the same switch and an appropriate QoS action can be applied.

Table Map Marking

Table map marking enables the mapping and conversion from one field to another using a conversion table. This conversion table is called a table map.

Depending upon the table map attached to an interface, CoS, DSCP, and UP values (UP specific to wireless packets) of the packet are rewritten. The switch allows configuring both ingress table map policies and egress table map policies.

Note The switch stack supports a total of 14 table maps. Only one table map is supported per wired port per direction .

As an example, a table map can be used to map the Layer 2 CoS setting to a precedence value in Layer 3. This feature enables combining multiple **set** commands into a single table, which indicates the method to perform the mapping. This table can be referenced in multiple policies, or multiple times in the same policy.

The following table shows the currently supported forms of mapping:

Table 3: Packet-Marking Types for Which a To-From Relationship Can Be Established

The "To" Packet-Marking Type	The "From" Packet-Marking Type
Precedence	CoS
Precedence	QoS Group
DSCP	CoS
DSCP	QoS Group
CoS	Precedence
CoS	DSCP
QoS Group	Precedence
QoS Group	DSCP

A table map-based policy supports the following capabilities:

- Mutation—You can have a table map that maps from one DSCP value set to another DSCP value set and this can be attached to an egress port.
- Rewrite—Packets coming in are rewritten depending upon the configured table map.
- Mapping—Table map based policies can be used instead of set policies.

The following steps are required for table map marking:

1. Define the table map—Use the **table-map** global configuration command to map the values. The table does not know of the policies or classes within which it will be used. The default command in the table map is used to indicate the value to be copied into the 'to' field when there is no matching 'from' field.
2. Define the policy map—You must define the policy map where the table map will be used.
3. Associate the policy to an interface.

Note A table map policy on an input port changes the trust setting of that port to "from" type of qos-marking.

Related Topics

Configuring Table Maps, on page 49

Examples: Table Map Marking Configuration, on page 79

Traffic Conditioning

To support QoS in a network, traffic entering the service provider network needs to be policed on the network boundary routers to ensure that the traffic rate stays within the service limit. Even if a few routers at the network boundary start sending more traffic than what the network core is provisioned to handle, the increased traffic load leads to network congestion. The degraded performance in the network makes it difficult to deliver QoS for all the network traffic.

Traffic policing functions (using the police feature) and shaping functions (using the traffic shaping feature) manage the traffic rate, but differ in how they treat traffic when tokens are exhausted. The concept of tokens comes from the token bucket scheme, a traffic metering function.

Note When running QoS tests on network traffic, you may see different results for the shaper and policing data. Network traffic data from shaping provides more accurate results.

This table compares the policing and shaping functions.

Table 4: Comparison Between Policing and Shaping Functions

Policing Function	Shaping Function
Sends conforming traffic up to the line rate and allows bursts.	Smooths traffic and sends it out at a constant rate.

Policing Function	Shaping Function
When tokens are exhausted, action is taken immediately.	When tokens are exhausted, it buffers packets and sends them out later, when tokens are available. A class with shaping has a queue associated with it which will be used to buffer the packets.
Policing has multiple units of configuration – in bits per second, packets per second and cells per second.	Shaping has only one unit of configuration - in bits per second.
Policing has multiple possible actions associated with an event, marking and dropping being example of such actions.	Shaping does not have the provision to mark packets that do not meet the profile.
Works for both input and output traffic.	Implemented for output traffic only.
Transmission Control Protocol (TCP) detects the line at line speed but adapts to the configured rate when a packet drop occurs by lowering its window size.	TCP can detect that it has a lower speed line and adapt its retransmission timer accordingly. This results in less scope of retransmissions and is TCP-friendly.

Policing

The QoS policing feature is used to impose a maximum rate on a traffic class. The QoS policing feature can also be used with the priority feature to restrict priority traffic. If the rate is exceeded, then a specific action is taken as soon as the event occurs. The rate (committed information rate [CIR] and peak information rate [PIR]) and the burst parameters (conformed burst size [B_c] and extended burst size [B_e]) are all configured in bytes per second.

The following policing forms or policers are supported for QoS:

- Single-rate two-color policing
- Dual-rate three-color policing

Single-Rate Two-Color Policing

Single-rate two-color policer is the mode in which you configure only a CIR and a B_c.

The B_c is an optional parameter, and if it is not specified it is computed by default. In this mode, when an incoming packet has enough tokens available, the packet is considered to be conforming. If at the time of packet arrival, enough tokens are not available within the bounds of B_c, the packet is considered to have exceeded the configured rate.

Note For information about the token-bucket algorithm, see Token-Bucket Algorithm, on page 15.

Related Topics

Configuring Police, on page 57

Examples: Single-Rate Two-Color Policing Configuration, on page 78

Dual-Rate Three-Color Policing

Within the dual rate policer, there are two possible modes:

- Color-blind mode
- Color-aware mode

In both modes, you configure a committed information rate (CIR) and a peak information rate (PIR). As the name suggests, there are two token buckets in this case, one for the peak rate, and one for the conformed rate.

Note For information about the token-bucket algorithm, see Token-Bucket Algorithm, on page 15.

In the color-blind mode, the incoming packet is first checked against the peak rate bucket. If there are not enough tokens available, the packets is said to violate the rate. If there are enough tokens available, then the tokens in the conformed rate buckets are checked to determine if there are enough tokens available. The tokens in the peak rate bucket are decremented by the size of the packet. If it does not have enough tokens available, the packet is said to have exceeded the configured rate. If there are enough tokens available, then the packet is said to conform, and the tokens in both the buckets are decremented by the size of the packet.

In the color-aware mode, as already mentioned, the incoming packets have already colored into conform, exceed, and violate classes. The algorithm used by the color aware policer as described below for a packet of size B.

1. If the packet belongs to the violate-class, then apply the violate action.
2. Compare the packet size against the number of tokens in the peak rate bucket:
   - If the packet size is more than the number of tokens, then apply the violate action.
   - If the packet size is less than the number of tokens, then go to step 3.
3. If the packet is marked as exceeded, decrement the token in the peak rate bucket by the size of the packet, then apply the exceed action.
4. Compare the packet size against the number of tokens in the conform rate bucket.
   - If the packet size is more than the number of tokens, decrement the token in the peak rate bucket by the size of the packet, then apply the exceed action.
   - If the packet size is less than the number of tokens, then go to step 5.
5. Decrement the number of tokens in the conform bucket by the size of the packet and then apply the conform action.

The rate at which tokens are replenished depends on the packet arrival. Assume that a packet comes in at time T1 and the next one comes in at time T2. The time interval between T1 and T2 determines the number of tokens that need to be added to the token bucket. This is calculated as:

Time interval between packets (T2-T1) * CIR)/8 bytes

Related Topics

Configuring Police, on page 57

Examples: Dual-Rate Three-Color Policing Configuration, on page 79

Shaping

Shaping is the process of imposing a maximum rate of traffic, while regulating the traffic rate in such a way that the downstream switches and routers are not subjected to congestion. Shaping in the most common form is used to limit the traffic sent from a physical or logical interface.

Shaping has a buffer associated with it that ensures that packets which do not have enough tokens are buffered as opposed to being immediately dropped. The number of buffers available to the subset of traffic being shaped is limited and is computed based on a variety of factors. The number of buffers available can also be tuned using specific QoS commands. Packets are buffered as buffers are available, beyond which they are dropped.

Class-based Traffic Shaping

The switch uses class-based traffic shaping. This shaping feature is enabled on a class in a policy that is associated to an interface. A class that has shaping configured is allocated a number of buffers to hold the packets that do not have tokens. The buffered packets are sent out from the class using FIFO. In the most common form of usage, class based shaping is used to impose a maximum rate for an physical interface or logical interface as a whole. The following shaping forms are supported in a class:

- Average rate shaping
- Hierarchical shaping

Shaping is implemented using a token bucket. The values of CIR, B_c and B_e determine the rate at which the packets are sent out and the rate at which the tokens are replenished.

Note For information about the token-bucket algorithm, see Token-Bucket Algorithm, on page 15.

Average Rate Shaping

You use the **shape average** policy-map class command to configure average rate shaping.

This command configures a maximum bandwidth for a particular class. The queue bandwidth is restricted to this value even though the port has more bandwidth available. The switch supports configuring shape average by either a percentage or by a target bit rate value.

Related Topics

Configuring Shaping, on page 67

Examples: Average Rate Shaping Configuration, on page 75

Hierarchical Shaping

Shaping can also be configured at multiple levels in a hierarchy. This is accomplished by creating a parent policy with shaping configured, and then attaching child policies with additional shaping configurations to the parent policy.

There are two supported types of hierarchical shaping:

- Port shaper
- User-configured shaping

The port shaper uses the class default and the only action permitted in the parent is shaping. The queueing action is in the child with the port shaper. With the user configured shaping, you cannot have queueing action in the child.

Related Topics

Configuring Shaping, on page 67

Queueing and Scheduling

The switch uses both queueing and scheduling to help prevent traffic congestion. The switch supports the following queueing and scheduling features:

- Bandwidth
- Weighted Tail Drop
- Priority queues
- Queue buffers

Bandwidth

The switch supports the following bandwidth configurations:

- Bandwidth percent
- Bandwidth remaining ratio

Related Topics

Configuring Bandwidth, on page 55

Bandwidth Percent

You can use the **bandwidth percent** policy-map class command to allocate a minimum bandwidth to a particular class. The total sum cannot exceed 100 percent and in case the total sum is less than 100 percent, then the rest of the bandwidth is divided equally among all bandwidth queues.

Note A queue can oversubscribe bandwidth in case the other queues do not utilize the entire port bandwidth.

You cannot mix bandwidth types on a policy map. For example, you cannot configure bandwidth in a single policy map using both a bandwidth percent and in kilobits per second.

Bandwidth Remaining Ratio

You use the **bandwidth remaining ratio** policy-map class command, to create a ratio for sharing unused bandwidth in specified queues. Any unused bandwidth will be used by these specific queues in the ratio that is specified by the configuration. Use this command when the **priority** command is also used for certain queues in the policy.

When you assign ratios, the queues will be assigned certain weights which are inline with these ratios.

You can specify ratios using a range from 0 to 100. For example you can configure a bandwidth remaining ration of 2 on one class, and another queue with a bandwidth remaining ratio of 4 on another class. The bandwidth remaining ratio of 2 will be scheduled twice as often as the bandwidth remaining ratio of 4.

The total bandwidth ratio allocation for the policy can exceed 100. For example, you can configure a queue with a bandwidth remaining ratio of 50, and another queue with a bandwidth remaining ratio of 100.

Weighted Tail Drop

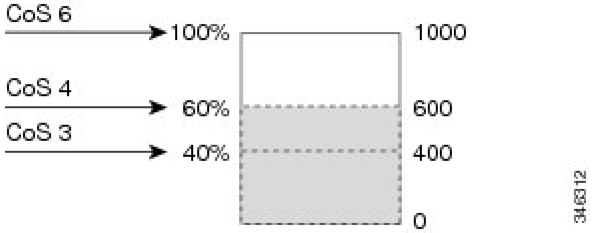
The switch egress queues use an enhanced version of the tail-drop congestion-avoidance mechanism called weighted tail drop (WTD). WTD is implemented on queues to manage the queue lengths and to provide drop precedences for different traffic classifications.

As a frame is enqueued to a particular queue, WTD uses the frame's assigned QoS label to subject it to different thresholds. If the threshold is exceeded for that QoS label (the space available in the destination queue is less than the size of the frame), the switch drops the frame.

Each queue has three configurable threshold values. The QoS label determines which of the three threshold values is subjected to the frame.

The following figure shows an example of WTD operating on a queue whose size is 1000 frames. Three drop percentages are configured: 40 percent (400 frames), 60 percent (600 frames), and 100 percent (1000 frames). These percentages indicate that up to 400 frames can be queued at the 40-percent threshold, up to 600 frames at the 60-percent threshold, and up to 1000 frames at the 100-percent threshold.

Figure 2: WTD and Queue Operation



In the example, CoS value 6 has a greater importance than the other CoS values, and is assigned to the 100-percent drop threshold (queue-full state). CoS values 4 is assigned to the 60-percent threshold, and CoS values 3 is assigned to the 40-percent threshold. All of these threshold values are assigned using the **queue-limit cos** command.

Assuming the queue is already filled with 600 frames, and a new frame arrives. It contains CoS value 4 and is subjected to the 60-percent threshold. If this frame is added to the queue, the threshold will be exceeded, so the switch drops it.

Related Topics

Configuring Queue Limits, on page 64

Examples: Queue-limit Configuration, on page 75

Weighted Tail Drop Default Values

The following are the Weighted Tail Drop (WTD) default values and the rules for configuring WTD threshold values.

- If you configure less than three queue-limit percentages for WTD, then WTD default values are assigned to these thresholds.

  The following are the WTD threshold default values:

  Table 5: WTD Threshold Default Values

Threshold	Default Value Percentage
0	80
1	90
2	400

- If 3 different WTD thresholds are configured, then the queues are programmed as configured.
- If 2 WTD thresholds are configured, then the maximum value percentage will be 400.
- If a WTD single threshold is configured as x, then the maximum value percentage will be 400.
  - If the value of x is less than 90, then threshold1=90 and threshold 0= x.
  - If the value of x equals 90, then threshold1=90, threshold 0=80.
  - If the value x is greater than 90, then threshold1=x, threshold 0=80.

Priority Queues

Each port supports eight egress queues, of which two can be given a priority.

You use the **priority level** policy class-map command to configure the priority for two classes. One of the classes has to be configured with a priority queue level 1, and the other class has to be configured with a priority queue level 2. Packets on these two queues are subjected to less latency with respect to other queues.

Related Topics

Configuring Priority, on page 59

Queue Buffer

Each 1-Gigabit port on the switch is allocated 168 buffers. Each 10-Gigabit port is allocated 1800 buffers. At boot time, when there is no policy map enabled on the wired port, there are two queues created by default. Wired ports can have a maximum of 8 queues configured using MQC-based policies. The following table shows which packets go into which one of the queues:

Table 6: DSCP, Precedence, and CoS - Queue Threshold Mapping Table

DSCP, Precedence or CoS	Queue	Threshold
Control Packets	0	1
Rest of Packets	1	2

Note You can guarantee the availability of buffers, set drop thresholds, and configure the maximum memory allocation for a queue. You use the **queue-buffers** policy-map class command to configure the queue buffers. You use the **queue-limit** policy-map class command to configure the maximum thresholds.

There are two types of buffer allocations: hard buffers, which are explicitly reserved for the queue, and soft buffers, which are available for other ports when unused by a given port. By default, Queue 0 will be given 40 percent of the buffers that are available for the interface as hard buffers, that is 67 buffers are allocated for Queue 0 in the context of 1-Gigabit ports, and 720 buffers in the context of 10-Gigabit ports. The soft maximum for this queue is set to 268 (calculated as 67 * 400/100) for 1-Gigabit ports and 2880 for 10-Gigabit ports, where 400 is the default maximum threshold that is configured for any queue.

Queue 1 does not have any hard buffers allocated. The default soft buffer limit is set to 400 (which the maximum threshold). The threshold would determine the maximum number of soft buffers that can be borrowed from the common pool.

Queue Buffer Allocation

The buffer allocation to any queue can be tuned using the **queue-buffers ratio** policy-map class configuration command.

Related Topics

Configuring Queue Buffers, on page 62

Examples: Queue Buffers Configuration, on page 76

Dynamic Threshold and Scaling

Traditionally, reserved buffers are statically allocated for each queue. No matter whether the queue is active or not, its buffers are held up by the queue. In addition, as the number of queues increases, the portion of the reserved buffers allocated for each queue can become smaller and smaller. Eventually, a situation may occur where there are not enough reserved buffers to support a jumbo frame for all queues.

The switch supports Dynamic Thresholding and Scaling (DTS), which is a feature that provides a fair and efficient allocation of buffer resources. When congestion occurs, this DTS mechanism provides an elastic buffer allocation for the incoming data based on the occupancy of the global/port resources. Conceptually, DTS scales down the queue buffer allocation gradually as the resources are used up to leave room for other queues, and vice versa. This flexible method allows the buffers to be more efficiently and fairly utilized.

As mentioned in the previous sections, there are two limits configured on a queue—a hard limit and a soft limit.

Hard limits are not part of DTS. These buffers are available only for that queue. The sum of the hard limits should be less than the globally set up hard maximum limit. The global hard limit configured for egress queuing is currently set to 5705. In the default scenario when there are no MQC policies, configured, the 24 1-Gigabit ports would take up 24 * 67 = 1608, and the 4 10-Gigabit ports would take up 4 * 720 = 2880, for a total of 4488 buffers, allowing room for more hard buffers to be allocated based upon the configuration.

Soft limit buffers participate in the DTS process. Additionally, some of the soft buffer allocations can exceed the global soft limit allocation. The global soft limit allocation for egress queuing is currently set to 7607. The sum of the hard and soft limits add up to 13312, which in turn translates to 3.4 MB. Because the sum of the soft buffer allocations can exceed the global limit, it allows a specific queue to use a large number of buffers when the system is lightly loaded. The DTS process dynamically adjusts the per-queue allocation as the system becomes more heavily loaded.

Trust Behavior

Trust Behavior for Wired Ports

For wired ports that are connected to the switch (end points such as IP phones, laptops, cameras, telepresence units, or other devices), their DSCP, precedence, or CoS values coming in from these end points are trusted by the switch and therefore are retained in the absence of any explicit policy configuration.

The packets are enqueued to the appropriate queue per the default initial configuration.

In scenarios where the incoming packet type differs from the outgoing packet type, the trust behavior and the queuing behavior are explained in the following table. Note that the default trust mode for a wired port is DSCP based. The trust mode 'falls back' to CoS if the incoming packet is a pure Layer 2 packet. You can also change the trust setting from DSCP to CoS. This is accomplished by using an MQC policy that has a class default with a 'set cos cos table default default-cos' action, where default-cos is the name of the table map created (which only performs a default copy).

Table 7: Trust and Queueing Behavior

Incoming Packet	Outgoing Packet	Trust Behavior	Queuing Behavior
Layer 3	Layer 3	Preserve DSCP/Precedence	Based on DSCP
Layer 2	Layer 2	Not applicable	Based on CoS
Tagged	Tagged	Preserve DSCP and CoS	Based on DSCP (trust DSCP takes precedence)
Layer 3	Tagged	Preserve DSCP, CoS is set to 0	Based on DSCP

Port Security on a Trusted Boundary for Cisco IP Phones

In a typical network, you connect a Cisco IP Phone to a switch port and cascade devices that generate data packets from the back of the telephone. The Cisco IP Phone guarantees the voice quality through a shared data link by marking the CoS level of the voice packets as high priority (CoS = 5) and by marking the data packets as low priority (CoS = 0). Traffic sent from the telephone to the switch is typically marked with a tag that uses the 802.1Q header. The header contains the VLAN information and the class of service (CoS) 3-bit field, which is the priority of the packet.

For most Cisco IP Phone configurations, the traffic sent from the telephone to the switch should be trusted to ensure that voice traffic is properly prioritized over other types of traffic in the network. By using the **trust device** interface configuration command, you configure the switch port to which the telephone is connected to trust the traffic received on that port.

With the trusted setting, you also can use the trusted boundary feature to prevent misuse of a high-priority queue if a user bypasses the telephone and connects the PC directly to the switch. Without trusted boundary, the CoS labels generated by the PC are trusted by the switch (because of the trusted CoS setting). By contrast, trusted boundary uses CDP to detect the presence of a Cisco IP Phone (such as the Cisco IP Phone 7910, 7935, 7940, and 7960) on a switch port. If the telephone is not detected, the trusted boundary feature disables the trusted setting on the switch port and prevents misuse of a high-priority queue. Note that the trusted boundary feature is not effective if the PC and Cisco IP Phone are connected to a hub that is connected to the switch.

Related Topics

Configuring Trust Behavior for the Device Type, on page 51

Standard QoS Default Settings

Default Wired QoS Configuration

There are two queues configured by default on each wired interface on the switch. All control traffic traverses and is processed through queue 0. All other traffic traverses and is processed through queue 1.

DSCP Maps

All the DSCP maps, except the DSCP-to-DSCP-mutation map, are globally defined and are applied to all ports.

Default CoS-to-DSCP Map

You use the CoS-to-DSCP map to map CoS values in incoming packets to a DSCP value that QoS uses internally to represent the priority of the traffic. The following table shows the default CoS-to-DSCP map. If these values are not appropriate for your network, you need to modify them.

Table 8: Default CoS-to-DSCP Map

CoS Value	DSCP Value
0	0

CoS Value	DSCP Value
1	8
2	16
3	24
4	32
5	40
6	48
7	56

Default IP-Precedence-to-DSCP Map

You use the IP-precedence-to-DSCP map to map IP precedence values in incoming packets to a DSCP value that QoS uses internally to represent the priority of the traffic. The following table shows the default IP-precedence-to-DSCP map. If these values are not appropriate for your network, you need to modify them.

Table 9: Default IP-Precedence-to-DSCP Map

IP Precedence Value	DSCP Value
0	0
1	8
2	16
3	24
4	32
5	40
6	48
7	56

Default DSCP-to-CoS Map

You use the DSCP-to-CoS map to generate a CoS value, which is used to select one of the four egress queues. The following table shows the default DSCP-to-CoS map. If these values are not appropriate for your network, you need to modify them.

Table 10: Default DSCP-to-CoS Map

DSCP Value	CoS Value
0–7	0
8–15	1
16–23	2
24–31	3
32–39	4
40–47	5
48–55	6
56–63	7

How to Configure QoS

Configuring Class, Policy, and Table Maps

Creating a Traffic Class

To create a traffic class containing match criteria, use the **class-map** command to specify the traffic class name, and then use the following **match** commands in class-map configuration mode, as needed.

Before You Begin

All match commands specified in this configuration task are considered optional, but you must configure at least one match criterion for a class.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** {*class-map name* | **match-any** }
3. **match access-group** {*index number* | *name* }
4. **match class-map** *class-map name*
5. **match cos** *cos value*
6. **match dscp** *dscp value*
7. **match ip** {**dscp** *dscp value* | **precedence** *precedence value* }
8. **match non-client-nrt**
9. **match qos-group** *qos group value*
10. **match vlan** *vlan value*
11. **match wlan user-priority** *wlan value*
12. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**class-map** {*class-map name* | **match-any** }
	Example:
	`Switch(config)# class-map test_1000`
	`Switch(config-cmap)#`
		Enters class map configuration mode.
		• Creates a class map to be used for matching packets to the class whose name you specify.
		• If you specify **match-any**, one of the match criteria must be met for traffic entering the traffic class to be classified as part of the traffic class. This is the default.

Step 3	**match access-group** {*index number* | *name* }
	Example:
	`Switch(config-cmap)# match access-group 100`
	`Switch(config-cmap)#`
		The following parameters are available for this command:
		• access-group
		• class-map
		• cos
		• dscp
		• ip
		• non-client-nrt
		• precedence
		• qos-group

	Command or Action	Purpose
		• vlan • wlan user priority (Optional) For this example, enter the access-group ID: • Access list index (value from 1 to 2799) • Named access list

Step 4	**match class-map** *class-map name*
	Example:
	`Switch(config-cmap)# match class-map test_2000`
	`Switch(config-cmap)#`
		(Optional) Matches to another class-map name.

Step 5	**match cos** *cos value*
	Example:
	`Switch(config-cmap)# match cos 2 3 4 5`
	`Switch(config-cmap)#`
		(Optional) Matches IEEE 802.1Q or ISL class of service (user) priority values:
		• Enters up to 4 CoS values separated by spaces (0 to 7).

Step 6	**match dscp** *dscp value*
	Example:
	`Switch(config-cmap)# match dscp af11 af12`
	`Switch(config-cmap)#`
		(Optional) Matches the DSCP values in IPv4 and IPv6 packets.

Step 7	**match ip** {**dscp** *dscp value* | **precedence** *precedence value* }
	Example:
	`Switch(config-cmap)# match ip dscp af11 af12`
	`Switch(config-cmap)#`
		(Optional) Matches IP values including the following:
		• **dscp—**Matches IP DSCP (DiffServ codepoints).
		• **precedence—**Matches IP precedence (0 to 7).

Step 8	**match non-client-nrt**
	Example:
	`Switch(config-cmap)# match non-client-nrt`
	`Switch(config-cmap)#`
		(Optional) Matches non-client NRT (Non-Real-Time).
		Note This match is applicable only for policies on a wireless port. It carries all the multi-destination and AP (non-client) bound traffic.

Step 9	**match qos-group** *qos group value*
	Example:
	`Switch(config-cmap)# match qos-group 10`
	`Switch(config-cmap)#`
		(Optional) Matches QoS group value (from 0 to 31).

	Command or Action	Purpose

Step 10	**match vlan** *vlan value*
	Example:
	`Switch(config-cmap)# match vlan 210`
	`Switch(config-cmap)#`
		(Optional) Matches a VLAN ID (from 1 to 4095).

Step 11	**match wlan user-priority** *wlan value*
	Example:
	`Switch(config-cmap)# match wlan user priority 7`
	`Switch(config-cmap)#`
		(Optional) Matches 802.11 specific values. Enter the user priority 802.11 TID user priority (0 to 7).

Step 12	**end**
	Example:
	`Switch(config-cmap)# end`
		Saves the configuration changes.

What to Do Next

Configure the policy map.

Related Topics

Class Maps, on page 12

Examples: Classification by Access Control Lists, on page 71

Creating a Traffic Policy

To create a traffic policy, use the **policy-map** global configuration command to specify the traffic policy name.

The traffic class is associated with the traffic policy when the **class** command is used. The **class** command must be issued after you enter the policy map configuration mode. After entering the **class** command, the switch is automatically in policy map class configuration mode, which is where the QoS policies for the traffic policy are defined.

The following policy map class-actions are supported:

- admit—Admits the request for Call Admission Control (CAC).
- bandwidth—Bandwidth configuration options.
- exit—Exits from the QoS class action configuration mode.
- no—Negates or sets default values for the command.

- police—Policer configuration options.
- priority—Strict scheduling priority configuration options for this class.
- queue-buffers—Queue buffer configuration options.
- queue-limit—Queue maximum threshold for Weighted Tail Drop (WTD) configuration options.
- service-policy—Configures the QoS service policy.
- set—Sets QoS values using the following options:
    - CoS values
    - DSCP values
    - Precedence values
    - QoS group values
    - WLAN values
- shape—Traffic shaping configuration options.

Before You Begin

You should have first created a class-map.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy-map name*
3. **class** {*class-name* | **class-default** }
4. **admit**
5. **bandwidth** {**kb/s** *kb/s value* | **percent** *percentage* | **remaining** {*percent* | *ratio* }}
6. **exit**
7. **no**
8. **police** {*target_bit_rate* | **cir** | **rate** }
9. **priority** {*kb/s* | **level** *level value* | **percent** *percentage value* }
10. **queue-buffers ratio** *ratio limit*
11. **queue-limit** {*packets* | **cos** | **dscp** | **percent** }
12. **service-policy** *policy-map name*
13. **set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan**}
14. **shape average** {*target _bit_rate* | **percent** }
15. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy-map name*
	Example:
	`Switch(config)# policy-map test_2000`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** {*class-name* | **class-default** }
	Example:
	`Switch(config-pmap)# class test_1000`
	`Switch(config-pmap-c)#`
		Specifies the name of the class whose policy you want to create or change.
		You can also create a system default class for unclassified packets.

Step 4	**admit**
	Example:
	`Switch(config-pmap-c)# admit cac wmm-tspec`
	`Switch(config-pmap-c)#`
		(Optional) Admits the request for Call Admission Control (CAC). For a more detailed example of this command and its usage, see Configuring Call Admission Control, on page 53.
		Note This command only configures CAC for wireless QoS.

Step 5	**bandwidth** {**kb/s** *kb/s value* | **percent** *percentage* | **remaining** {*percent* | *ratio* }}
	Example:
	`Switch(config-pmap-c)# bandwidth 50`
	`Switch(config-pmap-c)#`
		(Optional) Sets the bandwidth using one of the following:
		• **kb/s**—Kilobits per second, enter a value between 20000 and 10000000 for Kb/s.
		• **percent**—Enter the percentage of the total bandwidth to be used for this policy map.
		• **remaining**—Enter the percentage ratio of the remaining bandwidth.
		For a more detailed example of this command and its usage, see Configuring Bandwidth, on page 55.

Step 6	**exit**
	Example:
	`Switch(config-pmap-c)# exit`
	`Switch(config-pmap-c)#`
		(Optional) Exits from QoS class action configuration mode.

Step 7	**no**	(Optional) Negates the command.

	Command or Action	Purpose

	Example:
	`Switch(config-pmap-c)# no`
	`Switch(config-pmap-c)#`	

Step 8	**police** {*target_bit_rate* | **cir** | **rate** }
	Example:
	`Switch(config-pmap-c)# police 100000`
	`Switch(config-pmap-c)#`
		(Optional) Configures the policer:
		• *target_bit_rate*—Enter the bit rate per second, enter a value between 8000 and 10000000000.
		• **cir**—Committed Information Rate
		• **rate**—Specify police rate, PCR for hierarchical policies or SCR for single-level ATM 4.0 policer policies.
		For a more detailed example of this command and its usage, see Configuring Police, on page 57.

Step 9	**priority** {*kb/s* | **level** *level value* | **percent** *percentage value* }
	Example:
	`Switch(config-pmap-c)# priority percent 50`
	`Switch(config-pmap-c)#`
		(Optional) Sets the strict scheduling priority for this class. Command options include:
		• *kb/s*—Kilobits per second, enter a value between 1 and 2000000.
		• **level**—Establishes a multi-level priority queue. Enter a value (1 or 2).
		• **percent**—Enter a percent of the total bandwidth for this priority.
		For a more detailed example of this command and its usage, see Configuring Priority, on page 59.

Step 10	**queue-buffers ratio** *ratio limit*
	Example:
	`Switch(config-pmap-c)# queue-buffers ratio 10`
	`Switch(config-pmap-c)#`
		(Optional) Configures the queue buffer for the class. Enter the queue buffers ratio limit (0 to 100).
		For a more detailed example of this command and its usage, see Configuring Queue Buffers, on page 62.

Step 11	**queue-limit** {*packets* | **cos** | **dscp** | **percent** }
	Example:
	`Switch(config-pmap-c)# queue-limit cos 7 percent 50`
	`Switch(config-pmap-c)#`
		(Optional) Specifies the queue maximum threshold for the tail drop:
		• *packets*—Packets by default, enter a value between 1 to 2000000.
		• **cos**—Enter the parameters for each COS value.
		• **dscp**—Enter the parameters for each DSCP value.
		• **percent**—Enter the percentage for the threshold.
		For a more detailed example of this command and its usage, see Configuring Queue Limits, on page 64.

Step 12	**service-policy** *policy-map name*	(Optional) Configures the QoS service policy.

	Command or Action	Purpose

	Example:
	`Switch(config-pmap-c)# service-policy test_2000`
	`Switch(config-pmap-c)#`	

Step 13	**set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan**}
	Example:
	`Switch(config-pmap-c)# set cos 7`
	`Switch(config-pmap-c)#`
		(Optional) Sets the QoS values. Possible QoS configuration values include:
		• **cos**—Sets the IEEE 802.1Q/ISL class of service/user priority.
		• **dscp**—Sets DSCP in IP(v4) and IPv6 packets.
		• **ip**—Sets IP specific values.
		• **precedence**—Sets precedence in IP(v4) and IPv6 packet.
		• **qos-group**—Sets the QoS Group.
		• **wlan**—Sets the WLAN user-priority.

Step 14	**shape average** {*target _bit_rate* | **percent** }
	Example:
	`Switch(config-pmap-c) #shape average percent 50`
	`Switch(config-pmap-c) #`
		(Optional) Sets the traffic shaping. Command parameters include:
		• *target_bit_rate*—Target bit rate.
		• **percent**—Percentage of interface bandwidth for Committed Information Rate.
		For a more detailed example of this command and its usage, see Configuring Shaping, on page 67.

Step 15	**end**
	Example:
	`Switch(config-pmap-c) #end`
	`Switch(config-pmap-c) #`
		Saves the configuration changes.

What to Do Next

Configure the interface.

Related Topics

Policy Maps, on page 13

Configuring Class-Based Packet Marking

This procedure explains how to configure the following class-based packet marking features on your switch:

- CoS value
- DSCP value
- IP value
- Precedence value
- QoS group value
- WLAN value

Before You Begin

You should have created a class map and a policy map before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **set cos** { *cos value* | **cos table** *table-map name* | **dscp table** *table-map name* | **precedence table** *table-map name* | **qos-group table** *table-map name* | **wlan user-priority table** *table-map name* }
5. **set dscp** { *dscp value* | **default** | **dscp table** *table-map name* | **ef** | **precedence table** *table-map name* | **qos-group table** *table-map name* | **wlan user-priority table** *table-map name* }
6. **set ip** { **dscp** | **precedence** }
7. **set precedence** { *precedence value* | **cos table** *table-map name* | **dscp table** *table-map name* | **precedence table** *table-map name* | **qos-group table** *table-map name* }
8. **set qos-group** { *qos-group value* | **dscp table** *table-map name* | **precedence table** *table-map name* }
9. **set wlan user-priority** { *wlan user-priority value* | **cos table** *table-map name* | **dscp table** *table-map name* | **qos-group table** *table-map name* | **wlan table** *table-map name* }
10. **end**
11. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy1`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

	Command or Action	Purpose

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# ` **`class class1`**
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change.
		Command options for policy class map configuration mode include the following:
		• **admit—**Admits the request for Call Admission Control (CAC).
		• **bandwidth—**Bandwidth configuration options.
		• **exit—**Exits from the QoS class action configuration mode.
		• **no—**Negates or sets default values for the command.
		• **police—**Policer configuration options.
		• **priority—**Strict scheduling priority configuration options for this class.
		• **queue-buffers—**Queue buffer configuration options.
		• **queue-limit—**Queue maximum threshold for Weighted Tail Drop (WTD) configuration options.
		• **service-policy—**Configures the QoS service policy.
		• **set—**Sets QoS values using the following options:
		◦ CoS values
		◦ DSCP values
		◦ Precedence values
		◦ QoS group values
		◦ WLAN values
		• **shape—**Traffic shaping configuration options.
		Note This procedure describes the available configurations using **set** command options. The other command options (**admit**, **bandwidth**, etc.) are described in other sections of this guide. Although this task lists all of the possible **set** commands, only one **set** command is supported per class.

Step 4	**set cos** { *cos value* | **cos table** *table-map name* | **dscp table** *table-map name* | **precedence table** *table-map name* | **qos-group table** *table-map name* | **wlan user-priority table** *table-map name* }
	Example:
	`Switch(config-pmap)# ` **`set cos 5`**
	`Switch(config-pmap)#`
		(Optional) Sets the specific IEEE 802.1Q Layer 2 CoS value of an outgoing packet. Values are from 0 to7.
		You can also set the following values using the **set cos** command:
		• **cos table—**Sets the CoS value based on a table map.
		• **dscp table—**Sets the code point value based on a table map.
		• **precedence table—**Sets the code point value based on a table map.
		• **qos-group table—**Sets the CoS value from QoS group based on a table map.

	Command or Action	Purpose
		• **wlan user-priority table**—Sets the CoS value from the WLAN user priority based on a table map.

Step 5	**set dscp** { *dscp value* | **default** | **dscp table** *table-map name* | **ef** | **precedence table** *table-map name* | **qos-group table** *table-map name* | **wlan user-priority table** *table-map name* }
	Example:
	`Switch(config-pmap)# set dscp af11`
	`Switch(config-pmap)#`
		(Optional) Sets the DSCP value.
		In addition to setting specific DSCP values, you can also set the following using the **set dscp** command:
		• **default**—Matches packets with default DSCP value (000000).
		• **dscp table**—Sets the packet DSCP value from DSCP based on a table map.
		• **ef**—Matches packets with EF DSCP value (101110).
		• **precedence table**—Sets the packet DSCP value from precedence based on a table map.
		• **qos-group table**—Sets the packet DSCP value from a QoS group based upon a table map.
		• **wlan user-priority table**—Sets the packet DSCP value based upon a WLAN user-priority based upon a table map.

Step 6	**set ip** { **dscp** | **precedence** }
	Example:
	`Switch(config-pmap)# set ip dscp c3`
	`Switch(config-pmap)#`
		(Optional) Sets IP specific values. These values are either IP DSCP or IP precedence values.
		You can set the following values using the **set ip dscp** command:
		• *dscp value*—Sets a specific dscp value.
		• **default**—Matches packets with default DSCP value (000000).
		• **dscp table**—Sets the packet DSCP value from DSCP based on a table map.
		• **ef**—Matches packets with EF DSCP value (101110).
		• **precedence table**—Sets the packet DSCP value from precedence based on a table map.
		• **qos-group table**—Sets the packet DSCP value from a QoS group based upon a table map.
		• **wlan user-priority table**—Sets the packet DSCP value based upon a WLAN user-priority based upon a table map.
		You can set the following values using the **set ip precedence** command:
		• *precedence value*—Sets the precedence value (from 0 to 7) .
		• **cos table**—Sets the packet precedence value from Layer 2 CoS based on a table map.
		• **dscp table**—Sets the packet precedence from DSCP value based on a table map.

	Command or Action	Purpose
		• **precedence table**—Sets the precedence value from precedence based on a table map • **qos-group table**—Sets the precedence value from a QoS group based upon a table map.

Step 7	**set precedence** { *precedence value* | **cos table** *table-map name* | **dscp table** *table-map name* | **precedence table** *table-map name* | **qos-group table** *table-map name* }
	Example:
	`Switch(config-pmap)# set precedence 5`
	`Switch(config-pmap)#`
		(Optional) Sets precedence values in IPv4 and IPv6 packets.
		You can set the following values using the **set precedence** command:
		• *precedence value*—Sets the precedence value (from 0 to 7) .
		• **cos table**—Sets the packet precedence value from Layer 2 CoS on a table map.
		• **dscp table**—Sets the packet precedence from DSCP value on a table map.
		• **precedence table**—Sets the precedence value from precedence based on a table map.
		• **qos-group table**—Sets the precedence value from a QoS group based upon a table map.

Step 8	**set qos-group** { *qos-group value* | **dscp table** *table-map name* | **precedence table** *table-map name* }
	Example:
	`Switch(config-pmap)# set qos-group 10`
	`Switch(config-pmap)#`
		(Optional) Sets QoS group values. You can set the following values using this command:
		• *qos-group value*—A number from 1 to 31.
		• **dscp table**—Sets the code point value from DSCP based on a table map.
		• **precedence table**—Sets the code point value from precedence based on a table map.

Step 9	**set wlan user-priority** { *wlan user-priority value* | **cos table** *table-map name* | **dscp table** *table-map name* | **qos-group table** *table-map name* | **wlan table** *table-map name* }
	Example:
	`Switch(config-pmap)# set wlan user-priority 1`
	`Switch(config-pmap)#`
		(Optional) Sets the WLAN user priority value. You can set the following values using this command:
		• *wlan user-priority value*—A value between 0 to 7.
		• **cos table**—Sets the WLAN user priority value from CoS based on a table map.
		• **dscp table**—Sets the WLAN user priority value from DSCP based on a table map.
		• **qos-group table**—Sets the WLAN user priority value from QoS group based on a table map.
		• **wlan table**—Sets the WLAN user priority value from the WLAN user priority based on a table map.

Step 10	**end**	Saves configuration changes.

	Command or Action	Purpose

	Example:
	`Switch(config-pmap)# end`
	`Switch#`	

Step 11	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Attach the traffic policy to an interface using the **service-policy** command.

Attaching a Traffic Policy to an Interface

After the traffic class and traffic policy are created, you must use the **service-policy** interface configuration command to attach a traffic policy to an interface, and to specify the direction in which the policy should be applied (either on packets coming into the interface or packets leaving the interface).

Before You Begin

A traffic class and traffic policy must be created before attaching a traffic policy to an interface.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type*
3. **service-policy** {**input** *policy-map* | **output** *policy-map* }
4. **end**
5. **show policy map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.
Step 2	**interface** *type*	Enters interface configuration mode and configures an interface.

	Command or Action	Purpose

	Example:
	`Switch(config)# `**`interface GigabitEthernet1/0/1`**
	`Switch(config-if)#`
		Command parameters for the interface configuration include:
		• **Auto Template—** Auto-template interface
		• **Capwap—**Capwap tunnel interface
		• **GigabitEthernet—**Gigabit Ethernet IEEE 802
		• **GroupVI—**Group virtual interface
		• **Internal Interface—** Internal interface
		• **Loopback—**Loopback interface
		• **Null—**Null interface
		• **Port-channel—**Ethernet Channel of interface
		• **TenGigabitEthernet—**10-Gigabit Ethernet
		• **Tunnel—**Tunnel interface
		• **Vlan—**Catalyst VLANs
		• **Range—**interface range

Step 3	**service-policy** {**input** *policy-map* | **output** *policy-map* }
	Example:
	`Switch(config-if)# `**`service-policy output policy_map_01`**
	`Switch(config-if)#`
		Attaches a policy map to an input or output interface. This policy map is then used as the service policy for that interface.
		In this example, the traffic policy evaluates all traffic leaving that interface.

Step 4	**end**
	Example:
	`Switch(config-if)# `**`end`**
	`Switch#`
		Saves configuration changes.

Step 5	**show policy map** **Example:** `Switch# `**`show policy map`**	(Optional) Displays statistics for the policy on the specified interface.

What to Do Next

Proceed to attach any other traffic policy to an interface, and to specify the direction in which the policy should be applied.

Related Topics

Policy Map on Physical Port, on page 13

Classifying, Policing, and Marking Traffic on Physical Ports by Using Policy Maps

You can configure a nonhierarchical policy map on a physical port that specifies which traffic class to act on. Actions supported are remarking and policing.

Before You Begin

You should have already decided upon the classification, policing, and marking of your network traffic by policy maps prior to beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** {*class-map name* | **match-any** }
3. **match access-group** { *access list index* | *access list name* }
4. **policy-map** *policy-map-name*
5. **class** {*class-map-name* | **class-default**}
6. **set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan user-priority**}
7. **police** {*target_bit_rate* | **cir** | **rate** }
8. **exit**
9. **exit**
10. **interface** *interface-id*
11. **service-policy input** *policy-map-name*
12. **end**
13. **show policy-map** [*policy-map-name* [**class** *class-map-name*]]
14. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**class-map** {*class-map name* | **match-any** }
	Example:
	`Switch(config)# class-map ipclass1`
	`Switch(config-cmap)# exit`
	`Switch(config)#`
		Enters class map configuration mode.
		• Creates a class map to be used for matching packets to the class whose name you specify.
		• If you specify **match-any**, one of the match criteria must be met for traffic entering the traffic class to be classified as part of the traffic class. This is the default.

	Command or Action	Purpose

Step 3	**match access-group** { *access list index* | *access list name* }
	Example:
	`Switch(config-cmap)# `**`match access-group 1000`**
	`Switch(config-cmap)# `**`exit`**
	`Switch(config)#`
		Specifies the classification criteria to match to the class map. You can match on the following criteria:
		• **access-group—**Matches to access group.
		• **class-map—**Matches to another class map.
		• **cos—**Matches to a CoS value.
		• **dscp—**Matches to a DSCP value.
		• **ip—**Matches to a specific IP value.
		• **non-client-nrt—**Matches non-client NRT.
		• **precedence—**Matches precedence in IPv4 and IPv6 packets.
		• **qos-group—**Matches to a QoS group.
		• **vlan—**Matches to a VLAN.
		• **wlan—**Matches to a wireless LAN.

Step 4	**policy-map** *policy-map-name*
	Example:
	`Switch(config)# `**`policy-map flowit`**
	`Switch(config-pmap)#`
		Creates a policy map by entering the policy map name, and enters policy-map configuration mode.
		By default, no policy maps are defined.

Step 5	**class** {*class-map-name* | **class-default**}
	Example:
	`Switch(config-pmap)# `**`class ipclass1`**
	`Switch(config-pmap-c)#`
		Defines a traffic classification, and enter policy-map class configuration mode.
		By default, no policy map class-maps are defined.
		If a traffic class has already been defined by using the **class-map** global configuration command, specify its name for *class-map-name* in this command.
		A **class-default** traffic class is predefined and can be added to any policy. It is always placed at the end of a policy map. With an implied **match any** included in the **class-default** class, all packets that have not already matched the other traffic classes will match **class-default**.

Step 6	**set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan user-priority**}
	Example:
	`Switch(config-pmap-c)# `**`set dscp 45`**
	`Switch(config-pmap-c)#`
		(Optional) Sets the QoS values. Possible QoS configuration values include:
		• **cos—**Sets the IEEE 802.1Q/ISL class of service/user priority.
		• **dscp—**Sets DSCP in IP(v4) and IPv6 packets.
		• **ip—**Sets IP specific values.
		• **precedence—**Sets precedence in IP(v4) and IPv6 packet.
		• **qos-group—**Sets QoS group.

	Command or Action	Purpose
		• **wlan user-priority—**Sets WLAN user priority. In this example, the **set dscp** command classifies the IP traffic by setting a new DSCP value in the packet.

Step 7	**police** {*target_bit_rate* | **cir** | **rate** }
	Example:
	`Switch(config-pmap-c)# police 100000 conform-action transmit exceed-action drop`
	`Switch(config-pmap-c)#`
		(Optional) Configures the policer:
		• *target_bit_rate*—Specifies the bit rate per second, enter a value between 8000 and 10000000000.
		• **cir—**Committed Information Rate.
		• **rate—**Specifies the police rate, PCR for hierarchical policies, or SCR for single-level ATM 4.0 policer policies.
		In this example, the **police** command adds a policer to the class where any traffic beyond the 100000 set target bit rate is dropped.

Step 8	**exit** **Example:** `Switch(config-pmap-c)# exit`	Returns to policy map configuration mode.
Step 9	**exit** **Example:** `Switch(config-pmap)# exit`	Returns to global configuration mode.
Step 10	**interface** *interface-id* **Example:** `Switch(config)# interface gigabitethernet 2/0/1`	Specifies the port to attach to the policy map, and enters interface configuration mode. Valid interfaces include physical ports.
Step 11	**service-policy input** *policy-map-name* **Example:** `Switch(config-if)# service-policy input flowit`	Specifies the policy-map name, and applies it to an ingress port. Only one policy map per ingress port is supported.

Step 12	**end**
	Example:
	`Switch(config-if)# end`
		Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 13	**show policy-map** [*policy-map-name* [**class** *class-map-name*]] **Example:** `Switch# show policy-map`	(Optional) Verifies your entries.
Step 14	**copy running-config startup-config** **Example:** `Switch# copy-running-config startup-config`	(Optional) Saves your entries in the configuration file.

What to Do Next

If applicable to your QoS configuration, configure classification, policing, and marking of traffic on SVIs by using policy maps.

Classifying, Policing, and Marking Traffic on SVIs by Using Policy Maps

Before You Begin

You should have already decided upon the classification, policing, and marking of your network traffic by using policy maps prior to beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** {*class-map name* | **match-any** }
3. **match vlan** *vlan number*
4. **policy-map** *policy-map-name*
5. **description** *description*
6. **class** {*class-map-name* | **class-default**}
7. **set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan user-priority**}
8. **police** {*target_bit_rate* | **cir** | **rate** }
9. **exit**
10. **exit**
11. **interface** *interface-id*
12. **service-policy input** *policy-map-name*
13. **end**
14. **show policy-map** [*policy-map-name* [**class** *class-map-name*]]
15. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**class-map** {*class-map name* | **match-any** }
	Example:
	`Switch(config)# class-map class_vlan100`
		Enters class map configuration mode.
		• Creates a class map to be used for matching packets to the class whose name you specify.
		• If you specify **match-any**, one of the match criteria must be met for traffic entering the traffic class to be classified as part of the traffic class. This is the default.

Step 3	**match vlan** *vlan number*
	Example:
	`Switch(config-cmap)# match vlan 100`
	`Switch(config-cmap)# exit`
	`Switch(config)#`
		Specifies the VLAN to match to the class map.

	Command or Action	Purpose

Step 4	**policy-map** *policy-map-name*
	Example:
	`Switch(config)# policy-map policy_vlan100`
	`Switch(config-pmap)#`
		Creates a policy map by entering the policy map name, and enters policy-map configuration mode.
		By default, no policy maps are defined.

Step 5	**description** *description* **Example:** `Switch(config-pmap)# description vlan 100`	(Optional) Enters a description of the policy map.

Step 6	**class** {*class-map-name* | **class-default**}
	Example:
	`Switch(config-pmap)# class class_vlan100`
	`Switch(config-pmap-c)#`
		Defines a traffic classification, and enters the policy-map class configuration mode.
		By default, no policy map class-maps are defined.
		If a traffic class has already been defined by using the **class-map** global configuration command, specify its name for *class-map-name* in this command.
		A **class-default** traffic class is predefined and can be added to any policy. It is always placed at the end of a policy map. With an implied **match any** included in the **class-default** class, all packets that have not already matched the other traffic classes will match **class-default**.

Step 7	**set** {**cos** | **dscp** | **ip** | **precedence** | **qos-group** | **wlan user-priority**}
	Example:
	`Switch(config-pmap-c)# set dscp af23`
	`Switch(config-pmap-c)#`
		(Optional) Sets the QoS values. Possible QoS configuration values include:
		• **cos—**Sets the IEEE 802.1Q/ISL class of service/user priority.
		• **dscp—**Sets DSCP in IP(v4) and IPv6 packets.
		• **ip—**Sets IP specific values.
		• **precedence—**Sets precedence in IP(v4) and IPv6 packet.
		• **qos-group—**Sets QoS group.
		• **wlan user-priority—**Sets WLAN user-priority.
		In this example, the **set dscp** command classifies the IP traffic by matching the packets with a DSCP value of AF23 (010010).

Step 8	**police** {*target_bit_rate* | **cir** | **rate** }
	Example:
	`Switch(config-pmap-c)# police 200000 conform-action transmit exceed-action drop`
	`Switch(config-pmap-c)#`
		(Optional) Configures the policer:
		• *target_bit_rate*—Specifies the bit rate per second. Enter a value between 8000 and 10000000000.
		• **cir—**Committed Information Rate.
		• **rate—**Specifies the police rate, PCR for hierarchical policies, or SCR for single-level ATM 4.0 policer policies.

	Command or Action	Purpose
		In this example, the **police** command adds a policer to the class where any traffic beyond the 200000 set target bit rate is dropped.
Step 9	**exit** **Example:** `Switch(config-pmap-c)# exit`	Returns to policy map configuration mode.
Step 10	**exit** **Example:** `Switch(config-pmap)# exit`	Returns to global configuration mode.
Step 11	**interface** *interface-id* **Example:** `Switch(config)# interface gigabitethernet 1/0/3`	Specifies the port to attach to the policy map, and enters interface configuration mode. Valid interfaces include physical ports.
Step 12	**service-policy input** *policy-map-name* **Example:** `Switch(config-if)# service-policy input policy_vlan100`	Specifies the policy-map name, and applies it to an ingress port. Only one policy map per ingress port is supported.

Step 13	**end**
	Example:
	`Switch(config-if)# end`
		Returns to privileged EXEC mode.

Step 14	**show policy-map** [*policy-map-name* [**class** *class-map-name*]] **Example:** `Switch# show policy-map`	(Optional) Verifies your entries.
Step 15	**copy running-config startup-config** **Example:** `Switch# copy-running-config startup-config`	(Optional) Saves your entries in the configuration file.

Related Topics

Policy Map on VLANs, on page 14

Examples: Policer VLAN Configuration, on page 77

Configuring Table Maps

Table maps are a form of marking, and also enable the mapping and conversion of one field to another using a table. For example, a table map can be used to map and convert a Layer 2 CoS setting to a precedence value in Layer 3.

Note A table map can be referenced in multiple policies or multiple times in the same policy.

SUMMARY STEPS

1. **configure terminal**
2. **table-map** *name* { **default** {*default value* | **copy** | **ignore**} | **exit** | **map** {**from** *from value* **to** *to value* } | **no** }
3. **map from** *value* **to** *value*
4. **exit**
5. **exit**
6. **show table-map**
7. **configure terminal**
8. **policy-map**
9. **class class-default**
10. **set cos dscp table** *table map name*
11. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**table-map** *name* { **default** {*default value*	**copy**	**ignore**}	**exit**	**map** {**from** *from value* **to** *to value* }	**no** }
						Example:
						`Switch(config)# table-map table01`
							Creates a table map and enters the table map configuration mode. In table map configuration mode, you can perform the following tasks:
							• **default**—Configures the table map default value, or sets the default behavior for a value not found in the table map to copy or ignore.

	Command or Action	Purpose
	`Switch(config-tablemap)#`	• **exit**—Exits from the table map configuration mode. • **map**—Maps a *from* to a *to* value in the table map. • **no**—Negates or sets the default values of the command.

Step 3	**map from** *value* **to** *value*
	Example:
	`Switch(config-tablemap)#` **`map from 0 to 2`**
	`Switch(config-tablemap)#` **`map from 1 to 4`**
	`Switch(config-tablemap)#` **`map from 24 to 3`**
	`Switch(config-tablemap)#` **`map from 40 to 6`**
	`Switch(config-tablemap)#` **`default 0`**
	`Switch(config-tablemap)#`
		In this step, packets with DSCP values 0 are marked to the CoS value 2, DSCP value 1 to the CoS value 4, DSCP value 24 to the CoS value 3, DSCP value 40 to the CoS value 6 and all others to the CoS value 0.
		Note The mapping from CoS values to DSCP values in this example is configured by using the **set** policy map class configuration command as described in a later step in this procedure.

Step 4	**exit**
	Example:
	`Switch(config-tablemap)#` **`exit`**
	`Switch(config)#`
		Returns to global configuration mode.

Step 5	**exit**
	Example:
	`Switch(config)` **`exit`**
	`Switch#`
		Returns to privileged EXEC mode.

Step 6	**show table-map**
	Example:
	`Switch#` **`show table-map`**
	`Table Map table01`
	`    from 0 to 2`
	`    from 1 to 4`
	`    from 24 to 3`
	`    from 40 to 6`
	`    default 0`
		Displays the table map configuration.

Step 7	**configure terminal**
	Example:
	`Switch#` **`configure terminal`**
	`Switch(config)#`
		Enters global configuration mode.

Step 8	**policy-map**	Configures the policy map for the table map.

	Command or Action	Purpose

	Example:
	`Switch(config)# policy-map table-policy`
	`Switch(config-pmap)#`	

Step 9	**class class-default**
	Example:
	`Switch(config-pmap)# class  class-default`
	`Switch(config-pmap-c)#`
		Matches the class to the system default.

Step 10	**set cos dscp table** *table map name*
	Example:
	`Switch(config-pmap-c)# set cos dscp table table01`
	`Switch(config-pmap-c)#`
		If this policy is applied on input port, that port will have trust dscp enabled on that port and marking will take place depending upon the specified table map.

Step 11	**end**
	Example:
	`Switch(config-pmap-c)# end`
	`Switch#`
		Returns to privileged EXEC mode.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Table Map Marking, on page 16

Examples: Table Map Marking Configuration, on page 79

Configuring Trust

Configuring Trust Behavior for the Device Type

This procedure explains how to configure trust for one or more device classes within your network configuration.

Before You Begin

There are two types of trust behavior supported on the switch:

- Trust QoS at the policy level. You can configure trust for individual packets by creating specific policy maps and applying them on an interface. If you do not configure a specific policy map, then the default is to trust DSCP.
- Trust devices at the interface level. You can configure trust for the device using the **trust device** interface configuration command.

Note The default mode on an interface is trusted and changes to untrusted only when an untrusted device is detected. In the untrusted mode, the DSCP, IP precedence, or CoS value is reset to 0.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type*
3. **trust device** { **cisco-phone** | **cts** | **ip-camera** | **media-player** }
4. **end**
5. **show interface status**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**interface** *type*
	Example:
	`Switch(config)# interface GigabitEthernet1/0/1`
	`Switch(config-if)#`
		Enters interface configuration mode and configures an interface.
		Command parameters for the interface configuration include:
		• **Auto Template—** Auto-Template interface
		• **Capwap—**Capwap tunnel interface
		• **GigabitEthernet—**Gigabit Ethernet IEEE 802
		• **GroupVI—**Group virtual interface
		• **Internal Interface—**Internal interface
		• **Loopback—**Loopback interface
		• **Null—**Null interface
		• **Port-channel—**Ethernet Channel of interface
		• **TenGigabitEthernet—**10-Gigabit Ethernet

	Command or Action	Purpose
		• **Tunnel**—Tunnel interface • **Vlan**—Catalyst VLANs • **range**—interface range

Step 3	**trust device** { **cisco-phone** | **cts** | **ip-camera** | **media-player** }
	Example:
	`Switch(config-if)# trust device cisco-phone`
	`Switch(config-if)#`
		Configures the trust value for the interface. You can configure trust for the following supported devices:
		• **cisco-phone**—Cisco IP Phone
		• **cts**—Cisco TelePresence system
		• **ip-camera**—IPVSC
		• **media-player**—DMP

Step 4	**end**
	Example:
	`Switch(config-if)# end`
	`Switch#`
		Saves configuration changes.

Step 5	**show interface status**
	Example:
	`Switch# show interface status`
	`Switch#`
		(Optional) Displays the configured interface's status.

What to Do Next

Connect the trusted device to the appropriately configured trusted port on the switch.

Related Topics

Port Security on a Trusted Boundary for Cisco IP Phones, on page 26

Configuring QoS Features and Functionality

Configuring Call Admission Control

This task explains how to configure class-based, unconditional packet marking features on your switch for Call Admission Control (CAC).

CAC is a concept that applies to voice traffic only—not data traffic. If an influx of data traffic oversubscribes a particular link in the network, queueing, buffering, and packet drop decisions resolve the congestion. The extra traffic is simply delayed until the interface becomes available to send the traffic, or, if traffic is dropped, the protocol or the end user initiates a timeout and requests a retransmission of the information.

Network congestion cannot be resolved in this manner when real-time traffic, sensitive to both latency and packet loss, is present, without jeopardizing the quality of service (QoS) expected by the users of that traffic. For real-time delay-sensitive traffic such as voice, it is better to deny network access under congestion conditions than to allow traffic onto the network to be dropped and delayed, causing intermittent impaired QoS and resulting in customer dissatisfaction.

CAC is therefore a deterministic and informed decision that is made before a voice call is established and is based on whether the required network resources are available to provide suitable QoS for the new call.

Before You Begin

You should have created a class map for CAC before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **admit cac wmm-tspec**
5. **end**
6. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_CAC01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_CAC01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default**—System default class matching any otherwise unclassified packets.

	Command or Action	Purpose

Step 4	**admit cac wmm-tspec**
	Example:
	`Switch(config-pmap-c)# admit cac wmm-tspec`
	`Switch(config-pmap-c)#`
		Configures call admission control for the policy map.
		Note This command only configures CAC for wireless QoS.

Step 5	**end**
	Example:
	`Switch(config-pmap)# end`
	`Switch#`
		Saves configuration changes.

Step 6	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Configuring Bandwidth

This procedure explains how to configure bandwidth on your switch.

Before You Begin

You should have created a class map for bandwidth before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio* } }
5. **end**
6. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_bandwidth01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_bandwidth01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default**—System default class matching any otherwise unclassified packets.

Step 4	**bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio* } }
	Example:
	`Switch(config-pmap-c)# bandwidth 200000`
	`Switch(config-pmap-c)#`
		Configures the bandwidth for the policy map. The parameters include:
		• *Kb/s*—Configures a specific value in kilobits per second (from 20000 to 10000000).
		• **percent-**—Allocates minimum bandwidth to a particular class based on a percentage. The queue can oversubscribe bandwidth in case other queues do not utilize the entire port bandwidth. The total sum cannot exceed 100 percent, and in case it is less than 100 percent, the rest of the bandwidth is equally divided along all bandwidth queues.
		• **remaining**— Allocates minimum bandwidth to a particular class. The queue can oversubscribe bandwidth in case other queues do not utilize entire port bandwidth. The total sum cannot exceed 100 percent. It is preferred to use this command when the **priority** command is used for certain queues in the policy. You can also assign ratios rather than percentages to each queue; the queues will be assigned certain weights which are inline with these ratios. Ratios can range from 0 to 100. Total bandwidth ratio allocation for the policy in this case can exceed 100.
		Note You cannot mix bandwidth types on a policy map. For example, you cannot configure bandwidth in a single policy map using both a bandwidth percent and in kilobits per second.

Step 5	**end**	Saves configuration changes.

	Command or Action	Purpose

	Example:
	`Switch(config-pmap-c)# end`
	`Switch#`	

Step 6	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating the policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Bandwidth, on page 21

Configuring Police

This procedure explains how to configure policing on your switch.

Before You Begin

You should have created a class map for policing before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **police** { *target_bit_rate* [*burst bytes* | **bc** | **conform-action** | **pir**] | **cir** { *target_bit_rate* | **percent** *percentage* } | **rate** { *target_bit_rate* | **percent** *percentage* } **conform-action transmit exceed-action** { **drop** [**violate action**] | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **transmit** [**violate action**] } }
5. **end**
6. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_police01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_police01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default**—System default class matching any otherwise unclassified packets.

Step 4	**police** { *target_bit_rate* [*burst bytes* | **bc** | **conform-action** | **pir**] | **cir** { *target_bit_rate* | **percent** *percentage* } | **rate** { *target_bit_rate* | **percent** *percentage* } **conform-action transmit exceed-action** { **drop** [**violate action**] | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **transmit** [**violate action**] } }
	Example:
	`Switch(config-pmap-c)# police 8000 conform-action transmit exceed-action drop`
	`Switch(config-pmap-c)#`
		The following **police** subcommand options are available:
		• *target_bit_rate*—Bits per second (from 8000 to 10000000000).
		◦ *burst bytes*—Enter a value from 1000 to 512000000.
		◦ **bc**—Conform burst.
		◦ **conform-action**—Action taken when rate is less than conform burst.
		◦ **pir**—Peak Information Rate.
		• **cir**—Committed Information Rate.
		◦ *target_bit_rate*—Target bit rate (8000 to10000000000).
		◦ **percent**—Percentage of interface bandwidth for CIR.
		• **rate**—Specifies the police rate, PCR for hierarchical policies, or SCR for single-level ATM 4.0 policer policies.
		◦ *target_bit_rate*—Target Bit Rate (8000-10000000000).
		◦ **percent**—Percentage of interface bandwidth for rate.
		The following **police conform-action transmit exceed-action** subcommand options are available:

	Command or Action	Purpose
		• **drop**—Drops the packet. • **set-cos-transmit**—Sets the CoS value and sends it. • **set-dscp-transmit**—Sets the DSCP value and sends it. • **set-prec-transmit**—Rewrites the packet precedence and sends it. • **transmit**—Transmits the packet. **Note** Policer based markdown actions are only supported using table maps. Only one markdown table map is allowed for each marking field in the switch.

Step 5	**end**
	Example:
	`Switch(config-pmap-c)# end`
	`Switch#`
		Saves configuration changes.

Step 6	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Single-Rate Two-Color Policing, on page 18

Examples: Single-Rate Two-Color Policing Configuration, on page 78

Dual-Rate Three-Color Policing, on page 19

Examples: Dual-Rate Three-Color Policing Configuration, on page 79

Policing, on page 14

Examples: Policing Action Configuration, on page 77

Token-Bucket Algorithm, on page 15

Examples: Policing Units, on page 78

Configuring Priority

This procedure explains how to configure priority on your switch.

The switch supports giving priority to specified queues. There are two priority levels available (1 and 2).

Note Queues supporting voice and video should be assigned a priority level of 1.

Before You Begin

You should have created a class map for priority before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **priority** [*Kb/s* [*burst_in_bytes*] | **level** *level_value* [*Kb/s* [*burst_in_bytes*] | **percent** *percentage* [*burst_in_bytes*]] | **percent** *percentage* [*burst_in_bytes*]]
5. **end**
6. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_priority01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_priority01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default—**System default class matching any otherwise unclassified packets.

Step 4	**priority** [*Kb/s* [*burst_in_bytes*]	**level** *level_value* [*Kb/s* [*burst_in_bytes*]	**percent** *percentage* [*burst_in_bytes*]]	**percent** *percentage* [*burst_in_bytes*]]	The **priority** command assigns a strict scheduling priority for the class. The command options include: • *Kb/s*—Specifies the kilobits per second (from 1 to 2000000).

	Command or Action	Purpose

	Example:
	`Switch(config-pmap-c)# **priority level 1**`
	`Switch(config-pmap-c)#`
		◦ *burst_in_bytes*—Specifies the burst in bytes (from 32 to 2000000).
		• **level** *level_value*—Specifies the multilevel (1-2) priority queue.
		◦ *Kb/s*—Specifies the kilobits per second (from 1 to 2000000).
		◦ *burst_in_bytes*—Specifies the burst in bytes (from 32 to 2000000).
		◦ **percent**—Percentage of the total bandwidth.
		◦ *burst_in_bytes*—Specifies the burst in bytes (from 32 to 2000000).
		• **percent**—Percentage of the total bandwidth.
		◦ *burst_in_bytes*—Specifies the burst in bytes (32 to 2000000).
		Note Priority level 1 is more important than priority level 2. Priority level 1 reserves bandwidth that is processed first for QoS, so its latency is very low. Both priority level 1 and 2 reserve bandwidth.

Step 5	**end**
	Example:
	`Switch(config-pmap-c)# **end**`
	`Switch#`
		Saves configuration changes.

Step 6	**show policy-map** **Example:** `Switch# **show policy-map**`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Priority Queues, on page 23

Configuring Queues and Shaping

Configuring Egress Queue Characteristics

Depending on the complexity of your network and your QoS solution, you may need to perform all of the procedures in this section. You need to make decisions about these characteristics:

- Which packets are mapped by DSCP, CoS, or QoS group value to each queue and threshold ID?
- What drop percentage thresholds apply to the queues, and how much reserved and maximum memory is needed for the traffic type?
- How much of the fixed buffer space is allocated to the queues?
- Does the bandwidth of the port need to be rate limited?
- How often should the egress queues be serviced and which technique (shaped, shared, or both) should be used?

Note You can only configure the egress queues on the switch.

Configuring Queue Buffers

The switch allows you to allocate buffers to queues. If there is no allocation made to buffers, then they are divided equally for all queues. You can use the queue-buffer ratio to divide it in a particular ratio. Since by default DTS (Dynamic Threshold and Scaling) is active on all queues, these are soft buffers.

Note The queue-buffer ratio is supported on both wired and wireless ports, but the queue-buffer ratio cannot be configured with a queue-limit.

Before You Begin

The following are prerequisites for this procedure:

- You should have created a class map for the queue buffer before beginning this procedure.
- You must have configured either bandwidth, shape, or priority on the policy map prior to configuring the queue buffers.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio value* } }
5. **queue-buffers** {**ratio** *ratio value* }
6. **end**
7. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_queuebuffer01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_queuebuffer01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default**—System default class matching any otherwise unclassified packets.

Step 4	**bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio value* } }
	Example:
	`Switch(config-pmap-c)# bandwidth percent 80`
	`Switch(config-pmap-c)#`
		Configures the bandwidth for the policy map. The command parameters include:
		• *Kb/s*—Use this command to configure a specific value. The range is 20000 to 10000000.
		• **percent**—Allocates a minimum bandwidth to a particular class using a percentage. The queue can oversubscribe bandwidth in case other queues do not utilize the entire port bandwidth. The total sum cannot exceed 100 percent, and in case it is less than 100 percent, the rest of the bandwidth is equally divided along all bandwidth queues.
		• **remaining**—Allocates a minimum bandwidth to a particular class. The queue can oversubscribe bandwidth in case other queues do not utilize

	Command or Action	Purpose
		entire port bandwidth. The total sum cannot exceed 100 percent. It is preferred to use this command when the **priority** command is used for certain queues in the policy. You can also assign ratios rather than a percentage to each queue; the queues will be assigned certain weights that are inline with these ratios. Ratios can range from 0 to 100. Total bandwidth ratio allocation for the policy in this case can exceed 100. **Note** You cannot mix bandwidth types on a policy map.

Step 5	**queue-buffers** {**ratio** *ratio value* }
	Example:
	`Switch(config-pmap-c)#`
	`queue-buffers ratio 10`
	`Switch(config-pmap-c)#`
		Configures the relative buffer size for the queue.
		Note The sum of all configured buffers in a policy must be less than or equal to 100 percent. Unallocated buffers are are evenly distributed to all the remaining queues.

Step 6	**end**
	Example:
	`Switch(config-pmap-c)#` **`end`**
	`Switch#`
		Saves configuration changes.

Step 7	**show policy-map** **Example:** `Switch#` **`show policy-map`**	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Queue Buffer Allocation, on page 24

Examples: Queue Buffers Configuration, on page 76

Configuring Queue Limits

You use queue limits to configure Weighted Tail Drop (WTD). WTD ensures the configuration of more than one threshold per queue. Each class of service is dropped at a different threshold value to provide for QoS differentiation. With the switch, each queue has 3 explicit programmable threshold classes—0, 1, 2. Therefore, the enqueue/drop decision of each packet per queue is determined by the packet's threshold class assignment, which is determined by the DSCP, CoS, or QoS group field of the frame header.

WTD also uses a soft limit, and therefore you are allowed to configure the queue limit to up to 400 percent (maximum four times the reserved buffer from common pool). This soft limit prevents overrunning the common pool without impacting other features.

Note You can only configure queue limits on the switch egress queues on wired ports.

Before You Begin

The following are prerequisites for this procedure:

- You should have created a class map for the queue limits before beginning this procedure.
- You must have configured either bandwidth, shape, or priority on the policy map prior to configuring the queue limits.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio value* } }
5. **queue-limit** { *packets* **packets** | **cos** {*cos value* { *maximum threshold value* | **percent** *percentage* } | **values** {*cos value* | **percent** *percentage* } } | **dscp** {*dscp value* { *maximum threshold value* | **percent** *percentage* } | *match packet* { *maximum threshold value* | **percent** *percentage* } | **default** { *maximum threshold value* | **percent** *percentage* } | **ef** { *maximum threshold value* | **percent** *percentage* } | **dscp values** *dscp value* } | **percent** *percentage* } }
6. **end**
7. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_queuelimit01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

	Command or Action	Purpose

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_queuelimit01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default—**System default class matching any otherwise unclassified packets.

Step 4	**bandwidth** { *Kb/s* | **percent** *percentage* | **remaining** { **ratio** *ratio value* } }
	Example:
	`Switch(config-pmap-c)# bandwidth 500000`
	`Switch(config-pmap-c)#`
		Configures the bandwidth for the policy map. The parameters include:
		• *Kb/s*—Use this command to configure a specific value. The range is 20000 to 10000000
		• **percent—**Allocates a minimum bandwidth to a particular class. The queue can oversubscribe bandwidth in case other queues do not utilize the entire port bandwidth. The total sum cannot exceed 100 percent, and in case it is less than 100 percent, the rest of the bandwidth is equally divided along all bandwidth queues.
		• **remaining—**Allocates a minimum bandwidth to a particular class. The queue can oversubscribe bandwidth in case other queues do not utilize entire port bandwidth. The total sum cannot exceed 100 percent. It is preferred to use this command when the **priority** command is used for certain queues in the policy. You can also assign ratios rather than a percentage to each queue; the queues will be assigned certain weights that are inline with these ratios. Ratios can range from 0 to 100. Total bandwidth ratio allocation for the policy in this case can exceed 100.
		Note You cannot mix bandwidth types on a policy map.

Step 5	**queue-limit** { *packets* **packets** | **cos** {*cos value* { *maximum threshold value* | **percent** *percentage* } | **values** {*cos value* | **percent** *percentage* } } | **dscp** {*dscp value* { *maximum threshold value* | **percent** *percentage* } | *match packet* { *maximum threshold value* | **percent** *percentage* } | **default** { *maximum threshold value* | **percent** *percentage* } | **ef** { *maximum threshold value* | **percent** *percentage* } | **dscp values** *dscp value* } | **percent** *percentage* } }
	Example:
	`Switch(config-pmap-c)# queue-limit dscp 3 percent 20`
	`Switch(config-pmap-c)# queue-limit dscp 4 percent 30`
	`Switch(config-pmap-c)# queue-limit dscp`
		Sets the queue limit threshold percentage values.
		With every queue, there are three thresholds (0,1,2), and there are default values for each of these thresholds. Use this command to change the default or any other queue limit threshold setting. For example, if DSCP 3, 4, and 5 packets are being sent into a specific queue in a configuration, then you can use this command to set the threshold percentages for these three DSCP values. For additional information about queue limit threshold values, see Weighted Tail Drop, on page 22.
		Note The switch does not support absolute queue-limit percentages. The switch only supports dscp or cos queue-limit percentages.

	Command or Action	Purpose
	`5 percent 40`	

Step 6	**end**
	Example:
	`Switch(config-pmap-c)# end`
	`Switch#`
		Saves configuration changes.

Step 7	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Proceed to configure any additional policy maps for QoS for your network. After creating your policy maps, proceed to attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Weighted Tail Drop, on page 22

Examples: Queue-limit Configuration, on page 75

Configuring Shaping

You use the **shape** command to configure shaping (maximum bandwidth) for a particular class. The queue's bandwidth is restricted to this value even though the port has additional bandwidth left. You can configure shaping as an average percent, as well as a shape average value in bits per second.

Before You Begin

You should have created a class map for shaping before beginning this procedure.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** *policy name*
3. **class** *class name*
4. **shape average** { *target bit rate* | **percent** *percentage* }
5. **end**
6. **show policy-map**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters the global configuration mode.

Step 2	**policy-map** *policy name*
	Example:
	`Switch(config)# policy-map policy_shaping01`
	`Switch(config-pmap)#`
		Enters policy map configuration mode.
		Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy.

Step 3	**class** *class name*
	Example:
	`Switch(config-pmap)# class class_shaping01`
	`Switch(config-pmap-c)#`
		Enters policy class map configuration mode. Specifies the name of the class whose policy you want to create or change. Command options for policy class map configuration mode include the following:
		• *word*—Class map name.
		• **class-default**—System default class matching any otherwise unclassified packets.

Step 4	**shape average** { *target bit rate* | **percent** *percentage* }
	Example:
	`Switch(config-pmap-c)# shape average percent 50`
	`Switch(config-pmap-c)#`
		Configures the average shape rate. You can configure the average shape rate by target bit rates (bits per second) or by percentage of interface bandwidth for the Committed Information Rate (CIR).

Step 5	**end**
	Example:
	`Switch(config-pmap-c)# end`
	`Switch#`
		Saves configuration changes.

Step 6	**show policy-map** **Example:** `Switch# show policy-map`	(Optional) Displays policy configuration information for all classes configured for all service policies.

What to Do Next

Configure any additional policy maps for QoS for your network. After creating your policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Average Rate Shaping, on page 20

Examples: Average Rate Shaping Configuration, on page 75

Hierarchical Shaping, on page 20

Monitoring QoS

The following commands can be used to monitor QoS on the switch:

Table 11: Monitoring QoS

Command	Description
show class-map [*class_map_name*]	Displays a list of all class maps configured.
show policy-map [*policy_map_name*]	Displays a list of all policy maps configured. Command parameters include: • **policy map name** • **interface** • **session**

Command	Description
show policy-map interface { **Auto-template** | **Capwap** | **GigabitEthernet** | **GroupVI** | **InternalInterface** | **Loopback** | **Null** | **Port-channel** | **TenGigabitEthernet** | **Tunnel** | **Vlan** | **Brief** | **class** | **input** | **output** | **wireless** }	Shows the runtime representation and statistics of all the policies configured on the switch. Command parameters include: • **Auto-template—**Auto-Template interface • **Capwap—**CAPWAP tunnel interface • **GigabitEthernet—**Gigabit Ethernet IEEE.802.3z • **GroupVI—**Group virtual interface • **InternalInterface—**Internal interface • **Loopback—**Loopback interface • **Null—**Null interface • **Port-channel—**Ethernet channel of interfaces • **TenGigabitEthernet—**10-Gigabit Ethernet • **Tunnel—**Tunnel interface • **Vlan—**Catalyst VLANs • **Brief—**Brief description of policy maps • **Class—**Show statistics for individual class • **Input—**Input policy • **Output—**Output policy • **Wireless—**wireless
show policy-map interface wireless ap [*access point*]	Shows the runtime representation and statistics for all the wireless APs on the switch.
show policy-map interface wireless ssid [*ssid*]	Shows the runtime representation and statistics for all the SSID targets on the switch.

Command	Description
show policy-map interface wireless client [*client*]	Shows the runtime representation and statistics for all the client targets on the switch.
show policy-map session [**input** | **output** | **uid** *UUID*]	Shows the session QoS policy. Command parameters include: • **input**—Input policy • **output**—Output policy • **uid**—Policy based on SSS unique identification.
show table-map	Displays all the table maps and their configurations.

Configuration Examples for QoS

Examples: Classification by Access Control Lists

This example shows how to classify packets for QoS by using access control lists (ACLs):

```
Switch# configure terminal
Switch(config)# access-list 101 permit ip host 12.4.1.1 host 15.2.1.1
Switch(config)# class-map acl-101
Switch(config-cmap)# description match on access-list 101
Switch(config-cmap)# match access-group 101
Switch(config-cmap)#
```

After creating a class map by using an ACL, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Related Topics

Creating a Traffic Class, on page 28

Class Maps, on page 12

Examples: Class of Service Layer 2 Classification

This example shows how to classify packets for QoS using a class of service Layer 2 classification:

```
Switch# configure terminal
Switch(config)# class-map cos
Switch(config-cmap)# match cos ?
  <0-7>  Enter up to 4 class-of-service values separated by white-spaces
Switch(config-cmap)# match cos 3 4 5
Switch(config-cmap)#
```

After creating a class map by using a CoS Layer 2 classification, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Examples: Class of Service DSCP Classification

This example shows how to classify packets for QoS using a class of service DSCP classification:

```
Switch# configure terminal
Switch(config)# class-map dscp
Switch(config-cmap)# match dscp af21 af22 af23
Switch(config-cmap)#
```

After creating a class map by using a DSCP classification, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Examples: VLAN ID Layer 2 Classification

This example shows how to classify for QoS using a VLAN ID Layer 2 classification:

```
Switch# configure terminal
Switch(config)# class-map vlan-120
Switch(config-cmap)# match vlan ?
  <1-4095>  VLAN id
Switch(config-cmap)# match vlan 120
Switch(config-cmap)#
```

After creating a class map by using a VLAN Layer 2 classification, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Examples: Classification by DSCP or Precedence Values

This example shows how to classify packets by using DSCP or Precedence values:

```
Switch# configure terminal
Switch(config)# class-map prec2
Switch(config-cmap)# description matching precedence 2 packets
Switch(config-cmap)# match ip precedence 2
Switch(config-cmap)# exit
Switch(config)# class-map ef
Switch(config-cmap)# description EF traffic
Switch(config-cmap)# match ip dscp ef
Switch(config-cmap)#
```

After creating a class map by using a DSCP or Precedence values, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Examples: Hierarchical Classification

The following is an example of a hierarchical classification, where a class named parent is created, which matches another class named child. The class named child matches based on the IP precedence being set to 2.

```
Switch# configure terminal
Switch(config)# class-map child
Switch(config-cmap)# match ip precedence 2
Switch(config-cmap)# exit
Switch(config)# class-map parent
Switch(config-cmap)# match class child
Switch(config-cmap)#
```

After creating the parent class map, you then create a policy map for the class, and apply the policy map to an interface for QoS.

Related Topics

Hierarchical QoS, on page 5

Examples: Hierarchical Policy Configuration

The following is an example of a configuration using hierarchical polices:

```
Switch# configure terminal
Switch(config)# class-map c1
Switch(config-cmap)# exit

Switch(config)# class-map c2
Switch(config-cmap)# exit

Switch(config)# class-map c3
Switch(config-cmap)# exit

Switch(config)# policy-map child
Switch(config-pmap)# class c1
Switch(config-pmap-c)# priority level 1
Switch(config-pmap-c)# police rate percent 20 conform-action transmit exceed action drop
Switch(config-pmap-c-police)# exit
Switch(config-pmap-c)# exit
Switch(config-pmap)# class c2
Switch(config-pmap-c)# bandwidth 20000
Switch(config-pmap-c)# exit
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# bandwidth 20000
Switch(config-pmap-c)# exit
Switch(config-pmap)# exit

Switch(config)# policy-map parent
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# shape average 1000000
Switch(config-pmap-c)# service-policy child
Switch(config-pmap-c)# end
```

Examples: Classification for Voice and Video

This example describes how to classify packet streams for voice and video using switch specific information.

In this example, voice and video are coming in from end-point A into GigabitEthernet1/0/1 on the switch and have precedence values of 5 and 6, respectively. Additionally, voice and video are also coming from end-point B into GigabitEthernet1/0/2 on the switch with DSCP values of EF and AF11, respectively.

Assume that all the packets from the both the interfaces are sent on the uplink interface, and there is a requirement to police voice to 100 Mbps and video to 150 Mbps.

To classify per the above requirements, a class to match voice packets coming in on GigabitEthernet1/0/1 is created, named voice-interface-1, which matches precedence 5. Similarly another class for voice is created, named voice-interface-2, which will match voice packets in GigabitEthernet1/0/2. These classes are associated to two separate policies named input-interface-1, which is attached to GigabitEthernet1/0/1, and input-interface-2, which is attached to GigabitEthernet1/0/2. The action for this class is to mark the qos-group to 10. To match packets with QoS-group 10 on the output interface, a class named voice is created which matches on QoS-group 10. This is then associated to another policy named output-interface, which is associated to the uplink interface. Video is handled in the same way, but matches on QoS-group 20.

The following example shows how classify using the above switch specific information:

```
Switch(config)#
Switch(config)# class-map voice-interface-1
Switch(config-cmap)# match ip precedence 5
Switch(config-cmap)# exit

Switch(config)# class-map video-interface-1
Switch(config-cmap)# match ip precedence 6
Switch(config-cmap)# exit

Switch(config)# class-map voice-interface-2
Switch(config-cmap)# match ip dscp ef
Switch(config-cmap)# exit

Switch(config)# class-map video-interface-2
Switch(config-cmap)# match ip dscp af11
Switch(config-cmap)# exit

Switch(config)# policy-map input-interface-1
Switch(config-pmap)# class voice-interface-1
Switch(config-pmap-c)# set qos-group 10
Switch(config-pmap-c)# exit

Switch(config-pmap)# class video-interface-1
Switch(config-pmap-c)# set qos-group 20

Switch(config-pmap-c)# policy-map input-interface-2
Switch(config-pmap)# class voice-interface-2
Switch(config-pmap-c)# set qos-group 10
Switch(config-pmap-c)# class video-interface-2
Switch(config-pmap-c)# set qos-group 20
Switch(config-pmap-c)# exit
Switch(config-pmap)# exit

Switch(config)# class-map voice
Switch(config-cmap)# match qos-group 10
Switch(config-cmap)# exit

Switch(config)# class-map video
Switch(config-cmap)# match qos-group 20

Switch(config)# policy-map output-interface
Switch(config-pmap)# class voice
Switch(config-pmap-c)# police 256000 conform-action transmit exceed-action drop
Switch(config-pmap-c-police)# exit
Switch(config-pmap-c)# exit

Switch(config-pmap)# class video
Switch(config-pmap-c)# police 1024000 conform-action transmit exceed-action drop
Switch(config-pmap-c-police)# exit
Switch(config-pmap-c)# exit
```

Examples: Average Rate Shaping Configuration

The following example shows how to configure average rate shaping:

```
Switch# configure terminal
Switch(config)# class-map prec1
Switch(config-cmap)# description matching precedence 1 packets
Switch(config-cmap)# match ip precedence 1
Switch(config-cmap)# end

Switch# configure terminal
Switch(config)# class-map prec2
Switch(config-cmap)# description matching precedence 2 packets
Switch(config-cmap)# match ip precedence 2
Switch(config-cmap)# exit

Switch(config)# policy-map shaper
Switch(config-pmap)# class prec1
Switch(config-pmap-c)# shape average 512000
Switch(config-pmap-c)# exit

Switch(config-pmap)# policy-map shaper
Switch(config-pmap)# class prec2
Switch(config-pmap-c)# shape average 512000
Switch(config-pmap-c)# exit

Switch(config-pmap)# class class-default
Switch(config-pmap-c)# shape average 1024000
```

After configuring the class maps, policy map, and shape averages for your configuration, proceed to then apply the policy map to the interface for QoS.

Related Topics

Configuring Shaping, on page 67

Average Rate Shaping, on page 20

Examples: Queue-limit Configuration

The following example shows how to configure a queue-limit policy based upon DSCP values and percentages:

```
Switch# configure terminal
Switch#(config)# policy-map port-queue
Switch#(config-pmap)# class dscp-1-2-3
Switch#(config-pmap-c)# bandwidth percent 20
Switch#(config-pmap-c)# queue-limit dscp 1 percent 80
Switch#(config-pmap-c)# queue-limit dscp 2 percent 90
Switch#(config-pmap-c)# queue-limit dscp 3 percent 100
Switch#(config-pmap-c)# exit

Switch#(config-pmap)# class dscp-4-5-6
Switch#(config-pmap-c)# bandwidth percent 20
Switch#(config-pmap-c)# queue-limit dscp 4 percent 20
Switch#(config-pmap-c)# queue-limit dscp 5 percent 30
Switch#(config-pmap-c)# queue-limit dscp 6 percent 20
Switch#(config-pmap-c)# exit
```

```
Switch#(config-pmap)# class dscp-7-8-9
Switch#(config-pmap-c)# bandwidth percent 20
Switch#(config-pmap-c)# queue-limit dscp 7 percent 20
Switch#(config-pmap-c)# queue-limit dscp 8 percent 30
Switch#(config-pmap-c)# queue-limit dscp 9 percent 20
Switch#(config-pmap-c)# exit

Switch#(config-pmap)# class dscp-10-11-12
Switch#(config-pmap-c)# bandwidth percent 20
Switch#(config-pmap-c)# queue-limit dscp 10 percent 20
Switch#(config-pmap-c)# queue-limit dscp 11 percent 30
Switch#(config-pmap-c)# queue-limit dscp 12 percent 20
Switch#(config-pmap-c)# exit

Switch#(config-pmap)# class dscp-13-14-15
Switch#(config-pmap-c)# bandwidth percent 10
Switch#(config-pmap-c)# queue-limit dscp 13 percent 20
Switch#(config-pmap-c)# queue-limit dscp 14 percent 30
Switch#(config-pmap-c)# queue-limit dscp 15 percent 20
Switch#(config-pmap-c)# end
Switch#
```

After finishing with the above policy map queue-limit configuration, you can then proceed to apply the policy map to an interface for QoS.

Related Topics

Configuring Queue Limits, on page 64

Weighted Tail Drop, on page 22

Examples: Queue Buffers Configuration

The following example shows how configure a queue buffer policy and then apply it to an interface for QoS:

```
Switch# configure terminal
Switch(config)# policy-map policy1001
Switch(config-pmap)# class class1001
Switch(config-pmap-c)# bandwidth remaining ratio 10
Switch(config-pmap-c)# queue-buffer ratio ?
  <0-100>  Queue-buffers ratio limit
Switch(config-pmap-c)# queue-buffer ratio 20
Switch(config-pmap-c)# end

Switch# configure terminal
Switch(config)# interface gigabitEthernet2/0/3
Switch(config-if)# service-policy output policy1001
Switch(config-if)# end
```

Related Topics

Configuring Queue Buffers, on page 62

Queue Buffer Allocation, on page 24

Examples: Policing Action Configuration

The following example displays the various policing actions that can be associated to the policer. These actions are accomplished using the conforming, exceeding, or violating packet configurations. You have the flexibility to drop, mark and transmit, or transmit packets that have exceeded or violated a traffic profile.

For example, a common deployment scenario is one where the enterprise customer polices traffic exiting the network towards the service provider and marks the conforming, exceeding and violating packets with different DSCP values. The service provider could then choose to drop the packets marked with the exceeded and violated DSCP values under cases of congestion, but may choose to transmit them when bandwidth is available.

Note The Layer 2 fields can be marked to include the CoS fields, and the Layer 3 fields can be marked to include the precedence and the DSCP fields.

One useful feature is the ability to associate multiple actions with an event. For example, you could set the precedence bit and the CoS for all conforming packets. A submode for an action configuration could then be provided by the policing feature.

This is an example of a policing action configuration:

```
Switch# configure terminal
Switch(config)# policy-map police
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# police cir 1000000 pir 2000000
Switch(config-pmap-c-police)# conform-action transmit
Switch(config-pmap-c-police)# exceed-action set-dscp-transmit dscp table exceed-markdown-table
Switch(config-pmap-c-police)# violate-action set-dscp-transmit dscp table
violate-markdown-table
Switch(config-pmap-c-police)# end
```

In this example, the exceed-markdown-table and violate-mark-down-table are table maps.

Note Policer based markdown actions are only supported using table maps. Only one markdown table map is allowed for each marking field in the switch.

Related Topics

Configuring Police, on page 57

Policing, on page 14

Examples: Policer VLAN Configuration

The following example displays a VLAN policer configuration. At the end of this configuration, the VLAN policy map is applied to an interface for QoS.

```
Switch# configure terminal
Switch(config)# class-map vlan100
Switch(config-cmap)# match vlan 100
Switch(config-cmap)# exit
Switch(config)# policy-map vlan100
Switch(config-pmap)# policy-map class vlan100
Switch(config-pmap-c)# police 100000 bc conform-action transmit exceed-action drop
Switch(config-pmap-c-police)# end
Switch# configure terminal
Switch(config)# interface gigabitEthernet1/0/5
Switch(config-if)#  service-policy input vlan100
```

Related Topics

Classifying, Policing, and Marking Traffic on SVIs by Using Policy Maps, on page 45

Policy Map on VLANs, on page 14

Examples: Policing Units

The following examples display the various units of policing that are supported for QoS. The policing unit is the basis on which the token bucket works .

The following units of policing are supported:

- CIR and PIR are specified in bits per second. The burst parameters are specified in bytes. This is the default mode; it is the unit that is assumed when no units are specified. The CIR and PIR can also be configured in percent, in which case the burst parameters have to be configured in milliseconds.
- CIR and PIR are specified in packets per second. In this case, the burst parameters are configured in packets as well.

The following is an example of a policer configuration in bits per second:

```
Switch(config)# policy-map bps-policer
Switch(config-pmap)# class class-default
Switch(config-pmap-c) # police rate 256000 bps burst 1000 bytes
conform-action transmit exceed-action drop
```

The following is an example of a policer configuration in packets per second. In this configuration, a dual-rate three-color policer is configured where the units of measurement is packet. The burst and peak burst are all specified in packets.

```
Switch(config)# policy-map pps-policer
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# police rate 5000 pps burst 100 packets
peak-rate 10000 pps peak-burst 200 packets conform-action transmit
exceed-action drop violate-action drop
```

Related Topics

Configuring Police, on page 57

Token-Bucket Algorithm, on page 15

Examples: Single-Rate Two-Color Policing Configuration

The following example shows how to configure a single-rate two-color policer:

```
Switch(config)# class-map match-any prec1
Switch(config-cmap)# match ip precedence 1
Switch(config-cmap)# exit
Switch(config)# policy-map policer
Switch(config-pmap)# class prec1
Switch(config-pmap-c)# police cir 256000 conform-action transmit exceed-action drop
Switch(config-pmap-c-police)# exit
Switch(config-pmap-c)#
```

Related Topics

Configuring Police, on page 57

Single-Rate Two-Color Policing, on page 18

Examples: Dual-Rate Three-Color Policing Configuration

The following example shows how to configure a dual-rate three-color policer:

```
Switch# configure terminal
Switch(config)# policy-Map dual-rate-3color-policer
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# police cir 64000 bc 2000 pir 128000 be 2000
Switch(config-pmap-c-police)# conform-action transmit
Switch(config-pmap-c-police)# exceed-action set-dscp-transmit dscp table exceed-markdown-table
Switch(config-pmap-c-police)# violate-action set-dscp-transmit dscp table
violate-markdown-table
Switch(config-pmap-c-police)# exit
Switch(config-pmap-c)#
```

In this example, the exceed-markdown-table and violate-mark-down-table are table maps.

Note Policer based markdown actions are only supported using table maps. Only one markdown table map is allowed for each marking field in the switch.

Related Topics

Configuring Police, on page 57

Dual-Rate Three-Color Policing, on page 19

Examples: Table Map Marking Configuration

The following steps and examples show how to use table map marking for your QoS configuration:

1 Define the table map.

Define the table-map using the **table-map** command and indicate the mapping of the values. This table does not know of the policies or classes within which it will be used. The default command in the table map indicates the value to be copied into the 'to' field when there is no matching 'from' field. In the example, a table map named table-map1 is created. The mapping defined is to convert the value from 0 to 1 and from 2 to 3, while setting the default value to 4.

```
Switch(config)# table-map table-map1
Switch(config-tablemap)# map from 0 to 1
Switch(config-tablemap)# map from 2 to 3
Switch(config-tablemap)# default 4
Switch(config-tablemap)# exit
```

2. Define the policy map where the table map will be used.

   In the example, the incoming CoS is mapped to the DSCP based on the mapping specified in the table table-map1. For this example, if the incoming packet has a DSCP of 0, the CoS in the packet is set 1. If no table map name is specified the command assumes a default behavior where the value is copied as is from the ‘from’ field (DSCP in this case) to the ‘to’ field (CoS in this case). Note however, that while the CoS is a 3-bit field, the DSCP is a 6-bit field, which implies that the CoS is copied to the first three bits in the DSCP.

```
Switch(config)# policy map policy1
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# set cos dscp table table-map1
Switch(config-pmap-c)# exit
```

3. Associate the policy to an interface.

```
Switch(config)# interface GigabitEthernet1/0/1
Switch(config-if)# service-policy output policy1
Switch(config-if)# exit
```

Related Topics

Configuring Table Maps, on page 49

Table Map Marking, on page 16

Example: Table Map Configuration to Retain CoS Markings

The following example shows how to use table maps to retain CoS markings on an interface for your QoS configuration.

The cos-trust-policy policy (configured in the example) is enabled in the ingress direction to retain the CoS marking coming into the interface. If the policy is not enabled, only the DSCP is trusted by default. If a pure Layer 2 packet arrives at the interface, then the CoS value will be rewritten to 0 when there is no such policy in the ingress port for CoS.

```
Switch# configure terminal
Switch(config)# table-map cos2cos
Switch(config-tablemap)# default copy
Switch(config-tablemap)# exit


Switch(config)# policy map cos-trust-policy
Switch(config-pmap)# class class-default
Switch(config-pmap-c)# set cos cos table cos2cos
Switch(config-pmap-c)# exit

Switch(config)# interface GigabitEthernet1/0/2
Switch(config-if)# service-policy input cos-trust-policy
Switch(config-if)# exit
```

Where to Go Next

Review the auto-QoS documentation to see if you can use these automated capabilities for your QoS configuration.

Additional References for QoS

Related Documents

Related Topic	Document Title
QoS CLI commands	*QoS Command Reference (Catalyst 3850 Switches)*
Cisco Flexible NetFlow	*Cisco Flexible NetFlow Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)* *Flexible Netflow Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)*
Call Admission Control (CAC)	*System Management Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)*
Platform-independent configuration information	• *QoS: Classification Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)* • *QoS: Congestion Management Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3850 Switches)*

Standards and RFCs

Standard/RFC	Title
Not applicable	

MIBs

MIB	MIBs Link
All supported MIBs for this release.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/support

Feature History and Information for QoS

This table lists the features in this module and provides links to specific configuration information.

Table 12: Feature Information for QoS

Feature Name	Release	Feature Information
QoS functionality	Cisco IOS XE 3.2SE	The following functionality is supported: • QoS for wired targets • QoS for wireless targets