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.

Prerequisites for QoS

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

- Standard QoS concepts.

- Wireless concepts and network topologies.
- Classic Cisco IOS QoS.
- Modular QoS CLI (MQC).
- Understanding of QoS implementation.
- The types of applications used and the traffic patterns on your network.
- Traffic characteristics and needs of your 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 network.
- Location of congestion points in the network.

Related Topics

Restrictions for QoS on Wired Targets, on page 39

Restrictions for QoS on Wireless Targets, on page 41

QoS Components

QoS consists of the following key components:

- Classification— Classification is the process of distinguishing one type of traffic from another based upon ACLs, Differentiated Services Code Point (DSCP), Class of Service (CoS), and other factors.
- Marking and mutation— Marking is used on traffic to convey specific information to a downstream device in the network, or to carry information from one interface in a switch to another. When traffic is marked, QoS operations on that traffic can be applied. This can be accomplished directly using the **set** command or through a table map, which takes input values and translates them directly to values on output.
- Shaping and policing— Shaping is the process of imposing a maximum rate of traffic, while regulating the traffic rate in such a way that downstream devices are not subjected to congestion. Shaping in the most common form is used to limit the traffic sent from a physical or logical interface. Policing is used to impose a maximum rate on a traffic class. If the rate is exceeded, then a specific action is taken as soon as the event occurs.
- Queuing — Queueing is used to prevent traffic congestion. Traffic is sent to specific queues for servicing and scheduling based upon bandwidth allocation. Traffic is then scheduled or sent out through the port.
- Bandwidth—Bandwidth allocation determines the available capacity for traffic that is subject to QoS policies.
- Trust— Trust enables traffic to pass through the switch, and the DSCP, precedence, or CoS values coming in from the end points are retained in the absence of any explicit policy configuration.

QoS Terminology

The following terms are used interchangeably in this QoS configuration guide:

- Upstream (direction towards the switch) is the same as ingress.
- Downstream (direction from the switch) is the same as egress.

Note Upstream is wireless to wired. Downstream is wired to wireless. Wireless to wireless has no specific term.

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

Related Topics

Restrictions for QoS on Wired Targets, on page 39

Restrictions for QoS on Wireless Targets, on page 41

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, while 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.

Wireless QoS Overview

Wireless QoS can be configured on the following wireless targets:

- Wireless ports, including all physical ports to which an access point can be associated.

- Radio
- SSID (applicable on a per-radio, per-AP, and per-SSID)
- Client

The following table displays how policies are supported for the wireless targets.

Table 1: Wireless Targets Policies Support

Wireless Target	Policies on Wireless Targets Supported	Policies Supported Downstream Direction	Policies Supported Upstream Direction
Wireless port	Yes	Yes - user configurable	No
Radio	Yes	Yes - but not configurable by user	No
SSID	Yes	Yes - user configurable	Yes - user configurable
Client	Yes	Yes - user configurable	Yes - user configurable

Note Additional polices that are user configured include multi-destination policers and VLANs.

Wireless QoS supports the following additional features:

- Queuing support
- Policing of wireless traffic
- Shaping of wireless traffic
- Rate limiting in both downstream and upstream direction
- Approximate Fair Drop (AFD)
- Mobility support for QoS
- Compatibility with precious metal QoS policies available on Cisco Unified Wireless Controllers.

QoS and IPv6 for Wireless

From this release onwards, the switch supports QoS for both IPv4 and IPv6 traffic, and client policies can now have IPv4 and IPv6 filters.

Wired and Wireless Access Supported Features

The following table describes the supported features for both wired and wireless access.

Table 2: Supported QoS Features for Wired and Wireless Access

Feature	Wired	Wireless
Targets	• Gigabit Ethernet • 10 Gigabit Ethernet • VLAN	• Wireless port (CAPWAP tunnel) • SSID • Client • Radio • CAPWAP multicast tunnel
Configuration Sequence	QoS policy installed using the **service-policy** command.	• When an access point joins the switch, the switch installs a policy on the port. The port policy has a child policy called port_child_policy. • A policy is installed on the radio which has a shaper configured to the radio rate. The default radio policy (which cannot be modified) is attached to the radio. • The default client policies take effect when a WMM client associates, and if admission control is enabled on the radio. • User can modify the port_child_policy to add more classes. • User can attach a user-defined policy at the SSID level. • User can attach a user-defined policy at the client level.
Number of queues permitted at port level	Up to 8 queues supported on a port.	Only four queues supported.

Feature	Wired	Wireless
Classification mechanism	• DSCP • IP precedence • CoS • QoS-group • ACL membership including: ◦ IPv4 ACLs ◦ IPv6 ACLS ◦ MAC ACLs	• Port level ◦ Ingress: QoS policies not supported on ingress in wireless ports. ◦ Egress: Only DSCP based classification. • SSID level ◦ Ingress: DSCP, UP ◦ Egress: DSCP,COS, QoS group • Client level ◦ Ingress: ACL, DSCP, UP ◦ Egress: ACL, DSCP, and COS

Related Topics

Port Policy Format, on page 8

Supported QoS Features on Wireless Targets

This table describes the various features available on wireless targets.

Table 3: QoS Features Available on Wireless Targets

Target	Features	Traffic	Direction Where Policies Are Applicable	Comments
Port	• Port shaper • Priority queuing • Multicast policing	Non-Real Time (NRT), Real Time (RT)	Downstream	
Radio	• Shaping	Non-Real Time	Downstream	Radio policies are not user configurable.

Target	Features	Traffic	Direction Where Policies Are Applicable	Comments
SSID	• Shaping • Police • Table map • BRR	Non-Real Time, Real Time	Upstream and downstream	Queuing actions such as shaping and BRR are allowed only in the downstream direction.
Client	• Set • Police	Non-Real Time, Real time	Upstream and downstream	

Related Topics

Applying a QoS Policy on a WLAN (GUI), on page 97
Port Policies, on page 7

Port Policy Format, on page 8

Radio Policies, on page 9

Configuring SSID Policies (GUI), on page 61

Applying an SSID or Client Policy on a WLAN (CLI), on page 62

Applying a QoS Policy on a WLAN (GUI), on page 97
SSID Policies, on page 10

Configuring Client Policies (CLI)
Configuring Client Policies (GUI), on page 51
Applying a QoS Policy on a WLAN (GUI), on page 97
Client Policies, on page 10

Port Policies

The switch supports port-based policies. The port policies includes port shaper and a child policy (port_child_policy).

Note Port child policies only apply to wireless ports and not to wired ports on the switch. A wireless port is defined as a port to which APs join. A default port child policy is applied on the switch to the wireless ports at start up.The port shaper rate is limited to 1G

Port shaper specifies the traffic policy applicable between the device and the AP. This is the sum of the radio rates supported on the access point.

The child policy determines the mapping between packets and queues defined by the port-child policy. The child policy can be configured to include voice, video, class-default, and non-client-nrt classes where voice and video are based on DSCP value (which is the outer CAPWAP header DSCP value). The definition of class-default is known to the system as any value other than voice and video DSCP.

The DSCP value is assigned when the packet reaches the port. Before the packet arrives at the port, the SSID policies are applied on the packet. Port child policy also includes multicast percentage for a given port traffic. By default, the port child policy allocates up to 10 percent of the available rate.

Related Topics

Applying a QoS Policy on a WLAN (GUI), on page 97
Restrictions for QoS on Wireless Targets, on page 41

Supported QoS Features on Wireless Targets, on page 6

Examples: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic, on page 105

Port Policy Format

This section describes the behavior of the port policies on a switch. The ports on the switch do not distinguish between wired or wireless physical ports. Depending on the kind of device associated to the switch, the policies are applied. For example, when an access point is connected to a switch port, the switch detects it as a wireless device and applies the default hierarchical policy which is in the format of a parent-child policy. This policy is an hierarchical policy. The parent policy cannot be modified but the child policy (port-child policy) can be modified to suit the QoS configuration. The switch is pre configured with a default class map and a policy map.

Default class map:

```
Class Map match-any non-client-nrt-class
   Match non-client-nrt
```

The above port policy processes all network traffic to the Q3 queue. You can view the class map by executing the **show class-map** command.

Default policy map:

```
Policy Map port_child_policy
    Class non-client-nrt-class
      bandwidth remaining ratio 10
```

Note The class map and policy map listed are system-defined policies and cannot be changed.

The following is the system-defined policy map available on the ports on which wireless devices are associated. The format consists of a parent policy and a service child policy (**port_child_policy**). To customize the policies to suite your network needs, you must configure the port child policy.

```
Policy-map policy_map_name
    Class class-default
         Shape average average_rate
         Service-policy port_child_policy
```

Note The parent policy is system generated and cannot be changed. You must configure the *port_child_policy* policy to suit the QoS requirements on your network.

Depending on the type of traffic in your network, you can configure the port child policy. For example, in a typical wireless network deployment, you can assign specific priorities to voice and video traffic. Here is an example:

```
Policy-map port_child_policy
     Class  voice-policy-name (match dscp ef)
          Priority level 1
         Police (multicast-policer-name-voice) Multicast Policer
    Class video-policy-name (match dscp af41)
        Priority level 2
        Police (multicast-policer-name-video) Multicast Policer
Class non-client-nrt-class traffic(match non-client-nrt)
        Bandwidth remaining ratio (brr-value-nrt-q2)
    Class class-default  (NRT Data)
        Bandwidth remaining ratio (brr-value-q3)
```

In the above port child policy:

- *voice-policy-name*— Refers to the name of the class that specifies rules for the traffic for voice packets. Here the DSCP value is mapped to a value of 46 (represented by the keyword **ef**). The voice traffic is assigned the highest priority of 1.
- *video-policy-name*— Refers to the name of the class that specifies rules for the traffic for video packets. The DSCP value is mapped to a value of 34 (represented by the keyword **af41**).
- *multicast-policer-name-voice*— If you need to configure multicast voice traffic, you can configure policing for the voice class map.
- *multicast-policer-name-video*— If you need to configure multicast video traffic, you can configure policing for the video class map.

In the above sample configuration, all voice and video traffic is directed to the Q0 and Q1 queues, respectively. These queues maintain a strict priority. The packets in Q0 and Q1 are processed in that order. The bandwidth remaining ratios *brr-value-nrt-q2* and *brr-value-q3* are directed to the Q2 and Q3 respectively specified by the class maps and *class-default* and *non-client-nrt*. The processing of packets on Q2 and Q3 are based on a weighted round-robin approach. For example, if the *brr-value-nrtq2* has a value of 90 and *brr-value-nrtq3* is 10, the packets in queue 2 and queue 3 are processed in the ratio of 9:1.

Related Topics

Applying a QoS Policy on a WLAN (GUI), on page 97
Restrictions for QoS on Wireless Targets, on page 41
Supported QoS Features on Wireless Targets, on page 6
Examples: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic, on page 105
Wired and Wireless Access Supported Features, on page 4
Policy Maps, on page 20

Radio Policies

The radio policies are system defined and are not user configurable. Radio wireless targets are only applicable in the downstream direction.

Radio policies are applicable on a per-radio, per-access point basis. The rate limit on the radios is the practical limit of the AP radio rate. This value is equivalent to the sum of the radios supported by the access point.

The following radios are supported:

- 802.11 a/n
- 802.11 b/n
- 802.11 a/c

Related Topics

Restrictions for QoS on Wireless Targets, on page 41

Supported QoS Features on Wireless Targets, on page 6

SSID Policies

You can create QoS policies on SSID BSSID (Basic Service Set Identification) in both the upstream and downstream directions. By default, there is no SSID policy. You can configure an SSID policy based on the SSID name. The policy is applicable on a per BSSID.

The types of policies you can create on SSID include marking by using table maps (table-maps), shape rate, and RT1 (Real Time 1) and RT2 (Real Time 2) policiers. If traffic is upstream, you usually configure a marking policy on the SSID. If traffic is downstream, you can configure marking and queuing.

There should be a one-to-one mapping between the policies configured on a port and an SSID. For example, if you configure class voice and class video on the port, you can have a similar policy on the SSID.

SSID priorities can be specified by configuring bandwidth remaining ratio. Queuing SSID policies are applied in the downstream direction.

Related Topics

Configuring SSID Policies (GUI), on page 61

Applying an SSID or Client Policy on a WLAN (CLI), on page 62

Applying a QoS Policy on a WLAN (GUI), on page 97

Supported QoS Features on Wireless Targets, on page 6

Examples: SSID Policy

Examples: Configuring Downstream SSID Policy, on page 105

Client Policies

Client policies are applicable in the upstream and downstream direction. The wireless control module of the switch applies the default client policies when admission control is enabled for WMM clients. When admission control is disabled, there is no default client policy. You can configure policing and marking policies on clients.

Note A client policy can have both IPv4 and IPv6 filters.

You can configure client policies in the following ways:

- Using AAA—You can use a combination of AAA and TCLAS, and AAA and SIP snooping when configuring with AAA.

- Using the Cisco IOS MQC CLI—You can use a combination of CLI and TCLAS and CLI and SIP snooping.
- Using the default configuration

Note When applying client policies on a WLAN, you must disable the WLAN before modifying the client policy. SSID policies can be modified even if the WLAN is enabled.

Note If you configured AAA by configuring the unified wireless controller procedure, and using the MQC QoS commands, the policy configuration performed through the MQC QoS commands takes precedence.

For client policies, the following filters are supported:

- ACL
- DSCP
- COS
- WLAN UP

Related Topics

Configuring Client Policies (CLI)
Configuring Client Policies (GUI), on page 51
Applying a QoS Policy on a WLAN (GUI), on page 97
Supported QoS Features on Wireless Targets, on page 6

Examples: Client Policies, on page 106

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 103

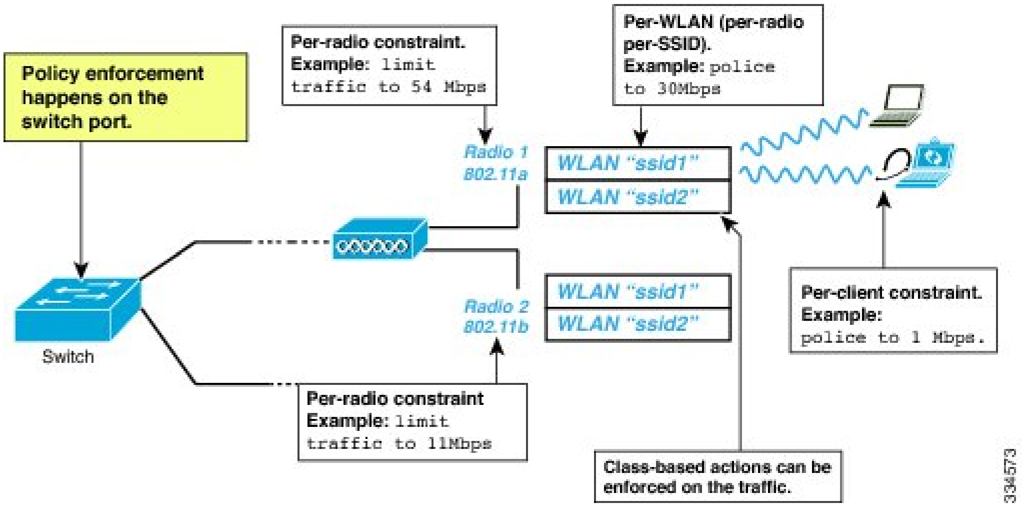
Examples: Hierarchical Policy Configuration, on page 103

Hierarchical Wireless QoS

The switch supports hierarchical QoS for wireless targets. Hierarchical QoS policies are applicable on port, radio, SSID, and client. QoS policies configured on the device (including marking, shaping, policing) can be applied across the targets. If the network contains non-realtime traffic, the non-realtime traffic is subject to approximate fair drop. Hierarchy refers to the process of application of the various QoS policies on the packets arriving to the device.

This figure shows the various targets available on a wireless network, as well as a hierarchal wireless configuration. Wireless QoS is applied per-radio constraint, per-WLAN, and per-client constraint.

Figure 1: Hierarchical QoS


Policy enforcement happens on the switch port.
Per-radio constraint. Example: limit traffic to 54 Mbps
Per-WLAN (per-radio per-SSID). Example: police to 30Mbps
Radio 1 802.11a
WLAN "ssid1"
WLAN "ssid2"
Switch
Radio 2 802.11b
WLAN "ssid1"
WLAN "ssid2"
Per-client constraint. Example: police to 1 Mbps.
Per-radio constraint Example: limit traffic to 11Mbps
Class-based actions can be enforced on the traffic.
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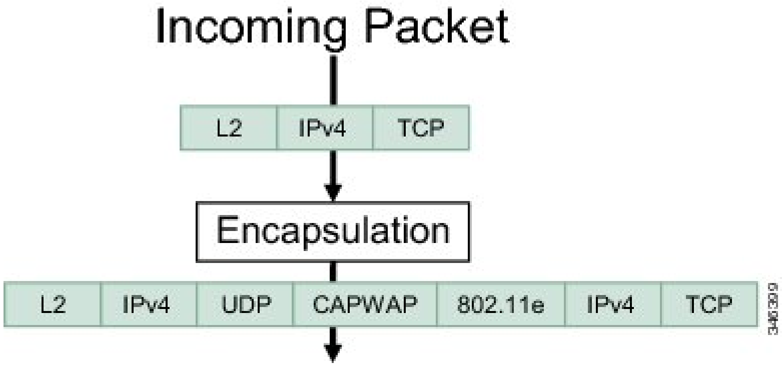
Wireless Packet Format

This figure displays the wireless packet flow and encapsulation used in hierarchical wireless QoS. The incoming packet enters the switch. The switch encapsulates this incoming packet and adds the 802.11e and CAPWAP headers.

Figure 2: Wireless Packet Path in the Egress Direction during First Pass



Hierarchical AFD

Approximate Fair Dropping (AFD) is a feature provided by the QoS infrastructure in Cisco IOS. For wireless targets, AFD can be configured on SSID (via shaping) and clients (via policing). AFD shaping rate is only applicable for downstream direction. Unicast real-time traffic is not subjected to AFD drops.

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.

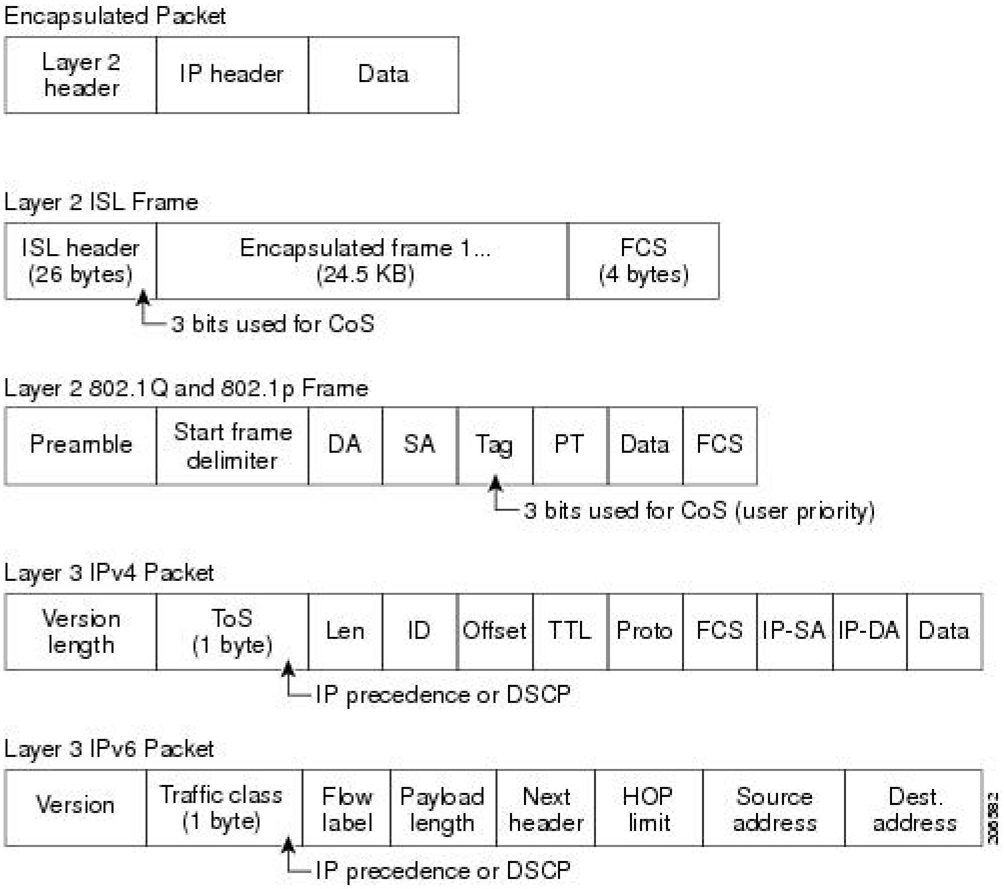
When you configure the QoS feature, you can select specific network traffic, prioritize it according to its relative importance, and use congestion-management and congestion-avoidance techniques to provide preferential treatment. Implementing QoS in your network makes network performance more predictable 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 3: QoS Classification Layers in Frames and Packets



Related Topics

Restrictions for QoS on Wired Targets, on page 39

Restrictions for QoS on Wireless Targets, on page 41

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. 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 4: 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. 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 you might be required to aggregate traffic coming from multiple input interfaces into a specific class in the output interface. For example, multiple customer edge routers might be 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 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 (CLI), on page 44

Examples: Classification by Access Control Lists, on page 101

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 (CLI), on page 47

Port Policy Format, on page 8

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 (CLI), on page 59

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 (CLI), on page 67

Examples: Policer VLAN Configuration, on page 111

Wireless QoS Rate Limiting

QoS per Client Rate Limit—Wireless

QoS policies can be configured to rate-limit client traffic using policiers. Ths includes both real-time and non real time traffic. The non real-time traffic is policed using AFD policiers. These policiers can only be one rate two color.

Note For client policy, the voice and video rate limits are applied at the same time.

QoS Downstream Rate Limit—Wireless

Downstream rate limiting is done using policing at the SSID level. AFD cannot drop real-time traffic, it can only be policed in the traffic queues. Real-time policing and AFD shaping is performed at the SSID level.

The radio has a default shaping policy. This shaping limit is the physical limit of the radio itself. You can check the policy maps on the radio by using the **show policy-map interface wireless radio** command.

Wireless QoS Multicast

You can configure multicast policing rate at the port level.

Related Topics

Configuring QoS Policies for Multicast Traffic (CLI), on page 96

Examples: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic, on page 105

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.

To avoid out-of-order packets, both conform and nonconforming traffic typically exit the same queue.

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 only configure policing on a physical port.

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 (CLI), on page 83

Examples: Policing Action Configuration, on page 110

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 (CLI), on page 83

Examples: Policing Units, on page 111

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 5: Packet-Marking Types Used for Establishing a To-From Relationship

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 the from type of qos-marking.

Related Topics

Configuring Table Maps (CLI), on page 70

Examples: Table Map Marking Configuration, on page 113

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 6: 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.
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.

Policing Function	Shaping Function
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

Note Single-rate three-color policing is not supported.

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 22.

Related Topics

Configuring Police (CLI), on page 83

Examples: Single-Rate Two-Color Policing Configuration, on page 112

Dual-Rate Three-Color Policing

With the dual rate policer, the switch supports only color-blind mode. In this mode, 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 22.

In the color-blind mode, the incoming packet is first checked against the peak rate bucket. If there are not enough tokens available, the packet 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.

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 (CLI), on page 83

Examples: Dual-Rate Three-Color Policing Configuration, on page 112

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 22.

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 (CLI), on page 93

Examples: Average Rate Shaping Configuration, on page 108

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 (CLI), on page 93

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 (CLI), on page 81

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 4 will be scheduled twice as often as the bandwidth remaining ratio of 2.

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.

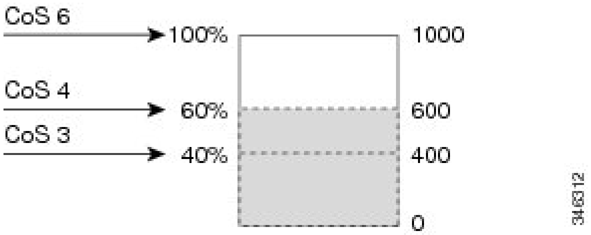
As a frame is enqueued to a particular queue, WTD uses the frame's assigned QoS label to subject it to different thresholds. If the threshold is exceeded for that QoS label (the space available in the destination queue is less than the size of the frame), the switch drops the frame.

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 4: 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 (CLI), on page 90

Examples: Queue-limit Configuration, on page 109

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 7: 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 (CLI), on page 86

Queue Buffer

Each 1-gigabit port on the switch is allocated 168 buffers for a wireless port and 300 buffers for a wired port. 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 8: DSCP, Precedence, and CoS - Queue Threshold Mapping Table

DSCP, Precedence or CoS	Queue	Threshold
Control Packets	0	2
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.

For the wireless port 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. The soft maximum for this queue is set to 268 (calculated as 67 * 400/100) for 1-gigabit ports, where 400 is the default maximum threshold that is configured for any queue.

For the wired port default, Queue 0 will be given 40 percent of the buffers that are available for the interface as hard buffers, that is 120 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 480 (calculated as 120 * 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 is 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 (CLI), on page 88

Examples: Queue Buffers Configuration, on page 110

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.

Queuing in Wireless

Queuing in the wireless component is performed based on the port policy and is applicable only in the downstream direction. The wireless module supports the following four queues:

- Voice—This is a strict priority queue. Represented by Q0, this queue processes control traffic and multicast or unicast voice traffic. All control traffic (such as CAPWAP packets) is processed through the voice queue. The QoS module uses a different threshold within the voice queue to process control and voice packets to ensure that control packets get higher priority over other non-control packets.

- Video—This is a strict priority queue. Represented by Q1, this queue processes multicast or unicast video traffic.
- Data NRT—Represented by Q2, this queue processes all non-real-time unicast traffic.
- Multicast NRT—Represented by Q3, this queue processes Multicast NRT traffic. Any traffic that does not match the traffic in Q0, Q1, or Q2 is processed through Q3.

Note By default, the queues Q0 and Q1 are not enabled.

Note A weighted round-robin policy is applied for traffic in the queues Q2 and Q3.

For upstream direction only one queue is available. Port and radio policies are applicable only in the downstream direction.

Note The wired ports support eight queues.

Trust Behavior

Trust Behavior for Wired and Wireless Ports

For wired or wireless 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.

This trust behavior is applicable to both upstream and downstream QoS.

The packets are enqueued to the appropriate queue per the default initial configuration. No priority queuing at the switch is done by default. This is true for unicast and multicast packets.

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 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 setting change 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 9: Trust and Queueing Behavior

Incoming Packet	Outgoing Packet	Trust Behavior	Queuing Behavior
Layer 3	Layer 3	Preserve DSCP/Precedence	Based on DSCP

Incoming Packet	Outgoing Packet	Trust Behavior	Queuing Behavior
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

The Cisco IOS XE 3.2 Release supported different trust defaults for wired and wireless ports. The trust default for wired ports was the same as for this software release. For wireless ports, the default system behavior was non-trust, which meant that when the switch came up, all markings for the wireless ports were defaulted to zero and no traffic received priority treatment. For compatibility with an existing wired switch, all traffic went to the best-effort queue by default. The access point performed priority queuing by default. In the downstream direction, the access point maintained voice, video, best-effort, and background queues for queuing. The access selected the queuing strategy based on the 11e tag information. By default, the access point treated all wireless packets as best effort.

The default trust behavior in the case of wireless ports could be changed by using the **qos wireless default untrust** command.

Note If you upgrade from Cisco IOS XE 3.2 SE Release to a later release, the default behavior of the wireless traffic is still untrusted. In this situation, you can use the **no qos wireless-default untrust** command to enable trust behavior for wireless traffic. However, if you install Cisco IOS XE 3.3 SE or a later release on the switch, the default QoS behavior for wireless traffic is trust. Starting with Cisco IOS XE 3.3 SE Release and later, the packet markings are preserved in both egress and ingress directions for new installations (not upgrades) for wireless traffic.

Related Topics

Configuring Trust Behavior for Wireless Traffic (CLI), on page 73

Example: Table Map Configuration to Retain CoS Markings, on page 113

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.

Note The **trust device** *device_type* interface configuration command is only supported in an auto-QoS configuration, and not as a stand-alone command on the switch. When using the **trust device** *device_type* interface configuration command in an auto-QoS configuration, if the connected peer device is not a corresponding device (defined as a device matching your trust policy), both CoS and DSCP values are set to "0" and any input policy will not take effect.

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

Wireless QoS Mobility

Wireless QoS mobility enables you to configure QoS policies so that the network provides the same service anywhere in the network. A wireless client can roam from one location to another and as a result the client can get associated to different access points associated with a different switch. Wireless client roaming can be classified into two types:

- Intra-switch roaming
- Inter-switch roaming

Note The client policies must be available on all of the switches in the mobility group. The same SSID and port policy must be applied to all switches in the mobility group so that the clients get consistent treatment.

Inter-Switch Roaming

When a client roams from one location to another, the client can get associated to access points either associated to the same switch (anchor switch) or a different switch (foreign switch). Inter-switch roaming refers to the scenario where the client gets associated to an access point that is not associated to the same device before the client roamed. The host device is now foreign to the device to which the client was initially anchored.

In the case of inter-switch roaming, the client QoS policy is always executed on the foreign controller. When a client roams from anchor switch to foreign switch, the QoS policy is uninstalled on the anchor switch and installed on the foreign switch. In the mobility handoff message, the anchor device passes the name of the policy to the foreign switch. The foreign switch should have a policy with the same name configured for the QoS policy to be applied correctly.

In the case of inter-switch roaming, all of the QoS policies are moved from the anchor device to the foreign device. While the QoS policies are in transition from the anchor device to the foreign device, the traffic on the foreign device is provided the default treatment. This is comparable to a new policy installation on the client target.

Note If the foreign device is not configured with the user-defined physical port policy, the default port policy is applicable to all traffic is routed through the NRT queue, except the control traffic which goes through RT1 queue. The network administrator must configure the same physical port policy on both the anchor and foreign devices symmetrically.

Intra-Switch Roaming

With intra-switch roaming, the client gets associated to an access point that is associated to the same switch before the client roamed, but this association to the device occurs through a different access point.

Note QoS policies remain intact in the case of intra-switch roaming.

Precious Metal Policies for Wireless QoS

Wireless QoS is backward compatible with the precious metal policies offered by the unified wireless controller platforms. The precious metal policies are system-defined policies that are available on the controller.

The following policies are available:

- Platinum—Used for VoIP clients.
- Gold—Used for video clients.
- Silver— Used for traffic that can be considered best-effort.
- Bronze—Used for NRT traffic.

These policies (also known as profiles) can be applied to a WLAN based on the traffic. We recommend the configuration using the Cisco IOS MQC configuration. The policies are available in the system based on the precious metal policy required.

Based on the policies applied, the 802.1p, 802.11e (WMM), and DSCP fields in the packets are affected. These values are preconfigured and installed when the switch is booted.

Note Unlike the precious metal policies that were applicable in the Cisco Unified Wireless controllers, the attributes rt-average-rate, nrt-average-rate, and peak rates are not applicable for the precious metal policies configured on this switch platform.

Related Topics

Configuring Precious Metal Policies (CLI), on page 95

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

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 10: Default CoS-to-DSCP Map

CoS Value	DSCP Value
0	0
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 11: Default IP-Precedence-to-DSCP Map

IP Precedence Value	DSCP Value
0	0
1	8

IP Precedence Value	DSCP Value
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 12: 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

Default Wireless QoS Configuration

The ports on the switch do not distinguish between wired or wireless physical ports. Depending on the kind of device associated to the switch, the policies are applied. For example, when an access point is connected to a switch port, the switch detects it as a wireless device and applies the default hierarchical policy which is in the format of a parent-child policy. This policy is an hierarchical policy. The parent policy cannot be modified but the child policy (port-child policy) can be modified to suite the QoS configuration. The switch is preconfigured with a default class map and a policy map.

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 or VLAN. A wireless target can be either a port, radio, SSID, or client. Only port, SSID, and client policies are user configurable. Radio polices are not user configurable. Wireless QoS policies for port, radio, SSID, and client are applied in the downstream direction, and for upstream only SSID and client targets are supported. Downstream indicates that traffic is flowing from the switch to the wireless client. Upstream indicates that traffic is flowing from wireless client to the switch.

The following are restrictions for applying QoS features on the switch for 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.
- 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 when a policy has the port shaper in the parent and queueing features in the child policy.
- A QoS policy cannot be attached to any EtherChannel interface.
- 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.
- Class-maps with empty actions are not supported.
- A maximum of 256 classes are supported per policy on the wired port for the wired target.
- 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.
- Classification counters have the following specific restrictions:
    - Classification counters count packets instead of bytes.
    - Only QoS configurations with marking or policing trigger the classification counter.

    - The classification counter is not port based. This means that the classification counter aggregates all packets belonging to the same class of the same policy which attach to different interfaces.
    - As long as there is policing or marking action in the policy, the class-default will have classification counters.
    - When there are multiple match statements in a class, then the classification counter only shows the traffic counter for one of the match statements.

- Table maps have the following specific restrictions:
    - Only one table map for policing exceeding the markdown and one table map for policing violating the markdown 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 shaping and child marking/policing

- 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.

- The **trust device** *device_type* interface configuration command is only supported in an auto-QoS configuration, and not as a stand-alone command on the switch. When using the **trust device** *device_type* interface configuration command in an auto-QoS configuration, if the connected peer device is not a corresponding device (defined as a device matching your trust policy), both CoS and DSCP values are set to "0" and any input policy will not take effect.

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 and considerations for applying QoS features on EtherChannel and channel member interfaces:

- QoS is not supported on an EtherChannel interface.

- QoS is supported on EtherChannel member interfaces in both ingress and egression directions. All EtherChannel members must have the same QoS policy applied. If the QoS policy is not the same, each individual policy on the different link acts independently.
- On attaching a service policy to channel members, the following warning message appears to remind the user to make sure the same policy is attached to all ports in the EtherChannel: ' Warning: add service policy will cause inconsistency with port xxx in ether channel xxx. '.
- Auto QoS is not supported on EtherChannel members.

Note On attaching a service policy to an EtherChannel, the following message appears on the console: ' Warning: add service policy will cause inconsistency with port xxx in ether channel xxx. '. This warning message should be expected. This warning message is a reminder to attach the same policy to other ports in the same EtherChannel. The same message will be seen during boot up. This message does not mean there is a discrepancy between the EtherChannel member ports.

Related Topics

Restrictions for QoS on Wireless Targets, on page 41

Prerequisites for QoS, on page 1

QoS Overview, on page 3

QoS Implementation, on page 13

Restrictions for QoS on Wireless Targets

General Restrictions

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 or VLAN. A wireless target can be either a port, radio, SSID, or client. Only port, SSID, and client policies are user configurable. Radio polices are not user configurable. Wireless QoS policies for port, radio, SSID, and client are applied in the downstream direction, and for upstream only SSID and client targets are supported. Downstream indicates that traffic is flowing from the switch to the wireless client. Upstream indicates that traffic is flowing from wireless client to the switch.

- Only port, SSID, and client (using AAA and Cisco IOS command-line interface) policies are user-configurable. Radio policies are set by the wireless control module and are not user-configurable.
- Port and radio policies are applicable only in the downstream direction.
- SSID and client support non-queuing policies in the upstream direction.

  SSID and client targets can be configured with marking and policing policies.
- One policy per target per direction is supported.

Wireless QoS Restrictions on Ports

The following are restrictions for applying QoS features on a wireless port target:

- All wireless ports have similar parent policy with one class-default and one action shape under class-default. Shape rates are dependent on the 802.11a/b/g/ac bands.
- You can create a maximum of four classes in a child policy by modifying the `port_chlid_policy`.
- If there are four classes in the `port_child_policy` at the port level, one must be a non-client-nrt class and one must be class-default.
- No two classes can have the same priority level. Only priority level 1 (for voice traffic and control traffic) and 2 (for video) are supported.
- Priority is not supported in the multicast NRT class (non-client-nrt class) and `class-default`.
- If four classes are configured, two of them have to be priority classes. If only three classes are configured, at least one of them should be a priority class. If three classes are configured and there is no non-client-nrt class, both priority levels must be present.
- Only match DSCP is supported.
- The port policy applied by the wireless control module cannot be removed using the CLI.
- Both priority rate and police CIR (using MQC) in the same class is unsupported.
- Queue limit (which is used to configure Weighted Tail Drop) is unsupported.

Wireless QoS Restrictions on SSID

The following are restrictions for applying QoS features on SSID:

- One table map is supported at the ingress policy.
- Table maps are supported for the parent class-default only. Up to two table maps are supported in the egress direction and three table-maps can be configured when a QoS group is involved.

Note Table-maps are not supported at the client targets.

- If a wireless port has a default policy with only two queues (one for multicast-NRT, one for class-default), the policy at SSID level cannot have voice and video class in the egress direction.
- Policing without priority is not supported in the egress direction.
- Priority configuration at the SSID level is used only to configure the RT1 and RT2 policers (AFD for policer). Priority configuration does not include the shape rate. Therefore, priority is restricted for SSID policies without police.
- The mapping in the DSCP2DSCP and COS2COS table should be based on the classification function for the voice and video classes in the port level policy.
- No action is allowed under the class-default of a child policy.
- For a flat policy (non hierarchical), in the ingress direction, the policy configuration must be a set (table map) or policing or both.

Wireless QoS Restrictions on Clients

The following are restrictions for applying QoS policies on client targets:

- Queuing is not supported.
- Attaching, removing, or modifying client policies on a WLAN in the enabled state is not supported. You must shut down the WLAN to apply, remove, or modify a policy.
- Table-map configuration is not supported for client targets.
- Policing and set configured together in class-default is blocked in both the upstream and downstream direction:

```
policy-map foo
class class-default
police X
set dscp Y
```

- Child policy is not supported under class-default if the parent policy contains other user-defined class maps in it.
- Hierarchical client polies are only supported in the egress direction.
- For flat egress client policy, policing in class-default and marking action in other classes are not supported.
- Restrictions for ACLs:
  - All the filters in classes in a policy map for client policy must have the same attributes. Filters matching on protocol-specific attributes such as IPv4 or IPv6 addresses are considered as different attribute sets.
  - For filters matching on ACLs, all ACEs (Access Control Entry) in the access list should have the same type and number of attributes. For example, the following is an invalid access list as they match on different attributes:

```
policy map foo
  class acl-101 (match on 3 tuple)
  police X
  class acl-102 (match on 5 tuple)
  police Y
```

  - For filters matching on marking attributes, all filters in the policy-map must match on the same marking attribute. For example, If filter matches on DSCP, then all filters in the policy must match on DSCP.
  - ACL matching on port ranges and subnet are only supported in ingress direction.
- If an ingress SSID policy is configured along with an ingress client policy matching ACLs with port ranges, the SSID policy takes precedence over the client policy. As a result, the client policy will not take effect.

Related Topics

Applying a QoS Policy on a WLAN (GUI), on page 97
Port Policies, on page 7

Port Policy Format, on page 8

Radio Policies, on page 9

Restrictions for QoS on Wired Targets, on page 39

Prerequisites for QoS, on page 1

QoS Overview, on page 3

QoS Implementation, on page 13

How to Configure QoS

Configuring Class, Policy, and Table Maps

Creating a Traffic Class (CLI)

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**}	Enters class map configuration mode.

	Command or Action	Purpose

	Example:
	`Switch(config)#` **`class-map test_1000`**
	`Switch(config-cmap)#`
		- 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
		- 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`**	(Optional) Matches the DSCP values in IPv4 and IPv6 packets.

	Command or Action	Purpose
	`Switch(config-cmap)#`	

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).

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 802.11e specific values. Enter the user priority 802.11e 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 19

Examples: Classification by Access Control Lists, on page 101

Creating a Traffic Policy (CLI)

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 entered 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`	(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 (CLI), on page 74. **Note** This command only configures CAC for wireless QoS.

	Command or Action	Purpose

	`wmm-tspec`
	`Switch(config-pmap-c)#`	

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 (CLI), on page 81.

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

Step 7	**no**
	Example:
	`Switch(config-pmap-c)# no`
	`Switch(config-pmap-c)#`
		(Optional) Negates the command.

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 (CLI), on page 83.

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.

	Command or Action	Purpose
		For a more detailed example of this command and its usage, see Configuring Priority (CLI), on page 86.

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 (CLI), on page 88.

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 (CLI), on page 90.

Step 12	**service-policy** *policy-map name*
	Example:
	`Switch(config-pmap-c)# service-policy test_2000`
	`Switch(config-pmap-c)#`
		(Optional) Configures the QoS service policy.

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.

	Command or Action	Purpose
		For a more detailed example of this command and its usage, see Configuring Shaping (CLI), on page 93.

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 20

Configuring Client Policies (GUI)

Step 1 Choose **Configuration** > **Wireless**.

Step 2 Expand the **QoS** node by clicking on the left pane and choose **QOS-Policy**.
The **QOS-Policy** page is displayed.

Step 3 Click **Add New** to create a new QoS Policy.
The **Create QoS Policy** page is displayed.

Step 4 Select **Client** from the **Policy Type** drop-down menu.

Step 5 Select the direction into which the policy needs to be applied from the **Policy Direction** drop-down menu.
The available options are:

- **Ingress**
- **Egress**

Step 6 Specify a policy name in the **Policy Name** text box.

Step 7 Provide a description to the policy in the **Description** text box.

Step 8 (Optional) Configure the default voice or video configuration parameters by checking the **Enable Voice** or **Enable Video** checkbox.
The following options are available:

- **Trust—**Specify the classification type behavior on this policy. The options available are:
    - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.

    - **User Priority—**This option is available when the **Policy Direction** is ingress. Enter the 802.11e user priority. The range is from 0 to 7.
    - **COS—**This option is available when the **Policy Direction** is egress. Matches IEEE 802.1Q class of service. The range is from 0 to 7.

- **Mark—**Specify the marking label for each packet. The following options are available:
    - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.
    - **CoS—**Matches IEEE 802.1Q class of service. The range is from 0 to 7.
    - **User Priority—**Enter the 802.11e user priority. The range is from 0 to 7.

- **Police(kbps)—**Specify the policing rate in kbps.

Note The marking and policing options are optional.

Step 9 Specify the **Class-default** parameters.
The following options are available:

- **Mark—**Specify the marking label for each packet. The following options are available:
    - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.
    - **CoS—**Matches IEEE 802.1Q class of service. The range is from 0 to 7.
    - **User Priority—**Enter the 802.11e user priority. The range is from 0 to 7.

- **Police (kbps)—**This option is available when the **Policy Direction** is egress. This option Specify the policing rate in kbps.

Step 10 (Optional) To configure user defined classes, check the **User Defined Classes** checkbox.
The following options are available:

- **Trust—**Specify the classification type behavior on this policy.
    - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.
    - **User Priority—**This option is available when the **Policy Direction** is ingress. Enter the 802.11e user priority. The range is from 0 to 7.
    - **COS—**This option is available when the **Policy Direction** is egress. Matches IEEE 802.1Q class of service. The range is from 0 to 7.

- **Mark—**Specify the marking label for each packet. The following options are available:
    - **DSCP—**Assigns a label to indicate the given quality of service. The range is from 0 to 63.
    - **CoS—**Matches IEEE 802.1Q class of service. The range is from 0 to 7.
    - **User Priority—**Enter the 802.11e user priority. The range is from 0 to 7.

- **Police (kbps)—**This option is available when the **Policy Direction** is egress. This option Specify the policing rate in kbps.

Step 11 Click **Add** to add the policy.

Related Topics

Client Policies, on page 10

Supported QoS Features on Wireless Targets, on page 6

Examples: Client Policies, on page 106

Configuring Class-Based Packet Marking (CLI)

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.

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.

	Command or Action	Purpose
		• **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.
		• **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.

	Command or Action	Purpose
		• **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.
		• **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`
		(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.

	Command or Action	Purpose
	`Switch(config-pmap)#`	• **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**
	Example:
	`Switch(config-pmap)#` **`end`**
	`Switch#`
		Saves configuration changes.

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.

Configuring Class Maps for Voice and Video (CLI)

To configure class maps for voice and video traffic, follow these steps:

SUMMARY STEPS

1. **configure terminal**
2. **class-map** *class-map-name*
3. **match dscp** *dscp-value-for-voice*
4. **end**
5. **configure terminal**
6. **class-map** *class-map-name*
7. **match dscp** *dscp-value-for-video*
8. **end**

DETAILED STEPS

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

Step 2	**class-map** *class-map-name*
	Example:
	`Switch(config)# class-map voice`
		Creates a class map.

Step 3	**match dscp** *dscp-value-for-voice* **Example:** `Switch(config-cmap)# match dscp 46`	Matches the DSCP value in the IPv4 and IPv6 packets. Set this value to 46.

Step 4	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Step 5	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.

Step 6	**class-map** *class-map-name*
	Example:
	`Switch(config)# class-map video`
		Configures a class map.

	Command or Action	Purpose
Step 7	**match dscp** *dscp-value-for-video* **Example:** `Switch(config-cmap)# match dscp 34`	Matches the DSCP value in the IPv4 and IPv6 packets. Set this value to 34.

Step 8	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Attaching a Traffic Policy to an Interface (CLI)

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*
	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

	Command or Action	Purpose
		• **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 20

Configuring SSID Policies (GUI)

Step 1 Choose **Configuration** > **Wireless**.

Step 2 Expand the **QoS** node by clicking on the left pane and choose **QOS-Policy**.
The **Create QoS Policy** page is displayed.

Step 3 Click **Add New** to create a new QoS Policy.
The **QoS Policy** page is displayed.

Step 4 Select **SSID** from the **Policy Type** drop-down menu.

Step 5 Select the direction into which the policy needs to be applied from the **Policy Direction** drop-down list.
The available options are:

- **Ingress**
- **Egress**

Note Voice and video configurations are available only in the egress direction.

Note When creating an egress SSID policy for voice and video classes, if the **port_child_policy** is already configured with voice and video classes having priority level, the existing **port_child_policy** is used. If a **port_child_policy** does not exist with voice and video classes, the switch will create voice and video classes with priority levels 1 and 2 under **port_child_policy** for voice and video traffic.

Step 6 Specify a policy name in the **Policy Name** text box.

Step 7 Provide a description to the policy in the **Description** text box.

Step 8 Select the trust parameter from the **Trust** drop-down list.
The following options are available:

- **DSCP—** Assigns a label to indicate the given quality of service as DSCP.
- **COS—**Matches IEEE 802.1Q class of service. This option is not available when the **Policy Direction** is engres.
- **User Priority—**Enter the 802.11e user priority. This option is not available when the **Policy Direction** is engres.
- **None—**This option is available when the **Policy Direction** is egress. This option is available only for egress policies.

Step 9 If you chose **Egress** policy above, the following options are available:

- **Bandwidth—**Specifies the bandwidth rate. The following options are available:
  - ◦ **Rate—**Specifies the bandwidth in kbps. Enter a value in kbps in the **Value** field.
  - ◦ **Remaining Ratio—**Specifies the bandwidth in BRR (bandwidth remaining ratio). Enter the percentage in the **Percent** field.

  Note If you choose the **Rate** option for the **Bandwidth** parameter, this value must be greater than the sum of the policing values for voice and video traffic.

  .

- **Enable Voice—**Click on the **Enable Voice** checkbox to enable voice traffic on this policy. Specify the following properties:

- ◦ **Priority—**Sets the priority for this policy for strict scheduling. The priority level is set to 1.
- ◦ **Police (kbps)—**Specifies the police rate in Kilobits per second.
- ◦ **CAC—**Enables or disables CAC. If CAC is enabled, you must specify the following options:
  - ◦ **User priority**This option is available when the **Policy Direction** is ingress. Enter the 802.11e user priority. The range is from 0 to 7. By default, a value of 6 is assigned.
  - ◦ **Rate(kbps)**

  Note The CAC rate must be less than the police rate.

- **Enable Video—**Check the **Enable Video** checkbox to enable video traffic on this policy. Specify the following properties:

- **Priority—**Sets the priority for this policy for strict scheduling.
- **Police (kbps)—**Specifies the police rate in kilobits per second.

Step 10 Click **Apply**.

Related Topics

SSID Policies, on page 10

Supported QoS Features on Wireless Targets, on page 6

Examples: SSID Policy

Examples: Configuring Downstream SSID Policy, on page 105

Applying an SSID or Client Policy on a WLAN (CLI)

Before You Begin

You must have a service-policy map configured before applying it on an SSID.

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *profile-name*
3. **service-policy** [**input** | **output**] *policy-name*
4. **service-policy client** [**input** | **output**] *policy-name*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 2	**wlan** *profile-name* **Example:** `Switch# wlan test4`	Enters the WLAN configuration submode. The *profile-name* is the profile name of the configured WLAN.
Step 3	**service-policy** [**input** | **output**] *policy-name* **Example:** `Switch(config-wlan)# service-policy input policy-map-ssid`	Applies the policy. The following options are available: • **input**— Assigns the policy map to WLAN ingress traffic. • **output**— Assigns the policy map to WLAN egress traffic.
Step 4	**service-policy client** [**input** | **output**] *policy-name* **Example:** `Switch(config-wlan)# service-policy client input policy-map-client`	Applies the policy. The following options are available: • **input**— Assigns the client policy for ingress direction on the WLAN. • **output**— Assigns the client policy for egress direction on the WLAN.

Step 5	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Related Topics

SSID Policies, on page 10

Supported QoS Features on Wireless Targets, on page 6

Examples: SSID Policy

Examples: Configuring Downstream SSID Policy, on page 105

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

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.

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.

	Command or Action	Purpose
		• **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.
		• **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.

	Command or Action	Purpose
		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.

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 (CLI)

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.

	Command or Action	Purpose

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.

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).

	Command or Action	Purpose

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.
		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.

	Command or Action	Purpose
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 21

Examples: Policer VLAN Configuration, on page 111

Configuring Table Maps (CLI)

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`
	`Switch(config-tablemap)#`
		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.
		• **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`
		Displays the table map configuration.

	Command or Action	Purpose

	`from 0 to 2`
	`from 1 to 4`
	`from 24 to 3`
	`from 40 to 6`
	`default 0`	

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

Step 8	**policy-map**
	Example:
	`Switch(config)#` **`policy-map table-policy`**
	`Switch(config-pmap)#`
		Configures the policy map for the table map.

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 23

Examples: Table Map Marking Configuration, on page 113

Configuring Trust

Configuring Trust Behavior for Wireless Traffic (CLI)

The Cisco IOS XE 3.2 Release supported different trust defaults for wired and wireless ports. The trust default for wired ports was the same as for this software release. For wireless ports, the default system behavior was non-trust, which meant that when the switch came up, all markings for the wireless ports were defaulted to zero and no traffic received priority treatment. For compatibility with an existing wired switch, all traffic went to the best-effort queue by default. The access point performed priority queuing by default. In the downstream direction, the access point maintained voice, video, best-effort, and background queues for queuing. The access selected the queuing strategy based on the 11e tag information. By default, the access point treated all wireless packets as best effort.

SUMMARY STEPS

1. **configure terminal**
2. **qos wireless-default-untrust**
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 2	**qos wireless-default-untrust** **Example:** `Switch (config)# qos wireless-default-untrust`	Configures the behavior of the switch to untrust wireless traffic. To configure the switch to trust wireless traffic by default, use the **no** form of the command.

Step 3	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Related Topics

Trust Behavior for Wired and Wireless Ports, on page 33

Configuring QoS Features and Functionality

Configuring Call Admission Control (CLI)

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

SUMMARY STEPS

1. **configure terminal**
2. **class-map** *class name*
3. **match dscp** *dscp value*
4. **exit**
5. **class-map** *class name*
6. **match dscp** *dscp value*
7. **exit**
8. **table-map** *name*
9. **default copy**
10. **exit**
11. **table-map** *name*
12. **default copy**
13. **exit**
14. **policy-map** *policy name*
15. **class** *class-map-name*
16. **priority level** *level_value*
17. **police** [*target_bit_rate* | **cir** | **rate**]
18. **admit cac wmm-tspec**
19. **rate** *value*
20. **wlan-up** *value*
21. **exit**
22. **exit**
23. **class** *class name*
24. **priority level** *level_value*
25. **police** [*target_bit_rate* | **cir** | **rate**]
26. **admit cac wmm-tspec**
27. **rate** *value*
28. **wlan-up** *value*
29. **exit**
30. **exit**
31. **policy-map** *policy name*
32. **class** *class-map-name*
33. **set dscp dscp table** *table_map_name*
34. **set wlan user-priority dscp table** *table_map_name*
35. **shape average** {*target bit rate* | **percent** *percentage*}
36. **queue-buffers** {**ratio** *ratio value*}
37. **service-policy** *policy_map_name*
38. **end**
39. **show policy-map**

DETAILED STEPS

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

Step 2	**class-map** *class name*
	Example:
	`Switch(config)# class-map voice`
	`Switch(config-cmap)#`
		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 3	**match dscp** *dscp value* **Example:** `Switch(config-cmap)#  match dscp 46`	(Optional) Matches the DSCP values in IPv4 and IPv6 packets.

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

Step 5	**class-map** *class name*
	Example:
	`Switch(config)# class-map video`
	`Switch(config-cmap)#`
		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 6	**match dscp** *dscp value* **Example:** `Switch(config-cmap)#  match dscp 34`	(Optional) Matches the DSCP values in IPv4 and IPv6 packets.
Step 7	**exit**	Returns to global configuration mode.

	Command or Action	Purpose

	Example:
	`Switch(config-cmap)# exit`
	`Switch(config)#`	

Step 8	**table-map** *name*
	Example:
	`Switch(config)# table-map  dscp2dscp`
	`Switch(config-tablemap)#`
		Creates a table map and enters the table map configuration mode.

Step 9	**default copy** **Example:** `Switch(config-tablemap)# default copy`	Sets the default behavior for value not found in the table map to copy. **Note** This is the default option. You can also do a mapping of values for DSCP to DSCP.

Step 10	**exit**
	Example:
	`Switch(config-tablemap)# exit`
	`Switch(config)#`
		Returns to global configuration mode.

Step 11	**table-map** *name*
	Example:
	`Switch(config)# table-map dscp2up`
	`Switch(config-tablemap)#`
		Creates a new table map and enters the table map configuration mode.

Step 12	**default copy** **Example:** `Switch(config-tablemap)# default copy`	Sets the default behavior for value not found in the table map to copy. **Note** This is the default option. You can also do a mapping of values for DSCP to UP.

Step 13	**exit**
	Example:
	`Switch(config-tablemap)# exit`
	`Switch(config)#`
		Returns to global configuration mode.

Step 14	**policy-map** *policy name* **Example:** `Switch(config)#  policy-map ssid_child_cac`	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
	`Switch(config-pmap)#`	

Step 15	**class** *class-map-name*
	Example:
	`Switch(config-pmap)# class voice`
		Defines an interface-level traffic classification, and enters policy-map configuration mode.

Step 16	**priority level** *level_value* **Example:** `Switch(config-pmap-c)# priority level 1`	The **priority** command assigns a strict scheduling priority for the class. **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 17	**police** [*target_bit_rate* | **cir** | **rate**] **Example:** `Switch(config-pmap-c)#  police cir 10m`	(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.

Step 18	**admit cac wmm-tspec**
	Example:
	`Switch(config-pmap-c)# admit cac wmm-tspec`
	`Switch(config-pmap-cac-wmm)#`
		Configures call admission control for the policy map.
		Note This command only configures CAC for wireless QoS.

Step 19	**rate** *value* **Example:** `Switch(config-pmap-admit-cac-wmm)# rate 5000`	Configures the target bit rate (Kilo Bits per second). Enter a value from 8 to 10000000.
Step 20	**wlan-up** *value* **Example:** `Switch(config-pmap-admit-cac-wmm)# wlan-up 6 7`	Configures the WLAN UP value. Enter a value from 0 to 7.
Step 21	**exit** **Example:** `Switch(config-pmap-admit-cac-wmm)# exit`	Returns to policy map class configuration mode.

	Command or Action	Purpose
	`Switch(config-pmap-c)#`	

Step 22	**exit**
	Example:
	`Switch(config-pmap-c)# exit`
	`Switch(config-pmap)#`
		Returns to policy map configuration mode.

Step 23	**class** *class name*
	Example:
	`Switch(config-pmap)# class video`
	`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 24	**priority level** *level_value* **Example:** `Switch(config-pmap-c)# priority level 2`	The **priority** command assigns a strict scheduling priority for the class. **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 25	**police** [*target_bit_rate* | **cir** | **rate**] **Example:** `Switch(config-pmap-c)#  police cir 20m`	(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.

Step 26	**admit cac wmm-tspec**
	Example:
	`Switch(config-pmap-c)# admit cac wmm-tspec`
	`Switch(config-pmap-admit-cac-wmm)#`
		Configures call admission control for the policy map.
		Note This command only configures CAC for wireless QoS.

Step 27	**rate** *value* **Example:** `Switch(config-pmap-admit-cac-wmm)# rate 5000`	Configures the target bit rate (Kilo Bits per second). Enter a value from 8 to 10000000.
Step 28	**wlan-up** *value*	Configures the WLAN UP value. Enter a value from 0 to 7.

	Command or Action	Purpose
	Example: `Switch(config-pmap-admit-cac-wmm)#` **`wlan-up 4 5`**	

Step 29	**exit**
	Example:
	`Switch(config-pmap-cac-wmm)#` **`exit`**
	`Switch(config-pmap)#`
		Returns to policy map configuration mode.

Step 30	**exit**
	Example:
	`Switch(config-pmap)#` **`exit`**
	`Switch(config)#`
		Returns to global configuration mode.

Step 31	**policy-map** *policy name*
	Example:
	`Switch(config)#` **`policy-map ssid_cac`**
	`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 32	**class** *class-map-name*
	Example:
	`Switch(config-pmap)#` **`class default`**
		Defines an interface-level traffic classification, and enters policy-map configuration mode.
		In this example, the class map is set to default.

Step 33	**set dscp dscp table** *table_map_name* **Example:** `Switch(config-pmap-c)#` **`set dscp dscp table dscp2dscp`**	(Optional) Sets the QoS values. In this example, the **set dscp dscp table** command creates a table map and sets its values.
Step 34	**set wlan user-priority dscp table** *table_map_name* **Example:** `Switch(config-pmap-c)#` **`set wlan user-priority dscp table dscp2up`**	(Optional) Sets the QoS values. In this example, the **set wlan user-priority dscp table** command sets the WLAN user priority.

	Command or Action	Purpose

Step 35	**shape average** {*target bit rate* | **percent** *percentage*}
	Example:
	`Switch(config-pmap-c)# shape average 100000000`
		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 36	**queue-buffers** {**ratio** *ratio value*}
	Example:
	`Switch(config-pmap-c)# queue-buffers ratio 0`
		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 evenly distributed to all the remaining queues.

Step 37	**service-policy** *policy_map_name* **Example:** `Switch(config-pmap-c)#  service-policy ssid_child_cac`	Specifies the policy map for the service policy.

Step 38	**end**
	Example:
	`Switch(config-pmap)# end`
	`Switch#`
		Saves configuration changes.

Step 39	**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.

For additional information about CAC, refer to the *System Management Configuration Guide, Cisco IOS XE Release 3SE (Catalyst 3650 Switches).*

Configuring Bandwidth (CLI)

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.

	Command or Action	Purpose
		• **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**
	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 the policy maps, attach the traffic policy or polices to an interface using the **service-policy** command.

Related Topics

Bandwidth, on page 28

Configuring Police (CLI)

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`
		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.

	Command or Action	Purpose

	`drop`
	`Switch(config-pmap-c)#`
		◦ *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 to 10000000000).
		◦ **percent**—Percentage of interface bandwidth for rate.
		The following **police conform-action transmit exceed-action** subcommand options are available:
		• **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 26

Examples: Single-Rate Two-Color Policing Configuration, on page 112

Dual-Rate Three-Color Policing, on page 26

Examples: Dual-Rate Three-Color Policing Configuration, on page 112

Policing, on page 22

Examples: Policing Action Configuration, on page 110

Token-Bucket Algorithm, on page 22

Examples: Policing Units, on page 111

Configuring Priority (CLI)

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.

	Command or Action	Purpose

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*]]
	Example:
	`Switch(config-pmap-c)# priority level 1`
	`Switch(config-pmap-c)#`
		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).
		◦ *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 31

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 (CLI)

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.

	Command or Action	Purpose
		• **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-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 32

Examples: Queue Buffers Configuration, on page 110

Configuring Queue Limits (CLI)

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 29.
		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 29

Examples: Queue-limit Configuration, on page 109

Configuring Shaping (CLI)

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 28

Examples: Average Rate Shaping Configuration, on page 108

Hierarchical Shaping, on page 28

Configuring Precious Metal Policies (CLI)

You can configure precious metal QoS policies on a per-WLAN basis.

SUMMARY STEPS

1. **configure terminal**
2. **wlan** *wlan-name*
3. **service-policy output** *policy-name*
4. **end**
5. **show wlan** {*wlan-id* | *wlan-name*}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global command mode.
Step 2	**wlan** *wlan-name* **Example:** `Switchwlan test4`	Enters the WLAN configuration submode.

Step 3	**service-policy output** *policy-name*
	Example:
	`Switch(config-wlan)# service-policy output platinum`
	Example:
	`Switch(config-wlan)# service-policy input platinum-up`
		Configures the WLAN with the QoS policy. To configure the WLAN with precious metal policies, you must enter one of the following keywords: **platinum**, **gold**, **silver**, or **bronze**. The upstream policy is specified with the keyword **platinum-up** as shown in the example.
		Note Upstream policies differ from downstream policies. The upstream policies have a suffix of -up.

	Command or Action	Purpose

Step 4	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit the global configuration mode.

Step 5	**show wlan** {*wlan-id* | *wlan-name*}
	Example:
	`Switch# show wlan name qos-wlan`
		Verifies the configured QoS policy on the WLAN.
		`Switch# show wlan name qos-wlan`
		`. . .`
		`. . .`
		`. . .`
		`QoS Service Policy - Input`
		`  Policy Name                                 : platinum-up`
		`  Policy State                                : Validated`
		`QoS Service Policy - Output`
		`  Policy Name                                 : platinum`
		`  Policy State                                : Validated`
		`. . .`
		`. . .`

Related Topics

Precious Metal Policies for Wireless QoS, on page 36

Configuring QoS Policies for Multicast Traffic (CLI)

Before You Begin

The following are the prerequisites for configuring a QoS policy for multicast traffic:

- You must have a multicast service policy configured.
- You must enable multicast-multicast mode before applying the policy.

SUMMARY STEPS

1. **configure terminal**
2. **ap capwap multicast service-policy output** *service-policy-name*
3. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Switch# configure terminal`	Enters global configuration mode.
Step 2	**ap capwap multicast service-policy output** *service-policy-name* **Example:** `Switch(config)#ap capwap multicast service-policy output service-policy-mcast`	Applies the configured multicast policy.

Step 3	**end**
	Example:
	`Switch(config)# end`
		Returns to privileged EXEC mode. Alternatively, you can also press **Ctrl-Z** to exit global configuration mode.

Related Topics

Wireless QoS Multicast, on page 21

Examples: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic, on page 105

Applying a QoS Policy on a WLAN (GUI)

Step 1 Choose **Configuration** > **Wireless**.

Step 2 Expand the **WLAN** node by clicking on the left pane and choose **WLANs**.
The **WLANs** page is displayed.

Step 3 Select the WLAN for which you want to configure the QoS policies by clicking on the WLAN **Profile**.

Step 4 Click the QoS tab to configure the QoS policies on the WLAN.
The following options are available:

Parameter	Description
QoS SSID Policy	
Downstream QoS Policy	QoS downstream policy configuration. The **Existing Policy** column displays the current applied policy. To change the existing policy, select the policy from the drop-down list in the **Assign Policy** column.

Parameter	Description
Upstream QoS Policy	QoS upstream policy configuration. The **Existing Policy** column displays the current applied policy. To change the existing policy, select the policy from the drop-down list in the **Assign Policy** column.
QoS Client Policy	
Downstream QoS Policy	QoS downstream policy configuration. The **Existing Policy** column displays the current applied policy. To change the existing policy, select the policy from the drop-down list in the **Assign Policy** column.
Upstream QoS Policy	QoS upstream policy configuration. The **Existing Policy** column displays the current applied policy. To change the existing policy, select the policy from the drop-down list in the **Assign Policy** column.
WMM	
WMM Policy	WMM Policy. Values are the following: • Disabled—Disables this WMM policy. • Allowed—Allows the clients to communicate with the WLAN. • Required—Ensures that it is mandatory for the clients to have WMM features enabled on them to communicate with the WLAN.

Step 5 Click **Apply**.

Related Topics

Port Policies, on page 7

Port Policy Format, on page 8

Restrictions for QoS on Wireless Targets, on page 41

Supported QoS Features on Wireless Targets, on page 6

Examples: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic, on page 105

SSID Policies, on page 10

Supported QoS Features on Wireless Targets, on page 6

Examples: SSID Policy
Examples: Configuring Downstream SSID Policy, on page 105

Client Policies, on page 10

Supported QoS Features on Wireless Targets, on page 6

Examples: Client Policies, on page 106

Monitoring QoS

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

Note Classification counters and statistics are not supported for any wireless targets.

Table 13: 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.
show policy-map interface wireless ssid name *ssid-name* **radio type** {**24ghz** | **5ghz**} **ap name** *ap-name*	Displays SSID policy configuration on an access point.

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 (CLI), on page 44

Class Maps, on page 19

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 11

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)# match dscp 30
Switch(config-cmap)# exit

Switch(config)# class-map c2
Switch(config-cmap)# match precedence 4
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
```

Related Topics

Hierarchical QoS, on page 11

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: Wireless QoS Policy Classified by Voice, Video, and Multicast Traffic

The following example provides a template for creating a port child policy for managing quality of service for voice and video traffic.

```
Policy-map port_child_policy
    Class voice (match dscp ef)
            Priority level 1
            Police  Multicast Policer
    Class video (match dscp af41)
            Priority level 2
            Police  Multicast Policer
    Class mcast-data  (match non-client-nrt)
            Bandwidth remaining ratio <>
    Class class-default  (NRT Data)
            Bandwidth remaining ratio <>
```

Note Multicast Policer in the example above is not a keyword. It refers to the policing policy configured.

Two class maps with name voice and video are configured with DSCP assignments of 46 and 34. The voice traffic is assigned the priority of 1 and the video traffic is assigned the priority level 2 and is processed using Q0 and Q1. If your network receives multicast voice and video traffic, you can configure multicast policers. The non-client NRT data and NRT data are processed using the Q2 and Q3 queues.

Related Topics

Applying a QoS Policy on a WLAN (GUI), on page 97
Port Policies, on page 7
Port Policy Format, on page 8
Configuring QoS Policies for Multicast Traffic (CLI), on page 96
Wireless QoS Multicast, on page 21

Examples: Configuring Downstream SSID Policy

To configure a downstream BSSID policy, you must first configure a port child policy with priority level queuing.

Configuring a User-Defined Port Child Policy

The following is an example of configuring a user-defined port child policy:

```
policy-map port_child_policy
   class voice
     priority level 1 20000

   class video
     priority level 2 10000

   class non-client-nrt-class
     bandwidth remaining ratio 10

   class class-default
     bandwidth remaining ratio 15
```

Configuring Downstream BSSID Policy

The following configuration example displays how to configure a downstream BSSID policy:

```
policy-map bssid-policer
   queue-buffer ratio 0
   class class-default
   shape average 30000000
set dscp dscp table dscp2dscp
set wlan user-priority dscp table dscp2up
service-policy ssid_child_qos
```

The SSID child QoS policy may be defined as below:

```
Policy Map ssid-child_qos
    Class voice
      priority level 1
      police cir 5m
      admit cac wmm-tspec
           UP 6,7  / tells WCM allow ‘voice’ TSPEC\SIP snoop for this ssid
            rate 4000 / must be police rate value is in kbps)
   Class video
      priority level 2
      police cir 60000
```

Related Topics

Configuring SSID Policies (GUI), on page 61

Applying an SSID or Client Policy on a WLAN (CLI), on page 62

Applying a QoS Policy on a WLAN (GUI), on page 97

SSID Policies, on page 10

Examples: Client Policies

The following example shows a default client policy in the downstream direction. Any incoming traffic contains the user-priority as 0:

Note The default client policy is enabled only on WMM clients that are ACM-enabled.

```
Policy-map client-def-down
  class class-default
```

```
      set wlan user-priority 0
```

The following example shows the default client policy in the upstream direction. Any traffic that is sent to the wired network from wireless network will result in the DSCP value being set to 0.

Note The default client policy is enabled only on WMM clients that are ACM-enabled.

```
Policy-map client-def-up
   class class-default
    set dscp 0
```

The following examples shows client policies that are generated automatically and applied to the WMM client when the client authenticates to a profile in AAA with a QoS-level attribute configured.

```
Policy Map platinum-WMM
Class voice-plat
  set wlan user-priority 6
 Class video-plat
 set wlan user-priority 4
Class class-default
  set wlan user-priority 0

Policy Map gold-WMM
Class voice-gold
  set wlan user-priority 4
 Class video-gold
 set wlan user-priority 4
Class class-default
  set wlan user-priority 0
```

The following is an example of non-WMM client precious metal policies:

```
Policy Map platinum
  set wlan user-priority 6
```

Any traffic matching class voice1 the user priority is set to a pre-defined value. The class can be set to assign a DSCP or ACL.

```
Policy Map client1-down
Class voice1     //match dscp, cos
  set wlan user-priority <>
Class voice2    //match acl
   set wlan user-priority <>
Class voice3
   set wlan user-priority <>
Class class-default
  set wlan user-priority 0
```

The following is an example of a client policy based on AAA and TCLAS:

```
Policy Map client2-down[ AAA+ TCLAS pol example]
Class      voice\\match dscp
      police <>
      set <>
Class class-default
    set <>
Class voice1|| voice2 [match acls]
      police <>
      class voice1
        set <>
      class voice2
        set <>
```

The following is an example of a client policy for voice and video for traffic in the downstream direction:

```
Policy Map client3-down
    class voice \\match dscp, cos
          police X
     class video
         police Y
    class class-default
        police Z
```

The following is an example of a client policy for voice and video for traffic in the upstream direction using policing:

```
Policy Map client1-up
    class voice     \\match dscp, up, cos
      police X
    class video
     police Y
  class class-default
    police Z
```

The following is an example of a client policy for voice and video based on DSCP:

```
Policy Map client2-up
    class voice     \\match dscp, up, cos
set dscp <>
    class video
     set dscp <>
  class class-default
    set dscp <>
```

Related Topics

Configuring Client Policies (CLI)

Configuring Client Policies (GUI), on page 51

Applying a QoS Policy on a WLAN (GUI), on page 97

Client Policies, on page 10

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 (CLI), on page 93

Average Rate Shaping, on page 28

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 (CLI), on page 90

Weighted Tail Drop, on page 29

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 (CLI), on page 88

Queue Buffer Allocation, on page 32

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 (CLI), on page 83

Policing, on page 22

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 (CLI), on page 67

Policy Map on VLANs, on page 21

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 (CLI), on page 83

Token-Bucket Algorithm, on page 22

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 (CLI), on page 83

Single-Rate Two-Color Policing, on page 26

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 (CLI), on page 83

Dual-Rate Three-Color Policing, on page 26

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 (CLI), on page 70

Table Map Marking, on page 23

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
```

Related Topics

Trust Behavior for Wired and Wireless Ports, on page 33

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
For complete syntax and usage information for the commands used in this chapter.	*QoS Command Reference (Catalyst 3650 Switches)* *Cisco IOS Quality of Service Solutions Command Reference*
Call Admission Control (CAC)	*System Management Configuration Guide (Catalyst 3650 Switches)* *System Management Command Reference (Catalyst 3650 Switches)*
Multicast Shaping and Policing Rate	*IP Multicast Routing Configuration Guide (Catalyst 3650 Switches)*
Precious Metal Policies	*Cisco Wireless LAN Controller Configuration Guide.*

Error Message Decoder

Description	Link
To help you research and resolve system error messages in this release, use the Error Message Decoder tool.	https://www.cisco.com/cgi-bin/Support/Errordecoder/index.cgi

Standards and RFCs

Standard/RFC	Title
—	

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

Release	Modification
Cisco IOS XE 3.3SE	This feature was introduced.