



QoS: Congestion Avoidance Configuration Guide, Cisco IOS Release 15M&T

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CHAPTER

1

Congestion Avoidance Overview

Congestion avoidance techniques monitor network traffic loads in an effort to anticipate and avoid congestion at common network bottlenecks. Congestion avoidance is achieved through packet dropping. Among the more commonly used congestion avoidance mechanisms is Random Early Detection (RED), which is optimum for high-speed transit networks. Cisco IOS QoS includes an implementation of RED that, when configured, controls when the router drops packets. If you do not configure Weighted Random Early Detection (WRED), the router uses the cruder default packet drop mechanism called tail drop.

This module gives a brief description of the kinds of congestion avoidance mechanisms provided by the Cisco IOS QoS features. It discusses the following features:

- Tail drop. This is the default congestion avoidance behavior when WRED is not configured.
- WRED. WRED and distributed WRED (DWRED)--both of which are the Cisco implementations of RED--combine the capabilities of the RED algorithm with the IP Precedence feature. Within the section on WRED, the following related features are discussed:
 - Flow-based WRED. Flow-based WRED extends WRED to provide greater fairness to all flows on an interface in regard to how packets are dropped.
 - DiffServ Compliant WRED. DiffServ Compliant WRED extends WRED to support Differentiated Services (DiffServ) and Assured Forwarding (AF) Per Hop Behavior (PHB). This feature enables customers to implement AF PHB by coloring packets according to differentiated services code point (DSCP) values and then assigning preferential drop probabilities to those packets.

- [Finding Feature Information, page 1](#)
- [Tail Drop, page 2](#)
- [Weighted Random Early Detection, page 2](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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

Tail Drop

Tail drop treats all traffic equally and does not differentiate between classes of service. Queues fill during periods of congestion. When the output queue is full and tail drop is in effect, packets are dropped until the congestion is eliminated and the queue is no longer full.

Weighted Random Early Detection

This section gives a brief introduction to RED concepts and addresses WRED, the Cisco implementation of RED for standard Cisco IOS platforms.

WRED avoids the globalization problems that occur when tail drop is used as the congestion avoidance mechanism on the router. Global synchronization occurs as waves of congestion crest only to be followed by troughs during which the transmission link is not fully utilized. Global synchronization of TCP hosts, for example, can occur because packets are dropped all at once. Global synchronization manifests when multiple TCP hosts reduce their transmission rates in response to packet dropping, then increase their transmission rates once again when the congestion is reduced.

About Random Early Detection

The RED mechanism was proposed by Sally Floyd and Van Jacobson in the early 1990s to address network congestion in a responsive rather than reactive manner. Underlying the RED mechanism is the premise that most traffic runs on data transport implementations that are sensitive to loss and will temporarily slow down when some of their traffic is dropped. TCP, which responds appropriately--even robustly--to traffic drop by slowing down its traffic transmission, effectively allows the traffic-drop behavior of RED to work as a congestion-avoidance signalling mechanism.

TCP constitutes the most heavily used network transport. Given the ubiquitous presence of TCP, RED offers a widespread, effective congestion-avoidance mechanism.

In considering the usefulness of RED when robust transports such as TCP are pervasive, it is important to consider also the seriously negative implications of employing RED when a significant percentage of the traffic is not robust in response to packet loss. Neither Novell NetWare nor AppleTalk is appropriately robust in response to packet loss, therefore you should not use RED for them.

How It Works

RED aims to control the average queue size by indicating to the end hosts when they should temporarily slow down transmission of packets.

RED takes advantage of the congestion control mechanism of TCP. By randomly dropping packets prior to periods of high congestion, RED tells the packet source to decrease its transmission rate. Assuming the packet source is using TCP, it will decrease its transmission rate until all the packets reach their destination, indicating that the congestion is cleared. You can use RED as a way to cause TCP to slow down transmission of packets. TCP not only pauses, but it also restarts quickly and adapts its transmission rate to the rate that the network can support.

RED distributes losses in time and maintains normally low queue depth while absorbing spikes. When enabled on an interface, RED begins dropping packets when congestion occurs at a rate you select during configuration.

Packet Drop Probability

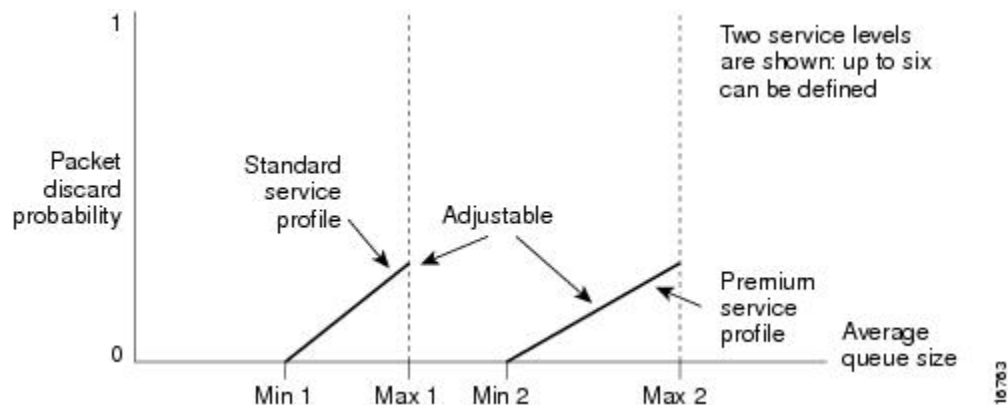
The packet drop probability is based on the minimum threshold, maximum threshold, and mark probability denominator.

When the average queue depth is above the minimum threshold, RED starts dropping packets. The rate of packet drop increases linearly as the average queue size increases until the average queue size reaches the maximum threshold.

The mark probability denominator is the fraction of packets dropped when the average queue depth is at the maximum threshold. For example, if the denominator is 512, one out of every 512 packets is dropped when the average queue is at the maximum threshold.

When the average queue size is above the maximum threshold, all packets are dropped. The figure below summarizes the packet drop probability.

Figure 1: RED Packet Drop Probability



The minimum threshold value should be set high enough to maximize the link utilization. If the minimum threshold is too low, packets may be dropped unnecessarily, and the transmission link will not be fully used.

The difference between the maximum threshold and the minimum threshold should be large enough to avoid global synchronization of TCP hosts (global synchronization of TCP hosts can occur as multiple TCP hosts reduce their transmission rates). If the difference between the maximum and minimum thresholds is too small, many packets may be dropped at once, resulting in global synchronization.

How TCP Handles Traffic Loss

When the recipient of TCP traffic--called the receiver--receives a data segment, it checks the four octet (32-bit) sequence number of that segment against the number the receiver expected, which would indicate that the data segment was received in order. If the numbers match, the receiver delivers all of the data that it holds to the target application, then it updates the sequence number to reflect the next number in order, and finally it either immediately sends an acknowledgment (ACK) packet to the sender or it schedules an ACK to be sent to the sender after a short delay. The ACK notifies the sender that the receiver received all data segments up to but not including the one marked with the new sequence number.

Receivers usually try to send an ACK in response to alternating data segments they receive; they send the ACK because for many applications, if the receiver waits out a small delay, it can efficiently include its reply acknowledgment on a normal response to the sender. However, when the receiver receives a data segment out of order, it immediately responds with an ACK to direct the sender to resend the lost data segment.

When the sender receives an ACK, it makes this determination: It determines if any data is outstanding. If no data is outstanding, the sender determines that the ACK is a keepalive, meant to keep the line active, and it does nothing. If data is outstanding, the sender determines whether the ACK indicates that the receiver has received some or none of the data. If the ACK indicates receipt of some data sent, the sender determines if new credit has been granted to allow it to send more data. When the ACK indicates receipt of none of the data sent and there is outstanding data, the sender interprets the ACK to be a repeatedly sent ACK. This condition indicates that some data was received out of order, forcing the receiver to retransmit the first ACK, and that a second data segment was received out of order, forcing the receiver to retransmit the second ACK. In most cases, the receiver would receive two segments out of order because one of the data segments had been dropped.

When a TCP sender detects a dropped data segment, it resends the segment. Then it adjusts its transmission rate to half of what it was before the drop was detected. This is the TCP back-off or slow-down behavior. Although this behavior is appropriately responsive to congestion, problems can arise when multiple TCP sessions are carried on concurrently with the same router and all TCP senders slow down transmission of packets at the same time.

How the Router Interacts with TCP

To see how the router interacts with TCP, we will look at an example. In this example, on average, the router receives traffic from one particular TCP stream every other, every 10th, and every 100th or 200th message in the interface in MAE-EAST or FIX-WEST. A router can handle multiple concurrent TCP sessions. Because network flows are additive, there is a high probability that when traffic exceeds the Transmit Queue Limit (TQL) at all, it will vastly exceed the limit. However, there is also a high probability that the excessive traffic depth is temporary and that traffic will not stay excessively deep except at points where traffic flows merge or at edge routers.

If the router drops all traffic that exceeds the TQL, as is done when tail drop is used by default, many TCP sessions will simultaneously go into slow start. Consequently, traffic temporarily slows down to the extreme and then all flows slow-start again; this activity creates a condition of global synchronization.

However, if the router drops no traffic, as is the case when queueing features such as fair queueing or custom queueing (CQ) are used, then the data is likely to be stored in main memory, drastically degrading router performance.

By directing one TCP session at a time to slow down, RED solves the problems described, allowing for full utilization of the bandwidth rather than utilization manifesting as crests and troughs of traffic.

About WRED

WRED combines the capabilities of the RED algorithm with the IP Precedence feature to provide for preferential traffic handling of higher priority packets. WRED can selectively discard lower priority traffic when the interface begins to get congested and provide differentiated performance characteristics for different classes of service.

You can configure WRED to ignore IP precedence when making drop decisions so that nonweighted RED behavior is achieved.

For interfaces configured to use the Resource Reservation Protocol (RSVP) feature, WRED chooses packets from other flows to drop rather than the RSVP flows. Also, IP Precedence governs which packets are

dropped--traffic that is at a lower precedence has a higher drop rate and therefore is more likely to be throttled back.

WRED differs from other congestion avoidance techniques such as queueing strategies because it attempts to anticipate and avoid congestion rather than control congestion once it occurs.

Why Use WRED

WRED makes early detection of congestion possible and provides for multiple classes of traffic. It also protects against global synchronization. For these reasons, WRED is useful on any output interface where you expect congestion to occur.

However, WRED is usually used in the core routers of a network, rather than at the edge of the network. Edge routers assign IP precedences to packets as they enter the network. WRED uses these precedences to determine how to treat different types of traffic.

WRED provides separate thresholds and weights for different IP precedences, allowing you to provide different qualities of service in regard to packet dropping for different traffic types. Standard traffic may be dropped more frequently than premium traffic during periods of congestion.

WRED is also RSVP-aware, and it can provide the controlled-load QoS service of integrated service.

How It Works

By randomly dropping packets prior to periods of high congestion, WRED tells the packet source to decrease its transmission rate. If the packet source is using TCP, it will decrease its transmission rate until all the packets reach their destination, which indicates that the congestion is cleared.

WRED generally drops packets selectively based on IP precedence. Packets with a higher IP precedence are less likely to be dropped than packets with a lower precedence. Thus, the higher the priority of a packet, the higher the probability that the packet will be delivered.

WRED reduces the chances of tail drop by selectively dropping packets when the output interface begins to show signs of congestion. By dropping some packets early rather than waiting until the queue is full, WRED avoids dropping large numbers of packets at once and minimizes the chances of global synchronization. Thus, WRED allows the transmission line to be used fully at all times.

In addition, WRED statistically drops more packets from large users than small. Therefore, traffic sources that generate the most traffic are more likely to be slowed down than traffic sources that generate little traffic.

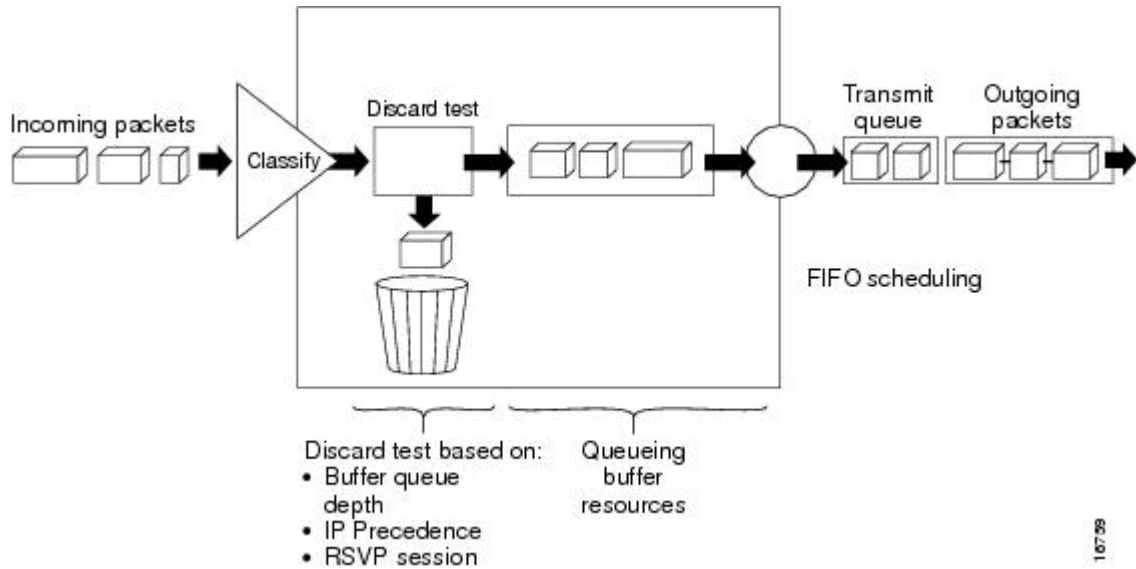
WRED avoids the globalization problems that occur when tail drop is used as the congestion avoidance mechanism. Global synchronization manifests when multiple TCP hosts reduce their transmission rates in response to packet dropping, then increase their transmission rates once again when the congestion is reduced.

WRED is only useful when the bulk of the traffic is TCP/IP traffic. With TCP, dropped packets indicate congestion, so the packet source will reduce its transmission rate. With other protocols, packet sources may not respond or may resend dropped packets at the same rate. Thus, dropping packets does not decrease congestion.

WRED treats non-IP traffic as precedence 0, the lowest precedence. Therefore, non-IP traffic, in general, is more likely to be dropped than IP traffic.

The figure below illustrates how WRED works.

Figure 2: Weighted Random Early Detection



Average Queue Size

The router automatically determines parameters to use in the WRED calculations. The average queue size is based on the previous average and the current size of the queue. The formula is:

$$\text{average} = (\text{old_average} * (1 - 2^{-n})) + (\text{current_queue_size} * 2^{-n})$$

where n is the exponential weight factor, a user-configurable value. The default value of the exponential weight factor is 9. It is recommended to use only the default value for the exponential weight factor. Change this value from the default value only if you have determined that your scenario would benefit from using a different value.

For high values of n , the previous average becomes more important. A large factor smooths out the peaks and lows in queue length. The average queue size is unlikely to change very quickly, avoiding drastic swings in size. The WRED process will be slow to start dropping packets, but it may continue dropping packets for a time after the actual queue size has fallen below the minimum threshold. The slow-moving average will accommodate temporary bursts in traffic.



Note

If the value of n gets too high, WRED will not react to congestion. Packets will be sent or dropped as if WRED were not in effect.

For low values of n , the average queue size closely tracks the current queue size. The resulting average may fluctuate with changes in the traffic levels. In this case, the WRED process responds quickly to long queues. Once the queue falls below the minimum threshold, the process will stop dropping packets.

If the value of n gets too low, WRED will overreact to temporary traffic bursts and drop traffic unnecessarily.

Restrictions

You cannot configure WRED on the same interface as Route Switch Processor (RSP)-based CQ, priority queueing (PQ), or weighted fair queueing (WFQ).

Distributed Weighted Random Early Detection

Distributed WRED (DWRED) is an implementation of WRED for the Versatile Interface Processor (VIP). DWRED provides the complete set of functions for the VIP that WRED provides on standard Cisco IOS platforms.

The DWRED feature is only supported on Cisco 7000 series routers with an RSP-based RSP7000 interface processor and Cisco 7500 series routers with a VIP-based VIP2-40 or greater interface processor. A VIP2-50 interface processor is strongly recommended when the aggregate line rate of the port adapters on the VIP is greater than DS3. A VIP2-50 interface processor is required for OC-3 rates.

DWRED is configured the same way as WRED. If you enable WRED on a suitable VIP interface, such as a VIP2-40 or greater with at least 2 MB of SRAM, DWRED will be enabled instead.

In order to use DWRED, distributed Cisco Express Forwarding (dCEF) switching must be enabled on the interface.

You can configure both DWRED and distributed weighted fair queueing (DWFQ) on the same interface, but you cannot configure distributed WRED on an interface for which RSP-based CQ, PQ, or WFQ is configured.

How It Works

When a packet arrives and DWRED is enabled, the following events occur:

- The average queue size is calculated. See the [Average Queue Size, on page 7](#) section for details.
- If the average is less than the minimum queue threshold, the arriving packet is queued.
- If the average is between the minimum queue threshold and the maximum queue threshold, the packet is either dropped or queued, depending on the packet drop probability. See the [Packet-Drop Probability, on page 8](#) section for details.
- If the average queue size is greater than the maximum queue threshold, the packet is automatically dropped.

Average Queue Size

The average queue size is based on the previous average and the current size of the queue. The formula is:

$$\text{average} = (\text{old_average} * (1 - 1/2^n)) + (\text{current_queue_size} * 1/2^n)$$

where n is the exponential weight factor, a user-configurable value.

For high values of n , the previous average queue size becomes more important. A large factor smooths out the peaks and lows in queue length. The average queue size is unlikely to change very quickly, avoiding drastic swings in size. The WRED process will be slow to start dropping packets, but it may continue dropping packets for a time after the actual queue size has fallen below the minimum threshold. The slow-moving average will accommodate temporary bursts in traffic.

**Note**

If the value of n gets too high, WRED will not react to congestion. Packets will be sent or dropped as if WRED were not in effect.

For low values of n , the average queue size closely tracks the current queue size. The resulting average may fluctuate with changes in the traffic levels. In this case, the WRED process responds quickly to long queues. Once the queue falls below the minimum threshold, the process stops dropping packets.

If the value of n gets too low, WRED will overreact to temporary traffic bursts and drop traffic unnecessarily.

Packet-Drop Probability

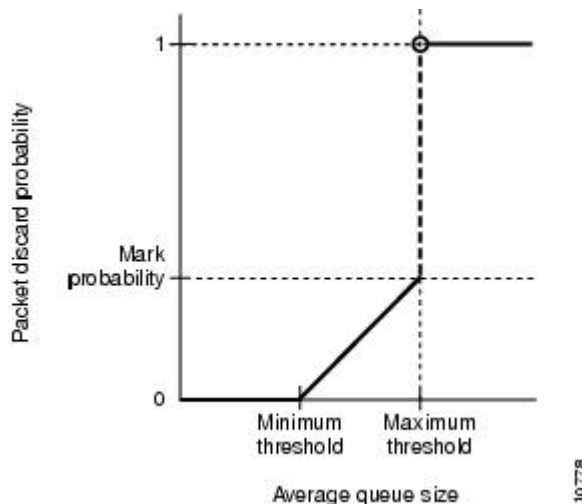
The probability that a packet will be dropped is based on the minimum threshold, maximum threshold, and mark probability denominator.

When the average queue size is above the minimum threshold, RED starts dropping packets. The rate of packet drop increases linearly as the average queue size increases, until the average queue size reaches the maximum threshold.

The mark probability denominator is the fraction of packets dropped when the average queue size is at the maximum threshold. For example, if the denominator is 512, one out of every 512 packets is dropped when the average queue is at the maximum threshold.

When the average queue size is above the maximum threshold, all packets are dropped. The figure below summarizes the packet drop probability.

Figure 3: Packet Drop Probability



The minimum threshold value should be set high enough to maximize the link utilization. If the minimum threshold is too low, packets may be dropped unnecessarily, and the transmission link will not be fully used.

The difference between the maximum threshold and the minimum threshold should be large enough to avoid global synchronization of TCP hosts (global synchronization of TCP hosts can occur as multiple TCP hosts reduce their transmission rates). If the difference between the maximum and minimum thresholds is too small, many packets may be dropped at once, resulting in global synchronization.

Why Use DWRED

DWRED provides faster performance than does RSP-based WRED. You should run DWRED on the VIP if you want to achieve very high speed on the Cisco 7500 series platform--for example, you can achieve speed at the OC-3 rates by running WRED on a VIP2-50 interface processor.

Additionally, the same reasons you would use WRED on standard Cisco IOS platforms apply to using DWRED. For instance, when WRED or DWRED is not configured, tail drop is enacted during periods of congestion. Enabling DWRED obviates the global synchronization problems that result when tail drop is used to avoid congestion.

The DWRED feature provides the benefit of consistent traffic flows. When RED is not configured, output buffers fill during periods of congestion. When the buffers are full, tail drop occurs; all additional packets are dropped. Because the packets are dropped all at once, global synchronization of TCP hosts can occur as multiple TCP hosts reduce their transmission rates. The congestion clears, and the TCP hosts increase their transmission rates, resulting in waves of congestion followed by periods when the transmission link is not fully used.

RED reduces the chances of tail drop by selectively dropping packets when the output interface begins to show signs of congestion. By dropping some packets early rather than waiting until the buffer is full, RED avoids dropping large numbers of packets at once and minimizes the chances of global synchronization. Thus, RED allows the transmission line to be used fully at all times.

In addition, RED statistically drops more packets from large users than small. Therefore, traffic sources that generate the most traffic are more likely to be slowed down than traffic sources that generate little traffic.

DWRED provides separate thresholds and weights for different IP precedences, allowing you to provide different qualities of service for different traffic. Standard traffic may be dropped more frequently than premium traffic during periods of congestion.

Restrictions

The following restrictions apply to the DWRED feature:

- Interface-based DWRED cannot be configured on a subinterface. (A subinterface is one of a number of virtual interfaces on a single physical interface.)
- DWRED is not supported on Fast EtherChannel and tunnel interfaces.
- RSVP is not supported on DWRED.
- DWRED is useful only when the bulk of the traffic is TCP/IP traffic. With TCP, dropped packets indicate congestion, so the packet source reduces its transmission rate. With other protocols, packet sources may not respond or may resend dropped packets at the same rate. Thus, dropping packets does not necessarily decrease congestion.
- DWRED treats non-IP traffic as precedence 0, the lowest precedence. Therefore, non-IP traffic is usually more likely to be dropped than IP traffic.
- DWRED cannot be configured on the same interface as RSP-based CQ, PQ, or WFQ. However, both DWRED and DWFQ can be configured on the same interface.

**Note**

Do not use the **match protocol** command to create a traffic class with a non-IP protocol as a match criterion. The VIP does not support matching of non-IP protocols.

Prerequisites

This section provides the prerequisites that must be met before you configure the DWRED feature.

Weighted Fair Queueing

Attaching a service policy to an interface disables WFQ on that interface if WFQ is configured for the interface. For this reason, you should ensure that WFQ is not enabled on such an interface before configuring DWRED.

WRED

Attaching a service policy configured to use WRED to an interface disables WRED on that interface. If any of the traffic classes that you configure in a policy map use WRED for packet drop instead of tail drop, you must ensure that WRED is not configured on the interface to which you intend to attach that service policy.

Access Control Lists

You can specify a numbered access list as the match criterion for any traffic class that you create. For this reason, before configuring DWRED you should know how to configure access lists.

Cisco Express Forwarding

In order to use DWRED, dCEF switching must be enabled on the interface.

Flow-Based WRED

Flow-based WRED is a feature that forces WRED to afford greater fairness to all flows on an interface in regard to how packets are dropped.

Why Use Flow-Based WRED

Before you consider the advantages that use of flow-based WRED offers, it helps to think about how WRED (without flow-based WRED configured) affects different kinds of packet flows. Even before flow-based WRED classifies packet flows, flows can be thought of as belonging to one of the following categories:

- Nonadaptive flows, which are flows that do not respond to congestion.
- Robust flows, which on average have a uniform data rate and slow down in response to congestion.
- Fragile flows, which, though congestion-aware, have fewer packets buffered at a gateway than do robust flows.

WRED tends toward bias against fragile flows because all flows, even those with relatively fewer packets in the output queue, are susceptible to packet drop during periods of congestion. Though fragile flows have fewer buffered packets, they are dropped at the same rate as packets of other flows.

To provide fairness to all flows, flow-based WRED has the following features:

- It ensures that flows that respond to WRED packet drops (by backing off packet transmission) are protected from flows that do not respond to WRED packet drops.
- It prohibits a single flow from monopolizing the buffer resources at an interface.

How It Works

Flow-based WRED relies on the following two main approaches to remedy the problem of unfair packet drop:

- It classifies incoming traffic into flows based on parameters such as destination and source addresses and ports.
- It maintains state about active flows, which are flows that have packets in the output queues.

Flow-based WRED uses this classification and state information to ensure that each flow does not consume more than its permitted share of the output buffer resources. Flow-based WRED determines which flows monopolize resources and it more heavily penalizes these flows.

To ensure fairness among flows, flow-based WRED maintains a count of the number of active flows that exist through an output interface. Given the number of active flows and the output queue size, flow-based WRED determines the number of buffers available per flow.

To allow for some burstiness, flow-based WRED scales the number of buffers available per flow by a configured factor and allows each active flow to have a certain number of packets in the output queue. This scaling factor is common to all flows. The outcome of the scaled number of buffers becomes the per-flow limit. When a flow exceeds the per-flow limit, the probability that a packet from that flow will be dropped increases.

DiffServ Compliant WRED

DiffServ Compliant WRED extends the functionality of WRED to enable support for DiffServ and AF Per Hop Behavior PHB. This feature enables customers to implement AF PHB by coloring packets according to DSCP values and then assigning preferential drop probabilities to those packets.



Note

This feature can be used with IP packets only. It is not intended for use with Multiprotocol Label Switching (MPLS)-encapsulated packets.

The Class-Based Quality of Service MIB supports this feature. This MIB is actually the following two MIBs:

- CISCO-CLASS-BASED-QOS-MIB
- CISCO-CLASS-BASED-QOS-CAPABILITY-MIB

The DiffServ Compliant WRED feature supports the following RFCs:

- RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*
- RFC 2475, *An Architecture for Differentiated Services Framework*

- RFC 2597, *Assured Forwarding PHB*
- RFC 2598, *An Expedited Forwarding PHB*

How It Works

The DiffServ Compliant WRED feature enables WRED to use the DSCP value when it calculates the drop probability for a packet. The DSCP value is the first six bits of the IP type of service (ToS) byte.

This feature adds two new commands, **random-detect dscp** and **dscp**. It also adds two new arguments, *dscp-based* and *prec-based*, to two existing WRED-related commands--the **random-detect(interface)** command and the **random-detect-group** command.

The *dscp-based* argument enables WRED to use the DSCP value of a packet when it calculates the drop probability for the packet. The *prec-based* argument enables WRED to use the IP Precedence value of a packet when it calculates the drop probability for the packet.

These arguments are optional (you need not use any of them to use the commands) but they are also mutually exclusive. That is, if you use the *dscp-based* argument, you cannot use the *prec-based* argument with the same command.

After enabling WRED to use the DSCP value, you can then use the new **random-detect dscp** command to change the minimum and maximum packet thresholds for that DSCP value.

Three scenarios for using these arguments are provided.

Usage Scenarios

The new *dscp-based* and *prec-based* arguments can be used whether you are using WRED at the interface level, at the per-virtual circuit (VC) level, or at the class level (as part of class-based WFQ (CBWFQ) with policy maps).

WRED at the Interface Level

At the interface level, if you want to have WRED use the DSCP value when it calculates the drop probability, you can use the *dscp-based* argument with the **random-detect(interface)** command to specify the DSCP value. Then use the **random-detect dscp** command to specify the minimum and maximum thresholds for the DSCP value.

WRED at the per-VC Level

At the per-VC level, if you want to have WRED use the DSCP value when it calculates the drop probability, you can use the *dscp-based* argument with the **random-detect-group** command. Then use the **dscp** command to specify the minimum and maximum thresholds for the DSCP value or the mark-probability denominator.

This configuration can then be applied to each VC in the network.

WRED at the Class Level

If you are using WRED at the class level (with CBWFQ), the *dscp-based* and *prec-based* arguments can be used within the policy map.

First, specify the policy map, the class, and the bandwidth. Then, if you want WRED to use the DSCP value when it calculates the drop probability, use the *dscp-based* argument with the **random-detect**(interface)command to specify the DSCP value. Then use the **random-detect dscp** command to modify the default minimum and maximum thresholds for the DSCP value.

This configuration can then be applied wherever policy maps are attached (for example, at the interface level, the per-VC level, or the shaper level).

Usage Points to Note

Remember the following points when using the new commands and the new arguments included with this feature:

- If you use the *dscp-based* argument, WRED will use the DSCP value to calculate the drop probability.
- If you use the *prec-based* argument, WRED will use the IP Precedence value to calculate the drop probability.
- The *dscp-based* and *prec-based* arguments are mutually exclusive.
- If you do not specify either argument, WRED will use the IP Precedence value to calculate the drop probability (the default method).
- The **random-detect dscp** command must be used in conjunction with the **random-detect**(interface)command.
- The **random-detect dscp** command can only be used if you use the *dscp-based* argument with the **random-detect**(interface)command.
- The **dscp** command must be used in conjunction with the **random-detect-group** command.
- The **dscp** command can only be used if you use the *dscp-based* argument with the **random-detect-group** command.



CHAPTER 2

IPv6 QoS: MQC WRED-Based Drop

WRED implements the RED-based drop policy on the packets that are likely to overflow the limits of CBWFQ.

- [Finding Feature Information, page 15](#)
- [Information About IPv6 QoS: MQC WRED-Based Drop, page 15](#)
- [Additional References, page 16](#)
- [Feature Information for IPv6 QoS: MQC WRED-Based Drop, page 17](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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

Information About IPv6 QoS: MQC WRED-Based Drop

Implementation Strategy for QoS for IPv6

IPv6 packets are forwarded by paths that are different from those for IPv4. QoS features supported for IPv6 environments include packet classification, queuing, traffic shaping, weighted random early detection (WRED), class-based packet marking, and policing of IPv6 packets. These features are available at both the process switching and Cisco Express Forwarding switching paths of IPv6.

All of the QoS features available for IPv6 environments are managed from the modular QoS command-line interface (MQC). The MQC allows you to define traffic classes, create and configure traffic policies (policy maps), and then attach those traffic policies to interfaces.

To implement QoS in networks that are running IPv6, follow the same steps that you would follow to implement QoS in networks running only IPv4. At a very high level, the basic steps for implementing QoS are as follows:

- Know which applications in your network need QoS.
- Understand the characteristics of the applications so that you can make decisions about which QoS features would be appropriate.
- Know your network topology so that you know how link layer header sizes are affected by changes and forwarding.
- Create classes based on the criteria that you establish for your network. In particular, if the same network is also carrying IPv4 traffic along with IPv6 traffic, decide if you want to treat both of them the same way or treat them separately and specify match criteria accordingly. If you want to treat them the same, use match statements such as **match precedence**, **match dscp**, **set precedence**, and **set dscp**. If you want to treat them separately, add match criteria such as **match protocol ip** and **match protocol ipv6** in a match-all class map.
- Create a policy to mark each class.
- Work from the edge toward the core in applying QoS features.
- Build the policy to treat the traffic.
- Apply the policy.

Congestion Avoidance for IPv6 Traffic

WRED implements the RED-based drop policy on the packets that are likely to overflow the limits of class-based weighted fair queueing (CBWFQ). WRED supports class-based and flow-based queueing (using DSCP or precedence values).

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	<i>IPv6 Configuration Guide</i>
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
IPv6 commands	Cisco IOS IPv6 Command Reference
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping
WRED Configuration	“Configuring Weighted Random Early Detection” module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	IPv6 RFCs

MIBs

MIB	MIBs Link
	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 and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IPv6 QoS: MQC WRED-Based Drop

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 1: Feature Information for IPv6 QoS: MQC WRED-Based Drop

Feature Name	Releases	Feature Information
IPv6 QoS: MQC WRED-Based Drop	12.0(28)S 12.2(33)SRA 12.2(18)SXE2 12.2(13)T 12.3 12.3(2)T 12.4 12.4(2)T	WRED implements the RED-based drop policy on the packets that are likely to overflow the limits of CBWFQ.



Configuring Weighted Random Early Detection

Feature History

Release	Modification
Cisco IOS	For information about feature support in Cisco IOS software, use Cisco Feature Navigator.

This module describes the tasks for configuring Weighted Random Early Detection (WRED), distributed WRED (DWRED), flow-based WRED, and DiffServ Compliant WRED on a router.



Note

WRED is useful with adaptive traffic such as TCP/IP. With TCP, dropped packets indicate congestion, so the packet source will reduce its transmission rate. With other protocols, packet sources may not respond or may resend dropped packets at the same rate. Thus, dropping packets does not decrease congestion. WRED treats non-IP traffic as precedence 0, the lowest precedence. Therefore, non-IP traffic is more likely to be dropped than IP traffic. You cannot configure WRED on the same interface as Route Switch Processor (RSP)-based custom queueing (CQ), priority queueing (PQ), or weighted fair queueing (WFQ). However, you can configure both DWRED and DWFQ on the same interface.

Random Early Detection (RED) is a congestion avoidance mechanism that takes advantage of the congestion control mechanism of TCP. By randomly dropping packets prior to periods of high congestion, RED tells the packet source to decrease its transmission rate. WRED drops packets selectively based on IP precedence. Edge routers assign IP precedences to packets as they enter the network. (WRED is useful on any output interface where you expect to have congestion. However, WRED is usually used in the core routers of a network, rather than at the edge.) WRED uses these precedences to determine how it treats different types of traffic.

When a packet arrives, the following events occur:

- 1 The average queue size is calculated.
- 2 If the average is less than the minimum queue threshold, the arriving packet is queued.
- 3 If the average is between the minimum queue threshold for that type of traffic and the maximum threshold for the interface, the packet is either dropped or queued, depending on the packet drop probability for that type of traffic.

4 If the average queue size is greater than the maximum threshold, the packet is dropped.

- [Finding Feature Information](#), page 20
- [Weighted Random Early Detection Configuration Task List](#), page 20
- [DWRED Configuration Task List](#), page 22
- [Flow-Based WRED Configuration Task List](#), page 24
- [DiffServ Compliant WRED Configuration Task List](#), page 25
- [WRED Configuration Examples](#), page 27
- [DWRED Configuration Examples](#), page 30
- [Flow-Based WRED Configuration Example](#), page 31
- [DiffServ Compliant WRED Configuration Examples](#), page 32

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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

Weighted Random Early Detection Configuration Task List

Enabling WRED



Note

To avoid counter issues do not configure WRED and queue-limit on the same interface at the same time.

Command	Purpose
Router(config-if)# random-detect	Enables WRED. If you configure this command on a Versatile Interface Processor (VIP) interface, DWRED is enabled.

Changing WRED Parameters



Note

The default WRED parameter values are based on the best available data. We recommend that you do not change the parameters from their default values unless you have determined that your applications will benefit from the changed values.

Command	Purpose
Router(config-if)# random-detect exponential-weighting-constant <i>exponent</i>	Configures the weight factor used in calculating the average queue length.
Router(config-if)# random-detect precedence <i>precedence min-threshold max-threshold mark-prob-denominator</i>	Configures parameters for packets with a specific IP Precedence. The minimum threshold for IP Precedence 0 corresponds to half the maximum threshold for the interface. Repeat this command for each precedence. To configure RED, rather than WRED, use the same parameters for each precedence.

Monitoring WRED

Command	Purpose
Router# show queue <i>interface-type interface-number</i>	Displays the header information of the packets inside a queue. This command does not support DWRED.
Router# show queueing interface <i>interface-number [vc [[vpi /] vci]]</i>	Displays the WRED statistics of a specific virtual circuit (VC) on an interface.
Router# show queueing random-detect	Displays the queueing configuration for WRED.
Router# show interfaces [<i>type slot port-adapter port</i>]	Displays WRED configuration on an interface.

DWRED Configuration Task List

Configuring DWRED in a Traffic Policy

SUMMARY STEPS

1. Router(config)# **policy-map** *policy-map*
2. Router(config-pmap)# **class** *class-name*
3. Steps 3, 4, and 5 are optional. If you do not want to configure the exponential weight factor, specify the amount of bandwidth, or specify the number of queues to be reserved, you can skip these three steps and continue with step 6.
4. Router(config-pmap-c)# **random-detect exponential-weighting-constant** *exponent*
5. Router(config-pmap-c)# **bandwidth** *bandwidth-kbps*
6. Router(config-pmap-c)# **fair-queue queue-limit** *queue-values*
7. Router(config-pmap-c)# **queue-limit** *number-of-packets*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# policy-map <i>policy-map</i>	Specifies the name of the traffic policy to be created or modified.
Step 2	Router(config-pmap)# class <i>class-name</i>	Specifies the name of a traffic class to be created and included in the traffic policy
Step 3	Steps 3, 4, and 5 are optional. If you do not want to configure the exponential weight factor, specify the amount of bandwidth, or specify the number of queues to be reserved, you can skip these three steps and continue with step 6.	
Step 4	Router(config-pmap-c)# random-detect exponential-weighting-constant <i>exponent</i>	Configures the exponential weight factor used in calculating the average queue length.
Step 5	Router(config-pmap-c)# bandwidth <i>bandwidth-kbps</i>	Specifies the amount of bandwidth, in kbps, to be assigned to the traffic class.
Step 6	Router(config-pmap-c)# fair-queue queue-limit <i>queue-values</i>	Specifies the number of queues to be reserved for the traffic class.
Step 7	Router(config-pmap-c)# queue-limit <i>number-of-packets</i>	Specifies the maximum number of packets that can be queued for the specified traffic class.

Configuring DWRED to Use IP Precedence Values in a Traffic Policy

SUMMARY STEPS

1. Router(config)# **policy-map** *policy-map*
2. Router(config-pmap)# **class** *class-name*
3. Router(config-pmap-c)# **random-detect exponential-weighting-constant** *exponent*
4. Router(config-pmap-c)# **random-detect precedence** *precedence min-threshold max-threshold mark-prob-denominator*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# policy-map <i>policy-map</i>	Specifies the name of the traffic policy to be created or modified.
Step 2	Router(config-pmap)# class <i>class-name</i>	Specifies the name of a traffic class to associate with the traffic policy
Step 3	Router(config-pmap-c)# random-detect exponential-weighting-constant <i>exponent</i>	Configures the exponential weight factor used in calculating the average queue length.
Step 4	Router(config-pmap-c)# random-detect precedence <i>precedence min-threshold max-threshold mark-prob-denominator</i>	Configures the parameters for packets with a specific IP Precedence. The minimum threshold for IP Precedence 0 corresponds to half the maximum threshold for the interface. Repeat this command for each precedence.

Monitoring and Maintaining DWRED

Command	Purpose
Router# show policy-map	Displays all configured traffic policies.
Router# show policy-map <i>policy-map-name</i>	Displays the user-specified traffic policy.
Router# show policy-map interface	Displays statistics and configurations of all input and output policies attached to an interface.
Router# show policy-map interface <i>interface-spec</i>	Displays configuration and statistics of the input and output policies attached to a particular interface.
Router# show policy-map interface <i>interface-spec input</i>	Displays configuration and statistics of the input policy attached to an interface.
Router# show policy-map interface <i>interface-spec output</i>	Displays configuration statistics of the output policy attached to an interface.
Router# show policy-map interface [<i>interface-spec</i> [<i>input</i> output] [<i>class class-name</i>]]]	Displays the configuration and statistics for the class name configured in the policy.

Flow-Based WRED Configuration Task List

Configuring Flow-Based WRED

SUMMARY STEPS

1. Router(config-if)# **random-detect flow**
2. Router(config-if)# **random-detect flow average-depth-factor** *scaling-factor*
3. Router(config-if)# **random-detect flow count** *number*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config-if)# random-detect flow	Enables flow-based WRED.
Step 2	Router(config-if)# random-detect flow average-depth-factor <i>scaling-factor</i>	Sets the flow threshold multiplier for flow-based WRED.
Step 3	Router(config-if)# random-detect flow count <i>number</i>	Sets the maximum flow count for flow-based WRED.

DiffServ Compliant WRED Configuration Task List

Configuring WRED to Use the Differentiated Services Code Point Value

WRED at the Interface Level

SUMMARY STEPS

1. Router(config-if)# **random-detect** *dscp-based*
2. Router(config-if)# **random-detect dscp** *dscpvalue min-threshold max-threshold[mark-probability-denominator]*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config-if)# random-detect <i>dscp-based</i>	Indicates that WRED is to use the DSCP value when it calculates the drop probability for the packet.
Step 2	Router(config-if)# random-detect dscp <i>dscpvalue min-threshold max-threshold[mark-probability-denominator]</i>	Specifies the minimum and maximum thresholds, and, optionally, the mark-probability denominator for the specified DSCP value.

WRED at the per-VC Level

SUMMARY STEPS

1. Router(config)# **random-detect-group** *group-name dscp-based*
2. Router(cfg-red-grp)# **dscp** *dscpvalue min-threshold max-threshold[mark-probability-denominator]*
3. Router(config-atm-vc)# **random-detect[attach** *group-name]*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# random-detect-group <i>group-name dscp-based</i>	Indicates that WRED is to use the DSCP value when it calculates the drop probability for the packet.
Step 2	Router(cfg-red-grp)# dscp <i>dscpvalue min-threshold max-threshold[mark-probability-denominator]</i>	Specifies the DSCP value, the minimum and maximum packet thresholds and, optionally, the mark-probability denominator for the DSCP value.
Step 3	Router(config-atm-vc)# random-detect[attach <i>group-name]</i>	Enables per-VC WRED or per-VC VIP-DWRED.

WRED at the Class Level

SUMMARY STEPS

1. Router(config-if)# **class-map** *class-map-name*
2. Router(config-cmap)# **match** *match criterion*
3. Router(config-if)# **policy-map** *policy-map*
4. Router(config-pmap)# **class** *class-map-name*
5. Router(config-pmap-c)# **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. Router(config-pmap-c)# **random-detect dscp-based**
7. Router(config-pmap-c)# **random-detect dscp** *dscpvalue min-threshold max-threshold[mark-probability-denominator]*
8. Router(config-if)# **service-policy output** *policy-map*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config-if)# class-map <i>class-map-name</i>	Creates a class map to be used for matching packets to a specified class.

	Command or Action	Purpose
Step 2	Router(config-cmap)# match <i>match criterion</i>	Configures the match criteria for a class map.
Step 3	Router(config-if)# policy-map <i>policy-map</i>	Creates or modifies a policy map that can be attached to one or more interfaces to specify a traffic policy.
Step 4	Router(config-pmap)# class <i>class-map-name</i>	Specifies the QoS actions for the default class.
Step 5	Router(config-pmap-c)# bandwidth { <i>bandwidth-kbps</i> percent <i>percent</i> }	Specifies or modifies the bandwidth allocated for a class belonging to a policy map.
Step 6	Router(config-pmap-c)# random-detect dscp-based	Indicates that WRED is to use the DSCP value when it calculates the drop probability for the packet.
Step 7	Router(config-pmap-c)# random-detect dscp <i>dscpvalue min-threshold</i> <i>max-threshold</i> [<i>mark-probability-denominator</i>]	Specifies the minimum and maximum packet thresholds and, optionally, the mark-probability denominator for the DSCP value.
Step 8	Router(config-if)# service-policy output <i>policy-map</i>	Attaches a policy map to an output interface or VC to be used as the traffic policy for that interface or VC.

Verifying the DSCP Value Configuration

Command	Purpose
Router# show queueing interface	Displays the queueing statistics of an interface or VC.
Router# show policy-map interface	Displays the configuration of classes configured for traffic policies on the specified interface or permanent virtual circuit (PVC).

WRED Configuration Examples

Example WRED Configuration

The following example enables WRED with default parameter values:

```
interface Serial5/0
description to qos1-75a
ip address 200.200.14.250 255.255.255.252
random-detect
```

Use the **show interfaces** command output to verify the configuration. Notice that the "Queueing strategy" report lists "random early detection (RED)."

```
Router# show interfaces serial 5/0
Serial5/0 is up, line protocol is up
  Hardware is M4T
  Description: to qos1-75a
  Internet address is 200.200.14.250/30
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 237/255
  Encapsulation HDLC, crc 16, loopback not set
  Keepalive not set
  Last input 00:00:15, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:05:08
  Input queue: 0/75/0 (size/max/drops); Total output drops: 1036
  Queueing strategy: random early detection (RED)
  5 minutes input rate 0 bits/sec, 2 packets/sec
  5 minutes output rate 119000 bits/sec, 126 packets/sec
    594 packets input, 37115 bytes, 0 no buffer
    Received 5 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    37525 packets output, 4428684 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 output buffer failures, 0 output buffers swapped out
    0 carrier transitions      DCD=up DSR=up DTR=up RTS=up CTS=up
```

Use the **show queue** command output to view the current contents of the interface queue. Notice that there is only a single queue into which packets from all IP precedences are placed after dropping has taken place. The output has been truncated to show only three of the five packets.

```
Router# show queue serial 5/0

Output queue for Serial5/0 is 5/0
Packet 1, linktype: ip, length: 118, flags: 0x288
  source: 190.1.3.4, destination: 190.1.2.2, id: 0x0001, ttl: 254,
  TOS: 128 prot: 17, source port 11111, destination port 22222
  data: 0x2B67 0x56CE 0x005E 0xE89A 0xCBA9 0x8765 0x4321
        0x0FED 0xCBA9 0x8765 0x4321 0x0FED 0xCBA9 0x8765
Packet 2, linktype: ip, length: 118, flags: 0x288
  source: 190.1.3.5, destination: 190.1.2.2, id: 0x0001, ttl: 254,
  TOS: 160 prot: 17, source port 11111, destination port 22222
  data: 0x2B67 0x56CE 0x005E 0xE89A 0xCBA9 0x8765 0x4321
        0x0FED 0xCBA9 0x8765 0x4321 0x0FED 0xCBA9 0x8765
Packet 3, linktype: ip, length: 118, flags: 0x280
  source: 190.1.3.6, destination: 190.1.2.2, id: 0x0001, ttl: 254,
  TOS: 192 prot: 17, source port 11111, destination port 22222
  data: 0x2B67 0x56CE 0x005E 0xE89A 0xCBA9 0x8765 0x4321
        0x0FED 0xCBA9 0x8765 0x4321 0x0FED 0xCBA9 0x8765
```

Use the **show queueing** command output to view the current settings for each of the precedences. Also notice that the default minimum thresholds are spaced evenly between half and the entire maximum threshold. Thresholds are specified in terms of packet count.

```
Router# show queueing
Current random-detect configuration:
Serial5/0
  Queueing strategy: random early detection (WRED)
  Exp-weight-constant: 9 (1/512)
  Mean queue depth: 28

Class  Random      Tail      Minimum      Maximum      Mark
      drop      drop  threshold  threshold  probability
    0      330         0           20           40           1/10
    1      267         0           22           40           1/10
    2      217         0           24           40           1/10
    3      156         0           26           40           1/10
    4       61         0           28           40           1/10
    5        6         0           31           40           1/10
    6         0         0           33           40           1/10
```

```

      7          0          0          35          40          1/10
  rsvp         0          0          37          40          1/10

```

Example Parameter-Setting DWRED

The following example specifies the same parameters for each IP precedence. Thus, all IP precedences receive the same treatment. Start by enabling DWRED.

```

interface FastEthernet1/0/0
 ip address 200.200.14.250 255.255.255.252
 random-detect

```

Next, enter the **show queuing random-detect** command to determine reasonable values to use for the precedence-specific parameters.

```

Router# show queuing random-detect
Current random-detect configuration:
FastEthernet2/0/0
Queueing strategy:fifo
Packet drop strategy:VIP-based random early detection (DWRED)
Exp-weight-constant:9 (1/512)
Mean queue depth:0
Queue size:0          Maximum available buffers:6308
Output packets:5    WRED drops:0    No buffer:0
Class   Random      Tail   Minimum   Maximum   Mark      Output
        drop       drop  threshold threshold probability Packets
  0         0         0      109      218      1/10      5
  1         0         0      122      218      1/10      0
  2         0         0      135      218      1/10      0
  3         0         0      148      218      1/10      0
  4         0         0      161      218      1/10      0
  5         0         0      174      218      1/10      0
  6         0         0      187      218      1/10      0
  7         0         0      200      218      1/10      0

```

Complete the configuration by assigning the same parameter values to each precedence. Use the values obtained from the **show queuing random-detect** command output to choose reasonable parameter values.

```

interface FastEthernet1/0/0
 random-detect precedence 0 100 218 10
 random-detect precedence 1 100 218 10
 random-detect precedence 2 100 218 10
 random-detect precedence 3 100 218 10
 random-detect precedence 4 100 218 10
 random-detect precedence 5 100 218 10
 random-detect precedence 6 100 218 10
 random-detect precedence 7 100 218 10

```

Example Parameter-Setting WRED

The following example enables WRED on the interface and specifies parameters for the different IP precedences:

```

interface Hssi0/0/0
 description 45Mbps to R1
 ip address 10.200.14.250 255.255.255.252
 random-detect
 random-detect precedence 0 32 256 100
 random-detect precedence 1 64 256 100
 random-detect precedence 2 96 256 100
 random-detect precedence 3 120 256 100
 random-detect precedence 4 140 256 100
 random-detect precedence 5 170 256 100

```

```

random-detect precedence 6 290 256 100
random-detect precedence 7 210 256 100
random-detect precedence rsvp 230 256 100

```

DWRED Configuration Examples

Example DWRED on an Interface

The following example configures DWRED on an interface with a weight factor of 10:

```

Router(config)# interface hssi0/0/0
Router(config-if)# description 45mbps to R1
Router(config-if)# ip address 192.168.14.250 255.255.255.252
Router(config-if)# random-detect
Router(config-if)# random-detect exponential-weighting-constant 10

```

Example Modular QoS CLI

The following example enables DWRED using the Legacy CLI (non-Modular QoS Command-Line Interface) feature on the interface and specifies parameters for the different IP precedences:

```

interface Hssi0/0/0
description 45Mbps to R1
ip address 200.200.14.250 255.255.255.252
random-detect
random-detect precedence 0 32 256 100
random-detect precedence 1 64 256 100
random-detect precedence 2 96 256 100
random-detect precedence 3 120 256 100
random-detect precedence 4 140 256 100
random-detect precedence 5 170 256 100
random-detect precedence 6 290 256 100
random-detect precedence 7 210 256 100
random-detect precedence rsvp 230 256 100

```

The following example uses the Modular QoS CLI to configure a traffic policy called policy10. For congestion avoidance, WRED packet drop is used, not tail drop. IP Precedence is reset for levels 0 through 5.

```

policy-map policy10
class acl10
bandwidth 2000
random-detect exponential-weighting-constant 10
random-detect precedence 0 32 256 100
random-detect precedence 1 64 256 100
random-detect precedence 2 96 256 100
random-detect precedence 3 120 256 100
random-detect precedence 4 140 256 100
random-detect precedence 5 170 256 100

```

Example Configuring DWRED in Traffic Policy

The following example configures policy for a traffic class named int10 to configure the exponential weight factor as 12. This is the weight factor used for the average queue size calculation for the queue for traffic class int10. WRED packet drop is used for congestion avoidance for traffic class int10, not tail drop.

```

policy-map policy12

```

```
class int10
bandwidth 2000
random-detect exponential-weighting-constant 12
```

Flow-Based WRED Configuration Example

The following example enables WRED on the serial interface 1 and configures flow-based WRED. The **random-detect** interface configuration command is used to enable WRED. Once WRED is enabled, the **random-detect flow** command is used to enable flow-based WRED.

After flow-based WRED is enabled, the **random-detect flow average-depth-factor** command is used to set the scaling factor to 8 and the **random-detect flow count** command is used to set the flow count to 16. The scaling factor is used to scale the number of buffers available per flow and to determine the number of packets allowed in the output queue for each active flow.

```
configure terminal
interface Serial1
 random-detect
 random-detect flow
 random-detect flow average-depth-factor 8
 random-detect flow count 16
end
```

The following part of the example shows a sample configuration file after the previous flow-based WRED commands are issued:

```
Router# more system:running-config
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug datetime msec localtime
service timestamps log uptime
no service password-encryption
service tcp-small-servers
!
no logging console
enable password lab
!
clock timezone PST -8
clock summer-time PDT recurring
ip subnet-zero
no ip domain-lookup
!
interface Ethernet0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 shutdown
!
interface Serial0
 no ip address
 no ip directed-broadcast
 no ip mroute-cache
 no keepalive
 shutdown
!
interface Serial1
 ip address 190.1.2.1 255.255.255.0
 no ip directed-broadcast
 load-interval 30
 no keepalive
 random-detect
 random-detect flow
 random-detect flow count 16
 random-detect flow average-depth-factor 8
```

```

!
router igrp 8
 network 190.1.1.0.0
!
ip classless
no ip http server
!
line con 0
 transport input none
line 1 16
 transport input all
line aux 0
 transport input all
line vty 0 4
 password lab
 login
!
end

```

DiffServ Compliant WRED Configuration Examples

Example WRED Configured to Use the DSCP Value

The following example configures WRED to use the DSCP value 8. The minimum threshold for the DSCP value 8 is 24 and the maximum threshold is 40. This configuration was performed at the interface level.

```

Router(config-if)# interface sec/0
Router(config-if)# random-detect dscp-based
Router(config-if)# random-detect dscp 8 24 40

```

The following example enables WRED to use the DSCP value 9. The minimum threshold for the DSCP value 9 is 20 and the maximum threshold is 50. This configuration can be attached to other VCs, as required.

```

Router(config)# random-detect-group sanjose dscp-based
Router(cfg-red-grp)# dscp 9 20 50
Router(config-subif-vc)# random-detect attach sanjose

```

The following example enables WRED to use the DSCP value 8 for the class c1. The minimum threshold for the DSCP value 8 is 24 and the maximum threshold is 40. The last line attaches the traffic policy to the output interface or VC p1.

```

Router(config-if)# class-map c1
Router(config-cmap)# match access-group 101
Router(config-if)# policy-map p1
Router(config-pmap)# class c1
Router(config-pmap-c)# bandwidth 48
Router(config-pmap-c)# random-detect dscp-based
Router(config-pmap-c)# random-detect dscp 8 24 40
Router(config-if)# service-policy output p1

```

Example DSCP Value Configuration Verification

When WRED has been configured to use the DSCP value when it calculates the drop probability of a packet, all entries of the DSCP table are initialized with the appropriate default values. The example in the following section are samples of the **show policy interface** command for WRED at the class level.

This example displays packet statistics along with the entries of the DSCP table, confirming that WRED has been enabled to use the DSCP value when it calculates the drop probability for a packet.

Router# **show policy interface Serial6/3**

```

Serial6/3
Service-policy output: test
Class-map: c1 (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
Match: protocol ip
  0 packets, 0 bytes
  5 minute rate 0 bps
Weighted Fair Queueing
Output Queue: Conversation 265
Bandwidth 20 (%)
Bandwidth 308 (kbps)
(pkts matched/bytes matched) 0/0
(depth/total drops/no-buffer drops) 0/0/0
exponential weight: 9
mean queue depth: 0

dscp      Transmitted      Random drop      Tail drop      Minimum Maximum      Mark
          pkts/bytes      pkts/bytes      pkts/bytes      thresh  thresh      prob
af11      0/0              0/0              0/0              32     40     1/10
af12      0/0              0/0              0/0              28     40     1/10
af13      0/0              0/0              0/0              24     40     1/10
af21      0/0              0/0              0/0              32     40     1/10
af22      0/0              0/0              0/0              28     40     1/10
af23      0/0              0/0              0/0              24     40     1/10
af31      0/0              0/0              0/0              32     40     1/10
af32      0/0              0/0              0/0              28     40     1/10
af33      0/0              0/0              0/0              24     40     1/10
af41      0/0              0/0              0/0              32     40     1/10
af42      0/0              0/0              0/0              28     40     1/10
af43      0/0              0/0              0/0              24     40     1/10
cs1       0/0              0/0              0/0              22     40     1/10
cs2       0/0              0/0              0/0              24     40     1/10
cs3       0/0              0/0              0/0              26     40     1/10
cs4       0/0              0/0              0/0              28     40     1/10
cs5       0/0              0/0              0/0              30     40     1/10
cs6       0/0              0/0              0/0              32     40     1/10
cs7       0/0              0/0              0/0              34     40     1/10
ef        0/0              0/0              0/0              36     40     1/10
rsvp      0/0              0/0              0/0              36     40     1/10
default   0/0              0/0              0/0              20     40     1/10
    
```




WRED-Explicit Congestion Notification

Currently, the congestion control and avoidance algorithms for Transmission Control Protocol (TCP) are based on the idea that packet loss is an appropriate indication of congestion on networks transmitting data using the best-effort service model. When a network uses the best-effort service model, the network delivers data if it can, without any assurance of reliability, delay bounds, or throughput. However, these algorithms and the best-effort service model are not suited to applications that are sensitive to delay or packet loss (for instance, interactive traffic including Telnet, web-browsing, and transfer of audio and video data). Weighted Random Early Detection (WRED), and by extension, Explicit Congestion Notification (ECN), helps to solve this problem.

This document describes the WRED--Explicit Congestion Notification feature in Cisco IOS Release 12.2(8)T.

- [Finding Feature Information, page 35](#)
- [Prerequisites for WRED-Explicit Congestion Notification, page 36](#)
- [Information About WRED-Explicit Congestion Notification, page 36](#)
- [How to Configure WRED-Explicit Congestion Notification, page 38](#)
- [Configuration Examples for WRED-Explicit Congestion Notification, page 41](#)
- [Additional References, page 42](#)
- [Feature Information for WRED-Explicit Congestion Notification, page 43](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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

Prerequisites for WRED-Explicit Congestion Notification

ECN must be configured through the Modular Quality of Service Command-Line Interface (MQC). For more information about the MQC, see the "Applying QoS Features Using the MQC" module.

Information About WRED-Explicit Congestion Notification

WRED-Explicit Congestion Notification Feature Overview

Currently, the congestion control and avoidance algorithms for Transmission Control Protocol (TCP) are based on the idea that packet loss is an appropriate indication of congestion on networks transmitting data using the best-effort service model. When a network uses the best-effort service model, the network delivers data if it can, without any assurance of reliability, delay bounds, or throughput. However, these algorithms and the best-effort service model are not suited to applications that are sensitive to delay or packet loss (for instance, interactive traffic including Telnet, web-browsing, and transfer of audio and video data). Weighted Random Early Detection (WRED), and by extension, Explicit Congestion Notification (ECN), helps to solve this problem.

RFC 3168, *The Addition of Explicit Congestion Notification (ECN) to IP*, states that with the addition of active queue management (for example, WRED) to the Internet infrastructure, routers are no longer limited to packet loss as an indication of congestion.

How WRED Works

WRED makes early detection of congestion possible and provides a means for handling multiple classes of traffic. WRED can selectively discard lower priority traffic when the router begins to experience congestion and provide differentiated performance characteristics for different classes of service. It also protects against global synchronization. Global synchronization occurs as waves of congestion crest, only to be followed by periods of time during which the transmission link is not used to capacity. For these reasons, WRED is useful on any output interface or router where congestion is expected to occur.

WRED is implemented at the core routers of a network. Edge routers assign IP precedences to packets as the packets enter the network. With WRED, core routers then use these precedences to determine how to treat different types of traffic. WRED provides separate thresholds and weights for different IP precedences, enabling the network to provide different qualities of service, in regard to packet dropping, for different types of traffic. Standard traffic may be dropped more frequently than premium traffic during periods of congestion.

For more information about WRED, refer to the "Congestion Avoidance Overview" module.

ECN Extends WRED Functionality

WRED drops packets, based on the average queue length exceeding a specific threshold value, to indicate congestion. ECN is an extension to WRED in that ECN marks packets instead of dropping them when the average queue length exceeds a specific threshold value. When configured with the WRED -- Explicit Congestion Notification feature, routers and end hosts would use this marking as a signal that the network is congested and slow down sending packets.

As stated in RFC 3168, *The Addition of Explicit Congestion Notification (ECN) to IP*, implementing ECN requires an ECN-specific field that has two bits--the ECN-capable Transport (ECT) bit and the CE (Congestion Experienced) bit--in the IP header. The ECT bit and the CE bit can be used to make four ECN field combinations of 00 to 11. The first number is the ECT bit and the second number is the CE bit. The table below lists each of the ECT and CE bit combination settings in the ECN field and what the combinations indicate.

Table 2: ECN Bit Setting

ECT Bit	CE Bit	Combination Indicates
0	0	Not ECN-capable
0	1	Endpoints of the transport protocol are ECN-capable
1	0	Endpoints of the transport protocol are ECN-capable
1	1	Congestion experienced

The ECN field combination 00 indicates that a packet is not using ECN.

The ECN field combinations 01 and 10--called ECT(1) and ECT(0), respectively--are set by the data sender to indicate that the endpoints of the transport protocol are ECN-capable. Routers treat these two field combinations identically. Data senders can use either one or both of these two combinations. For more information about these two field combinations, and the implications of using one over the other, refer to RFC 3168, *The Addition of Explicit Congestion Notification (ECN) to IP*.

The ECN field combination 11 indicates congestion to the endpoints. Packets arriving a full queue of a router will be dropped.

How Packets Are Treated When ECN Is Enabled

- If the number of packets in the queue is below the minimum threshold, packets are transmitted. This happens whether or not ECN is enabled, and this treatment is identical to the treatment a packet receives when WRED only is being used on the network.
- If the number of packets in the queue is between the minimum threshold and the maximum threshold, one of the following three scenarios can occur:
 - If the ECN field on the packet indicates that the endpoints are ECN-capable (that is, the ECT bit is set to 1 and the CE bit is set to 0, or the ECT bit is set to 0 and the CE bit is set to 1)--and the WRED algorithm determines that the packet should have been dropped based on the drop probability--the ECT and CE bits for the packet are changed to 1, and the packet is transmitted. This happens because ECN is enabled and the packet gets marked instead of dropped.
 - If the ECN field on the packet indicates that neither endpoint is ECN-capable (that is, the ECT bit is set to 0 and the CE bit is set to 0), the packet may be dropped based on the WRED drop probability. This is the identical treatment that a packet receives when WRED is enabled without ECN configured on the router.

- If the ECN field on the packet indicates that the network is experiencing congestion (that is, both the ECT bit and the CE bit are set to 1), the packet is transmitted. No further marking is required.
- If the number of packets in the queue is above the minimum threshold, packets are dropped based on the drop probability. This is the identical treatment a packet receives when WRED is enabled without ECN configured on the router.

Benefits of WRED-Explicit Congestion Notification

Improved Method for Congestion Avoidance

This feature provides an improved method for congestion avoidance by allowing the network to mark packets for transmission later, rather than dropping them from the queue. Marking the packets for transmission later accommodates applications that are sensitive to delay or packet loss and provides improved throughput and application performance.

Enhanced Queue Management

Currently, dropped packets indicate that a queue is full and the network is experiencing congestion. When a network experiences congestion, this feature allows networks to mark the IP header of a packet with a CE bit. This marking, in turn, triggers the appropriate congestion avoidance mechanism and allows the network to better manage the data queues. With this feature, ECN-capable routers and end hosts can respond to congestion before a queue overflows and packets are dropped, providing enhanced queue management.

For more information on the benefits associated with ECN, refer to RFC 2309, *Internet Performance Recommendations*.

How to Configure WRED-Explicit Congestion Notification

Configuring Explicit Congestion Notification

To configure ECN, complete the following steps.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** {*class-name*| **class-default**}
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect**
7. **random-detect ecn**
8. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: <pre>Router# configure terminal</pre>	Enters global configuration mode.
Step 3	policy-map <i>policy-map-name</i> Example: <pre>Router(config)# policy-map policy1</pre>	Creates or modifies a policy map that can be attached to one or more interfaces to specify a service policy. Enters QoS policy-map configuration mode. <ul style="list-style-type: none"> • Enter the name of the policy map.
Step 4	class { <i>class-name</i> class-default } Example: <pre>Router(config-pmap)# class class-default</pre>	Specifies the name of the class whose policy you want to create or change or specifies the default class (commonly known as the class-default class) before you configure its policy. Enters policy-map-class configuration mode. <ul style="list-style-type: none"> • Enter the name of the class or enter the class-default keyword.
Step 5	bandwidth { <i>bandwidth-kbps</i> percent percent } Example: <pre>Router(config-pmap-c)# bandwidth percent 35</pre>	Specifies or modifies the bandwidth (either in kbps or a percentage) allocated for a class belonging to a policy map. <ul style="list-style-type: none"> • Enter the bandwidth in kilobytes per second or enter the bandwidth percentage.
Step 6	random-detect Example: <pre>Router(config-pmap-c)# random-detect</pre>	Enables WRED or distributed WRED (dWRED).
Step 7	random-detect ecn Example: <pre>Router(config-pmap-c)# random-detect ecn</pre>	Enables ECN.
Step 8	end	(Optional) Exits policy-map class configuration mode.

	Command or Action	Purpose
	Example: <pre>Router(config-pmap-c) # end</pre>	

Verifying the Explicit Congestion Notification Configuration

To verify the ECN configuration, complete the following steps.

SUMMARY STEPS

1. **enable**
2. **show policy-map**
3. **show policy-map interface**
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: <pre>Router> enable</pre>	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	show policy-map Example: <pre>Router# show policy-map</pre>	If ECN is enabled, displays ECN marking information for a specified policy map.
Step 3	show policy-map interface Example: <pre>Router# show policy-map interface</pre>	If ECN is enabled, displays ECN marking information for a specified interface.
Step 4	end Example: <pre>Router#</pre>	(Optional) Exits privileged EXEC mode.

	Command or Action	Purpose
	end	

Configuration Examples for WRED-Explicit Congestion Notification

Example Enabling ECN

The following example enables ECN in the policy map called poll1:

```
Router(config)# policy-map poll1
Router(config-pmap)# class class-default
Router(config-pmap-c)# bandwidth per 70
Router(config-pmap-c)# random-detect
Router(config-pmap-c)# random-detect ecn
```

Example Verifying the ECN Configuration

The following is sample output from the **show policy-map** command. The words "explicit congestion notification" (along with the ECN marking information) included in the output indicate that ECN has been enabled.

```
Router# show policy-map
Policy Map poll1
Class class-default
  Weighted Fair Queueing
  Bandwidth 70 (%)
  exponential weight 9
  explicit congestion notification
  class min-threshold max-threshold mark-probability
  -----
  0 - - 1/10
  1 - - 1/10
  2 - - 1/10
  3 - - 1/10
  4 - - 1/10
  5 - - 1/10
  6 - - 1/10
  7 - - 1/10
  rsvp - - 1/10
```

The following is sample output from the **show policy-map interface** command. The words "explicit congestion notification" included in the output indicate that ECN has been enabled.

```
Router# show policy-map interface
Serial4/1
Serial4/1
Service-policy output:policy_ecn
```

```

Class-map:precl (match-all)
  1000 packets, 125000 bytes
  30 second offered rate 14000 bps, drop rate 5000 bps
  Match:ip precedence 1
  Weighted Fair Queueing
    Output Queue:Conversation 42
    Bandwidth 20 (%)
    Bandwidth 100 (kbps)
    (pkts matched/bytes matched) 989/123625
  (depth/total drops/no-buffer drops) 0/455/0
  exponential weight:9
  explicit congestion notification
  mean queue depth:0
class Transmitted Random drop Tail drop Minimum Maximum Mark
      pkts/bytes   pkts/bytes   pkts/bytes threshold threshold probability
  0      0/0          0/0          0/0          20          40          1/10
  1    545/68125     0/0          0/0          22          40          1/10
  2      0/0          0/0          0/0          24          40          1/10
  3      0/0          0/0          0/0          26          40          1/10
  4      0/0          0/0          0/0          28          40          1/10
  5      0/0          0/0          0/0          30          40          1/10
  6      0/0          0/0          0/0          32          40          1/10
  7      0/0          0/0          0/0          34          40          1/10
rsvp    0/0          0/0          0/0          36          40          1/10
class  ECN Mark
      pkts/bytes
  0      0/0
  1    43/5375
  2      0/0
  3      0/0
  4      0/0
  5      0/0
  6      0/0
  7      0/0
rsvp    0/0

```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	<i>Cisco IOS Quality of Service Solutions Command Reference</i>
MQC	"Applying QoS Features Using the MQC" module
Congestion avoidance concepts	"Congestion Avoidance Overview" module

Standards

Standard	Title
No new or modified standards are supported, and support for existing standards has not been modified.	--

MIBs

MIB	MIBs Link
No new or modified MIBs are supported, and support for existing MIBs has not been modified.	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

RFCs

RFC	Title
RFC 2309	<i>Internet Performance Recommendation</i>
RFC 2884	<i>Performance Evaluation of Explicit Congestion Notification (ECN) in IP Networks</i>
RFC 3168	<i>The Addition of Explicit Congestion Notification (ECN) to IP</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for WRED-Explicit Congestion Notification

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 3: Feature Information for WRED-Explicit Congestion Notification

Feature Name	Software Releases	Feature Configuration Information
WRED--Explicit Congestion Notification	12.2(8)T	<p>Currently, the congestion control and avoidance algorithms for Transmission Control Protocol (TCP) are based on the idea that packet loss is an appropriate indication of congestion on networks transmitting data using the best-effort service model. When a network uses the best-effort service model, the network delivers data if it can, without any assurance of reliability, delay bounds, or throughput. However, these algorithms and the best-effort service model are not suited to applications that are sensitive to delay or packet loss (for instance, interactive traffic including Telnet, web-browsing, and transfer of audio and video data). Weighted Random Early Detection (WRED), and by extension, Explicit Congestion Notification (ECN), helps to solve this problem.</p> <p>The following commands were introduced or modified: random-detect ecn, show policy-map, show policy-map interface.</p>



Shaping on Dialer Interfaces

The Shaping on Dialer Interfaces feature provides support for Point-to-Point Protocol over Ethernet (PPPoE) and Point-to-Point Protocol over Asynchronous Transfer Mode (PPPoA) configurations on dialer interfaces. The feature provides support for Modular QoS CLI (MQC)-based queuing and shaping that supports per-customer quality of service (QoS). Parent policies are attached to an Ethernet in the First Mile (EFM) interface, and child policies are attached to individual dialer interfaces. Class of service (CoS) values are set by applying a policy to the dialer interface. The feature also enables the collection of queuing statistics on the dialer interface and the polling of traffic counters for dialer interfaces.

- [Finding Feature Information, page 45](#)
- [Restrictions for Shaping on Dialer Interfaces, page 45](#)
- [Information About Shaping on Dialer Interfaces, page 46](#)
- [How to Configure Shaping on Dialer Interfaces, page 47](#)
- [Configuration Examples for Shaping on Dialer Interfaces, page 65](#)
- [Additional References for Shaping on Dialer Interfaces, page 68](#)
- [Feature Information for Shaping on Dialer Interfaces, page 68](#)

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see [Bug Search Tool](#) and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table at the end of this module.

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Restrictions for Shaping on Dialer Interfaces

- The output queuing policy must have a parent class-default shaper, and any other queuing actions must be configured in a child policy.

Information About Shaping on Dialer Interfaces

QoS on PPP Session on Dialer Interfaces

The Shaping on Dialer Interfaces feature consolidates the output queuing and classification on the egress interface (where all the queuing features are run). The police and set features (such as CoS marking) also work in the output path.

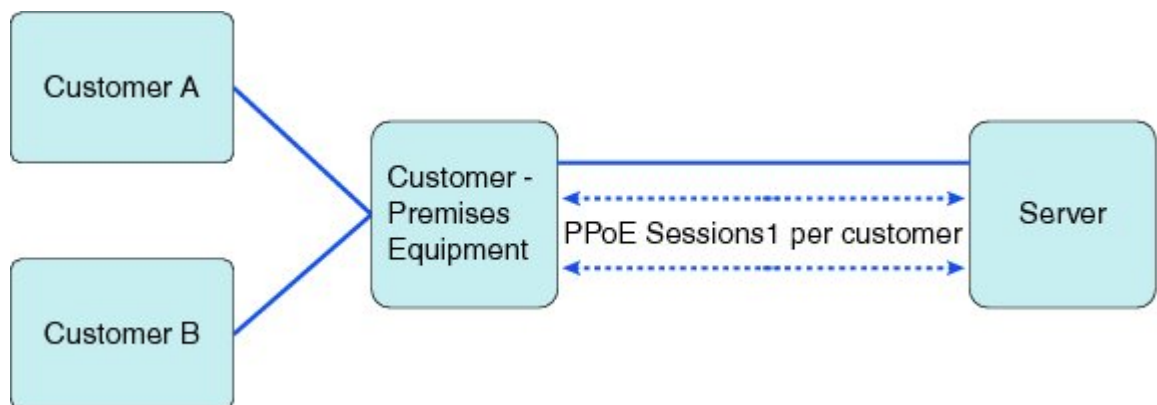
MQC-based QoS queuing and shaping features can be used to attach flat class-default shaped policies to the EFM and attach HQoS parent-shaped policies to the dialer interface.

Policies are applied to the dialer interface using the **service-policy** command. In addition the related show and debug commands display policy and queuing statistics associated with the dialer target.

QoS Dialer Interface Topology

The following figure shows the supported topology for the Shaping on Dialer Interfaces feature:

Figure 4: Shaping on Dialer Interfaces Topology



The Customer Premises Equipment (CPE) is shared between several customers. Each customer connects to the CPE through a VLAN on a Gigabit Ethernet port. The CPE connects to the service over a DSL using an EFM interface (this looks like an Ethernet connection but uses DSL) over which all the incoming VLANs will be forwarded. The traffic for each VLAN (customer) is transmitted in a separate PPP session. Each session is set up using a dialer interface.

How to Configure Shaping on Dialer Interfaces

Configuring an Output Queueing Policy for Dialer Interfaces

Before You Begin

Because the dialer target is added to the dynamic target API, the output queueing policy must have a parent class-default shaper with any other queueing actions configured in a child policy.

**Note**

Effective with Cisco IOS Release 15.3(1)T, the QoS handling will take place under the dialer interface only and not under the virtual-access interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** *class-name*
5. **priority percent** *percentage*
6. **exit**
7. **class** *class-name*
8. **bandwidth percent** *percentage*
9. **exit**
10. **class** {*class-name* | **class-default**}
11. **fair-queue**
12. **exit**
13. **exit**
14. **policy-map** *policy-map-name*
15. **class class-default**
16. **shape average** *target-bit-rate*
17. **service-policy** *policy-map-name*
18. **exit**
19. **exit**
20. **interface** *type number*
21. **service-policy output** *policy-name*
22. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	policy-map <i>policy-map-name</i> Example: Device(config)# policy-map child	Specifies the name of the policy map created earlier and enters policy-map configuration mode. <ul style="list-style-type: none"> • Enter the policy map name.
Step 4	class <i>class-name</i> Example: Device(config-pmap)# class voice	Specifies the name of the class whose policy you want to create and enters policy-map class configuration mode. This class is associated with the class map created earlier. <ul style="list-style-type: none"> • Enter the name of the class or enter the class-default keyword.
Step 5	priority percent <i>percentage</i> Example: Device(config-pmap-c)# priority percent 30	Specifies that the amount of guaranteed bandwidth will be specified by the percent of available bandwidth.
Step 6	exit Example: Device(config-pmap-c)# exit	Returns to policy-map configuration mode.
Step 7	class <i>class-name</i> Example: Device(config-pmap)# class video	Specifies the name of the class whose policy you want to create and enters policy-map class configuration mode. This class is associated with the class map created earlier. <ul style="list-style-type: none"> • Enter the name of the class or enter the class-default keyword.
Step 8	bandwidth percent <i>percentage</i> Example: Device(config-pmap-c)# bandwidth percent 50	Specifies that the amount of guaranteed bandwidth will be specified by the percent of total bandwidth.

	Command or Action	Purpose
Step 9	exit Example: Device(config-pmap-c)# exit	Returns to policy-map configuration mode.
Step 10	class { <i>class-name</i> class-default } Example: Device(config-pmap)# class class-default	Specifies the name of the class whose policy you want to create and enters policy-map class configuration mode. This class is associated with the class map created earlier. <ul style="list-style-type: none"> • Enter the name of the class or enter the class-default keyword.
Step 11	fair-queue Example: Device(config-pmap-c)# fair-queue	Enables flow-based fair queueing in this class.
Step 12	exit Example: Device(config-pmap-c) exit	Returns to policy-map configuration mode.
Step 13	exit Example: Device(config-pmap) exit	Returns to global configuration mode.
Step 14	policy-map <i>policy-map-name</i> Example: Device(config)# policy-map parent	Specifies the name of a policy map and enters policy-map configuration mode. <ul style="list-style-type: none"> • Enter the policy map name.
Step 15	class class-default Example: Device(config-pmap)# class class-default	Creates the class-default class.
Step 16	shape average <i>target-bit-rate</i> Example: Device(config-pmap-c)# shape average 1000000	Specifies average rate traffic shaping as bits-per-second on an interface.

	Command or Action	Purpose
Step 17	service-policy <i>policy-map-name</i> Example: Device(config-pmap-c)# service policy child	Configures a service policy policy map.
Step 18	exit Example: Device(config-pmap-c) exit	Returns to policy-map configuration mode.
Step 19	exit Example: Device(config-pmap) exit	Returns to global configuration mode.
Step 20	interface <i>type number</i> Example: Device(config)# interface Dialer 0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 21	service-policy output <i>policy-name</i> Example: Device(config-if)# service-policy output parent	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 22	exit Example: Device(config-if) exit	Returns to global configuration mode.

Configuring QoS for PPPoEoA for Dialer Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* [**name-tag**]
4. **no ip address**
5. **no atm ilmi-keepalive**
6. **exit**
7. **interface** *type number* [**name-tag**]
8. **pvc** *vpi/vci*
9. **vbr-nrt** *output-pcr output-scr*
10. **pppoe-client dial-pool-number** *number*
11. **exit**
12. **exit**
13. **interface** *type number* [**name-tag**]
14. **mtu** *ip-address*
15. **ip address** *ip-address mask*
16. **encapsulation** *encapsulation-type*
17. **dialer pool** *number*
18. **dialer-group** *number*
19. **service-policy output** *name*
20. **exit**
21. **dialer-list** *dialer-group protocol protocol-name* **permit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface <i>type number</i> [name-tag] Example: Device(config)# interface ATM 0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 4	no ip address Example: Device(config-if)# no ip address	Disables IP processing on the interface.
Step 5	no atm ilmi-keepalive Example: Device(config-if)# no atm ilmi-keepalive	Disables Interim Local Management Interface (ILMI) keepalives on the interface.
Step 6	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 7	interface <i>type number</i> [name-tag] Example: Device(config)# interface ATM 0.1 point-to-point	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type, number, and name.
Step 8	pvc <i>vpi/vci</i> Example: Device(config-if)# pvc 4/46	Creates an ATM permanent virtual circuit (PVC), and enters ATM virtual circuit configuration mode. <ul style="list-style-type: none"> • Enter the ATM network virtual path identifier (VPI) and ATM network virtual channel identifier (VCI) for this PVC.
Step 9	vbr-nrt <i>output-pcr output-scr</i> Example: Device(config-if-atm-vc)# vbr-nrt 738 738	Configures the variable bit rate-nonreal time (VBR-NRT) quality of service (QoS) and specifies the output peak cell rate (PCR), and output sustainable cell rate (SCR) for an ATM permanent virtual circuit (PVC).
Step 10	pppoe-client dial-pool-number <i>number</i> Example: Device(config-if-atm-vc)# pppoe-client dial-pool-number 1	Configures a PPP over Ethernet (PPPoE) client and specifies the dial-on-demand routing (DDR) functionality.

	Command or Action	Purpose
Step 11	exit Example: Device(config-if-atm-vc)# exit	Exits ATM virtual circuit configuration mode.
Step 12	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 13	interface <i>type number</i> [name-tag] Example: Device(config)# interface Dialer 0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 14	mtu <i>ip-address</i> Example: Device(config-if)# mtu 1200	Adjusts the maximum packet size or maximum transmission unit (MTU) size.
Step 15	ip address <i>ip-address mask</i> Example: Device(config-if)# ip address 172.16.0.0 255.0.0.0	Sets the primary IP address for the interface. <ul style="list-style-type: none"> • Enter the IP address and the IP address mask.
Step 16	encapsulation <i>encapsulation-type</i> Example: Device(config-if)# encapsulation ppp	Sets the encapsulation method used by the interface.
Step 17	dialer pool <i>number</i> Example: Device(config-if)# dialer pool 1	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.
Step 18	dialer-group <i>number</i> Example: Device(config-if)# dialer-group 1	Controls access by configuring the interface to belong to a specific dialing group.

	Command or Action	Purpose
Step 19	service-policy output <i>name</i> Example: Device(config-if)# service-policy output dialer-output-sp	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 20	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 21	dialer-list <i>dialer-group</i> protocol <i>protocol-name</i> permit Example: Device(config)# dialer-list 1 protocol ip permit	Defines a dial-on-demand routing (DDR) dialer list for dialing by protocol or by a combination of a protocol and a previously defined access list.

Configuring QoS for PPPoE for Dialer Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* [**name-tag**]
4. **ppp enable group** *group-name*
5. **pppoe-client dial-pool-number** *number*
6. **exit**
7. **interface** *type number* [**name-tag**]
8. **mtu** *ip-address*
9. **ip address** *ip-address mask*
10. **encapsulation** *encapsulation-type*
11. **dialer pool** *number*
12. **dialer-group** *number*
13. **service-policy output** *name*
14. **exit**
15. **dialer-list** *dialer-group* **protocol** *protocol-name* **permit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface type number [name-tag] Example: Device(config)# interface Ethernet 0/0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type, number, and name.
Step 4	ppp enable group group-name Example: Device(config-if)# ppp enable group global	Enables PPPoE sessions on an Ethernet interface or subinterface.
Step 5	pppoe-client dial-pool-number number Example: Device(config-if)# pppoe-client dial-pool-number 1	Configures a PPPoE client and to specify the dial-on-demand routing (DDR) functionality.
Step 6	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 7	interface type number [name-tag] Example: Device(config)# interface Dialer 0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 8	mtu ip-address Example: Device(config-if)# mtu 1200	Adjusts the maximum packet size or maximum transmission unit (MTU) size.
Step 9	ip address ip-address mask	Sets the primary IP address for the interface.

	Command or Action	Purpose
	<p>Example:</p> <pre>Device(config-if)# ip address 172.16.0.0 255.0.0.0</pre>	<ul style="list-style-type: none"> Enter the IP address and the IP address mask.
Step 10	<p>encapsulation <i>encapsulation-type</i></p> <p>Example:</p> <pre>Device(config-if)# encapsulation ppp</pre>	Sets the encapsulation method used by the interface.
Step 11	<p>dialer pool <i>number</i></p> <p>Example:</p> <pre>Device(config-if)# dialer pool 1</pre>	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.
Step 12	<p>dialer-group <i>number</i></p> <p>Example:</p> <pre>Device(config-if)# dialer-group 1</pre>	Controls access by configuring the interface to belong to a specific dialing group.
Step 13	<p>service-policy output <i>name</i></p> <p>Example:</p> <pre>Device(config-if)# service-policy output dialer-output-sp</pre>	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 14	<p>exit</p> <p>Example:</p> <pre>Device(config-if)# exit</pre>	Exits interface configuration mode.
Step 15	<p>dialer-list <i>dialer-group</i> protocol <i>protocol-name</i> permit</p> <p>Example:</p> <pre>Device(config)# dialer-list 1 protocol ip permit</pre>	Defines a dial-on-demand routing (DDR) dialer list for dialing by protocol or by a combination of a protocol and a previously defined access list.

Configuring QoS for PPPoA for Dialer Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* [**name-tag**]
4. **pvc** *vpi/vci*
5. **vbr-nrt** *output-pcr output-scr output-maxburstsize*
6. **dialer pool-member** *number*
7. **protocol** *protocol*
8. **exit**
9. **exit**
10. **interface** *type number* [**name-tag**]
11. **mtu** *ip-address*
12. **ip address** *ip-address mask*
13. **encapsulation** *encapsulation-type*
14. **dialer pool** *number*
15. **dialer-group** *number*
16. **service-policy output** *name*
17. **exit**
18. **dialer-list** *dialer-group protocol protocol-name permit*

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface <i>type number</i> [name-tag] Example: Device(config)# interface ATM 0.1 point-to-point	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type, number, and name.

	Command or Action	Purpose
Step 4	<p>pvc <i>vpi/vci</i></p> <p>Example:</p> <pre>Device(config-if)# pvc 4/46</pre>	<p>Creates an ATM permanent virtual circuit (PVC), and enters ATM virtual circuit configuration mode.</p> <ul style="list-style-type: none"> Enter the ATM network virtual path identifier (VPI) and ATM network virtual channel identifier (VCI) for this PVC.
Step 5	<p>vbr-nrt <i>output-pcr output-scr output-maxburstsize</i></p> <p>Example:</p> <pre>Device(config-if-atm-vc)# vbr-nrt 738 738 32</pre>	<p>Configures the variable bit rate-nonreal time (VBR-NRT) quality of service (QoS) and specifies the output peak cell rate (PCR), output sustainable cell rate (SCR), and output maximum burst cell size for an ATM permanent virtual circuit (PVC).</p>
Step 6	<p>dialer pool-member <i>number</i></p> <p>Example:</p> <pre>Device(config-if-atm-vc)# dialer pool-member 1</pre>	<p>Configures a physical interface to be a member of a dialer profiles dialing pool.</p>
Step 7	<p>protocol <i>protocol</i></p> <p>Example:</p> <pre>Device(config-if-atm-vc)# protocol ppp dialer</pre>	<p>Configures a static map for an ATM permanent virtual circuit (PVC), switched virtual circuit (SVC), or virtual circuit (VC) class.</p>
Step 8	<p>exit</p> <p>Example:</p> <pre>Device(config-if-atm-vc)# exit</pre>	<p>Exits ATM virtual circuit configuration mode.</p>
Step 9	<p>exit</p> <p>Example:</p> <pre>Device(config-if)# exit</pre>	<p>Exits interface configuration mode.</p>
Step 10	<p>interface <i>type number</i> [name-tag]</p> <p>Example:</p> <pre>Device(config)# interface Dialer 0</pre>	<p>Configures an interface type and enters interface configuration mode.</p> <ul style="list-style-type: none"> Enter the interface type and number.
Step 11	<p>mtu <i>ip-address</i></p> <p>Example:</p> <pre>Device(config-if)# mtu 1200</pre>	<p>Adjusts the maximum packet size or maximum transmission unit (MTU) size.</p>
Step 12	<p>ip address <i>ip-address mask</i></p>	<p>Sets the primary IP address for the interface.</p>

	Command or Action	Purpose
	<p>Example:</p> <pre>Device(config-if)# ip address 172.16.0.0 255.0.0.0</pre>	<ul style="list-style-type: none"> Enter the IP address and the IP address mask.
Step 13	<p>encapsulation <i>encapsulation-type</i></p> <p>Example:</p> <pre>Device(config-if)# encapsulation ppp</pre>	Sets the encapsulation method used by the interface.
Step 14	<p>dialer pool <i>number</i></p> <p>Example:</p> <pre>Device(config-if)# dialer pool 1</pre>	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.
Step 15	<p>dialer-group <i>number</i></p> <p>Example:</p> <pre>Device(config-if)# dialer-group 1</pre>	Controls access by configuring the interface to belong to a specific dialing group.
Step 16	<p>service-policy output <i>name</i></p> <p>Example:</p> <pre>Device(config-if)# service-policy output dialer-output-sp</pre>	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 17	<p>exit</p> <p>Example:</p> <pre>Device(config-if)# exit</pre>	Exits interface configuration mode.
Step 18	<p>dialer-list <i>dialer-group</i> protocol <i>protocol-name</i> permit</p> <p>Example:</p> <pre>Device(config)# dialer-list 1 protocol ip permit</pre>	Defines a dial-on-demand routing (DDR) dialer list for dialing by protocol or by a combination of a protocol and a previously defined access list, .

Configuring QoS for Multiple Sessions on Dialer Interfaces

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* [**name-tag**]
4. **ppp enable group** *group-name*
5. **pppoe-client dial-pool-number** *number*
6. **pppoe-client dial-pool-number** *number*
7. **pppoe-client dial-pool-number** *number*
8. **exit**
9. **interface** *type number* [**name-tag**]
10. **dialer pool** *number*
11. **service-policy output** *name*
12. **exit**
13. **interface** *type number* [**name-tag**]
14. **dialer pool** *number*
15. **service-policy output** *name*
16. **exit**
17. **interface** *type number* [**name-tag**]
18. **dialer pool** *number*
19. **service-policy output** *name*
20. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.

	Command or Action	Purpose
Step 3	interface <i>type number</i> [name-tag] Example: Device(config)# interface Ethernet 0/0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type, number, and name.
Step 4	ppp enable group <i>group-name</i> Example: Device(config-if)# ppp enable group global	Enables PPPoE sessions on an Ethernet interface or subinterface.
Step 5	pppoe-client dial-pool-number <i>number</i> Example: Device(config-if)# pppoe-client dial-pool-number 1	Configures a PPPoE client and to specify the dial-on-demand routing (DDR) functionality.
Step 6	pppoe-client dial-pool-number <i>number</i> Example: Device(config-if)# pppoe-client dial-pool-number 2	Configures a PPPoE client and to specify the dial-on-demand routing (DDR) functionality.
Step 7	pppoe-client dial-pool-number <i>number</i> Example: Device(config-if)# pppoe-client dial-pool-number 3	Configures a PPPoE client and to specify the dial-on-demand routing (DDR) functionality.
Step 8	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 9	interface <i>type number</i> [name-tag] Example: Device(config)# interface Dialer 0	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 10	dialer pool <i>number</i> Example: Device(config-if)# dialer pool 1	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.

	Command or Action	Purpose
Step 11	service-policy output <i>name</i> Example: Device(config-if)# service-policy output dialer-output-sp	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 12	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 13	interface <i>type number</i> [name-tag] Example: Device(config)# interface Dialer 1	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 14	dialer pool <i>number</i> Example: Device(config-if)# dialer pool 2	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.
Step 15	service-policy output <i>name</i> Example: Device(config-if)# service-policy output dialer-output-sp	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 16	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 17	interface <i>type number</i> [name-tag] Example: Device(config)# interface Dialer 2	Configures an interface type and enters interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 18	dialer pool <i>number</i> Example: Device(config-if)# dialer pool 3	Specifies the dialing pool that the dialer interface uses to connect to a specific destination subnetwork.

	Command or Action	Purpose
Step 19	service-policy output <i>name</i> Example: Device(config-if)# service-policy output dialer-output-sp	Attaches a policy map to an output interface that will be used as the service policy for the interface.
Step 20	exit Example: Device(config-if)# exit	Exits interface configuration mode.

Applying CoS Values to a Dialer Interface

Class of Service (CoS) values are set by applying a policy to the dialer interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class class-default**
5. **set cos** *cos-value*
6. **exit**
7. **exit**
8. **interface** *type number* [**name-tag**]
9. **service-policy output** *name*
10. **exit**
11. **interface** *type number* [**name-tag**]
12. **encapsulation** *encapsulation-type*
13. **pppoe-client dial-pool-number** *number*
14. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	enable	Enables privileged EXEC mode.

	Command or Action	Purpose
	<p>Example:</p> <pre>Device> enable</pre>	<ul style="list-style-type: none"> • Enter your password if prompted.
Step 2	<p>configure terminal</p> <p>Example:</p> <pre>Device# configure terminal</pre>	Enters global configuration mode.
Step 3	<p>policy-map <i>policy-map-name</i></p> <p>Example:</p> <pre>Device(config)# policy-map output_cos</pre>	<p>Specifies the name of the policy map created earlier and enters policy-map configuration mode.</p> <ul style="list-style-type: none"> • Enter the policy map name.
Step 4	<p>class class-default</p> <p>Example:</p> <pre>Device(config-pmap)# class class-default</pre>	Creates the default class for traffic classification and enters policy-map class configuration mode.
Step 5	<p>set cos <i>cos-value</i></p> <p>Example:</p> <pre>Device(config-pmap-c)# set cos 1</pre>	Specifies an IEEE 802.1Q CoS value from 0 to 7.
Step 6	<p>exit</p> <p>Example:</p> <pre>Device(config-pmap-c)# exit</pre>	Returns to policy-map configuration mode.
Step 7	<p>exit</p> <p>Example:</p> <pre>Device(config-pmap)# exit</pre>	Returns to global configuration mode.
Step 8	<p>interface <i>type number</i> [name-tag]</p> <p>Example:</p> <pre>Device(config)# interface Dialer 1</pre>	<p>Configures an interface type and enters interface configuration mode.</p> <ul style="list-style-type: none"> • Enter the interface type and number.
Step 9	<p>service-policy output <i>name</i></p> <p>Example:</p> <pre>Device(config-if)# service-policy output output-cos</pre>	Attaches a policy map to an output interface that will be used as the service policy for the interface.

	Command or Action	Purpose
Step 10	exit Example: Device(config-if)# exit	Exits interface configuration mode.
Step 11	interface type number [name-tag] Example: Device(config)# interface Ethernet 0.10	Configures an interface type and enters sub-interface configuration mode. <ul style="list-style-type: none"> • Enter the interface type and number.
Step 12	encapsulation encapsulation-type Example: Device(config-subif)# encapsulation dot1q 10	Sets the encapsulation method used by the interface.
Step 13	pppoe-client dial-pool-number number Example: Device(config-subif)# pppoe-client dial-pool-number 1	Configures a PPPoE client and to specify the dial-on-demand routing (DDR) functionality.
Step 14	exit Example: Device(config-subif)# exit	Returns to global configuration mode.

Configuration Examples for Shaping on Dialer Interfaces

Example: Configuring Output Queuing Policy for a Dialer Interface

The following example shows how to configure parent and child policy maps and how to attach the parent map to the dialer interface:

```

Device(config)# policy-map childExample
Device(config-pmap)# class voice
Device(config-pmap-c)# priority percent 30
Device(config-pmap-c)# exit

Device(config-pmap)# class video
Device(config-pmap-c)# bandwidth percent 50
Device(config-pmap-c)# exit

Device(config-pmap)# class class-default
Device(config-pmap-c)# fair-queue
Device(config-pmap-c)# exit

```

```

Device(config)# policy-map parent
Device(config-pmap)# class class-default
Device(config-pmap-c)# shape average 1000000
Device(config-pmap-c)# service-policy child
Device(config-pmap-c)# exit

Device(config)# interface dialer 0
Device(config-if)# service-policy output parent

```

Example: Configuring QoS for PPPoEoA for a Dialer Interface

```

Device(config)# interface ATM 0
Device(config-if)# no ip address
Device(config-if)# no atm ilmi-keepalive
Device(config-if)# exit

Device(config)# interface ATM 0.1 point-to-point
Device(config-if)# ip address 192.168.0.0 255.255.255.224
Device(config-if)# pvc 4/46
Device(config-if-atm-vc)# vbr-nrt 738 738
Device(config-if-atm-vc)# pppoe-client dial-pool-number 1
Device(config-if-atm-vc)# exit
Device(config-if)# exit

Device(config)# interface Dialer 0
Device(config-if)# mtu 1200
Device(config-if)# ip address 172.16.0.0 255.0.0.0
Device(config-if)# encapsulation ppp
Device(config-if)# dialer pool 1
Device(config-if)# dialer-group 1
Device(config-if)# service-policy output dialer-output-sp
!
Device(config)# dialer-list 1 protocol ip permit

```

Example: Configuring QoS for a PPPoE on a Dialer Interface

```

Device(config)# interface ethernet 0/0
Device(config-if)# pppoe enable group global
Device(config-if)# pppoe-client dial-pool-number 1
Device(config-if)# exit

Device(config)# interface Dialer 0
Device(config-if)# mtu 1200
Device(config-if)# ip address 172.16.0.0 255.0.0.0
Device(config-if)# encapsulation ppp
Device(config-if)# dialer pool 1
Device(config-if)# dialer-group 1
Device(config-if)# service-policy output dialer-output-sp
Device(config-if)# exit

Device(config)# dialer-list 1 protocol ip permit

```

Example: Configuring QoS for PPPoA on a Dialer Interface

```

Device(config)# interface ATM 0.1 point-to-point
Device(config-if)# ip address 192.168.0.0 255.255.255.224
Device(config-if)# pvc 4/46
Device(config-if-atm-vc)# vbr-nrt 738 738
Device(config-if-atm-vc)# dialer pool-member 1

```



```

Device(config-if-atm-vc) # protocol ppp dialer
Device(config-if-atm-vc) # exit
Device(config-if) # exit

Device(config) # interface Dialer 0
Device(config-if) # mtu 1200
Device(config-if) # ip address 172.16.0.0 255.0.0.0
Device(config-if) # encapsulation ppp
Device(config-if) # dialer pool 1
Device(config-if) # dialer-group 1
Device(config-if) # service-policy output dialer-output-sp
Device(config-if) # exit

Device(config) # dialer-list 1 protocol ip permit

```

Example: Configuring QoS for Multiple Sessions on a Dialer Interface

```

Device(config) # interface ethernet 0/0
Device(config-if) # pppoe enable group global
Device(config-if) # pppoe-client dial-pool-number 1
Device(config-if) # pppoe-client dial-pool-number 2
Device(config-if) # pppoe-client dial-pool-number 3
Device(config-if) # exit

Device(config) # interface Dialer 0
Device(config-if) # dialer pool 1
Device(config-if) # service-policy output dialer-output-sp
Device(config-if) # exit

Device(config) # interface Dialer 1
Device(config-if) # dialer pool 2
Device(config-if) # service-policy output dialer-output-sp
Device(config-if) # exit

Device(config) # interface Dialer 2
Device(config-if) # dialer pool 3
Device(config-if) # service-policy output dialer-output-sp
Device(config-if) # exit

```

Example: Applying CoS Values to a Dialer Interface

```

Device> enable
Device# configure terminal
Device(config) # policy-map output_cos
Device(config-pmap) # class class-default
Device(config-pmap-c) # set cos 1
Device(config-pmap-c) # exit
Device(config-pmap) # exit
Device(config) # interface Dialer 1
Device(config-if) # service-policy output output-cos
Device(config-if) # exit
Device(config) # interface Ethernet 0.10
Device(config-subif) # encapsulation dot1q 10
Device(config-subif) # pppoe-client dial-pool-number 1
Device(config-subif) # exit

```

Additional References for Shaping on Dialer Interfaces

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
QoS commands	<i>Cisco IOS Quality of Service Solutions Command Reference</i>
MQC	<i>QoS: Modular QoS: Command-Line Interface Configuration Guide</i>

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Shaping on Dialer Interfaces

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

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

Table 4: Feature Information for Shaping on Dialer Interfaces

Feature Name	Releases	Feature Information
Shaping on Dialer Interfaces	15.3(1)T	The Shaping on Dialer Interfaces feature provides support for PPPoE/A configurations on dialer interfaces.