

QoS Time-Based Thresholds for WRED and Queue Limit

The QoS Time-Based Thresholds for WRED and Queue Limit feature allows you to specify the Weighted Random Early Detection (WRED) minimum and maximum thresholds or the queue limit threshold in milliseconds (ms). Previously, these thresholds could only be specified in packets or bytes. Now, all three units of measure are available. Once the threshold limits are configured in a policy map, the policy map can be used on multiple interfaces, including those with different amounts of bandwidth.

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Prerequisites for QoS Time-Based Thresholds for WRED and Queue Limit

Before configuring this feature, a traffic class must be configured and a policy map must exist. To create the traffic class (specifying the appropriate match criteria) and the policy map, use the modular quality of service (QoS) command-line interface (MQC).

Restrictions for QoS Time-Based Thresholds for WRED and Queue Limit

This feature allows you to specify either the WRED thresholds or the queue limit threshold in packets (the default unit of measure), bytes, or milliseconds (ms). However, these units cannot be mixed. That is, the unit of measure in the *same* class, in the *same* policy map, cannot be mixed. For example, if you specify the minimum threshold for a particular class in milliseconds, the maximum threshold for that class must also be in milliseconds.

Information About QoS Time-Based Thresholds for WRED and Queue Limit

Benefits of QoS Time-Based Thresholds for WRED and Queue Limit

Queue Limit Thresholds Specified in Additional Units of Measure

Previously, the WRED thresholds and the queue limit thresholds could only be specified in packets or bytes. With this feature, the thresholds can be specified either in packets, bytes or milliseconds. These additional units of measure provide more flexibility and allow you to fine-tune your configuration.

Policy Maps Can be Reused as Needed on Multiple Interfaces

The WRED and queue limit thresholds are specified and configured in policy maps. Once the threshold limits are configured in a policy map, the policy map can be used on multiple interfaces, including those with different amounts of bandwidth. This is especially useful when the bandwidth for a class on given interface is being specified as a percentage of the total bandwidth available.

Setting Thresholds by Using WRED

WRED is a congestion avoidance mechanism. WRED combines the capabilities of the Random Early Detection (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.

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.

WRED is enabled by using the **random-detect**command. Then the minimum threshold, maximum threshold, and mark probability denominator can be set to determine the treatment that packets receive by using the appropriate command. For example, the **random-detect precedence** command can be used to determine the thresholds for a specific IP precedence.

Setting Thresholds by Using the queue-limit Command

The **queue-limit**command allows you to specify or modify the maximum number of packets the queue can hold (that is, the threshold) for a class policy configured in a policy map. Packets belonging to a class are subject to the guaranteed bandwidth allocation and the queue limits that characterize the traffic class. With the **queue-limit** command, the threshold is the aggregate threshold for the entire class.

After a queue has reached its configured queue limit, enqueuing of additional packets to the traffic class causes tail drop or WRED (if configured) to take effect, depending on how the policy map is configured. (Tail drop is a means of avoiding congestion that 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).

Tail drop is used for distributed class-based weighted fair queueing (DCBWFQ) traffic classes unless you explicitly configure a service policy to use WRED to drop packets as a means of avoiding congestion. Note that if you use WRED instead of tail drop for one or more traffic classes making up a service policy, you must ensure that WRED is not configured for the interface to which you attach that service policy.

random-detect Commands with the Milliseconds Keyword

This feature allows you to specify the WRED minimum and maximum thresholds in milliseconds (ms). You can specify the threshold in milliseconds by using the **ms** keyword available with the **random-detect** commands listed in the table below.

Table 1: random-detect Commands with the Milliseconds (ms) Keyword

Command	Description
random-detect clp	Configures the WRED parameters for a particular cell loss priority (CLP) value, or a particular CLP value for a class policy in a policy map.
random-detect cos	Configures the WRED parameters for a particular class of service (CoS) value, or a particular CoS value for a class policy in a policy map.
random-detect discard-class	Configures the WRED parameters for a particular discard-class, or a particular discard-class for a class policy in a policy map.
random-detect dscp	Configures the WRED parameters for a particular differentiated services code point (DSCP) value, or a particular DSCP value for a class policy in a policy map.
random-detect precedence	Configures WRED parameters for a particular IP precedence, or a particular IP precedence for a class policy in a policy map.

Mixing Threshold Units of Measure

With this feature, the thresholds can be specified in packets (the default unit of measure), bytes, or milliseconds (ms). For instance, with WRED, you can specify the minimum threshold and the maximum threshold in packets, bytes, or milliseconds. However, the units cannot be mixed. For example, if you specify the minimum threshold in milliseconds, the maximum threshold must also be specified in milliseconds.

How to Configure QoS Time-Based Thresholds for WRED and Queue Limit

Enabling WRED and Using WRED to Specify Thresholds

SUMMARY STEPS

1. **enable**
2. **configure terminal**

3. **policy-map** *policy-name*
4. **class** {*class-name***class-default**}
5. To continue with the configuration, you must either specify a bandwidth or enable traffic shaping. Choose one or the other.
6. **bandwidth** {*bandwidth-kbps* | **remaining percent** *percentage* | **percent** *percentage*}
7. **shape** [**average** | **peak**] *mean-rate* [*burst-size*] [*excess-burst-size*]
8. **random-detect**
9. **random-detect precedence** {*precedence* | **rsvp**} *min-threshold* {**bytes**| **ms**| **packets**} *max-threshold*{**bytes** | **ms**| **packets**} [*mark-probability-denominator*]
10. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**policy-map** *policy-name* **Example:** `Router(config)# policy-map policy1`	Specifies the name of the policy map to be created. Enters policy-map configuration mode. • Enter policy map name.
Step 4	**class** {*class-name***class-default**} **Example:** `Router(config-pmap)# class class1`	Specifies the class so that you can configure or modify its policy. Enters policy-map class configuration mode. • Enter the class name or specify the default class (class-default).
Step 5	To continue with the configuration, you must either specify a bandwidth or enable traffic shaping. Choose one or the other.	
Step 6	**bandwidth** {*bandwidth-kbps* | **remaining percent** *percentage* | **percent** *percentage*} **Example:** `Router(config-pmap-c)# bandwidth percent 40`	(Optional) Specifies or modifies the bandwidth allocated for a class belonging to a policy map. • Enter the bandwidth to be set or modified.
Step 7	**shape** [**average** | **peak**] *mean-rate* [*burst-size*] [*excess-burst-size*]	(Optional) Enables either average or peak rate traffic shaping.

	Command or Action	Purpose
	Example: `Router(config-pmap-c)# shape average 51200`	• Specify either average or peak traffic shaping.
Step 8	**random-detect** **Example:** `Router(config-pmap-c)# random-detect`	Enables WRED or distributed WRED (DWRED).
Step 9	**random-detect precedence** {*precedence* | **rsvp**} *min-threshold* {**bytes**| **ms**| **packets**} *max-threshold*{**bytes** | **ms**| **packets**} [*mark-probability-denominator*] **Example:** `Router(config-pmap-c)# random-detect precedence 2 512 ms 1020 ms`	Configures WRED and DWRED parameters for a particular IP precedence. • Specify the IP precedence or RSVP value, and thresholds, as needed. **Note** In this example, the WRED parameters were specified for traffic with a specific IP precedence value. Other values can be specified with other **random-detect**commands.
Step 10	**exit** **Example:** `Router(config-pmap-c)# exit`	(Optional) Exits policy-map class configuration mode.

Using the queue-limit Command to Specify the Thresholds

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-name*
4. **class** {*class-name* **class-default**}
5. To continue with the configuration, you must either specify a bandwidth or enable traffic shaping. Choose one or the other.
6. **bandwidth** {*bandwidth-kbps* | **remaining percent** *percentage* | **percent** *percentage*}
7. **shape** [**average** | **peak**] *mean-rate* [[*burst-size*] [*excess-burst-size*]]
8. **queue-limit** *number-of-packets* [**bytes** | **ms** | **packets**]
9. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.

Step 3	**policy-map** *policy-name*
	Example:
	`Router(config)#`
	`policy-map`
	`policy1`
		Specifies the name of the policy map to be created. Enters policy-map configuration mode.
		• Enter policy map name.

Step 4	**class** {*class-name* **class-default**} **Example:** `Router(config-pmap)# class class1`	Specifies the class so that you can configure or modify its policy. Enters policy-map class configuration mode. • Enter the class name or specify the default class (class-default).
Step 5	To continue with the configuration, you must either specify a bandwidth or enable traffic shaping. Choose one or the other.	
Step 6	**bandwidth** {*bandwidth-kbps* | **remaining percent** *percentage* | **percent** *percentage*} **Example:** `Router(config-pmap-c)# bandwidth percent 40`	(Optional) Specifies or modifies the bandwidth allocated for a class belonging to a policy map. • Enter the bandwidth to be set or modified.
Step 7	**shape** [**average** | **peak**] *mean-rate* [[*burst-size*] [*excess-burst-size*]] **Example:** `Router(config-pmap-c)# shape average 51200`	(Optional) Enables either average or peak rate traffic shaping. • Specifies either average or peak traffic shaping.
Step 8	**queue-limit** *number-of-packets* [**bytes** | **ms** | **packets**] **Example:** `Router(config-pmap-c)# queue-limit 200 ms`	(Optional) Specifies or modifies the maximum number of packets the queue can hold (that is, the queue limit) for a class configured in a policy map.

	Command or Action	Purpose
		• Enter the queue limit. The unit of measure can be bytes, milliseconds, or packets.
Step 9	**exit** **Example:** `Router(config-pmap-c)# exit`	(Optional) Exits policy-map class configuration mode.

Attaching the Policy Map to an Interface in a QoS Time-Based Threshold for WRED Configuration

Note Depending on the needs of your network, you may need to attach the policy map to a subinterface, an ATM PVC, a Frame Relay DLCI, or other type of interface.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number*
4. **pvc** [*name*] *vpi* / *vci* [**ilmi** | **qsaal** | **smds**]
5. **service-policy** {**input**| **output**} *policy-map-name*
6. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **Example:**	Configures an interface (or subinterface) type and enters interface configuration mode. • Enter the interface type number.

	Command or Action	Purpose
	`Router(config)#` `interface serial4/0`	
Step 4	**pvc** [*name*] *vpi* / *vci* [**ilmi** | **qsaal** | **smds**] **Example:** `Router(config-if)# pvc cisco 0/16 ilmi`	(Optional) Creates or assigns a name to an ATM PVC and specifies the encapsulation type on an ATM PVC. Enters ATM VC configuration mode. **Note** This step is required only if you are attaching the policy map to an ATM PVC. If you are not attaching the policy map to an ATM PVC, skip this step and proceed with Step 5 .

Step 5	**service-policy** {**input**| **output**} *policy-map-name*
	Example:
	`Router(config-if)#`
	`service-policy output policy1`
	Example:
		Specifies the name of the policy map to be attached to the input *or* output direction of the interface.
		Note
		Policy maps can be configured on ingress or egress routers. They can also be attached in the input or output direction of an interface. The direction (input or output) and the router (ingress or egress) to which the policy map should be attached varies according your network configuration. When using the **service-policy** command to attach the policy map to an interface, be sure to choose the router and the interface direction that are appropriate for your network configuration.
		• Enter the policy map name.

Step 6	**exit** **Example:** `Router(config-if)# exit`	(Optional) Exits interface configuration mode.

Verifying the QoS Time-Based Thresholds for WRED and Queue Limit Configuration

SUMMARY STEPS

1. **enable**
2. **show policy-map** [*policy-map*]
3. and/or
4. **show policy-map interface** *interface-name*
5. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**show policy-map** [*policy-map*] **Example:** `Router# show policy-map policy1`	Displays all information about a class map, including the match criterion. • Enter class map name.
Step 3	and/or	

Step 4	**show policy-map interface** *interface-name*
	Example:
	`Router#`
	`show policy-map interface serial4/0`
		Displays the packet statistics of all classes that are configured for all service policies either on the specified interface or subinterface or on a specific PVC on the interface.
		• Enter the interface name.

Step 5	**exit** **Example:** `Router# exit`	(Optional) Exits privileged EXEC mode.

Troubleshooting Tips

The commands in the "Verifying the Configuration" section allow you to verify that you achieved the intended configuration and that the feature is functioning correctly. If, after using the **show** commands listed above, you find that the configuration is not correct or the feature is not functioning as expected, perform these operations:

If the configuration is not the one you intended, complete the following steps:

1. Use the **show running-config** command and analyze the output of the command.
2. If the policy map does not appear in the output of the **show running-config** command, enable the **logging console** command.
3. Attach the policy map to the interface again.

If the packets are not being matched correctly (for example, the packet counters are not incrementing correctly), complete the following procedures:

1. Run the **show policy-map**command and analyze the output of the command.
2. Run the **show running-config** command and analyze the output of the command.

3. Use the **show policy-map interface** command and analyze the output of the command. Check the the following findings:
   a. If a policy map applies queueing, and the packets are matching the correct class, but you see unexpected results, compare the number of the packets in the queue with the number of the packets matched.

If the interface is congested, and only a small number of the packets are being matched, check the tuning of the transmission (tx) ring, and evaluate whether the queueing is happening on the tx ring. To do this, use the **show controllers** command, and look at the value of the tx count in the output of the command..

Configuration Examples for QoS Time-Based Thresholds for WRED and Queue Limit

Example Using WRED to Set Thresholds

In the following example, WRED has been configured in the policy map called "policy1". In this WRED configuration, the bandwidth has been specified as a percentage (80%), and the minimum and maximum thresholds for IP precedence 2 are set to 512 milliseconds and 1020 milliseconds, respectively.

```
Router> enable
Router# configure terminal
Router(config)#

policy-map policy1
Router(config-pmap)# class class1
Router(config-pmap-c)# bandwidth percent 80
Router(config-pmap-c)# random-detect
Router(config-pmap-c)# random-detect precedence 2 512 ms 1020 ms
Router(config-pmap-c)# exit

Router(config-pmap)# exit

Router(config)# interface s4/0
Router(config-if)#

service-policy output policy1
Router(config-if)# end
```

Example Using the queue-limit Command to Set Thresholds

In the following example, a policy map called "policy2" has been configured. The policy2 policy map contains a class called "class1." The bandwidth for this class has been specified as a percentage (80%) and the **queue-limit** command has been used to set the threshold to 200 milliseconds.

```
Router> enable
Router# configure terminal
Router(config)#

policy-map policy2
Router(config-pmap)# class class1
Router(config-pmap-c)# bandwidth percent 80
Router(config-pmap-c)# queue-limit 200 ms
```

```
Router(config-pmap-c)# exit

Router(config-pmap)# exit

Router(config)# interface s4/0
Router(config-if)#

service-policy output policy1
Router(config-if)# end
```

Example Verifying the Configuration

To verify that this feature is configured correctly, use either the **show policy-map**command or the **show policy-map interface** command.

This section contains two sets of sample output from the **show policy-map interface** command and the **show policy-map** command--one set showing the output when WRED is used to configure the feature, one set showing the output when the **queue-limit**command is used to configure the feature.

Example WRED Threshold Configuration Sample Output

The following is sample output of the **show policy-map** command when WRED has been used to specify the thresholds. The words "time-based wred" indicates that the thresholds have been specified in milliseconds (ms).

```
Router# show policy-map
  Policy Map policy1
    Class class1
      bandwidth 80 (%)
       time-based wred, exponential weight 9
      class    min-threshold    max-threshold    mark-probability
      ----------------------------------------------------------
      0       -                -                1/10
      1       -                -                1/10
      2       512              1024             1/10
      3       -                -                1/10
      4       -                -                1/10
      5       -                -                1/10
      6       -                -                1/10
      7       -                -                1/10
```

The following is sample output of the **show policy-map interface** command when WRED has been used to specify the thresholds.

```
Router# show policy-map interface Ethernet2/0
 Ethernet2/0
Service-policy output: policy1 (1100)
    Class-map: class1 (match-all) (1101/1)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: protocol ftp (1102)
      Queueing
      queue limit 16 ms/ 16000 bytes
      (queue depth/total drops/no-buffer drops) 0/0/0
      (pkts queued/bytes queued) 0/0
      bandwidth 80.00% (%) (8000 kbps)
        Exp-weight-constant: 9 (1/512)
        Mean queue depth: 0 ms/ 0 bytes
```

```
      class    Transmitted  Random drop   Tail drop    Minimum       Maximum       Mark
               pkts/bytes   pkts/bytes    pkts/bytes   thresh        thresh        prob
                                                      ms/bytes      ms/bytes
      0        0/0          0/0           0/0           4/4000        8/8000       1/10
      1        0/0          0/0           0/0           4/4500        8/8000       1/10
      2        0/0          0/0           0/0         512/512000   1024/1024000    1/10
      3        0/0          0/0           0/0           5/5500        8/8000       1/10
      4        0/0          0/0           0/0           6/6000        8/8000       1/10
      5        0/0          0/0           0/0           6/6500        8/8000       1/10
      6        0/0          0/0           0/0           7/7000        8/8000       1/10
      7        0/0          0/0           0/0           7/7500        8/8000       1/10
  Class-map: class-default (match-any) (1105/0)
    0 packets, 0 bytes
    5 minute offered rate 0 bps, drop rate 0 bps
    Match: any  (1106)
      0 packets, 0 bytes
      5 minute rate 0 bps

    queue limit 64 packets
    (queue depth/total drops/no-buffer drops) 0/0/0
    (pkts queued/bytes queued) 0/0
```

Formula for Converting the Threshold from Milliseconds to Bytes

When converting the threshold from milliseconds to bytes, the following formula is used:

milliseconds * (bandwidth configured for the class) / 8 = total number of bytes

For this example, the following numbers would be used in the formula:

512 ms * 8000 kbps / 8 = 512000 bytes

Note Class1 has a bandwidth of 8000 kbps.

Example queue-limit command Threshold Configuration Sample Output

The following is sample output of the **show policy-map** command when the **queue-limit** command has been used to specify the thresholds in milliseconds.

```
Router# show policy-map
  Policy Map policy1
    Class class1
      bandwidth 80 (%)
      queue-limit 200 ms
```

The following is sample output from the **show policy-map interface** command when the **queue-limit** command has been used to specify the thresholds.

```
Router# show policy-map interface
 Ethernet2/0
  Service-policy output: policy1 (1070)
    Class-map: class1 (match-all) (1071/1)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
      Match: protocol ftp (1072)
      Queueing
      queue limit 200 ms/ 200000 bytes
```

```
      (queue depth/total drops/no-buffer drops) 0/0/0
      (pkts queued/bytes queued) 0/0
      bandwidth 80.00% (%) (8000 kbps)
    Class-map: class-default (match-any) (1075/0)
      0 packets, 0 bytes
      5 minute offered rate 0 bps, drop rate 0 bps
Match: any  (1076)
        0 packets, 0 bytes
        5 minute rate 0 bps

      queue limit 64 packets
      (queue depth/total drops/no-buffer drops) 0/0/0
      (pkts queued/bytes queued) 0/0
```

Formula for Converting the Threshold from Milliseconds to Bytes

When converting the threshold from milliseconds to bytes, the following formula is used:

milliseconds * (bandwidth configured for the class)/ 8 = total number of bytes

For this example, the following numbers would be used in the formula:

200 ms * 8000 kbps / 8 = 200000 bytes

Note Class1 has a bandwidth of 8000 kbps.

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases
Quality of service (QoS) commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Quality of Service Solutions Command Reference*
Congestion avoidance mechanisms, including tail drop, RED and WRED	*Cisco IOS Quality of Service Solutions Configuration Guide*
Congestion management mechanisms, including CBWFQ, and DCBWFQ	*Cisco IOS Quality of Service Solutions Configuration Guide*
Byte-Based WRED	Byte-Based Weight Random Early Detection 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 XE software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

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

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 QoS Time-Based Thresholds for WRED and Queue Limit

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 2: Feature Information for QoS Time-Based Thresholds for WRED and Queue Limit

Feature Name	Releases	Feature Information
QoS Time-Based Thresholds for WRED and Queue Limit	Cisco IOS XE Release 3.2S	The QoS Time-Based Thresholds for WRED and Queue Limit feature allows you to specify the Weighted Random Early Detection (WRED) minimum and maximum thresholds or the queue limit threshold in milliseconds (ms). The following commands are introduced or modified: **queue-limit, random-detect precedence, show policy-map, show policy-map interface.**