Cisco 1000 Series Connected Grid Routers QoS Software Configuration Guide

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CHAPTER 1

Overview of QoS

This chapter provides an overview of the Quality of Service (QoS) feature that is configurable on the Cisco 1000 Series Connected Grid Routers (*hereafter* referred to as the Cisco CG-OS router).

QoS allows you to classify the network traffic, prioritize the traffic flow, and help avoid traffic congestion in your network.

This chapter includes the following sections:

- Information About QoS, page 1-1
- System Recovery, page 1-3
- QoS Configuration with Modular QoS CLI, page 1-3
- QoS Statistics, page 1-4

Information About QoS

QoS employs classification, marking, and priority queues to manage the flow of traffic through the network.

The control of traffic is based on the fields in the packets that flow through the system. You use the Modular QoS CLI (MQC) to create the traffic classes (class-maps) and policies (policy-maps) employed by QoS.

Note The system-defined components of the QoS feature such as traffic classes (class-maps) and policies (policy-maps), as discussed in Chapter 2, "Using Modular QoS CLI," apply globally to the entire Cisco CG-OS router.

This section includes the following topics:

- Using QoS, page 1-2
- Classification, page 1-2
- Marking, page 1-2
- Priority Queuing, page 1-3
- Sequencing of QoS Actions, page 1-3

Using QoS

QoS uses class maps, policy maps, and service policy assignments to direct how the Cisco CG-OS router manages and prioritizes traffic within the network.

To configure QoS on the Cisco CG-OS router, Cisco recommends the following configuration order:

1. Create class maps.

   Class maps are a class of traffic that is based on packet-matching criteria. Class maps are referenced in policy maps.

2. Create policy maps.

   Policy maps specify actions to take on class maps such as marking.

3. Apply service policies to a Layer 3 interface.

   Service policies apply a specified policy map to output packets on an interface. The Cisco CG-OS router supports the following interfaces: cellular (3G), WiMax, and Ethernet (Fast Ethernet and Gigabit Ethernet).

For details on creating class maps, policy maps, and service policies on the Cisco CG-OS router, see Chapter 2, “Using Modular QoS CLI.”

Note The QoS marking and monitoring statistics functions only use IPv4.

Classification

Classification partitions traffic into classes. You can classify traffic by using Access Control Lists (ACLs), Layer 3 packet length, and the packet header fields that include IP precedence and Differentiated Services Code Point (DSCP).

When you define a traffic class, you can specify multiple match criteria and you can choose to not match on a particular criterion, or you can determine the traffic class by matching any or all criteria.

The Cisco CG-OS router assigns any traffic that fails to match any class to a default class of traffic called *class-default*.

For more information about configuring classification, see Chapter 3, “Configuring Classification.”

Marking

Configuring marking on the Cisco CG-OS router allows you to modify the QoS fields of the outgoing packets on an interface. The QoS fields that you can mark are IP precedence and DSCP in Layer 3.

You define marking commands in class maps (traffic classes), which are then referenced in a policy map. Marking identifies the traffic type for priority queuing.

For more information about configuring marking, see Chapter 4, “Configuring Marking.”

Priority Queuing

Priority queuing allows you to manage the flow of traffic within the network and to achieve throughput and latency targets. Priority queuing employs index values, which you assign to class-maps to determine the order in which the Cisco CG-OS router forwards the traffic associated with that class-map.

For information about configuring priority queuing, see Chapter 5, "Configuring Priority Queuing."

Sequencing of QoS Actions

The Cisco CG-OS router performs QoS actions on incoming and outgoing Layer 3 (cellular, WiMax, Ethernet) interfaces.

The sequencing of QoS actions on egress traffic is as follows:

1. Classification
2. Marking
3. Priority Queuing

System Recovery

The Cisco CG-OS router recovers its previous state after a software restart without a loss of state.

QoS Configuration with Modular QoS CLI

You use Modular QoS CLI (MQC) to configure QoS. Table 1-1 lists the MQC configuration commands.

Table 1-1 MQC Configuration Commands

MQC Command	Description
class-map	Defines a class map that represents a class of traffic.
policy-map	Defines a policy map that represents a set of policies that the Cisco CG-OS router applies to a set of class maps.

You can modify or delete MQC objects, except system-defined objects (such as type qos), when the objects have no association with any interface. For information on system-defined MQC objects, see Chapter 2, "Using Modular QoS CLI."

After you define the QoS policy, you can attach the policy map to an interface by using the interface configuration command shown in Table 1-2.

Table 1-2 Interface Command to Attach a Policy Map to an Interface

Interface Command	Description
service-policy	Applies the specified service policy to input and output packets on the interface.

QoS Statistics

The Cisco CG-OS router maintains statistics for each policy, class action, and match criteria per interface. By default, the collection of statistics is enabled on the Cisco CG-OS router; however, you can disable the collection of statistics by entering the **no qos statistics** command. You can view QoS statistics by using the **show policy-map** interface command, and you can clear statistics based on an interface or policy map with the **clear qos statistics** command.

For information about monitoring QoS statistics, see Chapter 6, "Monitoring QoS Statistics."

Default QoS Behavior

By default, priority queuing is enabled on the Cisco CG-OS router and all traffic is assigned a priority queue index of 3 (best effort). For information about configuring priority queuing and its indexes, see Chapter 5, "Configuring Priority Queuing."

CHAPTER 2

Using Modular QoS CLI

This chapter describes how to configure Modular QoS CLI (MQC) objects that can be used for configuring QoS features using Cisco Connected Grid OS (Cisco CG-OS) software.

This chapter includes the following sections:

- Information About MQC, page 2-1
- Configuring or Modifying a Class Map, page 2-2
- Configuring or Modifying a Policy Map, page 2-3

Information About MQC

This section provides an overview of the Modular QoS and includes the following topics:

- MQC Structure
- System-Defined MQC Object
- Using an MQC Object

MQC Structure

MQC provides a language to define QoS policies.

To configure QoS on the Cisco CG-OS router, follow these steps:

1. Create class maps.

   Class maps are a class of traffic that is based on packet-matching criteria. Class maps are referenced in policy maps.

2. Create policy maps.

   Policy maps specify actions to take on class maps such as marking.

   Note You define the class-map and policy-map object types when you create them.

3. Apply service policies to a Layer 3 interface.

   Service policies apply a specified policy map to output packets on an interface. The Cisco CG-OS router supports the following interfaces: cellular, WiMax, and Ethernet.

You can view all or individual values for MQC objects by using the **show class-map** and **show policy-map** commands.

System-Defined MQC Object

Type qos is the default class-map on the Cisco CG-OS router. Additionally, by default, the Cisco CG-OS router assigns the **type qos class map** *class-default* to all packets that do not match any defined match criteria within a type qos policy map.

Using an MQC Object

A packet is matched sequentially to a class of traffic starting from the first traffic class definition (see Sequencing of QoS Actions, page 1-3). When a match is found, the Cisco CG-OS router applies the policy actions for that class to the packet.

The reserved class map receives all traffic that is not matched in type qos policies, and the Cisco CG-OS router applies the policy actions as it would for any other traffic class.

Configuring an MQC Object

When you specify an MQC object command, the Cisco CG-OS router creates the object and enters map mode (pmap) as seen in the example below:

```
router (config)# policy-map type qos priority_queuing_2
router (config-pmap-qos)#
```

Note Because **type qos** is the system-defined default, you can exclude **type qos** from the **policy-map type qos priority_queuing_2** command above and it yields the same result.

To remove a class-map or policy-map object, use the **no** form of the command that you used to create the object as seen in the example below:

```
router (config-pmap-qos)# no policy-map type qos priority_queuing_2
```

Configuring or Modifying a Class Map

You can create or modify a class map, and, then reference class maps in policy maps.

BEFORE YOU BEGIN

Determine the names that you want to assign to the class maps.

DETAILED STEPS

	Command	Purpose
Step 1	**configuration terminal**	Enters configuration mode.
Step 2	**class-map [type qos] [match-any | match-all]** *class-map-name*	Creates or accesses the class map of type qos, and then enters class-map qos mode. Class-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.
Step 3	**exit**	Exits class-map qos mode and enters configuration mode.
Step 4	**class-map type qos match-any** *class-map-name*	Creates or accesses the class map of type qos, and then enters class-map qos mode.
Step 5	**show class-map type qos** [*class-map-name*]	(Optional) Displays information about all configured class maps or a selected class map of type qos.
Step 6	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to create or modify a class map of type qos.

```
router# configuration terminal
router(config)# class-map type match-any priority_1
router(config-cmap-qos)# match dscp 5
router(config-cmap-qos)# exit
router(config)# copy running-config startup-config
```

Configuring or Modifying a Policy Map

You can create or modify a policy map to define the actions to perform on class maps.

DETAILED STEPS

	Command	Purpose
Step 1	**configuration terminal**	Enters configuration mode.
Step 2	**policy-map** [**type qos**] [**match-first**] *policy-map-name*	Creates or accesses the policy map of type qos and then enters policy-map mode. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.
Step 3	**show policy-map** [**type qos**] [*policy-map-name*]	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to create or modify a policy map of type qos.

```
router# configuration terminal
router(config)# policy-map policy1
router(config-pmap-qos)# copy running-config startup-config
```

Note In the example above, the **policy-map policy1** command is equivalent to the **policy-map type qos policy1** command. The Cisco CG-OS router assumes a policy map of **type qos,** because it is the system default when a command does not specify a type.

Applying Descriptions to MQC Objects

You can use the **description** command to add a description to an MQC object such as a class map and a policy map.

BEFORE YOU BEGIN

Access the class map or policy map.

DETAILED STEPS

	Command	Purpose
Step 1	**configuration terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any**] *class-map-name*	Creates or accesses the class map, and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 alphanumeric characters.
	policy-map [**type qos**] [**match-first**] [*policy-map-name*]	Creates or accesses the policy map, and then enters policy-map mode. The policy-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**description** *string*	Adds a description string to the MQC object. The description can be up to 200 alphanumeric characters. **Note** You cannot modify the description of system-defined qos class maps.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to add a description to a class map:

```
router# configuration terminal
router(config)# class-map class1
router(config-cmap-qos)# description my traffic class
router(config-cmap-qos)# copy running-config startup-config
```

Verifying an MQC Object

To display MQC object configuration information, perform one of the following tasks:

Command	Purpose
show class-map [**type qos**] [*class-map-name*]	Displays information about all configured class maps or a selected class map of type qos.
show policy-map [**type qos**] [*policy-map-name*]	Displays information about all configured policy maps or a selected policy map of type qos.

CHAPTER 3

Configuring Classification

This chapter describes how to configure classification on the Cisco 1000 Series Connected Grid Routers (*hereafter* referred to as Cisco CG-OS router). This chapter includes the following sections:

- Information About Classification, page 3-1
- Prerequisites for Classification, page 3-2
- Guidelines and Limitations, page 3-2
- Configuring Traffic Classes, page 3-2
- Verifying the Classification Configuration, page 3-8
- Configuration Examples for Classification, page 3-9

Information About Classification

Classification is the separation of packets into traffic classes. You configure the Cisco CG-OS router to take a specific action on the specified classified traffic, such as marking or priority queuing.

You can create class maps to represent each traffic class by matching packet characteristics with the classification criteria in Table 3-1.

For more information on class maps, see Chapter 2, "Using Modular QoS CLI".

Table 3-1 Classification Criteria

Classification Criteria	Description
IP precedence	Precedence value within the Type of Service (ToS) byte of the IP header.
Differentiated Services Code Point (DSCP)	DSCP value within the DiffServ field of the IP header.
Access control list (ACL)	IP ACL name.
Packet length	Size range of Layer 3 packet lengths.
Class map	Criteria specified in a named class-map object.

You can specify multiple match criteria, you can choose to not match on a particular criterion, or you can determine the traffic class by matching any or all criteria. Traffic that fails to match any class within a QoS policy map is assigned to a default class of traffic called **class-default**. You can also directly reference class-default within a QoS policy map to select unmatched traffic.

You can reuse class maps on the Cisco CG-OS router when defining QoS policies for different interfaces that process the same types of traffic.

For more information on class maps, see Chapter 2, "Using Modular QoS CLI".

Prerequisites for Classification

You must be familiar with Chapter 2, "Using Modular QoS CLI".

You are logged on to the Cisco CG-OS router.

Guidelines and Limitations

You can specify a maximum of 1024 match criteria in a class map.

You can configure a maximum of 4096 classes for use in a single policy map.

When you match on an ACL, the only other match you can specify is the Layer 3 packet length in a match-all class.

Configuring Traffic Classes

This section includes the following topics:

- Configuring Access Control List Classification, page 3-2
- Configuring DSCP Classification, page 3-3
- Configuring IP Precedence Classification, page 3-5
- Configuring Layer 3 Packet Length Classification, page 3-6
- Configuring Class Map Classification, page 3-7

Note For the examples within this section, please note that because **type qos** is the system-defined default, you can exclude **type qos** from the **class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name* command when you are configuring class maps and it yields the same result.

Configuring Access Control List Classification

You can classify traffic by matching packets based on existing access control lists (ACLs). The **permit** and **deny** ACL keywords are ignored in the matching process. QoS does not use the **permit** and **deny** functions of ACLs. You can classify traffic as either IPv4 or IPv6.

Note Tunneled IP packets are matched unless the tunneling protocol is also IP, and then the match applies to the outer IP header and not the encapsulated IP header.

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name*	Creates or accesses the class map named *class-map-name* and enters class-map mode. The class map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters. To delete the class map, enter the **no class-map [[type qos] [match-any | match-all]** *class-map-name* command.
Step 3	**match access-group name** *acl-name*	Configures the traffic class by matching packets based on the *acl-name*. The permit and deny ACL keywords are ignored in the matching.

EXAMPLE

This example shows how to create or access an ACL class map on the Cisco CG-OS router.

```
router# configure terminal
router(config)# class-map class_acl
router(config-cmap-qos)# match access-group name my_acl
```

Configuring DSCP Classification

You can classify traffic based on the DSCP value in the DiffServ field of the IP header. The standard DSCP values are listed in Table 3-2.

Table 3-2 Standard DSCP Values

Value	List of DSCP Values
af11	AF11 dscp (001010)—decimal value 10
af12	AF12 dscp (001100)—decimal value 12
af13	AF13 dscp (001110)—decimal value 14
af21	AF21 dscp (010010)—decimal value 18
af22	AF22 dscp (010100)—decimal value 20
af23	AF23 dscp (010110)—decimal value 22
af31	AF31 dscp (011010)—decimal value 26
af32	AF32 dscp (011100)—decimal value 28
af33	AF33 dscp (011110)—decimal value 30
af41	AF41 dscp (100010)—decimal value 34
af42	AF42 dscp (100100)—decimal value 36
af43	AF43 dscp (100110)—decimal value 38

Table 3-2 Standard DSCP Values (continued)

Value	List of DSCP Values
cs1	CS1 (precedence 1) dscp (001000)—decimal value 8
cs2	CS2 (precedence 2) dscp (010000)—decimal value 16
cs3	CS3 (precedence 3) dscp (011000)—decimal value 24
cs4	CS4 (precedence 4) dscp (100000)—decimal value 32
cs5	CS5 (precedence 5) dscp (101000)—decimal value 40
cs6	CS6 (precedence 6) dscp (110000)—decimal value 48
cs7	CS7 (precedence 7) dscp (111000)—decimal value 56
default	Default dscp (000000)—decimal value 0
ef	EF dscp (101110)—decimal value 46

Note Tunneled IP packets are matched unless the tunneling protocol is also IP, and the match applies to the outer IP header and not the encapsulated IP header.

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name*	Creates or accesses the class map named *class-map-name* and enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**match** [**not**] **dscp** *dscp-list*	Configures the traffic class by matching packets based on a *dscp-list*. Table 3-2 shows the standard DSCP values. Use the **not** keyword to match on values that do not match the specified range.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to configure a DSCP class-map with matching criteria of af21 and af32:

```
router# configure terminal
router(config)# class-map class_dscp
router(config-cmap-qos)# match dscp af21 af32
router(config-cmap-qos)# copy running-config startup-config
```

Configuring IP Precedence Classification

You can classify traffic based on the precedence value in the type of service (ToS) byte field of the IP header. Table 3-3 shows the precedence values.

Table 3-3 Precedence Values

Value	List of Precedence Values
<0-7>	IP precedence value
critical	Critical precedence (5)
flash	Flash precedence (3)
flash-override	Flash override precedence (4)
immediate	Immediate precedence (2)
internet	Internetwork control precedence (6)
network	Network control precedence (7)
priority	Priority precedence (1)
routine	Routine precedence (0)

Note Tunneled IP packets are matched unless the tunneling protocol is also IP, and the match applies to the outer IP header and not the encapsulated IP header.

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name*	Creates or accesses the class map named *class-map-name,* and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**match** [**not**] **precedence** *precedence-values*	Configures the traffic class by matching packets based on *precedence-values*. Values are shown in Table 3-3. Use the **not** keyword to match on values that do not match the specified range.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to classify traffic based on the precedence values of 1-2 and 5-7 (see Table 3-3) in the type of service (ToS) byte field of the IP header:

```
router# configure terminal
router(config)# class-map class_ip_precedence
router(config-cmap-qos)# match precedence 1-2, 5-7
router(config-cmap-qos)# copy running-config startup-config
```

Configuring Layer 3 Packet Length Classification

You can classify Layer 3 traffic based on various packet lengths.

Note This feature is designed for IPv4 and IPv6 packets only.

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name*	Creates or accesses the class map named *class-map-name,* and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**match** [**not**] **packet length** *packet-length-list*	Configures the traffic class by matching packets based on various packet lengths. Values can range from 1 to 9198. Use the **not** keyword to match on values that do not match the specified range.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to configure a packet length class-map.

```
router# configure terminal
router(config)# class-map class_packet_length
router(config-cmap-qos)# match packet length 2000
router(config-cmap-qos)# copy running-config startup-config
```

Configuring Class Map Classification

Before you reference a class-map within a match class-map command, you must create that referenced class map. Additionally, you can configure only one level of nesting of class maps; and, you cannot reference a class map that references another class map.

Note Before you delete a referenced class map, you must delete all references to that class map.

You can classify traffic based on the match criteria in another class map. You can reference the same class map in multiple policies.

Follow these guidelines while configuring the class-map classification:

- To perform a logical OR operation for a class map within the **match class-map** command, use the **match-any** keyword.
- To perform a logical AND operation for a class map within the class map specified in the **match class-map** command, use the **match-all** keyword.

BEFORE YOU BEGIN

Create the class map that you want to reference within the **match class-map** command.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-map-name*	Creates or accesses the class map named *class-map-name,* and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**match** [**not**] **class-map** *class-map-name*	Configures the traffic class by matching packets based on the match criteria in another class map. **match-all** is the default for the **class-map** command. Use the **not** keyword to match on values that do not match the specified range.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to configure the class-map, *class_class_map* to match its criteria with the match criteria defined within the *class_map3* class-map:

```
router# configure terminal
router(config)# class-map class_class_map
router(config-cmap-qos)# match class-map class_map3
router(config-cmap-qos)# copy running-config startup-config
```

Verifying the Classification Configuration

Use the **show class-map** command to verify the class-map configuration. This command displays all class maps.

```
router# show class-map
    show class-map

    Type qos class-maps
    ===================
    class-map type qos match-all class1
          match dscp 5
    class-map type qos match-all class33
          match dscp 10
```

Configuration Examples for Classification

The following example shows how to configure classification for two classes of traffic:

```
class-map class_dscp
  match dscp af21 af32
exit
class-map class_packet_length
  match packet length 2000
  exit
```

CHAPTER 4

Configuring Marking

This chapter describes how to configure the marking features on the Cisco 1000 Series Connected Grid Routers (*hereafter* referred to as the Cisco CG-OS router) that you can use to define the class of traffic to which the packet belongs.

This chapter includes the following sections:

- Information About Marking, page 4-1
- Prerequisites for Marking, page 4-2
- Guidelines and Limitations, page 4-2
- Configuring Marking, page 4-2
- Verifying the Marking Configuration, page 4-6
- Configuration Examples for Marking, page 4-7

Information About Marking

Marking is a method that you can configure on the Cisco CG-OS router to modify the QoS fields of the outgoing packets on a Layer 3 interface. The QoS fields that you can mark are IP precedence and Differentiated Service Code Point (DSCP) in Layer 3.

Note For a list of supported Layer 3 interfaces, see Configuring Priority Queuing, page 5-1.

You can use marking commands in traffic classes that are referenced in a policy map. Table 4-1 lists the marking features that you can configure on the Cisco CG-OS router.

Table 4-1 Configurable Marking Features

Marking Feature	Description
DSCP	Layer 3 DSCP.
IP precedence	Layer 3 IP precedence. **Note** IP precedence uses only the lower 3 bits of the type of service (ToS) field. The Cisco CG-OS router overwrites the first 3 bits of the ToS field to 0.

Prerequisites for Marking

Marking has the following prerequisites:

You must be familiar with Chapter 2, "Using Modular QoS CLI."

You are logged on to the Cisco CG-OS router.

Guidelines and Limitations

None.

Configuring Marking

You can combine one or more of the marking features in a policy map to control the setting of QoS values. You can then apply policies to outgoing packets on an interface.

This section includes the following topics:

- Configuring DSCP Marking, page 4-2
- Configuring IP Precedence Marking, page 4-4
- Configuring DSCP Port Marking, page 4-4

Configuring DSCP Marking

You can set the DSCP value in the six most significant bits of the DiffServ field of the IP header to a specific value. You can enter numeric values from 0 to 60, in addition to the standard DSCP values shown in Table 4-2.

Table 4-2 Standard DSCP Values

Value	List of DSCP Values
af11	AF11 dscp (001010)—decimal value 10
af12	AF12 dscp (001100)—decimal value 12
af13	AF13 dscp (001110)—decimal value 14
af21	AF21 dscp (010010)—decimal value 18
af22	AF22 dscp (010100)—decimal value 20
af23	AF23 dscp (010110)—decimal value 22
af31	AF31 dscp (011010)—decimal value 26
af32	AF32 dscp (011100)—decimal value 28
af33	AF33 dscp (011110)—decimal value 30
af41	AF41 dscp (100010)—decimal value 34
af42	AF42 dscp (100100)—decimal value 36
af43	AF43 dscp (100110)—decimal value 38

Table 4-2 Standard DSCP Values (continued)

Value	List of DSCP Values
cs1	CS1 (precedence 1) dscp (001000)—decimal value 8
cs2	CS2 (precedence 2) dscp (010000)—decimal value 16
cs3	CS3 (precedence 3) dscp (011000)—decimal value 24
cs4	CS4 (precedence 4) dscp (100000)—decimal value 32
cs5	CS5 (precedence 5) dscp (101000)—decimal value 40
cs6	CS6 (precedence 6) dscp (110000)—decimal value 48
cs7	CS7 (precedence 7) dscp (111000)—decimal value 56
default	Default dscp (000000)—decimal value 0
ef	EF dscp (101110)—decimal value 46

Note For more information about DSCP, see RFC 3260: *An Architecture for Differentiated Services.*

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name*]	Creates or accesses the policy map named *qos-policy-map-name,* and then enters policy-map mode. The policy-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**class** [**type qos**] {*class-map-name* | **class-default**}	Creates a reference to *class-map-name,* and enters policy-map class configuration mode. Use the **class-default** keyword to select all traffic that is not currently matched by classes in the policy map.
Step 4	**set dscp** *dscp-value*	Sets the DSCP value to *dscp-value*. Table 4-2 summarizes the standard values.

EXAMPLE

This example shows how to configure a DSCP marking policy-map.

```
router# configure terminal
router(config)# policy-map policy1
router(config-pmap-qos)# class class1
router(config-pmap-c-qos)# set dscp af31
```

Configuring IP Precedence Marking

You can set the value of the IP precedence field in bits 0–2 of the IPv4 ToS field of the IP header.

Note The Cisco CG-OS router rewrites the last 3 bits of the ToS field to 0 for packets that match this class.

BEFORE YOU BEGIN

No prerequisites.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**policy-map** [**type qos**] [**match-first**] [*policy-map-name*]	Creates or accesses the policy map named *policy-map-name,* and then enters policy-map mode type qos (default). The policy-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**class** [**type qos**] {*class-map-name* | **class-default**}	Creates a reference to *class-map-name* and enters class-map class configuration mode. The class is added to the end of the policy map. Use the **class-default** keyword to select all traffic that is not currently matched by classes in the policy map.
Step 4	**set precedence** *precedence-value*	Sets the IP precedence value to *precedence-value*. The value can range from 0 to 7.

EXAMPLE

This example shows how to configure IP precedence marking on the Cisco CG-OS router.

```
router# configure terminal
router(config)# policy-map policy1
router(config-pmap-qos)# class class1
router(config-pmap-c-qos)# set precedence 3
```

Configuring DSCP Port Marking

The default behavior of the Cisco CG-OS router is to preserve the DSCP value, or to trust DSCP. To make the port untrusted, change the DSCP value. Unless you configure a QoS policy and attach that policy to specified interfaces, the Cisco CG-OS router preserves the DSCP value.

Note

- You can attach only one policy type qos map to each interface in each direction.
- The DSCP value is trust on the Layer 3 port of a Cisco CG-OS router.

BEFORE YOU BEGIN

Install and configure the interface within the Cisco CG-OS router.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name*]	Creates or accesses the policy map named *qos-policy-map-name* and then enters policy-map mode. The policy-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.
Step 3	**class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-map-name*]	Creates a reference to *class-map-name* and enters policy-map class configuration mode. The class is added to the end of the policy map unless **insert-before** is used to specify the class to insert before. Use the **class-default** keyword to select all traffic that is not currently matched by classes in the policy map.
Step 4	**set dscp**-*value*	Sets the DSCP value to *dscp-value*. Table 4-2 shows valid values.
Step 5	**exit**	Returns to policy-map configuration mode.
Step 6	**class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-map-name*]	Creates a reference to *class-map-name,* and enters policy-map class configuration mode. The class is added to the end of the policy map unless **insert-before** is used to specify the class to insert before. Use the **class-default** keyword to select all traffic that is not currently matched by classes in the policy map.
Step 7	**set dscp**-*value*	Sets the DSCP value to *dscp-value*. Table 4-2 shows valid values.
Step 8	**exit**	Returns to policy-map configuration mode.
Step 9	**class [type qos] {***class-map-name* | **class-default} [insert-before** *before-class-map-name***]**	Creates a reference to *class-map-name,* and enters policy-map class configuration mode. The class is added to the end of the policy map unless **insert-before** is used to specify the class to insert before. Use the **class-default** keyword to select all traffic that is not currently matched by classes in the policy map.

	Command	Purpose
Step 10	**set dscp**-*value*	Sets the DSCP value to *dscp-value*. Table 4-2 shows valid values.
Step 11	**exit**	Returns to policy-map configuration mode.
Step 12	**interface ethernet** {*slot/port*}	Enters interface mode to configure the Ethernet interface for DSCP marking.
	interface cellular {*slot/port*}	Enters interface mode to configure the cellular (3G) interface for DSCP marking.
	interface wimax {*slot/port*}	Enters interface mode to configure the WiMax interface for DSCP marking.
Step 13	**service-policy** [**type qos**] {**input** | **output**} {*policy-map-name*} [**no-stats**]	Adds *policy-map-name* to the input packets of the interface. You can attach only one input policy and one output policy to an interface.

EXAMPLE

This example how to configure DSCP marking.

```
router# configure terminal
router(config)# policy-map policy1
router(config-pmap)# class class1
router(config-pmap-c-qos)# set dscp af31
router(config-pmap-c-qos)# exit
router(config-pmap-qos)# class class2
router(config-pmap-c-qos)# set dscp af13
router(config-pmap-c-qos)# exit
router(config-pmap-qos)# class class-default
router(config-pmap-c-qos)# set dscp af22
router(config-pmap-c-qos)# exit
router(config-pmap-qos)# exit
router(config)# interface cellular 3/1
router(config-if)# service-policy input policy1
```

Verifying the Marking Configuration

To display the marking configuration information, enter the following command.

Command	Purpose
show policy-map	Displays all policy maps.

Configuration Examples for Marking

The following example shows how to configure marking:

```
configure terminal
  policy-map type qos untrust_dcsp
   class class-default
     set dscp 0
```

CHAPTER 5

Configuring Priority Queuing

This chapter describes how to configure the QoS priority queuing feature on the Cisco 1000 Series Connected Grid Router (*hereafter* referred to as the Cisco CG-OS router). This chapter includes the following sections:

- Information About Priority Queuing, page 5-1
- Prerequisites for Priority Queuing, page 5-3
- Guidelines and Limitations, page 5-3
- Configuring Priority Queuing, page 5-3
- Verifying the Priority Queuing Configuration, page 5-5

Information About Priority Queuing

The Cisco CG-OS router employs priority queuing to manage the flow of traffic within the network and to achieve throughput and latency targets. Priority queuing employs index values, which you assign to class-maps to determine the order in which the Cisco CG-OS router forwards the associated packets.

You can only assign priority queue indexes to Layer 3 interfaces that are QoS classified or marked. Table 5-1 lists the Layer 3 interfaces supported on the Cisco CG-OS router.

Table 5-1 Layer 3 Interfaces Which Support Priority Queuing

Interface	Configuration Details
Ethernet	Software configuration details can be seen in this and other Cisco 1000 Series Connected Grid Routers Software Configuration documents. For hardware details, see *Cisco 1240 Connected Grid Router Hardware Installation Guide*
Cellular interface (CDMA)	Software configuration details can be seen in this and other Cisco 1000 Series Connected Grid Routers Software Configuration documents. For hardware details, see *Cisco Connected Grid Module–3G EVDO Rev A/0/1xRTT Installation and Configuration Guide*

Table 5-1 Layer 3 Interfaces Which Support Priority Queuing (continued)

Interface	Configuration Details
Cellular interface (GSM)	Software configuration details can be seen in this and other Cisco 1000 Series Connected Grid Routers Software Configuration documents. For hardware details, see *Cisco Connected Grid Module–3G HSPA+/UMTS/GSM/GPRS/EDGE Installation and Configuration Guide*
WiMax interface	Software configuration details can be seen in this and other Cisco 1000 Series Connected Grid Routers Software Configuration documents. For hardware details, see Cisco *Connected Grid Modules for CGR 1000 Series–WiMAX Installation and Configuration Guide*

Priority Queuing

The Cisco CG-OS router supports four priority queue settings for QoS, indexes 1 to 4, where 1 is the highest priority and 4 is the lowest. The Cisco CG-OS router sends outgoing traffic for each Layer 3 interface (see Table 5-1) based on its assigned priority queue index (see Table 5-2). You can assign these priority queue levels to traffic classes (class maps) to manage the sequencing of packets to yield a more consistent flow of traffic within the network.

For example, the Cisco CG-OS router forwards all outgoing traffic with a priority queue index of one, the highest priority setting, before forwarding any outgoing traffic with a priority queue index of 2. Likewise, the Cisco CG-OS router forwards all traffic with a priority queue index of 2 before traffic with a priority queue index of 3. This pattern continues until the Cisco CG-OS router forwards traffic from the lowest priority queue (4), which has an index of 4.

When the queue buffer overloads, the Cisco CG-OS router drops packets.

Table 5-2 Priority Queue Indexes

Value	Description
1	**Highest priority**. Traffic assigned this value, is always sent first.
2	**Medium Priority**. Traffic assigned this value is sent after priority 1 traffic and before traffic with assigned priority of 3 or 4.
3	**Best Effort Priority**. Traffic assigned this value is sent after priority 1 and 2 traffic and before traffic with assigned priority of 4. **Note** Default setting.
4	**Lowest priority**. Traffic assigned this value is always sent after those packets in the queue with priority of 1, 2, or 3 are sent.

Prerequisites for Priority Queuing

You must be familiar with Chapter 2, "Using Modular QoS CLI."

You are logged on to the Cisco CG-OS router.

Guidelines and Limitations

Configure system-defined class maps with care because the changes occur immediately and traffic might be disrupted.

Configuring Priority Queuing

You configure priority queuing by creating policy maps of type qos that you can apply to outgoing (egress) traffic on an interface. You can modify system-defined **class maps**, which are used in **policy maps** to define classes of traffic to which you want to apply policies. For information about configuring policy maps and class maps, see Chapter 2, "Using Modular QoS CLI."

This section includes the following topics:

- Configuring Priority Queuing, page 5-3
- Assigning Priority Queues to Layer 3 Interfaces, page 5-4

Configuring Priority Queuing

BEFORE YOU BEGIN

Configure the policy map. See Configuring or Modifying a Policy Map, page 2-3.

Configure the class map. See Configuring or Modifying a Class Map, page 2-2.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**policy-map type qos** *policy-map-name*	Configures the policy map and then enters policy-map mode for the policy-map name that you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

	Command	Purpose
Step 3	**class** *class-map-name*	Configures the class map and then enters the class-map qos mode.
Step 4	**priority [level** *n***]**	Sets the priority level (index) for the class map. Values are 1 to 4, highest priority to lowest priority. Default value is 3.
Step 5	**show policy-map type qos** [*policy-map-name*]	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.
Step 6	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to configure a priority queue index of 2 for the type qos class map, *priority_queuing2*:

```
router# configure terminal
router(config)# policy-map type qos priority_queuing2
router(config-pmap-qos)# class type_queuing
router(config-pmap-c-qos)# priority level 2
router(config-pmap-c-qos)# copy running-config startup-config
```

Assigning Priority Queues to Layer 3 Interfaces

You can assign a priority queue index to Layer 3 interfaces. Table 5-1 lists supported interfaces.

BEFORE YOU BEGIN

Configure the priority queue. See Configuring Priority Queuing, page 5-3.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**interface** *interface-name*	Enters the interface command mode.
Step 3	**service-policy [output]** *policy-map-name*	Applies this policy map to packets going out of this interface.
Step 4	**show policy-map type qos** [*policy-map-name*]	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.
Step 5	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to configure a priority queue of level 2 for a specific queue:

```
router# configure terminal
router(config)# interface cellular 3/1
router(config-if)# service-policy output priority_queuing2
router(config-if)# copy running-config startup-config
```

Note For details on how to view QoS statistics on the interfaces, see Chapter 6, "Monitoring QoS Statistics."

Verifying the Priority Queuing Configuration

To verify the QoS priority queuing configuration, enter the following command:

Command	Purpose
show policy-map type qos [*policy-map-name*]	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.

CHAPTER 6

Monitoring QoS Statistics

This chapter describes how to enable, display, and clear QoS statistics on the Cisco 1000 Series Connected Grid Routers (*hereafter* referred to as the Cisco CG-OS router). This chapter includes the following sections:

- Information About QoS Statistics, page 6-1
- Prerequisites for Monitoring QoS Statistics, page 6-1
- Enabling Statistics, page 6-1
- Monitoring the Statistics, page 6-2
- Clearing Statistics, page 6-3

Information About QoS Statistics

You can display various QoS statistics for the Cisco CG-OS router. By default, statistics are enabled, but you can disable this feature. For more information, see Enabling Statistics, page 6-1.

Prerequisites for Monitoring QoS Statistics

You must be familiar with Chapter 2, "Using Modular QoS CLI."

You must log in to the Cisco CG-OS router.

Guidelines and Limitations

None.

Enabling Statistics

You can enable or disable QoS statistics for all interfaces on the Cisco CG-OS router. By default, QoS statistics are enabled on the Cisco CG-OS router.

DETAILED STEPS

	Command	Purpose
Step 1	**configure terminal**	Enters configuration mode.
Step 2	**qos statistics**	Enables QoS statistics on all interfaces.
	no qos statistics	Disables QoS statistics on all interfaces.
Step 3	**show policy-map interface**	(Optional) Displays the statistics status and the configured policy maps on all interfaces.
Step 4	**copy running-config startup-config**	(Optional) Saves the running configuration to the startup configuration.

EXAMPLE

This example shows how to enable QoS statistics on all interfaces:

```
router# configure terminal
router(config)# qos statistics
router(config)# copy running-config startup-config
```

To disable QoS statistics on all interfaces, enter the **no qos statistics** command in the configuration mode.

Monitoring the Statistics

You can display QoS statistics for all interfaces or a selected interface, data direction, or a QoS type by using the following **show** command.

Command	Purpose
show policy-map [*policy-map-name*] [**interface {cellular | ethernet |wimax}** *slot/port*] [**output**] [**type qos**]	Displays statistics and the configured policy maps on all interfaces, a specific interface, data direction, and QoS type. **Note** The Cisco CG-OS router only supports the *output* option for data direction.

This example shows how to display QoS statistics for a specific interface.

```
router# show policy-map interface cellular 3/1 type qos
```

This example shows how to display the output data direction for all interfaces on the Cisco CG-OS router.

```
router# show policy-map interface output
```

Clearing Statistics

You can clear QoS statistics for all interfaces or a selected interface, data direction, or QoS type by using the **clear qos statistics** command.

Command	Purpose
clear qos statistics [**interface {cellular | ethernet |wimax}** *slot/port*] [**output**] [**type qos**]	Clears statistics and the configured policy maps on all interfaces or the specified interface, data direction, or QoS type.

This example shows how to clear QoS statistics for a specific interface.

```
router# clear qos statistics interface ethernet 2/1
```

This example shows how to clear all QoS statistics on the Cisco CG-OS router.

```
router# clear qos statistics type qos
```

Configuration Example For Monitoring QoS Statistics

The following example shows how to display QoS statistics.

```
router(config)# show policy-map interface cellular 3/1 type qos
```