Cisco Nexus 9000 Series NX-OS Quality of Service Configuration Guide, Release 9.2(x)

First Published: 2018-06-26

Last Modified: 2024-06-18

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
http://www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 527-0883

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS MUST TAKE FULL RESPONSIBILITY FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN THE INFORMATION PACKET THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT YOUR CISCO REPRESENTATIVE FOR A COPY.

The Cisco implementation of TCP header compression is an adaptation of a program developed by the University of California, Berkeley (UCB) as part of UCB's public domain version of the UNIX operating system. All rights reserved. Copyright © 1981, Regents of the University of California.

NOTWITHSTANDING ANY OTHER WARRANTY HEREIN, ALL DOCUMENT FILES AND SOFTWARE OF THESE SUPPLIERS ARE PROVIDED “AS IS" WITH ALL FAULTS. CISCO AND THE ABOVE-NAMED SUPPLIERS DISCLAIM ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THOSE OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OR ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

All printed copies and duplicate soft copies of this document are considered uncontrolled. See the current online version for the latest version.

Cisco has more than 200 offices worldwide. Addresses and phone numbers are listed on the Cisco website at www.cisco.com/go/offices.

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: https://www.cisco.com/c/en/us/about/legal/trademarks.html. Third-party trademarks mentioned are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (1721R)

© 2018–2024 Cisco Systems, Inc. All rights reserved.

CONTENTS

PREFACE

Preface xi

Audience xi

Document Conventions xi

Related Documentation for Cisco Nexus 9000 Series Switches xii

Documentation Feedback xii

Communications, services, and additional information xii

Cisco Bug Search Tool xiii

Documentation feedback xiii

CHAPTER 1

New and Changed Information 1

New and Changed Information 1

CHAPTER 2

Overview 3

Licensing Requirements 3

Supported Platforms 3

About QoS Features 3

Using QoS 4

Classification 4

Marking 5

Policing 5

Queuing and Scheduling 5

Sequencing of QoS Actions 5

Sequencing of Ingress Traffic Actions 6

Sequencing of Egress Traffic Actions 6

High Availability Requirements for QoS Features 6

QoS Feature Configuration with MQC 6

QoS Statistics 7
Default QoS Behavior 7
Virtual Device Contexts 7

CHAPTER 3 Using Modular QoS CLI 9
About MQC 9
Guidelines and Limitations for Modular QoS CLI 10
System Classes 10
Default System Classes 10
Using an MQC Object 11
Type qos Policies 11
Type Queuing Policies 12
System-Defined MQC Objects 12
System-Defined MQC Objects for 4q Mode 13
System-Defined MQC Objects for 8q Mode 15
Changing to 8q Mode 18
Changing from 8q Mode to 4q Mode 24
Configuring an MQC Object 24
Configuring or Modifying a Class Map 24
Configuring or Modifying a Policy Map 25
Applying Descriptions to MQC Objects 27
Verifying an MQC Object 28
Attaching and Detaching a QoS Policy Action 29
Configuring a Service Policy for a Layer 2 Interface 30
Configuring a Service Policy for a Layer 3 Interface 31
Attaching the System Service Policy 32
Attaching a QoS Policy Action to a VLAN 33
Session Manager Support for QoS 35

CHAPTER 4 Configuring QoS TCAM Carving 37
About QoS TCAM Carving 37
About QoS TCAM Lite Regions 40
Guidelines and Limitations for QoS TCAM Carving 41
Configuring QoS TCAM Carving 42

Enabling Layer 3 QoS (IPv6) 43
Enabling VLAN QoS (IPv4) 45
Notes for Enabling VLAN QoS 47
Enabling FEX QoS (IPv4) 48
Enabling Egress QoS (IPv4) 48
Using Templates to Configure TCAM Region Sizes 50
Verifying QoS TCAM Carving 52

CHAPTER 5 **Configure QoS Classification** 55
About Classification 55
Prerequisites for Classification 56
Guidelines and Limitations for Classification 56
Configuring Traffic Classes 58
Configuring ACL Classification 58
Examples: Configuring ACL Classification 59
Configuring DSCP Classification 60
Configuring IP Precedence Classification 62
Configuring Protocol Classification 63
Configuring Layer 3 Packet Length Classification 65
Configuring CoS Classification 66
Configuring CoS Classification for FEX 67
Configuring IP RTP Classification 69
Commands for classification configuration verification 70
Configuration Examples for Classification 70

CHAPTER 6 **Configuring Marking** 71
About Marking 71
Trust Boundaries 72
Class of Behavior 72
Prerequisites for Marking 73
Guidelines and Limitations for Marking 73
Configuring Marking 74
Configuring DSCP Marking 74
Configuring IP Precedence Marking 76

Configuring CoS Marking 78
Configuring CoS Marking for FEX 79
Configuring DSCP Port Marking 80
Verifying the Marking Configuration 82
Configuration Examples for Marking 82

CHAPTER 7 **Configuring Policing** 85
About Policing 85
Shared Policers 86
Licensing Requirements for Policing 86
Prerequisites for Policing 86
Guidelines and Limitations for QoS Policing 87
Configuring Policing 90
Configuring Ingress Policing 90
Configuring Egress Policing 91
Configuring 1-Rate and 2-Rate, 2-Color and 3-Color Policing 93
Configuring Markdown Policing 98
Configuring Shared Policers 99
Verifying the Policing Configuration 102
Configuration Examples for Policing 102

CHAPTER 8 **Configure Queuing and Scheduling** 103
Queuing and Scheduling 103
Traffic Queuing 103
Traffic Scheduling 103
Traffic Shaping 104
Congestion Avoidance 104
Congestion Management 105
Explicit Congestion Notification 105
Approximate Fair Drop 105
Weighted Random Early Detection 107
Comparison of WRED and AFD 107
Prerequisites for Queuing and Scheduling 107
Guidelines and Limitations for Queuing and Scheduling 107

Configure Queuing and Scheduling 112
Configure Type Queuing Policies 113
Configure Congestion Avoidance 115
Configure Tail Drop on Egress Queues 115
Configure WRED on Egress Queues 117
Configure AFD on Egress Queues 119
Configure Congestion Management 120
Configure Bandwidth and Bandwidth Remaining 120
Configure Priority 122
Configure Traffic Shaping 123
Apply a Queuing Policy on a System 124
Verify the Queuing and Scheduling Configuration 125
Control the QoS Shared Buffer 125
Manage Dynamic Buffer Sharing 126
Monitor the QoS Packet Buffer 126
Configuration Examples for Queuing and Scheduling 128
Example: Configuring WRED on Egress Queues 128
Example: Configuring Traffic Shaping 128

CHAPTER 9 **Configuring Network QoS** 131
About Network QoS 131
Prerequisites for Network QoS 131
Guidelines and Limitations for Network QoS 131
Dynamic Packet Prioritization 132
Configuring Network QoS Policies 133
Copying a Predefined Network QoS Policy 133
Configuring a User-Defined Network QoS Policy 134
Applying a Network QoS Policy on a System 135
Verifying the Network QoS 136

CHAPTER 10 **Configuring Link Level Flow Control** 137
Link Level Flow Control 137
Guidelines and Limitations for Link Level Flow Control 137
Information About Link Level Flow Control 138

Link Level Flow Control on Interfaces 138
Link Level Flow Control on Ports 139
Mismatched Link Level Flow Control Configurations 139
How to Configure Link Level Flow Control 139
Configuring Link Level Flow Control Receive 139
Configuring Link Level Flow Control Transmit 140
Configuration Examples for Link Level Flow Control 141
Example: Configuring Link Level Flow Control Receive and Send 141

CHAPTER 11 **Configuring Priority Flow Control 143**
About Priority Flow Control 143
About Priority Flow Control Watchdog 143
Workflow of Priority Flow Control Watchdog 144
Licensing Requirements for Priority Flow Control 145
Prerequisites for Priority Flow Control 146
Guidelines and Limitations for Priority Flow Control 146
Default Settings for Priority Flow Control 149
Configuring Priority Flow Control 149
Enabling Priority Flow Control on a Traffic Class 150
Configuring a Link Level Flow Control Watchdog and Priority Flow Control Watchdog 154
Configuring Pause Buffer Thresholds and Queue Limit Using Ingress Queuing Policy 158
Verifying the Priority Flow Control Configuration 160
Configuration Examples for Priority Flow Control 161

CHAPTER 12 **Monitoring QoS Statistics 165**
About QoS Statistics 165
Prerequisites for Monitoring QoS Statistics 165
Guidelines and Limitations for Monitoring QoS Statistics 165
Enable or disable QoS statistics 167
Monitor QoS statistics 168
Clear QoS Statistics 169
Configuration Examples For Monitoring QoS Statistics 169

CHAPTER 13 **Micro-Burst Monitoring 171**

Micro-Burst Monitoring 171
Guidelines and Limitations for Micro-Burst Monitoring 171
Configuring Micro-Burst Detection Per-Queue 174
Configuring Micro-Burst Detection Per-Switch 175
Clearing Micro-Burst Detection 177
Verifying Micro-Burst Detection 178
Example of Micro-Burst Detection Output 178

APPENDIX A FEX QoS Configuration 181
FEX QoS Configuration Information 181
TCAM Carving for FEX QoS 183
FEX QoS Configuration Example 184
Verifying the FEX QoS Configuration 200

APPENDIX B Additional References 201
RFCs 201

Preface

This preface includes the following sections:

- Audience, on page xi
- Document Conventions, on page xi
- Related Documentation for Cisco Nexus 9000 Series Switches, on page xii
- Documentation Feedback, on page xii
- Communications, services, and additional information, on page xii

Audience

This publication is for network administrators who install, configure, and maintain Cisco Nexus switches.

Document Conventions

Command descriptions use the following conventions:

Convention	Description
bold	Bold text indicates the commands and keywords that you enter literally as shown.
Italic	Italic text indicates arguments for which you supply the values.
[x]	Square brackets enclose an optional element (keyword or argument).
[x | y]	Square brackets enclosing keywords or arguments that are separated by a vertical bar indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments that are separated by a vertical bar indicate a required choice.
[x {y | z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.

Convention	Description
`variable`	Indicates a variable for which you supply values, in context where italics cannot be used.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string includes the quotation marks.

Examples use the following conventions:

Convention	Description
`screen font`	Terminal sessions and information the switch displays are in screen font.
`boldface screen font`	Information that you must enter is in boldface screen font.
italic screen font	Arguments for which you supply values are in italic screen font.
< >	Nonprinting characters, such as passwords, are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Related Documentation for Cisco Nexus 9000 Series Switches

The entire Cisco Nexus 9000 Series switch documentation set is available at the following URL:

https://www.cisco.com/en/US/products/ps13386/tsd_products_support_series_home.html

Documentation Feedback

To provide technical feedback on this document, or to report an error or omission, please send your comments to nexus9k-docfeedback@cisco.com. We appreciate your feedback.

Communications, services, and additional information

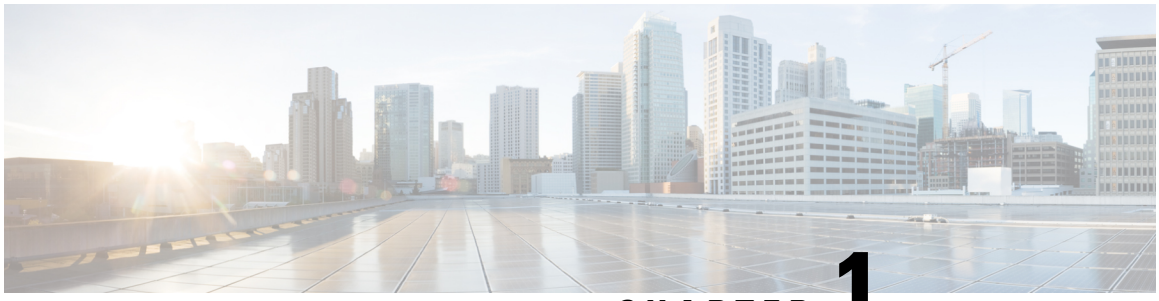
- To receive timely, relevant information from Cisco, sign up at Cisco Profile Manager.
- To get the business impact you're looking for with the technologies that matter, visit Cisco Services.
- To submit a service request, visit Cisco Support.
- To discover and browse secure, validated enterprise-class apps, products, solutions, and services, visit Cisco DevNet.
- To obtain general networking, training, and certification titles, visit Cisco Press.
- To find warranty information for a specific product or product family, access Cisco Warranty Finder.

Cisco Bug Search Tool

Cisco Bug Search Tool (BST) is a gateway to the Cisco bug-tracking system, which maintains a comprehensive list of defects and vulnerabilities in Cisco products and software. The BST provides you with detailed defect information about your products and software.

Documentation feedback

To provide feedback about Cisco technical documentation, use the feedback form available in the right pane of every online document.



CHAPTER 1

New and Changed Information

This chapter provides release-specific information for each new and changed feature in the *Cisco Nexus 9000 Series NX-OS QoS Configuration Guide, Release*.

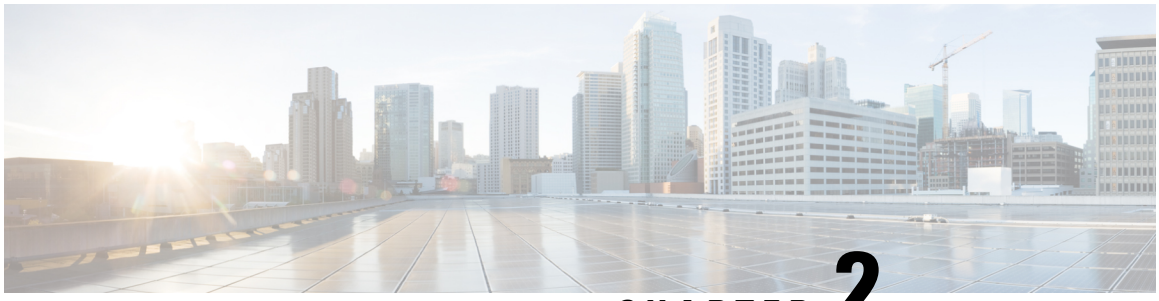
• New and Changed Information, on page 1

New and Changed Information

Table 1: New and Changed Features

Feature	Description	Changed in Release	Where Documented
Support for 2-Rate, 3-Color Ingress Policing	Support for 2-rate, 3-color ingress policing has been extended to additional switches and linecards.	9.2(3)	Guidelines and Limitations for QoS Policing, on page 87

New and Changed Information



CHAPTER 2

Overview

- Licensing Requirements, on page 3
- Supported Platforms, on page 3
- About QoS Features, on page 3
- Using QoS, on page 4
- Classification, on page 4
- Marking, on page 5
- Policing, on page 5
- Queuing and Scheduling, on page 5
- Sequencing of QoS Actions, on page 5
- High Availability Requirements for QoS Features, on page 6
- QoS Feature Configuration with MQC, on page 6
- QoS Statistics, on page 7
- Default QoS Behavior, on page 7
- Virtual Device Contexts, on page 7

Licensing Requirements

See the Cisco NX-OS Licensing Guide and Cisco NX-OS Licensing Options Guide for Cisco NX-OS licensing recommendations and instructions to obtain and apply licenses.

Supported Platforms

See the Nexus Switch Platform Support Matrix to know from which Cisco NX-OS releases various Cisco Nexus 9000 and 3000 switches support a selected feature.

About QoS Features

You use the QoS features to provide the most desirable flow of traffic through a network. QoS allows you to classify the network traffic, police and prioritize the traffic flow, and help avoid traffic congestion in a network. The control of traffic is based on the fields in the packets that flow through the system. You use the Modular QoS (MQC) CLI to create the traffic classes and policies of the QoS features.

QoS features are applied using QoS and queuing policies as follows:

- QoS policies include classification and marking features.
- QoS policies include policing features.
- QoS policies include shaping, weighted random early detection (WRED), and explicit congestion notification (ECN) features.
- Queuing policies use the queuing and scheduling features.

Note The system-defined QoS features and values that are discussed in the "Using Modular QoS CLI" section apply globally to the entire device and cannot be modified.

Using QoS

Traffic is processed based on how you classify it and the policies that you create and apply to traffic classes.

To configure QoS features, you use the following steps:

1. Create traffic classes by classifying the incoming packets that match criteria such as IP address or QoS fields.
2. Create policies by specifying actions to take on the traffic classes, such as policing, marking, or dropping packets.
3. Apply policies to a port, port channel, or subinterface.

You use MQC to create the traffic classes and policies of the QoS features.

Note The queuing and scheduling operations of the overall QoS feature are applicable to both IPv4 and IPv6.

Note IP tunnels do not support access control lists (ACLs) or QoS policies.

Classification

You use classification to partition traffic into classes. You classify the traffic based on the port characteristics or the packet header fields that include IP precedence, differentiated services code point (DSCP), Layer 3 to Layer 4 parameters, and the packet length.

The values used to classify traffic are called match criteria. When you define a traffic class, 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 is assigned to a default class of traffic called class-default.

Marking

Marking is the setting of QoS information that is related to a packet. You can set the value of a standard QoS field for COS, IP precedence and DSCP, and internal labels (such as QoS groups) that can be used in subsequent actions. Marking QoS groups is used to identify the traffic type for queuing and scheduling traffic.

Policing

Policing is the monitoring of data rates for a particular class of traffic. The device can also monitor associated burst sizes.

Single-rate policers monitor the specified committed information rate (CIR) of traffic. Dual-rate policers monitor both CIR and peak information rate (PIR) of traffic.

Queuing and Scheduling

The queuing and scheduling process allows you to control the bandwidth allocated to traffic classes so that you achieve the desired trade-off between throughput and latency.

You can apply weighted random early detection (WRED) to a class of traffic, which allows packets to be dropped based on the QoS group. The WRED algorithm allows you to perform proactive queue management to avoid traffic congestion.

You can shape traffic by imposing a maximum data rate on a class of traffic so that excess packets are retained in a queue to smooth (constrain) the output rate. In addition, minimum bandwidth shaping can be configured to provide a minimum guaranteed bandwidth for a class of traffic.

You can limit the size of the queues for a particular class of traffic by applying either static or dynamic limits.

ECN can be enabled along with WRED on a particular class of traffic to mark the congestion state instead of dropping the packets.

Sequencing of QoS Actions

The following are the three types of policies:

- **network qos**—Defines the characteristics of QoS properties network wide.
- **qos**—Defines MQC objects that you can use for marking and policing.
- **queuing**—Defines MQC objects that you can use for queuing and scheduling.

Note The default type of policy is **qos**.

The system performs actions for QoS policies only if you define them under the type qos service policies.

Sequencing of Ingress Traffic Actions

The sequence of QoS actions on ingress traffic is as follows:

1. Classification
2. Marking
3. Policing

Sequencing of Egress Traffic Actions

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

1. Queuing and scheduling

High Availability Requirements for QoS Features

The Cisco NX-OS QoS software recovers its previous state after a software restart, and it is capable of a switchover from the active supervisor to the standby supervisor without a loss of state.

Note For complete information on high availability, see the *Cisco Nexus 9000 Series NX-OS High Availability and Redundancy Guide*.

QoS Feature Configuration with MQC

You use MQC to configure QoS features. The MQC configuration commands are shown in the following table:

Table 2: 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 to be applied to a set of class maps.

You can modify or delete MQC objects, except system-defined objects, when the objects are not associated with any interfaces.

After a QoS policy is defined, you can attach the policy map to an interface by using the interface configuration command shown in the following table:

Table 3: Interface Command to Attach a Policy Map to an Interface

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

QoS Statistics

Statistics are maintained for each policy, class action, and match criteria per interface. You can enable or disable the collection of statistics, you can display statistics 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. Statistics are enabled by default and can be disabled globally.

Default QoS Behavior

The QoS queuing features are enabled by default. Specific QoS-type features, such as policing and marking, are enabled only when a policy is attached to an interface. Specific policies are enabled when that policy is attached to an interface.

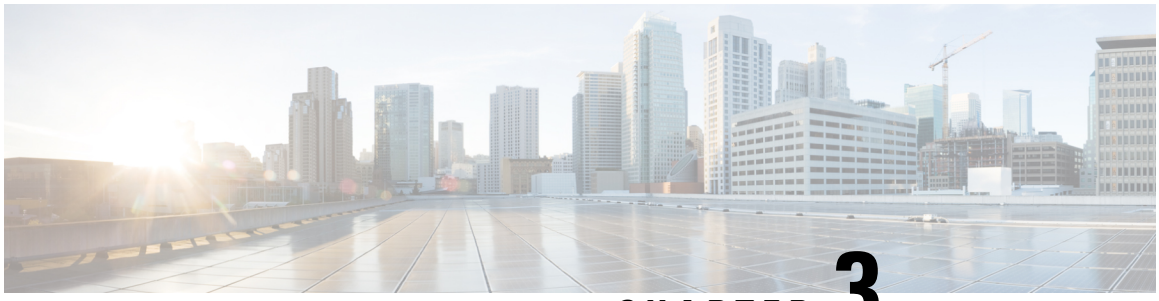
By default, the device always enables a system default queuing policy, or system-defined queuing policy map, on each port and port channel. When you configure a queuing policy and apply the new queuing policy to specified interfaces, the new queuing policy replaces the default queuing policy, and those rules now apply.

The device enables other QoS features, policing and marking, only when you apply a policy map to an interface.

Virtual Device Contexts

Cisco NX-OS can segment operating system and hardware resources into virtual device contexts (VDCs) that emulate virtual devices. The Cisco Nexus 9000 Series device currently does not support multiple VDCs. All device resources are managed in the default VDC.

Note The VDC feature is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).



CHAPTER 3

Using Modular QoS CLI

- About MQC, on page 9
- Guidelines and Limitations for Modular QoS CLI, on page 10
- System Classes, on page 10
- Default System Classes, on page 10
- Using an MQC Object, on page 11
- Attaching and Detaching a QoS Policy Action, on page 29
- Configuring a Service Policy for a Layer 2 Interface, on page 30
- Configuring a Service Policy for a Layer 3 Interface, on page 31
- Attaching the System Service Policy, on page 32
- Attaching a QoS Policy Action to a VLAN, on page 33
- Session Manager Support for QoS, on page 35

About MQC

Cisco Modular Quality of Service Command Line Interface (MQC) provides a language to define QoS policies.

You configure QoS policies by following these three steps:

1. Define traffic classes.
2. Associate policies and actions with each traffic class.
3. Attach policies to logical or physical interfaces.

MQC provides a command type to define traffic classes and policies:

- **policy-map**—Defines a policy map that represents a set of policies to be applied on a class-by-class basis to class maps.

  The policy map defines a set of actions to take on the associated traffic class, such as limiting the bandwidth or dropping packets.

You define the following class-map and policy-map object types when you create them:

- **network qos**—Defines MQC objects that you can use for system level-related actions.
- **qos**—Defines MQC objects that you can use for marking and policing.
- **queuing**—Defines MQC objects that you can use for queuing and scheduling.

Note The **qos** type is the default.

Egress QoS policies are not supported on the subinterfaces.

You can attach policies to ports, port channels, or subinterfaces by using the **service-policy** command.

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

Caution In the interface configuration mode, the device can accept QoS and access control list (ACL) commands irrespective of the line card on which the interface host is up or down. However, you cannot enter the interface submode when the line card is down because the device does not accept any preconfiguration information.

Guidelines and Limitations for Modular QoS CLI

Modular QoS CLI has the following configuration guidelines and limitations:

- On devices with R-Series line cards, data forwarding is not supported when configured with 4q mode policies. Instead, configure the device with 8q mode policies.

System Classes

The system qos is a type of MQC target. You use a service policy to associate a policy map with the system qos target. A system qos policy applies to all interfaces on the device unless a specific interface has an overriding service-policy configuration. The system qos policies are used to define system classes, the classes of traffic across the entire device, and their attributes.

If service policies are configured at the interface level, the interface-level policy always takes precedence over the system class configuration or defaults.

When you configure QoS features, and the system requests MQC objects, you can use system-defined MQC objects for 4q mode or system-defined objects for 8q mode.

On the Cisco Nexus device, a system class is uniquely identified by a qos-group value. A total of four system classes are supported. The device supports one default class which is always present on the device. Up to three additional system classes can be created by the administrator. Only egress queuing, network-qos, and type qos for FEX policies are supported on the system QoS target.

Default System Classes

The device provides the following system classes:

- Drop system class

By default, the software classifies all unicast and multicast Ethernet traffic into the default drop system class. This class is identified by qos-group 0.

Using an MQC Object

You configure QoS and queuing policies using the MQC class-map and policy-map objects. After you configure class maps and policy maps, you can attach one policy map of each type to an interface. A QoS policy can only be applied to the ingress direction.

A policy map contains either a QoS policy or queuing policy. The policy map references the names of class maps that represent traffic classes. For each class of traffic, the device applies the policies on the interface or VLAN that you select.

A packet is matched sequentially to a class of traffic starting from the first traffic class definition. When a match is found, the policy actions for that class are applied to the packet.

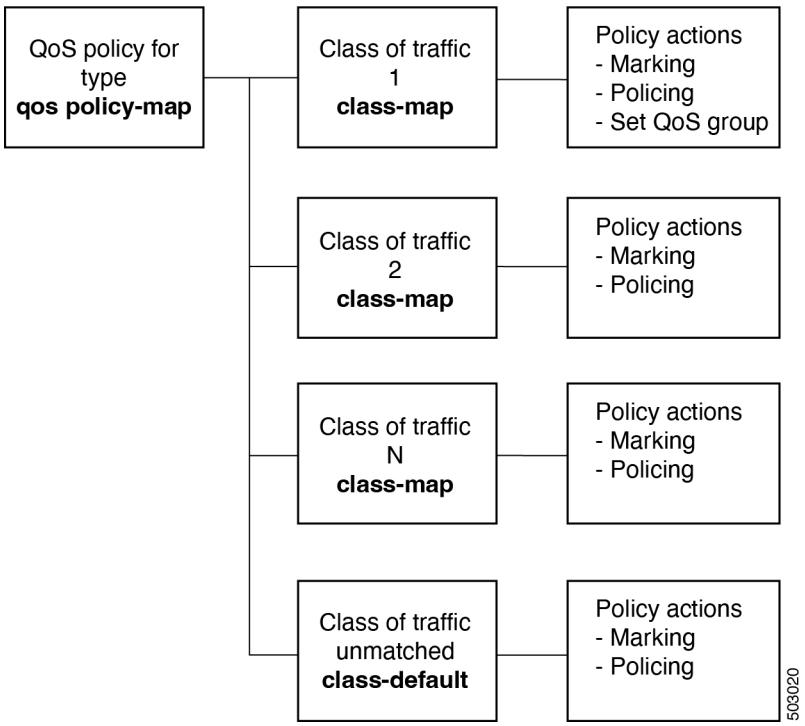
The reserved class map class-default receives all traffic that is not matched in type qos policies, and the device applies the policy actions as it would for any other traffic class.

Type qos Policies

You use type qos policies to mark and to police packets, and to set qos-groups, which drive matching conditions for system-defined type network-qos and type queuing class-maps.

The following figure shows the QoS policy structure with the associated MQC objects of type qos. The MQC objects are shown in bold.

Figure 1: QoS Policy Diagram Showing Type qos MQC Object Usage

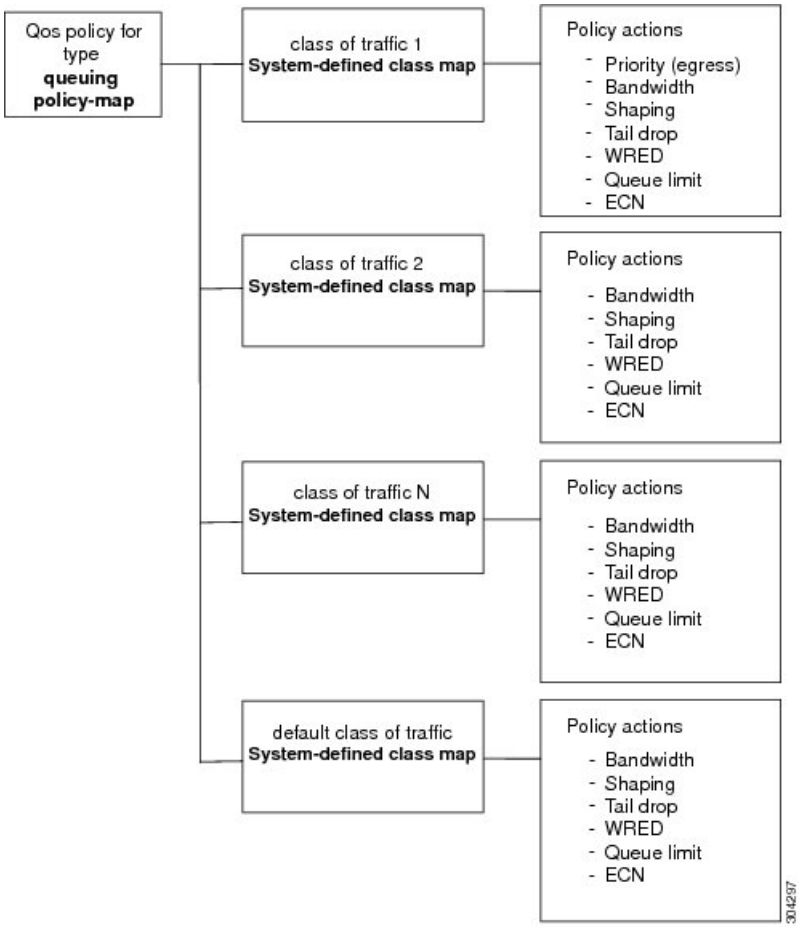


Type Queuing Policies

You use type queuing policies to shape and queue packets.

The following figure shows the QoS policy structure with associated MQC objects of type queuing. The MQC objects are shown in bold.

Figure 2: QoS Policy Diagram Showing Type Queuing MQC Object Usage



Note: See the "Configuring Queuing and Scheduling" chapter for information on configuring these parameters.

System-Defined MQC Objects

When you configure QoS features, and the system requests MQC objects, you can use system-defined objects for 4q mode or system-defined objects for 8q mode.

The system-defined objects for 8q mode are supported on the following devices:

- N9K-C92348GC-X
- Cisco Nexus 9300-EX switches

- Cisco Nexus 9300-FX switches
- Cisco Nexus 9300-FX2 switches
- Cisco Nexus 9300-GX switches
- Cisco Nexus 9504, 9508, and 9516 switches with Nexus X97160YC-EX or -FX line cards.

Note When FEX is connected, it should be configured with 4q.

Note The following Cisco Nexus switches and line cards do not support system-defined objects for 8q mode:

- N9K-C9272Q
- N9K-C9332PQ
- N9K-C93120TX
- N9K-X9464PX
- N9K-X9432PQ

Note System-defined objects for 8q mode are not supported on ACI (Application Centric Infrastructure) capable linecards.

System-Defined MQC Objects for 4q Mode

When you configure QoS features, and the system requests MQC objects, you can use the following system-defined objects:

Note The Cisco Nexus 9000 series NX-OS system operates in 8q mode by default. You must enable the following MQC objects to change to 4q mode.

Note System-defined MQC objects for 4q mode are not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

- Type qos class maps

Table 4: System-Defined Type qos Class Maps

Class Map Name	Description
class-default	Type qos class map that is assigned to all packets that match none of the criteria of traffic classes that you define in a type qos policy map.

- Type queuing class maps

Table 5: System-Defined Type queuing Class Maps for 4q Mode

Class Map Queue Name	Description
c-out-q-default	Egress default queue — QoS group 0
c-out-q1	Egress queue 1 — QoS group 1
c-out-q2	Egress queue 2 — QoS group 2
c-out-q3	Egress queue 3 — QoS group 3

- Type network-qos class maps

Table 6: System-Defined Type network-qos Class Maps for 4q Mode

Class Map Network-QoS Name	Description
c-nq-default	Network-qos class — QoS group 0
c-nq1	Network-qos class — QoS group 1
c-nq2	Network-qos class — QoS group 2
c-nq3	Network-qos class — QoS group 3

- Policy maps

Table 7: System-Defined Queuing Policy Maps for 4q Mode

Queuing Policy Map Name	Description

default-out-policy	Output queuing policy map that is attached to all module ports to which you do not apply a queuing policy map. The default configuration values are as follows:
	
	`policy-map type queuing default-out-policy`
	`  class type queuing c-out-q3`
	`   priority level 1`
	`  class type queuing c-out-q2`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-q1`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-q-default`
	`   bandwidth remaining percent 100`

Queuing Policy Map Name	Description

default-network-qos-policy	Network-qos queuing policy map that is attached to all module ports to which you do not apply a queuing policy map. The default configuration values are as follows:
	
	`policy-map type network-qos default-nq-policy`
	`  class type network-qos c-nq3`
	`   match qos-group 3`
	`   mtu 1500`
	`  class type network-qos c-nq2`
	`   match qos-group 2`
	`   mtu 1500`
	`  class type network-qos c-nq1`
	`   match qos-group 1`
	`   mtu 1500`
	`  class type network-qos c-nq-default`
	`   match qos-group 0`
	`   mtu 1500`

System-Defined MQC Objects for 8q Mode

When you configure QoS features, and the system requests MQC objects, you can use the following system-defined objects:

Note System-defined MQC objects for 8q mode are the default MQC objects.

Note The default queue for Cisco Nexus 9200 Series switches is 8q.

- Type qos class maps

Table 8: System-Defined Type qos Class Maps

Class Map Name	Description
class-default	Type qos class map that is assigned to all packets that match none of the criteria of traffic classes that you define in a type qos policy map.

- Type queuing class maps

Table 9: System-Defined Type queuing Class Maps for 8q Mode (Egress)

Class Map Queue Name	Description
c-out-8q-q-default	Egress default queue — QoS group 0
c-out-8q-q1	Egress queue 1 — QoS group 1
c-out-8q-q2	Egress queue 2 — QoS group 2

Class Map Queue Name	Description
c-out-8q-q3	Egress queue 3 — QoS group 3
c-out-8q-q4	Egress queue 4 — QoS group 4
c-out-8q-q5	Egress queue 5 — QoS group 5
c-out-8q-q6	Egress queue 6 — QoS group 6
c-out-8q-q7	Egress queue 7 — QoS group 7

Table 10: System-Defined Type queuing Class Maps for 8q Mode (Ingress)

Class Map Queue Name	Description
c-in-q-default	Ingress default queue — QoS group 0
c-in-q1	Ingress queue 1 — QoS group 1
c-in-q2	Ingress queue 2 — QoS group 2
c-in-q3	Ingress queue 3 — QoS group 3
c-in-q4	Ingress queue 4 — QoS group 4
c-in-q5	Ingress queue 5 — QoS group 5
c-in-q6	Ingress queue 6 — QoS group 6
c-in-q7	Ingress queue 7 — QoS group 7

- Type network-qos class maps

Note The System-Defined Type network-qos Class Maps for 8q Mode are not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

Table 11: System-Defined Type network-qos Class Maps for 8q Mode

Class Map Network-QoS Name	Description
c-8q-nq-default	Network-qos class — QoS group 0
c-8q-nq1	Network-qos class — QoS group 1
c-8q-nq2	Network-qos class — QoS group 2
c-8q-nq3	Network-qos class — QoS group 3
c-8q-nq4	Network-qos class — QoS group 4

Class Map Network-QoS Name	Description
c-8q-nq5	Network-qos class — QoS group 5
c-8q-nq6	Network-qos class — QoS group 6
c-8q-nq7	Network-qos class — QoS group 7

- Policy maps

Table 12: System-Defined Queuing Policy Maps for 8q Mode

Queuing Policy Map Name	Description

default-8q-out-policy	Output queuing policy map that is attached to all module ports to which you do not apply a queuing policy map. The default configuration values are as follows:
	
	`policy-map type queuing default-8q-out-policy`
	`  class type queuing c-out-8q-q7`
	`   priority level 1`
	`  class type queuing c-out-8q-q6`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q5`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q4`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q3`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q2`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q1`
	`   bandwidth remaining percent 0`
	`  class type queuing c-out-8q-q-default`
	`   bandwidth remaining percent 100`

Queuing Policy Map Name	Description

default-8q-network-qos-policy	Network-qos queuing policy map that is attached to all module ports to which you do not apply a queuing policy map. The default configuration values are as follows:
	
	`policy-map type network-qos default-8q-nq-policy`
	`  class type network-qos c-8q-nq7`
	`   match qos-group 7`
	`   mtu 1500`
	`  class type network-qos c-8q-nq6`
	`   match qos-group 6`
	`   mtu 1500`
	`  class type network-qos c-8q-nq5`
	`   match qos-group 5`
	`   mtu 1500`
	`  class type network-qos c-8q-nq4`
	`   match qos-group 4`
	`   mtu 1500`
	`  class type network-qos c-8q-nq3`
	`   match qos-group 3`
	`   mtu 1500`
	`  class type network-qos c-8q-nq2`
	`   match qos-group 2`
	`   mtu 1500`
	`  class type network-qos c-8q-nq1`
	`   match qos-group 1`
	`   mtu 1500`
	`  class type network-qos c-8q-nq-default`
	`   match qos-group 0`
	`   mtu 1500`

Changing to 8q Mode

Note The Cisco Nexus 9000 series NX-OS system operates in 8q mode by default.

Use the following guidelines to change to 8q mode:

- Change the network-qos policy to 8q mode.

  You can either activate the default-8q-nq-policy (which is the system created 8q default network-qos policy); or you can copy it using the **qos copy policy-map type network-qos** command, edit it as needed, and activate it.

- Change the queuing policy to 8q mode. (This means changing the system queuing policy and optionally any interface queuing policy.)

  Make a copy of the default-8q-out-policy (the default 8q queuing policy created by the system) using the **qos copy policy-map type queuing** command. Edit the copy of the default-8q-out-policy as needed and activate it at the system level and optionally at the interface level.

- After the network-qos and queuing policies are changed to 8q mode, you can start using **set qos-group** action for qos-groups 4-7 to steer the traffic to queues 4-7.

Notes About 8q Mode

The following are notes about 8q mode:

- When 8q policies are in active use, the system cannot be downgraded to a system image that does not support 8q mode.

Note As a best practice to avoid incompatibilities, remove the 8q policies before a downgrade.

The following example shows some incompatibilities when trying to downgrade to a system image that does not support 8q mode.

```
switch# show incompatibility nxos bootflash:n9000-dk9.6.1.2.I1.2.bin

The following configurations on active are incompatible with  the system image

1) Service : ipqosmgr , Capability : CAP_FEATURE_IPQOS_8Q_QUE_POLICY_ACTIVE
Description : QoS Manager - 8Q queuing policy active
Capability requirement : STRICT
Enable/Disable command : Please remove 8q queuing policy

2) Service : ipqosmgr , Capability : CAP_FEATURE_IPQOS_8Q_NQOS_POLICY_ACTIVE
Description : QoS Manager - 8Q network-qos policy active
Capability requirement : STRICT
Enable/Disable command : Please remove 8q network-qos policy
```

- No 8q policies can be activated on a system that has linecards that do not support 8-queues. All ACI (Application Centric Infrastructure) capable linecards do not support 8-queues.

Note As a best practice, power off all linecards that do not support 8-queues before using 8-queue functionality.

The following example shows some of the errors that occur when you attempt to use 8-queue functionality on a system that has linecards that do not support 8-queues.

```
switch(config)# system qos
  switch(config-sys-qos)# service-policy type queuing output default-8q-out-policy
  ERROR: policy-map default-8q-out-policy can be activated only on 8q capable platforms


  switch(config)# system qos
  switch(config-sys-qos)# service-policy type network-qos default-8q-nq-policy
  ERROR: policy-map default-8q-nq-policy can be activated only on 8q capable platforms


  switch(config)# policy-map p1
  switch(config-pmap-qos)# class c1
  switch(config-pmap-c-qos)# set qos-group 7
  ERROR: set on qos-group 4-7 is supported only on 8q capable platforms
```

Example of Changing to 8q Mode

The following is an example of changing to 8q mode:

Note This example is not applicable to the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

```
switch# qos copy policy-map type network-qos default-8q-nq-policy prefix my
switch# show policy-map type network-qos

  Type network-qos policy-maps
  ============================
  policy-map type network-qos my8q-nq
    class type network-qos c-8q-nq7
      mtu 1500
    class type network-qos c-8q-nq6
      mtu 1500
    class type network-qos c-8q-nq5
      mtu 1500
    class type network-qos c-8q-nq4
      mtu 1500
    class type network-qos c-8q-nq3
      mtu 1500
    class type network-qos c-8q-nq2
      mtu 1500
    class type network-qos c-8q-nq1
      mtu 1500
    class type network-qos c-8q-nq-default
      mtu 1500

switch# config t
switch(config)# policy-map type network-qos my8q-nq
switch(config-pmap-nqos)# class type network-qos c-8q-nq1
switch(config-pmap-nqos-c)# mtu 9216
switch(config-pmap-nqos-c)# class type network-qos c-8q-nq2
switch(config-pmap-nqos-c)# mtu 2240
switch(config-pmap-nqos-c)# class type network-qos c-8q-nq4
switch(config-pmap-nqos-c)# pause pfc-cos 4
switch(config-pmap-nqos-c)# class type network-qos c-8q-nq5
switch(config-pmap-nqos-c)# mtu 2240
switch(config-pmap-nqos-c)# pause pfc-cos 5
switch(config-pmap-nqos-c)# class type network-qos c-8q-nq6
switch(config-pmap-nqos-c)# mtu 9216
switch(config-pmap-nqos-c)# pause pfc-cos 6
switch(config-pmap-nqos-c)# show policy-map type network-qos my8q-nq

  Type network-qos policy-maps
  ============================
  policy-map type network-qos my8q-nq
    class type network-qos c-8q-nq7
      mtu 1500
    class type network-qos c-8q-nq6
      pause pfc-cos 6
      mtu 9216
    class type network-qos c-8q-nq5
      pause pfc-cos 5
      mtu 2240
    class type network-qos c-8q-nq4
      pause pfc-cos 4
      mtu 1500
    class type network-qos c-8q-nq3
      mtu 1500
    class type network-qos c-8q-nq2
      mtu 2240
    class type network-qos c-8q-nq1
```

```
      mtu 9216
    class type network-qos c-8q-nq-default
      mtu 1500

switch(config)# system qos
switch(config-sys-qos)# service-policy type network-qos my8q-nq
switch(config-sys-qos)# 2014 Jun 12 11:13:48 switch %$ VDC-1 %$
%IPQOSMGR-2-QOSMGR_NETWORK_QOS_POLICY_CHANGE: Policy my8q-nq is now active

switch(config-sys-qos)# show policy-map system type network-qos

  Type network-qos policy-maps
  ============================
  policy-map type network-qos my8q-nq
    class type network-qos c-8q-nq7
      match qos-group 7
      mtu 1500
    class type network-qos c-8q-nq6
      match qos-group 6
      pause pfc-cos 6
      mtu 9216
    class type network-qos c-8q-nq5
      match qos-group 5
      pause pfc-cos 5
      mtu 2240
    class type network-qos c-8q-nq4
      match qos-group 4
      pause pfc-cos 4
      mtu 1500
    class type network-qos c-8q-nq3
      match qos-group 3
      mtu 1500
    class type network-qos c-8q-nq2
      match qos-group 2
      mtu 2240
    class type network-qos c-8q-nq1
      match qos-group 1
      mtu 9216
    class type network-qos c-8q-nq-default
      match qos-group 0
      mtu 1500

switch# qos copy policy-map type queuing default-8q-out-policy prefix my
switch# show policy-map type queuing my8q-out


  Type queuing policy-maps
  ========================

  policy-map type queuing my8q-out
    class type queuing c-out-8q-q7
      priority level 1
    class type queuing c-out-8q-q6
      bandwidth remaining percent 0
    class type queuing c-out-8q-q5
      bandwidth remaining percent 0
    class type queuing c-out-8q-q4
      bandwidth remaining percent 0
    class type queuing c-out-8q-q3
      bandwidth remaining percent 0
    class type queuing c-out-8q-q2
      bandwidth remaining percent 0
    class type queuing c-out-8q-q1
      bandwidth remaining percent 0
```

```
    class type queuing c-out-8q-q-default
     bandwidth remaining percent 100

switch# config t
switch(config)# policy-map type queuing my8q-out
switch(config-pmap-c-que)# class type queuing c-out-8q-q-default
switch(config-pmap-c-que)# bandwidth remaining percent 30
switch(config-pmap-c-que)# class type queuing c-out-8q-q1
switch(config-pmap-c-que)# bandwidth remaining percent 15
switch(config-pmap-c-que)# class type queuing c-out-8q-q2
switch(config-pmap-c-que)# bandwidth remaining percent 15
switch(config-pmap-c-que)# class type queuing c-out-8q-q3
switch(config-pmap-c-que)# bandwidth remaining percent 10
switch(config-pmap-c-que)# class type queuing c-out-8q-q4
switch(config-pmap-c-que)# bandwidth remaining percent 10
switch(config-pmap-c-que)# class type queuing c-out-8q-q5
switch(config-pmap-c-que)# bandwidth remaining percent 10
switch(config-pmap-c-que)# class type queuing c-out-8q-q6
switch(config-pmap-c-que)# bandwidth remaining percent 10
switch(config-pmap-c-que)# show policy-map type queuing my8q-out


  Type queuing policy-maps
  ========================

  policy-map type queuing my8q-out
    class type queuing c-out-8q-q7
      priority level 1
    class type queuing c-out-8q-q6
      bandwidth remaining percent 10
    class type queuing c-out-8q-q5
      bandwidth remaining percent 10
    class type queuing c-out-8q-q4
      bandwidth remaining percent 10
    class type queuing c-out-8q-q3
      bandwidth remaining percent 10
    class type queuing c-out-8q-q2
      bandwidth remaining percent 15
    class type queuing c-out-8q-q1
      bandwidth remaining percent 15
    class type queuing c-out-8q-q-default
      bandwidth remaining percent 30

switch(config)# system qos
switch(config-sys-qos)# service-policy type queuing output my8q-out
switch(config-sys-qos)# show policy-map system type queuing



  Service-policy output:   my8q-out
          Service-policy (queuing) output:   my8q-out
            policy statistics status:   disabled (current status: disabled)

            Class-map (queuing):   c-out-8q-q7 (match-any)
              priority level 1

            Class-map (queuing):   c-out-8q-q6 (match-any)
              bandwidth remaining percent 10

            Class-map (queuing):   c-out-8q-q5 (match-any)
              bandwidth remaining percent 10

            Class-map (queuing):   c-out-8q-q4 (match-any)
              bandwidth remaining percent 10
```

```
Class-map (queuing):   c-out-8q-q3 (match-any)
  bandwidth remaining percent 10

Class-map (queuing):   c-out-8q-q2 (match-any)
  bandwidth remaining percent 15

Class-map (queuing):   c-out-8q-q1 (match-any)
  bandwidth remaining percent 15

Class-map (queuing):   c-out-8q-q-default (match-any)
  bandwidth remaining percent 30
```

Example of set qos-groups

The following is an example to set qos-groups with values 4-7.

```
switch(config)# policy-map p1
switch(config-pmap-qos)# class c1
switch(config-pmap-c-qos)# set qos-group 1
switch(config-pmap-c-qos)# ex
switch(config-pmap-qos)# class c2
switch(config-pmap-c-qos)# set qos-group 4
switch(config-pmap-c-qos)# ex
switch(config-pmap-qos)# class c3
switch(config-pmap-c-qos)# set qos-group 7
switch(config-pmap-c-qos)# ex
switch(config-pmap-qos)# ex
switch(config)# show policy-map p1


  Type qos policy-maps
  ====================

  policy-map type qos p1
    class  c1
      set qos-group 1
    class  c2
      set qos-group 4
    class  c3
      set qos-group 7
switch(config)# conf t
switch(config)# int ethernet 2/1
switch(config-if)# service-policy type qos input p1
switch(config-if)# show policy-map interface ethernet 2/1


Global statistics status :   enabled

Ethernet2/1

  Service-policy (qos) input:   p1
    SNMP Policy Index:  285226505

    Class-map (qos):   c1 (match-all)
      Match: dscp 10
      set qos-group 1

    Class-map (qos):   c2 (match-all)
      Match: dscp 20
      set qos-group 4
```

```
Class-map (qos):   c3 (match-all)
  Match: dscp 30
  set qos-group 7
```

Changing from 8q Mode to 4q Mode

Note Changing from 8q mode to 4q mode is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

Use the following guidelines to change from 8q mode to 4q mode:

- Ensure that none of the active input QoS policies have **set qos-group** action for qos-groups 4-7, so that no traffic flows towards queues 4-7.
- Ensure that all 8q interface policies and 8q system level policies are replaced with corresponding 4q policies.
- Replace the 8q network-qos policy with a corresponding 4q policy.

Configuring an MQC Object

When you specify an MQC object command, the device creates the object if it does not exist and then enters map mode.

To remove a class-map or policy-map object, use the **no** form of the command that you used to create the object.

Configuring or Modifying a Class Map

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

Note You cannot create a queuing class map; you must use one of the system-defined queuing class maps.

SUMMARY STEPS

1. **configure terminal**
2. **class-map type qos** [**match-any** | **match-all**] *class-name*
3. **exit**
4. **class-map type queuing match-any** *class-name*
5. **exit**
6. **show class-map** [**type qos** [*class-name*]]
7. **show class-map** [**type queuing** [*class-name*]]
8. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map type qos** [**match-any** | **match-all**] *class-name*
	Example:
	`switch(config)# class-map type qos class1`
	`switch(config-cmap-qos)#`
		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**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits class-map qos mode and enters global configuration mode.

Step 4	**class-map type queuing match-any** *class-name*
	Example:
	`switch(config)# class-map type queuing match-any c-out-q2`
	`switch(config-cmap-que)#`
		Creates or accesses the class map of type queuing and then enters class-map queuing mode.

Step 5	**exit**
	Example:
	`switch(config-cmap-que)# exit`
	`switch(config)#`
		Exits class map queuing mode and enters global configuration mode.

Step 6	**show class-map** [**type qos** [*class-name*]] **Example:** `switch(config)# show class-map type qos`	(Optional) Displays information about all configured class maps, all class maps of type qos, or a selected class map of type qos.
Step 7	**show class-map** [**type queuing** [*class-name*]] **Example:** `switch(config)# show class-map type queuing`	(Optional) Displays information about all configured class maps, all class maps of type queuing, or a selected class map of type queuing.
Step 8	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Configuring or Modifying a Policy Map

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

SUMMARY STEPS

1. **configure terminal**
2. **policy-map type qos** { [**match-first**] *policy-map-name*}
3. **exit**
4. **policy-map type queuing** {[**match-first**] *policy-map-name}*
5. **exit**
6. **show policy-map** [**type qos** [*policy-map-name*]]
7. **show policy-map** [**type queuing** [*policy-map-name* | *default-out-policy*]]
8. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map type qos** { [**match-first**] *policy-map-name*}
	Example:
	`switch(config)# policy-map type qos policy1`
	`switch(config-pmap-qos)#`
		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	**exit**
	Example:
	`switch(config-pmap)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 4	**policy-map type queuing** {[**match-first**] *policy-map-name}*
	Example:
	`switch(config)# policy-map type queuing policy_queue1`
	`switch(config-pmap-que)#`
		Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 5	**exit**
	Example:
	`switch(config-pmap)# exit`
	`switch(config)#`
		Exits policy map mode and enters global configuration mode.

Step 6	**show policy-map** [**type qos** [*policy-map-name*]] **Example:** `switch(config)# show policy-map type qos`	(Optional) Displays information about all configured policy maps, all policy maps of type qos, or a selected policy map of type qos.

	Command or Action	Purpose
Step 7	**show policy-map** [**type queuing** [*policy-map-name* | *default-out-policy*]] **Example:** `switch(config)# show policy-map type queuing`	(Optional) Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing or the default output queuing policy.
Step 8	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Applying Descriptions to MQC Objects

You can use the **description** command to add a description to a MQC object.

SUMMARY STEPS

1. **configure terminal**
2. Specify the MQC object whose description you want to set:
   - Class-map:

     class-map [**type qos**] [**match-any** | **match-all**] *class-name*
   - Policy-map:

     policy-map [**type qos**] [**match-first**] *policy-map-name*
3. **description** *string*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	Specify the MQC object whose description you want to set: • Class-map: **class-map** [**type qos**] [**match-any** | **match-all**] *class-name* • Policy-map: **policy-map** [**type qos**] [**match-first**] *policy-map-name*	• Class-map: 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:

	Command or Action	Purpose

	Example:
	• Class-map:
	`switch(config-cmap)# class-map class1`
	`switch(config-cmap)#`
	• Policy-map:
	`switch(config)# policy-map policy1`
	`switch(config-pmap)#`
		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*
	Example:
	`switch(config-cmap)# description my traffic class`
	`switch(config-cmap)#`
		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 queuing class maps.

Step 4	**exit**
	Example:
	`switch(config-cmap)# exit`
	`switch(config)#`
		Exits class-map mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Verifying an MQC Object

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

Command	Purpose
show class-map [**type qos** [*class-name*]]	Displays information about all configured class maps, all class maps of type qos, or a selected class map of type qos.
show class-map [**type queuing** [*class-name*]]	Displays information about all configured class maps, all class maps of type queuing, or a selected class map of type queuing.
show policy-map [**type qos** [*policy-map-name*]]	Displays information about all configured policy maps, all policy maps of type qos, or a selected policy map of type qos.
show policy-map [**type queuing** [*policy-map-name* | **default-out-policy**]]	Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

Attaching and Detaching a QoS Policy Action

The software does not allow you to enable or disable QoS features with a configuration command. To enable or disable QoS features, you must attach or detach QoS policies to or from interfaces or VLANs as described in this section.

The system-defined type queuing policy maps are attached to each interface unless you specifically attach a different policy map.

Note The device allows only one queuing policy per interface.

Policies that are defined at multiple interfaces have the following restrictions:

- A QoS policy attached to the physical port takes effect when the port is not a member of a port channel.
- A QoS policy attached to a port channel takes effect even when policies are attached to member ports.
- A QoS policy attached to a VLAN is applied to all ports in that VLAN that do not have other policies specifically applied.
- One ingress QoS policy is supported for each Layer 3 port and Layer 3 port-channel interface.
- One ingress QoS policy is supported for each VLAN.
- When a VLAN or port channel, or both, touches multiple forwarding engines, all policies that enforce a rate are enforced per forwarding engine.

  For example, if you configure a policer on a specific VLAN that limits the rate for the VLAN to 100 Mbps and if you configure one switch port in the VLAN on one module and another switch port in the VLAN on another module, each forwarding engine can enforce the 100-Mbps rate. In this case, you could actually have up to 200 Mbps in the VLAN that you configured to limit the rate to 100 Mbps.

Note Default queuing policies are active, unless you configure and apply another policy.

The interface where a QoS policy is applied is summarized in the following table. Each row represents the interface levels. The entry descriptions are as follows:

- Applied—Interface where an attached policy is applied.
- Present—Interface where a policy is attached but not applied.
- Not present—Interface where no policy is attached.
- Present or not—Interface where a policy is either attached or not, but not applied.

Table 13: QoS Policy Interfaces

Port Policy	Port-Channel Policy	VLAN Policy
Applied	Not present	Present or not

Present or not	Applied	Present or not
Not present	Not present	Applied

To attach a policy map to an interface or VLAN, use the **service-policy** command. The policies defined in the policy map are applied to the input stream of packets on the interface.

To detach a policy map from an interface, use the **no** form of the **service-policy** command.

Configuring a Service Policy for a Layer 2 Interface

Before you begin

Ensure that the ternary content addressable memory (TCAM) is carved for port QoS.

For more details, see the Configuring QoS TCAM Carving section.

SUMMARY STEPS

1. **configure terminal**
2. **interface interface** *slot/port*
3. **switchport**
4. **service-policy type** {**qos input** | **queuing output**} | {**qos output** | **queuing output**} *policy-map-name* [**no-stats**]
5. **show policy-map interface** *interface slot/port* **type** {**qos** | **queuing**}
6. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface interface** *slot/port*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Enters configuration interface mode.

Step 3	**switchport** **Example:** `switch(config-if)# switchport`	Selects the Layer 2 interface.

	Command or Action	Purpose

Step 4	**service-policy type** {**qos input** | **queuing output**} | {**qos output** | **queuing output**} *policy-map-name* [**no-stats**]
	Example:
	`switch(config-if)# service-policy input policy1`
	`switch(config-if)#`
	Example:
	`switch(config-if)# interface intf1`
	`switch(config-if)# service-policy type qos output egressqos`
	`switch(config-if)# exit`
	`switch(config)#`
		Specifies the policy map to use as the service policy for the Layer 2 interface. There are two policy-map configuration modes:
		• qos input or qos output — qos input is the default classification mode. To set the classification mode to egress, use qos output.
		• queuing output —Queuing mode.
		Note
		The **output** keyword specifies that this policy map should be applied to traffic transmitted from an interface. You can only apply **output** to a queuing policy.

Step 5	**show policy-map interface** *interface slot/port* **type** {**qos** | **queuing**} **Example:** `switch(config)# show policy-map interface ethernet 1/1 type qos`	(Optional) Displays information about policy maps that are applied to the specified interface. You can limit what the device displays to qos or queuing policies.
Step 6	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Configuring a Service Policy for a Layer 3 Interface

Before you begin

Ensure that the ternary content addressable memory (TCAM) is carved for Layer 3 QoS.

For more details, see the Configuring QoS TCAM Carving section.

SUMMARY STEPS

1. **configure terminal**
2. **interface interface** *slot/port*
3. **no switchport**
4. **service-policy type** {**qos input** \| **queuing output**} \| {**qos output** \| **queuing output**} *policy-map-name* [**no-stats**]
5. **show policy-map interface** *interface slot/port* **type** {**qos** \| **queuing**}
6. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface interface** *slot/port*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Enters configuration interface mode.

Step 3	**no switchport** **Example:** `switch(config-if)# no switchport`	Selects the Layer 3 interface.

Step 4	**service-policy type** {**qos input** | **queuing output**} | {**qos output** | **queuing output**} *policy-map-name* [**no-stats**]
	Example:
	`switch(config-if)# service-policy input policy1`
	`switch(config-if)#`
	Example:
	`switch(config-if)# service-policy output policy1`
	`switch(config-if)#`
		Specifies the policy map to use as the service policy for the Layer 3 interface. There are two policy-map configuration modes:
		• qos input or qos output — qos input is the default classification mode. To set the classification mode to egress, use qos output.
		• queuing output —Queuing mode.
		Note
		The **output** keyword specifies that this policy map should be applied to traffic transmitted from an interface. You can only apply **output** to a queuing policy.

Step 5	**show policy-map interface** *interface slot/port* **type** {**qos** | **queuing**} **Example:** `switch(config)# show policy-map interface ethernet 1/1 type qos`	(Optional) Displays information about policy maps that are applied to the specified interface. You can limit what the device displays to qos or queuing policies.
Step 6	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Attaching the System Service Policy

The **service-policy** command specifies the system class policy map as the service policy for the system.

SUMMARY STEPS

1. **configure terminal**
2. **system qos**
3. **service-policy type** {**network-qos** | **queuing output**} *policy-map-name*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**system qos**
	Example:
	`switch(config)# system qos`
	`switch(config-sys-qos)#`
		Enters system class configuration mode.

Step 3	**service-policy type** {**network-qos**	**queuing output**} *policy-map-name* **Example:** `switch(config-sys-qos)# service-policy input default-nq-policy`	Specifies the policy map to use as the service policy (default-nq-policy) for the system. There are two policy-map configuration modes: • network-qos—Network-wide (system qos) mode. **Note** To restore the system to the default service policies, use the **no** form of the command. • queuing—Queuing mode (output at system qos and interface). **Note** There is no default policy-map configuration mode. You must specify the type. The **output** keyword specifies that this policy map should be applied to traffic transmitted from an interface. You can only apply **output** to a queuing policy.

Attaching a QoS Policy Action to a VLAN

Before you begin

Ensure that the ternary content-addressable memory (TCAM) is carved for VLAN QoS.

For more details, see the QoS TCAM carving chapter.

SUMMARY STEPS

1. **configure terminal**
2. **vlan configuration** *vlan-id-list*
3. **service-policy** [**type qos**] {**input**} | {**qos output** } {*policy-map-name*} [**no-stats**]
4. **show policy-map** [**interface** *interface* | **vlan** *vlan-id*] [**input**] [**type qos** | **queuing**] [**class** [**type qos** | **queuing**] *class-map-name*]
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**vlan configuration** *vlan-id-list*
	Example:
	`switch(config)# vlan configuration 2`
	`switch(config-vlan-config)#`
		Enters VLAN configuration mode.
		Note
		vlan-id-list is a space-separated list of VLANs.

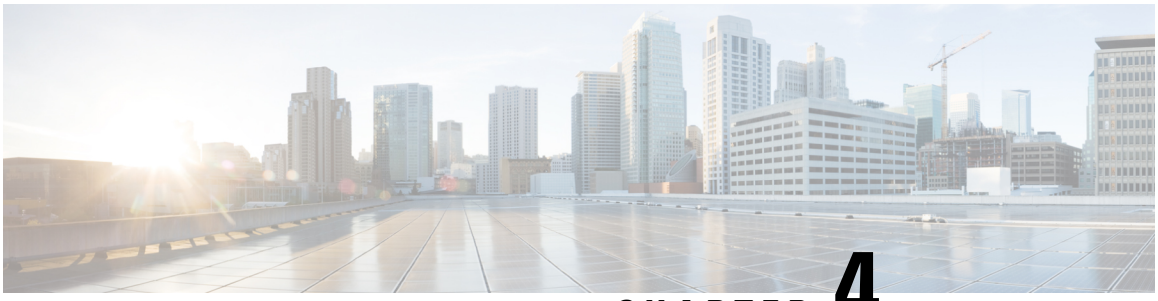
Step 3	**service-policy** [**type qos**] {**input**} | {**qos output** } {*policy-map-name*} [**no-stats**]
	Example:
	`switch(config-vlan-config)# service-policy type qos input policy1`
	Example:
	`switch(config-if)# service-policy type qos output egressqos`
	`switch(config-if)# exit`
	`switch(config)#`
		Adds the policy map to the input packets of a VLAN.
		Only one input policy can be attached to a VLAN. The example adds policy1 to the VLAN.
		Label sharing only occurs when QoS policies under VLANs are configured with the **no-stats** option. With the **no-stats** option, the QoS label gets shared when the same QoS policy is applied on multiple VLANs.
		Note
		When the **no-stats** option is configured, the ingress QoS policy-map statistics on a VLAN basis are not available because the label is shared.

Step 4	**show policy-map** [**interface** *interface* | **vlan** *vlan-id*] [**input**] [**type qos** | **queuing**] [**class** [**type qos** | **queuing**] *class-map-name*] **Example:** `switch(config)# show policy-map vlan 2`	(Optional) Displays information about policy maps that are applied to all interfaces or the specified interface. You can limit what the device displays to input policies, qos or queuing polices, and to a specific class.
Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Session Manager Support for QoS

Session Manger supports the configuration of QoS. This feature allows you to verify the QoS configuration and confirm that the resources required by the configuration are available prior to committing them to the running configuration. For information about Session Manager, see the *Cisco Nexus 9000 Series NX-OS System Management Configuration Guide*.

After you start the configuration session, do not enter any configuration commands using the configure terminal configuration mode until the configuration session is aborted or committed. Entering parallel configurations (one configuration that uses the configuration session and another using the configuration terminal configuration mode) might cause verification failures in the configuration session mode.



CHAPTER 4

Configuring QoS TCAM Carving

- About QoS TCAM Carving, on page 37
- Guidelines and Limitations for QoS TCAM Carving, on page 41
- Configuring QoS TCAM Carving, on page 42

About QoS TCAM Carving

You can change the size of the access control list (ACL) ternary content addressable memory (TCAM) regions in the hardware.

On Cisco Nexus 9300 and 9500 platform switches, the egress TCAM size is 1K, divided into four 256 entries. On Cisco Nexus NFE2-enabled devices (such as the Cisco Nexus 3232C and 3264Q switches), the ingress TCAM size is 6K, divided into twelve 512 slices. Three slices are in one group. On other Cisco Nexus 9300 and 9500 platform switches and Cisco Nexus 3164Q and 31128PQ switches, the ingress TCAM size is 4K, divided into eight 256 slices and four 512 slices. A slice is the unit of allocation. A slice can be allocated to one region only. For example, a 512-size slice cannot be used to configure two features of size 256 each. Similarly, a 256-size slice cannot be used to configure two features of size 128 each. The IPv4 TCAM regions are single wide. The IPv6, QoS, MAC, CoPP, and system TCAM regions are double wide and consume double the physical TCAM entries. For example, a logical region size of 256 entries actually consumes 512 physical TCAM entries.

On Cisco Nexus 9200 Series switches, the egress TCAM size is 2K, and the ingress TCAM size is 4K. The concepts of TCAM slices and single- and double-wide regions do not apply to these switches. For example, the ing-ifacl region can host IPv4, IPv6, or MAC type entries. IPv4 and MAC types occupy one TCAM entry whereas IPv6 types occupy two TCAM entries.

The number of default entries for QoS TCAM carving are:

- The default QoS TCAM carving for the Cisco Nexus 9504, Cisco Nexus 9508, and Cisco Nexus 9516 is for Layer 3 QoS (IPV4) with 256 entries. For these switches, all of the QoS TCAM entries are double wide.
- The default QoS TCAM carving for ALE (Application Leaf Engine) enabled devices is for Layer 2 port QoS (IPV4) with 256 entries. For these switches, all of the QoS TCAM entries are double wide.

Note In addition to the above TCAM, for ALE enabled devices, a separate TCAM in the Cisco Nexus C9396PX (uplink ports) and Cisco Nexus C93128TX (uplink ports) ASIC is used for the QoS classification policies applied on 40G uplink ports. By default, this separate TCAM is carved for Layer 3 QoS (IPV4), Layer 2 Port QoS (IPV4), and VLAN QoS (IPV4) with 256 entries each.

Table 14: QoS TCAM Regions (Cisco NX-OS Release 7.1(3)I6(1))

Feature	Purpose	Region Name
Egress QoS	QoS policy applied on interfaces in output direction.	IPV4: e-qos Cisco Nexus 922 series switch: egr-l2-qos, egr-l3-vlan-qos IPV6: e-ipv6-qos MAC: e-mac-qos See notes following table.

Table 15: QoS TCAM Regions (Cisco NX-OS Release 7.0(3)I1(1))

Feature	Purpose	Region Name
Layer 3 QoS	QoS policy applied on Layer 3 interfaces.	IPV4: l3qos*, ns-l3qos* IPV6: ipv6-l3qos*, ns-ipv6-l3qos* See notes following table.
Port QoS	QoS policy applied on Layer 2 interfaces.	IPV4: qos*, ns-qos* IPV6: ipv6-qos*, ns-ipv6-qos* MAC: mac-qos*, ns-mac-qos* See notes following table.
VLAN QoS	QoS policy applied on VLAN.	IPV4: vqos, ns-vqos IPV6: ipv6-vqos*, ns-ipv6-vqos* MAC: mac-vqos*, ns-mac-vqos* See notes following table.
FEX QoS	QoS policy applied on FEX interfaces.	IPV4: fex-qos* IPv6: fex-ipv6-qos* MAC: fex-mac-qos* See notes following table.

Table 16: QoS TCAM Regions (Cisco NX-OS Release 7.0(3)I1(2) and later)

Feature	Purpose	Region Name
Layer 3 QoS	QoS policy applied on Layer 3 interfaces.	IPV4: l3qos*, ns-l3qos*, rp-qos** Cisco Nexus 9200 Series switch: ing-l3-vlan-qos IPV6: ipv6-l3qos*, ns-ipv6-l3qos*, rp-ipv6-qos** See notes following table.
Port QoS	QoS policy applied on Layer 2 interfaces.	IPV4: qos*, ns-qos*, rp-qos** Cisco Nexus 9200 Series switch: ing-l2-qos IPV6: ipv6-qos*, ns-ipv6-qos*, rp-ipv6-qos** MAC: mac-qos*, ns-mac-qos*, rp-mac-qos** See notes following table.
VLAN QoS	QoS policy applied on VLAN.	IPV4: vqos, ns-vqos, rp-qos** Cisco Nexus 9200 Series switch: ing-l3-vlan-qos IPV6: ipv6-vqos*, ns-ipv6-vqos*, rp-ipv6-qos** MAC: mac-vqos*, ns-mac-vqos*, rp-mac-qos** See notes following table.
FEX QoS	QoS policy applied on FEX interfaces.	IPV4: fex-qos* IPv6: fex-ipv6-qos* MAC: fex-mac-qos* See notes following table.

Note * The region is applicable only for ALE enabled devices and are required for classification policies applied on 40G uplink ports.

Note ** The region is applicable only for 100G enabled devices (such as the Cisco Nexus 9300 platform switch with the N9K-M4PC-CFP2 GEM or the Cisco Nexus 9500 platform switch with the Cisco Nexus 9408PC-CFP2 line card) and are required for classification policies and QoS scheduling applied on 100G uplink ports.

You need to save the configuration and reload the system for the region configuration to become effective.

About QoS TCAM Lite Regions

IPV4 requires QoS TCAM regions to be double wide TCAMs to support conform/violate policer statistics. If conform/violate statistics are not required, the size of the QoS TCAM entries can be reduced to single wide TCAMs by using QoS TCAM lite regions. Policing is supported by these regions, however only violate packets/bytes statistics are supported.

Table 17: QoS TCAM Regions (Release 7.1(3)I6(1))

Feature	Purpose	Region Name
Egress QoS	QoS policy applied on interfaces in output direction.	IPV4: e-qos-lite See notes following table.

Table 18: QoS TCAM Lite Regions

Feature	Purpose	Region Name
Layer 3 QoS	QoS policy applied on Layer 3 interfaces.	IPV4: l3qos-lite
Port QoS	QoS policy applied on Layer 2 interfaces.	IPV4: qos-lite
VLAN QoS	QoS policy applied on VLAN.	IPV4: vqos-lite
FEX QoS	QoS policy applied on FEX interfaces.	IPV4: fex-qos-lite

Note Cisco Nexus 9200 Series switches do not support QoS TCAM lite regions.

Note The region is applicable only for ALE enabled devices and are required for classification policies applied on 40G uplink ports.

You need to save the configuration and reload the system for the region configuration to become effective.

Note Either the regular version or the lite version of the QOS TCAM can be enabled. Both cannot be enabled at the same time. For example, either the IPv4 Port QoS or the IPv4 Port QoS lite version can be enabled at any one time.

Guidelines and Limitations for QoS TCAM Carving

TCAM region sizes have the following configuration guidelines and limitations:

- TCAM must be carved for the vQOS region if the QoS policy is configured within a VLAN. This will avoid traffic failure as shown in the syslog message in this example:

```
switch(config-vlan-config)# vlan configuration 3
switch(config-vlan-config)# service-policy type qos input INPUT_PREC
switch(config-vlan-config)# 2019 Jan 2 17:56:49 switch %$ VDC-1 %$
%ACLQOS-SLOT2-2-ACLQOS_FAILED: ACLQOS failure: VLAN QOS policy not
supported without TCAM carving for VQOS, traffic will fail please carve
TCAM for VQOS and IPV6-VQOS reload the module configure vlan qos policy
after module is up
```

- **show** commands with the **internal** keyword are not supported.
- After TCAM carving, you must save the configuration and reload the switch.
- Cisco Nexus 9200 platform switches and Cisco Nexus 9300-EX platform switches are of the same type and therefore, they have the same TCAM regions.
- By default, all IPv6 TCAMs are disabled (the TCAM size is set to 0).
- Use the **show hardware access-list tcam region** command to view the configured TCAM region size.
- The global CLI **hardware qos classify ns-only** command is introduced to enable configuration of the QoS policy on the NS ports without carving the T2 QoS region, for example, qos and l3-qos regions. This command removes the TCAM restrictions that are associated with the QoS classifications on the Application Leaf Engine (ALE) ports and it is only supported on Cisco Nexus 9000 series switches with ALE.

  For example, for Layer 2 ALE port with IPv4 traffic, qos, and ns-qos TCAM carving is required for the QoS classification to work. With the **hardware qos classify ns-only** CLI command, ns-QoS TCAM alone is sufficient.

  See the following example for applying the CLI **hardware qos classify ns-only** command:

```
switch(config)# hardware qos classify ns-only
Warning: This knob removes the restriction of carving qos as well as ns-qos TCAM region
 for NS port QoS classification policies.
Warning: Only NS TCAM will be used, as a result policy-map statistics, marking and
policing is not supported on NS ports
```

  See the following example for removing the CLI **hardware qos classify ns-only** command:

```
switch(config)# no hardware qos classify ns-only
Warning: Special knob removed. Please remove and apply QoS policies on NS ports to get
 default behavior
```

Note Policing, policy-map statistics, and marking are not supported on the NS ports if the **hardware qos classify ns-only** CLI command is used. The **show policy-map interface ethernet** *x*/*y* does not return QoS statistics. The NS TCAM does not have some of the Network Forwarding Engine (NFE) TCAM resources, for example, range and so on. Therefore, the policies may need more TCAM entries.

- By default, the TCAM region for CoPP is 95% utilized on the Nexus 9300/Nexus 9500 platform switch. If you modify the CoPP policy, it is likely that you will need to modify other TCAM region sizes to allow for more space to be applied to the CoPP TCAM region.
- When any of the following classification criteria are used for IPv4 and IPv6, you must carve the IPv4 based QoS TCAM region. It is not necessary to carve an IPv6 based QoS TCAM region.
  - Differentiated Services Code Point (DSCP) based classification
  - Class of service (CoS) based classification
  - IP precedence-based classification
- When a QoS policy is applied on multiple interfaces or multiple VLANs, the label is not shared since the statistics option is enabled.

  To share the label for the same QoS policy that is applied on multiple interfaces or multiple VLANs, you must configure the QoS policy with no-stats option using the **service-policy type qos input my-policy no-stats** command.
- On Cisco Nexus 9300 platform switches, the Cisco Nexus 9536PQ, 9564PX, and 9564TX line cards are used to enforce the QoS classification policies that are applied on 40G ports. It has 768 TCAM entries available for carving in 256-entry granularity. These region names are prefixed with "ns-".
- For the Cisco Nexus 9536PQ, 9564PX, and 9564TX line cards, only the IPv6 TCAM regions consume double-wide entries. The rest of the TCAM regions consume single-wide entries.
- When a VACL region is configured, it is configured with the same size in both the ingress and egress directions. If the region size cannot fit in either direction, the configuration is rejected.
- On Cisco Nexus 9200 platform switches, the ing-sup region occupies a minimum size of 512 entries, and the egr-sup region occupies a minimum size of 256 entries. These regions cannot be configured to lesser values. Any region size can be carved with a value only in multiples of 256 entries (except for the span region, which can be carved only in multiples of 512 entries).
- VLAN QoS is only supported on the Cisco Nexus 9508 switch with the -R series line card.
- QoS has default TCAM sizes and these TCAM sizes must be nonzero on specific line cards to avoid failure of the line card during a reload.

  Cisco Nexus 9504 and Cisco Nexus 9508 switches with the following line cards are affected:
  - Cisco Nexus 96136YC-R
  - Cisco Nexus 9636C-RX
  - Cisco Nexus 9636Q-R
  - Cisco Nexus 9636C-R

Configuring QoS TCAM Carving

You can change the default QoS TCAM carving to accommodate your network requirements. The following sections contain examples of how to change the default QoS TCAM carving.

Note You can use this procedure for all Cisco Nexus 9200, 9300, and 9500 Series switches.

The examples do not apply to NFE2-enabled devices (such as the X9432C-S 100G line card and the C9508-FM-S fabric module), which must use TCAM templates to configure TCAM region sizes. For more information on using TCAM templates, see "Using Templates to Configure TCAM Region Sizes."

Once you apply a TCAM template, the **hardware access-list tcam region** command will not work. You must uncommit the template to use the command.

Enabling Layer 3 QoS (IPv6)

The default TCAM region configuration does not accommodate Layer 3 QoS (IPv6). To enable Layer 3 QoS (IPv6), you must decrease the TCAM size of another region and then increase the TCAM size to enable the new Layer 3 QoS (IPv6) region.

Table 19: Default TCAM Region Configuration (Ingress) for the Cisco Nexus 9504, Cisco Nexus 9508, and Cisco Nexus 9516 devices

Region Name	Size	Width	Total Size
IPV4 RACL	1536	1	1536
L3 QoS(IPV4)	256	2	512
COPP	256	2	512
System	256	2	512
Redirect	256	1	256
SPAN	256	1	256
VPC Convergence	512	1	512
			4K

Table 20: Default TCAM Region Configuration (Ingress) - For Layer 2-to-Layer 3 Configurations on Cisco Nexus 9200 Series Switches

Region Name	Size	Width	Total Size
Ingress NAT	0	1	0
Ingress port ACL	256	1	256
Ingress VACL	256	1	256
Ingress RACL	1536	1	1536
Ingress Layer 2 QoS	256	1	256
Ingress Layer 3 VLAN QoS	256	1	256
Ingress supervisor	512	1	512

Region Name	Size	Width	Total Size
Ingress Layer 2 ACL SPAN	256	1	256
Ingress Layer 3 ACL SPAN	256	1	256
Port-based SPAN	512	1	512
			4096

Table 21: Default TCAM Region Configuration (Ingress) - For Layer 3 Configurations on Cisco Nexus 9200 Series Switches

Region Name	Size	Width	Total Size
Ingress NAT	0	1	0
Ingress port ACL	0	1	0
Ingress VACL	0	1	0
Ingress RACL	1792	1	1792
Ingress Layer 2 QoS	256	1	256
Ingress Layer 3 VLAN QoS	512	1	512
Ingress supervisor	512	1	512
Ingress Layer 2 ACL SPAN	256	1	256
Ingress Layer 3 ACL SPAN	256	1	256
Port-based SPAN	512	1	512
			4096

Procedure

	Command or Action	Purpose
Step 1	**hardware access-list tcam region** *region tcam-size*	To enable carving your Layer 3 QoS (IPv6) TCAM region, specify another region to free up resources. Also specify the reduced TCAM size for the region. **Note** Repeat this step for as many regions as necessary to free up sufficient resources to carve the new Layer 3 QoS (IPv6) TCAM region.
Step 2	**hardware access-list tcam region** *region tcam-size*	Carve the new Layer 3 QoS (IPv6) TCAM region including the TCAM size (number of double wide entries).

Example

This example sets the ingress Layer 3 QoS (IPv6) TCAM region size to 256. A Layer 3 QoS (IPv6) of size 256 takes 512 entries because IPv6 is double wide.

- Reduce the span and redirect regions to 0. This creates 512 entry spaces that are used to carve Layer 3 QoS (IPV6) with 256 entries (double wide).

```
switch(config)# hardware access-list tcam region redirect 0
 Warning: Please reload the linecard for the configuration to take effect
 Warning: BFD, DHCPv4 and DHCPv6 features will NOT be supported after this configuration
change.
switch(config)# hardware access-list tcam region span 0
 Warning: Please reload the linecard for the configuration to take effect
switch(config)# hardware access-list tcam region ipv6-l3qos 256
 Warning: Please reload the linecard for the configuration to take effect
```

Table 22: Updated TCAM Region Configuration After Reducing the IPv4 RACL (Ingress)

Region Name	Size	Width	Total Size
IPv4 RACL	1536	1	1536
Layer 3 QoS (IPv6)	256	2	512
Layer 3 QoS (IPv4)	256	2	512
CoPP	256	2	512
System	256	2	512
Redirect	0	1	0
SPAN	0	1	0
VPC Convergence	512	1	512
			4K

Enabling VLAN QoS (IPv4)

To enable VLAN QoS (IPv4), you must decrease the TCAM size of another region and then increase the TCAM size to enable the new VLAN QoS (IPv4) region.

The following table list the default sizes for the ingress TCAM regions for ALE enabled devices.

Table 23: Default TCAM Region Configuration (Ingress)

Region Name	Size	Width	Total Size
PACL (IPV4)	512	1	512
Port QoS (IPV4)	256	2	512

Region Name	Size	Width	Total Size
VACL (IPV4)	512	1	512
RACL(IPV4)	512	1	512
System	256	2	512
COPP	256	2	512
Redirect	512	1	512
SPAN	256	1	256
VPC Converg	256	1	256
			4K

Procedure

	Command or Action	Purpose
Step 1	**hardware access-list tcam region** *region tcam-size*	To enable carving for your VLAN QoS (IPv4) TCAM region, specify another region to free up resources. Also specify the reduced TCAM size for the region. **Note** Repeat this step for as many regions as necessary to free up sufficient resources to carve the new VLAN QoS (IPv4) TCAM region.
Step 2	**hardware access-list tcam region** *region tcam-size*	Carve the new VLAN QoS (IPv4) TCAM region including the TCAM size (number of double wide entries).

Example

This example sets the VLAN QoS (IPv4) TCAM size to 256. A VLAN QoS (IPv4) of size 256 takes 512 entries because QoS TCAM is double wide.

- Reduce the ingress Port QoS (IPv4) by 256 bytes (QoS features are double wide, 2 x 256 = 512) and add an ingress VLAN QoS (IPv4) with 256 (2 x 256).

```
switch(config)# hardware access-list tcam region qos 0
 Warning: Please reload the linecard for the configuration to take effect
switch(config)# hardware access-list tcam region vqos 256
 Warning: Please reload the linecard for the configuration to take effect
```

Table 24: Updated TCAM Region Configuration After Reducing the IPv4 Port QoS Ingress

Region Name	Size	Width	Total Size
PACL (IPV4)	512	1	512

Region Name	Size	Width	Total Size
Port QoS (IPV4)	0	2	0
VLAN QoS(IPV4)	256	2	512
VACL (IPV4)	512	1	512
RACL(IPV4)	512	1	512
System	256	2	512
COPP	256	2	512
Redirect	512	1	512
SPAN	256	1	256
VPC Converg	256	1	256
			4K

Notes for Enabling VLAN QoS

The VLAN QoS feature enables Layer 2 bridged database lookup for QoS with VLAN as the key instead of the port.

To enable VLAN QoS, you must decrease the TCAM size of another region and increase the TCAM size for the VLAN QoS region.

To configure the size of the VLAN QoS TCAM region:

- Configure the IPv4 vqos to 640 entries.
- Configure the IPv6 ipv6-vqos to 256 entries.
- Decrease the IPv4 qos to 0 entries.
- Decrease the IPv6 ipv6-qos to 0 entries.

```
switch(config)# hardware access-list tcam region vqos 640
switch(config)# hardware access-list tcam region ipv6-vqos 256
switch(config)# hardware access-list tcam region qos 0
switch(config)# hardware access-list tcam region ipv6-qos 0
```

Note After configuring the TCAM size for VLAN QOS, it is necessary to reload the line card.

Enabling FEX QoS (IPv4)

Note The FEX QoS feature is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

To enable FEX QoS (IPv4), you must decrease the TCAM size of another region and then increase the TCAM size to enable the new FEX QoS (IPv4) region.

Procedure

	Command or Action	Purpose
Step 1	**hardware access-list tcam region** *region tcam-size*	To enable carving your FEX QoS (IPv4) TCAM region, specify another region to free up resources. Also specify the reduced TCAM size for the region. **Note** Repeat this step for as many regions as necessary to free up sufficient resources to carve the new FEX QoS (IPv4) TCAM region.
Step 2	**hardware access-list tcam region** *region tcam-size*	Carve the new FEX QoS (IPv4) TCAM region including the TCAM size (number of double wide entries).

Example

This example sets the FEX QoS (IPv4) TCAM size to 256. A FEX QoS (IPv4) of size 256 takes 512 entries because QoS TCAM is double wide.

- Reduce the IPv4 FEX IFACL region by 512 entries and add a FEX QoS (IPv4) region with 512 entries.

```
switch(config)# hardware access-list tcam region fex-ifacl 0
 Warning: Please reload the linecard for the configuration to take effect
switch(config)# hardware access-list tcam region fex-qos 256
 Warning: Please reload the linecard for the configuration to take effect
```

Enabling Egress QoS (IPv4)

To enable QoS (IPv4) TCAM, you must decrease the TCAM size of another region and then increase the TCAM size to enable the newQoS (IPv4) TCAM region.

Note The egress QoS feature is not supported on the Cisco Nexus 9508 switch (Cisco NX-OS 7.0(3)F3(3)).

Note Egress marking and policing is supported on all Network Forwarding Engine (NFE) platforms. Egress classification for egress packet scheduling is supported only on 100G platforms.

Beginning with Cisco NX-OS Release 7.0(3)I6(1), the Cisco Nexus 93108TC-EX, 93180LC-EX, and 93180YC-EX switches, and 97160YC-EX, 9732C-EX, 9736C-EX line cards support the Layer 2 and Layer 3 egress policer.

Beginning with Cisco NX-OS Release 7.0(3)I1(2), to enable egress QoS (IPv4), you must decrease the TCAM size of the **e-racl** region and then increase the TCAM size for the egress QoS (IPv4) region.

The following are considerations for egress QoS (IPv4) and TCAM regions:

- Egress QoS TCAM is based on packet type, such as **e-qos**. TCAM carving is needed to match IPv4 packets on VLAN, layer 2, and layer 3 port types.
- All egress QoS (IPv4, IPv6, and MAC) TCAM regions are double-wide, except for the **e-qos-lite** region which is single-wide.
- Violated and non-violated statistics are supported for policing action when a double-wide TCAM is configured.
- When a single-wide TCAM (**e-qos-lite**) is configured, only non-violated statistics are reported in the presence of a policing action. The violated statistics are always reported as zero instead of NA for the **qos-lite** region. The policing action (1R2C or 2R3C) is still properly enforced. Only statistics reporting is limited to non-violated statistics. If you want to view violated statistics, regular QoS TCAM should be used instead.
- Statistics are disabled when the optional **no-stats** keyword is used and policies are shared (where applicable).
- Egress QoS policies on ALE uplink ports on top-of-rack (TOR) platforms are not supported.
- The egress QoS policy supports marking, policing, and classification.

Note Egress classification for egress packet scheduling is supported only on 100G platforms.

- Egress qos policies do not support packet-length based matching.
- The **set qos-group** command is not supported for egress QoS policies.

  However, the **set qos-group** command is supported for egress QoS policies when applied on a 100G interface.
- Depending on the policy-map match criteria, the relevant egress QoS TCAM regions, such as **e-qos**, **e-mac-qos**, **e-ipv6-qos**, **egr-l2-qos**, and **egr-l3-vlan-qos**, must be carved for end-to-end QoS within the device.
- Set the egress QoS TCAM region size to 0 before downgrading to earlier images. Remove all egress QoS policies before downgrading to earlier images.

Procedure

	Command or Action	Purpose
Step 1	**hardware access-list tcam region e-racl** *tcam-size*	To enable carving your QoS (IPv4) TCAM region, specify the **e-racl** region to free up resources. Also specify the reduced TCAM size for the **e-racl** region.

Step 2	**hardware access-list tcam region** [**e-qos** | **e-qos-lite** | **e-ipv6-qos** | **e-mac-qos** | **egr-l2-qos** | **egr-l3-vlan-qos**] *tcam-size*
	Example:
	`switch(config)# hardware access-list tcam region egr-l2-vlan-qos 256`
	`Warning: Please reload all linecards for the configuration to take effect`
	`switch(config)#`
	Example:
	`switch(config)# hardware access-list tcam region egr-l3-vlan-qos 256`
	`Warning: Please reload all linecards for the configuration to take effect`
	`switch(config)#`
		The **hardware access-list tcam region** [**e-qos** | **e-qos-lite** | **e-ip6-qos** | **e-mac-qos | egr-l2-qos | egr-l3-vlan-qos**] *tcam-size* command specifies the egress QoS (IPv4) TCAM region and the TCAM size. The **egr-l2-qos | egr-l3-vlan-qos** options specify the egress QoS TCAM regions and TCAM size. An egress QoS TCAM of 256 size, takes 512 entries because QoS TCAM is double-wide.
		Note
		All egress QoS (IPv4) TCAM regions are double wide, except for the **e-qos-lite** region which is single wide.

Using Templates to Configure TCAM Region Sizes

Note Using templates to configure TCAM region sizes is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

Beginning with Cisco NX-OS Release 7.0(3)I3(1), you can use create and apply custom templates to configure TCAM region sizes.

Note Once you apply a TCAM template, the **hardware access-list tcam region** command will not work. You must uncommit the template in order to use the command.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **hardware profile tcam resource template** *template-name* **ref-template** {**nfe** | **nfe2** | {**l2-l3** | **l3**}}
3. (Optional) *region tcam-size*
4. **exit**
5. [**no**] **hardware profile tcam resource service-template** *template-name*
6. (Optional) **show hardware access-list tcam template** {**all** | **nfe** | **nfe2** | **l2-l3** | **l3** | *template-name*}
7. (Optional) **copy running-config startup-config**

8. **reload**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	Required: [**no**] **hardware profile tcam resource template** *template-name* **ref-template** {**nfe** | **nfe2** | {**l2-l3** | **l3**}}
	Example:
	`switch(config)# hardware profile tcam resource template SR_MPLS_CARVE ref-template nfe2`
	`switch(config-tcam-temp)#`
		Creates a template for configuring ACL TCAM region sizes.
		nfe—The default TCAM template for Network Forwarding Engine (NFE)-enabled Cisco Nexus 9300 and 9500 Series, 3164Q, and 31128PQ devices.
		nfe2—The default TCAM template for NFE2-enabled Cisco Nexus 9500 Series, 3232C, and 3264Q devices.
		l2-l3—The default TCAM template for Layer 2 and Layer 3 security configurations on Cisco Nexus 9200 Series switches.
		l3—The default TCAM template for Layer 3 configurations on Cisco Nexus 9200 Series switches. The Layer 3 TCAM template is the default template for the Cisco Nexus 9200 Series switches.

Step 3	(Optional) *region tcam-size* **Example:** `switch(config-tcam-temp)# mpls 256`	Adds any desired TCAM regions and their sizes to the template. Enter this command for each region you want to add to the template.

Step 4	Required: **exit**
	Example:
	`switch(config-tcam-temp)# exit`
	`switch(config#)`
		Exits the TCAM template configuration mode.

Step 5	Required: [**no**] **hardware profile tcam resource service-template** *template-name* **Example:** `switch(config)# hardware profile tcam resource service-template SR_MPLS_CARVE`	Applies the custom template to all line cards and fabric modules.

	Command or Action	Purpose
Step 6	(Optional) **show hardware access-list tcam template** {**all** | **nfe** | **nfe2** | **l2-l3** | **l3** | *template-name*} **Example:** `switch(config)# show hardware access-list tcam template SR_MPLS_CARVE`	Displays the configuration for all TCAM templates or for a specific template.
Step 7	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.
Step 8	**reload** **Example:** `switch(config)# reload`	Reloads the device. **Note** The configuration is effective only after you enter **copy running-config startup-config** + **reload**.

Verifying QoS TCAM Carving

After you adjust the TCAM region sizes, enter the **show hardware access-list tcam region** command to display the TCAM sizes that will be applicable on the next reload of the device.

To display the configuration of a TCAM template, use the **show hardware access-list tcam template** {**all** | **nfe** | **nfe2** | **l2-l3** | **l3** | *template-name*} command where:

- **all**—Displays configuration for all TCAM templates.
- **nfe**—The default TCAM template for Network Forwarding Engine (NFE)-enabled Cisco Nexus 9300 and 9500 Series, 3164Q, and 31128PQ devices.
- **nfe2**—The default TCAM template for NFE2-enabled Cisco Nexus 9500, 3232C, and 3264Q devices.
- **l2-l3**—The default TCAM template for Layer 2-to-Layer 3 configurations on Cisco Nexus 9200 Series switches.
- **l3**—The default TCAM template for Layer 3 configurations on Cisco Nexus 9200 Series switches.

Note To keep all modules synchronized, you must reload all line card modules or enter the **copy running-config startup-config** command and the **reload** command to reload the device. Multiple TCAM region configurations require only a single reload. You can wait until you complete all of your TCAM region configurations before you reload the device.

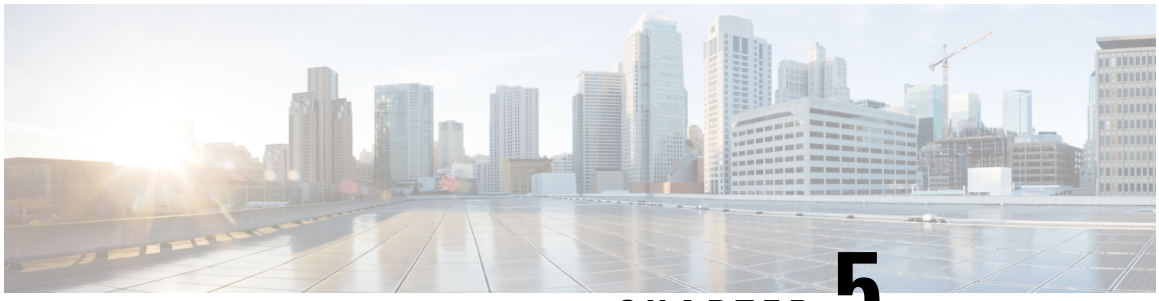
If you exceed the 4K ingress limit for all TCAM regions when you configure a TCAM region, the following message appears:

```
ERROR: Aggregate TCAM region configuration exceeded the available Ingress TCAM space.
```

```
Please re-configure.
```

If TCAM for a particular feature is not configured and you try to apply a feature that requires TCAM carving, the following message appears:

```
ERROR: Module x returned status: TCAM region is not configured. Please configure TCAM
region and retry the command.
```



CHAPTER 5

Configure QoS Classification

This chapter describes how to configure QoS Classification on Cisco NX-OS devices.

- About Classification, on page 55
- Prerequisites for Classification, on page 56
- Guidelines and Limitations for Classification, on page 56
- Configuring Traffic Classes, on page 58
- Commands for classification configuration verification, on page 70
- Configuration Examples for Classification, on page 70

About Classification

Classification is the separation of packets into traffic classes. You configure the device to take a specific action on the specified classified traffic, such as policing or marking down, or other actions.

You can create class maps to represent each traffic class by matching packet characteristics with the classification criteria in the following table:

Table 25: Classification Criteria

Classification Criteria	Description
CoS	Class of service (CoS) field in the IEEE 802.1Q header.
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.
ACL	IP, IPv6, or MAC ACL name.
Packet length	Size range of Layer 3 packet lengths. **Note** Match on packet-length is not supported on Cisco Nexus 9300 Series switches.

Classification Criteria	Description
IP RTP	Identify applications using Real-time Transport Protocol (RTP) by UDP port number range.

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.

Note However, if you match on an ACL, no other match criteria, except the packet length, can be specified in a match-all class. In a match-any class, you can match on ACLs and any other match criteria.

Traffic that fails to match any class in a QoS policy map is assigned to a default class of traffic called class-default. The class-default can be referenced in a QoS policy map to select this unmatched traffic.

You can reuse class maps when defining the QoS policies for different interfaces that process the same types of traffic.

Prerequisites for Classification

Classification has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for Classification

Configuration guidelines and limitations

- The **show** commands with the **internal** keyword are not supported.
- When the **destination interface sup-eth0** CLI command is configured, the following system log message is displayed: `Enabling span destination to SUP will affect ingress QoS classification.`
- Matching the packets based on DSCP, CoS, or precedence in Cisco Nexus 9300-EX platform switches, the TCAM entries for both IPv4 (single-wide is one entry) and IPv6 (double-wide are two entries) are installed in the hardware. For example, if you match DSCP 4, three entries are installed in the hardware, one entry for IPv4 and two entries for IPv6.
- You can specify a maximum of 1024 match criteria in a class map.
- You can configure a maximum of 128 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.

- The **match-all** option in the **class-map type qos match-all** command is not supported. The match criteria of this command becomes the same as in the **class-map type qos match-any** command. The **class-map type qos match-all** command yields the same results as the **class-map type qos match-any** command.
- The **match-all** option is not supported in CoPP class-map and it always defaults to the **match-any** option.
- You can classify traffic on Layer 2 ports that are based on either the port policy or VLAN policy of the incoming packet but not both. If both are present, the device acts on the port policy and ignores the VLAN policy.
- When a Cisco Nexus Fabric Extender (FEX) is connected and in use, do not mark data traffic with a CoS value of 7. CoS 7 is reserved for control traffic transiting the Fabric Extender.
- Control traffic (control frames) from the switch to the FEX are marked with a CoS value of 7 and are limited to a jumbo MTU frame size of 2344 bytes.
- Jumbo ping (MTU of 2400 or greater) from a switch supervisor with a COS of 7, to a FEX host, fails because the control queue on a FEX supports an MTU limited to 2240.
- QoS classification policies are not supported under system QoS for Layer 2 switch ports. However, you can configure a QoS policy to classify the incoming traffic based on CoS/DSCP and map it to different queues. The QoS policy must be applied under all the interfaces that require the classification.
- A QoS policy with a MAC-based ACL as a match in the class map does not work for IPv6 traffic. For QoS, IPv6 traffic must be matched based on IPv6 addresses and not on MAC addresses.
- As a best practice, avoid having a voice VLAN configuration where an access VLAN is same as the voice VLAN.

  The following are alternative approaches:

  - If a separate dot1p tag (cos) value is not required for voice traffic, use the **switchport voice vlan untagged** command.

    ```
    switch(config)# interface ethernet 1/1
    switch(config-if)# switchport access vlan 20
    switch(config-if)# switchport voice vlan untagged
    ```

  - If a separate cos value is required for voice traffic, use the **switchport voice vlan dot1p** command.

    ```
    switch(config)# interface ethernet 1/1
    switch(config-if)# switchport access vlan 20
    switch(config-if)# switchport voice vlan dot1p
    ```

- MPLS packets with a NULL label on transit nodes, receive an MPLS classification that is based on its NULL label EXP.
- Ingress DROP_ACL_DROP is seen with Cisco Nexus 9272Q, 9236C, and 92160YC-X switches on an ASIC during congestion. However, these drops do not impact the performance of the switch.

Unsupported features

- PVLANs do not provide support for PVLAN QoS.
- QoS classification is not supported on the FEX interfaces ingressing the VXLAN traffic. This limitation is applicable to all Cisco Nexus 9000 series switches.

- Cisco Nexus 9504 and Cisco Nexus 9508 switches with the specified line cards do not support QoS match acl with fragments:
  - Cisco Nexus 96136YC-R
  - Cisco Nexus 9636C-RX
  - Cisco Nexus 9636Q-R
  - Cisco Nexus 9636C-R
- A QoS policy that references an ACL that contains a match for ICMP type or code is not supported.

Supported features and platforms

- FEX QoS policy supports FEX host interfaces (HIF).
  - QoS TCAM carving is supported on ALE (Application Leaf Engine) enabled switches.
  - Only system level policies are supported.
  - Match on CoS is supported.
  - Match on QoS-group is supported.
- A QoS Policy that references an ACL that contains a match for TCP flags is only supported on the following Cisco Nexus 9000 series switches:
  - Cisco Nexus 9200 platform switches
  - Cisco Nexus 9300-EX platform switches
  - Cisco Nexus 9300-FX platform switches
  - Cisco Nexus 9500 platform switches with Cisco Nexus X97160YC-EX and 9700-FX line cards

Guidelines and limitations for Cisco Nexus 9800 Series switches

Configuring Traffic Classes

Configuring ACL Classification

You can classify traffic by matching packets based on an existing access control list (ACL). Traffic is classified by the criteria defined in the ACL. The permit and deny ACL keywords are ignored in the matching; even though a match criteria in the access-list has a deny action, it is still used for matching for this class.

Note Use the **class-map class_acl** command to display the ACL class-map configuration.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match access-group name** *acl-name*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any**	**match-all**] *class-name* **Example:** `switch(config)# class-map class_acl`	Creates or accesses the class map named class-name and enters class-map mode. The class map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters. (**match-any** is the default when no option is selected and multiple match statements are entered.)
Step 3	**match access-group name** *acl-name* **Example:** `switch(config-cmap-qos)# match access-group name my_acl`	Configures the traffic class by matching packets based on the *acl-name*. The **permit** and **deny** ACL keywords are ignored in the matching.

Examples: Configuring ACL Classification

To prevent packets from being matched by the QoS class-map, you must explicitly specify the packets you want to match with permit statements. The *implicit* default deny statement at the end of the ACL will filter out the remainder. Any *explicit* deny statements configured inside the access list of a QoS class map will be ignored in the matching and treated as an explicit permit statement as shown in the examples below.

The following examples, A1, B1, and C1, all produce the same QoS matching results:

- A1

```
ip access-list extended A1
  permit ip 10.1.0.0 0.0.255.255 any
  permit ip 172.16.128.0 0.0.1.255 any
  permit ip 192.168.17.0 0.0.0.255 any
```

- B1

```
ip access-list extended B1
  permit ip 10.1.0.0 0.0.255.255 any
  deny ip 172.16.128.0 0.0.1.255 any  /* deny is interpreted as a permit */
  permit ip 192.168.17.0 0.0.0.255 any
```

- C1

```
ip access-list extended C1
  deny ip 10.1.0.0 0.0.255.255 any   /* deny is interpreted as a permit */
 deny ip 172.16.128.0 0.0.1.255 any  /* deny is interpreted as a permit */
 deny ip 192.168.17.0 0.0.0.255 any  /* deny is interpreted as a permit */
```

Adding an explicit DENY ALL at the end of a QoS matching ACL causes the QoS ACL to permit all traffic.

The following examples, D1 and E1, produce the same QoS matching results:

- D1

```
ip access-list extended D1
  permit ip 10.1.0.0 0.0.255.255 any
  permit ip 172.16.128.0 0.0.1.255 any
  permit ip 192.168.17.0 0.0.0.255 any
 deny ip 0.0.0.0 255.255.255.255 any  /* deny is interpreted as a permit */
```

Note The last line in the example effectively becomes a PERMIT ALL statement and results in the QoS ACL to permit all packets.

- E1

```
ip access-list extended E1
    permit ip 0.0.0.0 255.255.255.255 any
```

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 the following table:

Table 26: 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	AF40 dscp (011100)—decimal value 28
af33	AF33 dscp (011110)—decimal value 30

Value	List of DSCP Values
af41	AF41 dscp (100010)—decimal value 34
af42	AF42 dscp (100100)—decimal value 36
af43	AF43 dscp (100110)—decimal value 38
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

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **dscp** *dscp-values*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any**	**match-all**] *class-name* **Example:** `switch(config)# class-map class_dscp`	Creates or accesses the class map named class-name and enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.

	Command or Action	Purpose
Step 3	**match** [**not**] **dscp** *dscp-values* **Example:** `switch(config-cmap-qos)# match dscp af21, af32`	Configures the traffic class by matching packets based on dscp-values. The standard DSCP values are shown in the following table. Use the **not** keyword to match on values that do not match the specified range.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the DSCP class-map configuration:

```
switch# show class-map class_dscp
```

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. The precedence values are listed in the following:

Table 27: 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)

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **precedence** *precedence-values*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-name* **Example:** `switch(config)# class-map class_ip_precedence`	Creates or accesses the class map named class-name and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **precedence** *precedence-values* **Example:** `switch(config-cmap-qos)# match precedence 1-2, 5-7`	Configures the traffic class by matching packets based on *precedence-values*. Values are shown in the following table. Use the **not** keyword to match on values that do not match the specified range.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the IP precedence class-map configuration:

```
switch# show class-map class_ip_precedence
```

Configuring Protocol Classification

For Layer 3 protocol traffic, you can use the ACL classification match.

Table 28: match Command Protocol Arguments

Argument	Description
arp	Address Resolution Protocol (ARP)
bridging	Bridging
cdp	Cisco Discovery Protocol (CDP)
dhcp	Dynamic Host Configuration (DHCP)
isis	Intermediate system to intermediate system (IS-IS)

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **protocol** {**arp** | **bridging** | **cdp** | **dhcp** | **isis**}
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any**	**match-all**] *class-name* **Example:** `switch(config)# class-map class_protocol`	Creates or accesses the class map named class-name and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **protocol** {**arp**	**bridging**	**cdp**	**dhcp**	**isis**} **Example:** `switch(config-cmap-qos)# match protocol isis`	Configures the traffic class by matching packets based on the specified protocol. Use the **not** keyword to match on protocols that do not match the protocol specified.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:**	(Optional) Saves the running configuration to the startup configuration.

	Command or Action	Purpose
	`switch(config)# copy running-config startup-config`	

Example

This example shows how to display the protocol class-map configuration:

```
switch# show class-map class_protocol
```

Configuring Layer 3 Packet Length Classification

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

Note This feature is designed for IP packets only.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **packet length** *packet-length-list*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any**	**match-all**] *class-name* **Example:** `switch(config)# class-map class_packet_length`	Creates or accesses the class map named class-name and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **packet length** *packet-length-list* **Example:** `switch(config-cmap-qos)# match packet length min 2000`	Configures the traffic class by matching packets based on various packet lengths (bytes). Values can range from 1 to 9198. Use the **not** keyword to match on values that do not match the specified range. **Note**

	Command or Action	Purpose
		This command is not supported on Cisco Nexus 9300 Series switches.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the packet length class-map configuration:

```
switch# show class-map class_packet_length
```

Configuring CoS Classification

You can classify traffic based on the class of service (CoS) in the IEEE 802.1Q header. This 3-bit field is defined in IEEE 802.1p to support QoS traffic classes. CoS is encoded in the high order 3 bits of the VLAN ID Tag field and is referred to as user_priority.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **cos** *cos-list*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any**	**match-all**] *class-name* **Example:**	Creates or accesses the class map named class-name and then enters class-map mode. The class-map name can

	Command or Action	Purpose
	`switch(config)# class-map class_cos`	contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **cos** *cos-list* **Example:** `switch(config-cmap-qos)# match cos 4,5-6`	Configures the traffic class by matching packets based on the list of CoS values. Values can range from 0 to 7. Use the **not** keyword to match on values that do not match the specified range. **Note** When a Cisco Nexus Fabric Extender (FEX) is connected and in use, data traffic should not be marked with a CoS value of 7. CoS 7 is reserved for control traffic transiting the Fabric Extender.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the CoS class-map configuration:

```
switch# show class-map class_cos
```

Configuring CoS Classification for FEX

Note The CoS Classification for FEX feature is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

You can classify traffic based on the class of service (CoS) for a FEX.

Before you begin

Before configuring the FEX, enable **feature-set fex**.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **cos** *cos-list*
4. **exit**

5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-name* **Example:** `switch(config)# class-map class_cos`	Creates or accesses the class map named class-name and then enters class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **cos** *cos-list* **Example:** `switch(config-cmap-qos)# match cos 4,5-6`	Configures the traffic class by matching packets based on the list of CoS values. Values can range from 0 to 7. Use the **not** keyword to match on values that do not match the specified range. **Note** When a Cisco Nexus Fabric Extender (FEX) is connected and in use, data traffic should not be marked with a CoS value of 7. CoS 7 is reserved for control traffic transiting the Fabric Extender.

Step 4	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits global class-map queuing mode and enters global configuration mode.

Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to configure the CoS class-map configuration:

```
switch# conf t
switch(config)# class-map type qos match-all cos6
switch(config-cmap-qos)# match cos 6
switch(config)# class-map type qos match-all cos1
switch(config-cmap-qos)# match cos 1
switch(config)# class-map type qos match-all cos2
switch(config-cmap-qos)# match cos 2
switch(config)# class-map type qos match-all cos3
```

```
switch(config-cmap-qos)# match cos 3
switch(config)# class-map type qos match-all cos0
switch(config-cmap-qos)# match cos 0
```

Configuring IP RTP Classification

The IP Real-Time Transport Protocol (RTP) is a transport protocol for real-time applications that transmit data such as audio or video (RFC 3550). Although RTP does not use a common TCP or UDP port, you typically configure RTP to use ports 16384 to 32767. UDP communications uses an even-numbered port and the next higher odd-numbered port is used for RTP Control Protocol (RTCP) communications.

When defining a match statement in a **type qos class-map**, to match with upper layer protocols and port ranges (UDP/TCP/RTP, among others), the system cannot differentiate, for example, between UDP traffic and RTP traffic in the same port range. The system classifies both traffic types the same. For better results, you must engineer the QoS configurations to match the traffic types present in the environment.

SUMMARY STEPS

1. **configure terminal**
2. **class-map** [**type qos**] [**match-any** | **match-all**] *class-name*
3. **match** [**not**] **ip rtp** *udp-port-value*
4. **exit**
5. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map** [**type qos**] [**match-any** | **match-all**] *class-name* **Example:** `switch(config)# class-map class_rtp`	Creates or accesses a class map and then enters the class-map mode. The class-map name can contain alphabetic, hyphen, or underscore characters, and can be up to 40 characters.
Step 3	**match** [**not**] **ip rtp** *udp-port-value* **Example:** `switch(config-cmap-qos)# match ip rtp 2000-2100, 4000-4100`	Configures the traffic class by matching packets that are based on a range of lower and upper UDP port numbers, targeting applications using RTP. Values can range from 2000 to 65535. Use the **not** keyword to match on values that do not match the specified range.
Step 4	**exit** **Example:**	Exits global class-map queuing mode and enters global configuration mode.

	Command or Action	Purpose
	`switch(config-cmap-qos)# exit` `switch(config)#`	
Step 5	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the RTP class-map configuration:

```
switch# show class-map class_rtp
```

Commands for classification configuration verification

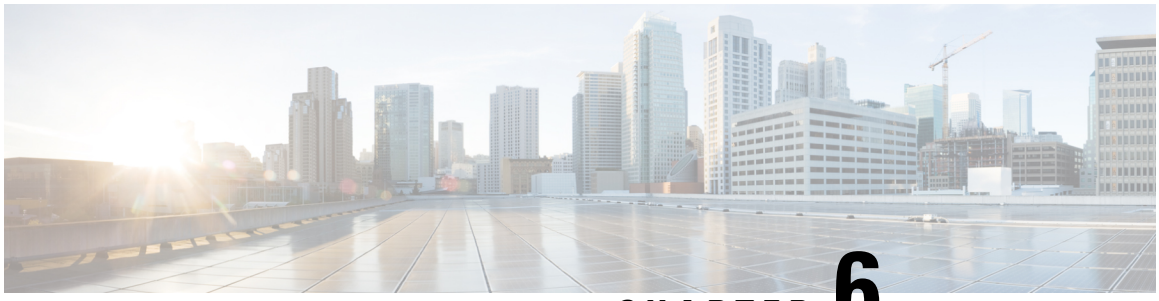
Use the following commands to verify the classification configuration:

Command	Purpose
show class-map	Displays all class maps.
show ip access-lists *name*	Displays the IPv4 ACL configuration.
show ipv6 access-lists *name*	Displays the IPv6 ACL configuration.

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_cos
match cos 4, 5-6
exit
```



CHAPTER 6

Configuring Marking

- About Marking, on page 71
- Prerequisites for Marking, on page 73
- Guidelines and Limitations for Marking, on page 73
- Configuring Marking, on page 74
- Verifying the Marking Configuration, on page 82
- Configuration Examples for Marking, on page 82

About Marking

Marking is a method that you use to modify the QoS fields of the incoming and outgoing packets. The QoS fields that you can mark are IP precedence and differentiated services code point (DSCP) in Layer 3. The QoS group is a label local to the system to which you can assign intermediate marking values. You can use the QoS group label to determine the egress scheduling.

You can use marking commands in traffic classes that are referenced in a policy map. The marking features that you can configure are listed in the following table:

Table 29: Configurable Marking Features

Marking Feature	Description
DSCP	Layer 3 DSCP.
IP precedence	Layer 3 IP precedence. **Note** IP precedence uses only the lower three bits of the type of service (ToS) field. The device overwrites the first three bits of the ToS field to 0.
QoS group	Locally significant QoS values that can be manipulated and matched within the system. The range is from 0 to 3.
Ingress	Status of the marking applies to incoming packets.
CoS	Layer 2 VLAN ID

Trust Boundaries

The trust boundary forms a perimeter on your network. Your network trusts (and does not override) the markings on your switch.

The incoming interface enforces the trust boundary as follows:

- All Fibre Channel and virtual Fibre Channel interfaces are automatically classified into the FCoE system class.
- By default, all Ethernet interfaces are trusted interfaces. A packet tagged with an 802.1p class of service (CoS) value is classified into a system class using the value in the packet.
- Any packet not tagged with an 802.1p CoS value is classified into the default drop system class. If the untagged packet is sent over a trunk, it is tagged with the default untagged CoS value, which is zero.
- You can override the default untagged CoS value for an Ethernet interface or port channel.

After the system applies the correct CoS value to an untagged packet, QoS treats the packet according to the newly defined class.

Class of Behavior

For routed unicast traffic, the CoS value is not available and the packet has the Differentiated Services Code Point (DSCP) value only. For bridged unicast traffic, the CoS value is copied from the CoS value received in the 802.1q header. Note that on Layer 2 access links there is no trunk header. Therefore, if traffic is received on an access port and bridged, it will egress the switch with CoS 0. The DSCP value does not change, but the packet may not get the desired priority. You can manually set the CoS value in a policy-map via any QoS policy that manually sets the CoS or DSCP value.

Routed multicast traffic derives its CoS value similar to routed unicast traffic. For bridged multicast traffic, the behavior depends on the Layer 3 state. If there is no Layer 3 state for the multicast group, the CoS is derived similar to the bridged unicast traffic. If there is a Layer 3 state for the multicast group, the CoS is derived similar to routed unicast traffic.

Note When you enable Protocol Independent Multicast (PIM) in sparse mode on the switch virtual interface (SVI) for the VLAN in which traffic is received, PIM creates an S,G entry for any multicast traffic.

Table 30: CoS Behavior per Traffic Type

Traffic Type	CoS Behavior
Routed unicast	Unchanged
Bridged unicast	Unchanged
Routed multicast	Copied from 3 MSB of ToS
Bridged multicast with Layer 3 state for group	Copied from 3 MSB of ToS
Bridged multicast with no Layer 3 state for group	Unchanged

Note CoS behavior per traffic type is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

Prerequisites for Marking

Classification has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for Marking

Marking has the following configuration guidelines and limitations:

- PVLANs do not provide support for PVLAN QoS.
- **show** commands with the **internal** keyword are not supported.
- Egress QoS policies are not supported on subinterfaces.
- The **set qos-group** command can only be used in ingress policies.

Note You can apply the marking instructions in a QoS policy map to ingress packets by attaching that QoS policy map to an interface. To select ingress, you specify the **input** keyword in the **service-policy** command.

For more information, see the "Attaching and Detaching a QoS Policy Action" section.

- The FEX QoS policy supports FEX host interfaces (HIF).

Note FEX host interfaces are not supported on the Cisco Nexus 9508 switch.

- QoS TCAM carving is supported on ALE (Application Leaf Engine) enabled switches.
- The FEX QoS policy supports only the **set qos-group** command. Other marking commands are not supported.

Note **set qos-group 0** is reserved for class default. It cannot be configured in user-defined classes.

- Match on QoS-group is supported.

- Interface level egress QoS policies must be applied on 100G ports for egress packet scheduling. When egress QoS policies are not configured for a 100G port, all egress packet traffic goes through the default queue (Qos-group 0).

Note Egress QoS policy for 100G ports is applicable only for Cisco Nexus 9300 platform switches with the N9K-M4PC-CFP2 GEM or for Cisco Nexus 9500 platform switches with the Cisco Nexus 9408PC-CFP2 line cards. In all other 100G Cisco Nexus series switches, egress QoS policy is not a must.

- Control traffic, such as BPDUs, routing protocol packets, LACP/CDP/BFD, GOLD packets, glean traffic, and management traffic, are automatically classified into a control group, based on a criteria. These packets are classified into qos-group 8 and have a strict absolute priority over other traffic. These packets are also given a dedicated buffer pool so that any congestion of data traffic does not affect control traffic. The control qos-group traffic classification cannot be modified.
- Span traffic automatically gets classified into qos-group 9 and is scheduled at absolute low priority.
- Egress QoS policies are not supported on Cisco Nexus 9200 platform switches.
- QoS marking policies can be enabled on subinterfaces
- Beginning with Cisco NX-OS Release 10.1(2), Marking is supported on the N9K-X9624D-R2 and N9K-C9508-FM-R2 platform switches.
- On Cisco Nexus 9364E-SG2-Q and 9364E-SG2-O switches, packets that are remarked with new DSCP values using ingress QoS policies may not match corresponding entries in egress ACLs.

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 either incoming or outgoing packets on an interface.

Note Do not press **Enter** after you use the **set** command and before you add the rest of the command. If you press **Enter** directly after entering the set keyword, you will be unable to continue to configure with the QoS configuration.

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 specified value. You can enter numeric values from 0 to 63, in addition to the standard DSCP values shown in the following table.

Table 31: Standard DSCP Values

Value	List of DSCP Values
af11	AF11 dscp (001010)—decimal value 10

Value	List of DSCP Values
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	AF40 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
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 2475.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] *policy-map-name*
3. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
4. **set dscp** *dscp-value*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] *policy-map-name*
	Example:
	`switch(config)# policy-map policy1`
	`switch(config-pmap-qos)#`
		Creates or accesses the policy map named *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-name* | **class-default**} [**insert-before** *before-class-name*]
	Example:
	`switch(config-pmap-qos)# class class1`
	`switch(config-pmap-c-qos)#`
		Creates a reference to *class-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** *dscp-value* **Example:** `switch(config-pmap-c-qos)# set dscp af31`	Sets the DSCP value to *dscp-value*. Standard values are shown in the previous Standard DSCP Values table. When the QoS policy is applied on the VLAN configuration level, the DSCP value derives the CoS value for bridged and routed traffic from the 3 most significant DSCP bits.

Example

This example shows how to display the policy-map configuration:

```
switch# show policy-map policy1
```

Configuring IP Precedence Marking

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

Note The device rewrites the last 3 bits of the ToS field to 0 for packets that match this class.

Table 32: Precedence Values

Value	List of Precedence Values
0-7	IP precedence value

Value	List of Precedence Values
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)

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] *policy-map-name*
3. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
4. **set precedence** *precedence-value*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] *policy-map-name*
	Example:
	`switch(config)# policy-map policy1`
	`switch(config-pmap-qos)#`
		Creates or accesses the policy map named *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-name* | **class-default**} [**insert-before** *before-class-name*]
	Example:
	`switch(config-pmap-qos)# class class1`
	`switch(config-pmap-c-qos)#`
		Creates a reference to *class-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.

Step 4	**set precedence** *precedence-value* **Example:** `switch(config-pmap-c-qos)# set precedence 3`	Sets the IP precedence value to *precedence-value*. The value can range from 0 to 7. You can enter one of the values shown in the above Precedence Values table.

Example

This example shows how to display the policy-map configuration:

```
switch# show policy-map policy1
```

Configuring CoS Marking

You can set the value of the CoS field in the high-order three bits of the VLAN ID Tag field in the IEEE 802.1Q header.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name* | **qos-dynamic**]
3. **class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-name*]
4. **set cos** *cos-value*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name*	**qos-dynamic**]
		Example:
		`switch(config)# policy-map policy1`
		`switch(config-pmap-qos)#`
			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-name*]
		Example:
		`switch(config-pmap-qos)# class class1`
		`switch(config-pmap-c-qos)#`
			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 cos** *cos-value*
	Example:
	`switch(config-pmap-c-qos)# set cos 3`
	`switch(config-pmap-c-qos)#`
		Sets the CoS value to *cos-value*. The value can range from 0 to 7.

Example

This example shows how to display the policy-map configuration:

```
switch# show policy-map policy1
```

Configuring CoS Marking for FEX

Note The CoS Marking for FEX feature is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

You can mark traffic based on the class of service (CoS) for a FEX.

Before you begin

Before configuring the FEX, enable **feature-set fex**.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name* | **qos-dynamic**]
3. **class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-name*]

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*qos-policy-map-name*	**qos-dynamic**]
		Example:
		`switch(config)# policy-map policy1`
		`switch(config-pmap-qos)#`
			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-name*]
		Example:
		`switch(config-pmap-qos)# class class1`
		`switch(config-pmap-c-qos)#`
			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.

Example

This example shows how to configure the CoS class-map configuration:

```
switch# conf t
switch(config)# policy-map type qos setpol
switch(config-pmap-qos)# class  cos6
switch(config-pmap-c-qos)# set qos-group 3
switch(config-pmap-qos)# class  cos3
switch(config-pmap-c-qos)# set qos-group 2
switch(config-pmap-qos)# class  cos1
switch(config-pmap-c-qos)# set qos-group 1
switch(config-pmap-qos)# class class-default
```

Configuring DSCP Port Marking

You can set the DSCP value for each class of traffic defined in a specified ingress policy map.

The default behavior of the device 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 DSCP value is preserved.

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 NX-OS device.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
3. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
4. **set** *dscp-value*
5. **exit**
6. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
7. **set** *dscp-value*
8. **exit**
9. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
10. **set** *dscp-value*
11. **exit**
12. **interface ethernet** *slot/port*
13. **service-policy** [**type qos**] {**input** | **output**} {*policy-map-name*} [**no-stats**]

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
	Example:
	`switch(config)# policy-map policy1`
	`switch(config-pmap-qos)#`
		Creates or accesses the policy map named *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-name* | **class-default**} [**insert-before** *before-class-name*]
	Example:
	`switch(config-pmap-qos)# class class1`
	`switch(config-pmap-c-qos)#`
		Creates a reference to *class-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* **Example:** `switch(config-pmap-c-qos)# set dscp af31`	Sets the DSCP value to dscp-value. Valid values are listed in the Standard DSCP Values table in the Configuring DSCP Marking section.

Step 5	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Returns to policy-map configuration mode.

Step 6	**class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
	Example:
	`switch(config-pmap-qos)# class class2`
	`switch(config-pmap-c-qos)#`
		Creates a reference to *class-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* **Example:** `switch(config-pmap-c-qos)# set dscp af1`	Sets the DSCP value to dscp-value. Valid values are listed in the Standard DSCP Values table in the Configuring DSCP Marking section.

Step 8	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Returns to policy-map configuration mode.

	Command or Action	Purpose

Step 9	**class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
	Example:
	`switch(config-pmap-qos)# class class-default`
	`switch(config-pmap-c-qos)#`
		Creates a reference to *class-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 10	**set** *dscp-value*
	Example:
	`switch(config-pmap-c-qos)# set dscp af22`
	`switch(config-pmap-c-qos)#`
		Sets the DSCP value to dscp-value. Valid values are listed in the Standard DSCP Values table in the Configuring DSCP Marking section.

Step 11	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Returns to policy-map configuration mode.

Step 12	**interface ethernet** *slot/port*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Enters interface mode to configure the Ethernet interface.

Step 13	**service-policy** [**type qos**] {**input** | **output**} {*policy-map-name*} [**no-stats**] **Example:** `switch(config-if)# service-policy input policy1`	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 shows how to display the policy-map configuration:

```
switch# show policy-map policy1
```

Verifying the Marking Configuration

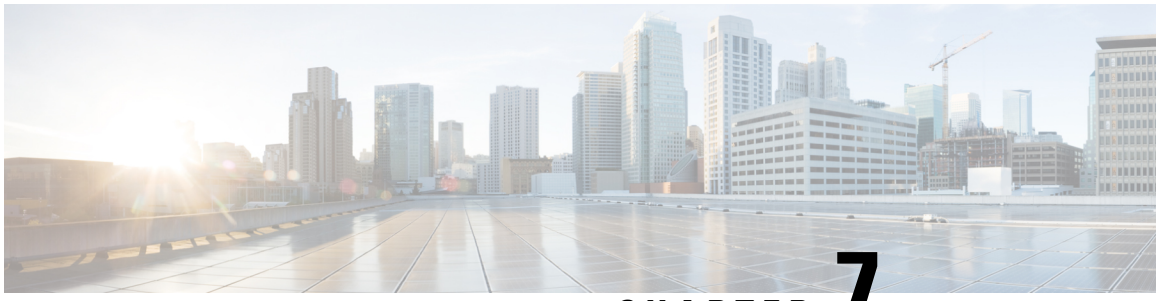
To display the marking configuration information, perform one of the following tasks:

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 precedence 3
set qos-qroup 3
set dscp 0
```



CHAPTER 7

Configuring Policing

- About Policing, on page 85
- Shared Policers, on page 86
- Licensing Requirements for Policing, on page 86
- Prerequisites for Policing, on page 86
- Guidelines and Limitations for QoS Policing, on page 87
- Configuring Policing, on page 90
- Configuring Shared Policers, on page 99
- Verifying the Policing Configuration, on page 102
- Configuration Examples for Policing, on page 102

About Policing

Policing is the monitoring of the data rates for a particular class of traffic. When the data rate exceeds user-configured values, marking or dropping of packets occurs immediately. Policing does not buffer the traffic; therefore, the transmission delay is not affected. When traffic exceeds the data rate, you instruct the system to either drop the packets or mark QoS fields in them.

You can define single-rate and dual-rate policers.

Single-rate policers monitor the committed information rate (CIR) of traffic. Dual-rate policers monitor both CIR and peak information rate (PIR) of traffic. In addition, the system monitors associated burst sizes. Three colors, or conditions, are determined by the policer for each packet depending on the data rate parameters supplied: conform (green), exceed (yellow), or violate (red).

You can configure only one action for each condition. For example, you might police for traffic in a class to conform to the data rate of 256000 bits per second, with up to 200 millisecond bursts. The system would apply the conform action to traffic that falls within this rate, and it would apply the violate action to traffic that exceeds this rate.

For more information about policers, see RFC 2697 and RFC 2698.

Shared Policers

Note The shared policer feature is only supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3) and later 7.0(3)F3(x) releases).

QoS applies the bandwidth limits specified in a shared policer cumulatively to all flows in the matched traffic. A shared policer applies the same policer to more than one interface simultaneously.

For example, if you configure a shared policer to allow 1 Mbps for all Trivial File Transfer Protocol (TFTP) traffic flows on VLAN 1 and VLAN 3, the device limits the TFTP traffic for all flows combined on VLAN 1 and VLAN 3 to 1 Mbps.

The following are guidelines for configuring shared policers:

- You create named shared policers by entering the qos shared-policer command. If you create a shared policer and create a policy using that shared policer and attach the policy to multiple ingress ports, the device polices the matched traffic from all the ingress ports to which it is attached.
- You define shared policers in a policy map class within the police command. If you attach a named shared policer to multiple ingress ports, the device polices the matched traffic from all the ingress ports to which it is attached.
- Shared policing works independently on each module.
- When the shared policer is applied on interfaces or a VLAN with member ports that are across different cores or instances, the rate becomes two times the configured CIR rate.
- Use the **show qos shared-policer** [**type qos**] [*policer-name*] command to display information about shared policers.

Licensing Requirements for Policing

The following table shows the licensing requirements for this feature:

Product	License Requirement
Cisco NX-OS	The QoS feature does not a require license. Any feature not included in a license package is bundled with the NX-OS image and is provided at no extra charge to you. For a complete explanation of the Cisco NX-OS licensing scheme, see the Cisco NX-OS Licensing Guide.

Prerequisites for Policing

Policing has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for QoS Policing

Policing has the following configuration guidelines and limitations:

Common

The following are guidelines and limitations common to all policers:

- PVLANs do not provide support for PVLAN QoS.
- **show** commands with the **internal** keyword are not supported.
- Each module applies policing independently, which can affect QoS features that are applied to traffic that is distributed across multiple modules. The following are examples of these QoS features:
  - Policers that are applied to a port channel interface.
  - Policers that are applied to a VLAN.
- Policing only supports violated and nonviolated statistics when using either double width or single width TCAM with e-qos-lite.
- Using the optional keyword, no-stats disables statistics and ensures that applicable policies are shared.
- You can only use the **set qos-group** command in ingress policies.

Ingress Policing

The following are guidelines and limitations for ingress policing:

- All policers in the ingress direction must use the same mode.
- QoS Ingress policers can be enabled on subinterfaces.

Egress Policing

The following are guidelines and limitations for egress policing:

- Egress QoS policing is not supported on Cisco Nexus 9500 platform switches with the following line cards:
  - Cisco Nexus 9636C-R
  - Cisco Nexus 9636Q-R
  - Cisco Nexus 9636C-RX
  - Cisco Nexus 96136YC-R
- The egress RACL feature is not supported on the Cisco Nexus 9508 switch.

- Egress QoS policy statistics for CPU generated traffic are not supported on the following:
  - Cisco Nexus 9200, 9300-EX, and 9300-FX platform switches
  - Cisco Nexus 9500 platform switches with the following line cards:
    - Cisco Nexus 9732C-EX
    - Cisco Nexus 9736C-EX
    - Cisco Nexus 97160YC-EX
    - Cisco Nexus 9736C-FX

- The egress policing feature is supported on the following Cisco Nexus 9000 EX and FX-based switches and line cards:
  - Cisco Nexus 93108TC-EX
  - Cisco Nexus 93180YC-EX
  - Cisco Nexus 93180LC-EX
  - Cisco Nexus 97160YC-EX
  - Cisco Nexus 9732C-EX
  - Cisco Nexus 9736C-EX
  - Cisco Nexus 93108TC-FX
  - Cisco Nexus 9348GC-FXP
  - Cisco Nexus 9736C-FX

- The total number of policers that can be successfully attached in the egress direction is only half the size of the qos-lite TCAM region.
- When egress RACL and egress QoS are applied together, you can only enable statistics for one or the other, not both.
- The egress policing feature does not support egress QoS policers on ALE uplink ports on top-of-rack (ToR) platforms.
- When using egress QoS, we recommend using the appropriate match criteria to match data traffic. Avoid match criteria such as **permit ip any any**.
- Remark action for violated packets in the egress direction is not supported on the following Cisco Nexus 9000 -EX platform switches and line cards:
  - Cisco Nexus 93180YC-EX
  - Cisco Nexus 93108TC-EX
  - Cisco Nexus 9736C-EX
  - Cisco Nexus 97160YC-EX
  - Cisco Nexus 9732C-EX

They only support the drop action for violate in the egress direction.

- VLAN Egress QoS and Egress QoS on Layer 2 Port Channel (L2PO) are not supported on the following Cisco Nexus 9000 -EX platform line cards:
  - Cisco Nexus 97160YC-EX
  - Cisco Nexus 9732C-EX
  - Cisco Nexus 9736C-EX
- Egress QoS policies are not supported on subinterfaces.
- For Cisco Nexus 9504 switches, egress QoS policies are not supported on the following:
  - Sub-interfaces
  - Physical interfaces with configured sub-interfaces
- Egress QoS policies are not supported on Cisco Nexus 9200 Series switches.

1-Rate 2-Color and 2-Rate 3-Color Policing

The following are guidelines and limitations for 1-rate 2-color (1R2C) and 2-rate 3-color (2R3C) policing:

- 2-rate 3-color ingress policing is supported on the following Cisco Nexus 9000 series switches and line cards:

  New in Release 9.2(3):

  - Cisco Nexus 93180YC-FX
  - Cisco Nexus 93108TC-FX
  - Cisco Nexus 9348GC-FXP
  - Cisco Nexus 9364C
  - Cisco Nexus 9332C
  - Cisco Nexus 9336C-FX2
  - Cisco Nexus 93240YC-FX2
  - Cisco Nexus 9736C-FX
  - Cisco Nexus 9788TC-FX

  Existing support:

  - Cisco Nexus 9332PQ
  - Cisco Nexus 9372PX
  - Cisco Nexus 9372PX-E
  - Cisco Nexus 9372TX
  - Cisco Nexus 9372TX-E
  - Cisco Nexus 9396-PX

- Cisco Nexus 9396-TX
- Cisco Nexus 93120TX
- Cisco Nexus 93128-TX

- Cisco Nexus 9200 platform switches support a 1-rate 2-color policer. A 2-rate 3-color policer is not supported on Cisco Nexus 9200 platform switches.
- Only 1R2C policing in the egress direction is supported on the following Cisco Nexus 9000 -EX and -FX platform switches and line cards:
  - Cisco Nexus 93180YC-EX
  - Cisco Nexus 93108TC-EX
  - Cisco Nexus 9736C-EX
  - Cisco Nexus 97160YC-EX
  - Cisco Nexus 9732C-EX
  - Cisco Nexus 93108TC-FX
  - Cisco Nexus 9348GC-FXP
  - Cisco Nexus 9736C-FX
- Cisco Nexus 9200 platform switches only support 1R2C policing in the ingress direction.

Shared Policers

The following are guidelines and limitations for shared policers:

- The shared policer feature is only supported on the Cisco Nexus 9508 switch (Cisco NX-OS Release 7.0(3)F3(3) and later).
- When the shared policer is applied to interfaces or VLANs, with member ports that are across different cores or instances, the rate becomes two times the configured CIR rate.

Configuring Policing

You can configure a single or dual-rate policer.

Configuring Ingress Policing

You can apply the policing instructions in a QoS policy map to ingress packets by attaching that QoS policy map to an interface. To select ingress, you specify the **input** keyword in the **service-policy** command. For more information on attaching and detaching a QoS policy action from an interface, see the "Using Modular QoS CLI" section.

Configuring Egress Policing

Note The egress policing feature is supported only on Cisco Nexus 9000 -FX platform switches and line cards, such as Cisco Nexus 9736C-FX, 93108TC-FX, and 9348GC-FXP.

Note Egress QoS policing is not supported on Cisco Nexus 9500 platform switches with the following line cards:

- Cisco Nexus 9636C-R
- Cisco Nexus 9636Q-R
- Cisco Nexus 9636C-RX
- Cisco Nexus 96136YC-R

You can apply the policing instructions in a QoS policy map to ingress or egress packets by attaching that QoS policy map to an interface. To select ingress or egress, you specify the **input** keyword or the **output** keyword in the **service-policy** command.

Before you begin

- You must carve TCAM region for egress QoS before configuring policing.
- For more information about attaching and detaching a QoS policy action from an interface, see the "Using Modular QoS CLI" section.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
3. **class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-name*]
4. **police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate*] [**conform** {**transmit** | **set-prec-transmit** | **set-dscp-transmit** | **set-cos-transmit** | **set-qos-transmit**} [exceed { drop }**[violate** {**drop | set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit** }]]}
5. **exit**
6. **exit**
7. **show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**]
8. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
	Example:
	`switch(config)# policy-map policy1`
	`switch(config-pmap-qos)#`
		Creates or accesses the policy map named *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-name*]
	Example:
	`switch(config-pmap-qos)# class class-default`
	`switch(config-pmap-c-qos)#`
		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	**police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate*] [**conform** {**transmit** | **set-prec-transmit** | **set-dscp-transmit** | **set-cos-transmit** | **set-qos-transmit**} [exceed { drop }[**violate** {**drop** | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit** }]]}
	Example:
	`switch(config-pmap-qos)# policy-map type qos egressqos`
	`switch(config-pmap-qos)# class class-default`
	`switch(config-pmap-c-qos)# police [ cir] {committed-rate [data-rate] | percent cir-link-percent}`
	`[ bc committed-burst-rate][ conform { transmit | set-prec-transmit | set-dscp-transmit | set-cos-transmit | set-qos-transmit}] [ violate { drop}]}`
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)# exit`
	`switch(config)#`
		Polices **cir** in bits or as a percentage of the link rate. The **conform** action is taken if the data rate is <= cir. The actions are described in the Policer Actions for Exceed or Violate table and the Policer Actions for Conform table. The data rates and link speeds are described in the Data Rates for the police Command table and the Burst Sizes for the police Command table. See Configuring 1-Rate for more information.
		The following information describes the **drop** option for **violate**:
		• set-cos-transmit—Set dscp and send it.
		• set-prec-transmit—Set precedence and send it.
		• set-qos-transmit—Set qos-group and send it.
		Note
		For **cir** pps, the packet size is 64 bytes. So the pps to bps conversion is 64*8.

Step 5	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Exits policy-map class configuration mode and enters policy-map mode.

Step 6	**exit** **Example:**	Exits policy-map mode and enters global configuration mode.

	Command or Action	Purpose
	`switch(config-pmap-qos)# exit` `switch(config)#`	

Step 7	**show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**]
	Example:
	`switch(config)# show policy-map type qos egressqos`
	Example:
	`switch(config)# policy-map type qos egressqos`
	`class class-default`
	`police cir 10 mbs bc 200 ms conform transmit`
	`violate drop`
		(Optional) Displays information about the configured policy map of type qos.

Step 8	**copy running-config startup-config**
	Example:
	`switch(config)# copy running-config`
	`startup-config`
		(Optional) Saves the running configuration to the startup configuration.

Configuring 1-Rate and 2-Rate, 2-Color and 3-Color Policing

The type of policer created by the device is based on a combination of the **police** command arguments described in the following Arguments to the police Command table.

Note You must specify the identical value for **pir** and **cir** to configure 1-rate 3-color policing.

Note A 1-rate 2-color policer with the violate markdown action is not supported.

Note Cisco Nexus 9200 Series switches only support 1-rate 2-color policing.

Table 33: Arguments to the police Command

Argument	Description
cir	Committed information rate, or desired bandwidth, specified as a bit rate or a percentage of the link rate. Although a value for cir is required, the argument itself is optional. The range of values is from 1 to 80000000000. The range of policing values is from 8000 to 80 Gbps.
percent	Rate as a percentage of the interface rate. The range of values is from 1 to 100 percent.

Argument	Description
bc	Indication of how much the cir can be exceeded, either as a bit rate or an amount of time at cir. The default is 200 milliseconds of traffic at the configured rate. The default data rate units are bytes.
pir	Peak information rate, specified as a PIR bit rate or a percentage of the link rate. There is no default. The range of values is from 1 to 80000000000; the range of policing values is from 8000 bps to 480 Gbps. The range of percentage values is from 1 to 100 percent.
be	Indication of how much the pir can be exceeded, either as a bit rate or an amount of time at pir. When the bc value is not specified, the default is 200 milliseconds of traffic at the configured rate. The default data rate units are bytes. **Note** You must specify a value for pir before the device displays this argument.
conform	Single action to take if the traffic data rate is within bounds. The basic actions are transmit or one of the set commands listed in the following Policer Actions for Conform table. The default is transmit.
exceed	Single action to take if the traffic data rate is exceeded. The basic actions are drop or markdown. The default is drop.
violate	Single action to take if the traffic data rate violates the configured rate values. The basic actions are drop or markdown. The default is drop.

Although all the arguments in the above Arguments to the police Command table are optional, you must specify a value for **cir**. In this section, **cir** indicates its value but not necessarily the keyword itself. The combination of these arguments and the resulting policer types and actions are shown in the following Policer Types and Actions from Police Arguments Present table.

Table 34: Policer Types and Actions from Police Arguments Present

Police Arguments Present	Policer Type	Policer Action
cir, but not **pir**, **be**, or **violate**	1-rate, 2-color	<= **cir**, **conform**; else **violate**
cir and **pir**	2-rate, 3-color	<= **cir**, conform; <= **pir**, exceed; else **violate**

The policer actions that you can specify are described in the following Policer Actions for Exceed or Violate table and the following Policer Actions for Conform table.

Note Only **drop** and **transmit** actions are supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3) and later).

Table 35: Policer Actions for Exceed or Violate

Action	Description
drop	Drops the packet. This action is available only when the packet exceeds or violates the parameters.
set-cos-transmit	Sets CoS and transmits the packet.
set-dscp-transmit	Sets DSCP and transmits the packet.
set-prec-transmit	Sets precedence and transmits the packet.
set-qos-transmit	Sets qos-group and transmits the packet.

Table 36: Policer Actions for Conform

Action	Description
transmit	Transmits the packet. This action is available only when the packet conforms to the parameters.
set-prec-transmit	Sets the IP precedence field to a specified value and transmits the packet. This action is available only when the packet conforms to the parameters.
set-dscp-transmit	Sets the differentiated service code point (DSCP) field to a specified value and transmits the packet. This action is available only when the packet conforms to the parameters.
set-cos-transmit	Sets the class of service (CoS) field to a specified value and transmits the packet. This action is available only when the packet conforms to the parameters.
set-qos-transmit	Sets the QoS group internal label to a specified value and transmits the packet. This action can be used only in input policies and is available only when the packet conforms to the parameters.

Note The policer can only drop or mark down packets that exceed or violate the specified parameters. For information on marking down packets, see the Configuring Marking, on page 74 section.

The data rates used in the **police** command are described in the following Data Rates for the police Command table.

Table 37: Data Rates for the police Command

Rate	Description
bps	Bits per second (default)
kbps	1,000 bits per seconds
mbps	1,000,000 bits per second

Rate	Description
gbps	1,000,000,000 bits per second

Burst sizes used in the **police** command are described in the following Burst Sizes for the police Command table.

Table 38: Burst Sizes for the police Command

Speed	Description
bytes	bytes
kbytes	1,000 bytes
mbytes	1,000,000 bytes
ms	milliseconds
us	microseconds

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
3. **class** [**type qos**] {*class-map-name* | **class-default**} [**insert-before** *before-class-name*]
4. **police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate* [*link-speed*]][**pir**] {*peak-rate* [*data-rate*] | **percent** *cir-link-percent*} [**be** *peak-burst-rate* [*link-speed*]] [**conform** {**transmit** | **set-prec-transmit** | **set-dscp-transmit** | **set-cos-transmit** | **set-qos-transmit**} [**exceed** {**drop**} [**violate** {**drop** | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit**}]]}
5. [violate {**drop** | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit**}]
6. **exit**
7. **exit**
8. **show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**]
9. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*policy-map-name*] **Example:**	Creates or accesses the policy map named *policy-map-name* and then enters policy-map mode. The policy-map name

	Command or Action	Purpose
	`switch(config)# policy-map policy1` `switch(config-pmap-qos)#`	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-name*]
	Example:
	`switch(config-pmap-qos)# class class-default`
	`switch(config-pmap-c-qos)#`
		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	**police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate* [*link-speed*]][**pir**] {*peak-rate* [*data-rate*] | **percent** *cir-link-percent*} [**be** *peak-burst-rate* [*link-speed*]] [**conform** {**transmit** | **set-prec-transmit** | **set-dscp-transmit** | **set-cos-transmit** | **set-qos-transmit**} [**exceed** {**drop**} [**violate** {**drop** | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit**}]]}	Polices **cir** in bits or as a percentage of the link rate. The **conform** action is taken if the data rate is <= cir. If **be** and **pir** are not specified, all other traffic takes the **violate** action. If **be** or **violate** are specified, the **exceed** action is taken if the data rate <= **pir**, and the **violate** action is taken otherwise. The actions are described in the Policer Actions for Exceed or Violate table and the Policer Actions for Conform table. The data rates and link speeds are described in the Data Rates for the police Command table and the Burst Sizes for the police Command table.
Step 5	[violate {**drop** | **set-cos-transmit** | **set-dscp-transmit** | **set-prec-transmit** | **set-qos-transmit**}]	**set-cos-transmit**—Set cos and send it. **set-dscp-transmit**—Set dscp and send it. **set-prec-transmit**—Set precedence and send it. **set-qos-transmit**—Set qos-group and send it.

Step 6	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Exits policy-map class configuration mode and enters policy-map mode.

Step 7	**exit**
	Example:
	`switch(config-pmap-qos)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 8	**show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**] **Example:** `switch(config)# show policy-map`	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.
Step 9	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Example

This example shows how to display the policy1 policy-map configuration:

```
switch# show policy-map policy1
```

Configuring Markdown Policing

Markdown policing is the setting of a QoS field in a packet when traffic exceeds or violates the policed data rates. You can configure markdown policing by using the set commands for policing action described in the Policer Actions for Exceed or Violate table and the Policer Actions for Conform table.

Note You must specify the identical value for **pir** and **cir** to configure 1-rate 3-color policing.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
3. **class** [**type qos**] {*class-name* | **class-default**} [**insert-before** *before-class-name*]
4. **police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [[**bc** | **burst**] *burst-rate* [*link-speed*]] [[**be** | **peak-burst**] *peak-burst-rate* [*link-speed*]] [**conform** *conform-action* [**exceed** [**violate drop set dscp dscp table** *pir-markdown-map*]]}
5. **exit**
6. **exit**
7. **show policy-map** [**type qos**] [*policy-map-name*]
8. **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map** [**type qos**] [**match-first**] [*policy-map-name*]
	Example:
	`switch(config)# policy-map policy1`
	`switch(config-pmap-qos)#`
		Creates or accesses the policy map named *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-name* | **class-default**} [**insert-before** *before-class-name*]	Creates a reference to *class-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

	Command or Action	Purpose

	Example:
	`switch(config-pmap-qos)# class class-default`
	`switch(config-pmap-c-qos)#`
		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	**police** [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [[**bc** | **burst**] *burst-rate* [*link-speed*]] [[**be** | **peak-burst**] *peak-burst-rate* [*link-speed*]] [**conform** *conform-action* [**exceed** [**violate drop set dscp dscp table** *pir-markdown-map*]]}	Polices **cir** in bits or as a percentage of the link rate. The **conform** action is taken if the data rate is <= cir. If **be** and **pir** are not specified, all other traffic takes the **violate** action. If **be** or **violate** are specified, the **exceed** action is taken if the data rate <= **pir**, and the **violate** action is taken otherwise. The actions are described in the Policer Actions for Exceed or Violate table and the Policer Actions for Conform table. The data rates and link speeds are described in the Data Rates for the police Command table and the Burst Sizes for the police Command table.

Step 5	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Exits policy-map class configuration mode and enters policy-map mode.

Step 6	**exit**
	Example:
	`switch(config-pmap-qos)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 7	**show policy-map** [**type qos**] [*policy-map-name*] **Example:** `switch(config)# show policy-map`	(Optional) Displays information about all configured policy maps or a selected policy map of type qos.
Step 8	**copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	(Optional) Saves the running configuration to the startup configuration.

Configuring Shared Policers

The shared policer feature allows you to apply the same policing parameters to several interfaces simultaneously. You create a shared policer by assigning a name to a policer, and then applying that policer to a policy map that you attach to the specified interfaces. The shared policer is also referred to as the named aggregate policer in other Cisco documentation.

Note The shared policer feature is only supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3) and later).

Note When the shared policer is applied on interfaces or VLANs with member ports that are across different cores or instances, the rate becomes two times the configured **cir** rate.

To configure a shared policer:

1. Create the class map.
2. Create a policy map.
3. Reference the shared policer to the policy map as described in this section.
4. Apply the service policy to the interfaces.

Note The rates specified in the shared policer are shared by the number of interfaces to which you apply the service policy. Each interface does not have its own dedicated rate as specified in the shared policer.

SUMMARY STEPS

1. switch# **configure terminal**
2. switch(config)# **qos shared-policer** [**type qos**] *shared-policer-name* [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate* [*link-speed*]] [**pir**] {*peak-rate* [*data-rate*] | **percent** *cir-link-percent*} [**be** *peak-burst-rate* [*link-speed*]] {{**conform** *conform-action* [**exceed** {**drop** | **set dscp dscp table** *cir-markdown-map*} [**violate** {**drop** | **set dscp dscp table** *pir-markdown-map*}]]}}
3. switch(config)# **policy-map** [**type qos**] [**match-first**] {*qos-policy-map-name* | **qos-dynamic**}
4. switch(config-pmap-qos)# **class** [**type qos**] {*class-map-name* | **qos-dynamic** | **class-default**} [**insert-before** *before-class-map-name*]
5. switch(config-pmap-c-qos)# **police aggregate shared-policer-name**
6. switch(config-pmap-c-qos)# **exit**
7. switch(config-pmap-qos)# **exit**
8. (Optional) switch(config)# **show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**]
9. (Optional) switch(config)# **copy running-config startup-config**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	switch# **configure terminal**	Enters global configuration mode.
Step 2	switch(config)# **qos shared-policer** [**type qos**] *shared-policer-name* [**cir**] {*committed-rate* [*data-rate*] | **percent** *cir-link-percent*} [**bc** *committed-burst-rate* [*link-speed*]] [**pir**] {*peak-rate* [*data-rate*] | **percent** *cir-link-percent*} [**be** *peak-burst-rate* [*link-speed*]] {{**conform** *conform-action* [**exceed** {**drop** | **set dscp dscp**	Creates or accesses the shared policer. The shared-policer-name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters. Polices **cir** in bits or as a percentage of the link rate. The **conform** action is taken if the data rate is ≤ **cir**. If **be** and **pir** are not specified, all other traffic takes

	Command or Action	Purpose
	table *cir-markdown-map*} [**violate** {**drop** | **set dscp dscp table** *pir-markdown-map*}]]}}	the **violate** action. If **be** or **violate** are specified, the **exceed** action is taken if the data rate ≤ **pir**, and the **violate** action is taken otherwise. **Note** A 64 byte packet size is used for the case of **cir pps**.This results in a 64*8 **pps** to **bps** conversion. **Note** The *cir-markdown-map* and *pir-markdown-map* maps are not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).
Step 3	switch(config)# **policy-map** [**type qos**] [**match-first**] {*qos-policy-map-name* | **qos-dynamic**}	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 4	switch(config-pmap-qos)# **class** [**type qos**] {*class-map-name* | **qos-dynamic** | **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 5	switch(config-pmap-c-qos)# **police aggregate shared-policer-name**	Creates a reference in the policy map to *shared-policer-name*.
Step 6	switch(config-pmap-c-qos)# **exit**	Exits policy-map class configuration mode and enters policy-map mode.
Step 7	switch(config-pmap-qos)# **exit**	Exits policy-map mode and enters global configuration mode.
Step 8	(Optional) switch(config)# **show policy-map** [**type qos**] [*policy-map-name* | **qos-dynamic**]	Displays information about all configured policy maps or a selected policy map of type qos.
Step 9	(Optional) switch(config)# **copy running-config startup-config**	Saves the running configuration to the startup configuration.

Example

This example shows how to display the test1 shared-policer configurations:

```
switch# show qos shared-policer test1
```

Verifying the Policing Configuration

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

Command	Purpose
show policy-map	Displays information about policy maps and policing.

Configuration Examples for Policing

The following example shows how to configure policing for a 1-rate, 2-color policer:

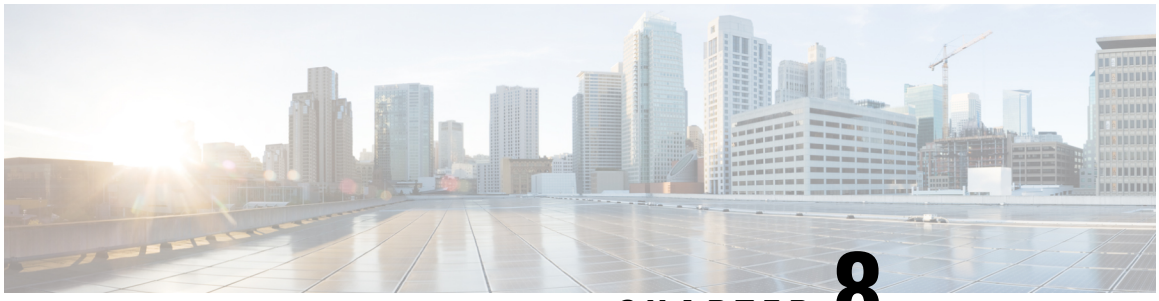
```
configure terminal
  policy-map policy1
    class one_rate_2_color_policer
      police cir 256000 conform transmit violate drop
```

The following example shows how to configure policing for a 1-rate, 2-color policer with DSCP markdown:

```
configure terminal
  policy-map policy2
    class one_rate_2_color_policer_with_dscp
      police cir 256000 conform transmit violate drop
```

The following example shows how to configure policing for a shared policer:

```
configure terminal
 qos shared-policer type qos udp_10mbps cir 10 mbps pir 20 mbps conform transmit exceed
set dscp dscp table cir-markdown-map violate drop
 policy-map type qos udp_policy
  class type qos udp_qos
   police aggregate udp_10mbps
```



CHAPTER 8

Configure Queuing and Scheduling

- Queuing and Scheduling, on page 103
- Prerequisites for Queuing and Scheduling, on page 107
- Guidelines and Limitations for Queuing and Scheduling, on page 107
- Configure Queuing and Scheduling, on page 112
- Configure Congestion Management, on page 120
- Apply a Queuing Policy on a System, on page 124
- Verify the Queuing and Scheduling Configuration, on page 125
- Control the QoS Shared Buffer, on page 125
- Manage Dynamic Buffer Sharing, on page 126
- Monitor the QoS Packet Buffer, on page 126
- Configuration Examples for Queuing and Scheduling , on page 128

Queuing and Scheduling

The queuing and scheduling processes provides a robust framework for managing network traffic, ensuring that data flows smoothly and efficiently across the network. Traffic queuing, traffic scheduling, traffic shaping, congestion avoidance, and congestion management services are used to achieve this as mentioned in the following sections.

Traffic Queuing

Traffic queuing involves ordering packets for both input and output data. Devices can support multiple queues to control packet sequencing in different traffic classes. This is crucial for managing how data flows through a network, ensuring that packets are processed in an orderly manner.

Traffic Scheduling

Traffic scheduling is the methodical output of packets at a desired frequency to accomplish a consistent flow of traffic. You can apply traffic scheduling to different traffic classes to weight the traffic by priority.

Modifying Class Maps

Note The provided system-defined queuing class maps cannot be modified.

- **Default Behavior**: By default, all network traffic is grouped into a single category called **qos-group 0**. This means that without any specific configuration, all traffic is treated the same way.
- **System-Defined Classes**: These are predefined categories that manage how different types of traffic are handled. They cannot be changed directly.
- **Policy Handling**:
  - You can create a type queuing policy which allows you to configure particular que group. For more information see Configure Type Queuing Policies, on page 113.
  - When you assign traffic to a different qos-group using a **Type QoS policy**, you might need to adjust these system-defined policies further to meet specific needs, such as reallocating bandwidth.

For information about configuring policy maps and class maps, see the Using Modular QoS CLI, on page 9 chapter.

Traffic Shaping

Traffic shaping is a technique that is used to control the flow of traffic leaving an interface to ensure it matches the speed of the remote target interface and adheres to contracted policies. This process helps eliminate bottlenecks caused by data-rate mismatches by regulating and smoothing packet flow. Key aspects include:

- **Maximum Traffic Rate**: Imposes a limit on the traffic rate for each port's egress queue, buffering packets that exceed this threshold to minimize packet loss.
- **Comparison to Traffic Policing**: Traffic shaping buffers packets instead of dropping them, thereby improving TCP traffic behavior.
- **Bandwidth Control**: Allows control over available bandwidth, ensuring traffic conforms to the shaper rates and avoids excess egress traffic for the particular target interface.
- **Queue Length Thresholds**: Configured using Weighted Random Early Detection (WRED) to manage queue lengths effectively.

Congestion Avoidance

You can use the following methods to proactively avoid traffic congestion on the device:

- Apply WRED to TCP or non-TCP traffic.
- Apply tail drop to TCP or non-TCP traffic.

Congestion Management

Congestion Management uses the following methods to maintain network performance by preventing congestion when queues exceed their thresholds.

- Explicit Congestion Notification
- Approximate Fair Drop
- Weighted Random Early Detection

For information about configuring congestion management, see the Configuring WRED on Egress Queues section.

Explicit Congestion Notification

Explicit Congestion Notification (ECN) is an extension to WRED that marks packets instead of dropping them when the average queue length exceeds a specific threshold value. This helps in signaling congestion to routers and end hosts, prompting them to slow down packet transmission.

Approximate Fair Drop

Approximate Fair Drop (AFD) is an Active Queue Management (AQM) algorithm that acts on long lived large flows (elephant flows) in case of congestion, and does not impact short flows (mice flows).

When congestion occurs, the AFD algorithm maintains the queue occupancy at the configured queue desired value by probabilistically dropping packets from the large flows and not impacting short flows.

ECN can be enabled with AFD on a particular class of traffic to mark the congestion state instead of dropping the packets.

Note The AFD algorithm is applicable only on the flows that are qualified as elephant flows. Mice flows are protected and are not subject to AFD dropping.

AFD User Profiles

Three user profiles are provided with AFD:

- Mesh (Aggressive)

  AFD and ETRAP timers are set to be aggressive, so that the queue depth does not grow much and is kept close to the queue-desired value.

- Burst (Default)

  AFD and ETRAP timers are neither aggressive nor conservative, so that the queue depth could be observed to be hovering near the queue-desired value.

- Ultra-burst (Conservative)

  AFD and ETRAP timers are set to be conservative, so that more bursts are absorbed and fluctuations for queue depth can be observed around the queue-desired value.

These profiles set the ETrap and AFD timers to pre-configured values for different traffic profiles such as, very bursty or not-so bursty traffic. For more configuration flexibility, the ETrap period set by the profile can be overridden by configuring the ETrap age-period with the **hardware qos etrap** command. However, the AFD timer cannot be changed.

The following is an example of configuring the ETrap age-period:

```
switch(config)# hardware qos etrap age-period 50 usec
```

The following are examples of configuring the AFD user profiles:

- Mesh (Aggressive with ETrap age-period: 20 µsec and AFD period: 10 µsec)

  ```
  switch(config)# hardware qos afd profile mesh
  ```

- Burst (Default with ETrap age-period: 50 µsec and AFD period: 25 µsec)

  ```
  switch(config)# hardware qos afd profile burst
  ```

- Ultra-burst (Conservative with ETrap age-period: 100 µsec and AFD period: 50 µsec)

  ```
  switch(config)# hardware qos afd profile ultra-burst
  ```

Elephant Flow

When the number of bytes received in a flow exceeds the number of bytes specified by the ETrap byte-count-threshold, the flow is considered an elephant flow or large flow.

For a flow to continue to be an elephant flow, the configured **bw_threshold** number of bytes has to be received in the configured timer period. Otherwise, the flow is evicted from the ETrap hash table.

The ingress rate of every elephant flow is calculated and forwarded to egress for the AFD algorithm to consume.

Elephant Trap

The Elephant Trap (ETrap) identifies and hashes flows and forwards the arrival rate per flow to AFD for drop probability computation. It helps in distinguishing between large and short flows, ensuring that only large flows are subject to AFD dropping.

ETrap Parameters

ETrap has the following parameters that can be configured:

- **Byte-count**

  Byte-count Is used to identify elephant flows. When number of bytes received in a flow exceeds the number of bytes specified by the byte-count-threshold, the flow is considered an elephant flow. (Default byte-count is ~ 1 MB.)

- **Age-period and Bandwidth-threshold**

  Age-period and Bandwidth-threshold are used together to track the activeness of an elephant flow.

  When the average bandwidth during the age-period time is lower than the configured bandwidth-threshold, an elephant flow is considered inactive and is timed-out and removed from the elephant flow table. (Default age-period is 50 µsec. Default bandwidth-threshold is 500 bytes.

Example:

```
switch (config)# hardware qos etrap age-period 50 usec
switch (config)# hardware qos etrap bandwidth-threshold 500 bytes
switch (config)# hardware qos etrap byte-count 1048555
```

Weighted Random Early Detection

Weighted Random Early Detection is another AQM algorithm that computes a random drop probability and drops packets indiscriminately across all flows in a traffic class. It cannot be used simultaneously with AFD, as both serve similar purposes but with different methodologies.

Comparison of WRED and AFD

Feature	WRED	AFD
Algorithm Type	Active Queue Management	Active Queue Management
Drop Mechanism/Congestion Management	Computes a random drop probability and drops packets indiscriminately across all flows in a class of traffic	Computes drop probability based on the arrival rate of incoming flows, compares it with the computed fair rate, and drops packets from large flows without impacting short flows
Priority Handling	Considers packet priority (CoS, DSCP/traffic class, or IP precedence value) to maintain higher-priority flows	Focuses on fairness by distinguishing between long-lived elephant flows and short-lived mice flows, exempting mice flows from dropping

Note AFD and WRED cannot be applied at the same time. Only one can be used in a system.

Prerequisites for Queuing and Scheduling

Queuing and scheduling have the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You must be logged on to the device.

Guidelines and Limitations for Queuing and Scheduling

Queuing and scheduling have the following configuration guidelines and limitations:

Note For scale information, see the release-specific Cisco Nexus 9000 Series NX-OS Verified Scalability Guide.

Configuration and Port Limitations for Queuing and Scheduling

- **Ports Limitations**
  - Changes are disruptive. The traffic passing through ports of the specified port type experiences a brief period of traffic loss. All ports of the specified type are affected.
  - Performance can be impacted. If one or more ports of the specified type do not have a queuing policy applied that defines the behavior for the new queue, the traffic mapping to that queue can experience performance degradation.
  - WRED is not supported on ALE enabled device front panel 40G uplink ports. When WRED is configured for the system level, the setting is ignored and no error message is displayed. When WRED is configured at the port level, the setting is rejected and an error message displays.
- **Configuration Limitations**
  - The **show** commands with the **internal** keyword are not supported.
  - The device supports a system-level queuing policy, so all ports in the system are impacted when you configure the queuing policy.
  - A **type queuing policy** can be attached to the system or to individual interfaces for input or output traffic.
  - When configuring priority for one class map queue (SPQ), configure the priority for QoS Group 3. When configuring priority for more than one class map queue, configure the priority on the higher numbered QoS groups. In addition, the QoS groups must be next to each other. For example, if you want to have two SPQs, you have to configure the priority on QoS Group 3 and on QoS Group 2.
  - If granted buffer is not carved out using a custom input queuing policy for a specified group, only global shared buffers are used.

Switch Limitations for Queuing and Scheduling

- About queue limits for 100G enabled devices (such as the Cisco Nexus 9300 platform switch with the N9K-M4PC-CFP2 GEM):
  - The maximum dynamic queue-limit alpha value can be greater that 8. However 8 is the maximum alpha value supported. If you configure the alpha value to a value greater than 8, it is overridden and set to the maximum.

    No message is issued when the alpha value is overridden.
  - The static queue-limit has a maximum of 20,000 cells. Any value specified greater than the maximum 20,000 cell limit is overridden by the 20,000 cell limit.

    No message is issued when the cell limit is overridden.

- 100G enabled devices (such as the Cisco Nexus 9300 Series switch with the N9K-M4PC-CFP2 GEM), the WRED threshold has a maximum of 20,000 cells. Any value specified greater than the maximum 20,000 cell limit is overridden by the 20,000 cell limit.

  No message is issued when the cell limit is overridden.

- Assigning a high alpha value on a Cisco Nexus 9200 platform switch uses more than the expected 50% of the available buffer space.

  Assigning a lower alpha value (7 or less) assures the usage of the expected 50% of the available buffer space.

- For Cisco Nexus 9200 platform switches, when a static limit is configured on a queue, both the static limit and the dynamic limit are calculated using the dynamic threshold (alpha value).
- Maximum queue occupancy for Leaf Spine Engine (LSE) enabled switches is limited to 64K cells (~13MB).
- For the following Cisco Nexus series switches and line cards, the lowest value that the egress shaper can manage, per queue, is 100 Mbps:
  - Cisco Nexus 9200 platform switches
  - Cisco Nexus 9300-EX/FX/FX2 platform switches
  - Cisco Nexus 9700-EX/FX line cards
- The **queue-limit** configuration is applicable only in ingress queuing policy on Cisco Nexus 9500 switches with 9600-R/RX line cards.
- The **bandwidth percent** configuration is applicable only in egress queuing policy on Cisco Nexus 9500 switches with 9600-R/RX line cards. Ensure that the ingress queue-limit is configured before configuring the bandwidth percent command.
- For Cisco Nexus 9300-EX Series switches, a queue is allocated a minimum bandwidth of 5%, regardless of whether a lower bandwidth is configured. In contrast, for Cisco Nexus 9300-FX Series and subsequent series switches, the minimum bandwidth allocated to a queue is 1%.

Feature Limitations for Queuing and Scheduling

- **Traffic Shaping**
  - Traffic shaping can increase the latency of packets due to queuing because it falls back to store-and-forward mode when packets are queued.
  - Traffic shaping is not supported on the Cisco Nexus 9300 ALE 40G ports. For more information on ALE 40G uplink ports, see the Limitations for ALE 40G Uplink Ports on the Cisco Nexus 9000 Series Switches.
  - Configuring traffic shaping for a queue is independent of priority or bandwidth in the same policy map.
  - The system queuing policy is applied to both internal and front panel ports. When traffic shaping is enabled on the system queuing policy, traffic shaping is also applied to the internal ports. As a best practice, do not enable traffic shaping on the system queuing policy.

- The lowest value that the egress shaper can manage, per queue, is 100 Mbps on Cisco Nexus 9200 series, 9300-EX/FX/FX2 switches and 9700-EX/FX line cards.

- **FEX**
  - FEX supports
    - System inputs (ingress) level queuing for HIF to NIF traffic.
    - The system outputs (egress) level queuing for NIF to HIF traffic and HIF to HIF traffic.
  - When the switch supported system queuing policy is configured, the FEX uses the default policy.
  - The FEX QoS system level queuing policy does not support the following features.
    - WRED
    - Queue-limit
    - Traffic Shaping
    - Policing features
    - Multiple priority levels.

- **AFD**
  - Approximate Fair Drop is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).
  - AFD and WRED cannot be applied at the same time. Only one can be used in a system.
  - If an AFD policy has already been applied in system QoS and you are configuring two unique AFD queuing policies, you must apply each unique AFD policy on ports on the same slice.

    The following is an example of the system error if you do not create and apply a unique AFD policy on the same slice:

```
Eth1/50    1a006200 1    0    40    255   196   -1    1     0     0    <<<slice 1
    Eth1/51    1a006400 1    0    32    255   200   -1    0     32    56   <<<slice
 0
    Eth1/52    1a006600 1    0    64    255   204   -1    1     24    48   <<<slice
 1
    Eth1/53    1a006800 1    0    20    255   208   -1    0     20    40   <<<slice
 0

switch(config)# interface ethernet 1/50
    switch(config-if)# service-policy type queuing output LM-out-40G
    switch(config)# interface ethernet 1/51
    switch(config-if)#service-policy type queuing output LM-out-100G
    switch(config)# interface ethernet 1/52
    switch(config-if)# service-policy type queuing output LM-out-100G
    Unable to perform the action due to incompatibility:  Module 1 returned status
 "Max profiles reached for unique values of queue management parameters (alpha,
beta, max-threshold) in AFD config"
```

  - If no AFD policy has already been applied in system QoS, then you can configure the same AFD policy on ports on a different slice, or configure different AFD policies on ports in the same slice.

Note You cannot configure an AFD queuing in the System QoS later.

The following is an example of the system error when AFD queuing is already configured in the system:

```
interface Ethernet1/50
      service-policy type queuing output LM-out-40G
    interface Ethernet1/51
      service-policy type queuing output LM-out-40G
    interface Ethernet1/52
      service-policy type queuing output LM-out-100G
    interface Ethernet1/53
      service-policy type queuing output LM-out-100G
    interface Ethernet1/54
      service-policy type queuing output LM-out-100G

    (config-sys-qos)# service-policy type queuing output LM-out
    Unable to perform the action due to incompatibility:  Module 1 returned status
 "Max profiles reached for unique values of queue management parameters (alpha,
beta, max-threshold) in AFD config"
```

Order of Resolution

The following describes the order of resolution for the pause buffer configuration and the queue-limit for a priority-group.

- Pause Buffer Configuration

  The pause buffer configuration is resolved in the following order:

  - Interfaces ingress queuing policy (if applied, and pause buffer configuration is specified for that class).
  - Systems ingress queuing policy (if applied, and pause buffer configuration is specified for that class).
  - System network-QoS policy (if applied, and pause buffer configuration is specified for that class).
  - Default values with regard to the speed of the port.

- Queue-limit for Priority-Group

  The queue-limit for a priority-group is resolved in the following order:

  - Interfaces ingress queuing policy (if applied, and queue-limit configuration is specified for that class).
  - Systems ingress queuing policy (if applied, and queue-limit configuration is specified for that class).
  - The **hardware qos ing-pg-share** configuration provided value.
  - System default value.

Ingress Queuing

The following are notes about ingress queuing:

- The default systems ingress queuing policy does not exist.
- The ingress queuing policy is used to override the specified pause buffer configuration.
- When downgrading to an earlier release of Cisco Nexus 9000 NX-OS, all ingress queuing configurations have to be removed.
- The ingress queuing feature is supported only on platforms where priority flow control is supported.
- Ingress queuing is not supported on devices with 100G ports.
- The ingress queuing policy is supported only at the system level (and not at the interface level) for Cisco Nexus 9508 switches with the Cisco Nexus 9732C-EX line card and Cisco Nexus 93108TC-EX and 93180YC-EX switches.
- The Cisco Nexus 9636C-R and 9636Q-R line cards and the Cisco Nexus 9508-FM-R fabric module (in a Cisco Nexus 9508 switch) support ingress queuing.
- The Cisco Nexus 9500 switches with 9600-R/RX line cards support only burst-mode to use the big-buffer provided by hardware.

Note The recommendation is to use the same port speeds at ingress and egress side.

Queuing Policy and Egress Queue Mapping

On Cisco Nexus 9500 switches with 9600-R, R2, RX line cards, the queuing policy and egress queue mapping differ from CloudScale switches. The queuing policies are mapped in reverse order.

R Series Example:

- Queuing Policy 7 → Egress Queue 0,
- Queuing Policy 6 → Egress Queue 1, and so on

Configure Queuing and Scheduling

Queuing and scheduling are configured by creating policy maps of type queuing that you apply to an egress interface. You cannot modify system-defined class maps, which are used in policy maps to define the classes of traffic to which you want to apply policies.

The system-defined policy map, default-out-policy, is attached to all ports to which you do not apply a queuing policy map. The default policy maps cannot be configured.

You can perform the following Queuing and Scheduling configurations:

- **Type Queuing Policies**
  - Type queuing policies for egress are used for scheduling and buffering the traffic of a specific system class. A type queuing policy is identified by its QoS group and can be attached to the system or to individual interfaces for input or output traffic.

Note The ingress queuing policy is used to configure pause buffer thresholds. For more details, see the Priority Flow Control section.

- **Congestion Avoidance**
  - **Tail drop configuration**: You can configure tail drop on egress queues by setting thresholds. The device drops any packets that exceed the thresholds. You can specify a threshold based on the queue size or buffer memory that is used by the queue.
  - **WRED configuration**: You can configure WRED on egress queues to set minimum and maximum packet drop thresholds. The frequency of dropped packets increases as the queue size exceeds the minimum threshold. When the maximum threshold is exceeded, all packets for the queue are dropped.
  - **AFD configuration**: AFD can be configured for an egress queuing policy.
- **Congestion Management**
  - **Bandwidth and bandwidth remaining configuration**: You can configure the bandwidth and bandwidth remaining on the ingress and egress queue to allocate a minimum percentage of the interface bandwidth to a queue.
  - **Priority configuration**: If you do not specify the priority, the system-defined egress priority queue(pq) queues behave as normal queues.
    - You can configure only one level of priority on an egress priority queue. Use the system-defined priority queue class for the type of module to which you want to apply the policy map.
    - For the nonpriority queues, you can configure how much of the remaining bandwidth to assign to each queue. By default, the device evenly distributes the remaining bandwidth among the nonpriority queues.

Note
- When a priority queue is configured, the other queues can only use the remaining bandwidth in the same policy map.
- When configuring priority for one class map queue (SPQ), you must configure the priority for QoS Group 3. When configuring priority for more than one class map queue, you must configure the priority on the higher numbered QoS groups. In addition, the QoS groups must be next to each other. For example, if you want to have two SPQs, you have to configure the priority on QoS Group 3 and on QoS Group 2.

- **Traffic shaping configuration**: You can configure traffic shaping on an egress queue to impose a minimum and maximum rate on it.

Configure Type Queuing Policies

Follow these steps to configure type queuing policies.

Procedure

Step 1 Run the **policy-map type queuing** *policy-name* command in global configuration mode, to create a named object that represents a set of policies that are to be applied to a set of traffic classes.

Example:

```
switch# configure terminal
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to associate a class map with the policy map, and enter the specified system class configuration mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-q-default
switch(config-pmap-c-que)#
```

Step 3 Run the **priority** command to specify that traffic in this class is mapped to a strict-priority queue.

Example:

```
switch(config-pmap-c-que)# priority
```

Run the **no priority** command to remove the strict priority queuing from the traffic in this class.

Step 4 Run the **shape min** *Target-bit-rate* [**kbps** | **mbps** | **gbps** | **mbps** | **pps**] **max** *Target-bit-rate* [**kbps** | **mbps** | **gbps** | **mbps** | **pps**] command to specify the maximum and minimum shape size for the queue.

Example:

```
switch(config-pmap-c-que)# shape min 100 mbps max 150 mbps
```

Step 5 Run the **bandwidth percent** *percentage* command to assign a minimum rate of the interface bandwidth to an output queue as the percentage of the underlying interface link rate.

Example:

```
switch(config-pmap-c-que)# bandwidth percent 25
```

The class receives the assigned percentage of interface bandwidth if there are no strict-priority queues. If there are strict-priority queues, however, the strict-priority queues receive their share of the bandwidth first. The remaining bandwidth is shared in a weighted manner among the class configured with a bandwidth percent. For example, if strict-priority queues take 90 percent of the bandwidth, and you configure 75 percent for a class, the class receives 75 percent of the remaining 10 percent of the bandwidth.

Note
Before you can successfully allocate bandwidth to the class, you must first reduce the default bandwidth configuration on class-default and class-fcoe.

Run the **no bandwidth percent** *percentage* command to remove the bandwidth specification from this class.

Step 6 (Optional) Run the **priority level** *level* command to specify the strict-priority levels for the switches.

Example:

```
switch(config-pmap-c-que)# priority level 3
```

Range: 1 to 7.

Step 7 (Optional) Run the **queue-limit** *queue size* [**dynamic** *dynamic threshold*] command to specify the static or dynamic shared limit available to the queue for switches.

Example:

```
switch(config-pmap-c-que)# queue-limit 1000 mbytes
```

- The static queue limit defines the fixed size to which the queue can grow.
- The **dynamic** queue limit allows the queue's threshold size to be decided depending on the number of free cells available, in terms of the alpha value.

Note
- Cisco Nexus 9200 Series switches only support a class level dynamic threshold configuration with respect to the alpha value. This means that all ports in a class share the same alpha value.

Configure Congestion Avoidance

You can configure congestion avoidance with tail drop or WRED features. Both features can be used in egress policy maps.

Note WRED and tail drop cannot be configured in the same class.

Configure Tail Drop on Egress Queues

Follow these steps to configure tail drop on egress queues

Procedure

Step 1 Run the **hardware qos q-noise percent** *value* command in global configuration mode, to tune the random noise parameter.

Example:

```
switch# configure terminal
switch(config)# hardware qos q-noise percent 30
```

Default: 20 percent.

This command is supported for Cisco Nexus 9200 and 9300-EX Series switches beginning with Cisco NX-OS Release 7.0(3)I4(4).

Step 2 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command to configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 3 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-q1
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 4 Run the **queue-limit** {*queue-size* [**bytes** | **kbytes** | **mbytes**] | **dynamic** *value*} command to assign a tail drop threshold based on the queue size.

Example:

```
switch(config-pmap-c-que)# queue-limit 1000 mbytes
```

Queue size is in bytes, kilobytes, megabytes or allows the queue's threshold size to be determined dynamically depending on the number of free cells available. The device drops packets that exceed the specified threshold.

The valid values for byte-based queue size: 1 to 83886080.

The valid values for dynamic queue size: 0 to 10 as specified in the following table:

Value of alpha	Network Forwarding Engine (NFE) enabled switches		Leaf Spine Engine (LSE) enabled switches		
	Definition	Max % per queue	Definition	Max % per queue	ASIC value
0	1/128	~0.8%	1/8	~11%	0
1	1/64	~1.5%	1/4	~20%	1
2	1/32	~3%	1/2	~33%	3
3	1/16	~6%	3/4	~42%	5
4	1/8	~11%	1 1/8	~53%	8
5	1/4	20%	1 3/4	~64%	14
6	1/2	~33%	3	~75%	16
7	1	50%	5	~83%	18
8	2	~66%	8	~89%	21
9	4	~80%	14	~92.5	27
10	8	~89%	18	~95%	31

For example, if you configure a dynamic queue size of 6, then the alpha value is ½. If you configure a dynamic queue size of 7, then the alpha value is 1.

To calculate the queue-limit consider the following:

queue-limit = (alpha/(1 + alpha)) x total buffers

For example, if you configure a queue-limit with a dynamic queue size of 7, then the queue-limit can grow up to (1/(1+1)) x total buffers. This means that queue-limit = ½ x total buffers.

Note
Although the above calculations determine the maximum queue occupancy, the maximum queue occupancy is limited to 64K cells in all cases for Application Spine Engine (ASE2, ASE3) and Leaf Spine Engine (LSE) enabled switches.

Note
Setting the threshold on ALE enabled devices is only supported for the system level. It is not supported for the port level.

Step 5 Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.

Step 6 Run the **show policy-map** [**type queuing** [*policy-map-name* | **default-out-policy**]] command to displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

Example:

```
switch(config)# show policy-map type queuing shape_queues
```

Step 7 Run the **copy running-config startup-config** command to save the running configuration to the startup configuration.

Example:

```
switch(config)# copy running-config
startup-config
```

Configure WRED on Egress Queues

Follow these steps to configure WRED on egress queues.

Procedure

Step 1 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command to configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-q1
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 3 Run the **random-detect** [**minimum-threshold** *min-threshold* {**packets** | **bytes** | **kbytes** | **mbytes**} **maximum-threshold** *max-threshold* {**packets** | **bytes** | **kbytes** | **mbytes**} **drop-probability** *value* **weight** *value*] [**threshold** {**burst-optimized**

| **mesh-optimized**}] [**ecn | non-ecn**] [**queue length weight** *value*] command to configure WRED on the specified queuing class.

Example:

WRED configuration

```
switch(config-pmap-c-que)# random-detect
minimum-threshold 10 mbytes
maximum-threshold 20 mbytes
```

Example:

WRED configuration with non ECN option

```
switch(config-pmap-c-que)# random-detect non-ecn
minimum-threshold 1000 kbytes
maximum-threshold 4000 kbytes
drop-probability 100
```

```
switch(config-pmap-c-que)# show queuing interface eth 1/1 | grep WRED
WRED Drop Pkts   0
WRED Non ECN Drop Pkts 0
switch(config-pmap-c-que)#
```

You can specify minimum and maximum thresholds used to drop packets from the queue. The thresholds are specified by the number of packets, bytes, kilobytes, or megabytes. The minimum and maximum thresholds must be of the same type. Range: 1 to 52428800.

Alternatively, you can specify a threshold that is optimized for burst or mesh traffic, or you can configure WRED to drop packets based on explicit congestion notification (ECN). Beginning with Cisco NX-OS Release 7.0(3)I6(1), the Network Forwarding Engine (NFE) platform supports the non-ecn option to configure drop thresholds for non-ECN flows.

Note

- The minimum-threshold and maximum-threshold parameters are not supported on the Cisco Nexus 9300 platform switches and Cisco Nexus 9564TX and 9564PX line cards.

When random-detect is configured under policy-map, the default thresholds and drop probabilities are as following:

a. On newer platforms, the threshold is 0 and then the drop probabilities would be enforced irrespective of buffer utilization.

b. On older platforms, the threshold is min 100KB, max 120KB.

The drop probabilities are consistently 10% and 90% for burst-optimized and mesh-optimized respectively on all platforms

You can also specify the queue length weight for the traffic. The range of the queue length is 0-15.

Step 4 (Optional) Repeat Steps 2 and 3 to configure WRED for other queuing classes.

Step 5 (Optional) Run the **congestion-control random-detect forward-nonecn** command to allow non-ECN-capable traffic to bypass WRED thresholds and grow until the egress queue-limit and tail drops.

Example:

```
switch(config-pmap-c-que)# congestion-control random-detect forward-nonecn
```

This is a global command intended to be used with a WRED and ECN configuration and when the intention is to avoid WRED drops of non-ECN-capable traffic. This option is available beginning with Cisco NX-OS Release 7.0(3)I4(2) and supported only for Cisco Nexus 9200 platform switches, Cisco Nexus 93108TC-EX and 93180YC-EX switches, and Cisco Nexus 9508 switches with the Cisco Nexus 9732C-EX line card.

Beginning with Cisco NX-OS Release 7.0(3)I4(5), this feature is supported on Cisco Nexus 9508 switches with the Cisco Nexus 9636PQ line cards and Cisco Nexus 3164Q switches.

Configure AFD on Egress Queues

Follow these steps to configure AFD on egress queues.

Procedure

Step 1 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command in global configuration mode, to configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch# configure terminal
switch(config)# policy-map type queuing afd_8q-out
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-8q-q3
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 3 Run the **afd queue-desired** <*number*> [**bytes** | **kbytes** | **mbytes**] [**ecn**] command to specify queue-desired.

Example:

Configuring AFD without ECN

```
switch(config)# policy-map type queuing afd_8q-out
switch(config-pmap-que)# class type queuing c-out-8q-q3
switch(config-pmap-c-que)# afd queue-desired 600 kbytes
```

Configuring AFD with ECN

```
switch(config)# policy-map type queuing afd-ecn_8q-out
switch(config-pmap-que)# class type queuing c-out-8q-q3
switch(config-pmap-c-que)# afd queue-desired 150 kbytes ecn
```

The following are recommended values for **queue-desired** for different port speeds:

Port Speed	Value for Queue
10G	150 kbytes
40G	600 kbytes

Port Speed	Value for Queue
100G	1500 kbytes

What to do next

After AFD is configured, you can apply the policy to the system or to an interface as follows:

- System

```
switch(config)# system qos
switch(config-sys-qos)# service-policy type queuing output afd_8q-out
```

- Interface

```
switch(config)# int e1/1
switch(config-if)# service-policy type queuing output afd_8q-out
```

Configure Congestion Management

You can configure only one of the following congestion management methods in a policy map:

- Allocate a minimum data rate to a queue by using the **bandwidth** and **bandwidth remaining** commands.
- Allocate all data for a class of traffic to a priority queue by using the **priority** command. You can use the **bandwidth remaining** command to distribute the remaining traffic among the nonpriority queues. By default, the system evenly distributes the remaining bandwidth among the nonpriority queues.
- Allocate a minimum and maximum data rate to a queue by using the **shape** command.

In addition to the congestion management feature that you choose, you can configure one of the following queue features in each class of a policy map:

- Tail drop thresholds based on the queue size and the queue limit usage. For more information, see Configure Tail Drop on Egress Queues, on page 115.
- WRED for preferential packet drops. For more information, see the Configuring WRED on Egress Queues section.

Note WRED is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3).

Configure Bandwidth and Bandwidth Remaining

You can configure the bandwidth and bandwidth remaining on the egress queue to allocate a minimum percentage of the interface bandwidth to a queue.

Note When a guaranteed bandwidth is configured, the priority queue must be disabled in the same policy map.

Follow these steps to configure bandwidth on egress queues.

Note If you are configuring bandwidth and bandwidth remaining on the egress queue for FEX, ensure that **feature-set fex** is enabled.

Procedure

Step 1 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command in global configuration mode, to configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch# configure terminal
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-q1
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 3 Run the **bandwidth** {**percent** *percent*} command to assign a minimum rate of the interface bandwidth to an output queue as the percentage of the underlying interface link rate.

Example:

```
switch(config-pmap-c-que)# bandwidth percent 25
```

Assigns a minimum rate of the interface bandwidth to an output queue as the percentage of the underlying interface link rate. The range: 0 to 100.

The example shows how to set the bandwidth to a minimum of 25 percent of the underlying link rate.

Step 4 Run the **bandwidth remaining percent** *percent* command to assign the percentage of the bandwidth that remains.

Example:

```
switch(config-pmap-c-que)# bandwidth remaining percent 25
```

Assigns the percentage of the bandwidth that remains to this queue. The range: 0 to 100.

The example shows how to set the bandwidth for this queue to 25 percent of the remaining bandwidth.

Step 5 (Optional) Repeat Steps 3 and 4 or 5 to assign bandwidth for other queue classes.

Step 6 Run the exit command to exit the policy-map queue mode and enter global configuration mode.

Example:

```
switch(config-cmap-que)# exit
switch(config)#
```

Step 7 (Optional) Run the **show policy-map** [**type queuing** [*policy-map-name* | **default-out-policy**]] command to display information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

Example:

```
switch(config)# show policy-map type queuing shape_queues
```

Step 8 Run the **copy running-config startup-config** command to save the running configuration to the startup configuration.

Example:

```
switch(config)# copy running-config startup-config
```

Configure Priority

Follow these steps to specify the priority on egress queues.

Note If you are configuring priority on the egress queue for FEX, ensure that **feature-set fex** is enabled.

Procedure

Step 1 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command in global configuration mode, to configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch# configure terminal
switch(config)# policy-map type queuing inq_pri
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-in-q3
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 3 Run the **priority** [**level** *value*] command to select this queue as a priority queue. Only one priority level is supported.

Example:

```
switch(config-pmap-c-que)# priority
```

Note
FEX QoS priority is supported only on the **c-out-q3 class map**.

Step 4 (Optional) Run the **class type queuing***class-name* command to configures the class map of type queuing and then enters policy-map class queuing mode.

Example:

```
switch(config-pmap-c-que)# class type queuing c-in-q2
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Choose a nonpriority queue where you want to configure the remaining bandwidth. By default, the system evenly distributes the remaining bandwidth among the nonpriority queues.

Step 5 Run the **bandwidth remaining percent** *percent* command to assign the percentage of the bandwidth that remains.

Example:

```
switch(config-pmap-c-que)# bandwidth remaining percent 25
```

Assigns the percentage of the bandwidth that remains to this queue. The range: 0 to 100.

The example shows how to set the bandwidth for this queue to 25 percent of the remaining bandwidth.

Step 6 (Optional) Repeat Steps 4 to 5 to assign the priority for the other nonpriority queues.

Step 7 (Optional) Run the **show policy-map** [**type queuing** [*policy-map-name* | **default-out-policy**]] command to display information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

Example:

```
switch(config)# show policy-map type queuing shape_queues
```

Step 8 Run the **copy running-config startup-config** command to save the running configuration to the startup configuration.

Example:

```
switch(config)# copy running-config startup-config
```

Configure Traffic Shaping

Follow these steps to configure traffic shaping.

Before you begin

Configure random detection minimum and maximum thresholds for packets.

Procedure

Step 1 Run the **policy-map** [**type queuing**] [**match-first**] [*policy-map-name*] command in global configuration mode, to configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

Example:

```
switch# configure terminal
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 2 Run the **class type queuing** *class-name* command to configure the class map of type queuing and then enter policy-map class queuing mode.

Example:

```
switch(config-pmap-que)# class type queuing c-out-q1
switch(config-pmap-c-que)#
```

Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

Step 3 Run the **shape min** *value* {**bps** | **gbps** | **kbps** | **mbps** | **pps**} **max** *value* {**bps** | **gbps** | **kbps** | **mbps** | **pps**}command to assign a minimum and maximum bit rate on an output queue.

Example:

```
switch(config-pmap-c-que)# shape min 100 mbps max 150 mbps
```

The default bit rate is in bits per second (bps).

The example shows how to shape traffic to a minimum rate of 100 megabits per second (mbps) and a maximum rate of 150 mbps.

Note
Most scenarios where traffic shaping is needed requires the configuration of only the max shaper value. For instance, if you want traffic shaped and limited to a maximum desired rate, configure the min shaper value as 0 and the max shaper value as the maximum desired rate.

You should only configure the min shaper value for specific scenarios where a guaranteed rate is desired. For instance, if you want traffic to have a guaranteed rate, configure the min shaper value as the guaranteed rate and the max value as something greater than guaranteed rate (or the maximum of the port speed rate).

Step 4 (Optional) Repeat Steps 2 and 3 to assign shape traffic for other queue classes.

Step 5 (Optional) Run the **show policy-map** [**type queuing** [*policy-map-name* | **default-out-policy**]] command to display information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

Example:

```
switch(config)# show policy-map type queuing shape_queues
```

Step 6 Run the **copy running-config startup-config** command to save the running configuration to the startup configuration.

Example:

```
switch(config)# copy running-config startup-config
```

Apply a Queuing Policy on a System

Follow these steps to apply a queuing policy globally on a system.

Procedure

Step 1 Run the **system qos** command in global configuration mode, to enter system QoS mode.

Example:

```
switch# configure terminal
switch (config)# system qos
switch (config-sys-qos)#
```

Step 2 Run the **service-policy type queuing output** {*policy-map-name* | **default-out-policy**} command to add the policy map to the input or output packets of the system.

Example:

```
switch (config-sys-qos)# service-policy type queuing map1
```

Note

- The **output** keyword specifies that this policy map should be applied to traffic sent from an interface.
- To restore the system to the default queuing service policy, use the **no** form of this command.

Verify the Queuing and Scheduling Configuration

Use the following commands to verify the queuing and scheduling configuration:

Command	Purpose
show class-map [**type queuing** [*class-name*]]	Displays information about all configured class maps, all class maps of type queuing, or a selected class map of type queuing.
show policy-map [**type queuing** [*policy-map-name* | **default-out-policy**]]	Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.
show policy-map system	Displays information about all configured policy maps on the system.

Control the QoS Shared Buffer

The QoS buffer provides support per port/queue and shared space. You can control the QoS buffer that is shared by all flows by disabling or restricting reservations.

The **hardware qos min-buffer** command is used to control the QoS shared buffer.

hardware qos min-buffer [**all** | **default** | **none**]	• **all** Current behavior where all reservations are enabled ON). • **default** Enables reservations only for qos-group-0. • **none** Disables reservations for all qos-groups.

The **show hardware qos min-buffer** command is used to display the current buffer configuration.

Manage Dynamic Buffer Sharing

Beginning with NX-OS 7.0(3)I7(4), dynamic buffer sharing (egress buffering) across slices is configured with the **hardware qos dynamic-buffer-sharing** command. Following the command, you must reload the switch to enable the dynamic buffering.

Buffer sharing is enabled by dynamic bank allocation (1 bank = 4k cells, 1 cell = 416 bytes) and controlled by a global controller (eCPU) that manages the banks being distributed among slices. Dynamic buffer sharing provides six reserved banks (10MB) for each slice and twelve banks for sharing across slices (20MB).

Note Dynamic Buffer Sharing is supported only on Nexus 9300-FX2 platform switches, see Nexus Switch Platform Support Matrix

Monitor the QoS Packet Buffer

The Cisco Nexus 9000 Series device has a 12-MB buffer memory that divides into a dedicated per port and dynamic shared memory. Each front-panel port has four unicast queues and four multicast queues in egress. In the scenario of burst or congestion, each egress port consumes buffers from the dynamic shared memory.

You can display the real-time and peak status of the shared buffer per port. All counters are displayed in terms of the number of cells. Each cell is 208 bytes in size. You can also display the global level buffer consumption in terms of consumption and available number of cells.

Note Monitoring the shared buffer on ALE enabled devices is not supported for the port level.

Note In the examples shown in this section, the port numbers are Broadcom ASIC ports.

This example shows how to clear the system buffer maximum cell usage counter.

```
switch# clear counters buffers
Max Cell Usage has been reset successfully
```

This example shows how to set a buffer utilization threshold for a specific module.

```
switch(config)# hardware profile buffer info port-threshold module 1 threshold 10
Port threshold changed successfully
```

Note

- The buffer threshold feature is not enabled for ports if they have a no-drop class configured (PFC).
- The configured threshold buffer count is checked every 5 seconds against all the buffers used by that port across all the queues of that port.
- You can configure the threshold percentage configuration for all modules or for a specific module, which is applied to all ports. The default threshold value is 90% of the switch cell count of shared pool SP-0. This configuration applies to both Ethernet (front panel) and internal (HG) ports.
- The buffer threshold feature is not supported for ACI capable device ports.

This example shows how to display the interface hardware mappings.

```
switch# show interface hardware-mappings
Legends:
       SMod  - Source Mod. 0 is N/A
       Unit  - Unit on which port resides. N/A for port channels
       HPort - Hardware Port Number or Hardware Trunk Id:
       FPort - Fabric facing port number. 255 means N/A
       NPort - Front panel port number
       VPort - Virtual Port Number. -1 means N/A

-------------------------------------------------------------------
Name       Ifindex  Smod Unit HPort FPort NPort VPort
-------------------------------------------------------------------
Eth2/1     1a080000 4    0    13    255   0     -1
Eth2/2     1a080200 4    0    14    255   1     -1
Eth2/3     1a080400 4    0    15    255   2     -1
Eth2/4     1a080600 4    0    16    255   3     -1
Eth2/5     1a080800 4    0    17    255   4     -1
Eth2/6     1a080a00 4    0    18    255   5     -1
Eth2/7     1a080c00 4    0    19    255   6     -1
Eth2/8     1a080e00 4    0    20    255   7     -1
Eth2/9     1a081000 4    0    21    255   8     -1
Eth2/10    1a081200 4    0    22    255   9     -1
Eth2/11    1a081400 4    0    23    255   10    -1
Eth2/12    1a081600 4    0    24    255   11    -1
Eth2/13    1a081800 4    0    25    255   12    -1
Eth2/14    1a081a00 4    0    26    255   13    -1
Eth2/15    1a081c00 4    0    27    255   14    -1
Eth2/16    1a081e00 4    0    28    255   15    -1
Eth2/17    1a082000 4    0    29    255   16    -1
Eth2/18    1a082200 4    0    30    255   17    -1
Eth2/19    1a082400 4    0    31    255   18    -1
Eth2/20    1a082600 4    0    32    255   19    -1
Eth2/21    1a082800 4    0    33    255   20    -1
Eth2/22    1a082a00 4    0    34    255   21    -1
```

```
Eth2/23    1a082c00 4    0    35    255   22    -1
Eth2/24    1a082e00 4    0    36    255   23    -1
```

Configuration Examples for Queuing and Scheduling

In this section, you can find examples of configuring queuing and scheduling.

Note The default system classes type queuing match based on qos-group (by default all traffic matches to qos-group 0, and this default queue gets 100% bandwidth). Create a type QoS policy that first sets the qos-group in order to drive the correct matching for the type queuing classes and policies.

Example: Configuring WRED on Egress Queues

The following example shows how to configure the WRED feature on an egress queue:

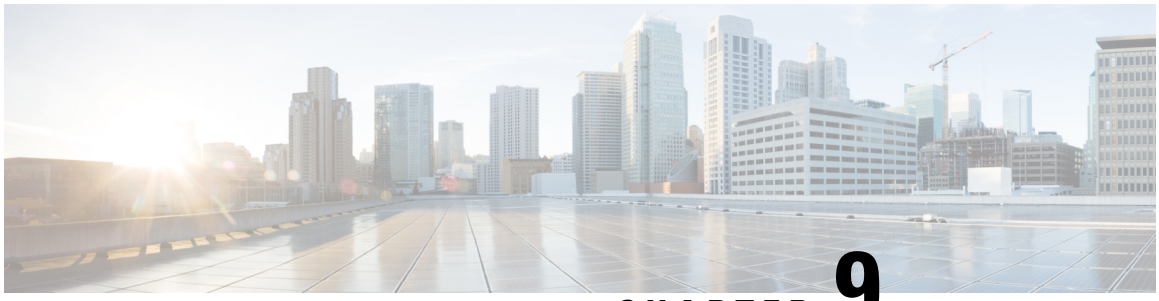
```
configure terminal
  class-map type queuing match-any c-out-q1
    match qos-group 1
  class-map type queuing match-any c-out-q2
    match qos-group 1
  policy-map type queuing wred
    class type queuing c-out-q1
      random-detect minimum-threshold 10 bytes maximum-threshold 1000 bytes
    class type queuing c-out-q2
      random-detect threshold burst-optimized ecn
```

Example: Configuring Traffic Shaping

The following example shows how to configure traffic shaping using 500 mbps and 1000 mbps for respective classes::

```
configure terminal
  class-map type queuing match-any c-out-q1
    match qos-group 1
  class-map type queuing match-any c-out-q2
    match qos-group 1
policy-map type queuing pqu
  class type queuing c-out-8q-q3
    bandwidth percent 20
    shape min 100 mbps max 500 mbps
  class type queuing c-out-8q-q2
    bandwidth percent 30
    shape min 200 mbps max 1000 mbps
  class type queuing c-out-8q-q-default
    bandwidth percent 50
  class type queuing c-out-8q-q1
    bandwidth percent 0
  class type queuing c-out-8q-q4
    bandwidth percent 0
  class type queuing c-out-8q-q5
    bandwidth percent 0
  class type queuing c-out-8q-q6
    bandwidth percent 0
  class type queuing c-out-8q-q7
```

```
    bandwidth percent 0
system qos
  service-policy type queuing output pqu
```



CHAPTER 9

Configuring Network QoS

- About Network QoS, on page 131
- Prerequisites for Network QoS, on page 131
- Guidelines and Limitations for Network QoS, on page 131
- Configuring Network QoS Policies, on page 133
- Applying a Network QoS Policy on a System, on page 135
- Verifying the Network QoS, on page 136

About Network QoS

The network QoS policy defines the characteristics of QoS properties network wide. With a network QoS policy, you can configure the following:

- Pause behavior—You can decide whether a QoS group requires the lossless behavior. The lossless behavior is provided by using a priority flow control (PFC) mechanism that prevents packet loss during congestion. You can configure drop (frames with this value that can be dropped) and no drop (frames with this value that cannot be dropped). For the drop and no drop configuration, you also need to enable PFC per port. For more information about PFC, see the "Configuring Priority Flow Control" section.

Prerequisites for Network QoS

The network QoS policy has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for Network QoS

The network QoS policy has the following guidelines and limitations:

- PVLANs do not provide support for PVLAN QoS.
- **show** commands with the **internal** keyword are not supported.

- Changing the network QoS policy is a disruptive operation, and it can cause traffic drops on any or all ports.
- When enabling jumbo MTU, the default network QoS policy can support jumbo frames. Under the network QoS policy, the MTU is used only for buffer carving when no-drop classes are configured. No additional MTU adjustments are required under the network QoS policy to support jumbo MTU.
- NX-OS does not allow more than 2 no-drop classes per policy-map.
- Network QoS is not supported on the Cisco Nexus 9508 switch.
- Beginning with NX-OS 7.0(3)I7(4), you can enable a network QoS pause configuration per QoS class with the **pause pfc-cos** *cos-list* **receive** command for the receive-only PFC option. When specifying this option, PFC pause frame generation is disabled for a particular queueing policy class or queue.

  A network QoS policy can have a maximum combined total of six asymmetric PFC (APFC) and PFC classes.

Note PFC is required to be enabled on a port to support APFC on that port.

- The following section describes the guidelines and limitations for Dynamic Packet Prioritization:

Dynamic Packet Prioritization

Dynamic Packet Prioritization (DPP) prioritizes a configured number of packets of every new flow in a particular class of traffic is prioritized and sent through a configured class of traffic that DPP is mapped to.

When the number of packets in a flow reaches a specific threshold, prioritization ends and the subsequent packets in the flow go to the normal class.

Note Default number of packets is 120.

- Maximum number of packets:
  - Application Spine Engine (ASE2) enabled switches — 256
  - Leaf Spine Engine (LSE) enabled switches — 1024

DPP uses an age-out timer to evict idle flows.

Note Default age-period is 5 msec.

The DPP feature is enabled on a queue using the **dpp set-qos-group** command under a network QoS policy configuration.

Note A DPP enabled queue cannot be a no-drop queue (For example, both pause pfc-cos and dpp cannot be enabled on the same queue.)

Configuring and applying the policy are as follows:

```
switch(config)# policy-map type network-qos dpp
switch(config-pmap-nqos)# class type network-qos c-8q-nq1
switch(config-pmap-nqos-c)# dpp set-qos-group 7

switch(config)# system qos
switch(config-sys-qos)# service-policy type network-qos dpp
```

Configuring the age-period and the max-num-packets are as follows:

```
switch(config)# hardware qos dynamic-packet-prioritization age-period 5000 usec

switch(config)# hardware qos dynamic-packet-prioritization max-num-pkts 120
```

Configuring Network QoS Policies

You can configure a network QoS policy by following one of these methods:

- Predefined policies—You can apply a predefined network QoS policy that fits your requirement. By default, default-nq-policy is configured.
- User-defined policy—You can create a network QoS policy that conforms to one of the system-defined policies.

Copying a Predefined Network QoS Policy

SUMMARY STEPS

1. **qos copy policy-map type network-qos default-nq-policy** {**prefix** *prefix* | **suffix** *suffix*}
2. **show policy-map type network-qos my_nq**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**qos copy policy-map type network-qos default-nq-policy** {**prefix** *prefix* | **suffix** *suffix*} **Example:** `switch# qos copy policy-map type network-qos default-nq-policy prefix my_nq`	Copies a predefined network QoS policy and adds a suffix or prefix to its name. A prefix or suffix name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.

	Command or Action	Purpose
Step 2	**show policy-map type network-qos my_nq** **Example:** `switch# show policy-map type network-qos my_nq`	(Optional) Displays the type network-qos policy map.

Configuring a User-Defined Network QoS Policy

SUMMARY STEPS

1. **configure terminal**
2. **class-map type network-qos match-any** *class-name*
3. **match qos-group** *group*
4. **exit**
5. **policy-map type network-qos** *policy-map-name*
6. **class type network-qos** {*class-name* | **class-default**}
7. **pause** *group*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map type network-qos match-any** *class-name*
	Example:
	`switch(config)# class-map type network-qos match-any c-nq2`
	`switch(config-cmap-nqos)#`
		Configures the class map of the type network-qos and enters class-map mode. Class network-qos names are listed in previous System-Defined Type network-qos Class Maps table.

Step 3	**match qos-group** *group* **Example:** `switch(config-cmap-nqos)# match qos-group 2`	Specifies the QoS group to match. The range is from 0 to 3.

Step 4	**exit**
	Example:
	`switch (config-cmap-nqos)# exit`
	`switch (config)#`
		Exits class-map mode and enters global configuration mode.

Step 5	**policy-map type network-qos** *policy-map-name* **Example:** `switch(config)# policy-map type network-qos map2`	Creates a policy map. The policy-map name can contain alphabetic, hyphen, or underscore characters, is case sensitive, and can be up to 40 characters.

	Command or Action	Purpose
Step 6	**class type network-qos** {*class-name* | **class-default**} **Example:** `switch(config-pmap-nqos)# class type network-qos c1-nq2`	Refers to the class map of type network-qos as configured in Step 2.
Step 7	**pause** *group* **Example:** `switch(config-pmap-nqos-c)# pause pfc-cos 2`	Specifies no-drop for the QoS group. **Note** For 7.0(3)I1(1) and earlier, the no-drop queuing configuration is not supported in the network-qos policy for the Cisco Nexus 9300 platform.

Applying a Network QoS Policy on a System

You apply a network QoS policy globally on a system. Applying a network QoS policy also automatically applies the corresponding queuing policies.

SUMMARY STEPS

1. **configure terminal**
2. **system qos**
3. **service-policy type network-qos** {*policy-map-name* | **default-nq-policy**}

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**system qos**
	Example:
	`switch (config)# system qos`
	`switch (config-sys-qos)#`
		Enters system qos mode.

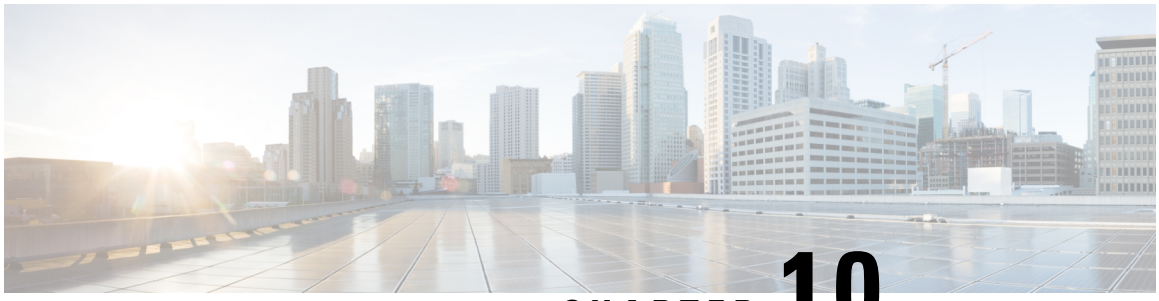
Step 3	**service-policy type network-qos** {*policy-map-name* | **default-nq-policy**} **Example:** `switch (config-sys-qos)# service-policy type network-qos map1`	Specifies the policy map to use as the service policy for the system. **Note** To restore the system to the default network QoS service policy, use the **no** form of this command. **Note**

	Command or Action	Purpose
		All Layer 4 class-maps under the network-qos policy-map must be configured before applying it under the system qos level.

Verifying the Network QoS

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

Command	Purpose
show class-map type network-qos	Displays the type network-qos class maps.
show policy-map type network-qos	Displays the type network-qos policy maps.
show policy-map system type network-qos	Displays the active type network-qos class maps.



CHAPTER 10

Configuring Link Level Flow Control

- Link Level Flow Control, on page 137
- Guidelines and Limitations for Link Level Flow Control, on page 137
- Information About Link Level Flow Control, on page 138
- How to Configure Link Level Flow Control, on page 139
- Configuration Examples for Link Level Flow Control, on page 141

Link Level Flow Control

Link-level flow control is a congestion management technique that pauses data transmission until the congestion in the system is resolved. When a receiving device becomes congested, it communicates with the transmitter by sending a PAUSE frame. When the transmitting device receives a Pause frame it stops the transmission of any further data frames for a short period of time. The link-level flow control feature applies to all the traffic on the link. The transmit and receive directions are separately configurable. By default, link-level flow control is disabled for both directions.

Guidelines and Limitations for Link Level Flow Control

Link Level Flow Control (LLFC) has the following configuration guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- Changing or configuring LLFC on FEX HIF or FEX HIF PO interfaces is not supported.
- LLFC is supported on Cisco Nexus 9500 platform switches with Network Forwarding Engine (NFE) (and Cisco Nexus 3164Q switch with NFE).
- LLFC is supported on Cisco Nexus 9200 platform switches.
- LLFC is supported on the Cisco Nexus 9300 and 9300-EX platform switches.
- The 100G Cisco Nexus 9408PC-CFP2 line card does not support LLFC.
- Ethernet interfaces do not autodetect the LLFC capability. LLFC must be configured explicitly.
- Enabling LLFC requires a part of the buffer to be reserved. This reservation reduces the available shared buffer space.
- Data Center Bridging Exchange Protocol (DCBX) is not supported.

- Configuration time quanta of the pause frames is not supported.
- On each Ethernet interface, the switch can enable either PFC or LLFC, but not both.

Note When both PFC and LLFC are enabled, LLFC is selected.

- Only pure CoS-based classification of traffic classes is supported.
- Setting of pause threshold values is restricted.
- Configuring LLFC on an interface causes the interface to flap which results in a momentary traffic loss.
- When a no-drop QoS group is configured, you must ensure that the packets received, on ports that do not have flow control send-on configured, are not classified to a no-drop QoS group.
- Only a no-drop QoS group can generate link-level pause frames.
- Do not enable Weighted Random Early Detection (WRED) on a no-drop class because it can cause an egress queue drop.
- We recommend the use of default buffer sizes for no-drop classes because if the buffer size is specified through the CLI, it allocates the same buffer size for all ports irrespective of the link speed, and MTU size.
- We recommend changing the LLFC configuration when there is no traffic, otherwise packets already in the MMU of the system may not get the expected treatment.
- LLFC and PFC are supported on Cisco Nexus 9300 platform switches and line cards that contain the Application Leaf Engine (ALE).
- First generation Cisco Nexus 9000 switches (NFE-based) can properly operate in cut-through switching mode only when there is no back pressure, i.e. LLFC pause frames should not be coming in. If RX LLFC is enabled alongside the default switching mode of cut-through, in some circumstances this can lead to output errors on the port configured with RX LLFC. To mitigate that, the user needs to either configure store and forward switching mode via the CLI "**switching-mode store-forward**" or disable RX LLFC on the given port. This limitation applies to the following PIDs:
  - N9K-C93120TX, N9K-C93128TX, N9K-C9332PQ, N9K-C9372PX, N9K-C9372PX-E, N9K-C9372TX, N9K-C9372TX-E, N9K-C9396PX, N9K-C9396TX, N9K-X9408PC-CFP2, N9K-X9432PQ, N9K-X9464PX, N9K-X9464TX, N9K-X9464TX2, N9K-X9536PQ, N9K-X9564PX, N9K-X9564TX, and N9K-X9636PQ.

Information About Link Level Flow Control

Link Level Flow Control on Interfaces

When link level flow control is configured the system changes the interface state to Down if the specified interface is in UP state and then applies the flow control configuration. After the configuration is successfully applied to the interface, the system restores the interface to the UP state.

Link Level Flow Control on Ports

During a port shutdown event, the flow-control settings on an interface are retained, however no traffic is received or transmitted on the link. During a port startup event the flow-control settings are reinstated on to the hardware.

Mismatched Link Level Flow Control Configurations

The transmit and receive directions can be configured separately, and each device on the network can have a different Link Level Flow Control (LLFC) configuration. The following table describes how devices with mis-matched configurations interact.

Switch A	Switch B	Description
LLFC configured to receive and transmit PAUSE frames.	LLFC configured to receive PAUSE frames.	Switch A can transmit 802.3x PAUSE frames and honor 802.3x PAUSE frames. Switch B can only receive 802.3x PAUSE frames.
LLFC configured to receive and transmit PAUSE frames.	LLFC configured to transmit PAUSE frames.	Switch A can transmit 802.3x PAUSE frames and honor 802.3x PAUSE frames. Switch B can transmit 802.3x PAUSE frames but will drop all received PAUSE frames.

How to Configure Link Level Flow Control

Configuring Link Level Flow Control Receive

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet 1/1**
3. **flowcontrol receive on**
4. **exit**

DETAILED STEPS

Procedure

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

	Command or Action	Purpose
Step 2	**interface ethernet 1/1** **Example:** `Device(config)# interface ethernet 1/1`	Configures an interface type and enters interface configuration mode.
Step 3	**flowcontrol receive on** **Example:** `Device(config-if)# flowcontrol receive on`	Enables the interface to receive and process pause frames.
Step 4	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode.

Configuring Link Level Flow Control Transmit

To configure link-level flow control transmit on an interface, you enable flow control on the interface, configure a network-qos type QoS policy to enable a no-drop QoS group, and apply a qos type QoS policy to classify the traffic that requires no-drop behavior to the no-drop class.

You must ensure that bandwidth is allocated for the No-Drop QoS class using a queuing policy when you define a no-drop class. For more information, see the "Configuring Type Queuing Policies" section.

Note When a no-drop QoS Group is configured you must ensure that packets received on ports that do not have flow-control send-on configured, are not classified to a no-drop QoS group. This is required as any ingress port that does not have flow-control send-on configured, can not generate a link level pause frame and there is no way to request the transmitting device to stop the transmission. Therefore, if flow-control send-on is not configured on all the interfaces you should not use a system policy to classify the packets to the no-drop QoS group. Instead, you should apply an interface QoS policy to the interfaces that having flow-control send-on enabled.

SUMMARY STEPS

1. **configure terminal**
2. **interface ethernet 1/1**
3. **flowcontrol send on**
4. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 2	**interface ethernet 1/1** **Example:** `Device(config)# interface ethernet 1/1`	Configures an interface type and enters interface configuration mode.
Step 3	**flowcontrol send on** **Example:** `Device(config-if)# flowcontrol transmit on`	Enables the interface to send pause frames to remote devices.
Step 4	**exit** **Example:** `Device(config-if)# exit`	Exits interface configuration mode and returns to global configuration mode.

Configuration Examples for Link Level Flow Control

Example: Configuring Link Level Flow Control Receive and Send

Configuring Link Level Flow Control Receive and Send

The following examples show how to configure Link Level Flow Control receive and send on the device.

- When only LLFC receive is enabled, no-drop class does not need to be configured on the system network-qos.

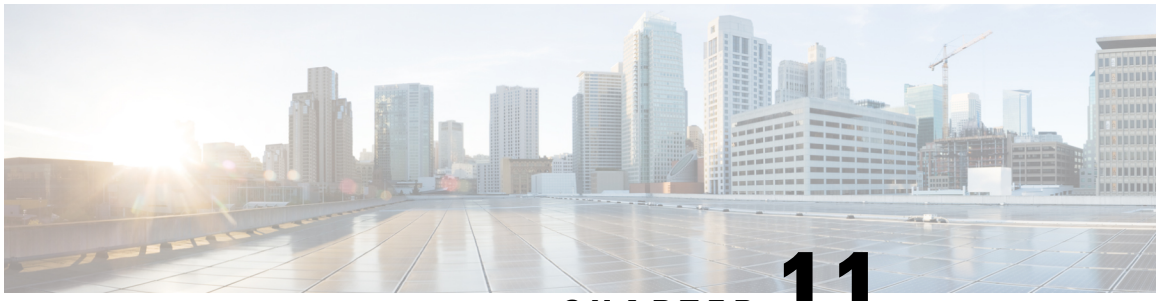
```
Device# configure terminal
Device(config)# interface ethernet 1/1
Device(config-if)# flowcontrol receive on
Device(config-if)# exit
```

- When both LLFC receive and send are enabled, no-drop class needs to be configured on the system network-qos. (Refer to the Configuring a No-Drop Policy example for information about configuring the no-drop class.)

```
Device# configure terminal
Device(config)# interface ethernet 1/1
Device(config-if)# flowcontrol receive on
Device(config-if)# flowcontrol send on
Device(config-if)# exit
```

- When only LLFC send is enabled, no-drop class needs to be configured on the system network-qos. (Refer to the Configuring a No-Drop Policy example for information about configuring the no-drop class.)

```
Device# configure terminal
Device(config)# interface ethernet 1/1
Device(config-if)# flowcontrol send on
Device(config-if)# exit
```



CHAPTER 11

Configuring Priority Flow Control

- About Priority Flow Control, on page 143
- Licensing Requirements for Priority Flow Control, on page 145
- Prerequisites for Priority Flow Control, on page 146
- Guidelines and Limitations for Priority Flow Control, on page 146
- Default Settings for Priority Flow Control, on page 149
- Configuring Priority Flow Control, on page 149
- Enabling Priority Flow Control on a Traffic Class, on page 150
- Configuring a Link Level Flow Control Watchdog and Priority Flow Control Watchdog, on page 154
- Configuring Pause Buffer Thresholds and Queue Limit Using Ingress Queuing Policy, on page 158
- Verifying the Priority Flow Control Configuration, on page 160
- Configuration Examples for Priority Flow Control, on page 161

About Priority Flow Control

Priority Flow Control (PFC) is used in lossless Ethernet to control the flow of data from a link partner for specific traffic priorities or classes specified as 'no-drop'. PFC Pause frames are transmitted to the link partner when certain queue thresholds are reached for a specific class or priority. PFC Pause frames are only local to the specific link but when traffic is suspended the congestion can cause PFC Pause frames to be generated on other links spreading the congestion. This can cause traffic for the priority or class to be suspended throughout the entire network for a time.

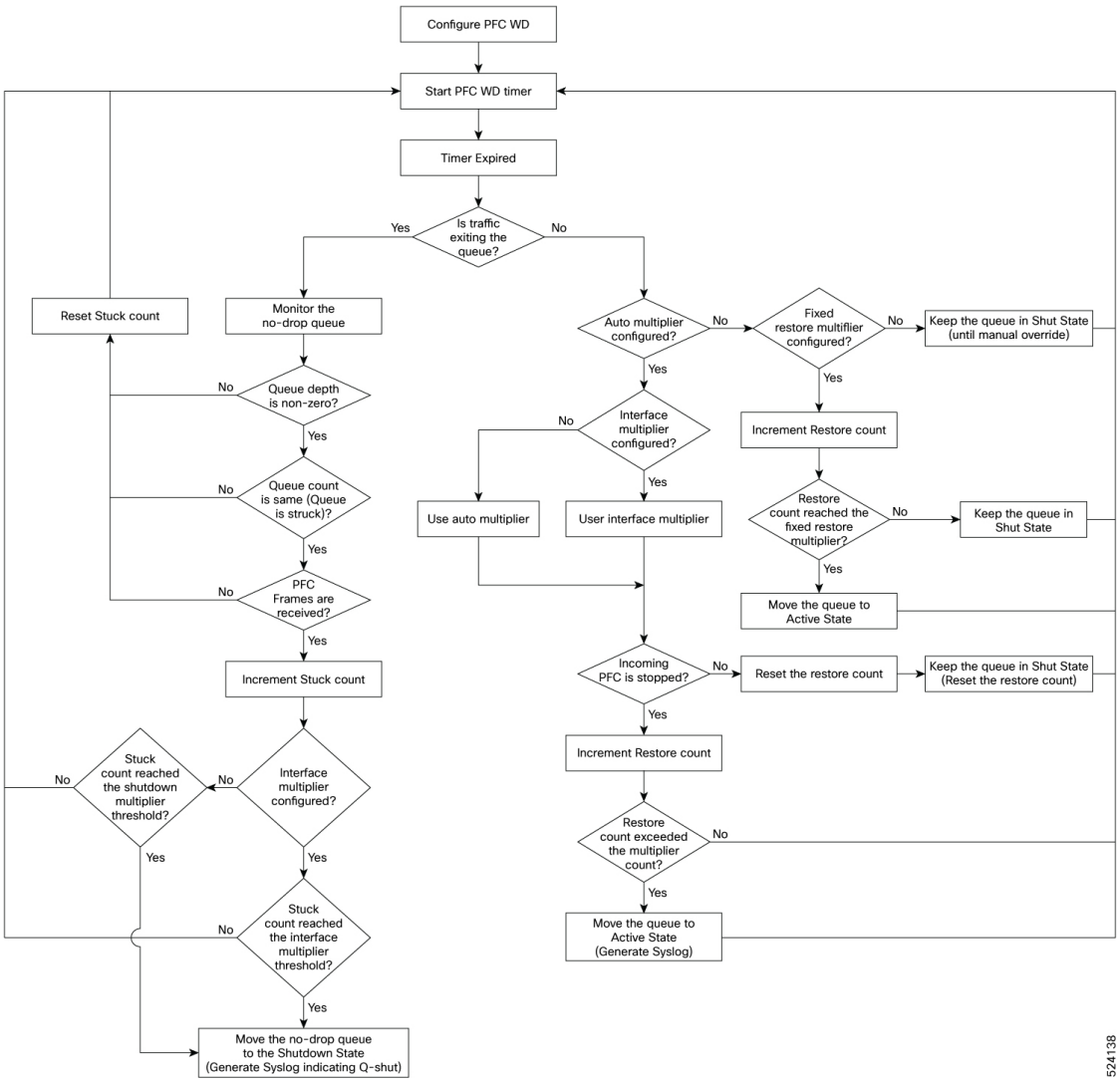
About Priority Flow Control Watchdog

Priority Flow Control Watchdog (PFCWD) is a mechanism designed to detect and resolve any PFC storms (queue-stuck condition) in the network. You can configure a PFC watchdog interval to detect whether packets in a no-drop queue are drained within a specified time period. When this time period is exceeded, all outgoing packets are dropped on interfaces that match the PFC queue that is not being drained.

Note The PFC watchdog feature is supported only for no-drop queues.

Workflow of Priority Flow Control Watchdog

- Monitors the PFC-enabled queues (no-drop queues) to identify the reception of an excessive number of PFC pause frames in a given interval (Watchdog interval).
- Monitors when an excessive number of PFC frames are received and traffic on the corresponding queues is halted for a specified time interval (auto + fixed multiplier).
- Initiates the shutdown timer and changes the queue's state to **wait-to-shutdown**.
- Drops all data packets when the queue transitions to a **shut** state if interface multiplier time exceeds (if the interface multiplier is configured) or shutdown multiplier timer expire exceeds (if the interface multiplier is not configured).
- Checks the queue for PFC frames and whether the traffic in the queue is still stuck at regular intervals (poll timer of 100ms) during the shutdown interval.
  - If traffic is stuck in the queue as PFC packets continue to arrive, the queue stays in the drop or shutdown state.
  - If the traffic is not stuck because the queue didn't receive any PFC frames, the queue reverts to the monitored state.
- Checks if the queue is stuck because of PFC frames when the traffic is no longer stuck at regular intervals, the auto-restore timer starts.
  - If the queue receives PFC frames during the last auto-restore interval (poll timer * auto-restore multiplier), the auto-restore timer (secs) is reset at its expiration.
  - If the queue receives no PFC frames during the last auto-restore interval, the watchdog module restores the queue, and traffic resumes.



Licensing Requirements for Priority Flow Control

The following table shows the licensing requirements for this feature:

Product	License Requirement
Cisco NX-OS	The PFC feature does not a require license. Any feature not included in a license package is bundled with the NX-OS image and is provided at no extra charge to you. For a complete explanation of the Cisco NX-OS licensing scheme, see the Cisco NX-OS Licensing Guide.

Prerequisites for Priority Flow Control

PFC has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for Priority Flow Control

PFC has the following configuration guidelines and limitations:

- PFC is not supported on the Cisco Nexus 9508 switch.
- The **show** commands with the **internal** keyword are not supported.
- Adding the "pause buffer size threshold" configuration is optional for cable lengths that are less than 100 meters and it does need not to be configured.
- Input queuing policy maps cannot have pause buffer and priority/bandwidth together.
- For cable lengths greater than 100m, the "pause buffer size threshold" configuration is mandatory and it is required as part of the QoS policy configuration.
- If PFC is enabled on a port or a port channel, it does not cause a port flap.
- PFC configuration enables PFC in both the send (Tx) and receive (Rx) direction.
- Configuration time quanta of the pause frames is not supported.
- You can configure a PFC watchdog interval to detect whether packets in a no-drop queue are being drained within a specified time period. When the time period is exceeded, all outgoing packets are dropped on interfaces that match the PFC queue that is not being drained. This feature is supported only for Cisco Nexus 9200 Series switches, Cisco Nexus 93108TC-EX, and 93180YC-EX switches, and Cisco Nexus 9508 switches with the X9732C-EX line cards.

  This feature is supported on Cisco Nexus 9508 switches with N9K-X9636PQ line cards and Cisco Nexus 3164Q switches.
- The configuration does not support pausing selected streams that are mapped to a particular traffic-class queue. All flows that are mapped to the class are treated as no-drop. It blocks out scheduling for the entire queue, which pauses traffic for all the streams in the queue. To achieve lossless service for a no-drop class, we recommend that you have only the no-drop class traffic on the queue.
- When a no-drop class is classified based on 802.1p CoS x and assigned an internal priority value (qos-group) of y, we recommend that you use the internal priority value x to classify traffic on 802.1p CoS only, and not on any other field. The packet priority that is assigned is x if the classification is not based on CoS, which results in packets of internal priority x and y to map to the same priority x.
- The PFC feature supports up to three no-drop classes of any maximum transmission unit (MTU) size. However, there is a limit on the number of PFC-enabled interfaces, based on the following factors:
  - MTU size of the no-drop class
  - Number of 10G and 40G ports

- You can define the upper limit of any MTU in the system using the **systemjumbomtu** command. The MTU range is from 1500 to 9216 bytes, and the default is 9216 bytes.
- The interface QoS policy takes precedence over the system policy. PFC priority derivation also happens in the same order.
- Ensure that you apply the same interface-level QoS policy on all PFC-enabled interfaces for both ingress and egress.

Caution Irrespective of the PFC configuration, we recommend that you stop traffic before applying or removing a queuing policy that has strict-priority levels at the interface level or the system level.

- To achieve end-to-end lossless service over the network, we recommend that you enable PFC on each interface through which the no-drop class traffic flows (Tx/Rx).
- We recommend that you change the PFC configuration when there is no traffic. Otherwise, packets already in the Memory Management Unit (MMU) of the system may not get the expected treatment.
- We recommend that you use default buffer sizes for no-drop classes or configure different input queuing policies suitable to 10G and 40G interfaces and the no-drop class MTU size. If the buffer size is specified through the CLI, it allocates the same buffer size for all ports irrespective of the link speed and MTU size. Applying the same pause buffer-size on 10G and 40G interfaces is not supported.
- Do not enable WRED on a no-drop class because it results in drops in the egress queue.
- Dynamic load balancing cannot be enabled for internal links with PFC. Disable DLB and enable RTAG7 load-balancing for internal links with the port-channel load-balance internal rtag7 command.
- The dynamic load balancing (DLB) based hashing scheme is enabled by default on all internal links of a linecard. When DLB is enabled, no-drop traffic may experience an out-of-order packet delivery when congestion on internal links occurs and PFC is applied. If applications on the system are sensitive to out-of-order delivery, you can adjust for this event by disabling DLB at the qos-group level. Disable DLB by using the **set dlb-disable** action in the QoS policy-maps and the **set qos-group** action for no-drop classes.

  In the following example, assume that qos-group 1 is a no-drop class. DLB is disabled for this no-drop class by adding the **set dlb-disable** action and the **set qos-group** action.

```
switch(config)# policy-map p1
switch(config-pmap-qos)# class c1
switch(config-pmap-c-qos)# set qos-group 1
switch(config-pmap-c-qos)# set dlb-disable
switch(config-pmap-c-qos)# end
switch# show policy-map p1


  Type qos policy-maps
  ====================

  policy-map type qos p1
    class  c1
      set qos-group 1
      set dlb-disable
```

Note The following Cisco Nexus platform switches do not support the **set-dlb-disable** command:

- Cisco Nexus 9200-series platform switches
- Cisco Nexus 9300-EX/FX/FX2 platform switches
- Cisco Nexus 9500-series platform switches with -EX and -FX line cards

- For VLAN-tagged packets, priority is assigned based on the 802.1p field in the VLAN tag and takes precedence over the assigned internal priority (qos-group). DSCP or IP access-list classification cannot be performed on VLAN-tagged frames.
- For non VLAN-tagged frames, priority is assigned based on the **set qos-group** action provided by the ingress QoS policy. Classification is based on a QoS policy-allowed match condition such as precedence, DSCP, or access-list. Ensure that the **pfc-cos** value that is provided in the network-qos policy for this class is the same as the **qos-group** value in this case.
- PFC is not supported for the N9K-X9408PC-CFP2 line card on Cisco Nexus 9500 Series switches.
- Link level flow control and PFC are supported on Cisco Nexus 9300 Series switches and line cards that contain the ALE (Application Leaf Engine).
- PFC on mode is used to support the hosts that support PFC but do not support the Data Center Bridging Capability Exchange Protocol (DCBXP).
- Only an exact match of the no-drop CoS is considered as a successful negotiation of PFC by the DCBXP.
- Beginning with Cisco NX-OS Release 7.0(3)I3(1), DCBXP is supported on the following Cisco Nexus switches:
  - Nexus 9332PQ switch
  - Nexus 9372PX switch
  - Nexus 9372PX-E switch
  - Nexus C9396PX switch
  - Nexus 9500 Series switches with the following line cards:
    - X9432PQ
    - X9464PX
    - X9464TX
    - X9536PQ
    - X9564PX
    - X9564TX
    - X9636PQ
- DCBXP is supported on Cisco Nexus 9200 and 9300-EX Series switches.

- The **no lldp tlv-select dcbxp** command is enhanced so that PFC is disabled for interfaces on both sides of back-to-back switches.
- BUM traffic is not supported in no-drop PFC queues. Avoid marking multicast traffic as no-drop and sending it to these queues.

Default Settings for Priority Flow Control

Table 39: Default PFC Setting

Parameter	Default
PFC	Auto

Configuring Priority Flow Control

You can configure PFC on a per-port basis to enable the no-drop behavior for the CoS as defined by the active network QoS policy. PFC can be configured in one of these modes:

- auto—Enables the no-drop CoS values to be advertised by the DCBXP and negotiated with the peer. A successful negotiation enables PFC on the no-drop CoS. Any failures because of a mismatch in the capability of peers causes the PFC not to be enabled. (Cisco NX-OS Release 7.0(3)I3(1) and later)
- on—Enables PFC on the local port regardless of the capability of the peers.
- off—Disables PFC on the local port.

Note You can use the **priority-flow-control override-interface mode off** command to globally disable PFC on all interfaces regardless of the current interface configuration. This command, which is meant to be used during troubleshooting, allows you to quickly disable PFC without having to disable PFC on each interface. It is supported beginning with Cisco NX-OS Release 7.0(3)I4(2) and only for Cisco Nexus 9200 platform switches, Cisco Nexus 93108TC-EX and 93180YC-EX switches, and Cisco Nexus 9508 switches with the Cisco Nexus 9732C-EX line card.

Beginning with Cisco NX-OS Release 7.0(3)I4(5), this feature is supported on Cisco Nexus 9508 switches with Cisco Nexus 9636PQ line cards and Cisco Nexus 3164Q switches.

SUMMARY STEPS

1. **configure terminal**
2. **interface** *type slot/port*
3. **priority-flow-control mode** [**auto** | **off** |**on**]
4. (Optional) **show interface priority-flow-control**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**interface** *type slot/port*
	Example:
	`switch(config)# interface ethernet 2/5`
	`switch(config-if)#`
		Enters interface mode on the interface specified.

Step 3	**priority-flow-control mode** [**auto** | **off** |**on**] **Example:** `switch(config-if)# priority-flow-control mode on`	Sets PFC to the on mode.
Step 4	(Optional) **show interface priority-flow-control** **Example:** `switch# show interface priority-flow-control`	Displays the status of PFC on all interfaces.

Enabling Priority Flow Control on a Traffic Class

You can enable PFC on a particular traffic class.

SUMMARY STEPS

1. **configure terminal**
2. **class-map type qos match** { **all** | **any** } *class-name*
3. **match cos** *cos-value*
4. **match dscp** *dscp-value*
5. **exit**
6. **policy-map type qos** *policy-name*
7. **class** *class-name*
8. **set qos-group** *qos-group-value*
9. **exit**
10. **exit**
11. **policy-map type network-qos** *policy-name*
12. **class type network-qos** *class-name*
13. **pause pfc-cos** *value* [**receive**]
14. **exit**
15. **exit**
16. **system qos**

17. **service-policy type network-qos** *policy-name*
18. **exit**
19. **interface ethernet** *slot* / *number*
20. **priority-flow-control mode** { **auto** | **on** | **off** }
21. **service-policy type qos input** *policy-name*
22. **exit**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**class-map type qos match** { **all** | **any** } *class-name*
	Example:
	`switch(config)# class-map type qos c1`
	`switch(config-cmap-qos)#`
		Creates a named object that represents a class of traffic. Class-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.
		match { **all** | **any** }: Default is **match all** (if multiple matching statements are present all of them must be matched).

Step 3	**match cos** *cos-value*
	Example:
	`switch(config-cmap-qos)# match cos 2`
	`switch(config-cmap-qos)#`
		Specifies the CoS value to match for classifying packets into this class. You can configure a CoS value in the range of 0 to 7.

Step 4	**match dscp** *dscp-value*
	Example:
	`switch(config-cmap-qos)# match dscp 3`
	`switch(config-cmap-qos)#`
		Specifies the DSCP value to match for classifying packets into this class. You can configure a DSCP value in the range of 0 to 63 or the listed values.

Step 5	**exit**
	Example:
	`switch(config-cmap-qos)# exit`
	`switch(config)#`
		Exits class-map mode and enters global configuration mode.

Step 6	**policy-map type qos** *policy-name*
	Example:
	`switch(config)# policy-map type qos p1`
	`switch(config-pmap-qos)#`
		Creates a named object that represents a set of policies that are to be applied to a set of traffic classes. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 7	**class** *class-name* **Example:**	Associates a class map with the policy map and enters the configuration mode for the specified system class.

	Command or Action	Purpose
	`switch(config-pmap-qos)# class c1` `switch(config-pmap-c-qos)#`	**Note** The associated class map must be the same type as the policy map type.

Step 8	**set qos-group** *qos-group-value*
	Example:
	`switch(config-pmap-c-qos)# set qos-group 3`
	`switch(config-pmap-c-qos)#`
		Configures one or more qos-group values to match on for classification of traffic into this class map. There is no default value.

Step 9	**exit**
	Example:
	`switch(config-pmap-c-qos)# exit`
	`switch(config-pmap-qos)#`
		Exits the system class configuration mode and enters policy-map mode.

Step 10	**exit**
	Example:
	`switch(config-pmap-qos)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 11	**policy-map type network-qos** *policy-name*
	Example:
	`switch(config)# policy-map type network-qos pfc-qos`
	`switch(config-pmap-nqos)#`
		Creates a named object that represents a set of policies that are to be applied to a set of traffic classes. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

Step 12	**class type network-qos** *class-name*
	Example:
	`switch(config-pmap-nqos)# class type network-qos nw-qos3`
	`switch(config-pmap-nqos-c)#`
		Associates a class map with the policy map, and enters the configuration mode for the specified system class.
		Note
		The associated class map must be the same type as the policy map type.

Step 13	**pause pfc-cos** *value* [**receive**]
	Example:
	`switch(config-pmap-nqos-c)# pause pfc-cos 3 receive`
	`switch(config-pmap-nqos-c)#`
		PFC sends a pause frame that indicates which CoS value needs to be paused. Only PFC receive is enabled for the list of PCF CoS values.
		receive: When this optional keyword is used, PFC only receives and honors pause frames. PFC will never send pause frames. This is known as "Asymmetric PFC".
		Note
		Although not required, the **pause pfc-cos** *value* should match the *qos-group-value* in the **set qos-group** command. See the **set qos-group** command in steps 8 above.

Step 14	**exit** **Example:**	Exits configuration mode and enters policy-map mode.

	Command or Action	Purpose
	`switch(config-pmap-nqos-c)# exit` `switch(config-pmap-nqos)#`	

Step 15	**exit**
	Example:
	`switch(config-pmap-nqos)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 16	**system qos**
	Example:
	`switch(config)# system qos`
	`switch(config-sys-qos)#`
		Enters system class configuration mode.

Step 17	**service-policy type network-qos** *policy-name* **Example:** `switch(config-sys-qos)# service-policy type network-qos pfc-qos`	Applies the policy map of type network-qos at the system level or to the specific interface.

Step 18	**exit**
	Example:
	`switch(config-sys-qos)# exit`
	`switch(config)#`
		Exits policy-map mode and enters global configuration mode.

Step 19	**interface ethernet** *slot* / *number*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Enters the ethernet interface configuration mode for the selected slot and chassis number.

Step 20	**priority-flow-control mode** { **auto** | **on** | **off** }
	Example:
	`switch(config-if)# priority-flow-control mode on`
	`switch(config-if)#`
		Enables the priority flow control policy for the interface.

Step 21	**service-policy type qos input** *policy-name* **Example:** `switch(config-if)# service-policy type qos input p1`	Adds classification to the interface ensuring that packets matching the previously configured CoS or DSCP values are classified in the correct QoS group.

Step 22	**exit**
	Example:
	`switch(config-if)# exit`
	`switch(config)#`
		Exits the ethernet interface mode and enters the global configuration mode.

Configuring a Link Level Flow Control Watchdog and Priority Flow Control Watchdog

Link Level Flow Control Watchdog (LLFCWD) is enabled globally by default. LLFCWD on an interface is enabled automatically when PFC and PFCWD are configured on the interface. If an LLFC packet is seen on a PFC/PFCWD configured interface that doesn't have LLFC configured, the LLFC watchdog is triggered.

PFCWD interval and PFCWD multiplier CLI commands are used to configure the LLFCWD interval and multipliers. Use this procedure to configure the LLFC watchdog interval and the multiplier used to restore the no-drop queue.

Note PFC watchdog is not supported on Cisco Nexus 9500 platform switches with Cisco Nexus 9400, 9500 and 9600 line cards, with the exception of Cisco Nexus 9636PQ line cards (that support the PFC watchdog feature).

Note Ingress drops provide statistics of PFC watchdog dropped packets on the front panel ports.

Note For Cisco Nexus 9200 platform switches, Cisco Nexus 9300-EX/FX/FX2 platform switches, and Cisco Nexus 9500 platform switches with -EXX97160YC-EX or -FX line cards, one of the following calculations is performed to determine when the queue is moved to the shutdown state:

If the interface multiplier is configured, the following calculation is used:

priority-flow-control watch-dog interval *value* * **priority-flow-control watch-dog internal-interface-multiplier** *multiplier*

If the interface multiplier is not configured, the watchdog shutdown multiplier is used instead:

priority-flow-control watch-dog interval *value* * **priority-flow-control watch-dog shutdown-multiplier** *multiplier*

Before you begin

Consider the following before configuring the Link Level Flow Control Watchdog Interval:

- Link Level Flow Control Watchdog is supported on the following Cisco Nexus 9000 Series platform switches and line cards:
  - N9K-C9232C
  - N9K-C9236C
  - N9K-C92304QC
  - N9K-X9736C-EX
  - N9K-X9732C-EX

- N9K-X9732C-EXM
- N9K-X97160YC-EX

- PFC must be enabled at the interface. PFCWD must be enabled at the interface and globally. LLFC shouldn't be configured on the same interface.

Note PFC watchdog uses a command to send a syslog message indicating that the queue is "stuck" (**priority-flow-control watch-dog-interval on disable-action**). If this command is invoked on a PFC interface, the queue isn't shut down but instead, the syslog message is generated. When the LLFC watchdog feature is enabled, and if a link level flow control packet is received on an interface, the queue is shut even with the **disable-action** command for PFC watchdog is enabled.

- Auto-restore and fixed restore should never be configured to 0.

SUMMARY STEPS

1. **configure terminal**
2. **priority-flow-control auto-restore multiplier** *value*
3. **priority-flow-control fixed-restore multiplier** *value*
4. **priority-flow-control watch-dog-interval** {**on** | **off**}
5. **priority-flow-control watch-dog interval** *value*
6. **priority-flow-control watch-dog shutdown-multiplier** *multiplier*
7. (Optional) **priority-flow-control watch-dog internal-interface-multiplier** *multiplier*
8. (Optional) **show queuing pfc-queue [interface** *interface-list***] [module** *module***] [detail]**
9. (Optional) **show queuing llfc-queue [interface** *interface-list***] [module** *module***] [detail]**
10. (Optional) **clear queuing pfc-queue [interface] [ethernet|ii] [intf-name]**
11. (Optional) **clear queuing llfc-queue [interface** *interface-list***] [module** *module***]**
12. (Optional) **priority-flow-control recover interface [ethernet|ii] [intf-name] [qos-group <0-7>]**

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**priority-flow-control auto-restore multiplier** *value*	Configures a value for the auto-restore multiplier, which is calculated by multiplying the set PFC WD interval time. The range is from 0 to 100. **Note**

	Command or Action	Purpose
		The auto-restore multiplier should never be configured to 0. When the LLFC watchdog no-drop queue is restored, a system logging message entry is created to record the conditions of the queue. The following is an example of the message: `Error Message TAHUSD-SLOT#-2-TAHUSD_SYSLOG_LLFCWD_QUEUE_RESTORED : [chars] Description : NO DROP Queue Restored due to LLFC WatchDog timer expiring message` This command is applicable for both LLFCWD and PFCWD.
Step 3	**priority-flow-control fixed-restore multiplier** *value*	Configures a value for the PFC fixed-restore multiplier.

Step 4	**priority-flow-control watch-dog-interval** {**on** | **off**}
	Example:
	`switch(config)# priority-flow-control watch-dog-interval on`
		Globally enables or disables the PFC watchdog interval for all interfaces. This command should be configured at global and also at an interface.
		See the following example of the command configured at global:
		`switch(config)# priority-flow-control watch-dog-interval on`
		See the following example of the command configured at an interface:
		`switch(config)# interface ethernet 7/5 switch(config-if)# priority-flow-control watch-dog-interval on`
		Note
		You can use this same command in interface configuration mode to enable or disable the PFC watchdog interval for a specific interface.
		This command is applicable for both LLFCWD and PFCWD.

Step 5	**priority-flow-control watch-dog interval** *value* **Example:** `switch(config)# priority-flow-control watch-dog interval 200`	Specifies the watchdog interval value of all queues and ports for which this configuration is enabled. The range is from 100 to 1000 milliseconds. **Note** This command is applicable for both LLFCWD and PFCWD.
Step 6	**priority-flow-control watch-dog shutdown-multiplier** *multiplier* **Example:**	Specifies when to declare the PFC queue as stuck shutdown multiplier * poll interval. The range is from 1 to 10, and the default value is 1.

	Command or Action	Purpose
	`switch(config)# priority-flow-control watch-dog shutdown-multiplier 5`	
Step 7	(Optional) **priority-flow-control watch-dog internal-interface-multiplier** *multiplier* **Example:** `switch(config)# priority-flow-control watch-dog internal-interface-multiplier 5`	Configures a PFC watchdog poll-interval multiplier for HiGig™ interfaces. The range is from 0 to 10, and the default value is 2. A value of 0 disables this feature on HiGig™ interfaces. **Note** This command is only applicable for EoR switches.
Step 8	(Optional) **show queuing pfc-queue [interface** *interface-list***] [module** *module***] [detail]** **Example:** `switch(config)# sh queuing pfc-queue interface ethernet 1/1 detail`	Displays the PFCWD statistics.
Step 9	(Optional) **show queuing llfc-queue [interface** *interface-list***] [module** *module***] [detail]** **Example:** `switch(config)# show queuing llfc-queue interface ethernet 1/1 detail`	Displays the LLFCWD statistics. See the output example at the end of this procedure.
Step 10	(Optional) **clear queuing pfc-queue [interface] [ethernet|ii] [intf-name]** **Example:** `switch(config)# clear queuing pfc-queue interface ethernet 1/1`	Clears the environment variable PFCWD statistics.
Step 11	(Optional) **clear queuing llfc-queue [interface** *interface-list***] [module** *module***]** **Example:** `switch(config)# clear queuing llfc-queue interface ethernet 1/1`	Clears the LLFCWD queue statistics.
Step 12	(Optional) **priority-flow-control recover interface [ethernet|ii] [intf-name] [qos-group <0-7>]** **Example:** `switch# priority-flow-control recover interface ethernet 1/1 qos-group 3`	Recovers the interface manually.

Example

Beginning with Cisco NX-OS Release 7.0(3)I6(1), on Cisco Nexus 9200, 9300, 9300-EX, and 9500 platform switches, using the detail option, you can account for Ingress drops.

```
| QOS GROUP 1 [Active] PFC [YES] PFC-COS [1]
+-------------------------------------------------+
|                                |  Stats         |
```

```
+-----------------------------------------------------+
|                        Shutdown|                   0|
|                        Restored|                   0|
|             Total pkts drained|                   0|
|             Total pkts dropped|                   0|
|   Total pkts drained + dropped|                   0|
|          Aggregate pkts dropped|                   0|
|     Total Ingress pkts dropped|                   0| ===>>>>>Ingress
| Aggregate Ingress pkts dropped|                   0|===>>>>Ingress
+-------------------------------+
```

The following example shows detail output of the **show queuing llfc-queue** command for an Ethernet 1/1 interface:

```
switch# show queuing llfc-queue interface 1/1 detail

slot  1
=======
+-----------------------------------------------------+
Global watch-dog interval [Enabled]
+-----------------------------------------------------+
+-----------------------------------------------------+
Global LLFC watchdog configuration details

LLFC watchdog poll interval                : 100 ms
LLFC watchdog auto-restore multiplier      : 10
LLFC watchdog fixed-restore multiplier     : 0
+-----------------------------------------------------+

+-----------------------------------------------------+
Ethernet1/1 Interface LLFC watchdog: [Enabled]
+-----------------------------------------------------+
+-----------------------------------------------------+
| QOS GROUP 6 [Active] LLFC [YES] LLFC-COS [6]
+-----------------------------------------------------+
|                               |  Stats              |
+-----------------------------------------------------+
|                        Shutdown|                   1|
|                        Restored|                   1|
|             Total pkts drained|                 554|
|             Total pkts dropped|            56093783|
|   Total pkts drained + dropped|            56094337|
|          Aggregate pkts dropped|            56094337|
|     Total Ingress pkts dropped|                   0|
| Aggregate Ingress pkts dropped|                   0|
+-----------------------------------------------------+
```

Configuring Pause Buffer Thresholds and Queue Limit Using Ingress Queuing Policy

The pause buffer thresholds specified in the network-qos policy are shared by all the ports in the system. However, there are situations where a few ports may need different thresholds (such as long distance connections). An ingress queuing policy can be used for this purpose.

An ingress queuing policy also allows the configuration of the queue-limit to restrict the amount of shared buffer that can be used in addition to the reserved pause buffer by the no-drop class.

Each no-drop class is mapped internally to one of the port's priority-group in the ingress direction. The configured pause buffer thresholds and queue-limit are applied to the priority-group associated with the class.

Note Adding pause buffer size threshold configuration is optional for cable lengths that are less than 100 meters and it need not be configured.

For cable lengths that are greater than 100m, the pause buffer size threshold configuration is mandatory and it is required as part of the QoS policy configuration.

Note About queue limits for 100G enabled devices (such as the Cisco Nexus 9300 platform switch with the N9K-M4PC-CFP2 GEM):

- The maximum dynamic queue-limit alpha value supported by the device might be greater that 8. However 8 is the maximum alpha value supported. Configuring the alpha value to a value greater than 8 is overridden by the maximum alpha value of 8.

  No message is issued when the alpha value is overridden.

- The static queue-limit has a maximum of 20,000 cells. Any value specified greater than the maximum 20,000 cell limit is overridden by the 20,000 cell limit.

  No message is issued when the cell limit is overridden.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map type queuing** *policy-map-name*
3. **class type queuing** *c-in-q1*
4. **pause buffer-size** *buffer-size* **pause threshold** *xoff-size* **resume threshold** *xon-size*
5. **no pause buffer-size** *buffer-size* **pause threshold** *xoff-size* **resume threshold** *xon-size*
6. **queue-limit** *queue size* [**dynamic** *dynamic threshold*]

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal**	Enters global configuration mode.
Step 2	**policy-map type queuing** *policy-map-name*	Enters policy-map queuing class mode and identifies the policy map assigned to the type queuing policy map.
Step 3	**class type queuing** *c-in-q1*	Attaches the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the System-Defined Type queuing Class Maps table. **Note**

	Command or Action	Purpose
		The qos-group associated with the class must be defined as a no-drop class in the network-qos policy applied in the system qos. **Note** Up to eight ingress queues are supported for the Cisco Nexus 9636C-R and 9636Q-R line cards and the Cisco Nexus 9508-FM-R fabric module (in a Cisco Nexus 9508 switch). The range is from c-in-8q-q-default to c-in-8q-q1 through 7.
Step 4	**pause buffer-size** *buffer-size* **pause threshold** *xoff-size* **resume threshold** *xon-size*	Specifies the buffer threshold settings for pause and resume.
Step 5	**no pause buffer-size** *buffer-size* **pause threshold** *xoff-size* **resume threshold** *xon-size*	Removes the buffer threshold settings for pause and resume.
Step 6	**queue-limit** *queue size* [**dynamic** *dynamic threshold*]	(Optional) Specifies either the static or dynamic shared limit available to the ingress priority-group. The static queue limit defines the fixed size to which the priority-group can grow. The dynamic queue limit allows the priority-group's threshold size to be decided depending on the number of free cells available, in terms of the alpha value. **Note** Cisco Nexus 9200 platform switches only support a class level dynamic threshold configuration with respect to the alpha value. This means that all ports in a class share the same alpha value. **Note** The queue limit for the Cisco Nexus 9636C-R and 9636Q-R line cards and the Cisco Nexus 9508-FM-R fabric module (in a Cisco Nexus 9508 switch) can be entered as a percent or in bytes/kbytes/mbytes/gbytes. For example, **queue-limit percent 1** or **queue-limit bytes 100**.

Verifying the Priority Flow Control Configuration

To display the PFC configuration, perform the following task:

Command	Purpose
show interface priority-flow-control [**module** *number*]	Displays the status of PFC on all interfaces or on specific modules.

Configuration Examples for Priority Flow Control

The following example shows how to configure PFC:

```
configure terminal
interface ethernet 5/5
priority-flow-control mode on
```

The following example shows how to enable PFC on a traffic class:

```
switch(config)# class-map type qos c1
switch(config-cmap-qos)# match cos 3
switch(config-cmap-qos)# exit
switch(config)# policy-map type qos p1
switch(config-pmap-qos)# class type qos c1
switch(config-pmap-c-qos)# set qos-group 3
switch(config-pmap-c-qos)# exit
switch(config-pmap-qos)# exit
switch(config)# class-map type network-qos match-any c1
switch(config-cmap-nqos)# match qos-group 3
switch(config-cmap-nqos)# exit
switch(config)# policy-map type network-qos p1
switch(config-pmap-nqos)# class type network-qos c-nq1
switch(config-pmap-nqos-c)# pause pfc-cos 3
switch(config-pmap-nqos-c)# exit
switch(config-pmap-nqos)# exit
switch(config)# system qos
switch(config-sys-qos)# service-policy type network-qos p1
```

The following example shows how to configuring the PFC mode and its policies which is a prerequisite for PFC watchdog:

```
Watchdog is enabled by default, with system default values of:

Watchdog interval = 100 ms

Shutdown multiplier = 1

Auto-restore multiplier = 10
```

The following example shows how to check PFC watchdog statistics:

```
switch# show queuing pfc-queue interface ethernet 1/23

slot  1
=======
+-------------------------------------------------+
Global watch-dog interval [Enabled]
Forced Global watch-dog   [Enabled]
+-------------------------------------------------+

+-------------------------------------------------+
Global PFC watchdog configuration details

PFC watchdog poll interval                : 100 ms
PFC watchdog shutdown multiplier          : 1
PFC watchdog auto-restore multiplier      : 10
PFC watchdog fixed-restore multiplier     : 0
PFC watchdog internal-interface multiplier : 2
+-------------------------------------------------+

+-----------------------------------------------------------+
```

```
| Port              PFC Watchdog  (VL bmap)  State (Shutdown) |
+-------------------------------------------------------------+
  Ethernet1/23      Enabled       ( 0x8 )   - - - - Y - - -  >>>>>>>>>>>>>>>> The Queue is
 marked as SHUT


switch# show queuing pfc-queue interface ethernet 1/23 detail

slot  1
=======
+---------------------------------------------------+
Global watch-dog interval [Enabled]
Forced Global watch-dog   [Enabled]
+---------------------------------------------------+

+---------------------------------------------------+
Global PFC watchdog configuration details

PFC watchdog poll interval                : 100 ms
PFC watchdog shutdown multiplier          : 1
PFC watchdog auto-restore multiplier      : 10
PFC watchdog fixed-restore multiplier     : 0
PFC watchdog internal-interface multiplier : 2
+---------------------------------------------------+

+---------------------------------------------------+
Ethernet1/23 Interface PFC watchdog: [Enabled]
Disable-action                      : No
PFC watch-dog interface-multiplier : 0
+---------------------------------------------------+
+---------------------------------------------------+
| QOS GROUP 3 [Shutdown] PFC [YES] PFC-COS [3]
+---------------------------------------------------+
|                              |  Stats             |
+---------------------------------------------------+
|                       Shutdown|                  1|
|                       Restored|                  0|
|             Total pkts drained|                  0|
|             Total pkts dropped|                  0|
|   Total pkts drained + dropped|                  0|
|         Aggregate pkts dropped|                  0|
|     Total Ingress pkts dropped|               1924|    >>>>>>>>> Account for Ingress
drops here
| Aggregate Ingress pkts dropped|               1924|
+---------------------------------------------------+
```

Configuring a No-Drop Policy

The following example shows how to configure a no-drop policy and attach the policy to a session policy:

```
Device# configure terminal
Device(config)# class-map type network-qos class1
Device(config-cmap-nq)# match qos-group 1
Device(config-cmap-nq)# policy-map type network-qos my_network_policy
Device(config-pmap-nq)# class type network-qos class1
Device(config-pmap-nq-c)# pause pfc-cos 2
Device(config-pmap-nq-c)# system qos
Device(config-sys-qos)# service-policy type network-qos my_network_policy
Device# show running ipqos
```

Classifying Traffic to a No-Drop Class

The following example shows how to create a QoS policy to map all the traffic to the no-drop class:

```
Device# configure terminal
Device(config)# class-map type qos class1
Device(config-cmap-qos)# match cos 2
Device(config-cmap-qos)# policy-map type qos my_qos_policy
Device(config-pmap-qos)# class type qos class1
Device(config-pmap-c-qos)# set qos-group 1
Device(config-pmap-c-qos)# interface e1/5
Device(config-sys-qos)# service-policy type qos input my_qos_policy
Device(config-sys-qos)#
```

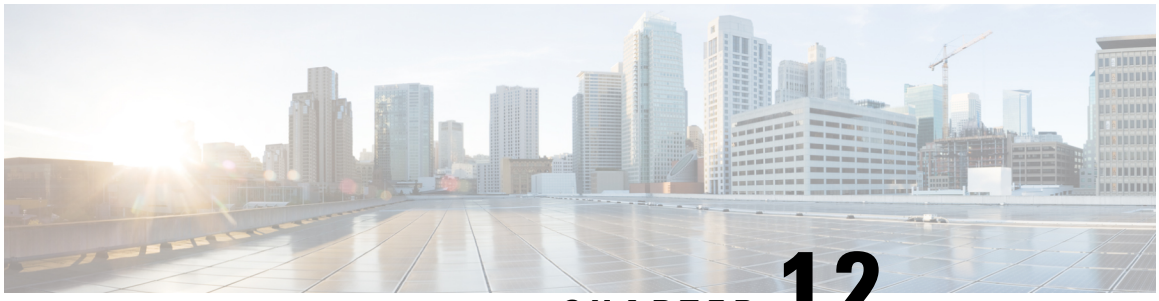
Add the queuing policy that guarantees the bandwidth for qos-group 1 and apply that under system-qos as outlined in the following example:

```
policy-map type queuing my_queuing_policy
class type queuing c-out-q-default
bandwidth percent 1
class type queuing c-out-q3
bandwidth percent 0
class type queuing c-out-q2
bandwidth percent 0
class type queuing c-out-q1
bandwidth percent 99

system qos
  service-policy type queuing output my_queuing_policy
```

In the above example, c-out-q1 by default matches the traffic on qos-group 1. Therefore, the non-default class-map for queuing which matches qos-group 1 is not needed. For further information on configuring queuing, see Configuring Queuing.

For LLFC to be enabled, you need to configure the no-drop policy on network-qos. The buffering module needs to inform the MAC module to generate pause (either LLFC or PFC based on the interface level configuration). PFC negotiation to the adapter is by using DCBX. LLFC or PFC is controlled by the configuration on the interfaces. For example, the **flow-control send and receive on** enables LLFC on the interfaces and the **priority-flow-control mode on** enables PFC on the interfaces.

If DCBX is supported, auto mode negotiates the PFC with the adapter. This is the interface level configuration to enable LLFC or PFC but regardless of it, you have to configure network-qos level pause configuration for LLFC to work. Even if the traffic is classified to qos-group 1 but when it generates pause, it generates LLFC based on the interface level configuration.



CHAPTER 12

Monitoring QoS Statistics

- About QoS Statistics, on page 165
- Prerequisites for Monitoring QoS Statistics, on page 165
- Guidelines and Limitations for Monitoring QoS Statistics, on page 165
- Enable or disable QoS statistics, on page 167
- Monitor QoS statistics, on page 168
- Clear QoS Statistics, on page 169
- Configuration Examples For Monitoring QoS Statistics, on page 169

About QoS Statistics

You can display various QoS statistics for the device. By default, statistics are enabled, but you can disable this feature. For more information, see the Configuration Examples For Monitoring QoS Statistics section.

Prerequisites for Monitoring QoS Statistics

Monitoring QoS statistics has the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.

Guidelines and Limitations for Monitoring QoS Statistics

Monitoring QoS statistics has the following guidelines and limitations:

- **show** commands with the **internal** keyword are not supported.
- The **show queuing interface** command can display information about internal interfaces.

  The command format for this information is specified as **ii** *x*/*y*/*z*. Where *x* is the module number, *y* is the value 1, and *z* is the internal interface number within the module.

Note The number of internal interfaces within a module varies based on the type of the line card.

Note Alternatively, you can display information about internal interfaces by providing the module number in the **show queuing** command. By including the module number, queuing information for both front-panel and internal interfaces of the module are displayed together.

Example:

```
switch# show queuing interface ii 4/1/2

slot  4
=======


Egress Queuing for ii4/1/2 [System]
------------------------------------------------------------------------
QoS-Group# Bandwidth% PrioLevel                Shape
                                    Min          Max        Units
------------------------------------------------------------------------
      3             -         1           -            -     -
      2             0         -           -            -     -
      1             0         -           -            -     -
      0           100         -           -            -     -
+-------------------------------------------------------------------------+
|                              QOS GROUP 0                                |
+-------------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------------+
|        Tx Pkts |               0|               0|          235775|
|        Tx Byts |               0|               0|        22634400|
|   Dropped Pkts |               0|               0|               0|
|   Dropped Byts |               0|               0|               0|
|   Q Depth Byts |               0|               0|               0|
+-------------------------------------------------------------------------+
|                              QOS GROUP 1                                |
+-------------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------------+
|        Tx Pkts |               0|               0|               0|
|        Tx Byts |               0|               0|               0|
|   Dropped Pkts |               0|               0|               0|
|   Dropped Byts |               0|               0|               0|
|   Q Depth Byts |               0|               0|               0|
+-------------------------------------------------------------------------+
|                              QOS GROUP 2                                |
+-------------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------------+
|        Tx Pkts |               0|               0|               0|
|        Tx Byts |               0|               0|               0|
|   Dropped Pkts |               0|               0|               0|
|   Dropped Byts |               0|               0|               0|
|   Q Depth Byts |               0|               0|               0|
```

```
+-------------------------------------------------------------------+
|                            QOS GROUP 3                            |
+-------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------+
|        Tx Pkts |              0|              0|              0|
|        Tx Byts |              0|              0|              0|
|   Dropped Pkts |              0|              0|              0|
|   Dropped Byts |              0|              0|              0|
|   Q Depth Byts |              0|              0|              0|
+-------------------------------------------------------------------+
|                      CONTROL QOS GROUP                            |
+-------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------+
|        Tx Pkts |              0|              0|              0|
|        Tx Byts |              0|              0|              0|
|   Dropped Pkts |              0|              0|              0|
|   Dropped Byts |              0|              0|              0|
|   Q Depth Byts |              0|              0|              0|
+-------------------------------------------------------------------+
|                         SPAN QOS GROUP                            |
+-------------------------------------------------------------------+
|                |  Unicast       | OOBFC Unicast  |  Multicast     |
+-------------------------------------------------------------------+
|        Tx Pkts |              0|              0|              0|
|        Tx Byts |              0|              0|              0|
|   Dropped Pkts |              0|              0|              0|
|   Dropped Byts |              0|              0|              0|
|   Q Depth Byts |              0|              0|              0|
+-------------------------------------------------------------------+
Cannot get ingress statistics for if_index: 0x4a180001 Error 0xe

Port Egress Statistics
------------------------------------------------------
WRED Drop Pkts                                  0

PFC Statistics
-------------------------------------------------------------------------------
TxPPP:                    0, RxPPP:                    0
-------------------------------------------------------------------------------
COS QOS Group        PG   TxPause   TxCount         RxPause         RxCount
   0         -         -  Inactive         0        Inactive               0
   1         -         -  Inactive         0        Inactive               0
   2         -         -  Inactive         0        Inactive               0
   3         -         -  Inactive         0        Inactive               0
   4         -         -  Inactive         0        Inactive               0
   5         -         -  Inactive         0        Inactive               0
   6         -         -  Inactive         0        Inactive               0
   7         -         -  Inactive         0        Inactive               0
-------------------------------------------------------------------------------
```

Enable or disable QoS statistics

By default, QoS statistics are enabled. Use this task to enable or disable global QoS statistics as needed.

Procedure

Step 1 Run the **configure terminal** command to enter global configuration mode.

Example:

```
configure terminal
```

Step 2 Run the **qos statistics** command to enable QoS statistics on all interfaces.

Example:

```
qos statistics
```

Step 3 Run the **no qos statistics** command to disable QoS statistics on all interfaces.

Example:

```
no qos statistics
```

Step 4 (Optional) Verify the statistics status and configured policy maps.

a) Run the **show policy-map interface** command to check the detailed statistics status.

Example:

```
show policy-map interface
```

b) Run the **show policy-map interface** command to check the brief policy map summary (policy names up to 25 characters).

Example:

```
show policy-map interface brief
```

Step 5 (Optional) Save the running configuration:

Example:

```
copy running-config startup-config
```

QoS statistics are enabled or disabled on all interfaces according to your configuration. If you save the configuration, your changes are preserved.

Monitor QoS statistics

You can view real-time QoS statistics for interfaces. These statistics help you monitor network performance and the policies that have been applied.

Follow these steps to monitor QoS-related statistics for all interfaces or a selected interface, including information filtered by direction or policy type.

Procedure

Run the **show policy-map** [*policy-map-name*] [**interface** [**input** | **output**]] [**type** {**control-plane** | **network-qos** | **qos** | **queuing**}] command to view policy-map statistics

Example:

```
switch# show policy-map interface ethernet 2/1
```

Displays statistics and the configured policy maps on all interfaces, a specified interface, or by data direction or QoS type.

Note
The `show queuing` command on the Cisco Nexus 9336C-SE1 switches works independently of the `qos statistics` configuration.

Clear QoS Statistics

You can clear QoS statistics for all interfaces. Alternatively, you can clear statistics for a selected interface, data direction, or QoS type.

Procedure

Run the **clear qos statistics** [**interface** [**input** | **output**] [**type** {**qos** | **queuing**}]] command to clear QoS statistics and the configured policy maps on all interfaces.

Example:

```
switch# clear qos statistics type qos
```

You can also use this command to clear statistics for a specific interface, for a particular data direction, for a specific QoS type, or to clear the configured policy maps.

Configuration Examples For Monitoring QoS Statistics

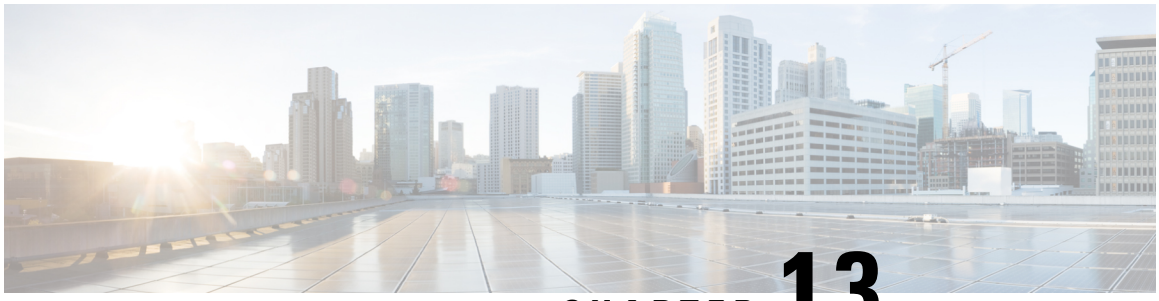
The following example shows how to display the QoS statistics:

```
Global statistics status :   enabled

Ethernet6/1
          Service-policy (queuing) output:   default-out-policy

            Class-map (queuing):   c-out-q3 (match-any)
              priority level 1

            Class-map (queuing):   c-out-q2 (match-any)
```

```
    bandwidth remaining percent 0

  Class-map (queuing):   c-out-q1 (match-any)
    bandwidth remaining percent 0

  Class-map (queuing):   c-out-q-default (match-any)
    bandwidth remaining percent 100
```

The following example shows how to obtain information about queuing and PFC related counters:

```
switch(config-vlan-config)# show queuing interface ethernet 2/1

Egress Queuing for Ethernet2/1 [System]
------------------------------------------------------------------
QoS-Group# Bandwidth% PrioLevel                Shape
                                     Min          Max        Units
------------------------------------------------------------------
      3             -         1           -             -     -
      2             0         -           -             -     -
      1             0         -           -             -     -
      0           100         -           -             -     -
+-------------------------------------------------------------------+
|                              QOS GROUP 0                          |
+-------------------------------------------------------------------+
|        Tx Pkts |               0|   Dropped Pkts |               0|
+-------------------------------------------------------------------+
|                              QOS GROUP 1                          |
+-------------------------------------------------------------------+
|        Tx Pkts |               0|   Dropped Pkts |               0|
+-------------------------------------------------------------------+
|                              QOS GROUP 2                          |
+-------------------------------------------------------------------+
|        Tx Pkts |               0|   Dropped Pkts |               0|
+-------------------------------------------------------------------+
|                              QOS GROUP 3                          |
+-------------------------------------------------------------------+
|        Tx Pkts |               0|   Dropped Pkts |               0|
+-------------------------------------------------------------------+
|                       CONTROL QOS GROUP 4                         |
+-------------------------------------------------------------------+
|        Tx Pkts |              58|   Dropped Pkts |               0|
+-------------------------------------------------------------------+
|                          SPAN QOS GROUP 5                         |
+-------------------------------------------------------------------+
|        Tx Pkts |               0|   Dropped Pkts |             948|
+-------------------------------------------------------------------+
```



CHAPTER 13

Micro-Burst Monitoring

- Micro-Burst Monitoring, on page 171
- Guidelines and Limitations for Micro-Burst Monitoring, on page 171
- Configuring Micro-Burst Detection Per-Queue, on page 174
- Configuring Micro-Burst Detection Per-Switch, on page 175
- Clearing Micro-Burst Detection, on page 177
- Verifying Micro-Burst Detection, on page 178
- Example of Micro-Burst Detection Output, on page 178

Micro-Burst Monitoring

The micro-burst monitoring feature allows you to monitor traffic to detect unexpected data bursts within a very small time window (microseconds). This allows you to detect traffic in the network that are at risk for data loss and for network congestion.

A micro-burst is detected when the buffer utilization in an egress queue rises above the configured rise-threshold (measured in bytes). The burst for the queue ends when the queue buffer utilization falls below the configured fall-threshold (measured in bytes).

The feature provides timestamp and instantaneous buffer utilization information about the various queues where micro-burst monitoring is enabled.

Depending on the switch, you can enable the micro-burst detection per-queue or per-switch.

Guidelines and Limitations for Micro-Burst Monitoring

The following are the guidelines and limitations for micro-burst monitoring:

- Micro-burst monitoring is not supported on Cisco Nexus 9500 platform switches.
- Micro-burst monitoring and detection is supported on the following platforms:

Switches	Minimum Burst Interval	IO FPGA Version
Cisco Nexus 9200	86 µsec 96 µsec	0x16 or later 0x10 or later 0x15 or later 0x6 or later 0x14 or later
Cisco Nexus 9300	73 µsec 78 µsec	0x8 or later 0x9 or later
Cisco Nexus 9300-EX		
Cisco Nexus 9300-FX		
Cisco Nexus 9300-FX2		
Cisco Nexus 9332C		
Cisco Nexus 9364C		

On these switches, micro-burst monitoring is supported on both unicast and multicast egress queues.

In addition, early detection of long bursts is supported. For bursts lasting more than 5 seconds, an early burst start record is displayed after 5 seconds from the start of the burst and is updated when the burst actually ends. This is not supported for Cisco Nexus 9300-FX, 9300-FX2, and 9364C platform switches.

Note On these switches, micro-burst duration is not affected by the number of queues configured.

- **show** commands with the **internal** keyword are not supported.
- Micro-burst monitoring is available with switches that contain the Network Forwarding Engine (NFE2). The minimum micro-burst that can be detected is 0.64 microseconds for 1 - 3 queues.

  On these switches, micro-burst monitoring is supported on unicast egress queues. It is not supported on multicast, CPU, or span queues.
- On switches that contain a Network Forwarding Engine (NFE2), micro-burst monitoring requires IO FPGA version 0x9 or later.

  Beginning with Cisco NX-OS Release 7.0(3)I5(1), micro-burst monitoring on Cisco Nexus 9200 or 9300-EX platform switches require the following IO FPGA versions:

Switch	IO FPGA Version
Cisco Nexus 92160YC-X	0x16 or later
Cisco Nexus 92304QC	0x10 or later
Cisco Nexus 9272Q	0x15 or later

Switch	IO FPGA Version
Cisco Nexus 9232C	0x6 or later
Cisco Nexus 9236C	0x14 or later
Cisco Nexus 93180YC-EX	0x8 or later
Cisco Nexus 93108TC-EX	0x9 or later

For more information about EPLD programming to upgrade the FPGA, see the *Cisco Nexus 9000 Series FPGA/EPLD Upgrade Release Notes*.

- The following are guidelines for micro-burst duration on switches that contain a Network Forwarding Engine (NFE2):

Note Micro-burst duration is the duration of the burst that can be detected. For example, when micro-burst monitoring is configured for 1 - 3 queues, micro-bursts that exceed 0.64 microseconds are detected. Increasing the number of queues that are configured for micro-burst monitoring increases the duration of the burst that can be detected. This does not apply to Cisco Nexus 9300-FX, 9300-FX2, and 9364C platform switches.

1 - 3 queues	0.64 microsecond duration
8 queues with 10 ports each	9.0 microsecond duration
10 queues with 132 ports each	140 microsecond (0.14 millisecond) duration

- By default, the switch stores a maximum of 1000 burst records. The maximum number of records is configurable within a range of 200 - 2000 records.
  - At least, 20 burst records are stored for each queue even when the maximum number of burst records has been reached.
  - When the maximum number of burst records has been reached, the oldest record is deleted to allow the storage of a new record.
  - You can use the **hardware qos burst-detect max-records** *number-of-records* command to configure the maximum number of burst records to store.
  - You can use the **show hardware qos burst-detect max-records** command to display the maximum number of burst records that can be stored.
- Too many back to back burst records while traffic is being drained from queues might result in jitter.

  To avoid jitter, configure the fall-threshold to be less than the rise-threshold. As a best practice, configure the fall-threshold to be approximately 20% of the rise-threshold value (bytes).

Configuring Micro-Burst Detection Per-Queue

You can enable micro-burst detection for all interfaces on the device.

Note This procedure is for all Cisco Nexus 9000 Series switches that support per-queue thresholds.

You can enable independent micro-burst thresholds per queue on the following switches:

- Cisco Nexus 9300-EX/ platform switches
- Cisco Nexus 9300-GX/GX2 platform switches
- Cisco Nexus 9400 platform switches
- Cisco Nexus 9336C-FX switch
- Cisco Nexus 93360YC-FX2 and Cisco Nexus 93216TC-FX2 switches from Release 9.3(7)

The parameters are defined under the individual queues in the queuing policy-maps.

SUMMARY STEPS

1. **configure terminal**
2. **policy-map type queuing** *policy-map-name*
3. **class type queuing** *class-name*
4. **burst-detect rise-threshold** *rise-threshold-bytes* **bytes fall-threshold** *fall-threshold-bytes* **bytes**
5. **exit**
6. **exit**
7. **interface ethernet** *slot/port*
8. **service-policy type queuing output** *policy-map-name*

DETAILED STEPS

Procedure

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	**policy-map type queuing** *policy-map-name*
	Example:
	`switch(config)# policy-map type queuing xyz`
	`switch(config-pmap-que)#`
		Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.

	Command or Action	Purpose

Step 3	**class type queuing** *class-name*
	Example:
	`switch(config-pmap-que)# class type queuing c-out-def`
	`switch(config-pmap-c-que)#`
		Configures the class map of type queuing and then enters policy-map class queuing mode.

Step 4	**burst-detect rise-threshold** *rise-threshold-bytes* **bytes fall-threshold** *fall-threshold-bytes* **bytes** **Example:** `switch(config-pmap-c-que)# burst-detect rise-threshold 208 bytes fall-threshold 208 bytes`	Specifies the rise-threshold and the fall-threshold for micro-burst detection.

Step 5	**exit**
	Example:
	`switch(config-pmap-c-que)# exit`
	`switch(config-pmap-que)#`
		Exits policy-map queue mode.

Step 6	**exit**
	Example:
	`switch(config-pmap-que)# exit`
	`switch(config)#`
		Exits policy-map queue mode.

Step 7	**interface ethernet** *slot/port*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Configures the interface.

Step 8	**service-policy type queuing output** *policy-map-name* **Example:** `switch(config-if)# service-policy type queuing output custom-out-8q-uburst`	Adds the policy map to the input or output packets of the system.

Configuring Micro-Burst Detection Per-Switch

You can enable micro-burst detection for all interfaces on the device.

Note This procedure is for all Cisco Nexus 9000 Series switches that support per-switch thresholds.

For the following switches, you have to enable thresholds per switch:

- Cisco Nexus 9200 switches

- Cisco Nexus 9300-FX switches
- Cisco Nexus 9332C switches
- Cisco Nexus 9364C switches

Therefore, the threshold is defined globally and applied to any queues where micro-burst detection is enabled in the queuing policy.

SUMMARY STEPS

1. **configure terminal**
2. **hardware qos burst-detect rise-threshold** *rise-threshold-bytes* **bytes** | **percentfall-threshold** *fall-threshold-bytes* **bytes**
3. **policy-map type queuing** *policy-map-name*
4. **class type queuing** *class-name*
5. **burst-detect enable**
6. **exit**
7. **exit**
8. **interface ethernet** *slot/port*
9. **service-policy type queuing output** *policy-map-name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**configure terminal** **Example:** `switch# configure terminal`	Enters global configuration mode.
Step 2	**hardware qos burst-detect rise-threshold** *rise-threshold-bytes* **bytes**	**percentfall-threshold** *fall-threshold-bytes* **bytes** **Example:** `switch(config)# hardware qos burst-detect rise-threshold 10000 bytes fall-threshold 2000 bytes`	Specifies the rise-threshold and the fall-threshold for micro-burst detection.
Step 3	**policy-map type queuing** *policy-map-name* **Example:** `switch(config)# policy-map type queuing custom-out-8q-uburst`	Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify.
Step 4	**class type queuing** *class-name* **Example:** `switch(config-pmap-que)# class type queuing c-out-8q-q-default`	Configures the class map of type queuing and then enters policy-map class queuing mode.

	Command or Action	Purpose
Step 5	**burst-detect enable** **Example:** `switch(config-pmap-c-que)# burst-detect enable`	Enable micro-burst detection on the queue.
Step 6	**exit** **Example:** `switch(config-pmap-c-que)# exit`	Exits policy-map class queue mode.
Step 7	**exit** **Example:** `switch(config-pmap-que)# exit`	Exits policy-map queue mode.

Step 8	**interface ethernet** *slot/port*
	Example:
	`switch(config)# interface ethernet 1/1`
	`switch(config-if)#`
		Configures the interface.

Step 9	**service-policy type queuing output** *policy-map-name* **Example:** `switch(config-if)# service-policy type queuing output custom-out-8q-uburst`	Adds the policy map to the input or output packets of the system.

Clearing Micro-Burst Detection

You can clear micro-burst detection for all interfaces or a selected interface.

Note Even after removing the queuing policy from an interface, previous micro-burst statistics remain. Use the **clear queuing burst-detect** command to clear the remaining records.

Procedure

	Command or Action	Purpose
Step 1	**clear queuing burst-detect** [*slot*] [**interface** *port* [**queue** *queue-id*]] **Example:**	Clears micro-burst information from all interfaces or the specified interface.

Example

- Example for an interface:

```
clear queuing burst-detect interface Eth1/2
```

- Example for a queue:

```
clear queuing burst-detect interface Eth1/2 queue 7
```

Verifying Micro-Burst Detection

The following displays micro-burst monitoring information:

Command	Purpose
show queuing burst-detect	Displays micro-burst counters information for all interfaces.

- Example for an interface:

```
show queuing burst-detect interface Eth 1/2
```

- Example for a queue:

```
show queuing burst-detect interface Eth 1/2 queue 7
```

Example of Micro-Burst Detection Output

Example output of TOR switch.

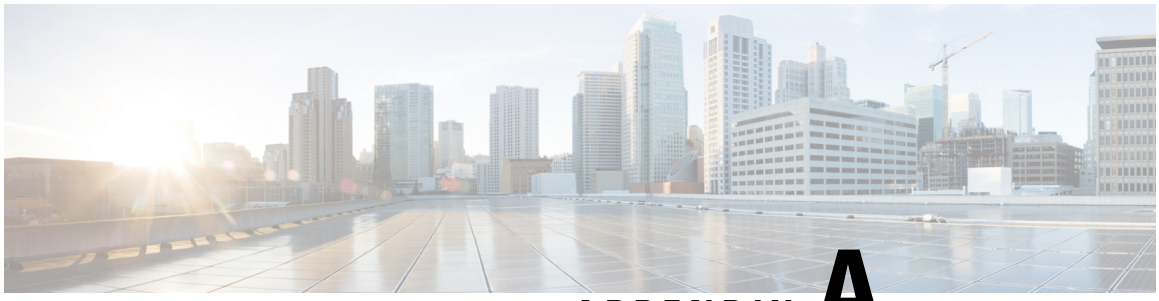
```
belv6# show queuing burst-detect detail
slot  1
=======
-----------------------------------------------------------------------------------------------------------------------------
          Microburst Statistics

Flags: E - Early start record, U - Unicast, M - Multicast
-----------------------------------------------------------------------------------------------------------------------------
Ethernet|Queue| Start |        Start Time        | Peak  |         Peak Time        |   End   |        End Time         |Duration
Intfc   |     | Depth |                          | Depth |                          |  Depth  |                         |
        |     |(bytes)|                          |(bytes)|                          | (bytes) |                         |
-----------------------------------------------------------------------------------------------------------------------------
 Eth1/36| U0  | 310128 |2011/01/11 22:31:51:081725|310128|2011/01/11 22:31:51:081725|     0|2011/01/11 22:31:51:081918|193.14 us
 Eth1/36| U0  | 311168 |2011/01/11 22:31:51:181765|311168|2011/01/11 22:31:51:181765|     0|2011/01/11 22:31:51:181959|193.90 us
 Eth1/36| U0  | 283712 |2011/01/11 22:31:51:281825|283712|2011/01/11 22:31:51:281825|     0|2011/01/11 22:31:51:282018|193.63 us
 Eth1/36| U0  | 283712 |2011/01/11 22:31:51:381862|283712|2011/01/11 22:31:51:381862|     0|2011/01/11 22:31:51:382056|193.42 us
 Eth1/36| U0  | 312000 |2011/01/11 22:31:51:481885|312000|2011/01/11 22:31:51:481885|     0|2011/01/11 22:31:51:482080|194.42 us
 Eth1/36| U0  | 221312 |2011/01/11 22:31:51:581974|221312|2011/01/11 22:31:51:581974|     0|2011/01/11 22:31:51:582168|193.58 us
 Eth1/36| U0  | 291616 |2011/01/11 22:31:51:681964|291616|2011/01/11 22:31:51:681964|     0|2011/01/11 22:31:51:682157|193.10 us
 Eth1/36| U0  | 190112 |2011/01/11 22:31:51:782067|190112|2011/01/11 22:31:51:782067|18512|2011/01/11 22:31:51:782154|  86.22 us
 Eth1/36| U0  |  70512 |2011/01/11 22:31:51:882167|  70512|2011/01/11 22:31:51:882167|     0|2011/01/11 22:31:51:882253|  85.74 us
 Eth1/36| U0  | 185328 |2011/01/11 22:31:52:082111|185328|2011/01/11 22:31:52:082111|     0|2011/01/11 22:31:52:082304|193.09 us
 Eth1/36| U0  | 245856 |2011/01/11 22:31:52:182158|245856|2011/01/11 22:31:52:182158|     0|2011/01/11 22:31:52:182352|193.34 us
 Eth1/36| U0  | 138112 |2011/01/11 22:31:52:282293|138112|2011/01/11 22:31:52:282293|     0|2011/01/11 22:31:52:282380|  86.53 us
 Eth1/36| U0  | 242112 |2011/01/11 22:31:52:382284|242112|2011/01/11 22:31:52:382284|     0|2011/01/11 22:31:52:382478|193.55 us
 Eth1/36| U0  | 136448 |2011/01/11 22:31:52:482264|195312|2011/01/11 22:31:52:482348|     0|2011/01/11 22:31:52:482542|278.16 us
 Eth1/36| U0  | 299312 |2011/01/11 22:31:52:582334|299312|2011/01/11 22:31:52:582334|     0|2011/01/11 22:31:52:582612|278.12 us
 Eth1/36| U0  | 184912 |2011/01/11 22:31:52:682432|184912|2011/01/11 22:31:52:682432|13312|2011/01/11 22:31:52:682517|  85.42 us
 Eth1/36| U0  | 148304 |2011/01/11 22:31:52:782387|148304|2011/01/11 22:31:52:782387|     0|2011/01/11 22:31:52:782580|192.94 us
 Eth1/36| U0  | 226512 |2011/01/11 22:31:52:882492|226512|2011/01/11 22:31:52:882492|     0|2011/01/11 22:31:52:882685|193.37 us
```

Example of **show queuing burst-detect nir detail** command:

```
config# show queuing burst-detect nir

slot  1
=======

------------------------------------------------------------------------------------------------------------------

          Microburst Statistics

Flags: E - Early start record, U - Unicast, M - Multicast
------------------------------------------------------------------------------------------------------------------
Ethernet |Queue|Start Depth|         Start Time         |Peak Depth|          Peak Time
      |End Depth|         End Time           |Duration
Interface|     |  (bytes)  |                            | (bytes)  |
      | (bytes) |                            |
------------------------------------------------------------------------------------------------------------------

   Eth1/6|  U6  |     416   | 2023/06/28 13:11:45:005625 |    3120  | 2023/06/28
13:11:45:005626 |     416 | 2023/06/28 13:11:45:005627 |       1.11 us
   Eth1/6|  U6  |     416   | 2023/06/28 13:11:45:005057 |    3120  | 2023/06/28
13:11:45:005058 |     416 | 2023/06/28 13:11:45:005059 |       1.44 us
```

Example of telemetry configuration on the switch to receive micro-burst data:

```
telemetry
destination-group 1
ip address receiver_ip_address port receiver_port protocol grpc encoding GPB-compact
sensor-group 1
data-source native
path microburst
subscription 1
dst-grp 1
snsr-grp 1 sample-interval 0
```



APPENDIX A

FEX QoS Configuration

- FEX QoS Configuration Information, on page 181
- TCAM Carving for FEX QoS, on page 183
- FEX QoS Configuration Example, on page 184
- Verifying the FEX QoS Configuration , on page 200

FEX QoS Configuration Information

Note FEX QoS is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3).

Note Only 4Q queuing policy model is supported on FEX. When you try to bring up FEX in 8Q queuing policy mode you will get an error message.

- Classification (system type qos policy)

Type	**System Level** **Action**	**Hardware Implementation** Direction: IN	
		FEX	Switch
match	cos	Yes	No
	ip access list	No	No
	dscp	No	No
	ip	No	No
	precedence	No	No
	protocol	No	No
set	qos-group	Yes	No

	precedence	No	No
	dscp	No	No
	cos	No	No

Type	**Interface Level** **Action**	**Hardware Implementation** Direction: IN	
		FEX	Switch
match	cos	No	Yes
	ip access list	No	Yes
	dscp	No	Yes
	ip	No	Yes
	precedence	No	Yes
	protocol	No	Yes
set	dscp	No	Yes
	precedence	No	Yes
	qos-group	No	Yes
	cos	No	Yes

- Input queuing

System Level **Action**	**Hardware Implementation** Direction: IN	
	FEX	Switch
Bandwidth	Yes	No
Bandwidth Remaining	Yes	No
Priority (only level 1)	Yes	No

Interface Level **Action**	**Hardware Implementation** Direction: IN	
	FEX	Switch
Bandwidth	No	No
Bandwidth Remaining	No	No
Priority	No	No

- Output queuing

System Level **Action**	**Hardware Implementation** Direction: OUT	
	FEX	Switch
Bandwidth	Yes	Yes
Bandwidth Remaining	Yes	Yes
Priority (only level 1 on FEX, 3 levels on switch)	Yes	Yes

Interface Level **Action**	**Hardware Implementation** Direction: OUT	
	FEX	Switch
Bandwidth	No	Yes
Bandwidth Remaining	No	Yes
Priority	No	Yes

TCAM Carving for FEX QoS

You must free up unused TCAM space to accommodate TCAM carving for FEX QoS.

Note FEX QoS is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3).

- For FEX QoS TCAM carving for IPv4 traffic, you can use the **hardware access-list tcam region fex-qos 256** command.

  As a best practice, you can use the **hardware access-list tcam region fex-qos-lite 256** command when policers are not used.

Note The fex-qos-lite region does not have conformed policer statistics support for IPv4.

- For IPv6 QoS TCAM carving support, you can use the **hardware access-list tcam region fex-ipv6-qos 256** command.
- For MAC based QoS TCAM carving support, you can use the **hardware access-list tcam region fex-mac-qos 256** command.

- When configuring end to end queuing from the HIF to the front panel port, the QoS classification policy needs to be applied to both system and HIF. This allows the FEX to queue on ingress appropriately (system) and allows the egress front panel port to queue appropriately (HIF).

  Example:

```
system qos
  service-policy type qos input LAN-QOS-FEX

interface Ethernet101/1/12
  service-policy type qos input LAN-QOS-FEX
```

Example of a FEX QoS Marking Policy Configuration

The following example is to configure set cos when the incoming traffic is untagged on the Layer 3 uplink port with DSCP values. In this way, it carries cos values to the FEX ports when traffic comes on the Layer 3 port and egress out on the FEX HIF port.

```
class-map type qos match-all DSCP8
       match dscp 8
class-map type qos match-all DSCP16
       match dscp 16
class-map type qos match-all DSCP32
       match dscp 32
policy-map type qos-remark
      class  DSCP8
           set qos-group 1
           set cos 0
      class  DSCP16
           set qos-group 2
           set cos 1
      class  DSCP32
           set qos-group 3
           set cos 3
     class  class-default
```

For configuring the uplink Layer 3 ports:

```
Int ethx/y
     Service-policy type qos input qos-remark
```

FEX QoS Configuration Example

Note FEX QoS is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3).

The following are examples of the aspects of a FEX QoS configuration.

Classification (system type qos policy)

Policies of type qos are applied to classify incoming packets.

- Class map configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.

switch(config)# class-map type qos match-all cos0
switch(config-cmap-qos)# match cos 0
switch(config-cmap-qos)#
switch(config-cmap-qos)# class-map type qos match-all cos1
switch(config-cmap-qos)# match cos 1
switch(config-cmap-qos)#
switch(config-cmap-qos)# class-map type qos match-all cos2
switch(config-cmap-qos)# match cos 2
switch(config-cmap-qos)#
switch(config-cmap-qos)# class-map type qos match-all cos3
switch(config-cmap-qos)# match cos 3
switch(config-cmap-qos)#
```

- Policy map configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.

switch(config)# policy-map type qos setpol
switch(config-pmap-qos)# class  cos0
switch(config-pmap-c-qos)# set qos-group 1
switch(config-pmap-c-qos)# class  cos1
switch(config-pmap-c-qos)# set qos-group 2
switch(config-pmap-c-qos)# class  cos3
switch(config-pmap-c-qos)# set qos-group 3
switch(config-pmap-c-qos)# class  class-default
switch(config-pmap-c-qos)#
```

- Attach service policy to system target configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.

switch(config)# system qos
switch(config-sys-qos)# service-policy type qos input setpol
```

- Verifying classification:

```
switch# show policy-map system type qos

          Service-policy (qos) input:   setpol
            policy statistics status:   disabled (current status: disabled)

            Class-map (qos):   cos0 (match-all)
              Match: cos 0
              set qos-group 1

            Class-map (qos):   cos1 (match-all)
              Match: cos 1
              set qos-group 2

            Class-map (qos):   cos23 (match-all)
              Match: cos 2-3
              set qos-group 3

            Class-map (qos):   class-default (match-any)
```

FEX QoS Configuration

```
switch# show queuing interface ethernet 101/1/1

slot  1
=======
Ethernet101/1/1 queuing information:
  Input buffer allocation:
  Qos-group: ctrl
  frh: 0
  drop-type: drop
  cos: 7
  xon       xoff      buffer-size
  ---------+---------+-----------
  2560      7680      10240
  Qos-group: 0  1  2  3  (shared)
  frh: 2
  drop-type: drop
  cos: 0 1 2 3 4 5 6
  xon       xoff      buffer-size
  ---------+---------+-----------
  19200     24320     48640
  Queueing:
  queue    qos-group    cos            priority  bandwidth mtu
  --------+------------+--------------+---------+---------+----
  ctrl-hi  n/a          7               PRI         0      2400
  ctrl-lo  n/a          7               PRI         0      2400
  2        0            4 5 6           WRR        10      9280
  3        1            0               WRR        20      9280
  4        2            1               WRR        30      9280
  5        3            2 3             WRR        40      9280
  Queue limit: 66560 bytes

Queue Statistics:
  queue  rx              tx              flags
  ------+---------------+---------------+-----
  0      0               68719476760      ctrl
  1      1               1                ctrl
  2      0               0                data
  3      1               109453           data
  4      0               0                data
  5      0               0                data

  Port Statistics:
  rx drop          rx mcast drop   rx error        tx drop          mux ovflow
  ---------------+---------------+---------------+---------------+--------------
  0                0               0               0                InActive

  Priority-flow-control enabled: no
  Flow-control status: rx 0x0, tx 0x0, rx_mask 0x0
  cos     qos-group   rx pause  tx pause  masked rx pause
  -------+-----------+---------+---------+---------------
  0              1    xon       xon       xon
  1              2    xon       xon       xon
  2              3    xon       xon       xon
  3              3    xon       xon       xon
  4              0    xon       xon       xon
  5              0    xon       xon       xon
  6              0    xon       xon       xon
  7            n/a    xon       xon       xon

  DSCP to Queue mapping on FEX
 ----+--+-----+-------+--+---

 DSCP to Queue map disabled
```

```
 FEX TCAM programmed successfully

switch#


switch# attach fex 101

fex-101# show platform software qosctrl port 0 0 hif 1
number of arguments 6: show port 0 0 3 1
------------------------------------------------------
QoSCtrl internal info {mod 0x0 asic 0 type 3 port 1}

PI mod 0 front port 0 if_index 0x00000000
   ups 0 downs 0 binds 0
Media type 0
Port speed 0
MAC addr b0:00:b4:32:05:e2
Port state: , Down

Untagged COS config valid: no
Untagged COS dump:
rx_cos_def[0]=0, tx_cos_def[0]=0
rx_cos_def[1]=3, tx_cos_def[1]=3
Last queueing config recvd from supId: 0
-----SUP 0  start -----

Queuing config per qos_group
Interface queueing config valid: no

 Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000


Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000000
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000000
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 0  end -----

-----SUP 1  start -----

Queuing config per qos_group
Interface queueing config valid: no

 Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
```

```
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000

 Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000000
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000000
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 1  end -----

PFC 0 (disabled), net_port 0x0
END of PI SECTION
HIF0/0/1


Default CoS: 0
CoS  Rx-Remap  Tx-Remap  Class
----+---------+---------+-----
0    0         0         3
1    1         1         4
2    2         2         5
3    3         3         5
4    4         4         2
5    5         5         2
6    6         6         2
7    7         7         1

Class  FRH  CT-En  MTU-Cells [Bytes]
------+----+------+-----------------
0      0    0      30  [2400 ]
1      0    0      30  [2400 ]
2      2    0      116 [9280 ]
3      2    0      116 [9280 ]
4      2    0      116 [9280 ]
5      2    0      116 [9280 ]
6      2    0      127 [10160]
7      2    0      127 [10160]

FRH configuration:
  Port En: 1, Tail Drop En: 0, Emergency Stop En: 1, Err Discard En: 1

FRH  Xon  Xoff  Total  Pause  u-Pause  Class-Map
----+----+-----+------+------+--------+---------
0    2    6     8      1      0        0x03
1    0    0     0      0      0        0x00
2    15   19    38     1      0        0x3c
3    0    0     0      0      0        0x00
4    0    0     0      0      0        0x00
5    0    0     0      0      0        0x00
6    0    0     0      0      0        0x00
7    0    0     0      0      0        0x00

Global FRH:
  FRH Map: 0x00, Pause Class Map: 0x00
  Xoff Threshold: 0, Total Credits: 0

Pause configuration:
```

```
  PFC disabled
  Rx PFC CoS map: 0x00, Tx PFC CoS map: 0x00


Index  CoS-to-Class  Class-to-CoS------+-------------+------------
0      0x00          0xff
1      0x00          0xff
2      0x00          0xff
3      0x00          0xff
4      0x00          0xff
5      0x00          0xff
6      0x00          0xff
7      0x00          0xff

OQ configuration:
  Credit Quanta: 1, IPG Adjustment: 0
  PQ0 En: 0, PQ0 Class: 0
  PQ1 En: 0, PQ1 Class: 0

Class  XoffToMap  TD  HD  DP  Grp  LSP  GSP  CrDec  bw
------+----------+---+---+---+----+----+----+-----+----
0      0 0        1   0   0   0    1    0    0       0
1      0 0        1   0   0   1    0    1    0       0
2      0 0        1   0   0   2    0    0    50     10
3      0 0        1   0   0   2    0    0    24     20
4      0 0        1   0   0   2    0    0    16     30
5      0 0        1   0   0   2    0    0    12     40
6      0 0        1   0   0   2    0    0    0       0
7      0 0        1   0   0   2    0    0    0       0

SS statistics:
Class  Rx (WR_RCVD)            Tx (RD_SENT)
------+-----------------------+----------------------
0      0                       0
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Discard (WR_DISC):               0
Rx Multicast Discard (WR_DISC_MC):  0
Rx Error (WR_RCV_ERR):              0

OQ statistics:
Packets flushed:   0
Packets timed out: 0


Pause statistics:
CoS    Rx PFC Xoff             Tx PFC Xoff
------+-----------------------+----------------------
0      0                       0
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Xoff:           0
Rx Xon:            0
Tx Xoff:           0
Tx Xon:            0
```

```
Rx PFC:            0
Tx PFC:            0
Rx Xoff Status:    0x00
Tx Xoff Status:    0x00

SS  RdPort  Class  Head   Tail   QCount  RealQCountRx
---+-------+------+------+------+-------+------------
0   1       0      3113   9348   0       0
0   1       1      11057  4864   0       0
0   1       2      5356   4257   0       0
0   1       3      12304  10048  0       0
0   1       4      11346  2368   0       0
0   1       5      162    165    0       0
0   1       6      14500  112    0       0
0   1       7      12314  9602   0       0
fex-101#
```

Input queuing (system type queuing input policy)

Note System input queuing is applied on NIF Ports for HIF to NIF traffic.

- Class map (system defined class map) configuration:

```
switch# show class-map type queuing
  Type queuing class-maps
  ========================
    class-map type queuing match-any c-out-q3
      Description: Classifier for Egress queue 3
      match qos-group 3

    class-map type queuing match-any c-out-q2
      Description: Classifier for Egress queue 2
      match qos-group 2

    class-map type queuing match-any c-out-q1
      Description: Classifier for Egress queue 1
      match qos-group 1

    class-map type queuing match-any c-out-q-default
      Description: Classifier for Egress default queue
      match qos-group 0

    class-map type queuing match-any c-in-q3
      Description: Classifier for Ingress queue 3
      match qos-group 3

    class-map type queuing match-any c-in-q2
      Description: Classifier for Ingress queue 2
      match qos-group 2

    class-map type queuing match-any c-in-q1
      Description: Classifier for Ingress queue 1
      match qos-group 1

    class-map type queuing match-any c-in-q-default
      Description: Classifier for Ingress default queue
      match qos-group 0
switch#
```

- Policy map configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# policy-map type queuing inq_pri
switch(config-pmap-que)# class type queuing c-in-q3
switch(config-pmap-c-que)# priority level 1
switch(config-pmap-c-que)# class type queuing c-in-q2
switch(config-pmap-c-que)# bandwidth remaining percent 50
switch(config-pmap-c-que)# class type queuing c-in-q1
switch(config-pmap-c-que)# bandwidth remaining percent 30
switch(config-pmap-c-que)# class type queuing c-in-q-default
switch(config-pmap-c-que)# bandwidth remaining percent 20
switch(config-pmap-c-que)#
```

- Attach service policy to system target configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.

switch(config)# system qos
switch(config-sys-qos)# service-policy type queuing input inq_pri
```

- Verifying input queuing:

```
switch# show policy-map system type queuing input

          Service-policy (queuing) input:   inq_pri
            policy statistics status:   disabled (current status: disabled)

            Class-map (queuing):   c-in-q3 (match-any)
              priority level 1

            Class-map (queuing):   c-in-q2 (match-any)
              bandwidth remaining percent 50

            Class-map (queuing):   c-in-q1 (match-any)
              bandwidth remaining percent 30

            Class-map (queuing):   c-in-q-default (match-any)
              bandwidth remaining percent 20


switch# attach fex 101

fex-101# show platform software qosctrl port 0 0 nif 1
number of arguments 6: show port 0 0 2 1
----------------------------------------------------------
QoSCtrl internal info {mod 0x0 asic 0 type 2 port 1}

PI mod 0 front port 0 if_index 0x00000000
   ups 0 downs 0 binds 0
Media type 3
Port speed 10000
MAC addr 00:00:00:00:00:00
Port state: , Down

fabric_num 0, ctrl_vntag 0
ctrl_vlan 0, vntag_etype 0

Untagged COS config valid: no
Untagged COS dump:
```

```
rx_cos_def[0]=0, tx_cos_def[0]=0
rx_cos_def[1]=3, tx_cos_def[1]=3

Last queueing config recvd from supId: 0

-----SUP 0  start -----

Queuing config per qos_group
Interface queueing config valid: no


Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000

 Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000004
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000005
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 0  end -----

-----SUP 1  start -----

Queuing config per qos_group
Interface queueing config valid: no

 Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000

 Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000004
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000005
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 1  end -----


PFC 1 (enabled), net_port 0x0
END of PI SECTION
NIF0/0/1
```

```
Default CoS: 0
CoS  Rx-Remap  Tx-Remap  Class
----+---------+---------+-----
0    0         0         3
1    1         1         4
2    2         2         5
3    3         3         5
4    4         4         2
5    5         5         2
6    6         6         2
7    7         7         1

Class  FRH  CT-En  MTU-Cells [Bytes]
------+----+------+-----------------
0      0    1      30  [2400 ]
1      0    1      30  [2400 ]
2      2    1      116 [9280 ]
3      3    1      116 [9280 ]
4      4    1      116 [9280 ]
5      5    1      116 [9280 ]
6      2    1      127 [10160]
7      2    1      127 [10160]

FRH configuration:
  Port En: 1, Tail Drop En: 1, Emergency Stop En: 1, Err Discard En: 1

FRH  Xon  Xoff  Total  Pause  u-Pause  Class-Map
----+----+-----+------+------+--------+---------
0    2    6     16     1      0        0x03
1    0    0     0      0      0        0x00
2    0    0     0      0      0        0x04
3    0    0     0      0      0        0x08
4    0    0     0      0      0        0x10
5    0    0     0      0      0        0x20
6    0    0     0      0      0        0x00
7    0    0     0      0      0        0x00

Global FRH:
  FRH Map: 0x3c, Pause Class Map: 0x3c
  Xoff Threshold: 0, Total Credits: 0


Pause configuration:
  PFC disabled
  Rx PFC CoS map: 0x00, Tx PFC CoS map: 0x00

Index  CoS-to-Class  Class-to-CoS
------+-------------+------------
0      0x00          0xff
1      0x00          0xff
2      0x00          0xff
3      0x00          0xff
4      0x00          0xff
5      0x00          0xff
6      0x00          0xff
7      0x00          0xff

OQ configuration:
  Credit Quanta: 1, IPG Adjustment: 0
  PQ0 En: 0, PQ0 Class: 0
  PQ1 En: 0, PQ1 Class: 0

Class  XoffToMap  TD  HD  DP  Grp  LSP  GSP  CrDec  bw
------+----------+---+---+---+----+----+----+-----+----
```

```
0      0 0        0   0   1   0    1    0    0       0
1      0 0        0   0   1   1    0    1    0       0
2      0 0        0   0   1   2    0    0    24      20
3      0 0        0   0   1   2    0    0    16      30
4      0 0        0   0   1   2    0    0    10      50
5      0 0        0   0   1   2    0    1    255     0
6      0 0        0   0   1   2    0    0    0       0
7      0 0        0   0   1   2    0    0    0       0

SS statistics:
Class  Rx (WR_RCVD)            Tx (RD_SENT)
------+-----------------------+----------------------
0      0                       68719476736
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Discard (WR_DISC):               0
Rx Multicast Discard (WR_DISC_MC):  0
Rx Error (WR_RCV_ERR):              0

OQ statistics:
Packets flushed:   0
Packets timed out: 0

Pause statistics:
CoS    Rx PFC Xoff             Tx PFC Xoff
------+-----------------------+----------------------
0      0                       0
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Xoff:           0
Rx Xon:            0
Tx Xoff:           0
Tx Xon:            0
Rx PFC:            0
Tx PFC:            0
Rx Xoff Status:    0x00
Tx Xoff Status:    0x00

fex-101#
```

Output queuing (system type queuing output policy)

Note System Output queuing is applied on HIF Ports for NIF to HIF traffic.

- Policy map (system defined policy map):

```
switch# show policy-map type queuing default-out-policy
```

```
Type queuing policy-maps
========================

policy-map type queuing default-out-policy
  class type queuing c-out-q3
    priority level 1
  class type queuing c-out-q2
    bandwidth remaining percent 0
  class type queuing c-out-q1
    bandwidth remaining percent 0
  class type queuing c-out-q-default
    bandwidth remaining percent 100
```

- Policy map (user defined policy map) configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# policy-map type queuing outq
switch(config-pmap-que)# class type queuing c-out-q3
switch(config-pmap-c-que)# bandwidth percent 40
switch(config-pmap-c-que)# class type queuing c-out-q2
switch(config-pmap-c-que)# bandwidth percent 30
switch(config-pmap-c-que)# class type queuing c-out-q1
switch(config-pmap-c-que)# bandwidth percent 20
switch(config-pmap-c-que)# class type queuing c-out-q-default
switch(config-pmap-c-que)# bandwidth percent 10
switch(config-pmap-c-que)#
```

- Attach service policy to system target configuration:

```
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.

switch(config)# system qos
switch(config-sys-qos)# service-policy type queuing output outq
```

- Verifying output queuing:

```
switch# show policy-map system type queuing output

          Service-policy (queuing) output:   outq
            policy statistics status:   disabled (current status: disabled)

            Class-map (queuing):   c-out-q3 (match-any)
              bandwidth percent 40

            Class-map (queuing):   c-out-q2 (match-any)
              bandwidth percent 30

            Class-map (queuing):   c-out-q1 (match-any)
              bandwidth percent 20

            Class-map (queuing):   c-out-q-default (match-any)
              bandwidth percent 10


switch# show queuing interface ethernet 101/1/1

slot  1
=======
Ethernet101/1/1 queuing information:
  Input buffer allocation:
  Qos-group: ctrl
```

```
  frh: 0
  drop-type: drop
  cos: 7
  xon       xoff      buffer-size
  ---------+---------+-----------
  2560      7680      10240
  Qos-group: 0  1  2  3  (shared)
  frh: 2
  drop-type: drop
  cos: 0 1 2 3 4 5 6
  xon       xoff      buffer-size
  ---------+---------+-----------
  19200     24320     48640
  Queueing:
  queue    qos-group    cos            priority  bandwidth mtu
  --------+------------+--------------+---------+---------+----
  ctrl-hi  n/a          7               PRI         0      2400
  ctrl-lo  n/a          7               PRI         0      2400
  2        0            4 5 6           WRR        10      9280
  3        1            0               WRR        20      9280
  4        2            1               WRR        30      9280
  5        3            2 3             WRR        40      9280
  Queue limit: 66560 bytes

Queue Statistics:
  queue  rx              tx              flags
  ------+---------------+---------------+-----
  0      0               68719476760     ctrl
  1      1               1               ctrl
  2      0               0               data
  3      1               109453          data
  4      0               0               data
  5      0               0               data

  Port Statistics:
  rx drop         rx mcast drop   rx error        tx drop         mux ovflow
  ---------------+---------------+---------------+---------------+--------------
  0               0               0               0               InActive

  Priority-flow-control enabled: no
  Flow-control status: rx 0x0, tx 0x0, rx_mask 0x0
  cos     qos-group   rx pause  tx pause  masked rx pause
  -------+-----------+---------+---------+---------------
  0              1    xon       xon       xon
  1              2    xon       xon       xon
  2              3    xon       xon       xon
  3              3    xon       xon       xon
  4              0    xon       xon       xon
  5              0    xon       xon       xon
  6              0    xon       xon       xon
  7            n/a    xon       xon       xon

  DSCP to Queue mapping on FEX
 ----+--+-----+-------+--+---

 DSCP to Queue map disabled

 FEX TCAM programmed successfully

switch#


switch# attach fex 101
fex-101# show platform software qosctrl port 0 0 hif 1
```

```
number of arguments 6: show port 0 0 3 1
------------------------------------------------------
QoSCtrl internal info {mod 0x0 asic 0 type 3 port 1}

PI mod 0 front port 0 if_index 0x00000000
   ups 0 downs 0 binds 0
Media type 0
Port speed 0
MAC addr b0:00:b4:32:05:e2
Port state: , Down

Untagged COS config valid: no
Untagged COS dump:
rx_cos_def[0]=0, tx_cos_def[0]=0
rx_cos_def[1]=3, tx_cos_def[1]=3
Last queueing config recvd from supId: 0
-----SUP 0  start -----

Queuing config per qos_group
Interface queueing config valid: no

 Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000


Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000000
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000000
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 0  end -----

-----SUP 1  start -----

Queuing config per qos_group
Interface queueing config valid: no

 Queueing per qos_group: 00006|
    |id|bw%|bw_unit|priority
grp |00|100|0000000|00000000
grp |01|000|0000000|00000000
grp |02|000|0000000|00000000
grp |03|000|0000000|00000000
grp |04|000|0000000|00000000
grp |05|000|0000000|00000000

 Scheduling Classes 00008|
      |id|cbmp|qid|bw%|nor_bw%|bw_unit|prio|dir |q2cos|class_grp|wk_gmap
class |00|0x01|000|000|0000000|0000007|0001|  TX| 0x80|000000000|0000000
class |01|0x02|001|000|0000000|0000007|0001|  TX| 0x00|000000000|0000000
class |02|0x04|002|000|0000000|0000007|0000|  TX| 0x08|000000002|0000000
class |03|0x08|003|100|0000100|0000007|0000|  TX| 0xf7|000000003|0000000
class |04|0x10|004|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
```

```
class |05|0x20|005|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |06|0x40|006|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000
class |07|0x80|007|000|0000000|0000007|0000|  TX| 0x00|000000003|0000000

-----SUP 1  end -----

PFC 0 (disabled), net_port 0x0
END of PI SECTION
HIF0/0/1


Default CoS: 0
CoS  Rx-Remap  Tx-Remap  Class
----+---------+---------+-----
0    0         0         3
1    1         1         4
2    2         2         5
3    3         3         5
4    4         4         2
5    5         5         2
6    6         6         2
7    7         7         1

Class  FRH  CT-En  MTU-Cells [Bytes]
------+----+------+-----------------
0      0    0      30  [2400 ]
1      0    0      30  [2400 ]
2      2    0      116 [9280 ]
3      2    0      116 [9280 ]
4      2    0      116 [9280 ]
5      2    0      116 [9280 ]
6      2    0      127 [10160]
7      2    0      127 [10160]

FRH configuration:
  Port En: 1, Tail Drop En: 0, Emergency Stop En: 1, Err Discard En: 1

FRH  Xon  Xoff  Total  Pause  u-Pause  Class-Map
----+----+-----+------+------+--------+---------
0    2    6     8      1      0        0x03
1    0    0     0      0      0        0x00
2    15   19    38     1      0        0x3c
3    0    0     0      0      0        0x00
4    0    0     0      0      0        0x00
5    0    0     0      0      0        0x00
6    0    0     0      0      0        0x00
7    0    0     0      0      0        0x00

Global FRH:
  FRH Map: 0x00, Pause Class Map: 0x00
  Xoff Threshold: 0, Total Credits: 0

Pause configuration:
  PFC disabled
  Rx PFC CoS map: 0x00, Tx PFC CoS map: 0x00


Index  CoS-to-Class  Class-to-CoS------+-------------+------------
0      0x00          0xff
1      0x00          0xff
2      0x00          0xff
3      0x00          0xff
4      0x00          0xff
5      0x00          0xff
```

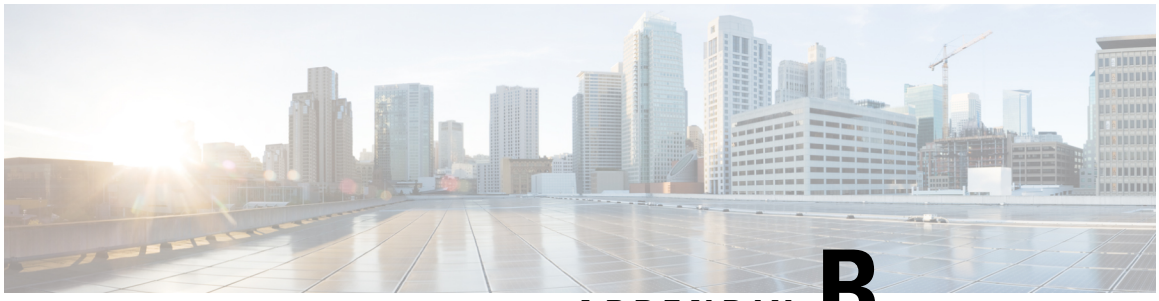
```
6      0x00          0xff
7      0x00          0xff

OQ configuration:
  Credit Quanta: 1, IPG Adjustment: 0
  PQ0 En: 0, PQ0 Class: 0
  PQ1 En: 0, PQ1 Class: 0

Class  XoffToMap  TD  HD  DP  Grp  LSP  GSP  CrDec  bw
------+----------+---+---+---+----+----+----+-----+----
0      0 0        1   0   0   0    1    0    0       0
1      0 0        1   0   0   1    0    1    0       0
2      0 0        1   0   0   2    0    0    50     10
3      0 0        1   0   0   2    0    0    24     20
4      0 0        1   0   0   2    0    0    16     30
5      0 0        1   0   0   2    0    0    12     40
6      0 0        1   0   0   2    0    0    0       0
7      0 0        1   0   0   2    0    0    0       0

SS statistics:
Class  Rx (WR_RCVD)            Tx (RD_SENT)
------+-----------------------+----------------------
0      0                       0
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Discard (WR_DISC):                0
Rx Multicast Discard (WR_DISC_MC):  0
Rx Error (WR_RCV_ERR):               0

OQ statistics:
Packets flushed:   0
Packets timed out: 0


Pause statistics:
CoS    Rx PFC Xoff             Tx PFC Xoff
------+-----------------------+----------------------
0      0                       0
1      0                       0
2      0                       0
3      0                       0
4      0                       0
5      0                       0
6      0                       0
7      0                       0
Rx Xoff:           0
Rx Xon:            0
Tx Xoff:           0
Tx Xon:            0
Rx PFC:            0
Tx PFC:            0
Rx Xoff Status:    0x00
Tx Xoff Status:    0x00

SS  RdPort  Class  Head   Tail   QCount  RealQCountRx
---+-------+------+------+------+-------+------------
0   1       0      3113   9348   0       0
0   1       1      11057  4864   0       0
0   1       2      5356   4257   0       0
```

```
0   1       3       12304  10048  0       0
0   1       4       11346  2368   0       0
0   1       5       162    165    0       0
0   1       6       14500  112    0       0
0   1       7       12314  9602   0       0
fex-101#
```

Verifying the FEX QoS Configuration

Use the following commands to verify the FEX QoS configuration:

Command	Purpose
show class-map type [**qos** | **queuing**]	Displays information about configured class maps of type qos or queuing.
show policy-map type [**qos** | **queueing**]	Displays information about configured policy maps of type qos or queuing.
show policy-map system type [**qos** | **queuing**]	Displays information about all configured policy maps of type qos or queuing on the system.
show queuing interface ethernet	Displays information about queuing on the ethernet interface.



APPENDIX B

Additional References

This appendix contains additional information related to implementing QoS on the Cisco NX-OS device.

This appendix includes the following sections:

- RFCs, on page 201

RFCs

RFCs	Title
RFC 2474	*Differentiated Services Field*
RFC 2475	*Architecture for Differentiated Services*
RFC 2697	*A Single Rate Three Color Marker*
RFC 2698	*A Dual Rate Three Color Marker*
RFC 3289	*Management Information Base for the Differentiated Services Architecture*

Additional References

INDEX

C

class type queuing **176**
congestion-control random-detect forward-nonecn **118**

H

hardware profile tcam resource service-template **51**
hardware profile tcam resource template **51**
hardware qos burst-detect rise-threshold **176**

I

interface ethernet **174–177**

P

policy-map type queuing **176**
priority-flow-control override-interface mode off **149**
priority-flow-control watch-dog internal-interface-multiplier **155, 157**
priority-flow-control watch-dog interval **155–156**
priority-flow-control watch-dog shutdown-multiplier **155–156**
priority-flow-control watch-dog-interval **155–156**

R

reload **51–52**

S

service-policy type queuing output **174–177**
show hardware access-list tcam template **52**