Packet Classification Using the Frame Relay DLCI Number

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The Packet Classification Using the Frame Relay DLCI Number feature allows customers to match and classify traffic based on the Frame Relay data-link connection identifier (DLCI) number associated with a packet. This new match criterion is in addition to the other match criteria, such as the IP precedence, differentiated service code point (DSCP) value, class of service (CoS), currently available.

History for the Packet Classification Using the Frame Relay DLCI Number Feature

Release	Modification
12.2(13)T	This feature was introduced.
12.0(26)S	This feature was integrated into Cisco IOS Release 12.0(26)S for the Cisco 7200 and 7500 series routers.
12.2(28)SB	This feature was integrated into Cisco IOS Release 12.2(28)SB.

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Information About Packet Classification Using the Frame Relay DLCI Number

To configure Packet Classification Using the Frame Relay DLCI Number, you need to understand the following concepts:

Modular Quality of Service Command-Line Interface

The Packet Classification Using the Frame Relay DLCI Number feature extends the functionality of the Modular Quality of Service (QoS) Command-Line Interface (CLI) (MQC).

The MQC, a feature included in the Cisco IOS software, allows customers to match traffic on the basis of user-specified criteria (for example, access lists, or IP precedences). Traffic that matches that criteria can be organized into specific classes (class maps) that can, in turn, receive specific user-defined QoS treatment when that class is included in a policy map. The class map is placed in a policy map, and the policy map is then attached to an interface for use on the network.

The MQC is a CLI that allows you to create traffic policies and attach these policies to interfaces.

In the MQC, the **class-map** command is used to define a traffic class (which is then associated with a traffic policy). The purpose of a traffic class is to classify traffic.

The MQC consists of the following three processes:

- Defining a traffic class with the **class-map** command.
- Creating a traffic policy by associating the traffic class with one or more QoS features (using the **policy-map** command).
- Attaching the traffic policy to the interface with the **service-policy** command.

A traffic class contains three major elements: a name, a series of **match** commands, and, if more than one **match** command exists in the traffic class, an instruction on how to evaluate these **match** commands. The traffic class is named in the **class-map** command line; that is, if you enter the **class-map cisco** command while configuring the traffic class in the CLI, the traffic class would be named “cisco”.

The **match** commands are used to specify various criteria for classifying packets. Packets are checked to determine whether they match the criteria specified in the **match** commands. If a packet matches the specified criteria, that packet is considered a member of the class and is forwarded according to the quality of service (QoS) specifications set in the traffic policy. Packets that fail to meet any of the matching criteria are classified as members of the default traffic class.

DLCI Numbers and Network Addressing

A DLCI number is a data link connection identifier. Permanent virtual circuits (PVCs) and switched virtual circuits (SVCs) are identified by a DLCI number. The DLCI number defines a single virtual connection through the WAN and are the Frame Relay equivalent to a hardware address.

Periodically, through the exchange of signaling messages, a network may announce a new virtual circuit with its corresponding DLCI number. However, protocol addressing is not included in the announcement. The station receiving such an indication will learn of the new connection, but will not be able to address the other side. Without a new configuration or mechanism for discovering the protocol address of the other side, this new virtual circuit is unusable.

For this reason, Inverse Address Resolution Protocol (Inverse ARP) was developed. Inverse ARP allows a Frame Relay network to discover the protocol address associated with the virtual circuit, and ARP is more flexible than relying on static configuration.

How to Configure Packet Classification Using the Frame Relay DLCI Number

This section contains the following procedures:

- Configuring the Class Map to Match on the Frame Relay DLCI Number, page 3 (required)
- Creating a Policy Map, page 4 (required)
- Attaching the Policy Map to an Interface, page 4 (required)
- Verifying the Configuration, page 6 (optional)

Configuring the Class Map to Match on the Frame Relay DLCI Number

Class maps can be used to classify packets into groups based on a user-specified criterion. For example, class maps can be configured to match packets on the basis of the DSCP value or access list number. In this case, the class map is configured to match on the Frame Relay DLCI number associated with the packet. To configure the class map to match on the Frame Relay DLCI number, use the following commands.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **class-map** *class-map-name*
4. **match fr-dlci** *dlci-number*
5. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**class-map** *class-map-name* **Example:** `Router(config)# class-map class1`	Specifies the name of the class map to be created and enters class-map configuration mode. **Note** If match-all or match-any are not specified, traffic must match all the match criterion to be classified as part of the class map. • Enter name of class map.
Step 4	**match fr-dlci** *dlci-number* **Example:** `Router(config-cmap) match fr-dlci 500`	Configures the class map created above to match traffic based on the Frame Relay DLCI number associated with the packet. • Enter the DLCI number.
Step 5	**exit** **Example:** `Router(config-cmap)# exit`	(Optional) Exits class-map configuration mode.

Creating a Policy Map

Traffic that matches a user-specified criterion can be organized into specific classes (class maps) that can, in turn, receive specific user-defined QoS treatment when that class is included in a policy map. A policy map (traffic policy) is created using the MQC.

To create a policy map using the MQC, refer to the instructions in the "Configuring the Modular Quality of Service Command-Line Interface" chapter of the *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2.

Attaching the Policy Map to an Interface

After a policy map is created, the next step is to attach the policy map to an interface. Policy maps can be attached to either the input or output direction of the interface.

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

To attach the policy map to an interface, use the following commands:

SUMMARY STEPS

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

DETAILED STEPS

	Command or Action	Purpose

Step 1	`enable`
	
	Example:
	`Router> enable`
		Enables privileged EXEC mode.
		• Enter your password if prompted.

Step 2	`configure terminal`
	
	Example:
	`Router# configure terminal`
		Enters global configuration mode.

Step 3	`interface` *type number* **Example:** `Router(config-if)# interface serial4/0`	Configures an interface (or subinterface) type and enters interface configuration mode. • Enter the interface type number.
Step 4	`pvc` [*name*] *vpi*/*vci* [`ilmi` | `qsaal` | `smds`] **Example:** `Router(config-if)# pvc cisco 0/16 ilmi`	(Optional) Creates or assigns a name to an ATM PVC and specifies the encapsulation type on an ATM PVC. Enters ATM VC configuration mode. **Note** This step is required only if you are attaching the policy map to an ATM PVC. If you are not attaching the policy map to an ATM PVC, skip this step and proceed with Step 5.

	Command or Action	Purpose
Step 5	**service-policy** {**input** | **output**} *policy-map-name* **Example:** `Router(config-if)# service-policy input policy1`	Specifies the name of the policy map to be attached to the input *or* output direction of the interface. **Note** Policy maps can be configured on ingress or egress routers. They can also be attached in the input or output direction of an interface. The direction (input or output) and the router (ingress or egress) to which the policy map should be attached varies according your network configuration. When using the **service-policy** command to attach the policy map to an interface, be sure to choose the router and the interface direction that are appropriate for your network configuration. • Enter the policy map name.
Step 6	**exit** **Example:** `Router(config-if)# exit`	(Optional) Exits interface configuration mode.

Verifying the Configuration

This task allows you to verify that you created the configuration you intended and that the feature is functioning correctly. To verify the configuration, use the following commands.

SUMMARY STEPS

1. **enable**
2. **show class-map** [*class-map-name*]

   or

   show policy-map interface *interface-name*
3. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

Step 2	**show class-map** [*class-map-name*]
	and/or
	show policy-map interface *interface-name*
	
	Example:
	`Router# show class-map class1`
	and/or
	
	Example:
	`Router# show policy-map interface serial4/0`
		Displays all information about a class map, including the match criterion.
		or
		Displays the packet statistics of all classes that are configured for all service policies either on the specified interface or subinterface or on a specific PVC on the interface.
		• Enter the interface name.

Step 3	**exit** **Example:** `Router# exit`	(Optional) Exits EXEC mode.

Troubleshooting Tips

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

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

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

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

- Run the **show policy-map** command and analyze the output of the command.
- Run the **show running-config** command and analyze the output of the command.
- Use the **show policy-map interface** command and analyze the output of the command. Check the the following findings:
  - If a policy map applies queueing, and the packets are matching the correct class, but you see unexpected results, compare the number of the packets in the queue with the number of the packets matched.
  - If the interface is congested, and only a small number of the packets are being matched, check the tuning of the tx ring, and evaluate whether the queueing is happening on the tx ring. To do this, use the **show controllers** command, and look at the value of the tx count in the output of the command.

Configuration Examples for Packet Classification Using the Frame Relay DLCI Number

This section provides the following configuration example:

- Configuring the Frame Relay DLCI Number As a Match Criterion Example, page 8

Configuring the Frame Relay DLCI Number As a Match Criterion Example

In the following example, two PVCs are configured on one serial interface. QoS is provisioned so that one PVC receives 70 percent of the bandwidth and the other PVC receives 25 percent of the bandwidth. When configured as shown below, all traffic belonging to Frame Relay DLCI-102 will be guaranteed 70 percent of the bandwidth, while traffic belonging to Frame Relay DLCI-105 is guaranteed 25 percent of the bandwidth.

```
Router(config)# class-map match-all dlci-102
Router(config-cmap)# match fr-dlci 102

Router(config)# class-map match-all dlci-105
Router(config-cmap)# match fr-dlci 105

Router(config)# policy-map test-policy
Router(config-pmap)# class dlci-102
Router(config-pmap-c)# bandwidth percent 70
Router(config-pmap)# class dlci-105
Router(config-pmap-c)# bandwidth percent 25

Router(config)# interface Serial9/0/0:0
Router(config-if)# service-policy output test-policy
```

In the following example, QoS is further provisioned for traffic for a PVC (while also guaranteeing bandwidth to the PVC) by using a hierarchical policy. In this configuration example, traffic for PVC 102 (Frame Relay DLCI-102, shown above) is allocated 40 percent of the bandwidth.

```
Router(config)# class-map match-all precedence2
Router(config-cmap)# match ip precedence 2
```

```
Router(config)# policy-map child
Router(config-pmap)# class precedence2
Router(config-pmap-c)# bandwidth percent 40

Router(config)# policy-map test-policy
Router(config-pmap)# class dlci-102
Router(config-pmap-c)# bandwidth percent 70
Router(config-pmap-c)# service-policy child
Router(config-pmap)# class dlci-105
Router(config-pmap-c)# bandwidth percent 25

Router(config)# interface Serial9/0/0:0
Router(config-if)# service-policy output test-policy
```

Additional References

The following sections provide additional references related to Packet Classification Using the Frame Relay DLCI Number.

Related Documents

Related Topic	Document Title
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Quality of Service Solutions Command Reference*, Release 12.3
Modular QoS Command-Line Interface (CLI) (MQC)	"Modular Quality of Service Command-Line Interface" chapter in *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.3
Information about attaching policy maps to interfaces	"Configuring the Modular Quality of Service Command-Line Interface" chapter in *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.3
Information about attaching policy maps to Frame Relay DLCIs	*Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.3
Additional match criteria that can be used for packet classification	"Configuring the Modular Quality of Service Command-Line Interface" chapter in *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.3
Frame Relay configuration information and information about DLCIs	*Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.3
Frame Relay commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Wide-Area Networking Command Reference*, Release 12.3

Standards

Standards	Title
None	—

MIBs

MIBs	MIBs Link
• CISCO-CLASS-BASED-QOS-MIB • CISCO-CLASS-BASED-QOS-CAPABILITY-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://tools.cisco.com/go/mibs

RFCs

RFCs	Title
None	—

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Command Reference

This section documents new and modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.3 command reference publications.

Modified Commands

- **match fr-dlci**
- **show class-map**

match fr-dlci

To specify the Frame Relay data-link connection identifier (DLCI) number as a match criterion in a class map, use the **match fr-dlci** command in class-map configuration mode. To remove a previously specified DLCI number as a match criterion, use the **no** form of this command.

match fr-dlci *dlci-number*

no match fr-dlci *dlci-number*

Syntax Description

dlci-number	Number of the DLCI associated with the packet.

Defaults

No DLCI number is specified.

Command Modes

Class-map configuration

Command History

Release	Modification
12.2(13)T	This command was introduced.
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

This match criterion can be used in main interfaces and point-to-multipoint subinterfaces in Frame Relay networks, and it can also be used in hierarchical policy maps.

Examples

In the following example a class map called “class1” has been created and the Frame Relay DLCI number of 500 has been specified as a match criterion. Packets matching this criterion are placed in class1.

```
Router(config)# class-map class1
Router(config-cmap)# match fr-dlci 500
Router(config-cmap)# end
```

Related Commands

Command	Description
show class-map	Displays all class maps and their matching criteria.
show policy-map interface	Displays the packet statistics of all classes that are configured for all service policies either on the specified interface or subinterface or on a specific PVC on the interface.

show class-map

To display all class maps and their matching criteria, use the **show class-map** command in EXEC mode.

show class-map [**type** {**stack** | **access-control**}] [*class-map-name*]

Syntax Description

type stack	(Optional) Displays class maps configured to determine the correct protocol stack in which to examine via flexible packet matching (FPM).
type access-control	(Optional) Displays class maps configured to determine the exact pattern to look for in the protocol stack of interest.
class-map-name	(Optional) Name of the class map. The class map name can be a maximum of 40 alphanumeric characters.

Command Modes

EXEC

Command History

Release	Modification
12.0(5)T	This command was introduced.
12.2(13)T	This command was modified to display the Frame Relay data-link connection identified (DLCI) number as a criterion for matching traffic inside a class map. In addition, this command was modified to display Layer 3 packet length as a criterion for matching traffic inside a class map.
12.4(4)T	The **type**, **stack**, and **access-control** keywords were added to support flexible packet matching (FPM).
12.2(28)SB	This command was integrated into Cisco IOS Release 12.2(28)SB.

Usage Guidelines

You can use the **show class-map** command to display all class maps and their matching criteria. If you enter the optional *class-map-name* argument, the specified class map and its matching criteria will be displayed.

Examples

In the following example, three class maps are defined. Packets that match access list 103 belong to class c3, IP packets belong to class c2, and packets that come through input Ethernet interface 1/0 belong to class c1. The output from the **show class-map** command shows the three defined class maps.

```
Router# show class-map

 Class Map c3
 Match access-group 103

 Class Map c2
 Match protocol ip

 Class Map c1
 Match input-interface Ethernet1/0
```

In the following example, a class map called “c1” has been defined, and the Frame Relay DLCI number of 500 has been specified as a match criterion:

```
Router# show class-map

class map match-all c1
   match fr-dlci 500
```

Table 1 describes the significant fields shown in the display.

Table 1 show class-map Field Descriptions[1]

Field	Description
Class Map	Class of traffic being displayed. Output is displayed for each configured class map in the policy. The choice for implementing class matches (for example, match-all or match-any) can also appear next to the traffic class.
Match	Match criteria specified for the class map. Choices include criteria such as the Frame Relay DLCI number, Layer 3 packet length, IP precedence, IP differentiated services code point (DSCP) value, Multiprotocol Label Switching (MPLS) experimental value, access groups, and quality of service (QoS) groups.

1. A number in parentheses may appear next to the class-map name, and match criteria information. The number is for Cisco internal use only and can be disregarded.

Related Commands

Command	Description
class-map	Creates a class map to be used for matching packets to a specified class.
match fr-dlci	Specifies the Frame Relay DLCI number as a match criterion in a class map.
match packet length (class-map)	Specifies and uses the length of the Layer 3 packet in the IP header as a match criterion in a class map.
show policy-map	Displays the configuration of all classes for a specified service policy map or all classes for all existing policy maps.
show policy-map interface	Displays the packet statistics of all classes that are configured for all service policies either on the specified interface or subinterface or on a specific PVC on the interface.