



# VRF and MQC Hierarchical Shaping in PXF

---

## Feature History

Release	Modification
12.2(15)B	This feature was introduced on the Cisco 7200 series and Cisco 7401ASR.
12.3(4)T	This feature for the Cisco 7200 series and Cisco 7401ASR was integrated into Cisco IOS Release 12.3(4)T.

This document describes the VRF and MQC Hierarchical Shaping in PXF feature in Cisco IOS Release 12.2(15)B and Cisco IOS Release 12.3(4)T. It includes the following sections:

- [Feature Overview, page 1](#)
- [Supported Platforms, page 3](#)
- [Supported Standards, MIBs, and RFCs, page 4](#)
- [Prerequisites, page 4](#)
- [Configuration Tasks, page 5](#)
- [Monitoring and Maintaining VRF and MQC Hierarchical Shaping in PXF, page 7](#)
- [Configuration Examples, page 8](#)
- [Command Reference, page 9](#)
- [Glossary, page 13](#)

## Feature Overview

VRF and MQC Hierarchical Shaping in PXF implements Virtual Route Forwarding (VRF) and Modular Quality of Service Command-Line Interface (MQC) hierarchical shaping in the Parallel Express Forwarding (PXF) path.

### PXF

The Parallel Express Forwarding (PXF) processor enables parallel IP multipacket processing functions, working with the Route Processor (RP) to provide accelerated packet switching, as well as accelerated IP Layer 3 feature processing.

For more information about PXF, including troubleshooting information, refer to the [Cisco 7401ASR Installation and Configuration Guide](#).

## MQC

Modular Quality of Service Command-Line Interface (MQC) is designed to simplify the configuration of Quality of Service (QoS) on Cisco routers and switches by defining a common command syntax and resulting set of QoS behaviors across platforms. This model replaces the previous model of defining unique syntaxes for each QoS feature and for each platform.

The MQC contains the following three steps:

- Define a traffic class by issuing the **class-map** command.
- Create a traffic policy by associating the traffic class with one or more QoS features by issuing the **policy-map** command.
- Attach the traffic policy to the interface, subinterface, or virtual circuit (VC) by issuing the **service-policy** command.

For more information about MQC, refer to the [Modular Quality of Service Command-Line Interface](#) document.

## Hierarchical Shaping

Using hierarchical shaping, it is possible to configure a group of classes to which class-based weighted fair queueing (CBWFQ) is applied within that group of classes. These separate classes can then be treated as an aggregate class for the purpose of shaping amongst other classes.

For more information about other QoS features supported by PXF, see the “Quality of Service Features for Parallel Express Forwarding” section of the [Release Notes for Cisco 7000 Family for Cisco IOS Release 12.2 B](#) for Cisco IOS Release 12.2(4)B.

## VRF

A VRF consists of an IP routing table, a derived Cisco Express Forwarding (CEF) table (which includes forwarding information base [FIB] and Adjacency tables), and a set of interfaces that use this forwarding table. A VRF consists of the following:

- IP routing table
- Cisco Express Forwarding (CEF) table
- Set of interfaces that use the CEF forwarding table
- Set of rules and routing protocol parameters to control the information in the routing tables

VRF PXF offloads any VRF-related routing from the Route Processor (RP) to the PXF.

## Benefits

This feature enables service providers to turn on VRF and MQC Hierarchical Shaping in PXF concurrently with other features in the PXF path without significant performance degradation.

## Restrictions

- A parent policy can have only one reachable class. This class can be the default class or a named class with “match any” as its match criterion. If there is no reachable class, PXF punts packets to the RP.
- When the **show policy interface** command is entered, the “packets delayed” and “bytes displayed” are not displayed for all PXF shaping.

- If you configure a policy on an interface and on one of its subinterfaces, packet match statistics are displayed by the **show policy interface** command only for the interface, and not for the subinterface.
- The class in the parent policy is allowed only two actions, shape and, optionally, bandwidth.

## Related Features and Technologies

- Multi-VRF CE
- Per VRF AAA

## Related Documents

- [Cisco IOS Quality of Service Solutions Command Reference](#), Release 12.3
- [Cisco IOS Quality of Service Solutions Configuration Guide](#) Release 12.3
- [Cisco 7401ASR Installation and Configuration Guide](#)
- [Modular Quality of Service Command-Line Interface](#)
- [Per VRF AAA](#)
- “Quality of Service Features for Parallel Express Forwarding” section of the [Release Notes for Cisco 7000 Family for Cisco IOS Release 12.2 B](#) Cisco IOS Release 12.2(4)B
- [Session Limit Per VRF](#)

## Supported Platforms

- Cisco 7200 series
- Cisco 7401ASR

### Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that are supported on specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator. Cisco Feature Navigator dynamically updates the list of supported platforms as new platform support is added for the feature.

Cisco Feature Navigator is a web-based tool that enables you to determine which Cisco IOS software images support a specific set of features and which features are supported in a specific Cisco IOS image. You can search by feature or release. Under the release section, you can compare releases side by side to display both the features unique to each software release and the features in common.

To access Cisco Feature Navigator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to [cco-locksmith@cisco.com](mailto:cco-locksmith@cisco.com). An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions found at this URL:

<http://www.cisco.com/register>

Cisco Feature Navigator is updated regularly when major Cisco IOS software releases and technology releases occur. For the most current information, go to the Cisco Feature Navigator home page at the following URL:

<http://www.cisco.com/go/fn>

#### **Availability of Cisco IOS Software Images**

Platform support for particular Cisco IOS software releases is dependent on the availability of the software images for those platforms. Software images for some platforms may be deferred, delayed, or changed without prior notice. For updated information about platform support and availability of software images for each Cisco IOS software release, refer to the online release notes or, if supported, Cisco Feature Navigator.

## Supported Standards, MIBs, and RFCs

### **Standards**

No new or modified standards are supported by this feature.

### **MIBs**

No new or modified MIBs are supported by this feature.

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/ITDIT/MIBS/servlet/index>

If Cisco MIB Locator does not support the MIB information that you need, you can also obtain a list of supported MIBs and download MIBs from the Cisco MIBs page at the following URL:

<http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml>

To access Cisco MIB Locator, you must have an account on Cisco.com. If you have forgotten or lost your account information, send a blank e-mail to [cco-locksmith@cisco.com](mailto:cco-locksmith@cisco.com). An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you. Qualified users can establish an account on Cisco.com by following the directions found at this URL:

<http://www.cisco.com/register>

### **RFCs**

No new or modified RFCs are supported by this feature.

## Prerequisites

To use the PXF processing, you must have IP CEF switching enabled.

## Configuration Tasks

See the following sections for the optional configuration tasks for the VRF and MQC Hierarchical Shaping in PXF feature. Each task in the list is identified as either required or optional.



### Note

For more information about general MQC configuration tasks, refer to the [Modular Quality of Service Command-Line Interface](#) document.

- [Configuring MQC Hierarchical Shaping, page 5](#) (optional)
- [Enabling the PXF Processors, page 6](#) (optional)
- [Verifying the PXF Processors, page 7](#) (optional)

## Configuring MQC Hierarchical Shaping

To configure MQC Hierarchical Shaping, enter the commands below, beginning in global configuration mode:

	Command	Purpose
Step 1	Router(config)# <b>class-map</b> <i>class-map-name</i>	Creates a class map to be used for matching packets to a specified class and enters QoS class-map configuration mode. <ul style="list-style-type: none"> <li>• <i>class-map-name</i>—Name of the class for the class map. The name can be a maximum of 40 alphanumeric characters. The class name is used for both the class map and to configure policy for the class in the policy map.</li> </ul>
Step 2	Router(config-cmap)# <b>match access-group</b> <i>access-group</i>	Configures the match criteria for a class map on the basis of the specified access control list (ACL). <ul style="list-style-type: none"> <li>• <i>access-group</i>—A numbered ACL whose contents are used as the match criteria against which packets are checked to determine if they belong to this class.</li> </ul>
Step 3	(Optional) Repeat Step 1 and Step 2 to configure additional class maps.	
Step 4	Router(config-cmap)# <b>exit</b>	Exits class-map configuration mode.
Step 5	Router(config)# <b>policy-map</b> <i>child-policy-map-name</i>	Creates a child policy map that is attached to one or more interfaces to specify a service policy and enters QoS policy-map configuration mode. <ul style="list-style-type: none"> <li>• <i>child-policy-map-name</i>—Name of the child policy map. The name can be a maximum of 40 alphanumeric characters.</li> </ul>
Step 6	Router(config-pmap)# <b>class</b> <i>class-name</i>	Identifies the class map created in Step 1.
Step 7	Router(config-pmap-c)# <b>bandwidth</b> <i>bandwidth-kbps</i>	Specifies or modifies the bandwidth allocated for a class belonging to a policy map. <ul style="list-style-type: none"> <li>• <i>bandwidth-kbps</i>—Amount of bandwidth, in kbps, to be assigned to the class.</li> </ul>

	Command	Purpose
Step 8	Router(config-pmap-c) # <b>exit</b>	(Optional) Exits policy-map class configuration mode. Enter this command if you are configuring additional policy map classes. Proceed to Step 10 to configure additional policy map class parameters.
Step 9	(Optional) Repeat Steps 6–8 to configure additional policy map classes and to allocate bandwidth to those classes.	
Step 10	Router(config) # <b>class-map</b> <i>class-map-name</i>	Creates a second class map for use in the parent policy.
Step 11	Router(config-cmap) # <b>match any</b>	Configures the match criteria for a class map to be a successful match criteria for all packets.
Step 12	Router(config-cmap) # <b>exit</b>	Exits class-map configuration mode.
Step 13	Router(config) # <b>policy-map</b> <i>parent-policy-map-name</i>	Creates or modifies a parent policy map that can be attached to one or more interfaces to specify a service policy. <ul style="list-style-type: none"> <li><i>parent-policy-map-name</i>—Name of the parent policy map. The name can be a maximum of 40 alphanumeric characters.</li> </ul>
Step 14	Router(config-pmap) # <b>class</b> <i>class-name</i>	Specifies the name of the class created in Step 10. <ul style="list-style-type: none"> <li><i>class-name</i>—The name of the class for which you want to configure or modify the actions in this policy.</li> </ul>
Step 15	Router(config-pmap-c) # <b>bandwidth</b> <i>bandwidth-kbps</i>	(Optional) Specifies or modifies the bandwidth allocated for a class belonging to a policy map. <ul style="list-style-type: none"> <li><i>bandwidth-kbps</i>—Amount of bandwidth, in kbps, to be assigned to the class.</li> </ul>
Step 16	Router(config-pmap-c) # <b>shape average</b> <i>mean-rate</i>	Shapes traffic to the indicated bit rate according to the algorithm specified. <ul style="list-style-type: none"> <li><b>average</b>—Committed burst (Bc) is the maximum number of bits sent out in each interval.</li> <li><i>mean-rate</i>—Indicates the bit rate used to shape the traffic, in bits per second.</li> </ul>
Step 17	Router(config-pmap-c) # <b>service-policy</b> <i>child-policy-map-name</i>	Identifies the policy to be used for prioritizing traffic within the shaping rate. <ul style="list-style-type: none"> <li><i>child-policy-map-name</i>—Name of the child policy map. The name can be a maximum of 40 alphanumeric characters.</li> </ul>
Step 18	Router(config-pmap-c) # <b>exit</b>	Exits policy-map class configuration mode.
Step 19	Router(config-pmap) # <b>exit</b>	Exits policy-map configuration mode.

## Enabling the PXF Processors

The PXF processors are enabled by default. If they are disabled, use the following commands in global configuration mode to enable PXF:

	Command	Purpose
Step 1	Router(config) # <b>ip cef</b>	Enables IP CEF switching on the Route Processor, if it is not currently enabled.
Step 2	Router(config-if) # <b>ip pxf</b>	Enables IP switching in PXF.

## Verifying the PXF Processors

PXF is enabled by default. The output of the **show running-config** command indicates that PXF is disabled by displaying “no ip pxf.” If you do not see “no ip pxf,” PXF is enabled.

```
Router# show running-config

Building configuration...

Current configuration : 1227 bytes
!
version 12.2
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router
!
boot system flash disk0:c7200-js-mz.122-8.B
enable password password1
!
ip subnet-zero
ip cef
!
no ip pxf
!
!
```

## Troubleshooting Tips

For PXF troubleshooting tips, refer to the “[PXF Troubleshooting Information](#)” section of the “[Configuration Tasks and Troubleshooting Information](#)” chapter of the *Network Processing Engine and Network Services Engine Installation and Configuration* document.

## Monitoring and Maintaining VRF and MQC Hierarchical Shaping in PXF

Use the following commands to monitor and maintain VRF and MQC Hierarchical Shaping in PXF:

Command	Purpose
Router# <b>show pxf accounting</b>	Displays PXF switching statistics for individual interfaces.
Router# <b>show pxf crash</b>	Displays PXF crash information.
Router# <b>show pxf feature cef</b>	Displays PXF routing feature tables for CEF.
Router# <b>show pxf feature cef vrf</b>	Displays the routing feature tables for VRFs on the PXF path.
Router# <b>show pxf interface</b>	Displays a summary of the interfaces on the router and the PXF features or capabilities enabled on these interfaces.
Router# <b>show policy-map interface</b>	Displays the configuration of all classes configured for all service policies on the specified interface.

# Configuration Examples

This section provides the following configuration examples:

- [Configuring MQC Hierarchical Shaping Example](#)
- [Enabling the PXF Processors Example](#)

## Configuring MQC Hierarchical Shaping Example

The following example shows how to configure hierarchical shaping:

```
class-map match-all Voice
  match access-group 2050
class-map match-all Business
  match access-group 2100
class-map match-all Mgmt
  match access-group 2150
class-map match-all Standard
  match access-group 2200
!
policy-map qos
  class Business
    bandwidth percent 80
    random-detect
    random-detect precedence 2 24 40 1
    police <Business rate with parameters> conform-action
      set-prec-transmit 3 exceed-action set-prec-
transmit 2
  class Standard
    bandwidth percent 20
    random-detect
policy-map <bandwidth>-out
  class class-default
    shape average <upper bandwidth>
    service-policy qos
!
interface FastEthernet1/0
  description unused
  bandwidth 100000
  ip address 192.168.71.98 255.255.255.252
  no ip redirects
  no ip proxy-arp
  service-policy output <bandwidth>-out
  duplex full
```

## Enabling the PXF Processors Example

The PXF processors are enabled by default. The following example shows how to enable PXF processors that have been disabled on a system on which IP CEF has also been disabled:

```
ip cef
ip pxf
```

# Command Reference

This section documents the new **show pxf feature cef vrf** command introduced by the VRF and MQC Hierarchical Shaping in PXF feature. All other commands used with this feature are documented in the [Cisco IOS Release 12.3 T command reference](#) publications.

- [show pxf feature cef vrf](#)

# show pxf feature cef vrf

To display the routing feature tables for VRFs on the PXF path, use the **show pxf feature cef vrf** command in privileged EXEC mode.

```
show pxf feature cef vrf vpn-name
```

Syntax Description	<i>vpn-name</i>	Name of the VPN to display.
--------------------	-----------------	-----------------------------

**Defaults** No default behavior or values.

**Command Modes** Privileged EXEC

Command History	Release	Modification
	12.2(15)B	This command was introduced.
	12.3(4)T	This command was integrated into Cisco IOS Release 12.3(4)T.

**Usage Guidelines** Use this command to display VRF PXF routing feature tables for CEF about a specified VPN. This command also displays information about prefix and MTRIE resource usage.

**Examples** The following is sample output for the **show pxf feature cef vrf** command for displaying information about the VRF “vpn1”:

```
Router# show pxf feature cef vrf vpn1
```

```
Shadow 8-8-4-4-8 PXF Mtrie:
 51 leaves, 2448 leaf bytes, 92 nodes, 56352 node bytes
 10 invalidations
 61 prefix updates
refcounts: 3666 leaf, 3733 node
```

Prefix/Length	Refcount	Parent	Address	Shadow
0.0.0.0/32	3		0xC0047218	0x62CAF2E8
5.0.0.0/16	558		0xC0047278	0x62CAF108
5.0.0.0/32	3	5.0.0.0/16	0xC0047268	0x62CAEE08
5.0.0.1/32	3	5.0.0.0/16	0xC0047260	0x62CAEA18
5.0.0.2/32	3	5.0.0.0/16	0xC0047388	0x62CAEA48
5.0.255.255/32	3	5.0.0.0/16	0xC0047270	0x62CAF0D8
30.1.0.0/16	288		0xC0047360	0x62CAEB38
30.1.1.1/32	3	30.1.0.0/16	0xC0047350	0x62CAEB98
70.0.0.0/32	3		0xC00472C0	0x62CAEEF8
70.1.1.1/32	3		0xC0047358	0x62CAEB68
70.1.1.2/32	3		0xC0047368	0x62CAEB08
70.1.1.3/32	3		0xC0047370	0x62CAEAD8
70.1.1.4/32	3		0xC0047378	0x62CAEAA8
70.1.1.5/32	3		0xC0047380	0x62CAEA78

```

224.0.0.0/24          3          0xC0047228 0x62CAF288
255.255.255.255/32  3          0xC0047220 0x62CAF2B8
=====
5 routes with less specific overlapping parent route

```

Table 1 describes the significant fields shown in the display.

**Table 1** *show pxf feature cef vrf Field Descriptions*

Field	Description
Shadow 8-8-4-4-8 PXF Mtrie:	MTRIE look-up table index structures.
51 leaves	All created leaves for all MTRIES.
2448 leaf bytes	Leaf byte counter. When a new leaf is created, the leaf byte counter is incremented by the size of the leaf structure.
92 nodes	All created nodes for all MTRIES.
56352 node bytes	Node byte counter. When a new node is created, the node byte counter is incremented.
10 invalidations	Invalidation counter. When a route (represented by a leaf) is deleted from a MTRIE, the invalidations counter is incremented. This counter includes all MTRIES.
61 prefix updates	IP prefix counter. When an IP prefix (represented by a leaf) is added to the MTRIE, the IP prefix counter is incremented. This counter includes all MTRIES.
refcounts:	Counters associated with references between leaves.
3666 leaf	MTRIES have leaf lock and leaf free functions. The leaf lock function increments the leaf refcount. The leaf free function decrements the leaf refcount. The leaf lock and leaf free functions prevent a leaf from being freed (deleted) while the leaf is still being referenced. This counter includes all MTRIES.
3733 node	Node counter. When a child node is added to another node, the node the child node is added to becomes a parent node. The node counter is decremented when a child node is deleted. This counter includes all MTRIES.
Prefix/Length	The IP address and subnet mask of a leaf.
Refcount	The number of leaves that reference a specified leaf. The refcount counter is incremented when the leaf lock function is called and decremented when the leaf free function is called.
Parent	When you add a less-specific route to a more-specific route, the more-specific route has a back pointer that points to the less-specific route when the less-specific route is added to the more-specific route. The back pointer represents the less-specific route to which the back pointer points.
Address	The address of the memory for the specified leaf.
Shadow	The shadow address in Route Processor memory for the specified leaf.

■ `show pxf feature cef vrf`**Related Commands**

<b>Command</b>	<b>Description</b>
<code>show pxf feature cef</code>	Displays PXF routing feature tables for CEF.
<code>show pxf feature nat</code>	Displays PXF routing feature tables for NAT.

# Glossary

**AAA**—Authentication, Authorization, and Accounting.

**CBWFQ**—Class-based weighted fair queueing. Class-based weighted fair queueing extends the standard weighted fair queueing (WFQ) functionality to provide support for user-defined traffic classes.

**CEF**—Cisco Express Forwarding.

**MTRIE**—A balanced-tree variation where the number of child nodes for each parent node may differ at each tree level, and the children of a parent node may be different types of nodes.

**PXF**—Parallel Express Forwarding.

**QoS**—Quality of Service.

**RP**—Route Processor. Processor module in the Cisco 7000 family routers that contains the CPU, system software, and most of the memory components that are used in the router.

**VPN**—Virtual Private Network. A system that permits dial-in networks to exist remotely to home networks, while giving the appearance of being directly connected. VPNs use L2TP and L2F to terminate the Layer 2 and higher parts of the network connection at the LNS instead of the LAC.

**VRF**—Virtual Route Forwarding. Initially, a router has only one global default routing/forwarding table. VRFs can be viewed as multiple disjointed routing/forwarding tables, where the routes of a user have no correlation with the routes of another user.

**WFQ**—Weighted fair queuing. Congestion management algorithm that identifies conversations (in the form of traffic streams), separates packets that belong to each conversation, and ensures that capacity is shared fairly between these individual conversations. WFQ is an automatic way of stabilizing network behavior during congestion and results in increased performance and reduced retransmission.

