



Frame Relay Queueing and Fragmentation at the Interface

Feature History

| Release | Modification |
|--------------------------|---|
| 12.2(11)S | This feature was introduced. |
| 12.2(13)T | This feature was integrated into Cisco IOS Release 12.2(13)T |
| Cisco IOS XE Release 2.1 | This feature was introduced on Cisco ASR 1000 series routers. |

This document describes the Frame Relay Queueing and Fragmentation at the Interface feature. This document includes the following sections:

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Feature Overview

The Frame Relay Queueing and Fragmentation at the Interface feature introduces support for low-latency queueing (LLQ) and FRF.12 end-to-end fragmentation on a Frame Relay interface. This new feature simplifies the configuration of low-latency, low-jitter quality of service (QoS) by enabling the queueing policy and fragmentation configured on the main interface to apply to all permanent virtual circuits (PVCs) and subinterfaces under that interface. Before the introduction of this feature, queueing and fragmentation had to be configured on each individual PVC. Subrate shaping can also be configured on the interface.



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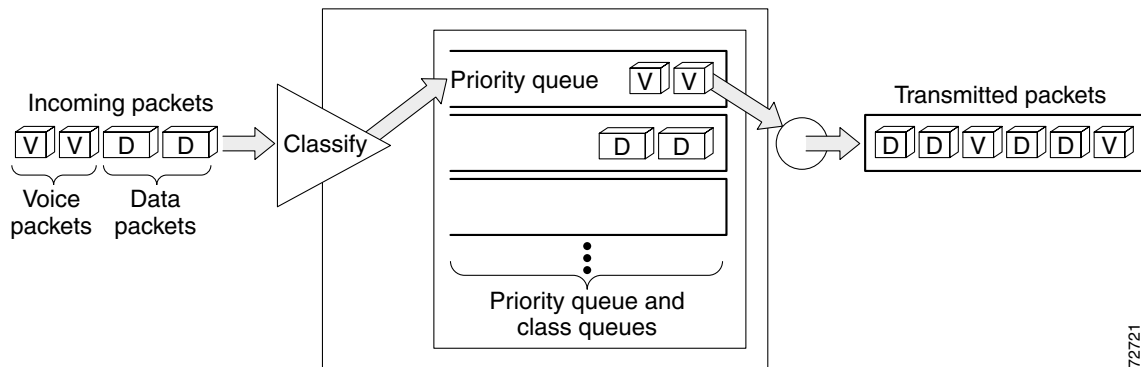
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How Frame Relay Queueing and Fragmentation at the Interface Works

When FRF.12 end-to-end fragmentation is enabled on an interface, all PVCs on the main interface and its subinterfaces will have fragmentation enabled with the same configured fragment size. To maintain low latency and low jitter for high-priority traffic, the configured fragment size must be greater than the largest high-priority frames. This configuration will prevent high-priority traffic from being fragmented and queued behind lower-priority fragmented frames. If the size of a high-priority frame is larger than the configured fragment size, the high-priority frame will be fragmented. Local Management Interface (LMI) traffic will not be fragmented and is guaranteed its required bandwidth.

When a low-latency queueing policy map is applied to the interface, traffic through the interface is identified using class maps and is directed to the appropriate queue. Time-sensitive traffic such as voice should be classified as high priority and will be queued on the priority queue. Traffic that does not fall into one of the defined classes will be queued on the class-default queue. Frames from the priority queue and class queues are subject to fragmentation and interleaving. As long as the configured fragment size is larger than the high-priority frames, the priority queue traffic will not be fragmented and will be interleaved with fragmented frames from other class queues. This approach provides the highest QoS transmission for priority queue traffic. Figure 1 illustrates the interface queueing and fragmentation process.

Figure 1 Frame Relay Queueing and Fragmentation at the Interface



Subrate shaping can also be applied to the interface, but interleaving of high-priority frames will not work when shaping is configured. If shaping is not configured, each PVC will be allowed to send bursts of traffic up to the physical line rate.

When shaping is configured and traffic exceeds the rate at which the shaper can send frames, the traffic is queued at the shaping layer using fair queueing. After a frame passes through the shaper, the frame is queued at the interface using whatever queueing method is configured. If shaping is not configured, then queueing occurs only at the interface.



Note

For interleaving to work, both fragmentation and the low-latency queueing policy must be configured with shaping disabled.

The Frame Relay Queueing and Fragmentation at the Interface feature supports the following functionality:

- Voice over Frame Relay
- Weighted Random Early Detection
- Frame Relay payload compression

**Note**

When payload compression and Frame Relay fragmentation are used at the same time, payload compression is always performed before fragmentation.

- IP header compression

Benefits

Simple Configuration

The Frame Relay Queueing and Fragmentation at the Interface feature allows fragmentation, low-latency queueing, and subrate shaping to be configured on a Frame Relay interface queue. The fragmentation and queueing and shaping policy will apply to all PVCs and subinterfaces under the main interface, eliminating the need to configure QoS on each PVC individually.

Flexible Bandwidth

This feature allows PVCs to preserve the logical separation of traffic from different services while reducing bandwidth partitioning between PVCs. Each PVC can send bursts of traffic up to the interface shaping rate or, if shaping is not configured, the physical interface line rate.

Restrictions

- Interface fragmentation and Frame Relay traffic shaping cannot be configured at the same time.
- Interface fragmentation and class-based fragmentation cannot be configured at the same time.
- Frame Relay switched virtual circuits (SVCs) are not supported.
- Hierarchical shaping and multiple shapers are not supported.

Related Documents

For more information about shaping and low-latency queueing for Frame Relay, refer to the following documents:

- *Cisco IOS Quality of Service Solutions Configuration Guide*, Release 12.2
- *Cisco IOS Quality of Service Solutions Command Reference*, Release 12.2
- *Low Latency Queueing for Frame Relay*, Cisco IOS Release 12.1(2)T feature module

For more information about Frame Relay fragmentation, refer to the following documents:

- *Cisco IOS Wide-Area Networking Configuration Guide*, Release 12.2
- *Cisco IOS Wide-Area Networking Command Reference*, Release 12.2

Supported Platforms

- Cisco 800 series
- Cisco 1400 series
- Cisco 1600 series

- Cisco 2500 series
- Cisco 2600 series
- Cisco 3600 series
- Cisco 7100 series
- Cisco 7200 series
- Cisco 7500 series
- Cisco AS5300 series
- Cisco AS5400
- Cisco AS5800
- Cisco MC3810
- Ciscoubr7200 series

Determining Platform Support Through Cisco Feature Navigator

Cisco IOS software is packaged in feature sets that support 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.

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<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

FRF.12, *Frame Relay Fragmentation Implementation Agreement*, December 1997

MIBs

No new or modified MIBs are supported by this feature.

To obtain lists of supported MIBs by platform and Cisco IOS release, and to download MIB modules, go to the Cisco MIB website on Cisco.com at the following URL:

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

RFCs

No new or modified RFCs are supported by this feature.

Prerequisites

The tasks in this document assume that you know how to configure low-latency queuing and shaping service policies.

The following prerequisites are specific to the Cisco 7500 series:

- The Frame Relay Queuing and Fragmentation at the Interface feature is supported on VIP-based interfaces with VIP2-50 or higher.
- Distributed Cisco Express Forwarding (dCEF) must be enabled both globally and on the Frame Relay interface.

Configuration Tasks

See the following sections for configuration tasks for the Frame Relay Queuing and Fragmentation at the Interface feature. Each task in the list is identified as either required or optional.

- [Configuring Class Policy for the Priority Queue](#) (required)
- [Configuring Class Policy for the Bandwidth Queues](#) (optional)
- [Configuring the Shaping Policy Using the Class-Default Class](#) (optional)
- [Configuring Queuing and Fragmentation on the Frame Relay Interface](#) (required)
- [Verifying Frame Relay Queuing and Fragmentation at the Interface](#) (optional)

Configuring Class Policy for the Priority Queue

To configure a policy map for the priority class, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|--------|--|---|
| Step 1 | Router(config)# policy-map <i>policy-map</i> | Specifies the name of the policy map to be created or modified. <ul style="list-style-type: none"> Use this command to define the queuing policy for the priority queue. |
| Step 2 | Router(config-pmap)# class <i>class-name</i> | Specifies the name of a class to be created and included in the service policy. <ul style="list-style-type: none"> The class name that you specify in the policy map defines the characteristics for that class and its match criteria as configured using the class-map command. |
| Step 3 | Router(config-pmap-c)# priority <i>bandwidth-kbps</i> | Creates a strict priority class and specifies the amount of bandwidth, in kbps, to be assigned to the class. |

Configuring Class Policy for the Bandwidth Queues

To configure a policy map and create class policies that make up the service policy, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|--------|---|--|
| Step 1 | Router(config)# policy-map <i>policy-map</i> | Specifies the name of the policy map to be created or modified. <ul style="list-style-type: none"> The bandwidth queues and the priority queue use the same policy map. |
| Step 2 | Router(config-pmap)# class <i>class-name</i> | Specifies the name of a class to be created and included in the service policy. <ul style="list-style-type: none"> The class name that you specify in the policy map defines the characteristics for that class and its match criteria as configured using the class-map command. |
| Step 3 | Router(config-pmap-c)# bandwidth <i>bandwidth-kbps</i> | Specifies the amount of bandwidth to be assigned to the class, in kbps, or as a percentage of the available bandwidth. Bandwidth must be specified in kbps or as a percentage consistently across classes. (Bandwidth of the priority queue must be specified in kbps.) <ul style="list-style-type: none"> The sum of all bandwidth allocation on an interface cannot exceed 75 percent of the total available interface bandwidth. However, if you need to configure more than 75 percent of the interface bandwidth to classes, you can override the 75 percent maximum by using the max-reserved-bandwidth command. |

Configuring the Shaping Policy Using the Class-Default Class

In general, the class-default class is used to classify traffic that does not fall into one of the defined classes. Even though the class-default class is predefined when you create the policy map, you still have to configure it. If a default class is not configured, traffic that does not match any of the configured classes is given best-effort treatment, which means that the network will deliver the traffic if it can, without any assurance of reliability, delay prevention, or throughput.

If you configure shaping in addition to queuing on the interface, use the class-default class to configure the shaping policy. The shaping policy will serve as the parent in a hierarchical traffic policy. The queuing policy will serve as the child policy. The class-default class is used for the shaping policy so that all traffic for the entire interface is shaped and a bandwidth-limited stream can be created.

To configure the shaping policy in the class-default class, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|--------|--|---|
| Step 1 | <code>Router(config)# policy-map policy-map</code> | Specifies the name of the policy map to be created or modified. <ul style="list-style-type: none"> Use this command to define the shaping policy. |
| Step 2 | <code>Router(config-pmap)# class class-default</code> | Specifies the default class so that you can configure or modify its policy. |
| Step 3 | <code>Router(config-pmap-c)# shape [average peak] mean-rate [[burst-size] [excess-burst-size]]</code> | (Optional) Shapes traffic to the indicated bit rate according to the algorithm specified. |
| Step 4 | <code>Router(config-pmap-c)# service-policy policy-map-name</code> | Specifies the name of a policy map to be used as a matching criterion (for nesting traffic policies [hierarchical traffic policies] within one another). <ul style="list-style-type: none"> Use this command to attach the policy map for the priority queue (the child policy) to the shaping policy (the parent policy). |

Configuring Queuing and Fragmentation on the Frame Relay Interface

To configure low-latency queuing and FRF.12 end-to-end fragmentation on a Frame Relay interface, use the following commands beginning in global configuration mode:

| | Command | Purpose |
|--------|--|---|
| Step 1 | <code>Router(config)# interface type number</code> | Configures an interface type and enters interface configuration mode. |
| Step 2 | <code>Router(config-if)# encapsulation frame-relay</code> | Enables Frame Relay encapsulation. |

| | Command | Purpose |
|--------|---|--|
| Step 3 | Router(config-if)# service-policy output <i>policy-map-name</i> | <p>Attaches a policy map to an output interface, to be used as the service policy for that interface.</p> <ul style="list-style-type: none"> • If shaping is being used, use this command to attach the shaping policy (which includes the nested queueing policy) to the interface. • Interleaving of high-priority frames will not work if shaping is configured on the interface. • If shaping is not being used, use this command to attach the queueing policy to the interface. |
| Step 4 | Router(config-if)# frame-relay fragment <i>fragment-size</i> end-to-end | <p>Enables fragmentation of Frame Relay frames.</p> <ul style="list-style-type: none"> • To maintain low latency and low jitter for priority queue traffic, configure the fragment size to be greater than the largest high-priority frame that would be expected. |

Verifying Frame Relay Queueing and Fragmentation at the Interface

To verify the configuration and performance of Frame Relay queueing and fragmentation at the interface, perform the following steps:

Step 1 Enter the **show running-config** command to verify the configuration.

```
Router# show running-config
Building configuration...

.
.
.

class-map match-all voice
  match ip precedence 5
!
!policy-map llq
  class voice
    priority 64
policy-map shaper
  class class-default
    shape peak 96000
    service-policy llq
!
!interface Serial1/1
ip address 16.0.0.1 255.255.255.0
encapsulation frame-relay
service-policy output shaper
frame-relay fragment 80 end-to-end
!
```

Step 2 Enter the **show policy-map interface** command to display low-latency queueing information, packet counters, and statistics for the policy map applied to the interface. Compare the values in the “packets” and the “pkts matched” counters; under normal circumstances, the “packets” counter is much larger than the “pkts matched” counter. If the values of the two counters are nearly equal, then the interface is receiving a large number of process-switched packets or is heavily congested.

The following sample output for the **show policy-map interface** command is based on the configuration in Step 1:

```
Router# show policy-map interface serial 1/1

Serial1/1

Service-policy output:shaper

Class-map:class-default (match-any)
 12617 packets, 1321846 bytes
 5 minute offered rate 33000 bps, drop rate 0 bps
Match:any
Traffic Shaping
   Target/Average   Byte   Sustain   Excess   Interval   Increment
   Rate             Limit  bits/int  bits/int  (ms)       (bytes)
   192000/96000     1992   7968      7968      83         1992

Adapt Queue      Packets  Bytes    Packets  Bytes    Shaping
Active Depth
-      0          12586   1321540  0        0        no

Service-policy :llq

Class-map:voice (match-all)
 3146 packets, 283140 bytes
 5 minute offered rate 7000 bps, drop rate 0 bps
Match:ip precedence 1
Weighted Fair Queueing
  Strict Priority
  Output Queue:Conversation 24
  Bandwidth 64 (kbps) Burst 1600 (Bytes)
  (pkts matched/bytes matched) 0/0
  (total drops/bytes drops) 0/0

Class-map:class-default (match-any)
 9471 packets, 1038706 bytes
 5 minute offered rate 26000 bps
Match:any
```

- Step 3** Enter the **show interfaces serial** command to display information about the queuing strategy, priority queue interleaving, and type of fragmentation configured on the interface. You can determine whether the interface has reached a congestion condition and packets have been queued by looking at the “Conversations” fields. A nonzero value for “max active” counter shows whether any queues have been active. If the “active” counter is a nonzero value, you can use the **show queue** command to view the contents of the queues.

The following sample output for the **show interfaces serial** command is based on the configuration in Step 1:

```
Router# show interfaces serial 1/1

Serial1/1 is up, line protocol is up
Hardware is M4T
Internet address is 16.0.0.1/24
MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec,
  reliability 255/255, txload 5/255, rxload 1/255
Encapsulation FRAME-RELAY, crc 16, loopback not set
Keepalive set (10 sec)
Restart-Delay is 0 secs
LMI enq sent 40, LMI stat recvd 40, LMI upd recvd 0, DTE LMI up
LMI enq recvd 0, LMI stat sent 0, LMI upd sent 0
LMI DLCI 1023 LMI type is CISCO frame relay DTE
```

```

Fragmentation type:end-to-end, size 80, PQ interleaves 0
Broadcast queue 0/64, broadcasts sent/dropped 0/0, interface broadcasts 0
Last input 00:00:03, output 00:00:00, output hang never
Last clearing of "show interface" counters 00:06:34
Input queue:0/75/0/0 (size/max/drops/flushes); Total output drops:0
Queueing strategy:weighted fair
Output queue:0/1000/64/0 (size/max total/threshold/drops)
  Conversations 0/1/256 (active/max active/max total)
  Reserved Conversations 0/0 (allocated/max allocated)
  Available Bandwidth 1158 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 33000 bits/sec, 40 packets/sec
  40 packets input, 576 bytes, 0 no buffer
  Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  15929 packets output, 1668870 bytes, 0 underruns
  0 output errors, 0 collisions, 0 interface resets
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions      DCD=up DSR=up DTR=up RTS=up CTS=up

```

Monitoring and Maintaining Frame Relay Queueing and Fragmentation at the Interface

To monitor and maintain Frame Relay queueing and fragmentation at the interface, use the following commands in privileged EXEC mode:

| Command | Purpose |
|---|--|
| Router# debug frame-relay fragment [<i>event</i> <i>interface type number dlc</i>] | Displays information related to Frame Relay fragmentation on a PVC. |
| Router# show frame-relay fragment [<i>interface type number [dlc]</i>] | Displays information about Frame Relay fragmentation. |
| Router# show interfaces serial <i>number</i> | Displays information about a serial interface. |
| Router# show queue <i>interface-type interface-number</i> | Displays the contents of packets inside a queue for a particular interface. |
| Router# show policy-map interface <i>number</i> [<i>input</i> <i>output</i>] | Displays the packet statistics of all classes that are configured for all service policies on the specified interface. |

Configuration Examples

This section provides the following configuration examples:

- [Frame Relay Queueing, Shaping, and Fragmentation at the Interface Example](#)
- [Frame Relay Queueing and Fragmentation at the Interface Example](#)

Frame Relay Queueing, Shaping, and Fragmentation at the Interface Example

The following example shows the configuration of a hierarchical policy for low-latency queueing, FRF.12 fragmentation, and shaping on serial interface 3/2. Note that traffic from the priority queue will not be interleaved with fragments from the class-default queue because shaping is configured.

```
class-map voice
  match access-group 101

policy-map llq
  class voice
    priority 64

policy-map shaper
  class class-default
    shape average 96000
    service-policy llq

interface serial 3/2
  ip address 10.0.0.1 255.0.0.0
  encapsulation frame-relay
  bandwidth 128
  clock rate 128000
  service-policy output shaper
  frame-relay fragment 80 end-to-end

access-list 101 match ip any host 10.0.0.2
```

Frame Relay Queueing and Fragmentation at the Interface Example

The following example shows the configuration of low-latency queueing and FRF.12 fragmentation on serial interface 3/2. Because shaping is not being used, a hierarchical traffic policy is not needed and traffic from the priority queue will be interleaved with fragments from the other queues. Without shaping, the output rate of the interface is equal to the line rate or configured clock rate. In this example, the clock rate is 128,000 bps.

```
class-map voice
  match access-group 101

policy-map llq
  class voice
    priority 64
  class video
    bandwidth 32

interface serial 3/2
  ip address 10.0.0.1 255.0.0.0
  encapsulation frame-relay
  bandwidth 128
  clock rate 128000
  service-policy output llq
  frame-relay fragment 80 end-to-end

access-list 101 match ip any host 10.0.0.2
```

Command Reference

The following commands are introduced or modified in the feature or features documented in this module. For information about these commands, see the *Cisco IOS Wide-Area Networking Command Reference* at http://www.cisco.com/en/US/docs/ios/wan/command/reference/wan_book.html. For information about all Cisco IOS commands, go to the Command Lookup Tool at <http://tools.cisco.com/Support/CLILookup> or to the *Cisco IOS Master Commands List*.

- **frame-relay fragment end-to-end**
- **show interfaces serial**

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