Frame Relay Queueing and Fragmentation at the Interface

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.

- Finding Feature Information, page 1
- Restrictions for Frame Relay Queueing and Fragmentation at the Interface, page 1
- Information About Frame Relay Queueing and Fragmentation at the Interface, page 2
- How to Configure Frame Relay Queueing and Fragmentation at the Interface, page 3
- Configuration Examples for Frame Relay Queueing and Fragmentation at the Interface, page 12
- Additional References, page 13
- Feature Information for Frame Relay Queueing and Fragmentation at the Interface, page 14

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Restrictions for Frame Relay Queueing and Fragmentation at the Interface

- 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.

Information About Frame Relay Queueing and Fragmentation at the Interface

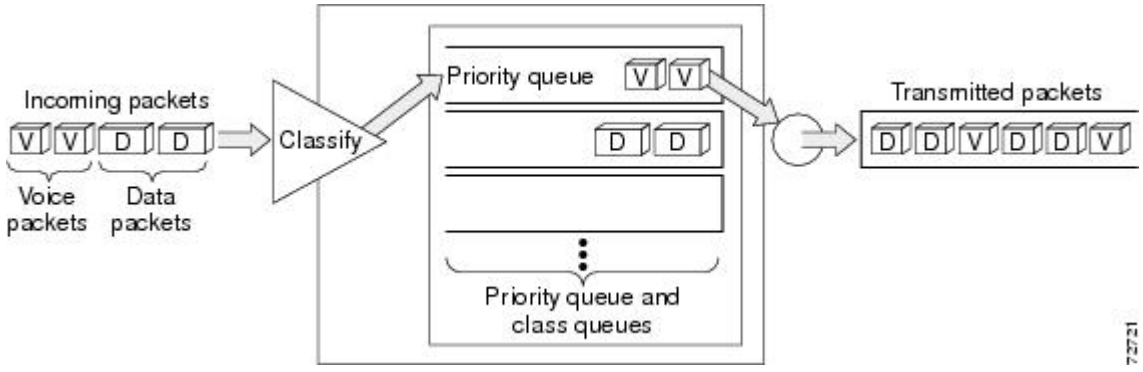
The Frame Relay Queueing and Fragmentation at the Interface feature simplifies the configuration of low-latency, low-jitter quality of service (QoS) by enabling the queueing policy and fragmentation configured on the main interface to apply to all permanent virtual circuits (PVCs) and subinterfaces under 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.

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. The figure below 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 of Frame Relay Queueing and Fragmentation at the Interface

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.

How to Configure Frame Relay Queueing and Fragmentation at the Interface

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:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map*
4. **class** *class-name*
5. Router(config-pmap-c)# **priority** *bandwidth-kbps*
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	**policy-map** *policy-map* **Example:** `Router(config) policy-map policy1`	Specifies the name of the policy map to be created or modified. • Use this command to define the queueing policy for the priority queue.
Step 4	**class** *class-name* **Example:** `Router(config-pmap)# class c1`	Specifies the name of a class to be created and included in the service policy. • 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 5	Router(config-pmap-c)# **priority** *bandwidth-kbps* **Example:** `Router(config-pmap-c)# priority 30`	Creates a strict priority class and specifies the amount of bandwidth, in kbps, to be assigned to the class.
Step 6	**exit** **Example:** `Router(config-pmap-c)# exit`	Exits the current configuration mode.

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:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map*
4. **class** *class-name*
5. Router(config-pmap-c)# **bandwidth** *bandwidth-kbps*
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	**policy-map** *policy-map* **Example:** `Router(config)# policy-map policy1`	Specifies the name of the policy map to be created or modified. • Use this command to define the queueing policy for the priority queue. • The bandwidth queues and the priority queue use the same policy map.
Step 4	**class** *class-name* **Example:** `Router(config-pmap)# class c1`	Specifies the name of a class to be created and included in the service policy. • 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 5	Router(config-pmap-c)# **bandwidth** *bandwidth-kbps* **Example:** `Router(config-pmap-c)# bandwidth 10`	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.) • 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.

	Command or Action	Purpose
Step 6	**exit** **Example:** `Router(config-pmap-c)# exit`	Exits the current configuration mode.

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 queueing 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 queueing 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:

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map*
4. **class class-default**
5. **shape** [**average** | **peak**] *mean-rate* [[*burst-size*] [*excess-burst-size*]]
6. **service-policy** *policy-map-name*
7. **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.

	Command or Action	Purpose
Step 3	**policy-map** *policy-map* **Example:** `Router(config)# policy-map policy1`	Specifies the name of the policy map to be created or modified. • Use this command to define the shaping policy.
Step 4	**class class-default** **Example:** `Router(config-pmap)# class class-default`	Specifies the default class so that you can configure or modify its policy.
Step 5	**shape** [**average** | **peak**] *mean-rate* [[*burst-size*] [*excess-burst-size*]] **Example:** `Router(config-pmap-c)# shape peak 10`	(Optional) Shapes traffic to the indicated bit rate according to the algorithm specified.
Step 6	**service-policy** *policy-map-name* **Example:** `Router(config-pmap-c)# service-policy policy1`	Specifies the name of a policy map to be used as a matching criterion (for nesting traffic policies [hierarchical traffic policies] within one another). • Use this command to attach the policy map for the priority queue (the child policy) to the shaping policy (the parent policy).
Step 7	**exit** **Example:** `Router(config-pmap-c)# exit`	Exits the current configuration mode.

Configuring Queueing and Fragmentation on the Frame Relay Interface

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

SUMMARY STEPS

1. Router(config)# **interface** *type number*
2. Router(config-if)# **encapsulation frame-relay**
3. Router(config-if)# **frame-relay interface-dlci** *dlci*
4. Router(config-if-dlci)# **class** *name*
5. Router(config-if-dlci)# **exit**
6. Router(config)# **map-class frame-relay** *name*
7. Router(config-map-class)# **frame-relay fragment** *fragment-size* **end-to-end**
8. Router(config-map-class)# **no frame-relay adaptive-shaping**
9. Router(config-map-class)# **service-policy output** *policy-map-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	Router(config)# **interface** *type number*	Configures an interface type and enters interface configuration mode.
Step 2	Router(config-if)# **encapsulation frame-relay**	Enables Frame Relay encapsulation.
Step 3	Router(config-if)# **frame-relay interface-dlci** *dlci*	Assigns a DLCI to a specified Frame Relay subinterface on the router.
Step 4	Router(config-if-dlci)# **class** *name*	Associates a map class with a specified DLCI.
Step 5	Router(config-if-dlci)# **exit**	Exits configuration mode.
Step 6	Router(config)# **map-class frame-relay** *name*	Specifies a map class to define QoS values for a Frame Relay SVC or PVC.
Step 7	Router(config-map-class)# **frame-relay fragment** *fragment-size* **end-to-end**	Enables fragmentation of Frame Relay frames. • 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.
Step 8	Router(config-map-class)# **no frame-relay adaptive-shaping**	Disables Frame Relay adaptive traffic shaping.
Step 9	Router(config-map-class)# **service-policy output** *policy-map-name*	Attaches a policy map to an output interface, to be used as the service policy for that interface. • 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.

	Command or Action	Purpose

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:

SUMMARY STEPS

1. Enter the **show running-config** command to verify the configuration.
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.
3. Enter the **show interfaces serial**command to display information about the queueing 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.

DETAILED STEPS

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

Example:

```
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:

Example:

```
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                         Delayed   Delayed   Active
        -      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 queueing 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:

Example:

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

Configuration Examples for Frame Relay Queueing and Fragmentation at the Interface

Example Frame Relay Queueing Shaping and Fragmentation at the Interface

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
```

Example Frame Relay Queueing and Fragmentation at the Interface

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
```

Additional References

Related Documents

Related Topic	Document Title
Frame Relay configuration	*Cisco IOS Wide-Area Networking Configuration Guide , Release 12.4T*
Frame Relay commands	*Cisco IOS Wide-Area Networking Command Reference, Release 12.4T*

Standards

Standard	Title
FRF.16.1	*Multilink Frame Relay UNI/NNI Implementation Agreement,* May 2002

MIBs

MIB	MIBs Link
None	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
None	--

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for Frame Relay Queueing and Fragmentation at the Interface

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Frame Relay Queueing and Fragmentation at the Interface

Feature Name	Releases	Feature Information
Frame Relay Queueing and Fragmentation at the Interface	Cisco IOS XE Release 2.1	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.