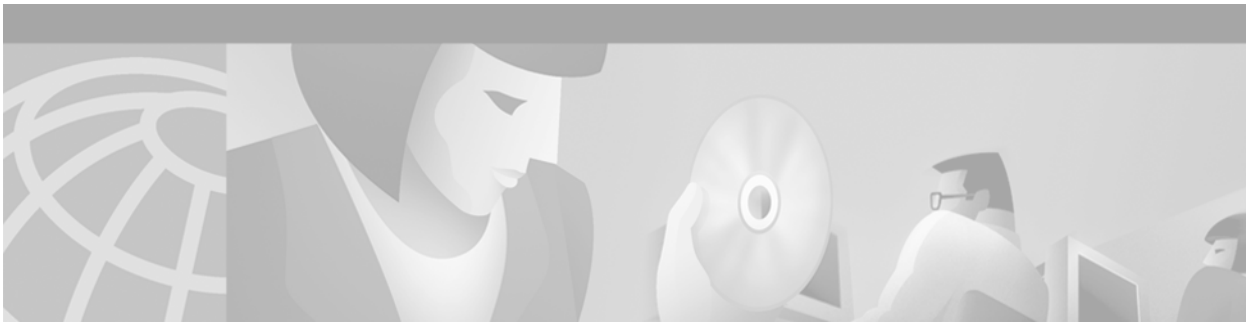


Versatile Interface Processor-Based Distributed FRF.11 and FRF.12 for Cisco IOS Release 12.1 T

Feature Overview

The Voice Over Frame Relay (VoFR) capabilities that were introduced in Cisco IOS Release 11.3 were extended to Cisco 2600, 3600, and 7200 series routers in Cisco IOS Release 12.0(4)T. In Cisco IOS Release 12.1(2)T, the Voice Over Frame Relay Using FRF.11 and FRF.12 feature was updated to standardize the configuration procedures across all platforms. After Cisco IOS Release 12.1(2)T, configuration procedures for the Cisco 2600, 3600, and 7200 series routers and the Cisco MC3810 multiservice access concentrator were nearly identical.

Versatile Interface Processor-Based Distributed FRF.11 and FRF.12 (VIP-Based FRF.11 and FRF.12) is now available in Cisco IOS Release 12.1(5)T. VIP-Based FRF.11 and FRF.12 brings the functionality of the Voice over Frame Relay Using FRF.11 and FRF.12 feature to VIP-enabled Cisco 7500 series routers running Cisco IOS Release 12.1 T.

Because VIP-Based Distributed FRF.11 and FRF.12 was not available in Cisco IOS Release 12.1 T until Cisco IOS Release 12.1(5)T, the configuration procedures for enabling FRF.11 and FRF.12 on the other supported platforms are almost identical to the procedures for enabling VIP-Based FRF.11 and FRF.12 on VIP-enabled Cisco 7500 series routers.

The one major difference between the other platforms and the VIP-enabled Cisco 7500 series router is the difference in map class configuration. The map class configuration procedure for VIP-enabled Cisco 7500 series routers is detailed in the “Configuring a Frame Relay Map Class to Support Voice over Frame Relay Fragmentation” section of this document.

This document describes the configuration procedures for VIP-enabled Cisco 7500 series routers enabling the VIP-Based FRF.11 and FRF.12 feature.

Benefits

Introduces Voice over Frame Relay Using FRF.11 and FRF.12 for VIP-Enabled Cisco 7500

VIP-Based FRF.11 and FRF.12 brings the functionality of the Voice over Frame Relay Using FRF.11 and FRF.12 feature to VIP-enabled Cisco 7500 series routers running Cisco IOS Release 12.1 T.

Restrictions

The following restrictions and limitations apply to the VIP-Based FRF.11 and FRF.12 feature:

- VIP-Based FRF.12 does not function properly with some of the older port adapters. The following list charts the port adapters that don't function properly with VIP-Based FRF.12 and also recommends updated versions of these port adapters that support VIP-Based FRF.12.

Table 1 Port Adapters that do not Support VIP-Based FRF.12

Port Adapter that do not Support VIP-Based FRF.12	Updated Port Adapter that Support VIP-Based FRF.12
PA-4T	PA-4T+
PA-H (rev. A)	PA-H (rev. B) or PA-2H (rev. B)
PA-2H (rev A)	PA-2H (rev. B)
PA-2CT1/PRI	PA-MC-2T1, PA-MC-4T1, PA-MC-8T1, and PA-MC-8DSX1
CT3IP	PA-MC-T3, PA-MC-E3

- In order for VoFR on a VIP-enabled Cisco 7500 series router to interoperate with VoFR on a Cisco MC3810, the Cisco MC3810 must be running Cisco IOS Release 12.0(3)XG or Cisco IOS Release 12.0(4)T or later.
- VIP-enabled Cisco 7500 series routers cannot terminate calls initiated by a Cisco MC3810 using VoFR implementations prior to Cisco IOS Release 12.0(3)XG or 12.0(4)T.
- It is currently not possible to translate from the Voice Over IP (VoIP) transport protocol to other protocols such as VoFR. As a result, a call coming in on a VoIP connection is not (tandem) switched to a VoFR connection.
- Hookflash for dial-tone recall from the router is not supported. However, the router can pass-through hookflash on FXO-FXS permanent connections and E&M-E&M connections using the **connection trunk** voice port configuration command.
- For VIP-enabled Cisco 7500 series routers, distributed Cisco Express Forwarding (dCEF) must be enabled to run VIP-Based FRF.11 and FRF.12.
- When using the **shape** command, the cir value needs to be a multiple of 8000. The bc/cir and be/cir must be multiples of 4 ms.
- A VIP with 128 MB of memory can support up to 500 service policies. Cisco Systems cannot guarantee support for possible problems caused by VIPs using more than 500 service policies at one time.
- Cisco MC3810 concentrators running Cisco IOS Releases before Release 12.0(3)XG or Release 12.0(4)T cannot tandem VoFR calls from non-Cisco MC3810 access concentrators, including VIP-enabled Cisco 7500 series routers.
- Voice over ATM Switched Virtual Circuits (SVCs) are not supported in this release.

Related Documents

For complete information about Voice over Frame Relay configuration, see the *Cisco IOS Multiservice Applications Configuration Guide* for Cisco IOS Release 12.1.

For information about VIP-Based Distributed FRF.11 and FRF.12 in Cisco IOS Release 12.1(1)E, see the *Versatile Interface Processor-Based Distributed FRF.11 and FRF.12* feature module that is located in the Cisco IOS Release 12.1(1)E new features documentation index.

For information about Voice over Frame Relay Using FRF.11 and FRF.12 for Cisco 2600, 3600, and 7200 series routers, as well as the Cisco MC3810 concentrator, see the *Voice Over Frame Relay Using FRF.11 and FRF.12* feature module on the 12.0(4)T new features documentation index and the *Voice Over Frame Relay Using FRF.11 and FRF.12* feature module on the 12.1(2)T new features documentation index. Both of these documents are available online on Cisco Connection Online (CCO).

For more information about voice technologies, refer to the *Cisco IOS Multiservice Applications Configuration Guide*, and the *Cisco IOS Multiservice Command Reference*, for Cisco IOS Release 12.1.

Supported Platforms

The VIP-Based FRF.11 and FRF.12 is only available for Cisco 7500 series routers with a Versatile Interface Processor (VIP).

Supported Standards, MIBs, and RFCs

Standards

None

MIBs

None

For descriptions of supported MIBs and how to use MIBs, see the Cisco MIB web site on CCO at http://www.cisco.com/public/sw-center/netmgmt/cmtk/mibs.shtml.

RFCs

None

Prerequisites

Before you can configure a Cisco router to use Voice over Frame Relay, you must do the following:

- Complete your company's dial plan.
- Establish a working Frame Relay network. For more information about configuring Frame Relay, refer to Cisco IOS Release 12.1 *Wide-Area Networking Configuration Guide* for Cisco IOS Release 12.1.
- Establish a working telephony network based on your company's dial plan:
  - Integrate your dial plan and telephony network into your existing Frame Relay network topology. Make routing and dialing transparent to the user—for example, avoid secondary dial tones from secondary switches where possible.
  - Contact your PBX vendor for instructions about how to reconfigure the appropriate PBX interfaces.

After you have analyzed your dial plan and decided how to integrate it into your existing Frame Relay network, you are ready to configure your network devices to support Voice over Frame Relay.

Configuration Tasks

This section describes the following new and modified configuration procedures for Voice over Frame Relay in this release:

- Configuring Dial Peer Digit Manipulation, page 4 (Required)
- Configuring Dial Peer Hunting, page 4 (Required)
- Disabling Dial Peer Hunting on a Specific Dial Peer, page 5
- Configuring a Frame Relay Map Class to Support Voice over Frame Relay Fragmentation, page 5
- Configuring Voice over Frame Relay Connections, page 7

For all remaining Voice over Frame Relay procedures, see the "Configuring Voice over Frame Relay" chapter in *Cisco IOS Multiservice Applications Configuration Guide* for Cisco IOS Release 12.1.

Configuring Dial Peer Digit Manipulation

To configure dial peer digit manipulation to forward digits, perform the following steps beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# dial-peer voice` *tag* `pots`	Enter dial peer configuration mode for a POTS dial peer.

Step 2	`Router(config-dial-peer)# forward-digits` {*num-digit* | `all` | `extra`}
	or
	`Router(config-dial-peer)# default forward-digits`
	or
	`Router(config-dial-peer)# no forward-digits`
		If using the forward-digits feature, configure the digit-forwarding method. The range for the number of digits forwarded (*num-digit*) is 0 through 32.
		See the "Command Reference" section on page 32 for an explanation of the command options.
		In the default condition, dialed digits not matching the destination pattern are forwarded.
		Note The **no** state is not the default state.

Configuring Dial Peer Hunting

After you have configured dial peers, you can configure how the router performs dial peer hunting functions. To configure the dial peer hunting behavior on the router, perform the following steps beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# dial-peer hunt hunt-order-number`	Specify the hunt selection order for dial peers.
Step 2	`Router(config)# dial-peer terminator character`	(Optional) Designate a special character to be used as a terminator for variable-length dialed numbers.

Disabling Dial Peer Hunting on a Specific Dial Peer

If using dial peer hunting, there may be situations when you want to disable dial peer hunting on a specific dial peer. To disable dial peer hunting on a dial peer, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# dial-peer voice tag {pots | vofr}`	Enter dial peer configuration mode for the specified dial peer.
Step 2	`Router(config-dial-peer)# huntstop`	Disable dial peer hunting on the dial peer. Once you enter this command, no further hunting is allowed if a call fails on the specified dial peer.

To reenable dial peer hunting on a dial peer, enter the **no huntstop** command.

Configuring a Frame Relay Map Class to Support Voice over Frame Relay Fragmentation

To configure a map class to support FRF.11 on a VIP-enabled Cisco 7500 series router, use the following commands to configure a service policy and apply this service policy in map class configuration mode:

	Command	Purpose
Step 1	`router(config)# class-map class-map-name`	Creates a class map that will be assigned to a group of Permanent Virtual Circuits (PVCs). The map class name must be unique.
Step 2	`router(config-class-map)# match protocol vofr`	Specifies Voice over Frame Relay packets as a matching criterion.
Step 3	`router(config-class-map)# exit`	Exits class map configuration mode.
Step 4	`router(config)# policy-map policy-map-name`	Specifies the name of the service policy to configure.
Step 5	`router(config-pmap-c)# class class-map-name`	Specifies the name of a predefined class, which was defined with the **class-map** command, included in the service policy. In this particular example, the *class-map-name* might have been specified in Step 1.

	Command	Purpose
Step 6	`router(config-pmap-c)# priority` *kpbs*	Specifies low latency service (in kbps) for priority traffic. Packets with low latency service are given preferential treatment and transmitted before the packets of any other traffic classes in congested environments.
Step 7	`router(config-pmap-c)# exit`	Exits policy map class configuration mode.
Step 8	`router(config-pmap)# exit`	Exits policy map configuration mode.
Step 9	`router(config)# policy-map` *policy-map-name*	Specifies the name of a new service policy to configure. The policy map name should be different for this service policy.
Step 10	`router(config-pmap)# class` *class-default*	Specifies the default traffic class as the associated traffic class.
Step 11	`router(config-pmap-c)# shape average` *bc cir*	Specifies the shaping parameters for the traffic policy. These shaping parameters will eventually be used in the map class.
Step 12	`router(config-pmap-c)# service-policy` *policy-map-name*	Specifies the previously-defined service policy to configure as part of this service policy. The policy map name for this step was defined in step 4 of this procedure.
Step 13	`router(config)# map-class frame-relay` *map-class-name*	Creates a map class name that will be assigned to a group of PVCs. The map class name must be unique.
Step 14	`router(config-map-class)# frame-relay fragment` *fragment-size*	Configures Frame Relay fragmentation for the map class. The *fragment_size* defines the payload size of a fragment, and excludes the Frame Relay headers and any Frame Relay fragmentation header. The valid range is from 16 to 1600 bytes, and the default is 53. The *fragment_size* should be less than or equal to the maximum transmission unit (MTU) size. Set the fragmentation size such that the largest data packet is not larger than the voice packets.
Step 15	`router(config-map-class)# service-policy output` *policy-map-name*	Specifies the name of the service policy to be attached to the interface. The policy map name was specified in step 9 of this procedure.

Configuring Voice over Frame Relay Connections

After you have configured the Frame Relay data-link connection identifier (DLCI) settings and you have configured your dial plan, you are ready to configure specific VoFR connections.

There are many different scenarios for VoFR connections. For information on the different connection types, see the next section, "Overview of Voice over Frame Relay Connection Types."

For procedures on how to configure the different connection types, see the following sections:

- Configuring Switched Calls (User-Dialed or Auto-Ringdown), page 9
- Configuring Cisco-Trunk Permanent (Private Line) Calls, page 11
- Configuring FRF.11 Trunk (Private Line) Calls, page 16

In addition, special consideration is required for configuring calls for tandem nodes. For more information, see the "Configuring Connections for Tandem Nodes" section on page 17.

Note Use of Cisco-trunks for permanent calls (private line) is recommended over FRF.11-trunk calls unless FRF.11-compliant standards-based interworking is required with non-Cisco devices. The Cisco-trunk protocol is a superset of the FRF.11 protocol and contains Cisco proprietary extensions designed to support switched call routing and other advanced features.

Overview of Voice over Frame Relay Connection Types

When you configure VoFR connections, you can use many different connection types depending on the hardware platform, whether the call is to be a regular switched (user-dialed or auto-ringdown) call, or whether the call is a permanent call (Cisco-trunk or FRF.11-trunk). You configure these specific connection types by using combinations of several commands.

Table 1Table 2 lists the different connection types for VoFR connections supported on the VIP-enabled Cisco 7500 series routers, and the combinations of commands to enter for each call type.

Table 2 Supported Voice over Frame Relay Connection Types

Type of Call	Frame Relay DLCI Interface Command to Enter	Data Fragmentation Supported by VoFR Command	Session Protocol Command to Enter in Dial Peer Mode	Voice Port Connection Command to Enter
Switched call (user-dialed or auto-ringdown) to other routers supporting VoFR	**vofr** [**data** *cid*] [**call-control** [*cid*]][1]	FRF.11 Annex C	**session protocol cisco-switched**[2]	For user-dialed calls: none For auto-ringdown calls: **connection plar** *destination-string*
Switched call (user-dialed or auto-ringdown) to a Cisco MC3810 running Cisco IOS Releases before 12.1(2)T	**vofr** cisco[3]	Cisco proprietary[4]	**session protocol cisco-switched**	For user-dialed calls: none For auto-ringdown calls: **connection plar** *destination-string*

Table 2 Supported Voice over Frame Relay Connection Types (continued)

Type of Call	Frame Relay DLCI Interface Command to Enter	Data Fragmentation Supported by VoFR Command	Session Protocol Command to Enter in Dial Peer Mode	Voice Port Connection Command to Enter
Cisco-trunk permanent call (private line) to other routers supporting VoFR	**vofr data** *cid* **call-control** *cid*	FRF.11 Annex C	**session protocol cisco-switched**	**connection trunk** *destination-string* [**answer mode**]
Cisco-trunk permanent call (private line) to a Cisco MC3810 running Cisco IOS Releases before 12.1(2)T	**vofr cisco**	Cisco proprietary	**session protocol cisco-switched**	**connection trunk** *destination-string* [**answer mode**]
FRF.11 trunk call (private line) to other routers supporting VoFR	**vofr** [**data** *cid*] [**call-control** *cid*][5]	FRF.11 Annex C	**session protocol frf11-trunk**	**connection trunk** *destination-string* [**answer mode**]

1. The recommended use of this command is **vofr data 4 call-control 5**.
2. The **session protocol cisco-switched** option is the default setting. If you do not enter this command, the setting still applies.
3. This command consumes data CID 4 and call-control CID 5.
4. Cisco proprietary fragmentation is based on an early draft of FRF.12 and is compatible with Cisco MC3810 concentrators running software releases before Cisco IOS Release 12.0(3)XG or Release 12.0(4)T.
5. For FRF.11 trunk calls, the call-control option is not required. It is only required if you mix FRF.11 trunk calls with other types of voice calls on the same PVC.

Configuring Switched Calls (User-Dialed or Auto-Ringdown)

This section describes how to configure switched calls (user-dialed or auto-ringdown) on the different router platforms. This section is divided into the following procedures:

- Configuring Switched Calls to Other Voice over Frame Relay Routers, page 9
- Configuring Switched Calls to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T, page 10

Configuring Switched Calls to Other Voice over Frame Relay Routers

To configure switched calls on routers that support VoFR, use the following commands from interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# frame-relay interface-dlci` *dlci*	Configure the Frame Relay DLCI and enter DLCI configuration mode.
Step 2	`Router(config-if)# vofr` [**data** *cid*] [**call-control** [*cid*]]	Configure the Frame Relay DLCI to support VoFR and set the data and call-control Channel IDs (CIDs). The recommended setting for this command is **vofr data 4 call-control 5**. **Note** When the **vofr** command is used, all subchannels on the DLCI are configured for FRF.11 encapsulation. If you enter the **vofr** command without any keywords or arguments, the data subchannel is CID 4 and there is no call-control subchannel. If you are configuring user-dialed calls, this procedure is completed. If you are configuring auto-ringdown calls, proceed to the next step.
Step 3	`Router(config)# voice-port` *slot/port:ds0-group*	Identify the voice port you want to configure and enter voice port configuration mode.
Step 4	`Router(config-voiceport)# connection plar` *destination-string*	(Optional) For auto-ringdown calls, configure the private line automatic ringdown (PLAR) connection, specifying the telephone number in the *destination-string*.

This configuration uses standard FRF.11 Annex C fragmentation.

Configuring Switched Calls to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T

You can configure switched calls to Cisco MC3810 concentrators running Cisco IOS releases before 12.1(2)T. However, the configuration is different from standard switched calls because earlier Cisco MC3810 releases used the Cisco proprietary version of FRF.12.

Note VIP-enabled Cisco 7500 series routers cannot terminate or initiate calls with a Cisco MC3810 running software releases before Cisco IOS Release 12.0(3)XG and Release 12.0(4)T.

To configure switched calls to a Cisco MC3810 running Cisco IOS releases before 12.1(2)T, use the following commands beginning in interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# frame-relay interface-dlci` *dlci*	Configure the Frame Relay DLCI and enter DLCI configuration mode. **Note** The **voice-encap** option of the **frame-relay interface-dlci** command on the Cisco MC3810 is no longer supported beginning in this release.
Step 2	`Router(config-if)# vofr cisco`	Configure the Frame Relay DLCI to support VoFR and the Cisco proprietary fragmentation implementation. When this command is entered, data CID 4 and call-control CID 5 are automatically assigned. If you are configuring user-dialed calls, this procedure is complete. If you are configuring auto-ringdown calls, proceed to the next step.
Step 3	`Router(config)# voice-port` *slot/port:ds0-group*	Identify the voice port you want to configure and enter voice port configuration mode.
Step 4	`Router(config-voiceport)# connection plar` *destination-string*	(Optional) For auto-ringdown calls, configure the PLAR connection, specifying the telephone number in the *destination-string*.

This configuration uses Cisco proprietary data fragmentation.

Configuring Cisco-Trunk Permanent (Private Line) Calls

This section describes how to configure Cisco-trunk permanent (private line) calls on the different router platforms. This section is divided into the following procedures:

Configuring Voice over Frame Relay Dial Peers for Cisco-Trunk (Private Line) Calls

If you are sending Cisco-trunk (private line) calls over the Frame Relay network, you must configure the Voice over Frame Relay dial peers to specifically support Cisco-trunk (private line) calls. Cisco-trunk (private line) calls are permanent calls.

One key task when you configure Cisco-trunk (private line) connections is to configure the signal type for the dial peer. The **signal-type** dial peer command supports the following options:

- **cas**—Use the **cas** option to support North American channel-associated signalling (CAS)/robbed-bit signaling. This is the default signaling type.
- **cept**—Use the **cept** option to provide a basic E1 ABCD protocol, primarily for CEPT Ear and Mouth (E&M) signaling. This option is primarily used for European voice networks. If this option is used with FXS or FXO voice ports, the signaling used is equivalent to Mercury Exchange Limited (MEL) CAS.
- **ext-signal**—Use the **ext-signal** option in cases where some external signaling channel is being used (for example, common channel signaling), or where no signaling information is being sent at all over a permanent “dumb” voice pipe. Applications where no signaling is required include using a simple voice pipe to carry audio for a public address system.
- **transparent**—Use the **transparent** option when the ABCD signaling bits are copied through from the T1/E1 interface “transparently” without modification or interpretation (also known as transparent FRF.11 signaling). This allows the router to handle or transport unknown signaling protocols.

Configure the signal type so that the signal type that is selected in the dial peers on the routers at both ends of the permanent voice call are the same.

To configure a VoFR dial peer to support Cisco-trunk permanent (private line) calls, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	`Router(config)# dial-peer voice number vofr`	Define a VoFR dial peer and enter dial peer configuration mode. All subsequent commands that you enter in dial peer voice mode before you exit will apply to this dial peer. The *number* tag value identifies the dial peer and must be unique on the router. Do not duplicate a specific tag number.
Step 2	`Router(config-dial-peer)# destination-pattern string`	Configure the dial peer's destination pattern. The same restrictions for the string listed in the POTS dial peer configuration also apply to the VoFR destination pattern.
Step 3	`Router(config-dial-peer)# session target interface dlci [cid]`	Configure the Frame Relay session target for the dial peer.
Step 4	`Router(config-dial-peer)# session protocol cisco-switched`	Configure the session protocol to support switched calls. This is the default setting, and entering this command is not required.
Step 5	`Router(config-dial-peer)# codec type [bytes bytes]`	Specify the voice coder rate of speech and payload size for the dial peer. The default dial peer codec is **g729r8**. Note that the Cisco MC3810 is limited to a maximum of 12 calls when using **g729r8**; to support up to 24 calls on the Cisco MC3810, use **g729ar8**. Specifying the payload size by entering the **bytes** value is optional. Each codec type defaults to a different payload size if you do not specify a value. To obtain a list of the default payload sizes, enter the **codec** command and the **bytes** option followed by a question mark (?). **Note** On the Cisco MC3810, you can also assign codec values to the voice port. When you configure the codec type for regular switched voice calls, you must set the codec type on the Cisco MC3810 voice port. When you configure the codec for permanent calls (**cisco-trunk** and **frf11-trunk**), you must configure the codec type on the dial peer. You cannot specify the payload size on the voice port.

	Command	Purpose
Step 6	`Router(config-dial-peer)#` **`dtmf-relay`**	(Optional) If the codec type is a low bit-rate codec such as **g729** or **g723**, specify support for dial-tone multifrequency (DTMF) relay to improve end-to-end transport of DTMF tones. DTMF tones do not always propagate reliably with low bit-rate codecs. DTMF relay is disabled by default.
Step 7	`Router(config-dial-peer)#` **`signal-type`** {**`cas`** | **`cept`** | **`ext-signal`** | **`transparent`**}	Define the flavor of the ABCD signaling packets that are generated by the voice port and sent to the data network. Enter **cas** to support CAS. Enter **cept** to support the European CEPT standard (related to MEL CAS). Enter **ext-signal** to indicate that ABCD signaling packets should not be sent for configurations where the line signaling information is carried externally to the voice port. Enter **transparent** (for digital T1/E1 interfaces) to read the ABCD signaling bits directly from the T1/E1 interface without interpretation, and to pass them transparently to the data network (this is also known as transparent FRF.11 signaling).
Step 8	`Router(config-dial-peer)#` **`no vad`**	(Optional) Disable voice activity detection (VAD) on the dial peer. This command is enabled by default.
Step 9	`Router(config-dial-peer)#` **`sequence-numbers`**	(Optional) Enable the voice sequence number if required for your configuration. This command is disabled by default.
Step 10	`Router(config-dial-peer)#` **`preference`** *value*	(Optional) Configure a preference for the VoFR dial peer. The value is a number from 0 through 10 where the lower the number, the higher the preference in hunt groups.
Step 11	`Router(config-dial-peer)#` **`fax rate`** {**`2400`** | **`4800`** | **`7200`** | **`9600`** | **`14400`** | **`disable`** | **`voice`**}	(Optional) Configure the transmission speed (in bps) at which a fax will be sent to the dial peer. The default is **voice**, which specifies the highest possible transmission speed allowed by the voice rate.
Step 12		To configure another VoFR dial peer, exit dial peer configuration mode and repeat steps 1 through 11.

Configuring Cisco-Trunk Permanent Calls

You can configure Cisco-trunk permanent calls on VIP-enabled Cisco 7500 series routers.

Note If you are configuring Cisco-trunk permanent calls to Cisco MC3810 concentrators running Cisco IOS releases before 12.1(2)T, see the "Configuring Cisco-Trunk Permanent Calls to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T" section on page 15.

To configure Cisco-trunk permanent calls, use the following commands from interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# frame-relay interface-dlci dlci`	Configure the Frame Relay DLCI and enter DLCI configuration mode.
Step 2	`Router(config-if)# vofr [data cid] [call-control [cid]]`	Configure the Frame Relay DLCI to support VoFR. **Note** When you enter the **vofr** command, all subchannels on the DLCI are configured for FRF.11 encapsulation. If you enter the **vofr** command without any keywords or arguments, the data subchannel is CID 4 and there are no call-control subchannels. If you are configuring tandem calls, this step ends your configuration.
Step 3	`Router(config)# voice-port slot/port:ds0-group`	Identify the voice port you want to configure and enter voice port configuration mode.
Step 4	`Router(config-voiceport)# connection trunk destination-string [answer-mode]`	For private line calls, configure the trunk connection by specifying the telephone number in the *destination-string*. When configuring Cisco-trunk permanent calls, one side must be the call initiator (master) and the other side is normally the call answerer (slave). By default, the voice operates in master mode. Enter the **answer-mode** keyword to specify that the voice port operates in slave mode.
Step 5	`Router(config-voiceport)# shutdown`	Shut down the voice port.
Step 6	`Router(config-voiceport)# no shutdown`	Reactivate the voice port to enable the trunk connection to take effect.

This configuration uses standard FRF.11 Annex C fragmentation.

Note Every time you enter the **connection trunk** or **no connection trunk** command, you must toggle the voice port (by entering **shutdown**, then **no shutdown**) for the changes to take effect.

Configuring Cisco-Trunk Permanent Calls to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T

To configure Cisco-trunk permanent calls to a Cisco MC3810 running Cisco IOS releases before 12.1(2)T, use the following commands from interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# frame-relay interface-dlci` *dlci*	Configure the Frame Relay DLCI and enter DLCI configuration mode.
Step 2	`Router(config-if)# vofr cisco`	Configure the Frame Relay DLCI to support VoFR and the Cisco proprietary data implementation. When this command is entered, data CID 4 and call-control CID 5 are automatically assigned.
Step 3	`Router(config)# voice-port` *slot/port:ds0-group*	Identify the voice port you want to configure and enter voice port configuration mode.
Step 4	`Router(config-voiceport)# connection trunk` *destination-string* [**answer-mode**]	For private line calls, configure the trunk connection by specifying the telephone number in *destination-string*. When configuring Cisco-trunk permanent calls, one side must be the call initiator (master) and the other side is normally the call answerer (slave). By default, the voice operates in master mode. Enter the **answer-mode** keyword to specify that the voice port should operate in slave mode.
Step 5	`Router(config-voiceport)# shutdown`	Shut down the voice port.
Step 6	`Router(config-voiceport)# no shutdown`	Reactivate the voice port to enable the trunk connection to take effect.

This configuration uses Cisco proprietary data fragmentation.

Note Every time you enter the **connection trunk** or **no connection trunk** command, you must toggle the voice port (by entering **shutdown**, then **no shutdown**) for the changes to take effect.

Configuring FRF.11 Trunk (Private Line) Calls

On a VIP-enabled Cisco 7500 series router, you can configure FRF.11 trunk calls to a second router.

You cannot configure FRF.11 trunk calls for tandem VoFR configurations.

Note This configuration requires that you set the **session protocol** dial peer configuration command to **frf11-trunk**.

To configure FRF.11 trunk (private line) calls, use the following commands from interface configuration mode:

	Command	Purpose
Step 1	`Router(config-if)# frame-relay interface-dlci` *dlci*	Configure the Frame Relay DLCI and enter DLCI configuration mode.
Step 2	`Router(config-if)# vofr` [**data** *cid*] [**call-control** *cid*]	Configure the Frame Relay DLCI to support VoFR and to optionally enter the data and call-control CIDs.
Step 3	`Router(config)# voice-port` *slot/port:ds0-group*	Identify the voice port you want to configure and enter voice port configuration mode.
Step 4	`Router(config-voiceport)# connection trunk` *destination-string* [**answer-mode**]	For private line calls, configure the trunk connection by specifying the telephone number in the *destination-string*. When configuring FRF.11 trunk calls, one side must be the call initiator (master) and the other side is normally the call answerer (slave). By default, the voice port is the master. Enter the **answer-mode** keyword to specify that the voice port is the slave.

This configuration uses FRF.11 Annex C data fragmentation.

Note Every time you enter the **connection trunk** or **no connection trunk** command, you must toggle the voice port (by entering **shutdown**, then **no shutdown**) for the changes to take effect.

Configuring Connections for Tandem Nodes

Tandeming is switching incoming VoFR calls on a Frame Relay DLCI to an outgoing VoFR enabled DLCI. Tandeming works for switched calls and Cisco-trunk permanent calls only. You cannot tandem FRF.11 trunk calls over a multi-hop network.

Tandeming is supported on all platforms that support Voice over Frame Relay Using FRF.11 and FRF.12, including VIP-enabled Cisco 7500 series routers.

Depending on which router is used as the end node and which router is used as the tandem node, you must use the correct Frame Relay PVC type when configuring your connections. Table 3 shows the different combinations of routers that can serve as end nodes and tandem nodes, and the Frame Relay PVC type required.

Table 3 Supported VoFR End Node and Tandem Node Combinations

End Nodes	Tandem Node	VoFR Command to Enter for the Frame Relay DLCI
Cisco 2600, Cisco 3600, Cisco MC3810, Cisco 7200, or VIP-enabled Cisco 7500	Cisco 2600, Cisco 3600, Cisco MC3810, Cisco 7200, or VIP-enabled Cisco 7500	**vofr call-control**
Cisco MC3810 running Cisco IOS releases before 12.1(2)T	Cisco 2600, Cisco 3600, Cisco 7200, or VIP-enabled Cisco 7500	**vofr cisco**

When you configure a tandem node, you must configure two VoFR dial peers, one for each tandem connection.

Verifying Your Voice Connections

Verify that the voice connection for switched calls is working by following these steps:

Step 1 Pick up the handset on a telephone connected to the configuration and verify that you can get a dial tone.

Step 2 Make a call from the local telephone to a configured dial peer and verify that the call attempt is successful.

Verify that the voice connection for FXO-FXS trunk calls from a telephone to a remote PBX is working by doing the following:

Step 1 Pick up the telephone and listen to hear the dial tone from the remote PBX.

Step 2 Dial digits so that the remote PBX routes the call.

You can check the validity of your dial peer and voice port configurations by performing the following tasks:

- If you have relatively few dial peers configured, enter the **show dial-peer voice** command to verify that the data configured is correct.
- To show the status of the voice ports, enter the **show voice port** command.
- To show the call status for all voice ports, enter the **show call active voice [brief]** command.

You can check the validity of your VoFR configuration on the DLCI by performing the following task:

- To show the VoFR configuration, enter the **show frame-relay vofr** [*interface* [*dlci* [*cid*]]] command.

Troubleshooting Tips

If you are having trouble connecting a call, you can try to resolve the problem by performing the following tasks:

- If no FRF.11 calls are going through, make sure that the **frame-relay voice bandwidth** command is configured.
- If you have Voice over Frame Relay configured on a PVC and are experiencing problems with data connectivity on that PVC, make sure that the **frame-relay fragment** command has been configured.
- If you suspect that the problem is with the dial plan or the dial peers, use the **show dial-plan number** *dial string* command to display which dial peers are used when a specific number is called.
- If you have problems connecting an FRF.11 trunk call, make sure that the **session protocol** dial peer command is set to **frf11-trunk**.
- If you are configuring FRF.11 trunk calls, verify that the **called-number vofr** dial peer command is configured and that its number matches the destination pattern of the corresponding POTS dial peer.

- Be sure that the voice port is set to **no shutdown**.
- Be sure that the serial port or the T1/E1 controller is set to **no shutdown**.
- Be sure to toggle the voice port (by first entering **shutdown**, then **no shutdown**) every time you enter the **connection trunk** or **no connection trunk** commands.

Configuration Examples

This section provides specific configuration examples for different VoFR connections and call type scenarios. This section includes the following examples:

Note In the examples, some commands are shown with a lowercase letter in boldface. These letters indicate command settings that must match on the different routers. For example, the **frame-relay cir *s*** value indicates that the committed information rate "s" must match on the routers as shown.

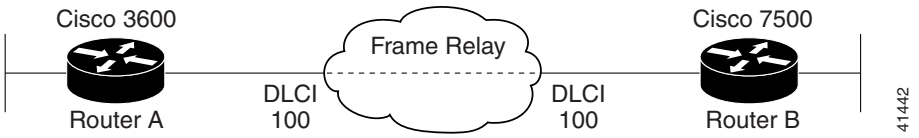
The examples do not provide complete configurations, but show the required commands to configure Voice over Frame Relay.

For examples of Voice over Frame Relay connections for non-Cisco 7500 series routers, see the *Voice Over Frame Relay Using FRF.11 and FRF.12 Configuration Updates* document on CCO or the Documentation CD-ROM.

Two Routers Using Frame Relay Fragmentation

Figure 1 shows an example of Frame Relay fragmentation between a Cisco 3600 and a VIP-enabled Cisco 7500 series router. This configuration uses FRF.12 fragmentation.

Figure 1 Two Routers Using Frame Relay Fragmentation



Router A (Cisco 3600)	Router B (VIP-Enabled Cisco 7500)

	`class-map frf`
	`match protocol vofr`
	
	`policy-map llq`
	`class frf`
	`priority` **`t`**
	
	`policy-map llq-shape`
	`class class-default`
	`shape average` **`u s`**
	`service-policy llq`

`interface serial 0/0`
`  encapsulation frame-relay`
`  frame-relay traffic shaping`
	`interface serial 0/0/0.1`
	`  encapsulation frame-relay`

`interface serial 0/0.1 point-to-point`
`frame-relay interface-dlci 100`
`  class frf12-class`
	`interface serial 0/0/0.1 point-to-point`
	`frame-relay interface-dlci 100`
	`class frf12-class`

`map-class frame-relay frf12-class`
`  frame-relay fragment` **`y`**
`  frame-relay cir` **`s`**
`  frame-relay bc` **`u`**
	`map-class frame-relay frf12-class`
	`frame-relay fragment` **`y`**
	`service-policy output llq-shape`

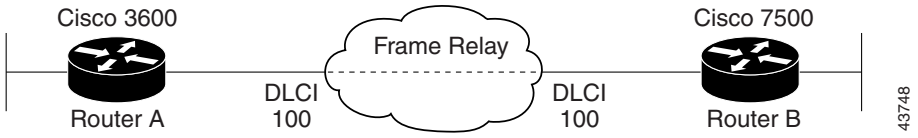
This example assumes that a map class called frf12-class was previously configured.

For information on low latency queueing on the VIP, see the *Distributed Low Latency Queueing* feature module on CCO. For information on distributed traffic shaping, see the *Distributed Traffic Shaping* feature module on CCO.

Two Routers Using a VoFR PVC

This example shows an example of Frame Relay fragmentation between a Cisco 7500 series router with a VIP and a Cisco 3600 series router.

Figure 2 .Two Routers Using a VoFR PVC



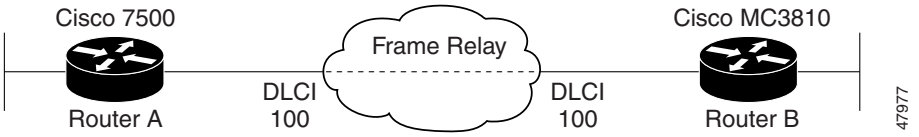
Router A (Cisco 3600)	Router B (VIP-Enabled Cisco 7500)
	class-map frf match protocol vofr policy-map llq class frf priority **t** policy-map llq-shape class class-default shape average **u s** service-policy llq
interface serial 0/0 encapsulation frame-relay frame-relay traffic shaping	interface serial 0/0/0.1 encapsulation frame-relay
interface serial 0/0.1 point-to-point frame-relay interface-dlci 100 vofr data 4 call 5 class frf11-class	interface serial 0/0/0.1 point-to-point frame-relay interface-dlci 100 vofr data 4 call 5 class frf11-class
map-class frame-relay frf11-class frame-relay fragment **y** frame-relay voice-bandwidth **t** frame-relay cir **s** frame-relay bc **u**	map-class frame-relay frf11-class frame-relay fragment **y** frame-relay voice-bandwidth **t** service-policy llq-shape

This configuration uses FRF.11 Annex C fragmentation.

Router Using a VoFR PVC to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T

Figure 3 shows an example of a Cisco 3600 series router with connections to a Cisco MC3810 running a Cisco IOS Releases before12.1(2)T. In this example, the Voice over Frame Relay interface on both the Cisco 3600 and the Cisco MC3810 is configured by using the **vofr cisco** command.

Figure 3 Router Using a VoFR PVC to a Cisco MC3810 Running Cisco IOS Releases Before 12.1(2)T



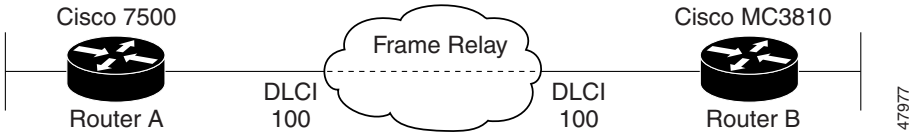
Router A (VIP-Enabled Cisco 7500 Series)	Router B (Cisco MC3810)
class-map frf match protocol vofr policy-map llq class frf priority **t** policy-map llq-shape class class-default shape average **u s** service-policy llq interface serial 0/0/0.1 ip address xxx.xxx.xxx 255.255.255.0 frame-relay interface-dlci **100** vofr cisco class frf11-class map-class frame-relay frf11-class frame-relay fragment **y** frame-relay voice-bandwidth **t** service-policy llq-shape	interface serial 0 ip address xxx.xxx.xxx 255.255.255.0 frame-relay traffic-shaping frame-relay class *toto* frame-relay interface-dlci **100** vofr cisco map-class frame-relay toto frame-relay voice-bandwidth **t** frame-relay min-cir **x** frame-relay cir **s** frame-relay bc **u** frame-relay fragment **y**

This configuration uses FRF.11 Annex C fragmentation.

Cisco-Trunk (Private Line) Calls Between Two Routers

Figure 4 shows an example of VoFR Cisco-trunk (private line) calls between two routers.

Figure 4 Cisco-Trunk (Private Line) Calls Between Two Routers



Router A (VIP-Enabled Cisco 7500)	Router B (Cisco MC3810)
`class-map frf` `match protocol vofr`	

`policy-map llq`
`class frf`
`priority` **`t`**	

`policy-map llq-shape`
`class class-default`
`shape average` **`u s`**
`service-policy llq`	

`interface serial 0/0/0.1`
`  ip address xxx.xxx.xxx 255.255.255.0`
`  encapsulation frame-relay`
`  frame-relay interface-dlci 100`
`  class voice`
`  vofr data 4 call-control 5`
	`interface serial 0`
	`  ip address xxx.xxx.xxx 255.255.255.0`
	`  encapsulation frame-relay`
	`  frame-relay traffic-shaping`
	`  frame-relay interface-dlci 100`
	`  class voice`
	`  vofr data 4 call-control 5`

`map-class frame-relay frf11-class`
`  frame-relay fragment` **`y`**
`  frame-relay voice-bandwidth` **`v`**
`service-policy llq-shape`
	`map-class frame-relay voice`
	`  frame relay cir` **`s`**
	`  frame relay bc` **`u`**
	`  frame-relay voice bandwidth v`
	`  frame-relay min-cir` **`x`**
	`  frame-relay fragment` **`y`**

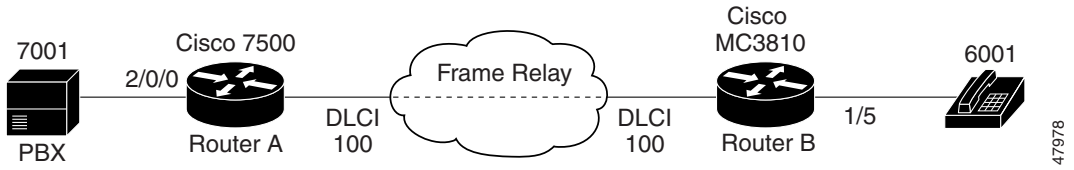
`voice-port 2/0/0` `  connection trunk 6001 answer-mode`	`voice-port 1/5` `  connection trunk 7001`
`dial-peer voice 1 pots`	`dial-peer voice 2 pots`

Router A (VIP-Enabled Cisco 7500)	Router B (Cisco MC3810)
destination-pattern 7001	destination-pattern 6001
port 2/0/0	port 1/5
dial-peer voice 2 vofr	dial-peer voice 4 vofr
codec **x** bytes **y**	codec **x** bytes **y**
destination-pattern 6001	destination-pattern 7001
session protocol cisco-switched	session protocol cisco-switched
session target **Sn** 100	session target **Sn** 100

FRF.11 Trunk Calls Between Two Routers

Figure 5 shows an example of FRF.11 trunk calls configured between two routers.

Figure 5 FRF.11 Trunk Calls Between Two Routers



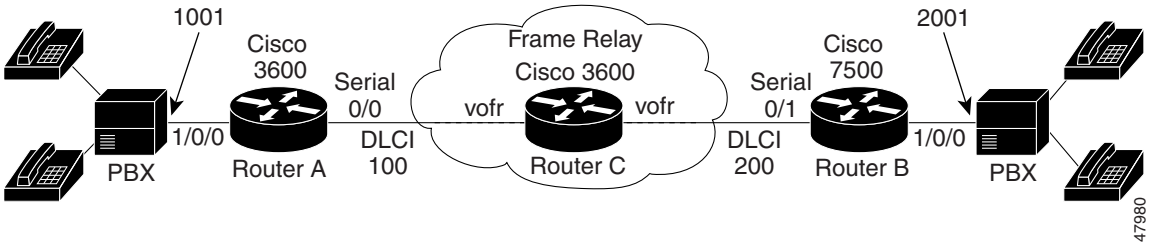
Router A (VIP-Enabled Cisco 7500)	Router B (Cisco MC3810)
class-map frf	
match protocol vofr	
policy-map llq	
class frf	
priority **t**	
policy-map llq-shape	
class class-default	
shape average **u s**	
service-policy llq	
interface serial 0/0/0.1	interface serial 0
ip address xxx.xxx.xxx 255.255.255.0	ip address xxx.xxx.xxx 255.255.255.0
encapsulation frame-relay	encapsulation frame-relay
frame-relay interface-dlci 100	frame-relay traffic-shaping
class voice	frame-relay interface-dlci 100
vofr data 4	class voice

Router A (VIP-Enabled Cisco 7500)	Router B (Cisco MC3810)
	vofr data 4
map-class frame-relay frf11-class	map-class frame-relay voice
frame-relay fragment **y**	frame relay cir **s**
frame-relay voice-bandwidth **v**	frame-relay min-cir in **x**
service-policy llq-shape	frame relay bc **u**
	frame-relay voice bandwidth **v**
	frame-relay fragment **y**
voice-port 2/0/0	voice-port 1/5
connection trunk 6001	connection trunk 7001
dial-peer voice 1 pots	dial-peer voice 2 pots
destination-pattern 7001	destination-pattern 6001
port 2/0/0	port 1/5
dial-peer voice 2 vofr	dial-peer voice 4 vofr
codec **x** bytes **y** bytes	codec **x** bytes **y**
destination-pattern 6001	destination-pattern 7001
session protocol frf11-trunk	session protocol frf11-trunk
session target **Sn** 100 **d**	session target Sn 100 d
called-number 7001	dtmf-relay
dtmf-relay	vad
vad	

Tandem Configuration with Three Routers for Switched Calls

Figure 6 shows an example of a tandem configuration with a Cisco 3600 router and a VIP-enabled Cisco 7500 series router as endpoints and a Cisco 3600 as a tandem node.

Figure 6 Tandem Configuration with Three Routers for Switched Calls



Router A (Cisco 3600) Endpoint	Router C (Cisco 3600) Tandem Node	Router B (VIP-Enabled Cisco 7500) Endpoint
		class-map frf match protocol vofr policy-map llq class frf priority **t** policy-map llq-shape class class-default shape average **u s** service-policy llq
interface serial 0/0 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0/0 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0/0/0.1 encapsulation frame-relay frame-relay interface-dlci 100 class voice vofr data 4 call-control 5
map-class frame-relay voice frame-relay cir **a** frame-relay min-cir **t** frame-relay bc **b** frame-relay voice bandwidth **c** frame-relay fragment d	interface serial 0/1 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 200 class voice vofr	map-class frame-relay voice frame-relay fragment **d** frame-relay voice-bandwidth **c** service-policy llq-shape

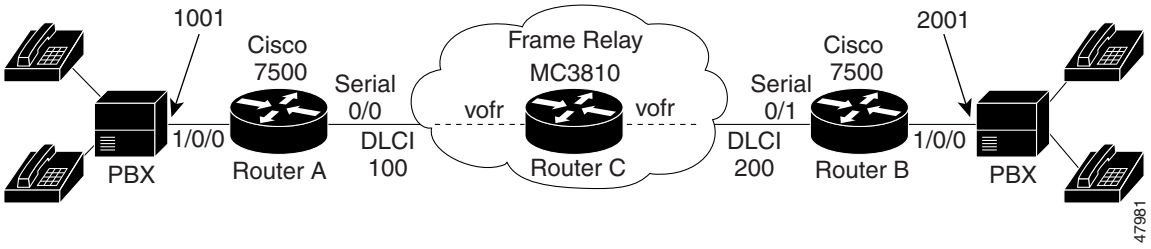
Router A (Cisco 3600) Endpoint	Router C (Cisco 3600) Tandem Node	Router B (VIP-Enabled Cisco 7500) Endpoint

dial-peer voice 1 pots
  destination-pattern 1001
  port 1/0/0
 	
dial-peer voice 2 vofr
  destination-pattern 2...
  session target serial 0/0 100
 	
voice-port 1/0/0
	map-class frame-relay voice
	  frame-relay cir **a**
	  frame-relay min-cir **t**
	  frame-relay bc **b**
	  frame-relay voice bandwidth **c**
	  frame-relay fragment **d**
	
	dial-peer voice 1 vofr
	  destination-pattern 1...
	  session target serial 0/0 100
	
	dial-peer voice 2 vofr
	  destination-pattern 2...
	  session target serial 0/1 200
		dial-peer voice 1 pots
		  destination-pattern 2001
		  port 1/0/0
		
		dial-peer voice 2 vofr
		  destination-pattern 1...
		  session target serial 0/0 200
		
		voice-port 1/0/0

Tandem Configuration with a Cisco MC3810 Tandem Node for Switched Calls

Figure 7 shows an example of a tandem configuration with a Cisco MC3810 acting as a tandem node.

Figure 7 Tandem Configuration with a Cisco MC3810 Tandem Node for Switched Calls



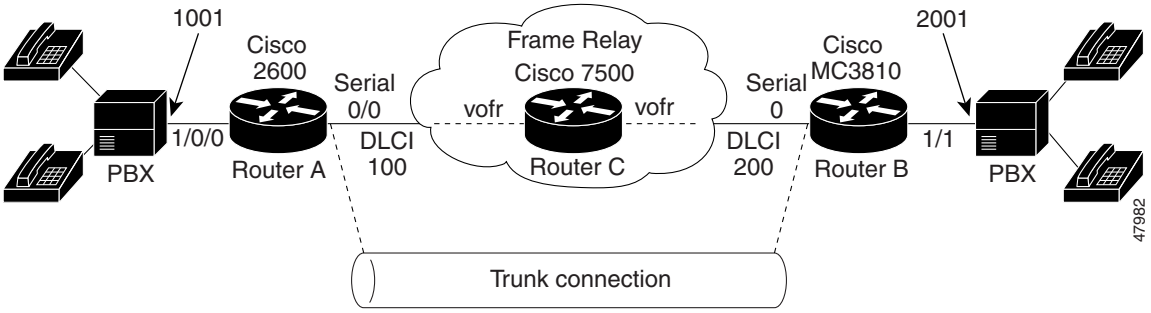
Router A (VIP-Enabled Cisco 7500) Endpoint	Router C (Cisco MC3810) Tandem Node	Router B (VIP-Enabled Cisco 7500) Endpoint
class-map frf match protocol vofr policy-map llq class frf priority **t**		class-map frf match protocol vofr policy-map llq class frf priority **t**

Router A (VIP-Enabled Cisco 7500) Endpoint	Router C (Cisco MC3810) Tandem Node	Router B (VIP-Enabled Cisco 7500) Endpoint
policy-map llq-shape class class-default shape average **u s** service-policy llq		policy-map llq-shape class class-default shape average **u s** service-policy llq
interface serial 0/0/0.1 encapsulation frame-relay frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0/0/0.1 encapsulation frame-relay frame-relay interface-dlci 200 class voice vofr data 4 call-control 5
map-class frame-relay voice frame-relay fragment **d** frame-relay voice-bandwidth **c** service-policy llq-shape	interface serial 1 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 200 class voice vofr data 4 call-control 5	map-class frame-relay voice frame-relay fragment **d** frame-relay voice-bandwidth **c** service-policy llq-shape
dial-peer voice 1 pots destination-pattern 1001 port 1/0/0	map-class frame-relay voice frame-relay cir **a** frame-relay min-cir **t** frame-relay bc **b** frame-relay voice bandwidth **c** frame-relay fragment **d**	dial-peer voice 1 pots destination-pattern 2001 port 1/0/0
dial-peer voice 2 vofr destination-pattern 2... session target serial 0/0/100	dial-peer voice 1 vofr destination-pattern 1... session target serial 0/0 100	dial-peer voice 2 vofr destination-pattern 1... session target serial 0/0/200
voice-port 1/0/0	dial-peer voice 2 vofr destination-pattern 2... session target serial 0/1 200	voice-port 1/0/0

Tandem Configuration with a Cisco MC3810 Endpoint Node for Cisco-Trunk (Private Line) Calls

Figure 8 shows an example of a tandem configuration with a Cisco MC3810 acting as an endpoint node for Cisco-trunk (private line) calls.

Figure 8 Tandem Configuration with a Cisco MC3810 Endpoint Node for Permanent Switched Calls



Router A (Cisco 2600) Endpoint	Router C (VIP-Enabled Cisco 7500) Tandem Node	Router B (Cisco MC3810) Endpoint
	class-map frf match protocol vofr policy-map llq class frf priority **t** policy-map llq-shape class class-default shape average **u s** service-policy llq	
interface serial 0/0 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0/0/0.1 encapsulation frame-relay frame-relay interface-dlci 100 class voice vofr data 4 call-control 5	interface serial 0 encapsulation frame-relay frame-relay traffic-shaping frame-relay interface-dlci 200 class voice vofr data 4 call-control 5

Router A (Cisco 2600) Endpoint	Router C (VIP-Enabled Cisco 7500) Tandem Node	Router B (Cisco MC3810) Endpoint

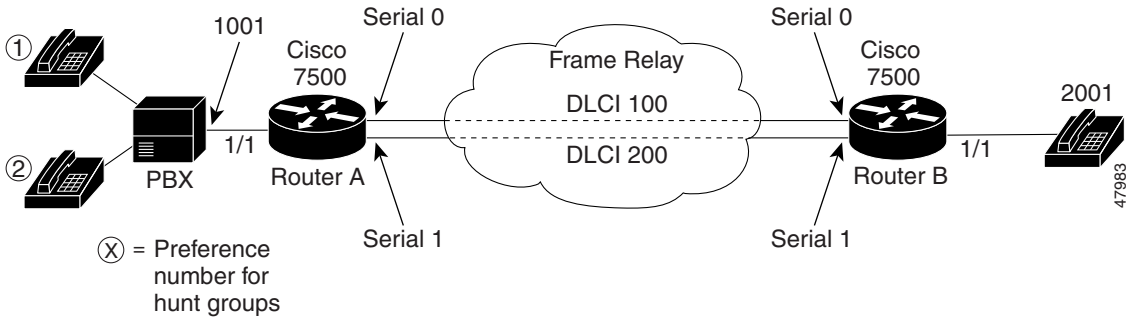
map-class frame-relay voice
  frame-relay cir **a**
	interface serial 0/1/0.1
	  encapsulation frame-relay
		map-class frame-relay voice
		  frame-relay cir **a**

frame-relay min-cir **t**	frame-relay interface-dlci 200	frame-relay min-cir **t**
frame-relay bc **b**	class voice	frame-relay bc **b**
frame-relay voice bandwidth **c**	vofr data 4 call-control 5	frame-relay voice bandwidth **c**
frame-relay fragment **d**		frame-relay fragment **d**
dial-peer voice 1 pots	map-class frame-relay voice	dial-peer voice 1 pots
destination-pattern 1001A	frame-relay fragment **d**	destination-pattern 2001A
port 1/0/0	frame-relay voice-bandwidth **c**	port 1/1
	service-policy llq-shape	
dial-peer voice 2 vofr	dial-peer voice 1 vofr	dial-peer voice 2 vofr
destination-pattern 2...	destination-pattern 1...	destination-pattern 1...
session target serial 0/0 100	session target serial 0/0/0.1 100	session target serial 0 200
voice-port 1/0/0	dial-peer voice 2 vofr	voice-port 1/1
connection trunk 2001A answer-mode	destination-pattern 2...	connection trunk 1001A
	session target serial 0/1/0.1 200	

Cisco-Trunk Call with Hunt Groups

Figure 9 shows an example of a Cisco-trunk (private line) call that is configured with hunt groups. In this example, the two routers are in master-slave mode with a backup path. Router B is configured as a slave and Router A is configured as the master. The master makes periodic attempts to establish the trunk until the trunk is established. Two dial peers match the destination string configured in the voice port, but because one dial peer has a higher preference than the other dial peer, the call setup is attempted through that dial peer. If the call setup fails, the master can continue attempting call setups by using the next available dial peer. After all dial peers are exhausted, the master can continue following the list cyclically by starting again from the dial peer with the highest preference.

Figure 9 Cisco-Trunk (Private Line) Call with Hunt Groups



Router A (VIP-Enabled Cisco 7500)	Router B (VIP-Enabled Cisco 7500)
`class-map frf`	`class-map frf`
`match protocol vofr`	`match protocol vofr`
`policy-map llq`	`policy-map llq`
`class frf`	`class frf`
`priority` **`t`**	`priority` **`t`**
`policy-map llq-shape`	`policy-map llq-shape`
`class class-default`	`class class-default`
`shape average` **`u s`**	`shape average` **`u s`**
`service-policy llq`	`service-policy llq`
`interface serial 0/0/0.1`	`interface serial 0/0/0.1`
`  encapsulation frame-relay`	`  encapsulation frame-relay`
`  frame-relay interface-dlci 100`	`  frame-relay interface-dlci 100`
`  class voice`	`  class voice`
`  vofr data 4 call-control 5`	`  vofr data 4 call-control 5`

Router A (VIP-Enabled Cisco 7500)	Router B (VIP-Enabled Cisco 7500)

interface serial 1/0/0.1
  encapsulation frame-relay
  frame-relay interface-dlci 200
  class voice
  vofr data 4 call-control 5
 	
map-class frame-relay voice
  frame-relay fragment **d**
  frame-relay voice-bandwidth **c**
  service-policy llq-shape
 	
dial-peer voice 1 pots
  destination-pattern 1001A
  port 1/1/0
 	
dial-peer voice 100 vofr
  destination-pattern 2...
  session target serial0 100
  preference 1
 	
dial-peer voice 200 vofr
  destination-pattern 2...
  session target serial1 200
  preference 2
 	
voice-port 1/1/0
  connection trunk 2005A
  description FXO port
	interface serial 1/0/0.1
	  encapsulation frame-relay
	  frame-relay interface-dlci 200
	  class voice
	  vofr data 4 call-control 5
	
	map-class frame-relay voice
	  frame-relay fragment **d**
	  frame-relay voice-bandwidth **c**
	  service-policy llq-shape
	
	dial-peer voice 1 pots
	  destination-pattern 2001A
	  port 1/1/0
	
	dial-peer voice 100 vofr
	  destination-pattern 1...
	  session target serial0 100
	  preference 1
	
	dial-peer voice 200 vofr
	  destination-pattern 1...
	  session target serial1 200
	  preference 2
	
	voice-port 1/1/0
	  description FXS port
	  connection trunk 1001A answer-mode

Command Reference

This section documents new or modified commands. All other commands used with this feature are documented in the Cisco IOS Release 12.1 command reference publications.

The following new and modified commands are described in this section:

- **frame-relay fragment**
- **service-policy**
- **show frame-relay fragment**

Note The command references in this section provide information for the listed commands on all platforms that support the specific command. The information in this section is not limited to VIP-enabled Cisco 7500 series routers.

frame-relay fragment

To enable fragmentation of Frame Relay frames for a Frame Relay map class, use the **frame-relay fragment** command. Use the **no** form of this command to disable Frame Relay fragmentation.

frame-relay fragment *fragment_size*

no frame-relay fragment

Syntax Description

fragment_size	Specifies the number of payload bytes from the original Frame Relay frame that will go into each fragment. This number excludes the Frame Relay header of the original frame. All the fragments of a Frame Relay frame except the last will have a payload size equal to *fragment_size*; the last fragment will have a payload less than or equal to *fragment_size*. Valid values are from 16 to 1600 bytes; the default is 53.

Defaults

Disabled

Command Modes

Map class configuration

Command History

Release	Modification
12.0(3)XG	This command was first introduced.
12.1(2)E	This command was introduced for Cisco 7500 series routers with a Versatile Interface Processor.
12.1(5)T	This command was introduced for Cisco 7500 series routers with a Versatile Interface Processor running Cisco IOS Release 12.1(5)T.

Usage Guidelines

Frame Relay fragmentation is enabled on a per-PVC basis. Before enabling Frame Relay fragmentation, you must first associate a Frame Relay map class with a specific data link connection identifier (DLCI), then enter map class configuration mode and enable or disable fragmentation for that map class. In addition, you must enable Frame Relay traffic shaping on the interface in order for fragmentation to work.

A Cisco 7500 series router requires a Versatile Interface Processor to utilize this command.

Frame Relay frames are fragmented using one of the following formats, depending on how the PVC is configured:

- Pure end-to-end FRF.12 format
- FRF.11 Annex C format
- Cisco proprietary format

Cisco recommends pure end-to-end FRF.12 fragmentation on PVCs that are carrying VoIP packets and on PVCs that are sharing the link with other PVCs carrying VoFR traffic.

In pure end-to-end FRF.12 fragmentation, Frame Relay frames with a payload less than the fragment size configured for that PVC are transmitted without the fragmentation header.

FRF.11 Annex C and Cisco proprietary fragmentation are used when VoFR frames are transmitted on a PVC. When fragmentation is enabled on a PVC, FRF.11 Annex C format is triggered when **vofr** is configured on that PVC; Cisco proprietary format is triggered when **vofr cisco** is configured.

In FRF.11 Annex C and Cisco proprietary fragmentation, VoFR frames are never fragmented, and all data packets (including VoIP packets) contain the fragmentation header regardless of the payload size.

Examples

The following example shows how to enable pure end-to-end FRF.12 fragmentation for the frag map class on a Cisco 2600, 3600, or 7200 starting from global configuration mode. The fragment payload size is set to 40 bytes. Frame Relay traffic shaping is required on the PVC; the only queuing type supported on the PVC when fragmentation is configured is weighted fair queuing (WFQ).

```
router(config)# interface serial 1/0/0
router(config-if)# frame-relay traffic-shaping
router(config-if)# frame-relay interface-dlci 100
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay cir 128000
router(config-map-class)# frame-relay bc 1000
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# frame-relay fair-queue
router(config-map-class)#
```

The following example shows how to enable pure end-to-end FRF.12 fragmentation for the frag map class on a VIP-enabled Cisco 7500 series router from global configuration mode. The fragment payload size is set to 40 bytes. Frame Relay traffic shaping is required on the PVC and is configured through the

use of a hierarchical service policy (which is configured using the Modular QoS CLI and applied to the map class using the **service-policy** command. See the service-policy command reference for additional information on hierarchical service policies).

```
router(config)# class-map frf
router(config-cmap)# match protocol vofr
router(config-cmap)# exit
router(config)# policy-map llq
router(config-pmap)# class frf
router(config-pmap-c)# priority 2000
router(config-pmap-c)# exit
router(config-pmap)# exit
router(config)# policy-map llq-shape
router(config-pmap)# class class-default
router(config-pmap-c)# shape average 1000 128000
router(config-pmap-c)# service-policy llq
router(config-pmap-c)# exit
router(config-pmap)# exit

router(config)# interface serial 1/0/0.1
router(config-if)# frame-relay interface-dlci 100
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# service-policy llq-shape
router(config-map-class)#
```

The following example shows how to enable FRF.11 Annex C fragmentation for data on a Cisco MC3810 PVC configured for VoFR. Note that fragmentation must be configured if a VoFR PVC is to carry data. The fragment payload size is set to 40 bytes. Frame Relay traffic shaping is required on the PVC; the only queuing type supported on the PVC when fragmentation is configured is weighted fair queuing (WFQ).

```
router(config)# interface serial 1/1
router(config-if)# frame-relay traffic-shaping
router(config-if)# frame-relay interface-dlci 101
router(config-fr-dlci)# vofr
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay cir 128000
router(config-map-class)# frame-relay bc 1000
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# frame-relay fair-queue
router(config-map-class)#
```

The following example is for the same configuration on a VIP-enabled Cisco 7500 series router:

```
router(config)# class-map frf
router(config-cmap)# match protocol vofr
router(config-cmap)# exit
router(config)# policy-map llq
router(config-pmap)# class frf
router(config-pmap-c)# priority 2000
router(config-pmap-c)# exit
router(config-pmap)# exit
router(config)# policy-map llq-shape
router(config-pmap)# class class-default
router(config-pmap-c)# shape average 1000 128000
router(config-pmap-c)# service-policy llq
router(config-pmap-c)# exit
router(config-pmap)# exit
router(config)# interface serial 1/1/0.1
router(config-if)# frame-relay interface-dlci 101
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# service-policy llq-shape
router(config-map-class)#
```

The following example shows how to enable Cisco proprietary Frame Relay fragmentation for the frag Frame Relay map class on a Cisco 2600, 3600, 7200, or 7500 series router, starting from global configuration mode. The fragment payload size is set to 40 bytes. Frame Relay traffic shaping is required on the PVC; the only queuing type supported on the PVC when fragmentation is configured is weighted fair queuing (WFQ).

```
router(config)# interface serial 2/0/0
router(config-if)# frame-relay traffic-shaping
router(config-if)# frame-relay interface-dlci 102
router(config-fr-dlci)# vofr cisco
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay cir 128000
router(config-map-class)# frame-relay bc 1000
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# frame-relay fair-queue
router(config-map-class)#
```

The following example is for the same configuration on a VIP-enabled Cisco 7500 series router:

```
router(config)# class-map frf
router(config-cmap)# match protocol vofr
router(config-cmap)# exit
router(config)# policy-map llq
router(config-pmap)# class frf
router(config-pmap-c)# priority 2000
router(config-pmap-c)# exit
router(config-pmap)# exit
router(config)# policy-map llq-shape
router(config-pmap)# class class-default
router(config-pmap-c)# shape average 1000 128000
router(config-pmap-c)# service-policy llq
router(config-pmap-c)# exit
router(config-pmap)# exit

router(config)# interface serial 2/0/0.1
router(config-if)# frame-relay interface-dlci 102
router(config-fr-dlci)# class frag
router(config-fr-dlci)# exit

router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# service-policy llq-shape
```

Related Commands

Command	Description
class	Associates a map class with a specified data link connection identifier (DLCI).
frame-relay fair-queue	Enables fair queueing in map class configuration mode.
frame-relay fragment	Enables weighted fair queuing for one or more Frame Relay PVCs on non-VIP-enabled Cisco 7500 series routers.
frame-relay interface-dlci	Assigns a data link connection identifier (DLCI) to a specified Frame Relay subinterface.
frame-relay traffic-shaping	Enables both traffic shaping and per-virtual circuit queuing for all PVCs and SVCs on a Frame Relay interface.
map-class frame-relay	Specifies a Frame Relay map class for the purpose of defining quality of service (QoS) parameter values for a PVC.

service-policy

To use a service policy as a QoS policy within a policy map (called a hierarchical service policy), use the **service-policy** policy map class configuration command. To disable a particular service policy as a QoS policy within a policy map, use the **no** form of this command.

service-policy *policy-map-name*

no service-policy *policy-map-name*

Syntax Description

policy-map-name	Specifies the name of the predefined policy map to be used as a QoS policy.

Defaults

No default behavior or values.

Command Modes

Policy map class configuration

Command History

Release	Modification
12.1(2)E	This command was introduced.
12.1(5)T	This command was introduced for Cisco IOS Release 12.1 T.

Usage Guidelines

This command is used to create hierarchical service policies in policy map class configuration mode.

This command is different from the **service-policy** [**input** | **output**] *policy-map-name* command used in interface configuration mode. The purpose of the **service-policy** [**input** | **output**] *policy-map-name* is to attach service policies to interfaces.

The child policy is the previously defined service policy that is being associated with the new service policy through the use of the **service-policy** command. The new service policy using the preexisting service policy is the parent policy. In the example in the next section, service policy child is the child policy and service policy parent is the parent policy.

This command has the following restrictions:

- The **set** command is not supported on the child policy.
- The **priority** command can be used in either the parent or the child policy, but not both policies simultaneously.
- The **fair-queue** command cannot be defined in the parent policy.
- If the **bandwidth** command is used in the child policy, the **bandwidth** command must also be used in the parent policy. The lone exception is for policies using the default class.

Examples

The following example creates a hierarchical service policy in service policy parent:

```
Router(config)# policy-map child
Router(config-pmap)# class voice
Router(config-pmap-c)# priority 50

Router(config)# policy-map parent
Router(config-pmap)# class class-default
Router(config-pmap-c)# shape average 10000000
Router(config-pmap-c)# service-policy child
```

FRF.11 and FRF.12 configurations on a VIP-enabled Cisco 7500 series routers often require a hierarchical service policy for configuration. A hierarchical service policy for FRF.11 and FRF.12 requires the following elements:

Requirement A. A traffic class that uses VoFR protocol as the only match criterion.

Requirement B. A traffic policy that insures Low Latency Queueing (LLQ, which is achieved using the **priority** command) for all VoFR protocol traffic

Requirement C. A traffic policy that defines the shaping parameters and includes the elements listed in Requirement B.

Requirement C can only be fulfilled through the use of a hierarchical service policy (which is configured using the **service-policy** command).

In the following example, requirement A is configured in traffic class frf, requirement B is configured in traffic policy llq, and requirement C is configured in traffic policy llq-shape.

```
router(config)# class-map frf
router(config-cmap)# match protocol vofr
router(config-cmap)# exit
router(config)# policy-map llq
router(config-pmap)# class frf
router(config-pmap-c)# priority 2000
router(config-pmap-c)# exit
router(config-pmap)# exit
router(config)# policy-map llq-shape
router(config-pmap)# class class-default
router(config-pmap-c)# shape average 1000 128000
Router(config-pmap-c)# service-policy llq
```

The final step in using a hierarchical service policy for FRF.11 and FRF.12 is using the service policy in map class configuration mode. In the following example, the llq-shape traffic policy is attached to map class frag:

```
router(config)# map-class frame-relay frag
router(config-map-class)# frame-relay fragment 40
router(config-map-class)# service-policy llq-shape
```

Related Commands

Command	Description
policy-map *policy-name*	Specifies the name of the service policy to configure.
service-policy [**input** | **output**] *policy-map-name*	Specifies the name of the service policy to be attached to the interface.
show policy-map	Displays all configured service policies.
show policy-map *policy-map-name*	Displays the user-specified service policy.
show policy-map interface	Displays statistics and configurations of all input and output service policies that are attached to an interface.

show frame-relay fragment

To display information about the Frame Relay fragmentation taking place in your Cisco router, use the **show frame-relay fragment** command from privileged EXEC mode.

show frame-relay fragment [**interface** *interface* [*dlci*]]

Syntax Description

interface	(Optional) Indicates a specific interface for which Frame Relay fragmentation information will be displayed.
interface	(Optional) Interface number containing the DLCI(s) for which you wish to display fragmentation information.
dlci	(Optional) Specific DLCI for which you wish to display fragmentation information.

Command Modes

Privileged EXEC

Command History

Release	Modification
12.0(3)XG	This command was first introduced.
12.1(2)E	This command was introduced for Cisco 7500 series routers with a Versatile Interface Processor.
12.1(5)T	This command was introduced for Cisco 7500 series routers with a Versatile Interface Processor running Cisco IOS Release 12.1 T.

Usage Guidelines

When no parameters are specified with this command, the output displays a summary of each DLCI configured for fragmentation. The information displayed includes the fragmentation type, the configured fragment size, and the number of fragments transmitted, received, and dropped.

When a specific interface and DLCI are specified, additional details are displayed.

Note This command will not produce any output for Cisco MC3810s configured with the **frame-relay interface-dlci voice-encap** command.

Examples

The following is sample output for the **show frame-relay fragment** command without any parameters specified:

```
router# show frame-relay fragment
interface         dlci  frag-type    frag-size  in-frag    out-frag   dropped-frag
Serial0           108   VoFR-cisco   100        1261       1298       0
Serial0           109   VoFR         100        0          243        0
Serial0           110   end-to-end   100        0          0          0
```

The following is sample output for the **show frame-relay fragment** command when an interface and DLCI are specified:

```
router# show frame-relay fragment interface Serial1/0
  fragment-size 45                   fragment type end-to-end
  in fragmented pkts 0               out fragmented pkts 0
  in fragmented bytes 0              out fragmented bytes 0
  in un-fragmented pkts 0            out un-fragmented pkts 0
  in un-fragmented bytes 0           out un-fragmented bytes 0
  in assembled pkts 0                out pre-fragmented pkts 0
  in assembled bytes 0               out pre-fragmented bytes
  in dropped reassembling pkts 0     out dropped fragmenting pkts 0
  in timeouts 0
  in out-of-sequence fragments 0
  in fragments with unexpected B bit set 0
  out interleaved packets 0
```

Table 4 describes the significant fields in this output.

Table 4 show frame-relay fragment command Field Descriptions

Field	Description
interface	Subinterface containing the DLCI for which the fragmentation information pertains.
dlci	Data-link connection identifier for which the displayed fragmentation information applies.
frag-type	Type of fragmentation configured on the designated DLCI. Supported types are end-to-end, VoFR, and VoFR-cisco.
frag-size	Configured fragment size in bytes.
in-frag	Total number of fragments received by the designated DLCI.
out-frag	The total number of fragments transmitted by the designated DLCI.
dropped-frag	Total number of fragments dropped by the designated DLCI.
in/out fragmented pkts	Total number of frames received/transmitted by this DLCI that have a fragmentation header.
in/out fragmented bytes	Total number of bytes, including those in the Frame Relay headers, that have been received/transmitted by this DLCI.
in/out un-fragmented pkts	Number of frames received/transmitted by this DLCI that do not require reassembly, and therefore do not contain the FRF.12 header. These counters can be incremented only when the end-to-end fragmentation type is set.
in/out un-fragmented bytes	Number of bytes received/transmitted by this DLCI that do not require reassembly, and therefore do not contain the FRF.12 header. These counters can be incremented only when the end-to-end fragmentation type is set.
in assembled pkts	Total number of fully reassembled frames received by this DLCI, including the frames received without a Frame Relay fragmentation header (in un-fragmented pkts). This counter corresponds to the frames viewed by the upper-layer protocols.
out pre-fragmented pkts	Total number of fully reassembled frames transmitted by this DLCI, including the frames transmitted without a Frame Relay fragmentation header (out un-fragmented pkts).

Table 4 show frame-relay fragment command Field Descriptions (continued)

Field	Description
in assembled bytes	Number of bytes in the fully reassembled frames received by this DLCI, including the frames received without a Frame Relay fragmentation header (in un-fragmented bytes). This counter corresponds to the total number of bytes viewed by the upper-layer protocols.
out pre-fragmented bytes	Number of bytes in the fully reassembled frames transmitted by this DLCI, including the frames transmitted without a Frame Relay fragmentation header (out un-fragmented bytes). This counter corresponds to the total number of bytes viewed by the upper-layer protocols.
in dropped reassembling pkts	Number of fragments received by this DLCI that are dropped for reasons such as running out of memory, receiving segments out of sequence, receiving an unexpected frame with a B bit set, or timing out on a reassembling frame.
out dropped fragmenting pkts	Number of fragments that are dropped by this DLCI during transmission because of running out of memory.
in timeouts	Number of reassembly timeouts that have occurred on incoming frames to this DLCI. (A frame that does not fully reassemble within two minutes is dropped and the timeout counter is incremented.)
in out-of-sequence fragments	Number of fragments received by this DLCI that have an unexpected sequence number.
in fragments with unexpected B bit set	Number of fragments received by this DLCI that have an unexpected B bit set. When this occurs, all fragments being reassembled are dropped and a new frame is begun with this fragment.
out interleaved packets	Number of packets leaving this DLCI that have been interleaved between segments. (Not available on Cisco 7500 series routers).

Related Commands

Command	Description
show frame-relay pvc	Displays statistics for PVCs associated with Frame Relay interfaces.
show frame-relay vofr	Displays information about the FRF.11 subchannels associated with VoFR DLCIs.
show interfaces serial	Displays information about a serial interface.
show traffic-shape queue	Displays information about the elements queued at the VC level.

Glossary

ABCD signaling—4-bit telephony line signaling coding in which each letter of "ABCD" represents one of the 4 bits. This is often associated with CAS or robbed-bit signaling on a T1 or E1 telephony trunk.

CID—Channel ID. Designates the Frame Relay subchannel ID for Voice over Frame Relay.

CIR—Committed information rate. The average rate of information transfer a subscriber (for example, a network administrator) has stipulated for a Frame Relay PVC.

Cisco-trunk (private line) call—A Cisco-trunk (private line) call is established by the forced connection of a dynamic switched call. A Cisco-trunk call is established during configuration of the trunk and stays up for the duration of the configuration. It optionally provides a pass-through connection path to pass signaling information between the two telephony interfaces at either end of the connection.

Codec—Coder-decoder. (i) An integrated circuit device that typically uses pulse code modulation to transform analog signals into a digital bit stream and digital signals back into analog signals. (ii) In Voice over IP, Voice over Frame Relay, and Voice over ATM, a DSP software algorithm used to compress/decompress speech or audio signals.

DLCI—Data-link connection identifier.

Dial peer—An addressable call endpoint that contains configuration information including voice protocol, codec type, and telephone number associated with the call endpoint. There are four kinds of dial peers: POTS, VoIP, VoFR, and VoATM.

DS0—A 64-kbps B channel on an E1 or T1 WAN interface.

DTMF—Dual-tone multifrequency. Uses two simultaneous voice-band tones for dial (such as touch tone).

DTMF relay—Enables the generation of FRF.11 Annex A frames for a VoFR dial peer. The DSP generates Annex A frames instead of passing a DTMF tone through the network as a voice sample.

Dynamic switched call—A telephone call dynamically established across a packet data network based on a dialed telephone number. In the case of VoFR, a Cisco proprietary session protocol similar to Q.931 is used to achieve call switching and negotiation between calling endpoints. The proprietary session protocol runs over FRF.11-compliant subchannels.

E&M—Stands for recEive and transMit (or Ear and Mouth). E&M is a trunking arrangement generally used for two-way switch-to-switch or switch-to-network connections. Cisco's analog E&M interface is an RJ-48 connector that allows connections to PBX trunk lines (tie lines). E&M is also available on E1 and T1 digital interfaces.

FIFO—First-in, first-out. In data communication, FIFO refers to a buffering scheme where the first byte of data entering the buffer is the first byte retrieved by the CPU. In telephony, FIFO refers to a queuing scheme where the first calls received are the first calls processed.

FRF—Frame Relay Forum. An association of corporate members consisting of vendors, carriers, users, and consultants committed to the implementation of Frame Relay in accordance with national and international standards. Go to http://www.frforum.com.

FRF.11—Frame Relay Forum implementation agreement for Voice over Frame Relay (v1.0 May 1997). This specification defines multiplexed data, voice, fax, DTMF digit-relay and CAS/robbed-bit signaling frame formats, but does not include call setup, routing, or administration facilities. Go to http://www.frforum.com.

FRF.11 Annex C—See FRF.12.

FRF11-trunk—A point-to-point permanent voice connection (private line) conforming to the FRF.11 specification.

FRF.12—The FRF.12 Implementation Agreement (also known as FRF.11 Annex C) was developed to allow long data frames to be fragmented into smaller pieces and interleaved with real-time frames. In this way, real-time voice and non-real-time data frames can be carried together on lower-speed links without causing excessive delay to the real-time traffic. Go to http://www.frforum.com.

FXO—Foreign Exchange Office. An FXO interface connects to the Public Switched Telephone Network's (PSTN) central office and is the interface offered on a standard telephone. Cisco's FXO interface is an RJ-11 connector that allows an analog connection to be directed at the PSTN's central office or to a station interface on a PBX.

FXS—Foreign Exchange Station. An FXS interface connects directly to a standard telephone and supplies ring, voltage, and dial tone. Cisco's FXS interface is an RJ-11 connector that allows connections to basic telephone service equipment, keysets, and PBXs.

Hookflash—A short on-hook period usually generated by a telephone-like device during a call to Mercury Exchange Limited (MEL) Channel Associated Signaling (CAS). A voice signaling protocol used primarily in the United Kingdom.

PBX—Private branch exchange. Privately owned central switching office.

Permanent calls—Permanent calls are private line calls used for fixed point-to-point calls, connections between PBXs (E&M to E&M), or for remote telephone extensions (FXO to FXS).

PLAR—Private line, automatic ringdown. A leased voice circuit that connects two single endpoints together. When either telephone handset is taken off-hook, the remote telephone automatically rings.

POTS—Plain old telephone service. Basic telephone service supplying standard single line telephones, telephone lines, and access to the PSTN.

POTS dial peer—Dial peer connected via a traditional telephony network. POTS peers point to a particular voice port on a voice network device.

PSTN—Public Switched Telephone Network. PSTN refers to the local telephone company.

PVC—Permanent virtual circuit.

SVC—Switched virtual circuit.

Switched calls—Switched calls are normal telephone calls in which a user picks up a telephone, hears dial tone, enters the destination telephone number to reach the other telephone. Switched calls can also be private line auto-ringdown (PLAR) calls, or tie-line calls for fixed E&M to E&M fixed point-to-point connections.

Tandem switching—The dynamic switching of voice calls between VoFR or VoATM PVCs and subchannels; also called tandeming. Tandem switching is often encountered in multi-hop VoFR call connection paths.

Trunk—Service that allows quasi-transparent connections between two PBXs, a PBX and a local extension, or some other combination of telephony interfaces with signaling passed transparently through the packet data network.

VoFR—Voice over Frame Relay.

VoFR dial peer—Dial peer connected via a Frame Relay network. VoFR peers point to specific VoFR devices.

Voice over Frame Relay—Voice over Frame Relay enables a router to carry voice traffic (for example, telephone calls and faxes) over a Frame Relay network. When sending voice traffic over Frame Relay, the voice traffic is segmented and encapsulated for transit across the Frame Relay network by using FRF.12 encapsulation.