

PPP over Frame Relay

Feature Summary

The PPP over Frame Relay feature allows a router to establish end-to-end Point-to-Point Protocol (PPP) sessions over Frame Relay. IP datagrams are transported over the PPP link using RFC 1973 compliant Frame Relay framing. This feature is useful for remote users running PPP to access their Frame Relay corporate networks as shown in Figure 1. Figure 2 shows a connectivity scenario using the Cisco 90i D4 channel card, which is capable of supporting Integrated Services Digital Network (ISDN) Digital Service Loop (DSL), PPP, or Frame Relay, which connects to an Internet Service Provider (ISP) or corporate network.

Figure 1 PPP Over Frame Relay Scenario

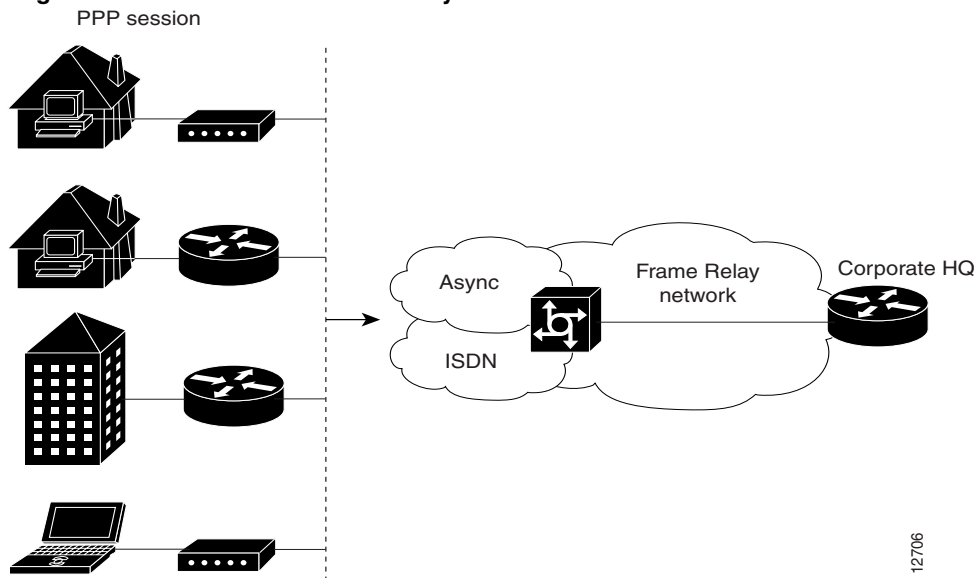
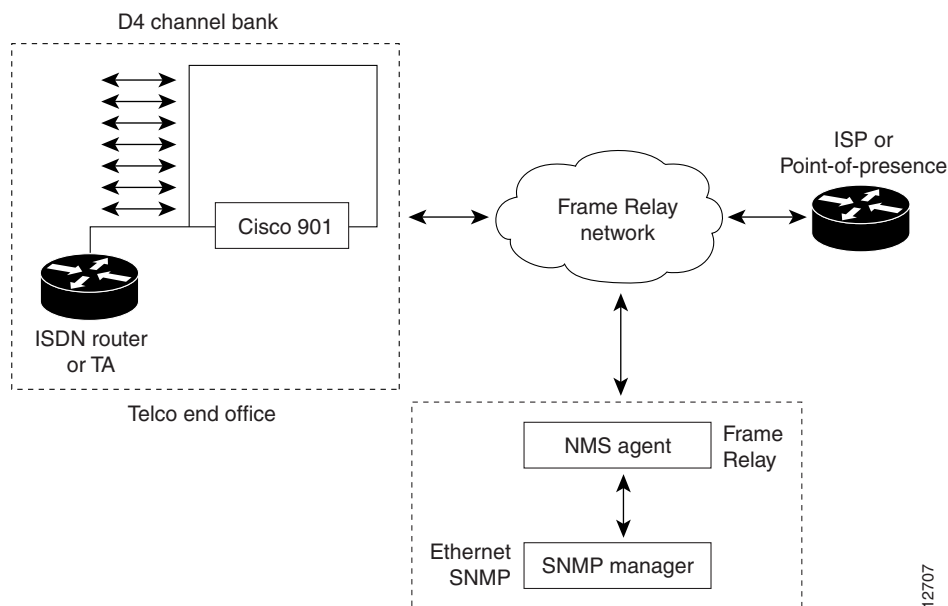


Figure 2 PPP over Frame Relay Using the Cisco 90i D4 Channel Unit



Benefits

PPP over Frame Relay provides the following benefits:

- Allows end-to-end PPP sessions over Frame Relay.
- Supports the 90i IDSL Channel Unit that supports both Frame Relay and Point-to-Point Protocol (PPP) on an ISDN DSL.

List of Terms

data-link connection identifier (DLCI)— A value that specifies a PVC or SVC in a Frame Relay network. In the basic Frame Relay specification, DLCIs are locally significant (connected devices might use different values to specify the same connection). In the LMI extended specification, DLCIs are globally significant (DLCIs specify individual end devices).

Integrated Services Digital Network (ISDN)—Communication protocols offered by telephone companies that permit telephone networks to carry data, voice, and other source traffic.

Link Control Protocol (LCP)—A protocol that establishes, configures, and tests data link connections used by PPP.

permanent virtual circuit (PVC)—Virtual circuit that is permanently established. PVCs save bandwidth associated with circuit establishment and tear down in situations where certain virtual circuits must exist all the time.

Point-to-Point Protocol (PPP)—A protocol that encapsulates network layer protocol information over point-to-point links. The RFC for PPP is RFC 1661.

virtual circuit (VC)—A logical circuit created to ensure reliable communication between two network devices. A virtual circuit can be either permanent (a PVC) or switched (an SVC). Virtual circuits are used in Frame Relay and X.25.

Restrictions

The following restrictions apply when using PPP over Frame Relay:

- Only Frame Relay PVCs are supported.
- Only the Internet Protocol (IP) is supported.

Platforms

This feature is supported on these platforms:

- Cisco 1600 series
- Cisco 2500 series
- Cisco 2600 series
- Cisco 3600 series
- Cisco 4000 series (Cisco 4000, 4000-M, 4500, 4500-M, 4700, 4700-M)
- Cisco 7200 series
- Cisco 7500 series

Prerequisites

Before you can configure PPP over Frame Relay, Frame Relay must be enabled on the router using the **encapsulation frame-relay** command.

Supported MIBs and RFCs

This feature supports the RFC 1973.

No new MIBs are supported by this feature.

Functional Description

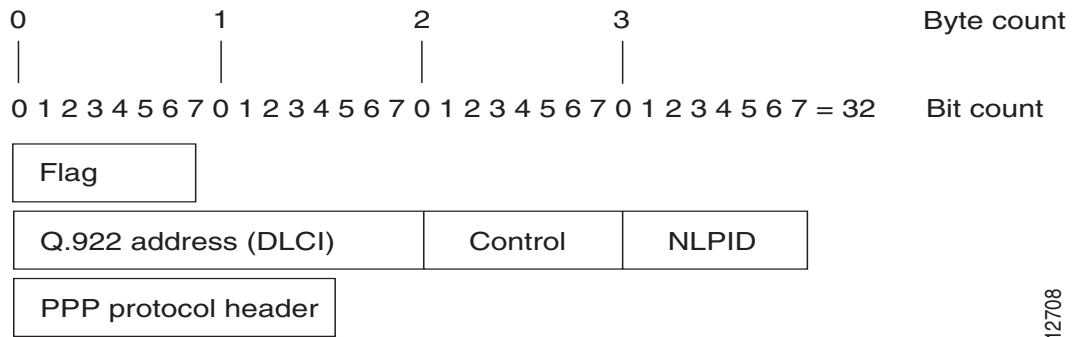
PPP over Frame Relay is compliant to the functionality and encapsulation specifications as outlined in RFC 1973. The frame format is shown in Figure 3.

A PPP connection is established over the Frame Relay permanent virtual circuit (PVC). The PPP session does not occur unless the associated Frame Relay PVC is in an “active” state. The Frame Relay VC can coexist with other circuits using different Frame Relay encapsulation methods, such as RFC 1490 and Cisco proprietary, over the same Frame Relay link. There can be multiple PPP-in-Frame Relay circuits existing on one Frame Relay link.

One PPP connection resides on one virtual access interface, which is internally created from a virtual template interface. A virtual access interface is cloned from a virtual template interface. The virtual access interfaces is coexistent with the creation of the Frame Relay circuit when the corresponding DLCI is configured. One virtual template interface, containing all the necessary PPP and network protocol information is shared by multiple virtual access interfaces. Hardware compression and fancy queuing algorithms, such as weighted fair queuing, custom queuing, and priority queuing, are not applied to virtual access interfaces. Once a Frame Relay circuit is established using PPP over

Frame Relay, all incoming and outgoing packets on this circuit are under RFC 1973 PPP-in-Frame-Relay encapsulation compliance until this DLCI is removed from the configuration. Refer to the Cisco IOS Release 11.3 *Wide Area Configuration Guide and Command Reference documents* for information about Frame Relay configuration options.

Figure 3 PPP over Frame Relay Frame Format



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The breakdown of the Frame Relay frame format components is listed in Table 1.

Table 1 PPP Frame Relay Format Descriptions

Field	Description
Flag	A single byte that indicates the beginning or end of a frame.
Address	A two byte field that indicates the logical connection that maps to the physical channel; the DLCI.
Control	A single byte that calls for transmission of user data. PPP over Frame Relay uses a value of 0X03, which indicates the frame is an unnumbered information (UI) frame.
NLPID	Network layer protocol ID, which is a single byte that uniquely identifies a PPP packet to Frame Relay.
PPP protocol	Identifies the PPP packet type.

Configuration Task

The only task required to implement PPP over Frame Relay is to configure the interface with the locally terminated PVC and the associated virtual template for PPP and IP, as described in the following section.

Enable PPP over Frame Relay

After you configure the Cisco router or access server for Frame Relay encapsulation, you must configure the physical interface with the PVC and apply a virtual template with PPP encapsulation to the DLCI that it applies to. To configure the physical interface that will carry the PPP session and link it to the appropriate virtual template interface, perform the following task in interface configuration mode:

Task	Command
Define the PVC and map it to the virtual template.	<code>frame-relay interface-dlci <i>dlci</i> [ppp <i>virtual-template-name-string</i>]</code>

Configuration Examples

This section provides the following examples:

- PPP over Frame Relay DTE Example
- PPP over Frame Relay DCE Example

PPP over Frame Relay DTE Example

The following example configures a router as a data terminating equipment (DTE) device for PPP over Frame Relay. Subinterface 2.1 contains the necessary DLCI and virtual template information. The virtual template interface (interface virtual-template 1) contains the PPP information that is applied to the PPP session associated with DLCI 32 on serial subinterface 2.1. Refer to the Cisco IOS Release 11.3 *Wide-Area Configuration Guide* and *Wide-Area Networking Command Reference* for information about Frame Relay configuration options.

```
interface serial 2
  no ip address
  encapsulation frame-relay
  frame-relay lmi-type ansi
!
interface serial 2.1 point-to-point
  frame-relay interface-dlci 32 ppp virtual-templatel
!
interface Virtual-Templatel
  ip unnumbered ethernet 0
  ppp authentication chap pap
```

Note By default, the encapsulation type for a virtual template interface is PPP encapsulation; therefore, **encapsulation ppp** will not show up when viewing the router's configuration.

PPP over Frame Relay DCE Example

The following example configures a router to act as a data communications equipment (DCE) device. Typically, a router is configured for a DCE if connecting directly to another router or if connected to a 90i D4 channel unit, which is connected to a telco channel bank. The three commands required for this type of configuration are the **frame-relay switching**, **frame-relay intf-type dce**, and **frame-relay route** commands. In this configuration

```
frame-relay switching
!
interface Serial2/0:0
  no ip address
  encapsulation frame-relay IETF
  frame-relay lmi-type ansi
  frame-relay intf-type dce
  frame-relay route 31 interface Serial1/2 100
  frame-relay interface-dlci 32 ppp Virtual-Template1
!
interface Serial2/0:0.2 point-to-point
  no ip address
  frame-relay interface-dlci 40 ppp Virtual-Template2
!
interface Virtual-Template1
  ip unnumbered Ethernet0/0
  peer default ip address pool default
  ppp authentication chap pap
!
interface Virtual-Template2
  ip address 100.1.1.2 255.255.255.0
  ppp authentication chap pap
```

Note By default, the encapsulation type for a virtual template interface is PPP encapsulation; therefore, **encapsulation ppp** will not show up when viewing the router's configuration.

Command Reference

This section documents the **frame-relay interface-dlci** command, which is revised to add the **ppp** keyword and **virtual-template-name-string** argument for PPP over Frame Relay. Only the revised keywords, which are used to configure PPP over Frame Relay are included. The **show interfaces** and **show frame-relay pvc** commands are modified to display configuration, status, and statistical information as related to Frame Relay interfaces configured for PPP.

- **frame-relay interface-dlci**
- **show frame-relay pvc**
- **Debug Commands**

frame-relay interface-dlci

To define a specific PVC to a DLCI and apply a virtual template configuration to a PPP session, use this form of the **frame-relay interface-dlci** interface configuration command. To remove this assignment, use the **no** form of this command.

```
frame-relay interface-dlci dlci [ppp virtual-template-name-string]  
no frame-relay interface-dlci dlci [ppp virtual-template-name-string]
```

Syntax Description

<i>dlci</i>	DLCI number to be used on the specified subinterface.
ppp	Enables the circuit to use the PPP in Frame Relay encapsulation.
<i>virtual-template-name-string</i>	Specifies which virtual template interface to apply the PPP connection to.

Default

PPP-in-Frame Relay encapsulation type is disabled.

Command Mode

Interface and subinterface configuration

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

The **ppp** keyword and **virtual-template-name-string** argument first appeared in Cisco IOS Release 11.3 T.

Example

The following example specifies DLCI 26 over subinterface serial 1.1 and assigns the characteristics under virtual-template 2 to this PPP connection:

```
interface serial1.1 point-to-point  
  frame-relay interface-dlci 26 ppp virtual-template2
```

Related Commands

```
show frame-relay pvc  
show interface
```

show frame-relay pvc

To display statistics about PVCs for Frame Relay interfaces, use the **show frame-relay pvc EXEC** command.

```
show frame-relay pvc [type number [dlci]]
```

Syntax Description

<i>type</i>	(Optional) Interface type.
<i>number</i>	(Optional) Interface number.
<i>dlci</i>	(Optional) One of the specific DLCI numbers used on the interface. Statistics for the specified PVC display when a DLCI is also specified.

Command Mode

EXEC

Usage Guidelines

This command first appeared in Cisco IOS Release 10.0.

This command was modified to display statistics about virtual access interfaces used for PPP connections over Frame Relay in Cisco IOS Release 11.3 T.

Use this command to monitor the PPP link control protocol (LCP) state as being open with an “up” state, or closed with a “down” state.

Sample Display

The following is sample output from the **show frame-relay pvc** command that shows the PVC statistics for serial interface 5, slot 1 and DLCI 55 is up. Refer to the Cisco IOS Release 11.3 *Wide-Area Configuration Guide* and *Wide-Area Networking Command Reference* for field description information.

```
Router# show frame-relay pvc 55

PVC Statistics for interface Serial5/1 (Frame Relay DTE)
DLCI = 55, DLCI USAGE = LOCAL, PVC STATUS = ACTIVE, INTERFACE = Serial5/1.1
  input pkts 9          output pkts 16          in bytes 154
  out bytes 338        dropped pkts 6          in FECN pkts 0
  in BECN pkts 0      out FECN pkts 0        out BECN pkts 0
  in DE pkts 0         out DE pkts 0
  out bcast pkts 0     out bcast bytes 0
  pvc create time 00:35:11, last time pvc status changed 00:00:22
  Bound to Virtual-Access1 (up, cloned from Virtual-Template5)
```

Debug Commands

The **debug frame-relay ppp** command is added to debug PPP sessions over Frame Relay.

debug frame-relay ppp

Use the **debug frame-relay ppp** EXEC command to display debugging information. To disable debugging output, use the **no** form of this command.

[no] debug frame-relay ppp

Usage Guidelines

Displays error messages for link states and LMI status changes for PPP over Frame Relay sessions.

To debug process-switched packets, use the **debug frame-relay packet** and/or **debug ppp packet** commands. To analyze the packets that have been *sent* on a Frame Relay interface, use the **debug frame-relay packet** command.

The **debug frame-relay ppp** command is generated from process level switching only and is not CPU intensive.

Sample Display

Figure 4 shows output from the **debug frame-relay ppp** command where the encapsulation failed for VC 100.

Figure 4 Sample Debug Frame-Relay PPP Output

```
Router# debug frame-relay ppp
FR-PPP: encaps failed for FR VC 100 on Serial0 down
FR-PPP: input- Serial0 vc or va down, pak dropped
```

Figure 5 shows the output from the **debug frame relay ppp** and **debug frame-relay packet** commands. This example shows a virtual interface (virtual interface 1) successfully establishing a PPP connection over PPP.

Figure 5 Sample Debug Frame-Relay PPP and Debug Frame Relay Packet Output

```
Router# debug frame-relay ppp
Router# debug frame-relay packet

Vi1 LCP: O CONFREQ [Closed] id 1 len 10
Vi1 LCP:   MagicNumber 0xE0638565 (0x0506E0638565)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 16
Vi1 PPP: I pkt type 0xC021, datagramsize 14
Vi1 LCP: I CONFACK [REQsent] id 1 len 10
Vi1 LCP:   MagicNumber 0xE0638565 (0x0506E0638565)
Vi1 PPP: I pkt type 0xC021, datagramsize 14
Vi1 LCP: I CONFREQ [ACKrcvd] id 6 len 10
Vi1 LCP:   MagicNumber 0x000EAD99 (0x0506000EAD99)
Vi1 LCP: O CONFACK [ACKrcvd] id 6 len 10
Vi1 LCP:   MagicNumber 0x000EAD99 (0x0506000EAD99)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 16
Vi1 IPCP: O CONFREQ [Closed] id 1 len 10
Vi1 IPCP:   Address 170.100.9.10 (0x0306AA64090A)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 16
Vi1 PPP: I pkt type 0x8021, datagramsize 14
Vi1 IPCP: I CONFREQ [REQsent] id 1 len 10
Vi1 IPCP:   Address 170.100.9.20 (0x0306AA640914)
Vi1 IPCP: O CONFACK [REQsent] id 1 len 10
Vi1 IPCP:   Address 170.100.9.20 (0x0306AA640914)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 16
Vi1 PPP: I pkt type 0x8021, datagramsize 14
Vi1 IPCP: I CONFACK [ACKsent] id 1 len 10
```

```

Vi1 IPCP:   Address 170.100.9.10 (0x0306AA64090A)
Vi1 PPP: I pkt type 0xC021, datagramsize 16
Vi1 LCP: I ECHOREQ [Open] id 1 len 12 magic 0x000EAD99
Vi1 LCP: O ECHOREP [Open] id 1 len 12 magic 0xE0638565
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 18
Vi1 LCP: O ECHOREQ [Open] id 1 len 12 magic 0xE0638565
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 18
Vi1 LCP: echo_cnt 4, sent id 1, line up

```

Figure 6 shows the output for the debug **frame-relay ppp** and **debug frame-relay packet** commands which report a failed PPP over Frame Relay session. The problem is due to a challenge handshake authentication protocol (CHAP) failure.

Figure 6 Failed PPP over Frame Relay Debug Output

```

Router# debug frame-relay ppp
Router# debug frame-relay packet

Vi1 LCP: O CONFREQ [Listen] id 24 len 10
Vi1 LCP:   MagicNumber 0xE068EC78 (0x0506E068EC78)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 16
Vi1 PPP: I pkt type 0xC021, datagramsize 19
Vi1 LCP: I CONFREQ [REQsent] id 18 len 15
Vi1 LCP:   AuthProto CHAP (0x0305C22305)
Vi1 LCP:   MagicNumber 0x0014387E (0x05060014387E)
Vi1 LCP: O CONFACK [REQsent] id 18 len 15
Vi1 LCP:   AuthProto CHAP (0x0305C22305)
Vi1 LCP:   MagicNumber 0x0014387E (0x05060014387E)
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 21
Vi1 PPP: I pkt type 0xC021, datagramsize 14
Vi1 LCP: I CONFACK [ACKsent] id 24 len 10
Vi1 LCP:   MagicNumber 0xE068EC78 (0x0506E068EC78)
Vi1 PPP: I pkt type 0xC223, datagramsize 32
Vi1 CHAP: I CHALLENGE id 12 len 28 from "krishna"
Vi1 LCP: O TERMREQ [Open] id 25 len 4
Serial2/1(o): dlci 201(0x3091), NLPID 0x3CF(PPP), datagramsize 10
Vi1 PPP: I pkt type 0xC021, datagramsize 8
Vi1 LCP: I TERMACK [TERMsent] id 25 len 4
Serial2/1(i): dlci 201(0x3091), pkt type 0x2000, datagramsize 303
%SYS-5-CONFIG_I: Configured from console by console
Vi1 LCP: TIMEOUT: Time 0x199580 State Listen

```