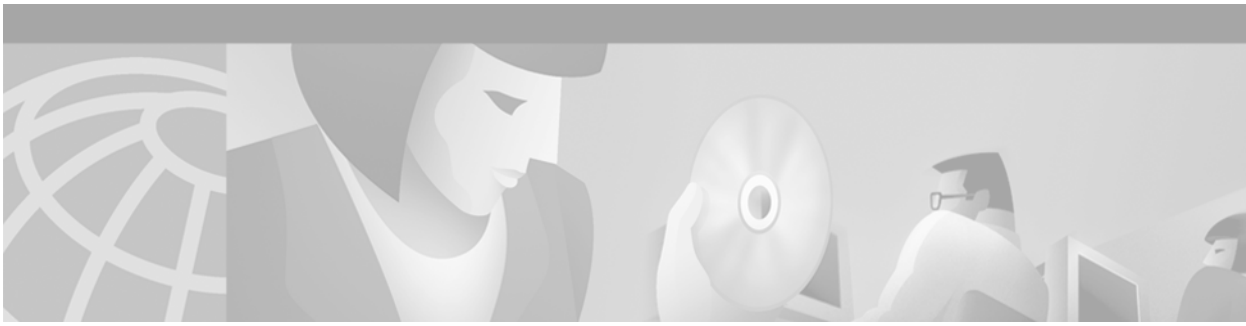


Configuring Legacy DDR Hubs

This chapter describes how to configure legacy dial-on-demand routing (DDR) on interfaces functioning as the hub in a hub-and-spoke network topology. It includes the following main sections:

- DDR Issues
- DDR Hubs Configuration Task Flow
- DDR Configuration Task List
- Legacy DDR Hub Configuration Examples

This chapter considers a *hub* interface to be any interface that calls or receives calls from more than one other router and a *spoke* interface to be an interface that calls or receives calls from exactly one router.

For configuration tasks for the spoke interfaces in a hub-and-spoke network topology, see the chapter "Configuring Legacy DDR Spokes" in this publication.

For information about the dialer profiles implementation of DDR, see the chapter "Configuring Peer-to-Peer DDR with Dialer Profiles" in this publication.

For a complete description of the DDR commands mentioned in this chapter, see the *Cisco IOS Dial Services Command Reference* publication. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

DDR Issues

A DDR configuration applies to a specified router interface but serves to meet the communication needs of the network. The router configured for DDR has a function to serve in preserving communications and ensuring that routes are known to other routers at both ends of the dial link. Thus, these issues are important:

- Types and number of router interfaces to be configured for DDR.
- Function of each specific interface—to place calls, or receive calls, or both—and the number of sites connecting to the interface.
- Identity and characteristics of the router at the other end of each connection—phone number, host name, next hop network protocol addresses, type of signalling used or required, ability to place or receive calls, other requirements.
- Types of packets that will be allowed to trigger outgoing calls—if the interface places calls.
- End of the connection that will control the communication: initiating calls, and terminating calls when the line is idle.

- Method for authenticating other routers—if the interface receives calls from multiple sites.
- Passing routing information across the dial link.

DDR Hubs Configuration Task Flow

Before you configure DDR, make sure you have completed the preparations for bridging or routing as described in the chapter "Preparing to Configure DDR" in this publication. That chapter provides information about the minimal requirements. For detailed information about bridging, routing, and wide-area networking configurations, see the appropriate chapters in other volumes of this documentation set.

When you configure DDR on a hub interface in a hub-and-spoke topology, you perform the following general steps:

Step 1 Specify the interface that will place calls to or receive calls from multiple sites. (See the chapter "Configuring Legacy DDR Spokes" in this publication for information about configuring an interface to place calls to or receive calls from one site only.)

Step 2 Enable DDR on the interface. This step is not required for some interfaces; for example, ISDN interfaces and passive interfaces that receive only from data terminal ready (DTR)-dialing interfaces.

Step 3 Configure the interface to receive calls only, if applicable. Receiving calls from multiple sites requires each inbound call to be authenticated.

Step 4 Configure the interface to place calls only, if applicable.

Step 5 Configure the interface to place and receive calls, if applicable.

Step 6 If the interface will place calls, specify access control for the following:

- Transparent bridging—Assign the interface to a bridge group, and define dialer lists associated with the bridging access lists. The interface switches between members of the same bridge group, and dialer lists specify which packets can trigger calls.

  or

- Routed protocols—Define dialer lists associated with the protocol access lists to specify which packets can trigger calls.

Step 7 Customize the interface settings (timers, interface priority, hold queues, bandwidth on demand, and disabling fast switching) as needed.

When you have configured the interface and it is operational, you can monitor its performance and its connections as described in the "Monitoring DDR Connections" section later in this chapter.

You can also enhance DDR by configuring Multilink PPP and configuring PPP callback. The PPP configuration tasks are described in the chapter "Configuring Media-Independent PPP and Multilink PPP" in this publication.

See the section "Legacy DDR Hub Configuration Examples" at the end of this chapter for examples of how to configure DDR on your network.

DDR Configuration Task List

To configure DDR on an interface, complete the tasks in the following sections. The first five bulleted items are required. The remaining tasks are not absolutely required, but might be necessary in your networking environment.

- Specifying the Interface (Required)
- Enabling DDR on the Interface (Required)
- Configuring the Interface to Place Calls Only (Required)
  or
  Configuring the Interface to Receive Calls Only (Required)
  or
  Configuring the Interface to Place and Receive Calls (Required)
- Configuring Access Control for Outgoing Calls (As Required)
- Customizing the Interface Settings (As Required)
- Sending Traffic over Frame Relay, X.25, or LAPB Networks (As Required)

See the section "Monitoring DDR Connections" later in this chapter for commands and other information about monitoring DDR connections. See the section "Legacy DDR Hub Configuration Examples" at the end of this chapter for ideas about how can implement DDR in your network.

Specifying the Interface

You can configure any asynchronous, synchronous serial, ISDN, or dialer interface for legacy DDR.

Note When you specify an interface, make sure to use the interface numbering scheme supported on the network interface module or other port hardware on the router. On the Cisco 7200 series router, for example, you specify an interface by indicating its type, slot number, and port number.

To specify an interface to configure for DDR, use one of the following commands in global configuration mode:

Command	Purpose
interface async *number* **interface serial** *number* **interface bri** *number* or	Specifies an interface to configure for DDR.
interface serial *slot*/*port*:**23** **interface serial** *slot*/*port*:**15** or	Specifies an ISDN PRI D channel (T1). Specifies an ISDN PRI D channel (E1).
interface dialer *number*	Specifies a logical interface to function as a dialer rotary group leader.

Dialer interfaces are logical or virtual entities, but they use physical interfaces to place or receive calls.

Enabling DDR on the Interface

This task is required for asynchronous serial, synchronous serial, and logical dialer interfaces.

This task is not required for ISDN interfaces (BRI interfaces and ISDN PRI D channels) and for *purely passive* interfaces that will receive calls only from interfaces that use DTR dialing.

Enabling DDR on an interface usually requires you to specify the type of dialer to be used. This task is not required for ISDN interfaces because the software automatically configures ISDN interfaces to be dialer type ISDN.

To enable DDR on the interface, use the following command in interface configuration mode:

Command	Purpose
dialer in-band [**no-parity** | **odd-parity**]	Enables DDR on an asynchronous interface or a synchronous serial interface using V.25*bis* modems.

You can optionally specify parity if the modem on this interface uses the V.25*bis* command set. The 1984 version of the V.25*bis* specification states that characters must have odd parity. However, the default for the **dialer in-band** command is no parity.

Configuring the Interface to Place Calls Only

To configure an interface to place calls to multiple destinations, complete the following tasks. The first task is required for all interface types. The second task is required only if you specified a dialer interface.

- Defining the Dialing Destination (Required)
- Specifying a Physical Interface to Use and Assigning it to a Dialer Rotary Group (As Required)

Defining the Dialing Destination

For calling multiple sites, an interface or dialer rotary group must be configured to map each next hop protocol address to the dial string (some form of a telephone number) used to reach it.

To define each dialing destination, use one of the following commands in interface configuration mode:

Command	Purpose
dialer map *protocol next-hop-address dial-string*[**:***isdn-subaddress*]	Defines a dialing destination for a synchronous serial interface or a dialer interface.
dialer map *protocol next-hop-address* [**spc**] [**speed 56** | **64**] [**broadcast**] [*dial-string*[**:***isdn-subaddress*]]	Defines a dialing destination for an ISDN interface (including an ISDN PRI D channel).
dialer map *protocol next-hop-address* [**modem-script** *modem-regexp*] [**system-script** *system-regexp*] *dial-string*[**:***isdn-subaddress*]	Defines a dialing destination for an asynchronous interface. If a modem dialing chat script has not been assigned to the line or a system login chat script must be specified, defines both a dialing destination and the chat scripts to use.

Repeat this task as many times as needed to ensure that all dialing destinations are reachable via some next hop address and dialed number.

If you intend to send traffic over other types of networks, see one of the following sections later in this chapter: "Configuring the Interface for Sending Traffic over a Frame Relay Network," "Configuring the Interface for Sending Traffic over an X.25 Network," or "Configuring the Interface for Sending Traffic over a LAPB Network."

Specifying a Physical Interface to Use and Assigning it to a Dialer Rotary Group

This section applies only if you specified a dialer interface to configure for DDR.

To assign a physical interface to a dialer rotary group, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	**interface serial** *number* or **interface async** *number*	Specifies a physical interface to use.
Step 2	**dialer rotary-group** *number*	Assigns the specified physical interface to a dialer rotary group.

Repeat these two commands for each physical interface to be used by the dialer interface.

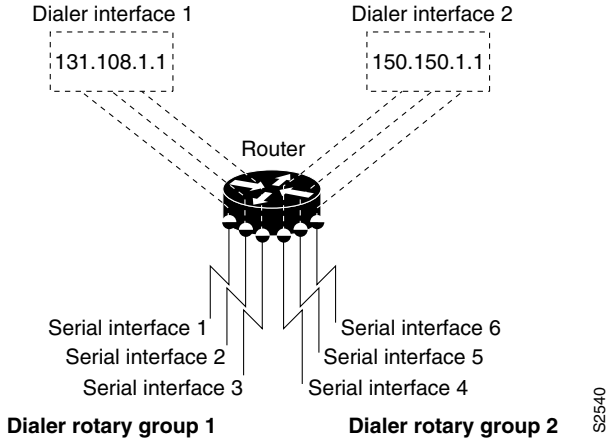
An ISDN BRI is a rotary group of B channels. An ISDN interface can be part of a rotary group comprising other interfaces (synchronous, asynchronous, ISDN BRI, or ISDN PRI). However, Cisco supports at most one level of recursion; that is, a rotary of rotaries is acceptable, but a rotary of rotaries of rotaries is not supported.

Interfaces in a dialer rotary group do not have individual addresses; when the interface is being used for dialing, it inherits the parameters configured for the dialer interface. However, if the individual interface is configured with an address and it is subsequently used to establish a connection from the user EXEC level, the individual interface address again applies.

Note When you look at your configuration file, commands will not appear in the order in which you entered them. You will also see interface configuration commands that you did not enter, because each interface assigned to a dialer rotary group inherits the parameters of the dialer interface in the dialer rotary group.

Figure 63 illustrates how dialer interfaces work. In this configuration, serial interfaces 1, 2, and 3 are assigned to dialer rotary group 1 and thereby take on the parameters configured for dialer interface 1. When it is used for dialing, the IP address of serial interface 2 is the same as the address of the dialer interface, 131.108.1.1.

Figure 63 Sample Dialer Interface Configuration



Configuring the Interface to Receive Calls Only

Once DDR is enabled on an asynchronous serial, synchronous serial, and ISDN interface, the interface can receive calls from multiple sites using one line or multiple lines. However, interfaces that receive calls from multiple sites require authentication of the remote sites. In addition, dialer interfaces require at least one physical interface to be specified and added to the dialer rotary group. The tasks in the following sections describe how to configuration authentication:

- Configuring the Interface for TACACS+

  or

- Configuring the Interface for PPP Authentication
- Specifying Physical Interfaces and Assigning Them to the Dialer Rotary Group

Configuring the Interface for TACACS+

To configure Terminal Access Controller Access Control System (TACACS) as an alternative to host authentication, use one of the following commands in interface configuration mode:

Command	Purpose
ppp use-tacacs [**single-line**] or **aaa authentication ppp**	Configures TACACS.

Use the **ppp use-tacacs** command with TACACS and extended TACACS. Use the **aaa authentication ppp** command with authentication, authorization, and accounting (AAA)/TACACS+.

Configuring the Interface for PPP Authentication

This section specifies the minimum required configuration for PPP Challenge Handshake Authentication Protocol (CHAP) or Password Authentication Protocol (PAP) authentication. For more detailed information, see the chapter "Configuring Media-Independent PPP and Multilink PPP" in this publication.

To use CHAP or PAP authentication, perform the following steps beginning in interface configuration mode:

Note After you have enabled one of these protocols, the local router or access server requires authentication of the remote devices that are calling. If the remote device does not support the enabled authentication protocol, no traffic will be passed to that device.

1. For CHAP, configure host name authentication and the secret or password for each remote system with which authentication is required.
2. Map the protocol address to the name of the host calling in.

To enable PPP encapsulation, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	**encapsulation ppp**	Enables PPP on an interface.
Step 2	**ppp authentication chap** [**if-needed**] or	Enables CHAP on an interface.
	ppp authentication pap	Enables PAP on an interface.
Step 3	**dialer map** *protocol next-hop-address* **name** *hostname*	For any host calling in to the local router or access server, maps its host name (case-sensitive) to the next hop address used to reach it. Repeat this step for each host calling in to this interface.
Step 4	**exit**	Returns to global configuration mode.
Step 5	**username** *name* [**user-maxlinks** *link-number*] **password** *secret*	Specifies the password to be used in CHAP caller identification. Optionally, you can specify the maximum number of connections a user can establish. To use the **user-maxlinks** keyword, you must also use the **aaa authorization network default local** command, and PPP encapsulation and name authentication on all the interfaces the user will be accessing. Repeat this step to add a **username** entry for each remote system from which the local router or access server requires authentication.

Specifying Physical Interfaces and Assigning Them to the Dialer Rotary Group

To assign a physical interface to a dialer rotary group, use the following commands beginning in global configuration mode:

	Command	Purpose
Step 1	**interface serial** *number* or **interface async** *number*	Specifies a physical interface to use.
Step 2	**dialer rotary-group** *number*	Assigns the specified physical interface to a dialer rotary group.

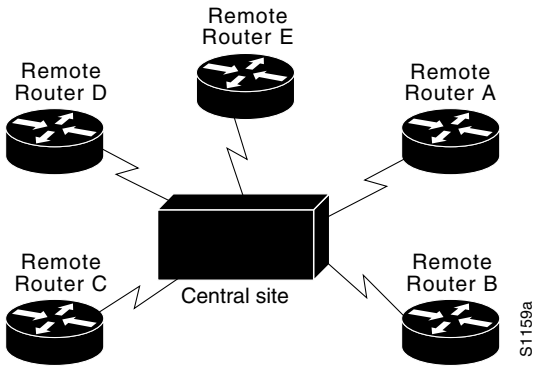
Repeat these two commands for each physical interface to be used by the dialer interface.

Configuring the Interface to Place and Receive Calls

You can configure an physical interface or dialer interface to both place and receive calls. For placing calls, the interface must be configured to map each next hop address to the telephone number to dial. For receiving calls from multiple sites, the interface must be configured to authenticate callers.

Figure 64 shows a configuration in which the central site is calling and receiving calls from multiple sites. In this configuration, multiple sites are calling in to a central site, and the central site might be calling one or more of the remote sites.

Figure 64 Hub-and-Spoke Configuration Using DDR



To configure a single line, multiple lines, or a dialer interface to place calls to and receive calls from multiple sites, complete the tasks in the following section:

- Defining One or More Dialing Destinations
- Defining the Traffic to Be Authenticated

If you intend to send traffic over other types of networks, see one of the following sections later in this chapter: “Configuring the Interface for Sending Traffic over a Frame Relay Network,” “Configuring the Interface for Sending Traffic over an X.25 Network,” or “Configuring the Interface for Sending Traffic over a LAPB Network.”

Defining One or More Dialing Destinations

For calling multiple sites, an interface or dialer rotary group must be configured to map each next hop protocol address to the dial string (some form of a telephone number) used to reach it.

To define each dialing destination, use one of the following commands in interface configuration mode:

Command	Purpose
dialer string *dial-string*[**:***isdn-subaddress*]	Defines only one dialing destination (used to configure one phone number on multiple lines only).
dialer map *protocol next-hop-address dial-string*[**:***isdn-subaddress*]	Defines one of several dialing destinations for a synchronous serial interface or a dialer interface.
dialer map *protocol next-hop-address* [**spc**] [**speed 56** | **64**][**broadcast**] [*dial-string*[**:***isdn-subaddress*]]	Defines one of several dialing destinations for an ISDN interface (including an ISDN PRI D channel).
dialer map *protocol next-hop-address* [**modem-script** *modem-regexp*] [**system-script** *system-regexp*] *dial-string*[**:***isdn-subaddress*]	Defines one of several dialing destinations for an asynchronous interface. If a modem dialing chat script has not been assigned to the line or a system login chat script must be specified, define both a dialing destination and the chat scripts to use.

Repeat this task as many times as needed to ensure that all dialing destinations are reachable via some next hop address and dialed number.

Defining the Traffic to Be Authenticated

Calls from the multiple sites must be authenticated. Authentication can be done through CHAP or PAP. In addition, the interface must be configured to map the protocol address of a host to the name to use for authenticating the remote host.

To enable CHAP or PAP on an interface and authenticate sites that are calling in, use the following commands in interface configuration mode:

	Command	Purpose
Step 1	**encapsulation ppp**	Configures an interface for PPP encapsulation.
Step 2	**ppp authentication chap** [**if-needed**] or **ppp authentication pap** [**if-needed**]	Enables CHAP. Enables PAP.
Step 3	**dialer map** *protocol next-hop-address* **name** *hostname* [**modem-script** *modem-regexp*] [**system-script** *system-regexp*] [*dial-string*[**:***isdn-subaddress*]]	Maps the protocol address to a host name.

If the dial string is not used, the interface will be able to receive calls from the host, but will not be able to place calls to the host.

Repeat for each site from which the router will receive calls.

Configuring Access Control for Outgoing Calls

Protocol access lists and dialer access lists are central to the operation of DDR. In general, access lists are used as the screening criteria for determining when to initiate DDR calls. All packets are tested against the dialer access list. Packets that match a permit entry are deemed *interesting* or *packets of interest*. Packets that do not match a permit entry or that do match a deny entry are deemed *uninteresting*. When a packet is found to be interesting, either the dialer idle timer is reset (if the line is active) or a connection is attempted (assuming the line is available but not active). If a tested packet is deemed *uninteresting*, it will be forwarded if it is intended for a destination known to be on a specific interface and the link is active. However, such a packet will not initiate a DDR call and will not reset the idle timer.

Configuring Access Control for Bridging

When you completed preparations for bridging over DDR, you entered global access lists to specify the protocol packets to be permitted or denied, and global dialer lists to specify which access list to use and which dialer group will place the outgoing calls.

Now you must tie those global lists to an interface configured for DDR. You do this by assigning selected interfaces to a bridge group. Because packets are bridged only among interfaces that belong to the same bridge group, you need to assign this interface and others to the same bridge group.

To assign an interface to a bridge group, use the following command in interface configuration mode:

Command	Purpose
bridge-group *bridge-group*	Assigns the specified interface to a bridge group.

For examples of bridging over DDR, see the "Transparent Bridging over DDR" section later in this chapter.

Configuring Access Control for Routing

Before you perform the tasks outlined in this section, you should have completed the preparations for routing a protocol over DDR as described briefly in the chapter "Preparing to Configure DDR" in this publication and as described in greater detail in the appropriate network protocols configuration guide (for example, the *Cisco IOS AppleTalk and Novell IPX Configuration Guide*).

An interface can be associated only with a single dialer access group; multiple dialer access group assignments are not allowed. To specify the dialer access group to which you want to assign an access list, use the following command in interface configuration mode:

Command	Purpose
dialer-group *group-number*	Specifies the number of the dialer access group to which the specific interface belongs.

Customizing the Interface Settings

Perform the tasks in the following sections as needed to customize DDR in your network:

- Configuring Timers on the DDR Interface (As Required)
- Setting Dialer Interface Priority (As Required)
- Configuring a Dialer Hold Queue (As Required)
- Configuring Bandwidth on Demand (As Required)
- Disabling and Reenabling DDR Fast Switching (As Required)

Configuring Timers on the DDR Interface

Perform the tasks in the following sections as needed to configure DDR interface timers:

- Setting Line-Idle Time (As Required)
- Setting Idle Time for Busy Interfaces (As Required)
- Setting Line-Down Time (As Required)
- Setting Carrier-Wait Time (As Required)

Setting Line-Idle Time

To specify the amount of time a line will stay idle before it is disconnected, use the following command in interface configuration mode:

Command	Purpose
dialer idle-timeout *seconds*	Sets line-idle time.

Setting Idle Time for Busy Interfaces

The dialer fast idle timer is activated if there is contention for a line. Contention occurs when a line is in use, a packet for a different next hop address is received, and the busy line is required to send the competing packet.

If the line has been idle for the configured amount of time, the current call is disconnected immediately and the new call is placed. If the line has not yet been idle as long as the fast idle timeout period, the packet is dropped because the destination is unreachable. (After the packet is dropped, the fast idle timer remains active and the current call is disconnected as soon as it has been idle for as long as the fast idle timeout). If, in the meantime, another packet is sent to the currently connected destination, and it is classified as interesting, the fast-idle timer is restarted.

To specify the amount of time a line for which there is contention will stay idle before the line is disconnected and the competing call is placed, use the following command in interface configuration mode:

Command	Purpose
dialer fast-idle *seconds*	Sets idle time for high traffic lines.

This command applies both to inbound and outbound calls.

Setting Line-Down Time

To set the length of time the interface stays down before it is available to dial again after a line is disconnected or fails, use the following command in interface configuration mode:

Command	Purpose
dialer enable-timeout *seconds*	Sets the interface downtime.

This command applies both to inbound and outbound calls.

Setting Carrier-Wait Time

To set the length of time an interface waits for the telephone service (carrier), use the following command in interface configuration mode:

Command	Purpose
dialer wait-for-carrier-time *seconds*	Sets the length of time the interface waits for the carrier to come up when a call is placed.

For asynchronous interfaces, this command sets the total time to wait for a call to connect. This time is set to allow for running the chat script.

Setting Dialer Interface Priority

You can assign dialer priority to an interface. Priority indicates which interface in a dialer rotary group will get used first. To assign priority to a dialer interface, use the following command in interface configuration mode:

Command	Purpose
dialer priority *number*	Specifies which dialer interfaces will be used first.

For example, you might give one interface in a dialer rotary group higher priority than another if it is attached to faster, more reliable modem. In this way, the higher-priority interface will be used as often as possible.

The range of values for *number* is 0 through 255. Zero is the default value and lowest priority; 255 is the highest priority. This command applies to outgoing calls only.

Configuring a Dialer Hold Queue

Sometimes packets destined for a remote router are discarded because no connection exists. Establishing a connection using an analog modem can take time, during which packets are discarded. However, configuring a dialer hold queue will allow *interesting* outgoing packets to be queued and sent as soon as the modem connection is established.

A dialer hold queue can be configured on any type of dialer, including in-band synchronous, asynchronous, DTR, and ISDN dialers. Also, *hunt group leaders* can be configured with a dialer hold queue. If a hunt group leader (of a rotary dialing group) is configured with a hold queue, all members of the group will be configured with a dialer hold queue and no hold queue for an individual member can be altered.

To establish a dialer hold queue, use the following command in interface configuration mode:

Command	Purpose
dialer hold-queue *packets*	Creates a dialer hold queue and specifies the number of packets to be held in it.

As many as 100 packets can be held in an outgoing dialer hold queue.

Configuring Bandwidth on Demand

You can configure a dialer rotary group to use additional bandwidth by placing additional calls to a single destination if the load for the interface exceeds a specified weighted value. Parallel communication links are established based on traffic load. The number of parallel links that can be established to one location is not limited.

To set the dialer load threshold for bandwidth on demand, use the following command in interface configuration mode:

Command	Purpose
dialer load-threshold *load*	Configures the dialer rotary group to place additional calls to a destination, as indicated by interface load.

Once multiple links are established, they are still governed by the load threshold. If the total load falls below the threshold, an idle link will be torn down.

Disabling and Reenabling DDR Fast Switching

Fast switching is enabled by default on all DDR interfaces. When fast switching is enabled or disabled on an ISDN D channel, it is enabled or disabled on all B channels. When fast switching is enabled or disabled on a dialer interface, it is enabled or disabled on all rotary group members but cannot be enabled or disabled on the serial interfaces individually.

Fast switching can be disabled and reenabled on a protocol-by-protocol basis. To disable fast switching and reenable it, use one of the following protocol-specific commands:

Command	Purpose
`no ip route-cache`	Disables IP fast switching over a DDR interface.
`ip route cache`	Reenables IP fast switching over a DDR interface.
`no ip route-cache distributed`	Disables distributed IP fast switching over a DDR interface. This feature works in Cisco 7500 routers with a Versatile Interface Processor (VIP) card.
`ip route-cache distributed`	Enables distributed IP fast switching over a DDR interface. This feature works in Cisco 7500 routers with a VIP card.
`no ipx route-cache`	Disables IPX fast switching over a DDR interface.
`ipx route-cache`	Reenables IPX fast switching over a DDR interface.

Sending Traffic over Frame Relay, X.25, or LAPB Networks

An interface configured for DDR can send traffic over networks that require Link Access Procedure, Balanced (LAPB), X.25, or Frame Relay encapsulation.

Before Cisco IOS software Release 12.0(6)T, encapsulation techniques such as Frame Relay, High-Level Data Link Control (HDLC), LAPB-TA, and X.25 could support only one ISDN B-channel connection over the entire link. HDLC and PPP could support multiple B channels, but the entire ISDN link needed to use the same encapsulation. Dynamic multiple encapsulations allow incoming calls over ISDN to be assigned encapsulation type based on calling line identification (CLID) or Dialed Number Identification Service (DNIS). With dynamic multiple encapsulations, once CLID binding is completed, the topmost interface is always used for all configuration and data structures. The ISDN B channel becomes a forwarding device, and the configuration on the D channel is ignored, thereby allowing the different encapsulation types and per-user configurations.

To configure an interface for those networks, complete the tasks in the following sections:

- Configuring the Interface for Sending Traffic over a Frame Relay Network (As Required)
- Configuring the Interface for Sending Traffic over an X.25 Network (As Required)
- Configuring the Interface for Sending Traffic over a LAPB Network (As Required)

Configuring the Interface for Sending Traffic over a Frame Relay Network

Access to Frame Relay networks is now available through dialup connections and leased lines. Dialup connectivity allows Frame Relay networks to be extended to sites that do not generate enough traffic to justify leased lines, and also allows a Frame Relay network to back up another network or point-to-point line.

DDR over Frame Relay is supported for synchronous serial and ISDN interfaces and for rotary groups, and is available for in-band, DTR, and ISDN dialers.

Frame Relay supports multiple permanent virtual circuit (PVC) connections over the same serial interface or ISDN B channel, but only one *physical* interface can be used (dialed, connected, and active) in a rotary group or with ISDN.

Dynamic multiple encapsulations support the following Frame Relay features:

- Frame Relay RTP Header Compression (RFC 1889)
- Frame Relay TCP/IP Header Compression
- Legacy DDR over Frame Relay
- Frame Relay Interface/Subinterface Backup

Dynamic multiple encapsulations support at least four Frame Relay PVCs on either dialer interfaces or dialer subinterfaces.

Note Frame Relay encapsulations in the dynamic multiple encapsulations feature do not support IETF or Cisco Encapsulation for IBM Systems Network Architecture (SNA). Frame Relay for SNA support is not applicable.

Configuration Restrictions

The following restrictions apply to DDR used over Frame Relay:

- Frame Relay is not available for asynchronous dialers.
- The Frame Relay dynamic multiple encapsulations does *not* provide bidirectional support.
- With the dynamic multiple encapsulations, there is no process switching for Frame Relay packets; these packets are always fast switched.
- Like HDLC, LAPB, X.25 and Frame Relay do not provide authentication. However, ISDN dialers can offer some authentication through the caller ID feature.
- Only one ISDN B channel can be dialed at any one time. When configuring a rotary group, you can use only one serial interface.

Note Frame Relay subinterfaces work the same on dialup connections as they do on leased lines.

Configuration Overview

No new commands are required to support DDR over Frame Relay. In general, you configure Frame Relay and configure DDR. In general, complete the following tasks to configure an interface for DDR over Frame Relay:

- Specify the interface.
- Specify the protocol identifiers for the interface.

  For example, enter the IP address and mask, the IPX network number, and the AppleTalk cable range and zone.

- Configure Frame Relay, as described in the chapter "Configuring Frame Relay" in the *Cisco IOS Wide-Area Networking Configuration Guide*.

  As a minimum, you must enable Frame Relay encapsulation and decide whether you need to do static or dynamic address mapping. If you decide to do dynamic mapping, you need not enter a command because Inverse ARP is enabled by default. If you decide to do static mapping, you must enter Frame Relay mapping commands.

  You can then configure various options as needed for your Frame Relay network topology.

- Configure DDR.

  At a minimum, you must decide and configure the interface for outgoing calls only, incoming calls only, or both outgoing and incoming calls.

  You can also configure DDR for your routed protocols (as specified in the chapter "Preparing to Configure DDR") and for snapshot routing (as specified in the chapter "Configuring Snapshot Routing" in the *Cisco IOS Dial Services Configuration Guide: Network Services* publication). You can also customize DDR on your router or access server (as described in the "Customizing the Interface Settings" section later in this chapter).

For examples of configuring various interfaces for DDR over Frame Relay, see the section "Frame Relay Support" later in this chapter.

Configuring the Interface for Sending Traffic over an X.25 Network

X.25 interfaces can now be configured to support DDR. Synchronous serial and ISDN interfaces on Cisco routers and access servers can be configured for X.25 addresses, X.25 encapsulation, and mapping of protocol addresses to the X.25 address of a remote host. In-band, DTR, and ISDN dialers can be configured to support X.25 encapsulation, but rotary groups cannot.

Remember that for ISDN interfaces, once CLID binding is completed, the topmost interface is always used for all configuration and data structures. The ISDN B channel becomes a forwarding device, and the configuration on the D channel is ignored, thereby allowing the different encapsulation types and per-user configurations. For X.25 encapsulations, the configurations reside on the dialer profile. The Dynamic Multiple Encapsulations feature provides support for packet assembler/disassembler (PAD) traffic and X.25 encapsulated and switched packets.

To configure an interface to support X.25 and DDR, use the following X.25-specific commands in interface configuration mode:

	Command	Purpose
Step 1	**encapsulation x25** [**dte** | **dce**] [**ietf**]	Configures the interface to use X.25 encapsulation.
Step 2	**x25 address** *x.121-address*	Assigns an X.25 address to the interface.
Step 3	**x25 map** *protocol address* [*protocol2 address2* [...[*protocol9 address9*]]] *x.121-address* [*option*]	Sets up the LAN protocols-to-remote host address mapping.

The order of DDR and X.25 configuration tasks is not critical; you can configure DDR before or after X.25, and you can even mix the DDR and X.25 commands.

For an example of configuring an interface for X.25 encapsulation and then completing the DDR configuration, see the section "X.25 Support Configuration" later in this chapter.

Configuring the Interface for Sending Traffic over a LAPB Network

DDR over serial lines now supports LAPB encapsulation, in addition to the previously supported PPP, HDLC, and X.25 encapsulations.

LAPB encapsulation is supported on synchronous serial, ISDN, and dialer rotary group interfaces, but not on asynchronous dialers.

Because the default encapsulation is HDLC, you must explicitly configure LAPB encapsulation. To configure an interface to support LAPB encapsulation and DDR, use the following command in interface configuration mode:

Command	Purpose
encapsulation lapb [**dte** | **dce**] [**multi** | *protocol*]	Specifies LAPB encapsulation.

For more information about the serial connections on which LAPB encapsulation is appropriate, see the **encapsulation lapb** command in the chapter "X.25 and LAPB Commands" in the *Cisco IOS Wide-Area Networking Command Reference* publication.

For an example of configuring an interface for DDR over LAPB, see the section "X.25 Support Configuration" later in this chapter.

Monitoring DDR Connections

To monitor DDR connections and snapshot routing, use the following commands in privileged EXEC mode:

Command	Purpose
show dialer [**interface** *type number*]	Displays general diagnostics about the DDR interface.
show dialer map	Displays current dialer maps, next-hop protocol addresses, user names, and the interfaces on which they are configured.
show interfaces bri 0	Displays information about the ISDN interface.
show ipx interface [*type number*]	Displays status about the IPX interface.
show ipx traffic	Displays information about the IPX packets sent by the router or access server, including watchdog counters.
show appletalk traffic	Displays information about the AppleTalk packets sent by the router or access server.
show vines traffic	Displays information about the Banyan VINES packets sent by the router or access server.
show decnet traffic	Displays information about the DECnet packets sent by the router or access server.
show xns traffic	Displays information about the XNS packets sent by the router or access server.
clear dialer	Clears the values of the general diagnostic statistics.

Legacy DDR Hub Configuration Examples

The following examples show various DDR configurations as follows:

- Transparent Bridging over DDR
- DDR Configuration in an IP Environment
- AppleTalk Configuration
- Banyan VINES Configuration
- DECnet Configuration
- ISO CLNS Configuration
- XNS Configuration
- Hub-and-Spoke DDR for Asynchronous Interfaces and Authentication
- Single Site or Multiple Sites Dialing Configuration
- Multiple Destinations Configuration
- Dialer Interfaces and Dialer Rotary Groups
- DDR Configuration Using Dialer Interface and PPP Encapsulation
- Two-Way DDR with Authentication
- Frame Relay Support
- X.25 Support Configuration
- LAPB Support Configuration

Transparent Bridging over DDR

The following two examples differ only in the packets that cause calls to be placed. The first example specifies by protocol (any bridge packet is permitted to cause a call to be made); the second example allows a finer granularity by specifying the Ethernet type codes of bridge packets.

The first example configures serial interface 1 for DDR bridging. Any bridge packet is permitted to cause a call to be placed.

```
no ip routing
!
interface Serial1
 no ip address
 encapsulation ppp
 dialer in-band
 dialer enable-timeout 3
 dialer map bridge name urk broadcast 8985
 dialer hold-queue 10
 dialer-group 1
 ppp authentication chap
 bridge-group 1
 pulse-time 1
!
dialer-list 1 protocol bridge permit
bridge 1 protocol ieee
bridge 1 hello 10
```

The second example also configures the serial interface 1 for DDR bridging. However, this example includes an **access-list** command that specifies the Ethernet type codes that can cause calls to be placed and a **dialer list protocol list** command that refers to the specified access list.

```
no ip routing
!
interface Serial1
 no ip address
 encapsulation ppp
 dialer in-band
 dialer enable-timeout 3
 dialer map bridge name urk broadcast 8985
 dialer hold-queue 10
 dialer-group 1
 ppp authentication chap
 bridge-group 1
 pulse-time 1
!
access-list 200 permit 0x0800 0xFFF8
!
dialer-list 1 protocol bridge list 200
bridge 1 protocol ieee
bridge 1 hello 10
```

DDR Configuration in an IP Environment

The following example shows how to configure DDR to call one site from a synchronous serial interface in an IP environment. You could use the same configuration on an asynchronous serial interface by changing the **interface serial 1** command to specify an asynchronous interface (for example, **interface async 0**).

```
interface serial 1
 ip address 131.108.126.1 255.255.255.0
 dialer in-band
 dialer idle-timeout 600
 dialer string 5551234
 pulse-time 1
! The next command adds this interface to the dialer access group defined with
! the dialer-list command.
 dialer-group 1
!
!The first access list statement, below, specifies that IGRP updates are not
!interesting packets. The second access-list statement specifies that all
!other IP traffic such as Ping, Telnet, or any other IP packet is interesting.
!The dialer-list command then creates dialer access group 1 and states that
!access list 101 is to be used to classify packets as interesting or
!uninteresting. The ip route commands specify that there is a route to network
!131.108.29.0 and to network 131.108.1.0 via 131.108.126.2. This means that
!several destination networks are available through a router that is dialed
!from interface serial 1.
!
access-list 101 deny igrp 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
dialer-list 1 list 101
ip route 131.108.29.0 131.108.126.2
ip route 131.108.1.0 131.108.126.2
ip local pool dialin 101.102.126.2 101.102.126.254
```

With many modems, the **pulse-time** command must be used so that DTR is dropped for enough time to allow the modem to disconnect.

AppleTalk Configuration

The following example configures DDR for AppleTalk access using an ISDN BRI. Two access lists are defined: one for IP and Interior Gateway Routing Protocol (IGRP), and one for AppleTalk. AppleTalk packets from network 2141 only (except broadcast packets) can initiate calls.

```
interface BRI0
 ip address 130.1.20.107 255.255.255.0
 encapsulation ppp
 appletalk cable-range 2141-2141 2141.65
 appletalk zone SCruz-Eng
 no appletalk send-rtmps
 dialer map ip 130.1.20.106 broadcast 1879
 dialer map appletalk 2141.66 broadcast 1879
 dialer-group 1
!
access-list 101 deny   igrp 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
access-list 601 permit cable-range 2141-2141 broadcast-deny
access-list 601 deny other-access
!
dialer-list 1 list 101
dialer-list 1 list 601
```

Banyan VINES Configuration

The following example configures a router for VINES and IP DDR with in-band dialing. The VINES access list does not allow RTP routing updates to place a call, but any other data packet is interesting.

```
vines routing BBBBBBBB:0001
!
hostname RouterA
!
username RouterB password 7 030752180500
username RouterC password 7 00071A150754
!
interface serial 0
 ip address 131.108.170.19 255.255.255.0
 encapsulation ppp
 vines metrics 10
 vines neighbor AAAAAAAA:0001 0
 dialer in-band
 dialer map ip 131.108.170.151 name RouterB broadcast 4155551234
 dialer map vines AAAAAAAA:0001 name RouterC broadcast 4155551212
 dialer-group 1
 ppp authentication chap
 pulse-time 1
!
access-list 101 deny igrp 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
!
vines access-list 107 deny RTP 00000000:0000 FFFFFFFF:FFFF 00000000:0000 FFFFFFFF:FFFF
vines access-list 107 permit IP 00000000:0000 FFFFFFFF:FFFF 00000000:0000 FFFFFFFF:FFFF
!
dialer-list 1 protocol ip list 101
dialer-list 1 protocol vines list 107
```

DECnet Configuration

The following example configures a router for DECnet DDR with in-band dialing:

```
decnet routing 10.19
username RouterB password 7 030752180531
!
interface serial 0
 no ip address
 decnet cost 10
 encapsulation ppp
 dialer in-band
 dialer map decnet 10.151 name RouterB broadcast 4155551212
 dialer-group 1
 ppp authentication chap
 pulse-time 1
!
access-list 301 permit 10.0 0.1023 0.0 63.1023
dialer-list 1 protocol decnet list 301
```

ISO CLNS Configuration

The following example configures a router for International Organization for Standardization Connectionless Network Service (ISO CLNS) DDR with in-band dialing:

```
username RouterB password 7 111C140B0E
clns net 47.0004.0001.0000.0c00.2222.00
clns routing
clns filter-set ddrline permit 47.0004.0001....
!
interface serial 0
 no ip address
 encapsulation ppp
 dialer in-band
 dialer map clns 47.0004.0001.0000.0c00.1111.00 name RouterB broadcast 1212
 dialer-group 1
 ppp authentication chap
 clns enable
 pulse-time 1
!
clns route default serial 0
dialer-list 1 protocol clns list ddrline
```

XNS Configuration

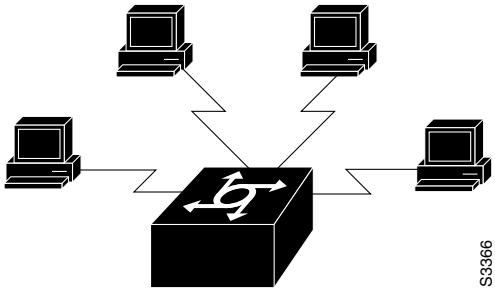
The following example configures a router for XNS DDR with in-band dialing. The access lists deny broadcast traffic to any host on any network, but allow all other traffic.

```
xns routing 0000.0c01.d8dd
username RouterB password 7 111B210A0F
interface serial 0
 no ip address
 encapsulation ppp
 xns network 10
 dialer in-band
 dialer map xns 10.0000.0c01.d877 name RouterB broadcast 4155551212
 dialer-group 1
 ppp authentication chap
 pulse-time 1
access-list 400 deny -1 -1.ffff.ffff.ffff 0000.0000.0000
access-list 400 permit -1 10
dialer-list 1 protocol xns list 400
```

Hub-and-Spoke DDR for Asynchronous Interfaces and Authentication

You can set up DDR to provide service to multiple remote sites. In a hub-and-spoke configuration, you can use a generic configuration script to set up each remote connection. Figure 65 illustrates a typical hub-and-spoke configuration.

Figure 65 Hub-and-Spoke DDR Configuration



The examples in the following sections show how to create this configuration.

Spoke Topology Configuration

The following commands are executed on the spoke side of the connection. (A different "spoke" password must be specified for each remote client.) The configuration provides authentication by identifying a password that must be provided on each end of the connection.

```
interface ethernet 0
 ip address 172.30.44.1 255.255.255.0
!
interface async 7
 async mode dedicated
 async default ip address 128.150.45.1
 ip address 1172.30.45.2 255.255.255.0
 encapsulation ppp
 ppp authentication chap
 dialer in-band
 dialer map ip 172.30.45.1 name hub system-script hub 1234
 dialer map ip 172.30.45.255 name hub system-script hub 1234
 dialer-group 1
!
ip route 172.30.43.0 255.255.255.0 172.30.45.1
 ip default-network 172.30.0.0
 chat-script generic ABORT BUSY ABORT NO ## AT OK ATDT\T TIMEOUT 30 CONNECT
 chat-script hub "" "" name: spoke1 word" <spoke1-passwd> PPP
 dialer-list 1 protocol ip permit
!
username hub password <spoke1-passwd>
!
router igrp 109
 network 172.30.0.0
 passive-interface async 7
!
line 7
 modem InOut
 speed 38400
 flowcontrol hardware
 modem chat-script generic
```

Hub Router Configuration

The following commands are executed on the local side of the connection—the hub router. The commands configure the server for communication with three clients and provides authentication by identifying a unique password for each "spoke" in the hub-and-spoke configuration.

```
interface ethernet 0
 ip address 172.30.43.1 255.255.255.0
!
interface async 7
 async mode interactive
 async dynamic address
 dialer rotary-group 1
!
interface async 8
 async mode interactive
 async dynamic address
 dialer rotary-group 1
!
```

```
interface dialer 1
 ip address 172.30.45.2 255.255.255.0
 no ip split-horizon
 encapsulation ppp
 ppp authentication chap
 dialer in-band
 dialer map ip 172.30.45.2 name spoke1 3333
 dialer map ip 172.30.45.2 name spoke2 4444
 dialer map ip 172.30.45.2 name spoke3 5555
 dialer map ip 172.30.45.255 name spoke1 3333
 dialer map ip 172.30.45.255 name spoke2 4444
 dialer map ip 172.30.45.255 name spoke3 5555
 dialer-group 1
!
ip route 172.30.44.0 255.255.255.0 172.30.45.2
ip route 172.30.44.0 255.255.255.0 172.30.45.3
ip route 172.30.44.0 255.255.255.0 172.30.45.4
 dialer-list 1 protocol ip list 101
 access-list 101 deny igrp 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
 access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
 chat-script generic ABORT BUSY ABORT NO ## AT OK ATDT\T TIMEOUT 30 CONNECT
!
username spoke1 password <spoke1-passwd>
username spoke2 password <spoke2-passwd>
username spoke3 password <spoke3-passwd>
username spoke1 autocommand ppp 172.30.45.2
username spoke2 autocommand ppp 172.30.45.3
username spoke3 autocommand ppp 172.30.45.4
!
router igrp 109
 network 172.30.0.0
 redistribute static
!
line 7
 login tacacs
 modem InOut
 speed 38400
 flowcontrol hardware
 modem chat-script generic
```

The **redistribute static** command can be used to advertise static route information for DDR applications. Without this command, static routes to the hosts or network that the router can access with DDR will not be advertised to other routers with which the router is communicating. This behavior can block communication because some routes will not be known. See the **redistribute static ip** command, described in the chapter "IP Routing Protocol-Independent Commands" in the *Cisco IOS IP and IP Routing Command Reference* publication.

Single Site or Multiple Sites Dialing Configuration

The following example is based on the configuration shown in Figure 66; the router receives a packet with a next hop address of 1.1.1.1.

Figure 66 Sample Dialer String or Dialer Map Configuration

If the interface on your router is configured to call a single site with phone number 5555555, it will send the packet to that site, assuming that the next hop address 1.1.1.1 indicates the same remote device as phone number 5555555. The **dialer string** command is used to specify the string (telephone number) to be called.

```
interface serial 1
 dialer in-band
 dialer string 5555555
```

If the interface is configured to dial multiple sites, the interface or dialer rotary group must be configured so that the correct phone number, 5555555, is mapped to the address 1.1.1.1. If this mapping is not configured, the interface or dialer rotary group does not know what phone number to call to deliver the packet to its correct destination, which is the address 1.1.1.1. In this way, a packet with a destination of 2.2.2.2 will not be sent to 5555555. The **dialer map** command is used to map next hop addresses to phone numbers.

```
interface serial 1
 dialer in-band
 dialer map ip 1.1.1.1 5555555
 dialer map ip 2.2.2.2 6666666
```

Multiple Destinations Configuration

The following example shows how to specify multiple destination numbers to dial for outgoing calls:

```
interface serial 1
 ip address 131.108.126.1 255.255.255.0
 dialer in-band
 dialer wait-for-carrier-time 100
 pulse-time 1
 dialer-group 1
 dialer map ip 131.108.126.10 5558899
 dialer map ip 131.108.126.15 5555555
!
access-list 101 deny igrp 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
dialer-list 1 protocol ip list 101
```

As in the "DDR Configuration in an IP Environment" section, a pulse time is assigned and a dialer access group specified.

The first **dialer map** command specifies that the number 555-8899 is to be dialed for IP packets with a *next-hop-address* value of 131.108.126.10. The second **dialer map** then specifies that the number 5555555 will be called when an IP packet with a *next-hop-address* value of 131.108.126.15 is detected.

Dialer Interfaces and Dialer Rotary Groups

The following configuration places serial interfaces 1 and 2 into dialer rotary group 1, defined by the **interface dialer 1** command:

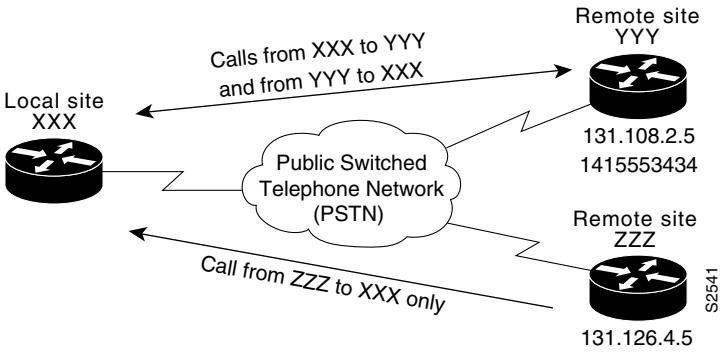
```
! PPP encapsulation is enabled for interface dialer 1.
interface dialer 1
 encapsulation ppp
 dialer in-band
 ip address 131.108.2.1 255.255.255.0
 ip address 131.126.2.1 255.255.255.0 secondary
! The first dialer map command allows remote site YYY and the central site to
! call each other. The second dialer map command, with no dialer string, allows
! remote site ZZZ to call the central site but the central site cannot call
! remote site ZZZ (no phone number).
!
 dialer map ip 131.108.2.5 name YYY 1415553434
 dialer map ip 131.126.2.55 name ZZZ
!
! The DTR pulse signals for three seconds on the interfaces in dialer group 1.
! This holds the DTR low so the modem can recognize that DTR has been dropped.
 pulse-time 3

! Serial interfaces 1 and 2 are placed in dialer rotary group 1. All the
! interface configuration commands (the encapsulation and dialer map commands
! shown earlier in this example) that applied to interface dialer 1 also apply
! to these interfaces.
interface serial 1
 dialer rotary-group 1
interface serial 2
 dialer rotary-group 1
```

DDR Configuration Using Dialer Interface and PPP Encapsulation

The following example shows a configuration for XXX, the local router shown in Figure 67. In this example, remote Routers YYY and ZZZ can call Router XXX. Router XXX has dialing information only for Router YYY and cannot call Router ZZZ.

Figure 67 DDR Configuration



Router XXX Configuration

```
username YYY password theirsystem
username ZZZ password thatsystem

! Create a dialer interface with PPP encapsulation and CHAP authentication.
interface dialer 1
 ip address 131.108.2.1 255.255.255.0
 ip address 131.126.4.1 255.255.255.0 secondary
 encapsulation ppp
 ppp authentication chap
 dialer in-band
 dialer group 1
! The first dialer map command indicates that calls between the remote site
! YYY and the central site will be placed at either end. The second dialer
! map command, with no dialer string, indicates that remote site ZZZ will call
! the central site but the central site will not call out.
 dialer map ip 131.108.2.5 name YYY 1415553434
 dialer map ip 131.126.4.5 name ZZZ
! The DTR pulse holds the DTR low for three seconds, so the modem can recognize
! that DTR has been dropped.
 pulse-time 3
!
! Place asynchronous serial interfaces 1 and 2 in dialer group 1. The interface commands
! applied to dialer group 1 (for example, PPP encapsulation and CHAP) apply to these
! interfaces.
!
interface async 1
 dialer rotary-group 1
interface async 2
 dialer rotary-group 1
```

Two-Way DDR with Authentication

You can set up two-way DDR with authentication in which both the client and server have dial-in access to each other. This configuration is demonstrated in the following two subsections.

Remote Configuration

The following commands are executed on the remote side of the connection. It provides authentication by identifying a password that must be provided on each end of the connection.

```
username local password secret1
username remote password secret2
!
interface ethernet 0
 ip address 172.30.44.1 255.255.255.0
!
interface async 7
 ip address 172.30.45.2 255.255.255.0
 async mode dedicated
 async default ip address 172.30.45.1
 encapsulation ppp
 dialer in-band
 dialer string 1234
 dialer-group 1
!
ip route 172.30.43.0 255.255.255.0 async 7
ip default-network 172.30.0.0
chat-script generic ABORT BUSY ABORT NO ## AT OK ATDT\T TIMEOUT 30 CONNECT
dialer-list 1 protocol ip permit
!
line 7
 no exec
 modem InOut
 speed 38400
 flowcontrol hardware
 modem chat-script generic
```

Local Configuration

The following commands are executed on the local side of the connection. As with the remote side configuration, it provides authentication by identifying a password for each end of the connection.

```
username remote password secret1
username local password secret2
!
interface ethernet 0
 ip address 172.30.43.1 255.255.255.0
!
interface async 7
 async mode dedicated
 async default ip address 172.30.45.2
 dialer rotary-group 1
!
interface async 8
 async mode dedicated
 async default ip address 172.30.45.2
 dialer rotary-group 1
!
```

```
interface dialer 1
 ip address 172.30.45.2 255.255.255.0
 encapsulation ppp
 ppp authentication chap
 dialer in-band
 dialer map ip 172.30.45.2 name remote 4321
 dialer load-threshold 80
!
ip route 172.30.44.0 255.255.255.0 172.30.45.2
 chat-script generic ABORT BUSY ABORT NO ## AT OK ATDT\T TIMEOUT 30 CONNECT
!
router igrp 109
 network 172.30.0.0
 redistribute static
 passive-interface async 7
!
line 7
 modem InOut
 speed 38400
 flowcontrol hardware
 modem chat-script generic
```

Frame Relay Support

The examples in this section present various combinations of interfaces, Frame Relay features, and DDR features.

Frame Relay Access with In-Band Dialing and Static Mapping

The following example configures a router for IP over Frame Relay using in-band dialing. A Frame Relay static map is used to associate the next hop protocol address to the DLCI. The dialer string allows dialing to only one destination.

```
interface Serial0
 ip address 1.1.1.1 255.255.255.0
 encapsulation frame-relay
 frame-relay map ip 1.1.1.2 100 broadcast
 dialer in-band
 dialer string 4155551212
 dialer-group 1
!
access-list 101 deny igrp any host 255.255.255.255
access-list 101 permit ip any any
!
dialer-list 1 protocol ip list 101
```

Frame Relay Access with ISDN Dialing and DDR Dynamic Maps

The following example shows a BRI interface configured for Frame Relay and for IP, Internet Protocol Exchange (IPX), and AppleTalk routing. No static maps are defined because this setup relies on Frame Relay Local Management Interface (LMI) signalling and Inverse ARP to determine the network addresses-to-DLCI mappings dynamically. (Because Frame Relay Inverse ARP is enabled by default, no command is required.)

```
interface BRI0
 ip address 1.1.1.1 255.255.255.0
 ipx network 100
 appletalk cable-range 100-100 100.1
 appletalk zone ISDN
 no appletalk send-rtmps
 encapsulation frame-relay IETF
 dialer map ip 1.1.1.2 broadcast 4155551212
 dialer map apple 100.2 broadcast 4155551212
 dialer map ipx 100.0000.0c05.33ed broadcast 4085551234
 dialer-group 1
!
access-list 101 deny igrp any host 255.255.255.255
access-list 101 permit ip any any
access-list 901 deny -1 FFFFFFFF 452
access-list 901 deny -1 FFFFFFFF 453
access-list 901 deny -1 FFFFFFFF 457
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 452
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 453
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 457
access-list 901 permit -1
access-list 601 permit cable-range 100-100 broadcast-deny
access-list 601 deny other-access
!
dialer-list 1 protocol ip list 101
dialer-list 1 protocol novell list 901
dialer-list 1 protocol apple list 601
```

Frame Relay Access with ISDN Dialing and Subinterfaces

The following example shows a BRI interface configured for Frame Relay and for IP, IPX, and AppleTalk routing. Two logical subnets are used; a point-to-point subinterface and a multipoint subinterface are configured. Frame Relay Annex A (LMI type Q933a) and Inverse ARP are used for dynamic routing.

```
interface BRI0
 no ip address
 encapsulation frame-relay
 dialer string 4155551212
 dialer-group 1
 frame-relay lmi-type q933a
!
interface BRI0.1 multipoint
 ip address 1.1.100.1 255.255.255.0
 ipx network 100
 appletalk cable-range 100-100 100.1
 appletalk zone ISDN
 no appletalk send-rtmps
 frame-relay interface-dlci 100
 frame-relay interface-dlci 110
 frame-relay interface-dlci 120
!
```

```
interface BRI0.2 point-to-point
 ip address 1.1.200.1 255.255.255.0
 ipx network 200
 appletalk cable-range 200-200 200.1
 appletalk zone ISDN
 no appletalk send-rtmps
 frame-relay interface-dlci 200 broadcast IETF
!
access-list 101 deny igrp any host 255.255.255.255
access-list 101 permit ip any any
access-list 901 deny -1 FFFFFFFF 452
access-list 901 deny -1 FFFFFFFF 453
access-list 901 deny -1 FFFFFFFF 457
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 452
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 453
access-list 901 deny -1 FFFFFFFF 0 FFFFFFFF 457
access-list 901 permit -1
access-list 601 permit cable-range 100-100 broadcast-deny
access-list 601 permit cable-range 200-200 broadcast-deny
access-list 601 deny other-access

dialer-list 1 protocol ip list 101
dialer-list 1 protocol novell list 901
dialer-list 1 protocol apple list 601
```

X.25 Support Configuration

The following example configures a router to support X.25 and DTR dialing:

```
interface serial 0
 ip address 131.108.170.19 255.255.255.0
 encapsulation x25
 x25 address 12345
 x25 map ip 131.108.171.20 67890 broadcast
 dialer dtr
 dialer-group 1
!
access-list 101 deny igrp 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
!
dialer-list 1 protocol ip list 101
```

LAPB Support Configuration

The following example configures a router for LAPB encapsulation and in-band dialing:

```
interface serial 0
 ip address 131.108.170.19 255.255.255.0
 encapsulation lapb
 dialer in-band
 dialer string 4155551212
 dialer-group 1
!
access-list 101 deny igrp 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
access-list 101 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
!
dialer-list 1 protocol ip list 101
```