CHAPTER 10

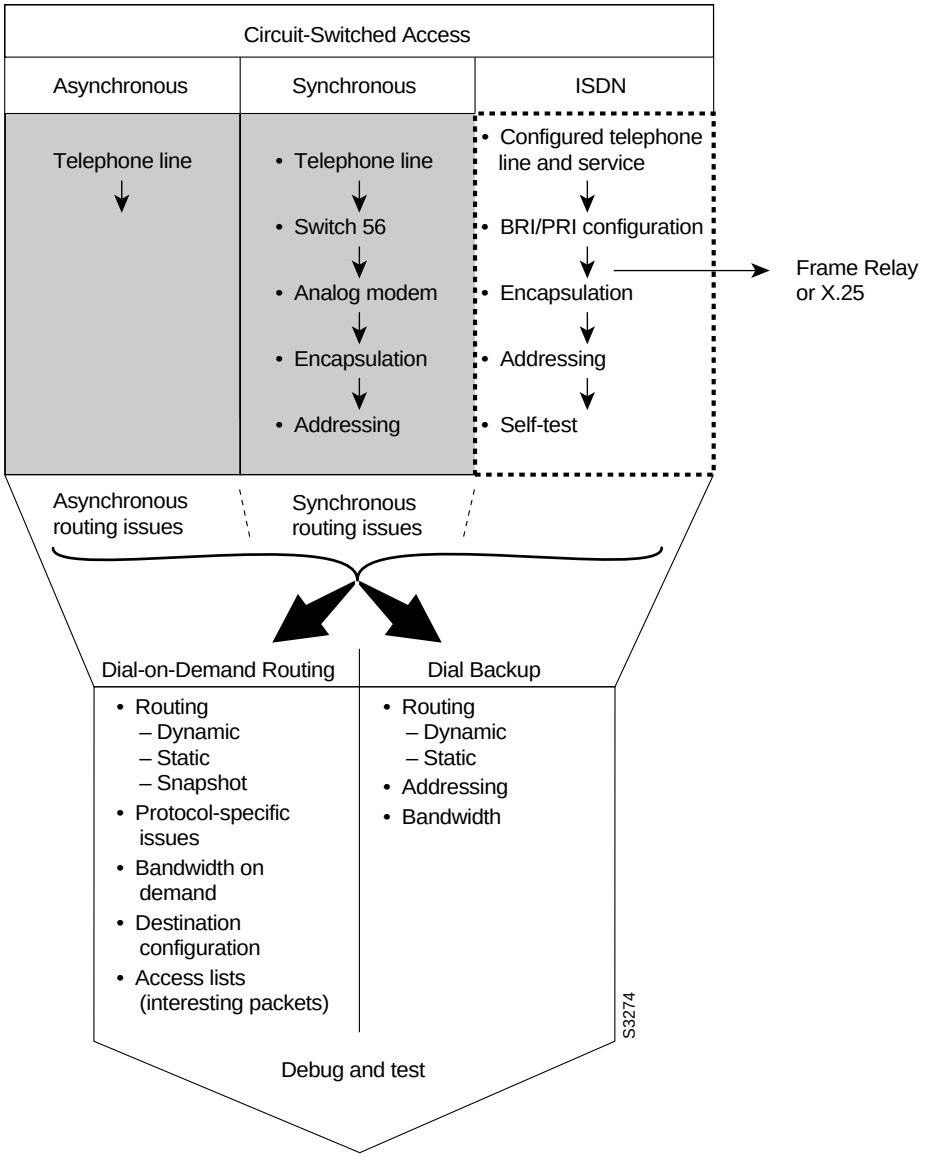
Configuring ISDN

This chapter describes tasks that are required to get an Integrated Services Digital Network (ISDN) line and interface up, and describes features involved in configuring ISDN in a circuit-switched internetworking environment.

This chapter does not address routing issues, dialer configuration, and dial backup. For information about those topics, see the "Configuring DDR" chapter.

Figure 10-1 represents the general relationships between circuit-switched access methods (asynchronous, synchronous, and ISDN) and DDR and dial backup. It also represents the general steps you use to get the appropriate line up and working; however, this chapter describes only ISDN.

Figure 10-1 Configuring ISDN Access



The ISDN specifications describe a planned digital network that will provide a wide and evolving variety of services and use digital transmission and switching technologies to provide worldwide, integrated access. ISDN is an effort to standardize user services, user/network interfaces, and network and internetwork capabilities. Among the services ISDN is planned to support are integrated text, voice, graphics, music, video, and data communications.

ISDN standards define services, common procedures, and a single set of interface rules so that any device can gain access to an ISDN network. ISDN standards describe a three-layer protocol architecture, similar but not identical to the OSI reference model's physical, data link, and network layers.

This chapter describes the tasks for configuring ISDN on the routers that support ISDN interfaces. For a complete description of the commands mentioned in this chapter, refer to the "ISDN Commands" chapter in the *Router Products Command Reference* publication. For historical background and a technical overview of ISDN, see the *Internetworking Technology Overview* publication.

Cisco's Implementation of ISDN

Cisco implements the physical layer protocols for the ISDN Basic Rate Interface (BRI) and the ISDN Primary Rate Interface (PRI) on the following routers:

- Native ISDN Basic Rate Interfaces (BRIs) are available on the Cisco 1003, Cisco 1004, , Cisco 2500, Cisco 3000, Cisco 4000 series routers.
  - The Cisco 1003, Cisco 1004, Cisco 2500, and Cisco 3000 series routers support a single BRI.
  - The Cisco 4000 series routers support a multiport BRI NIM. Two multiport BRI NIMs are available; One supports four separate BRIs, and the other supports eight separate BRIs.

  The BRI interface includes one ISDN Basic Rate connection. The Basic Rate connection consists of a D-channel and two B-channels, both of which are full-duplex, 64-kbps channels.
- The ISDN PRI is supported on the Cisco 7000 using T1 or E1 versions of the MultiChannel Interface Processor (MIP) card in conjunction with PRI signaling software. ISDN PRI over T1 offers 23 B-channels and 1 D-channel. The E1 support provides 30 B-channels and 1 D-channel.

For detailed technical information about Cisco's implementation, see the description of the Cisco ISDN MIB in the *Cisco Management Information Base (MIB) User Quick Reference* publication.

ISDN Channels

The Data or D-channel is used for call setup control and network connection teardown. Call setup involves the data link and network connection. D-channel communication is from the router to the ISDN switch.

The Bearer or B-channels contain user data. The B-channels are treated as 64 kbps serial lines and support HDLC and PPP encapsulation. The interface configuration is propagated to each of the B-channels. Although each channel is treated as a separate line, the B-channels cannot be configured separately.

Note A single switch type must be configured for the router as a whole.

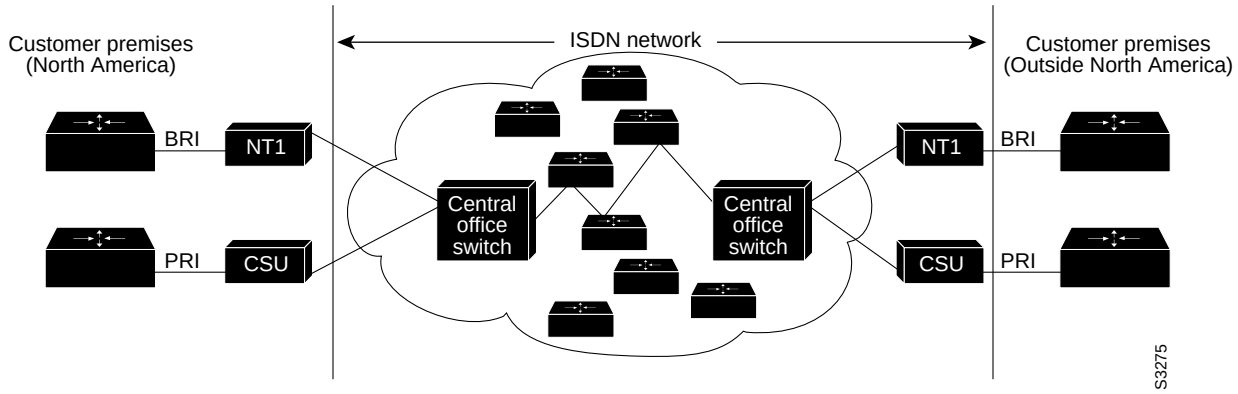
In North America and Japan, the PRI is a rotary group of 23 B-channels (T1) at the combined rate of 1.544 Mbps. Elsewhere, PRI is a rotary group of 30 B-channels (E1) at a combined rate of 2.048 Mbps. On the MBRI and PRI, it is possible to create a rotary group from a number of BRI or PRI interfaces.

Network-Customer Premises Boundary

In North America, the boundary between the ISDN network and the BRI on Cisco 2500, Cisco 3000, or Cisco 4000 series routers is represented by customer premises equipment known as network termination type 1 equipment (NT1). In North America, an NT1 is required for each BRI. Outside North America, the NT1 is supplied as part of the telecommunications services.

In North America, the boundary between the ISDN network and the PRI on Cisco 7000 series routers is represented by customer premises equipment known as a channel service unit (CSU). In North America, a CSU is required for each PRI. Outside North America, the CSU is supplied as part of the telecommunications services. Figure 10-2 illustrates the boundary between customer premises and the ISDN network in North America and in other locations.

Figure 10-2 Customer Premises and ISDN Network Boundary



Note The Cisco 1004 router, which contains a native BRI interface, also contains a built-in NT1. As a result, it can attach directly to the central office switch.

ISDN data link layer interface (used for call setup) provided by the router conforms to the specification defined by the ITU-T recommendation Q.921. The ISDN network layer interface (used for call control) provided by the router conforms to the specifications for specific switch types defined by the ITU-T recommendation Q.931.

Note The ITU-T carries out the functions of the former Consultative Committee for International Telephone and Telegraph (CCITT).

For a list of ISDN switch types that the ISDN interface supports, see the section “Select the ISDN Switch Type” later in this chapter.

ISDN Task List

Perform the tasks in the following sections to configure ISDN lines and interfaces. You must configure the ISDN interface (BRI, MBRI, or PRI) and the network addressing. Perform the encapsulation task only if the traffic sent over the ISDN interface will cross a Frame Relay or X.25 network. The remaining tasks are optional.

- Understand Line Configuration Requirements
- Configure an ISDN BRI

- Configure an ISDN PRI
- Configure Calling Line Identification (CLI) Screening
- Configure Encapsulation for Frame Relay or X.25 Networks
- Configure Network Addressing
- Configure Semipermanent Connections (optional, for Germany only)
- Perform Configuration Self-Tests
- Monitor and Maintain ISDN Interfaces

You can also optionally configure snapshot routing for ISDN interfaces. Snapshot routing is a method of learning remote routes dynamically and keeping the routes available for a specified period of time, even though routing updates are not exchanged during that period. See the "Configuring DDR" chapter of this publication for detailed information about snapshot routing.

To place calls on the ISDN interface, you must configure it with dial-on-demand routing (DDR). For configuration information about ISDN using DDR, see the "Configuring DDR" chapter. For command information, refer to the chapter entitled "DDR Commands" in the *Router Products Command Reference* publication.

To configure bandwidth on demand and dial backup, see the "Configuring DDR" chapter.

Understand Line Configuration Requirements

Before configuring the ISDN interfaces on your Cisco router, it is necessary to order a correctly configured ISDN line (BRI or PRI) from your telecommunications service provider.

This process varies dramatically from provider to provider on a national and international basis. However, some general guidelines follow:

- On a BRI, ask for two channels to be called by one number.
- On a PRI, ask for the channels to be called in descending order.
- Ask for delivery of Calling Line Identification (CLI). This is also known as Automatic Number Identification (ANI).
- If the router is going to be the only device attached to the BRI, ask for point-to-point service and a data-only line.
- If the router is going to be attached to an ISDN bus (to which other ISDN devices might be attached), ask for point-to-multipoint service (subaddressing is required) and a voice-and-data line.

Configure an ISDN BRI

This section describes how to configure a BRI, whether it is the only BRI in a router or is one of many in an MBRI. Each of the BRIs in an MBRI can be configured separately and is configured in the same way as a BRI.

Perform the tasks in the following sections to configure an ISDN BRI. The switch type selection and BRI specification tasks are required; the remaining are optional.

- Check the Buffers
- Select the ISDN Switch Type
- Define ISDN TEI Negotiation

- Specify an ISDN Basic Rate Interface
- Define ISDN Service Profile Identifiers (SPIDs) (if required)
- Configure Called Party Number Verification
- Configure ISDN Calling Number Identification (Australia only)
- Configure the Line Speed for Calls Not ISDN End-To-End

Check the Buffers

When configuring a BRI interface, after the system comes up, make sure enough buffers are in the free list of the buffer pool that matches the MTU of your BRI interface. If not, you must reconfigure buffers in order for the BRI interfaces to function properly.

To check the MTU size and the buffers and, if necessary, to configure the buffers and the MTU size, complete the following tasks beginning in EXEC mode:

Task	Command
Check the MTU size.	**show interfaces bri** *number*
Check the free buffers.	**show buffers** [1]
Configure the buffers.	**configure terminal** [2] **buffers big permanent** *number* **buffers big max-free** *number* **buffers big min-free** *number* **buffers big initial** *number*
Specify the interface and enter interface configuration mode.	**interface bri** *number*
Set the MTU size.	**mtu 1500**[3]

1. This command is documented in the "System Management Commands" chapter of the *Router Products Command Reference* publication.
2. This command is documented in the "System Image, Microcode Image, and Configuration File Load Commands" chapter of the *Router Products Command Reference* publication.
3. This command is documented in the "Interface Commands" chapter of the *Router Products Command Reference* publication.

Select the ISDN Switch Type

ISDN supports a variety of service provider switches. Table 10-1 lists, by geographic areas, the ISDN switch types supported by the ISDN interface. If you configure an interface with the **interface bri** command, you must also select a switch. Perform the following task in global configuration mode:

Task	Command
Select the service provider switch type.	**isdn switch-type** *switch-type*

Table 10-1 ISDN Service Provider Switch Types

Keywords by Area	Switch Type
none	No switch defined
Australia	
basic-ts013	Australian TS013 switches

Keywords by Area	Switch Type
Europe	
basic-1tr6	German 1TR6 ISDN switches
basic-nwnet3	Norway NET3 switches (phase 1)
basic-net3	NET3 ISDN switches (UK and others)
primary-net5	European ISDN PRI switches
vn2	French VN2 ISDN switches
vn3	French VN3 ISDN switches
Japan	
ntt	Japanese NTT ISDN switches
primary-ntt	Japanese ISDN PRI switches
North America	
basic-5ess	AT&T basic rate switches
basic-dms100	NT DMS-100 basic rate switches
basic-ni1	National ISDN-1 switches
primary-4ess	AT&T 4ESS switch type for the U.S. (ISDN PRI only)
primary-5ess	AT&T 5ESS switch type for the U.S. (ISDN PRI only)
primary-dms100	NT DMS-100 switch type for the U.S. (ISDN PRI only)
New Zealand	
basic-nznet3	New Zealand Net3 switches

Note Any router with an MBRI must be connected to the same switch type on all its ISDN interfaces.

Define ISDN TEI Negotiation

This section applies to ISDN BRI only. You can determine when Layer 2 ISDN Terminal Endpoint Identifier (TEI) negotiation occurs. The default is for negotiation to occur when the router is powered on. TEI negotiation is useful in Europe and also useful for switches that might deactivate Layer 2 when no calls are active.

To define when TEI negotiation will occur, perform the following task in global configuration mode:

Task	Command
Determine when ISDN TEI negotiation occurs.	**isdn tei** [**first-call** | **powerup**]

Specify an ISDN Basic Rate Interface

To specify an ISDN Basic Rate Interface (BRI) and enter interface configuration mode, perform the following task in global configuration mode:

Task	Command
Begin BRI configuration.	**interface bri** *number*

Define ISDN Service Profile Identifiers (SPIDs)

This section applies to ISDN BRI only. All ISDN devices subscribe to services provided by an ISDN service provider, usually a telephone company. However, only some service providers use Service Profile Identifiers (SPIDs) to define the services subscribed to by the ISDN device that is accessing the ISDN service provider. The service provider assigns the ISDN device one or more SPIDs when you first subscribe to the service. If you are using a service provider that requires SPIDs, your ISDN device cannot place or receive calls until it sends a valid, assigned SPID to the service provider when accessing the switch to initialize the connection.

Currently, only the DMS-100 and NI-1 switch types require SPIDs. The AT&T 5ESS switch type may support a SPID, but it is recommended that you set up that ISDN service without SPIDs. In addition, SPIDs only have significance at the local access ISDN interface. Remote routers are never sent the SPID.

A SPID is usually a seven-digit telephone number with some optional numbers. However, service providers may use different numbering schemes. For the DMS-100 switch type, two SPIDs are assigned, one for each B-channel. Once your service provider has assigned you SPIDs, you must define these SPIDs on the router so that when access to the switch is attempted, the router has the valid information available.

To define the SPIDs and the local directory number (LDN) on the router, perform the following tasks in interface configuration mode (after specifying **interface bri**):

Task	Command
Define a SPID and local directory number for the B1-channel.	**isdn spid1** *spid-number* [*ldn*]
Define a SPID and local directory number for the B2-channel.	**isdn spid2** *spid-number* [*ldn*]

The LDN is optional but might be necessary if the router is to answer calls made to the second directory number.

See the “Configuring DDR” chapter for information about configuring dial-on-demand routing (DDR). Refer to the “DDR Commands” chapter in the *Router Products Command Reference* publication for specific DDR commands.

Configure Called Party Number Verification

When multiple devices are attached to an ISDN BRI, you can ensure that only a single device answers an incoming call by verifying the number or subaddress in the incoming call against the device’s configured number or subaddress or both.

You can specify that the router verify a called-party number or subaddress number in the incoming setup message for ISDN BRI calls, if the number is delivered by the switch. You can do so by configuring the number that is allowed. To configure verification, perform the following task in interface configuration mode:

Task	Command
Specify that the router verify a called-party number or subaddress number in the incoming setup message.	**isdn answer1** [*called-party-number*][**:***subaddress*]

Verifying the called-party number ensures that only the desired router responds to an incoming call. If you want to allow an additional number for the router, you can configure it, too.

To configure a second number to be allowed, perform the following task in interface configuration mode:

Task	Command
Specify that the router verify a second called-party number or subaddress number in the incoming setup message.	**isdn answer2** [*called-party-number*][**:***subaddress*]

Configure ISDN Calling Number Identification

This feature applies only to routers used in Australia. A router with a basic-ts013 ISDN BRI interface might need to supply the network with a billing number for outgoing calls. The Australian network offers a better pricing on calls in which the number is presented.

To configure the interface to identify the billing number, perform the following task in interface configuration mode:

Task	Command
Specify the calling party number.	**isdn calling-number** *calling-number*

Note The **isdn calling-number** command is supported only on Australian basic-ts013 switch types.

Configure the Line Speed for Calls Not ISDN End-To-End

When calls are made at 56 kbps but delivered by the ISDN network at 64 kbps, the incoming data can be corrupted.

However, on ISDN calls, if the receiving side is informed that the call is not ISDN end-to-end, it can set the line speed for the incoming call.

To set the speed for incoming calls recognized as not ISDN end-to-end, complete the following task in interface configuration mode:

Task	Command
Set the speed to be used for incoming calls recognized as not ISDN end-to-end.	**isdn not-end-to-end** {**56** | **64**}

Configure an ISDN PRI

ISDN Primary Rate Interface (PRI) is supported on the Cisco 4000, the Cisco 4500, and the 7000 series routers using T1 or E1 versions of the Multichannel Interface Processor (MIP) card in conjunction with PRI signaling software. Channelized T1 ISDN PRI offers 23 B-channels and 1 D-channel. Channelized E1 ISDN PRI offers 30 B-channels and 1 D-channel.

Channelized T1 and channelized E1 are supported by corresponding controllers. A T1 or E1 controller has one physical network termination. However, it can have many virtual interfaces depending on the configuration.

Perform the tasks in the following sections as appropriate for the T1 controller or the E1 controller:

- Configure Channelized T1 ISDN PRI
- Configure Channelized E1 ISDN PRI

Configure Channelized T1 ISDN PRI

To configure ISDN PRI on a channelized T1 controller, perform the following tasks beginning in global configuration mode.

Task	Command
Select a service provider switch type that accommodates PRI. (See Table 10-1, earlier in this chapter, for a list of supported switch types.)	**isdn switch-type** *switch-type*
Specify a T1 controller on a Cisco 7000 or Specify a T1 controller on a Cisco 4000.	**controller t1** *slot/port*[1] or **controller t1** *number*
Define the framing characteristics as extended super frame (ESF).	**framing esf**[1]
Define the line code as bipolar 8 zero substitution (B8ZS).	**linecode b8zs**
Configure ISDN PRI.	**pri-group** [**timeslots** *range*]

1. This command is documented in the "Interface Commands" chapter of the *Router Products Command Reference* publication.

If you do not specify the timeslots, the specified controller is configured for 23 B-channels and 1 D-channel.

Note Any router configured for ISDN support must be connected to the same switch type on all its ISDN interfaces.

Configure Channelized E1 ISDN PRI

To configure ISDN PRI on a channelized E1 controller, perform the following tasks, beginning in global configuration mode.

Task	Command
Select a service provider switch type that accommodates PRI. (See Table 10-1, earlier in this chapter, for a list of supported switch types.)	**isdn switch-type** *switch-type*[1]
Specify a T1 controller in the Cisco 7000 series by slot and port number. or Specify a T1 controller in the Cisco 4000 series by unit number, ranging from 0 through 2.	**controller e1** *slot/port*[1] **controller e1** *number*
Define the framing characteristics as CRC4.	**framing crc4**[1]
Define the line code as high-density bipolar 3 (HDB3).	**linecode hdb3**[1]
Configure ISDN PRI.	**pri-group** [**timeslots** *range*]

1. This command is documented in the "Interface Commands" chapter of the *Router Products Command Reference* publication.

If you do not specify the timeslots, the specified controller is configured for 30 B-channels and one D-channel.

Note Any router configured for ISDN support must be connected to the same switch type on all its ISDN interfaces.

Configure Calling Line Identification (CLI) Screening

This task applies to any Cisco router that has one or more BRI or PRI interfaces. Calling line identification (CLI) (also called *caller ID*) screening adds a level of security by allowing you to screen incoming calls. You can verify that the calling line ID is from an expected origin. CLI screening requires a local switch that is capable of delivering the CLI to the router.

To configure caller ID screening, perform the following task in interface configuration mode:

Task	Command
Configure caller ID screening.	**isdn caller** *number*

Note If caller ID screening is configured and the local switch does not deliver caller IDs, the router rejects all calls.

Configure Encapsulation for Frame Relay or X.25 Networks

Each of the ISDN B-channels is treated as a serial line and supports HDLC and PPP encapsulation. The default serial encapsulation is HDLC.

However, if traffic sent from this ISDN interface will cross a Frame Relay network or an X.25 network, the appropriate addressing and encapsulation tasks must be completed, as required for Frame Relay or X.25 networks.

See the “Configuring Frame Relay” chapter or “Configuring X.25 and LAPB” chapter for more information about addressing, encapsulation, and other tasks.

Configure Network Addressing

The steps in this section support the primary goals of network addressing:

- Define which packets are interesting—and will thus cause the router to make an outgoing call.
- Define the remote host where the calls are going.
- Specify whether broadcast messages will be sent.
- Specify the dialing string to use in the call.

Intermediate steps that use shared argument values tie the host identification and dial string to the interesting packets to be transmitted to that host.

You must configure the switch type before you configure network addressing.

To configure network addressing, complete the following tasks beginning in interface configuration mode:

Task		Command
Step 1	Define the remote recipient's protocol address, host name, and dialing string; optionally, provide the ISDN subaddress; set the dialer speed to 56 or 64 kbps, as needed.	**dialer map** *protocol address* **name** *name* **speed** *speed dial-string*[**:***isdn-subaddress*][1]
Step 2	Assign the interface to a dialer group to control access to the interface.	**dialer-group** *dialer-group-number*[1]
Step 3	Associate the dialer group number with an access list number.	**dialer-list** *dialer-group-number* **list** *access-list-number*[1]
Step 4	Define an access list, permitting or denying access to specified protocols, sources, or destinations.	**access-list** *access-list-number* {**deny** | **permit**} *protocol source address source-mask destination destination-mask*[2]

1. This command is documented in the "DDR Commands" chapter of the *Router Products Command Reference* publication.
2. Many forms of this command are documented in various protocol-specific chapters of the *Router Products Command Reference* publication.

Packets that are permitted by the access list specified in Step 4 are considered "interesting" and will cause the router to place a call to the destination protocol address identified in both Steps 1 and 4.

Note The access list reference in Step 4 of this task list is an example of the access list commands allowed by different protocols. Some protocols might require a different command form or might require multiple commands. Refer to the relevant protocol chapter for more information about setting up access lists for a protocol.

For more information about defining outgoing call numbers, see the "Configuring DDR" chapter.

Configure Semipermanent Connections

German networks allow semipermanent connections between customer routers with BRIs and the 1TR6 basic rate switches in the exchange. Semipermanent connections are offered at better pricing than leased lines.

Configuring BRIs for semipermanent connection requires only that you use a keyword that indicates semipermanent connections when you are setting up network addressing as described in the previous section of this chapter.

To configure a BRI for semipermanent connections, use the following form of the **dialer map** command when you set up network addressing:

Task	Command
Define the remote recipient's protocol address, host name, and dialing string; indicate semipermanent connections; optionally, provide the ISDN subaddress; set the dialer speed to 56 or 64 kbps, as needed.	**dialer map** *protocol next-hop-address* **name** *hostname* **spc** [**speed 56** | **64**] [**broadcast**] *dial-string*[**:***isdn-subaddress*][1]

1. This command is documented in the "DDR Commands" chapter of the *Router Products Command Reference* publication.

Perform Configuration Self-Tests

To test the router's ISDN configuration, the following tasks are suggested:

Task	Command
Check Layer 1 (physical layer) of the BRI.	**show controllers bri** *number*[1]
Check Layer 1 (physical layer) of the PRI over T1.	**show controllers t1** *slot*/*port*[1]
Check Layer 1 (physical layer) of the PRI over E1.	**show controllers e1** *slot*/*port*[1]
Check Layer 2 (data link layer).	**debug q921**
Check Layer 3 (network layer).	**debug isdn events**
	debug q931
	debug dialer
	show dialer [2]

1. This command is documented in the "Interface Commands" chapter of the *Router Products Command Reference* publication.
2. This command is documented in the "DDR Commands" chapter of the *Router Products Command Reference* publication.

See the *Debug Command Reference* for information about the **debug** commands.

Monitor and Maintain ISDN Interfaces

Use the following commands to monitor and maintain ISDN interfaces:

Task	Command
Display information about the physical attributes of the ISDN BRI B- and D-channels.	**show interfaces bri** *number*
Display information about the physical attributes of the ISDN PRI over T1 B- and D-channels. (The *number* argument takes values between 1 and 23.)	**show interfaces serial** *slot*/*port* **bchannel** *number*[1]
Display information about the physical attributes of the ISDN PRI over E1 B- and D-channels. (The *number* argument takes values between 1 and 31.)	**show interfaces serial** *slot*/*port* **bchannel** *number*
Display protocol information about the ISDN B- and D-channels.	**show controllers bri** *number*
Display information about memory, Layer 2 or Layer 3 timers, or status of PRI channels. (The **service** keyword is available for PRI only.)	**show isdn** {**memory** | **timers** | **service**}
Obtain general diagnostic information about the specified interface.	**show dialer** [**interface** *type number*][2]

1. This command is documented in the "Interface Commands" chapter of the *Router Products Command Reference* publication.
2. This command is documented in the "DDR Commands" chapter of the *Router Products Command Reference* publication.