Configuring Channelized E1 and Channelized T1

Channelized T1 and channelized E1 can be configured for ISDN PRI, synchronous serial, and asynchronous serial communications.

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

This chapter describes how to configure channelized E1 and channelized T1 for ISDN PRI and for two types of signaling to support analog calls over digital lines. It provides three main configuration sections:

- Configure ISDN PRI
- Configure Robbed Bit Signaling for Analog Calls over T1 Lines (Cisco AS5200)
- Configure Channel-Associated Signaling for Analog Calls over E1 Lines (Cisco AS5200)

In addition, this chapter describes how to run interface loopback diagnostics on channelized E1 and channelized T1. For more information, see the "Troubleshoot Channelized E1 and Channelized T1" section.

For hardware technical descriptions, and for information about installing the controllers and interfaces, refer to the hardware installation and maintenance publication for your particular product.

For a complete description of the channelized E1/T1 commands in this chapter, refer to the "Channelized E1 and Channelized T1 Setup Commands" chapter of the *Dial Solutions Command Reference*. To locate documentation of other commands that appear in this chapter, use the command reference master index or search online.

Background Information

This section presents background information about signaling and about the use of channelized E1/T1 on the Cisco AS5200.

About In-Band and Out-of-Band Signaling

The terms *in-band* and *out-of-band* indicate whether various signals—used to set up, control, and terminate calls—travel in the same channel (or band) with users' voice calls or data, or whether those signals travel a separate channel (or band).

ISDN, which uses the D channel for signaling and the B channels for user data, fits into the out-of-band signaling category.

Robbed-bit signaling, which uses bits from specified frames in the user data channel for signaling, fits into the in-band signaling category.

Channel-associated signaling, which uses E1 timeslot 16 (the D channel) for signaling, fits into the out-of-band signaling category.

About Channelized E1 and T1 on the Cisco AS5200

On a Cisco AS5200, you can allocate the available channels for channelized E1 or T1 in the following ways:

- All channels can be configured to support ISDN PRI.
- If you are not running ISDN PRI, all channels can be configured to support robbed bit signaling (also known as *channel-associated signaling*), which enables a Cisco AS5200 modem to receive and transmit analog calls.
- All channels can be configured in a single channel group. For configuration information about this leased line or non-dial use, see the "Configuring Serial Interfaces" chapter in the *Configuration Fundamentals Configuration Guide*.
- Mix and match channels supporting ISDN PRI and channel grouping.
- Mix and match channels supporting ISDN PRI, robbed bit signaling, and channel grouping across the same T1 line. For example, on the same channelized T1 you can configure the **pri-group timeslots 1-10** command, **channel-group 11 timeslots 11-16** command, and **cas-group 17 timeslots 17-23 type e&m-fgb** command. This is a rare configuration because it requires you to align the correct range of timeslots on both ends of the connection.

See the "PRI Groups and Channel Groups on the Same Channelized T1 Controller Example," "Robbed Bit Signaling Examples," and the "ISDN Channel-Associated Signaling Examples" sections at the end of this chapter.

Configure ISDN PRI

This section describes tasks that are required to get ISDN PRI up and running. This section does not address routing issues, dialer configuration, and dial backup. For information about those topics, see the "Dial-on-Demand Routing" part of this manual.

ISDN PRI is supported on the Cisco 7200 series and 7500 series routers using T1 or E1 versions of the Multichannel Interface Processor (MIP) card, on the Cisco 4000 series channelized E1/T1/PRI network processor module (NPM), and on the Cisco AS5200. Channelized T1 ISDN PRI offers 23 B channels and 1 D channel. Channelized E1 ISDN PRI offers 30 B channels and 1 D channel. Channel 24 is the D channel for T1, and channel 16 is the D channel for E1.

For a complete description of the commands mentioned in this chapter, refer to the "Channelized E1 and Channelized T1 Setup Commands" chapter in the *Dial Solutions Command Reference*.

Perform the tasks in the following sections to configure ISDN PRI:

- Request PRI Line and Switch Configuration from a Telco Service Provider
- Configure Channelized E1 ISDN PRI
- Configure Channelized T1 ISDN PRI
- Configure the Serial Interface
- Configuring NSF Call-by-Call Support

- Perform Configuration Self-Tests (optional)
- Monitor and Maintain ISDN PRI Interfaces (optional)

See the end of this chapter for the "ISDN PRI Examples" section.

Note After the ISDN PRI interface and lines are operational, configure the D channel interface for DDR. The DDR configuration specifies the packets that can trigger outgoing calls, specifies whether to place or receive calls, and provides the protocol, address, and phone number to use.

For DDR configuration information, see the "Dial-on-Demand Routing" part of this manual. For command information, refer to the "Dial-on-Demand Routing" part of the *Dial Solutions Command Reference*.

Request PRI Line and Switch Configuration from a Telco Service Provider

Before configuring ISDN PRI on your Cisco router, you need to order a correctly provisioned ISDN PRI line 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 PRI, ask for the channels to be called in descending order.
- Ask for delivery of calling line identification. Providers sometimes call this *CLI* or *Automatic Number Identification* (ANI).
- If the router will 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.

When you order ISDN service, request the PRI switch configuration attributes displayed in Table 13.

Table 13 PRI Switch Configuration Attributes to Request from Service Vendor

Attribute	Value
Line format	Extended Superframe Format (ESF)
Line coding	Binary 8-zero substitution (B8ZS)
Call type	23 incoming channels and 23 outgoing channels
Speed	64 kbps
Call-by-call capability	Enabled
Channels	23 B+D
Trunk selection sequence	Descending from 23 to 1
B + D glare	Yield
Directory numbers	Only 1 directory number assigned by service provider
ISDN call speed outside local exchange	Speed set to 56 kbps outside local exchange
SPIDs required?	None

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 14 for a list of supported switch type keywords.)	**isdn switch-type** *switch-type*
Define the controller location in the Cisco7200 or Cisco 7500 series by slot and port number. or Define the controller location in the Cisco 4000 series or the Cisco AS5200 universal access server by unit number. [1]	**controller e1** *slot*/*port* **controller e1** *number*
Define the framing characteristics as cyclic redundancy check 4 (CRC4).	**framing crc4**
Define the line code as high-density bipolar 3 (HDB3).	**linecode hdb3**
Configure ISDN PRI.	**pri-group** [**timeslots** *range*]

1. Controller numbers range 0 through 2 on the Cisco 4000 series and 1 to 2 on the Cisco AS5200.

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

If you do not specify the time slots, the specified controller is configured for 30 B channels and one D channel. The B channel numbers range 1 to 31; channel 16 is the D channel for E1. Corresponding serial interfaces numbers range 0 to 30. In commands, the D channel is **interface serial** *controller-number***:15**. For example, **interface serial 0:15**.

Table 14 ISDN Service Provider PRI Switch Types

Keywords by Area	Switch Type
none	No switch defined
Europe	
primary-net5	European ISDN PRI switches; covers the Euro-ISDN E-DSS1 signaling system and is ETSI-compliant.
Japan	
primary-ntt	Japanese ISDN PRI switches
North America	
primary-4ess	AT&T 4ESS switch type for the U.S.
primary-5ess	AT&T 5ESS switch type for the U.S.
primary-dms100	NT DMS-100 switch type for the U.S.

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 14 for a list of supported PRI switch type keywords.)	**isdn switch-type** *switch-type*
Specify a T1 controller on a Cisco 7500 or Specify a T1 controller on a Cisco 4000.[1]	**controller t1** *slot/port* or **controller t1** *number*
Define the framing characteristics as Extended Superframe Format (ESF).	**framing esf**
Define the line code as binary 8 zero substitution (B8ZS).	**linecode b8zs**
Configure ISDN PRI. If you do not specify the time slots, this controller is configured for 23 B channels and 1 D channel.	**pri-group** [**timeslots** *range*][2]

1. Controller numbers range 0 through 2 on the Cisco 4000 series and 1 to 2 on the Cisco AS5200.
2. On channelized T1, timeslots range 1 to 24. You can specify a range or timeslots (or example, **pri-group timeslots 12-24**) if other timeslots are used for non-PRI channel groups.

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

If you do not specify the time slots, the specified controller is configured for 24 B channels and one D channel. The B channel numbers range 1 to 24; channel 24 is the D channel for T1. Corresponding serial interfaces numbers range 0 to 23. In commands, the D channel is **interface serial** *controller-number***:23**. For example, **interface serial 0:23**.

Configure the Serial Interface

When you configure ISDN PRI on the channelized E1 or channelized T1 controller, in effect you create a serial interface that corresponds to the PRI group timeslots This interface is a logical entity is associated with the specific controller. After you create the serial interface by configuring the controller, you must configure the D channel serial interface. The configuration applies to all the PRI B channels (timeslots).

To configure the D channel serial interface, complete the tasks in the following sections:

- Specify an IP Address for the Interface
- Configure Encapsulation
- Configure Network Addressing
- Configure ISDN Calling Number Identification
- Configure Inclusion of the Sending Complete Information Element

Specify an IP Address for the Interface

To configure the D channel serial interface created for ISDN PRI, complete the following tasks beginning in global configuration mode:

Task		Command
Step 1	Specify D channel on the serial interface for channelized T1.	**interface serial** *slot/port***:23** **interface serial** *number***:23**
	Specify D channel on the serial interface for channelized E1.	**interface serial** *slot/port***:15** **interface serial** *number***:15**
Step 2	Specify an IP address for the interface.	**ip address** *ip-address*

When you configure the D channel, its configuration is applied to all the individual B channels.

Configure Encapsulation

PPP encapsulation is configured for most ISDN communication. However, the router might require a different encapsulation for traffic sent over a Frame Relay or X.25 network, or the router might need to communicate with devices that require a different encapsulation protocol.

Configure encapsulation as described in one of the following sections:

- Configure PPP Encapsulation
- Configure Encapsulation for Frame Relay or X.25 Networks
- Configure Encapsulation for Combinet Compatibility

In addition, the router can be configured for automatic detection of encapsulation type on incoming calls. To configure this feature, complete the tasks in the following section:

- Configure Automatic Detection of Encapsulation Type of Incoming Calls

Configure PPP Encapsulation

Each ISDN B channel is treated as a serial line and supports HDLC and PPP encapsulation. The default serial encapsulation is HDLC. To configure PPP encapsulation, perform the following task in interface configuration mode:

Task	Command
Configure PPP encapsulation.	**encapsulation ppp**

Configure Encapsulation for Frame Relay or X.25 Networks

If traffic from this ISDN interface crosses a Frame Relay or 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 necessary to configure Frame Relay or X.25 networks.

Configure Encapsulation for Combinet Compatibility

Historically, Combinet devices supported only the Combinet Proprietary Protocol (CPP) for negotiating connections over ISDN B channels. To enable Cisco routers to communicate with those Combinet bridges, the Cisco IOS software supports a new CPP encapsulation type.

To enable routers to communicate over ISDN interfaces with Combinet bridges that support only CPP, perform the following tasks in interface configuration mode:

Task	Command
Specify CPP encapsulation.	**encapsulation cpp**
Enable CPP callback acceptance.	**cpp callback accept**
Enable CPP authentication.	**cpp authentication**

Now most Combinet devices support PPP. Cisco routers can communicate over ISDN with these devices by using PPP encapsulation, which supports both routing and fast switching.

Combinet devices support only IP, IPX, and bridging. For AppleTalk, Cisco routers automatically perform half-bridging with Combinet devices. For more information about half-bridging, see the "Configure PPP Half-Bridging" section in the "Configuring Media-Independent PPP" chapter of this publication.

Cisco routers can also half-bridge IP and IPX with Combinet devices that support only CPP. To configure this feature, you only need to set up the addressing with the ISDN interface as part of the remote subnet; no additional commands are required.

Configure Automatic Detection of Encapsulation Type of Incoming Calls

You can enable a serial or ISDN interface to accept calls and dynamically change the encapsulation in effect on the interface when the remote device does not signal the call type. For example, if an ISDN call does not identify the call type in the Lower Layer Compatibility fields and is using an encapsulation that is different from the one configured on the interface, the interface can change its encapsulation type at that time.

This feature enables interoperation with ISDN terminal adapters that use V.120 encapsulation but do not signal V.120 in the call setup message. An ISDN interface that by default answers a call as synchronous serial with PPP encapsulation can change its encapsulation and answer such calls.

Automatic detection is attempted for the first 10 seconds after the link is established or the first five packets exchanged over the link, whichever is first.

To enable automatic detection of encapsulation type, perform the following task in interface configuration mode:

Task	Command
Enable automatic detection of encapsulation type on the specified interface.	**autodetect encapsulation** *encapsulation-type*

You can specify one or more encapsulations to detect. Cisco IOS software currently supports automatic detection of PPP and V.120 encapsulations.

Configure Network Addressing

When you configure networking, you specify how to reach the remote recipient. 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. or (Australia) Use the **spc** keyword that enables ISDN semipermanent connections.	**dialer map** *protocol next-hop-address* **name** *hostname* **speed 56|64** *dial-string*[**:***isdn-subaddress*] **dialer map** *protocol next-hop-address* **name** *hostname* **spc** [**speed 56 | 64**] [**broadcast**] *dial-string*[**:***isdn-subaddress*]
Step 2	Assign the interface to a dialer group to control access to the interface.	**dialer-group** *group-number*
Step 3	Associate the dialer group number with an access list number.	**dialer-list** *dialer-group* **list** *access-list-number*
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*

Australian networks allow semipermanent connections between customer routers with PRIs and the TS-014 ISDN PRI switches in the exchange. Semipermanent connections are offered at better pricing than leased lines.

Packets that are permitted by the access list specified in Step 4 are considered interesting and cause the router to place a call to the destination protocol address that is identified in both Step 1 and Step 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 in the *Network Protocols Configuration Guide, Part 1, Part 2*, or *Part 3* for more information about setting up access lists for a protocol.

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

Configure ISDN Calling Number Identification

A router might need to supply the ISDN network with a billing number for outgoing calls. Some networks offer better pricing on calls in which the number is presented. When configured, the calling number information is included in the outgoing Setup message.

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*

This command can be used with all ISDN PRI switch types.

Configure ISDN Voice Calls

All incoming ISDN analog modem calls that come in on an ISDN PRI receive signaling information from the ISDN D channel. The D channel is used for circuit switched data calls and analog modem calls. To enable all incoming ISDN voice calls to access the Cisco AS5200 and AS5300 call switch module and integrated modems, use the following command beginning in interface configuration mode:

Task	Command
Route incoming ISDN modem calls to the modem module.	**isdn incoming-voice modem**

Configure Inclusion of the Sending Complete Information Element

In some geographic locations, such as Hong Kong and Taiwan, ISDN switches require that the Sending Complete information element be included in the outgoing Setup message to indicate that the entire number is included. This information element is not required in other locations.

To configure the interface to include the Sending Complete information element in the outgoing call Setup message, complete the following task in interface configuration mode:

Task	Command
Include the Sending Complete information element in the outgoing call Setup message.	**isdn sending-complete**

Configuring NSF Call-by-Call Support

Network-Specific Facilities (NSF) are used to request a particular service from the network or to provide an indication of the service being provided. Call-by-call support means that a B channel can be used for any service; its use is not restricted to a certain preconfigured service, such as incoming 800 calls or an outgoing 800 calls. This specific NSF call-by-call service supports outgoing calls configured as voice calls.

This NSF call-by-call support feature is vendor-specific; only routers connected to AT&T Primary-4ESS switches need to configure this feature. This feature is supported on channelized T1.

To enable the router to for NSF call-by-call support and, optionally, to place outgoing voice calls, complete the following steps:

Step 1 Configure the controller for ISDN PRI.

Step 2 Configure the D channel interface to place outgoing calls, using the **dialer map** command with a dialing-plan keyword. You can enter a **dialer map** command for each dialing plan to be supported.

Step 3 Define the dialer map class for that dialing plan.

To define the dialer map class for the dialing plan, complete the following tasks beginning in global configuration mode:

Task		Command
Step 1	Specify the dialer map class, using the dialing-plan keyword as the classname.	**map-class dialer** *classname*
Step 2	(Optional) Enable voice calls.	**dialer voice-call**
Step 3	Configure the specific dialer map class to make outgoing calls.	**dialer outgoing** *classname*

Note To set the called party type to international, the dialed number must be prefaced by 011.

Table 15 lists the NSF dialing plans and supported services offered on AT&T Primary-4ESS switches.

Table 15 NSF Supported Services on AT&T Primary-4ESS Switches

NSF Dialing Plan	Data	Voice	International
Software Defined Network (SDN)[1]	Yes	Yes	GSDN (Global SDN)
MEGACOMM	No	Yes	Yes
ACCUNET	Yes	Yes	Yes

1. The dialing plan terminology in this table is defined and used by AT&T.

Perform Configuration Self-Tests

To test the router's ISDN configuration, we suggest that you perform the following tasks:

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

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

Monitor and Maintain ISDN PRI Interfaces

Use the following commands to monitor and maintain ISDN interfaces:

Task	Command
Display information about the physical attributes of the ISDN PRI over T1 B and D channels.	**show interfaces serial** *slot*/*port* **bchannel** *channel-number* (Cisco 7500 series) **show interfaces serial** *number* **bchannel** *channel-number* (Cisco 4000 series)
Display information about the physical attributes of the ISDN PRI over E1 B and D channels.	**show interfaces serial** *slot*/*port* **bchannel** *channel-number* (Cisco 7500 series) **show interfaces serial** *number* **bchannel** *channel-number* (Cisco 4000 series)
Display information about the T1 links supported on the ISDN PRI B and D channels.	**show controllers t1** [*slot*/*port*] (Cisco 7500 series) **show controller t1** *number* (Cisco 4000 series)

Task	Command
Display information about the E1 links supported on the ISDN PRI B and D channels.	**show controllers e1** [*slot*/*port*] (Cisco 7500 series) **show controllers e1** *number* (Cisco 4000 series)
Display information about current calls, history, memory, services, status of PRI channels, or Layer 2 or Layer 3 timers. (The **service** keyword is available for PRI only.)	**show isdn** {**active** | **history** | **memory** | **services** | **status** [*dsl* | **serial** *number*] | **timers**}
Obtain general diagnostic information about the specified interface.	**show dialer** [**interface** *type number*]

Configure Robbed Bit Signaling for Analog Calls over T1 Lines

The Cisco AS5200 supports robbed bit signaling for receiving and transmitting analog calls on T1 lines. Robbed bit signaling emulates older analog trunk and line in-band signaling methods that are transmitted in many networks.

In countries that support T1 framing (such as the United States and Canada), many networks send supervisory and signaling information to each other by removing the 8th bit of each timeslot of the 6th and 12th frame for superframe (SF) framing. For networks supporting extended superframe (ESF) framing, the 6th, 12th, 18th, and 24th frames are affected. This is done to support channel banks in the network that convert various battery and ground operations on analog lines into signaling bits that are forwarded over digital lines.

Robbed bit signaling configured on the Cisco AS5200 enables the integrated modems in the access server to answer and transmit analog calls. To support analog signaling over T1 lines on the Cisco AS5200, robbed bit signaling must be enabled.

Note The signal type configured on the access server must match the signal type offered by your telco provider. Ask your telco provider which signal type to configure on each T1 controller.

The Cisco AS5200 has two controllers: controller T1 1 and controller T1 0, which must be configured individually.

To configure robbed bit signaling support for calls made and received, perform the following tasks beginning in global configuration mode:

Task		Command
Step 1	Enable the T1 0 controller, and enter controller configuration mode.	**controller t1 0**
Step 2	If the channelized T1 line connects to a smart jack instead of a CSU, set pulse equalization (use parameter values specified by your telco service provider).	**cablelength long** *dbgain-value dbloss-value*
Step 3	Set the framing to match your telco service provider's offering, which in most cases is *esf*.	**framing esf**
Step 4	Set the line code type to match your telco service provider's offering, which in most cases is *b8zs*.	**linecode b8zs**
Step 5	Configure one T1 line to serve as the primary or most stable clock source line.	**clock source line primary**

Task		Command
Step 6	Configure channels to accept voice calls. This step creates interfaces that you can configure.	**cas-group** *channel-number* **timeslots** *range* **type** *signal-type*
Step 7	Set the facilities data link exchange standard for the CSU, as specified by your telco service provider.	**fdl** {**att** | **ansi**}

If you want to configure robbed bit signaling on the other T1 controller, repeat Steps 1 through 7, making sure in Step 5 to select T1 controller 1's line as the secondary clock source.

If you want to configure ISDN on the other controller, see the "Configure ISDN PRI" section of this chapter. If you want to configure channel groupings on the other controller, see the "Configuring Synchronous Serial Ports" chapter in this manual; specify the channel groupings when you specify the interface.

Configure Channel-Associated Signaling for Analog Calls over E1 Lines

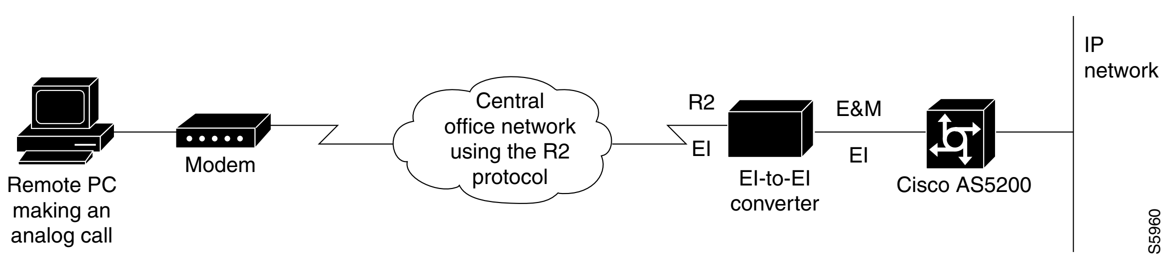
The Cisco AS5200 Universal Access Server now supports channel-associated signaling for channelized E1 lines, which are commonly deployed in networks in Latin America, Asia, and Europe. Channel-associated signaling is configured to support channel banks in the network that convert various battery and ground operations on analog lines into signaling bits, which are forwarded over digital lines.

Channel-associated signaling is call signaling that is configured on an E1 controller and enables the access server to send or receive analog calls. The signaling uses the16th channel (timeslot); thus, channel-associated signaling fits in the out-of-band signaling category.

Once channel-associated signaling is configured on a single E1 controller, up to 30 remote users can simultaneously dial in to the Cisco AS5200 through networks running the R2 protocol. The R2 protocol is an international signaling standard for analog connections. Because R2 signaling is not supported in the Cisco AS5200, an E1-to-E1 converter is required. See Figure 54.

Because the Cisco AS5200 has two physical E1 ports on its dual E1 PRI board, up to 60 simultaneous connections can be made through one dual E1 PRI board.

Figure 54 Remote PC Accessing Network Resources through the Cisco AS5200



Note For information on how to configure an Anadigicom E1-to-E1 converter, refer to the documentation that came with the converter.

Prerequisites

The dual E1 PRI card must be installed in the Cisco AS5200 before you attempt to configure channel-associated signaling.

Channel-Associated Signaling Configuration Tasks

To configure the Cisco AS5200's E1 controllers, perform the following tasks, beginning in global configuration mode:

Task		Command
Step 1	Define the controller location in the Cisco AS5200 by unit number, ranging from 1 to 2.	**controller e1** *number*
Step 2	Configure channel-associated signaling and the R2 signaling protocol on a specified number of timeslots.	**cas-group** *channel-number* **timeslots** *range* **type** *signal-type*
Step 3	Define the framing characteristics as cyclic redundancy check 4 (CRC4).	**framing crc4**
Step 4	Define the line code as high-density bipolar 3 (HDB3).	**linecode hdb3**
Step 5	Specify one E1 line to serve as the primary or most stable clock source line.	**clock source line primary**[1]

1. Specify the other E1 line as the secondary clock source with the **clock source line secondary** command.

If you do not specify the time slots, channel-associated signaling is configured on all 30 B channels and one D channel on the specified controller.

Troubleshoot Channelized E1 and Channelized T1

When troubleshooting channelized T1 or E1, you must first determine if the problem is with a particular channel group or with the T1 or E1 line.

If the problem is with a single channel group, you have a potential interface problem.

If the problem is with the T1 or E1 line, or with all channel groups, you have a potential controller problem.

The following sections describe how to determine whether the problem affects an interface or a controller.

Troubleshooting Channelized E1 and T1 Controllers

When you troubleshoot E1 or T1 controllers, first check that the configuration is correct. The framing type and line code should match to what the service provider has specified. Then check channel group and PRI-group configurations, especially to verify that the timeslots and speeds are what the service provider has specified.

At this point, the **show controller t1** or **show controller e1** commands should be used to check for T1 or E1 errors. Use the command several times to determine if error counters are increasing, or if the line status is continually changing. If this is occurring, you need to work with the service provider.

Note Cisco routers do not have CSU capability and do not react to any remote loopback codes at the T1 or E1 level.

Running Controller Loopback Diagnostic Tests

Controller loopback tests are available for channelized T1 controllers and for channelized E1 controllers.

Channelized T1 Controller Loopbacks

For the T1 controller, two loopbacks are available for testing:

- Local loopback
- Remote loopback

Local Loopback: The local loopback loops the controller both toward the router and toward the line. Since the loopback is done internally to the router, the controller should transition to the UP state within approximately 10 seconds, and no further T1 errors should be detected.

All channel groups will be looped back; if the encapsulation on that channel group supports loopbacks (for example, HDLC and PPP), you can test that channel group by pinging the interface address. For example, if you have assigned an IP address to the serial interface defined for a channel group, you can ping that IP address.

To place the controller into local loopback, perform the following task in controller configuration mode.

Task	Command
Loop the T1 controller toward the router and toward the line.	**loopback local** (controller)

To test a channel group, perform the following task in EXEC mode:

Ping the interface address.	**ping** *protocol protocol-address*

Check errors by performing the following task in EXEC mode:

Check errors.	**show controller t1**

If any errors occur, or the controller fails to change to the UP state, please contact the Cisco Technical Assistance Center (TAC).

Since the controller local loopback is bidirectional, the service provider can test the line integrity using a T1 BERT test set.

Remote Loopback: The second T1 controller loopback is a remote loopback. This loopback can be used only if the *entire* T1 goes to a remote CSU. This is not the case with 99.9% of channelized T1. When the **loopback remote** controller command is executed, an inband CSU loop-up code will be sent over the entire T1, which will attempt to loop up the remote CSU. To place the controller in remote loopback, perform the following task in controller configuration mode:

Task	Command
Place the T1 controller in remote loopback.	**loopback remote** (controller)

Note If controller loopbacks are used, they will disrupt service for all channel groups on that interface.

Channelized E1 Controller Loopback

For the E1 controller, only the local loopback is available. Local loopback operates the same as the local loopback on the T1 controller, forming a bidirectional loopback, both toward the router and toward the line. To place the E1 controller in local loopback, perform the following task in controller configuration mode:

Task	Command
Place the E1 controller in local loopback toward the router and toward the line.	**loopback** (controller)

All channel groups will be looped back; if the encapsulation on that channel group supports loopbacks (for example, HDLC and PPP), you can test that channel group by pinging the interface address. For example, if you have assigned an IP address to the serial interface defined for a channel group, you can ping that IP address.

To place the controller into local loopback, perform the following task in controller configuration mode.

Task	Command
Loop the T1 controller toward the router and toward the line.	**loopback local** (controller)

To test a channel group, perform the following task in EXEC mode:

Ping the interface address.	**ping** *protocol protocol-address*

Check errors if any. by performing the following task in EXEC mode:

Check errors.	**show controller t1**

If any errors occur, it is most likely a hardware problem; please contact the Cisco TAC. In addition, you can ask the service provider to test the line by using a T1 BERT test set.

Troubleshooting Channelized E1/T1 Channel Groups

Each channelized T1 or channelized E1 channel group is treated as a separate serial interface. To troubleshoot channel groups, first verify configurations and check everything that is normally checked for serial interfaces. You can verify that the timeslots and speed are correct for the channel group by checking for CRC errors and aborts on the incoming line.

Note None of the Cisco channelized interfaces will react to any loop codes. To loop a channelized interface requires that the configuration command be entered manually.

Two loopbacks are available for channel groups:

- Interface local loopback
- Interface remote loopback

Interface Local Loopback

Interface local loopback is a bidirectional loopback, which will loopback toward the router and toward the line. The entire set of timeslots for the channel group are looped back. The service provider can use a BERT test set to test the link from the central office to your local router, or the remote router can test using pings to their local interface (which will go from the remote site, looped back at your local site, and return to the interface on the remote site).

To place the serial interface (channel group) into local loopback, perform the following task in interface configuration mode:

Task	Command
Place the serial interface (channel group) in local loopback.	**loopback local**

Interface Remote Loopback

Remote loopback is the ability to put the remote DDS CSU/DSU in loopback. It will work only with channel groups that have a single DS0 (1 timeslot), and with equipment that works with a latched CSU loopback as specified in AT&T specification TR-TSY-000476, "OTGR Network Maintenance Access and Testing." To place the serial interface (channel group) in remote loopback, perform the following task in interface configuration mode:

Task	Command
Place the serial interface (channel group) in remote loopback.	**loopback remote** (interface)

Using the **loopback remote** interface command sends a latched CSU loopback command to the remote CSU/DSU. The router must detect the response code, at which time the remote loopback is verified.

Channelized E1 and Channelized T1 Configuration Examples

- ISDN PRI Examples
- PRI Groups and Channel Groups on the Same Channelized T1 Controller Example
- Robbed Bit Signaling Examples
- ISDN Channel-Associated Signaling Examples

ISDN PRI Examples

This section contains the following ISDN PRI examples:

- NSF Call-by-Call Support Example
- PRI on a Cisco AS5200 Examples

NSF Call-by-Call Support Example

The following example configures Network-Specific Facility (NSF), needed for an AT&T 4ESS switch when it is configured for Call-by-Call selection. The PRI 4ESS switch expects some AT&T-specific information when placing outgoing ISDN PRI voice calls; the options are accunet, sdn, and megacom.

This example shows both the controller and interface commands required to make the ISDN interface operational and the DDR commands, such as the **dialer map**, **dialer-group**, and **map-class dialer** commands, that are needed to configure the ISDN interface to make outgoing calls.

```
! The following lines configure the channelized T1 controller; all timeslots are
! configured for ISDN PRI.
!
controller t1 1/1
 framing esf
 linecode b8zs
 pri-group timeslots 1-23
 isdn switchtype primary-4ess
!
! The following lines configure the D channel for DDR. This configuration applies
! to all B channels on the ISDN PRI interface.
!
interface serial 1/1:23
 description Will mark outgoing calls from AT&T type calls.
 ip address 7.1.1.1 255.255.255.0
 encapsulation ppp
 dialer map ip 7.1.1.2 name tommyjohn class sdnplan 14193460913
 dialer map ip 7.1.1.3 name angus class megaplan 14182616900
 dialer map ip 7.1.1.4 name angus class accuplan 14193453730

dialer-group 1
 ppp authentication chap

map-class dialer sdnplan
 dialer outgoing sdn

map-class dialer megaplan
 dialer voice-call
 dialer outgoing mega

map-class dialer accuplan
 dialer outgoing accu
```

PRI on a Cisco AS5200 Examples

The following example configures ISDN PRI on the appropriate interfaces for IP dial-in on channelized T1:

```
! T1 PRI controller configuration

controller T1 0
 framing esf
 linecode b8zs
 clock source line primary
 pri-group timeslots 1-24
!
controller T1 1
 framing esf
 linecode b8zs
 clock source line secondary
 pri-group timeslots 1-24
!
```

```
interface Serial0:23
 isdn incoming-voice modem
 dialer rotary-group 1
!
interface Serial1:23
 isdn incoming-voice modem
 dialer rotary-group 1
!
interface Loopback0
 ip address 172.16.254.254 255.255.255.0
!
interface Ethernet0
 ip address 172.16.1.1 255.255.255.0
!
interface Group-Async1
 ip unnumbered Loopback0
 ip tcp header-compression passive
 encapsulation ppp
 async mode interactive
 peer default ip address pool default
 dialer-group 1
 ppp authentication chap pap default
 group-range 1 48
!
interface Dialer1
 ip unnumbered Loopback0
 encapsulation ppp
 peer default ip address pool default
 ip local pool default 172.16.254.1 172.16.254.48
 dialer in-band
 dialer-group 1
 dialer idle-timeout 3600
 ppp multilink
 ppp authentication chap pap default
```

The following example configures ISDN PRI on the appropriate interfaces for IP dial-in on channelized E1:

```
! E1 PRI controller configuration

controller E1 0
  framing crc4
 linecode hdb3
 clock source line primary
 pri-group timeslots 1-31
!
controller E1 1
 framing crc4
 linecode hdb3
 clock source line secondary
 pri-group timeslots 1-31

interface serial0:15
 isdn incoming-voice modem
 dialer rotary-group 1
!
interface serial1:15
 isdn incoming-voice modem
 dialer rotary-group 1
!
interface loopback0
 ip address 172.16.254.254 255.255.255.0
!
interface ethernet0
 ip address 172.16.1.1 255.255.255.0
!
```

```
!The following block of commands configures DDR for all the ISDN PRI interfaces
!configured above. The dialer-group and dialer rotary-group commands tie the
!interface configuration blocks to the DDR configuration.
!
interface dialer1
 ip unnumbered loopback0
 encapsulation ppp
 peer default ip address pool default
 ip local pool default 172.16.254.1 172.16.254.60
 dialer in-band
 dialer-group 1
 dialer idle-timeout 3600
 ppp multilink
 ppp authentication chap pap default
```

PRI Groups and Channel Groups on the Same Channelized T1 Controller Example

The following example shows a channelized T1 controller configured for PRI groups and for channel groups. The **pri-group** command and the **channel-group** command cannot have overlapping timeslots; note the correct timeslot configuration in this example.

```
controller t1 0
channel-group 0 timeslot 1-6
channel-group 1 timeslot 7
channel-group 2 timeslot 8
channel-group 3 timeslot 9-11
pri-group timeslot 12-24
```

The same type of configuration also applies to channelized E1.

Robbed Bit Signaling Examples

This section provides sample configurations for the Cisco AS5200's T1 controllers. You can configure the 24 channels of a channelized T1 to support ISDN PRI, robbed bit signaling, channel grouping, or a combination of all three. It provides the following sections:

- Allocating All Channels for Robbed Bit Signaling Example
- Mixing and Matching Channels Example

Allocating All Channels for Robbed Bit Signaling Example

The following example configures all 24 channels to support robbed bit signaling feature group B on a Cisco AS5200:

```
controller T1 0
 cas-group 1 timeslots 1-24 type e&m-fgb
```

Mixing and Matching Channels Example

The following example shows you how to configure all 24 channels to support a combination of ISDN PRI, robbed bit signaling, and channel grouping. The range of timeslots that you allocate must match the timeslot allocations that your central office chooses to use. This is a rare configuration due to the complexity of aligning the correct range of timeslots on both ends of the connection.

The following configuration creates serial interfaces 0 to 9, which correspond to ISDN PRI timeslots 1 to 10 (shown as serial 1:0 through serial 1:9). The serial line 1:23 is the D channel, which carries the analog signal bits that dial a modem's phone number and determine if a modem is busy or available. The D channel is automatically created and assigned to timeslot 24.

```
controller T1 0
! ISDN PRI is configured on timeslots 1 through 10.
 pri-group timeslots 1-10
! Channelized T1 data is transmitted over timeslots 11 through 16.
 channel-group 11 timeslots 11-16
! The channel-associated signal ear and mouth feature group B is configured on
! virtual signal group 17 for timeslots 17 to 23, which are used for incoming
! and outgoing analog calls.
 cas-group 17 timeslots 17-23 type e&m-fgb
```

There is no specific interface, such as the serial interface shown in the earlier examples, that corresponds to the timeslot range.

ISDN Channel-Associated Signaling Examples

This section provides channelized E1 sample configurations for the Cisco AS5200. You can configure the 30 available channels with channel-associated signaling, channel grouping, or a combination of the two.

- Allocating All Channels for Channel-Associated Signaling
- Mixing and Matching Channels Example

Allocating All Channels for Channel-Associated Signaling

The following interactive example configures channels (also known as timeslots) 1-30 with ear and mouth channel signaling and feature group B support on a Cisco AS5200; it also shows that the router displays informative messages about each timeslot. Signaling messages are transmitted in the 16th timeslot; therefore, that timeslot is not brought up.

```
Router#
%SYS-5-CONFIG_I: Configured from console by console
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# controller e1 0
Router(config-controller)# cas-group 1 timeslots 1-31 type e&m-fgb
Router(config-controller)#
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 1 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 2 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 3 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 4 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 5 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 6 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 7 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 8 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 9 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 10 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 11 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 12 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 13 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 14 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 15 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 17 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 18 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 19 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 20 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 21 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 22 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 23 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 24 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 25 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 26 is up
```

```
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 27 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 28 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 29 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 30 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 31 is up
```

Mixing and Matching Channels

The following interactive example shows you how to configure an E1 controller to support a combination of channel-associated signaling and channel grouping. The range of timeslots that you allocate must match the timeslot allocations that your central office chooses to use. This is a rare configuration because of the complexity of aligning the correct range of timeslots on both ends of the connection.

Timeslots 1 through 15 are assigned to channel group 1. In turn, these timeslots are assigned to serial interface 0 and virtual channel group 1 (shown as serial 0:1).

```
AS5200(config)# controller e1 0
Router(config-controller)# channel-group 1 timeslots 1-15
Router(config-controller)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0:1, changed state to down
%LINK-3-UPDOWN: Interface Serial0:1, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0:1, changed state to up
```

Timeslots 17 to 31 are configured with channel associated signaling.

```
Router(config-controller)# cas-group 2 timeslots 17-31 type e&m-fgb
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0:1, changed state to down
Router(config-controller)#
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 17 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 18 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 19 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 20 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 21 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 22 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 23 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 24 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 25 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 26 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 27 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 28 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 29 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 30 is up
%DSX0-5-RBSLINEUP: RBS of controller 0 timeslot 31 is up
Router(config-controller)#
```