Cisco Network Solutions for the Telco DCN: Telephone Switch Environments

Information in this document is directed to competitive local exchange carriers (CLECs), incumbent local exchange carriers (ILECs), and Post, Telephone, and Telegraph (PTT) agencies, collectively referred to as *telcos* (short for telephone companies). This document provides descriptions of Cisco network solutions for transporting data between a telephone switch and the Operations Support Systems (OSSs) in a telco data communications network (DCN).

The DCN transports network management traffic between network elements and their respective OSSs, making them a vital link between the service network and the network operations center (NOC). The solutions presented in following sections will help telcos migrate their legacy networks to a router-based TCP/IP network, which will simplify the DCN and reduce equipment costs.

Version History

Version Number	Date	Notes
1	November 4, 2002	This document was created as a joint effort between Don Schriner in the Cisco CTO Consulting Engineering Group and Alliene Turner in Cisco IOS Documentation.
2	April 28, 2004	This document was updated.
3	January 3, 2008	This document was updated.

Contents

Several methods for implementing the migration to TCP/IP are described in this document, including detailed configuration examples for migrating the host applications that preserve the legacy transport connection on the telephone switch. These migration methods are provided in the following sections:

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Prerequisites

The features described in this document are supported on the Cisco Telco and Enterprise feature sets.

Cisco IOS software is packaged in feature sets that are supported on specific platforms. To get updated information regarding platform support for this feature, access Cisco Feature Navigator at http://www.cisco.com/go/fn.

To access Cisco Feature Navigator, you must have an account on Cisco.com. Qualified users can establish an account on Cisco.com by following the directions at http://www.cisco.com/register. If you have an account but have forgotten or lost your account information, send a blank e-mail to cco-locksmith@cisco.com. An automatic check will verify that your e-mail address is registered with Cisco.com. If the check is successful, account details with a new random password will be e-mailed to you.

The Telco DCN Network

The telco DCN is an out-of-band operations support network used to connect telco central office (CO) equipment to a NOC. As part of the International Telecommunication Union (ITU) Telecommunications Management Network (TMN) specification defined by ITU-T M.3010, the DCN provides the link between the service network and the NOC. The specification defines the management requirements of DCN administrators to plan, provision, install, maintain, operate, and administer telecommunications networks and services. The primary function of the DCN is to enable surveillance and monitor the status of the support network, yet it also supports Operations, Administration, Maintenance, and Provisioning (OAM&P) functions including monitoring alarms and the trunk, collecting billing information, and network provisioning tasks.

Figure 1 shows the elements of a typical DCN network.

Figure 1   ***Typical DCN Network Elements***
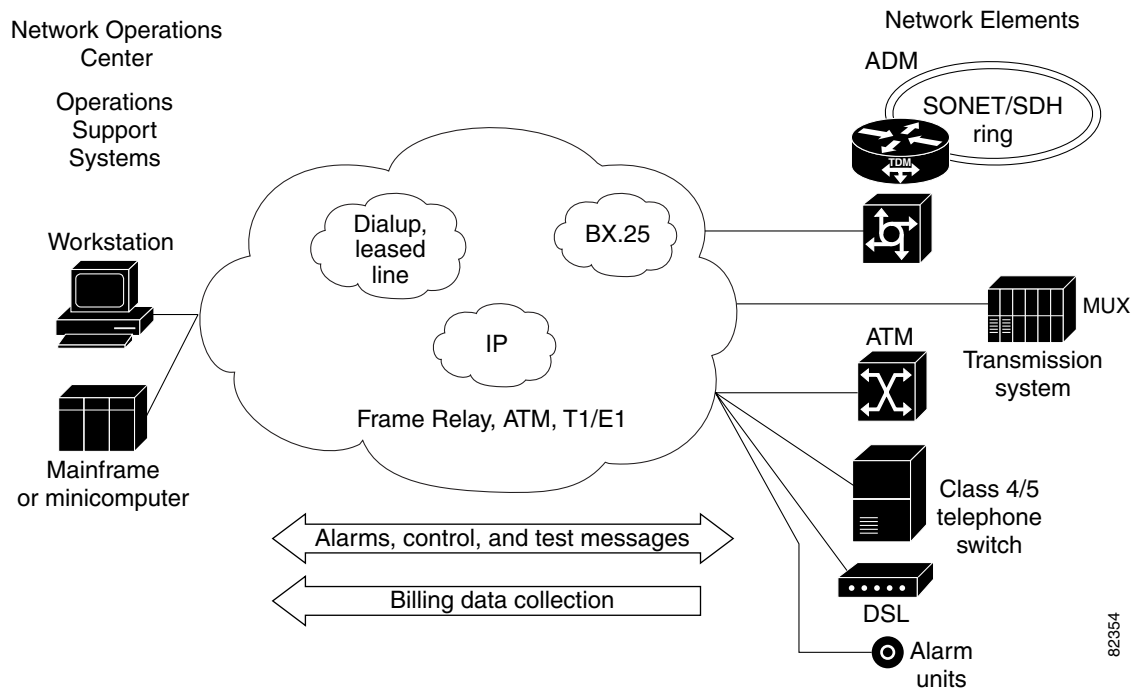
Multiple networks are included in the DCN network cloud. The networks serve to connect a mainframe or minicomputer and workstation configured as an OSS at a NOC, to a large array of devices and systems referred to as network elements.

Network elements in a DCN include alarm units, Class 4 and 5 telephone switches such as the Lucent 5ESS, add/drop multiplexers (ADMs) and optical repeaters, voice switches, digital cross-connect systems, Frame Relay or ATM switches, routers, digital subscriber line access multiplexers (DSLAMs), remote access switches, digital loop transmission systems, and so on, that make up the provisioned services infrastructure used to deliver services to customers. The OSS controls and stores the network management data collected about and from the various network elements.

BX.25 Overview

The following sections provide an overview of the BX.25 protocol:

BX.25 as a DCN Transport Mechanism

The regional Bell operating companies (RBOCs) and other incumbent local exchange carriers (ILECs) use the BX.25 protocol and the X.25 protocol to transport monitoring data, traffic data, and provisioning data between a Class 4 or Class 5 telephone switch and an OSS in their DCNs.

BX.25 is a variation of the ITU X.25 standard introduced in the early 1980s by AT&T Bell Laboratories. BX.25 contains many of the features standardized in the 1984 ITU X.25 standards, but adds some special features above Layer 3 of the Open System Interconnection (OSI) protocol stack. (Information presented here focuses only on the first three layers of the OSI protocol stack—the physical, data link, and network layers—and does not address the upper layer requirements of BX.25 such as the Transaction-Oriented Protocol).

Differences Between BX.25 and X.25

Many voice switch manufacturers use the BX.25 interface on the maintenance port. BX.25 or X.25 interfaces are also found on products such as the Lucent 5ESS/4ESS, Lucent 1A, Nortel DMS100, and Siemens Elektronisches Wahlsystem Digital (EWSD) telephone switches. These voice switches are used by many RBOCs, competitive local exchange carriers (CLECs), Post, Telephone, and Telegraph (PTT) organizations, and international exchange carriers.

The main difference between X.25 and BX.25 can be found in BX.25 Issue 3, which is also the basis for the migration strategies presented in the following sections.

BX.25 Issue 3 can be configured for use over point-to-point networks, over dialup connections, or over packet-switched networks. The solutions presented in the following sections show techniques available from Cisco IOS software to replicate the point-to-point environment and the packet-switched network environment over a TCP/IP backbone. The BX.25 protocol as of Issue 3 is compatible with Issue 1980 of the Consultative Committee for International Telegraph and Telephone (CCITT) recommendation for X.25. At the physical layer, BX.25 supports the CCITT V.35 EIA/TIA-232C and EIA/TIA-449 interfaces. (Note that the Cisco IOS software allows you to select either the 1980 or 1984 version of X.25 using the **x25 version** command. See the *X.25 Version Configuration* document at http://www.cisco.com/en/US/products/ps6350/products_configuration_guide_chapter09186a00804555 18.html.)

Cisco Telephone Switch Migration Solutions Overview

Solutions for that part of the DCN that uses BX.25 as a transport mechanism to a Class 4 or Class 5 telephone switch are described in following sections. You will see examples mainly of connectivity to a Lucent 5ESS telephone switch, although examples for Siemens and Nortel telephone switches are also included, and the procedures provided can be applied to DCNs with other types of switches and equipment.

Figure 2 shows a Lucent 5ESS telephone switch with the connections that are required for its use and maintenance.

Figure 2   Connections and Networks Required for a Lucent 5ESS Telephone Switch
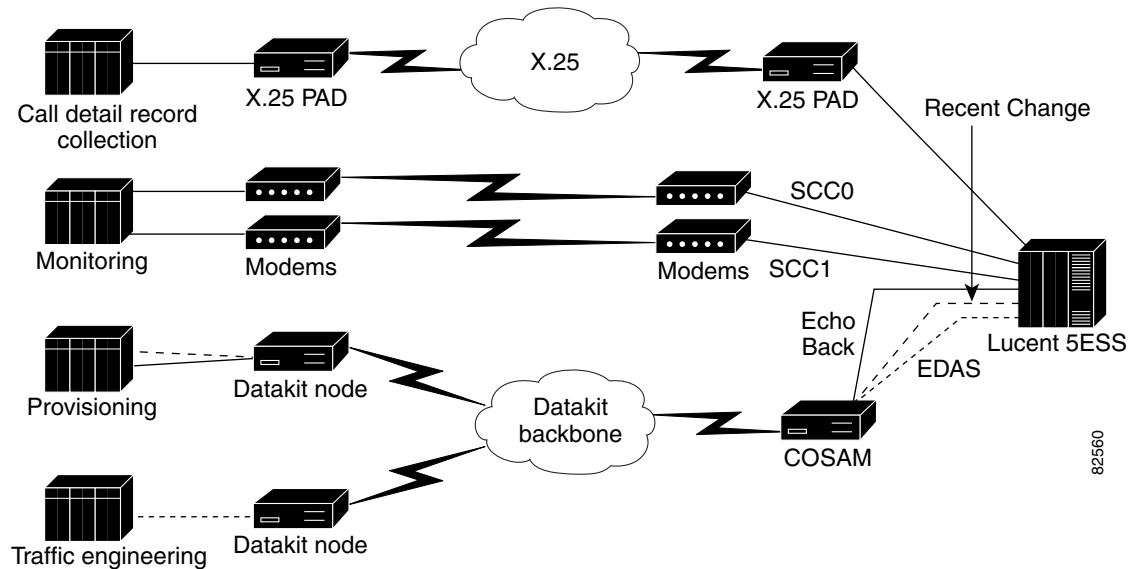
The connections can be divided into the following categories:

- Collection of call detail records (CDRs) or billing information
- Monitoring for alarms
- Provisioning of new services
- Collection of trunk (traffic) engineering data

Figure 2 shows multiple networks and the legacy transport methods that are used to connect multiple OSSs to the Lucent 5ESS telephone switch. This multiplicity of networks is not an uncommon occurrence in a large PTT or ILEC. Separate networks were built by the various operations organizations using a particular OSS. The billing organization, for example, would often build a separate network for just collecting CDR.

The long-term goal is to consolidate these various networks into an IP backbone. To this end, Cisco Systems offers several solutions that address the varying needs of service providers that have selected OSSs from various vendors with different features. The solutions you choose to migrate an application in your DCN to an IP-based network will depend on the OSS vendor. Today, Cisco can offer the following solutions:

- Cisco serial tunneling (STUN)
- XOT
- Cisco X.25 Record Boundary Preservation (RBP)

The short-term goal is to migrate all of the various OSSs to a TCP/IP stack utilizing the Cisco X.25 RBP solution, so that the DCN for a telco service provider will look like Figure 3.

Figure 3   ***A Telco DCN Fully Migrated to TCP/IP***
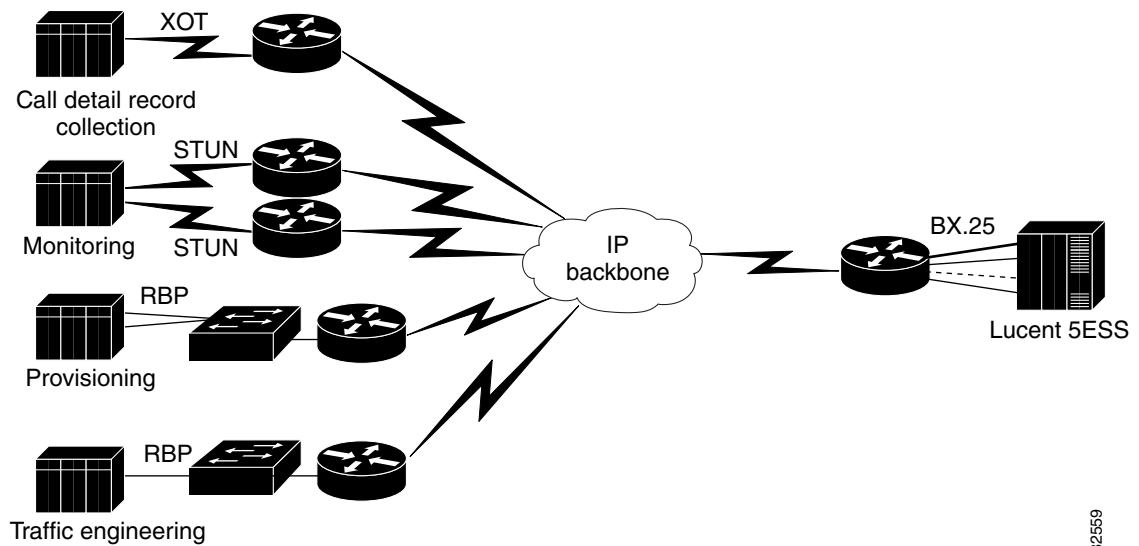
In Figure 3, the call detail record (CDR) collection host still has a BX.25 stack and a serial interface. XOT is used to transport the BX.25 data. The monitoring portion of the OSS has redundant serial BX.25 gateways defined and, in this configuration, the Cisco STUN feature is the best solution. The provisioning and the traffic engineering hosts have both implemented a TCP/IP stack and the Cisco X.25 RBP solution.

The following sections describe migration solutions for each of the connection categories:

- Data collected from the telephone switch for customer billing—See the "CDR Bill Collection Networks: Cisco XOT and RBP Solutions" section on page 7. This section includes information about the enhanced RBP Q-bit solution, which identifies control frames and data frames in the RBP six-byte header and allows Nortel's Multi Network Protocol (MNP) and Ericsson's Message Transfer Protocol (MTP) file types to be supported these file types use control frames in the CDR transfer.

- Data collected from the telephone switch for alarm monitoring—See the "Switch Monitoring Networks: Cisco STUN OSS Connectivity Solution" section on page 40, the "Switch Monitoring Networks: Cisco X.25 BAI OSS Connectivity Solution" section on page 52, and the "Switch Monitoring Networks: IP and Cisco X.25 BAI and EOR Solutions" section on page 71.

- Data exchanged between the telephone switch and the provisioning application—See the "Provisioning Networks: Cisco X.25 RBP Solution" section on page 81.

- Data exchanged between the traffic engineering application and the Engineering Data Acquisition System (EDAS) port on the telephone switch—See the "Traffic Data Collection Networks: Cisco X.25 RBP and XOT Solutions" section on page 101.

The solutions are presented with procedures and examples that have been tested with vendor-specific OSSs that transport the BX.25 data across the DCN when Cisco routers have been introduced into the network for the purpose of migrating the network to TCP/IP.

CDR Bill Collection Networks: Cisco XOT and RBP Solutions

This section describes Cisco telco solutions for CDR billing collection networks like the one highlighted in Figure 4.

Figure 4   *Legacy CDR Bill Collection Network*
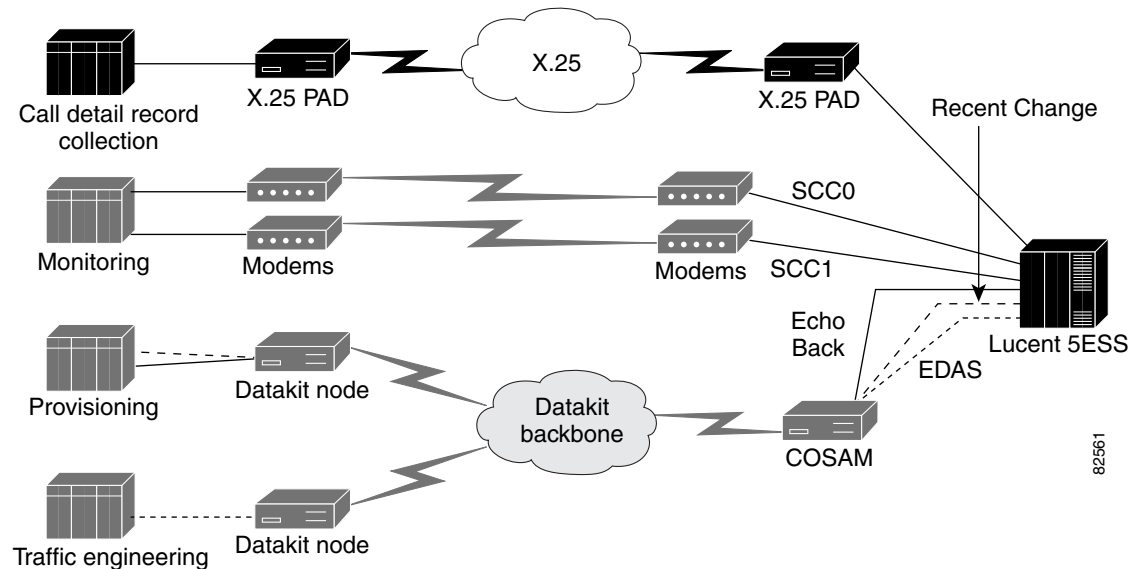
CDR billing collection information was originally collected on magnetic tapes and transported on trucks, then dialup connections were used for transferring this data electronically in early network implementations. As the amount of billing data grew, data collection migrated to X.25 networks.

The next generation of networks will transport the CDR data over a high-speed IP backbone. A first step toward this next-generation DCN is to use XOT or RBP to transport the CDR data. This section provides configuration tasks and examples for transporting CDR billing collection information over a router-based network using XOT and RBP. The tasks and examples in this section include a network with a Sterling 5000 Collector and a Kansys, Inc. Mercury Mediation device. The RBP solution was tested on Intec Telecom Systems and implemented RBP on its Inter-mediatE application.

This section contains the following information and tasks:

- Cisco XOT Features for Transporting CDR Data, page 8
- The BX.25 Security I-Frame, page 8
- Configuring XOT on the Billing Collector Side of the Network, page 11
- Configuring XOT on the Telephone Switch Side of the Network, page 13
- Configuring a Cisco Router for a Host That Supports XOT, page 19
- Cisco RBP and RBP Q-Bit Features for Transporting CDR Data, page 22
- Configuring a Cisco Router for a CDR Host That Supports the RBP Feature, page 23
- Configuring the Cisco X.25 RBP Q-Bit Feature for the MTP File Type, page 25
- Configuring the Cisco X.25 RBP Q-Bit Feature for the MNP File Type, page 28
- Debugging Cisco X.25 RBP, page 30
- Configuring an Intec Telecom Systems Inter-mediatE System, page 35

Cisco XOT Features for Transporting CDR Data

XOT was specified in RFC 1613 by engineers at Cisco Systems to allow for the transport of X.25 packets over a TCP/IP network; that is, XOT *tunnels* X.25 traffic through an IP cloud. XOT allows X.25 (and BX.25) packets to be sent over a TCP/IP network instead of a Link Access Procedure, Balanced (LAPB) link. The packets can originate from an X.25 DTE device or can be packet assembler/disassembler (PAD)-originated traffic. XOT allows the router to transport X.25 virtual connections (VCs) transparently over a TCP connection on a one-to-one basis; one VC creates one TCP connection. XOT preserves the legacy transport connection on the telephone switch in a DCN while allowing at least partial migration of the network to TCP/IP.

Configurations for the Sterling 5000 Collector map a permanent virtual circuit (PVC) from the Sterling 5000 Collector across an IP backbone to the telephone switch. XOT encapsulates the BX.25 packets in TCP/IP and transports the packets across the core of the network. The BX.25 packets are removed from TCP/IP and forwarded out the serial interface.

Kansys, Inc. has implemented the switched virtual circuit (SVC) portion of XOT in its Mercury Mediation device, which allows the OSS support of XOT directly on the host. In addition to these devices, Cisco has implemented and tested other CDR applications such as Lucent Billdats.

The BX.25 Security I-Frame

In early telco DCNs, BX.25 was implemented in a dialup environment that was used by bill collection applications such as the Lucent Billdats or the 4Tel Sterling 5000 Collector applications. Billing data represents a large part of the service provider revenue. The BX.25 implementation added an Information Frame (I-Frame) for security in the dialup network environment. The I-Frame passed a plain text password from the OSS to the telephone switch, a practice that was intended to prevent service providers from exposing their billing hosts and switches to public networks.

Note The *Operations Systems Network Communications Protocol Specification* (Publication 54001) calls for the I-Frame to be implemented only in a dialup or public environment. Although the billing hosts and the Class 5 telephone switches support the security I-Frame, the Cisco X.25 implementation does not. The Cisco network is typically a private enterprise, so Cisco customers must disable the I-Frame on the OSS and the Lucent 5ESS telephone switch. Cisco has validated that BX.25 can be transported directly over its networks using X.25, or over an IP infrastructure using X.25 over TCP (XOT) as defined in RFC 1613, once the I-Frames are disabled. These configurations have been successfully tested with both the Sterling 5000 Collector and the Lucent Billdats applications employing Cisco networks.

Before migrating to a Cisco TCP/IP network and using XOT to transport the billing data, you must turn off the BX.25 I-Frame.

The parameters for setting the I-Frame in the Lucent 5ESS telephone switch are contained in a switch configuration form named cpblx3. Figure 5 shows field 19, the security field, and the options for setting the I-Frame. To turn off security and the I-Frame, set this field to N. (See the "Lucent cpblx Form Parameter Descriptions" section on page 110 for more information about filling in the cpblx3 form.)

Figure 5   Security Field from Lucent 5ESS cpblx3 Form

```
19. security:
19 security definition: check security information legal values: Y, N, Null default value: N
```

Once this task is performed, you will need to configure X.25 and LAPB parameters for XOT. The following "X.25 and LAPB Parameters" section summarizes the more important X.25 and LAPB parameters and their Cisco default settings. Additional X.25 configuration and troubleshooting information can be found in the "Cisco IOS X.25 Toolkit."

X.25 and LAPB Parameters

X.25 is an International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) protocol standard capable of providing connectivity across public data networks (PDNs). The X.25 network layer protocol is called the Packet Level Protocol (PLP), and it manages packet exchanges between data terminal equipment (DTE) devices across virtual circuits. The PLP operates in five distinct modes: call setup, data transfer, idle, call clearing, and restarting.

LAPB operates at the data link layer of the OSI reference model. LAPB specifies methods for exchanging data (in units called frames), detecting out-of-sequence or missing frames, retransmitting frames, and acknowledging frames. Several protocol parameters can be modified to change LAPB protocol performance on a particular link. Because X.25 operates PLP on top of LAPB, setting the X.25 and LAPB parameters is essential for correct X.25 behavior. It is important that the X.25 and LAPB parameters match on the OSS host, the telephone switch, and the routers performing X.25 over TCP (XOT) encapsulation.

The Cisco X.25 and LAPB parameters and their Cisco defaults are listed in Table 1, Table 2, and Table 3. Sections following the table describe how to set these parameters for specific Cisco solutions.

Table 1　　　*Cisco X.25 Packet-Setting Parameters*

Function	Cisco IOS Commands	Default Value	Usage Notes
Input window size Output window size	**x25 win** **x25 wout**	2 packets	Window size is the default number of packets a VC can send before waiting for an X.25 acknowledgment.
Input packet size Output packet size	**x25 ips** **x25 ops**	128 packets	Input and output packet sizes must be set to the same value.
Window modulus	**x25 modulo**	modulo 8	Window modulus defines flow control with a sliding window sequence count. The window counter restarts at zero upon reaching the upper limit.
Lowest and highest incoming-only VC number	**x25 lic** **x25 hic**	0	X.25 switch is configured for an incoming-only VC range, from the perspective of the DTE device. 0 = disabled.
Lowest and highest outgoing-only VC number	**x25 loc** **x25 hoc**	0	X.25 switch is configured for an outgoing-only VC range, from the perspective of the DTE device. 0 = disabled.

Table 1   ***Cisco X.25 Packet-Setting Parameters (continued)***

Function	Cisco IOS Commands	Default Value	Usage Notes
Lowest two-way VC number	**x25 ltc**	1	X.25 switch is configured for a two-way VC range. Value must be larger than incoming-only range, and must come before any outgoing-only range.
Highest two-way VC number	**x25 htc**	1024	

Table 2   ***Cisco X.25 Timer Definitions***

Function	Cisco IOS Commands	Default	Usage Notes
T10	**x25 t10**	60 seconds	DCE Restart Request timer
T11	**x25 t11**	180 seconds	DCE Incoming Call timer
T12	**x25 t12**	60 seconds	DCE Reset Indication timer
T13	**x25 t13**	60 seconds	DCE Clear Indication timer
T20	**x25 t20**	180 seconds	DTE Restart Request retransmission timer
T21	**x25 t21**	200 seconds	DTE Call Request retransmission timer
T22	**x25 t22**	180 seconds	DTE Reset Request retransmission timer
T23	**x25 t23**	180 seconds	DTE Clear Request retransmission timer

Table 3   ***Cisco LAPB Timer Definitions***

| Function	Cisco IOS Commands	Default	Usage Notes
T1	**labp t1**	3000 milliseconds	Retransmission timer; period ranges from 1 to 64,000 milliseconds (ms).
T2	**labp t2**	0 milliseconds (disabled)	Explicit acknowledge deferral timer (length of time the DTE or DCE device has before acknowledging a frame).
T3	**lapb interface-outage**	0 milliseconds (disabled)	Interface outage timer (length of time the interface can be down before the packet layer is notified of an outage); partial T3 timer functionality.
T4	**lapb t4**	0 milliseconds (disabled by default)	Idle link timer, after which the Cisco IOS software sends out a poll packet to determine whether the link has suffered an unsignaled failure. Any T4 value (except 0) must be greater than what is set for the LAPB T1 timer.

Table 3   *Cisco LAPB Timer Definitions*

Function	Cisco IOS Commands	Default	Usage Notes
N1	lapb n1	Maximum value for the interface	The maximum number of bits in a LAPB frame, which determines the maximum size of an X.25 packet. When LAPB is used over leased lines, the N1 parameter should be eight times the hardware maximum transmission unit (MTU) size plus any protocol overhead. The LAPB N1 range is dynamically calculated by the Cisco IOS software whenever an MTU change, a Layer 2 or Layer 3 modulo change, or a compression change occurs on a LAPB interface.
N2	lapb n2	20 transmissions	Transmission count, or the maximum number of times a data frame can be transmitted.
K	lapb k	7 frames	The maximum permissible number of outstanding frames, called the window size.

Configuring XOT on the Billing Collector Side of the Network

Figure 4 shows a basic CDR network with a bill collector application that polls a Lucent 5ESS telephone switch for billing information over a BX.25 network.

Figure 6 shows what the CDR collection connection in Figure 4 would look like when Cisco routers replace the X.25 PAD and use TCP/IP via XOT to transport the billing information. The Cisco 3631 and Cisco 3662 edge routers encapsulate the BX.25 packets.

Figure 6   *Sterling 5000 Collector Polling a Telephone Switch Across a Cisco Network*
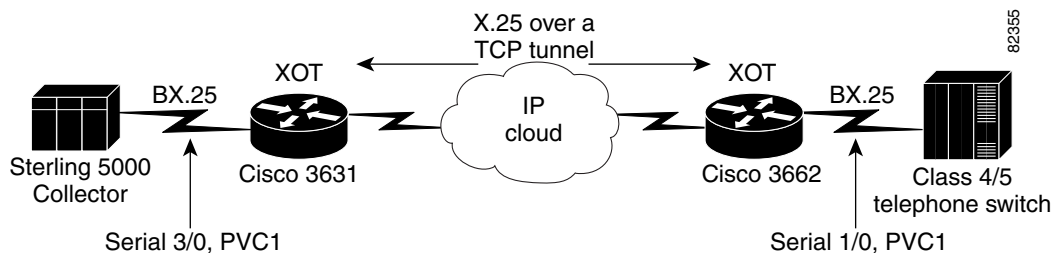
To configure XOT on a Cisco 3631 edge router connected to a Sterling 5000 Collector, see Figure 6 and perform the following steps. See the "Sterling 5000 Collector Configuration: Examples" section on page 14 for configuration examples.

Step 1   Enter configuration mode:

```
Router-3631# configure terminal
```

```
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Start interface configuration mode for the serial interface connected to the Sterling 5000 Collector port. In the following steps, serial interface 3/0 is used, which specifies network module 3 and port 0 on the Cisco 3631 router connected to the Sterling 5000 Collector.

```
Router-3631(config)# interface serial 3/0
```

Step 3 Shut down the interface:

```
Router-3631(config-if)# shutdown
```

Step 4 Enter a description for the serial interface:

```
Router-3631(config-if)# description AMA Billing FE56
```

Step 5 Configure X.25 DCE encapsulation on the serial interface:

```
Router-3631(config-if)# encapsulation x25 dce
```

Step 6 Set the low two-way channel VC number to 5, which sets the PVC range from 1 to 4:

```
Router-3631(config-if)# x25 ltc 5
```

Step 7 Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 7:

```
Router-3631(config-if)# x25 win 7
```

Step 8 Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 7:

```
Router-3631(config-if)# x25 wout 7
```

Step 9 Change the maximum input packet size from the default of 128 to 512:

```
Router-3631(config-if)# x25 ips 512
```

Step 10 Change the maximum output packet size from the default of 128 to 512:

```
Router-3631(config-if)# x25 ops 512
```

Step 11 The system default is to force X.25 packet-level restarts when the link level resets. Disable this function with the **no x25 linkrestart** command:

```
Router-3631(config-if)# no x25 linkrestart
```

Step 12 Map the PVC across the TCP/IP network to the serial interface on the Cisco router connected to the Lucent 5ESS telephone switch. In the example for this step, PVC 1 from the Sterling 5000 Collector OSS is mapped to PVC 1 at serial interface 1/0 on the Cisco router, at IP address 172.30.109.48. Specify an X.25 input and output window size of 3 for this interface:

```
Router-3631(config-if)# x25 pvc 1 tunnel 172.30.109.48 interface serial 1/0 pvc 1
windowsize 3 3
```

Step 13 The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 56000 baud:

```
Router-3631(config-if)# clockrate 56000
```

Step 14 Restart the interface:

```
Router-3631(config-if)# no shutdown
```

Step 15 Exit the interface and global configuration modes:

```
Router-3631(config-if)# end
Router-3631(config)# end
```

Step 16   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3631# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Configuring XOT on the Telephone Switch Side of the Network

To configure XOT on a Cisco 3662 edge router connected to a telephone switch, see Figure 6 and perform the following steps. See the "Sterling 5000 Collector Configuration: Examples" section on page 14 for configuration examples.

Step 1   Enter configuration mode:

```
Router-3662# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2   Start interface configuration mode for the serial interface connected to the Class 5 switch port. In this example, the port is a Lucent 5ESS telephone switch. In the following steps, serial interface 1/0 is used, which specifies network module 1 and port 0 on the Cisco 3662 router connected to the Lucent 5ESS:

```
Router-3662(config)# interface serial 1/0
```

Step 3   Shut down the interface:

```
Router-3662(config-if)# shutdown
```

Step 4   Enter a description for the serial interface:

```
Router-3662(config-if)# description AMA Billing 5ESS Lucent
```

Step 5   Configure X.25 DCE encapsulation on the serial interface:

```
Router-3662(config-if)# encapsulation x25 dce
```

Step 6   Set the low two-way channel VC number to 5, which sets the PVC range from 1 to 4:

```
Router-3662(config-if)# x25 ltc 5
```

Step 7   Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 7:

```
Router-3662(config-if)# x25 win 7
```

Step 8   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 7:

```
Router-3662(config-if)# x25 wout 7
```

Step 9   Change the maximum input packet size from the default of 128 to 512:

```
Router-3662(config-if)# x25 ips 512
```

Step 10   Change the maximum output packet size from the default of 128 to 512:

```
Router-3662(config-if)# x25 ops 512
```

Step 11   The system default is to force X.25 packet-level restarts when the link level resets. Disable this function with the **no x25 linkrestart** command:

```
Router-3662(config-if)# no x25 linkrestart
```

Step 12   Map the PVC across the TCP/IP network to the serial interface on the Cisco router connected to the Lucent 5ESS telephone switch:

```
Router-3662(config-if)# x25 pvc 1 xot 172.31.229.247 interface serial 3/0 pvc 1
xot-promiscuous window size 3 3
```

Step 13   The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 56000 baud:

```
Router-3662(config-if)# clockrate 56000
```

Step 14   Restart the interface:

```
Router-3662(config-if)# no shutdown
```

Step 15   Exit the interface and global configuration modes:

```
Router-3662(config-if)# end
Router-3662(config)# end
```

Step 16   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3662# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Sterling 5000 Collector Configuration: Examples

This section provides examples of the following Sterling 5000 Collector configurations:

The Sterling 5000 Collector configuration examples are similar and show how to configure XOT in a DCN that uses a Sterling 5000 Collector to poll a Class 5 telephone switch. Each configuration maps a PVC from the Sterling 5000 Collector across an IP backbone to the telephone switch. XOT encapsulates the BX.25 packets in TCP/IP and transports the packets across the core of the network. The BX.25 packets are removed from TCP/IP and forwarded out the serial interface. The main differences in the configuration examples provided in this section are the switch types; however, in your DCN there could also be variations with how X.25 or the Layer 3 parameters are configured.

Sterling 5000 Collector Polling a Lucent 5ESS Telephone Switch: Example

The following example shows how to configure XOT in a DCN that uses a Sterling 5000 Collector to poll a Lucent 5ESS telephone switch. The edge routers (the Cisco 3631 and Cisco 3662 routers in Figure 7) encapsulate the BX.25 packets.

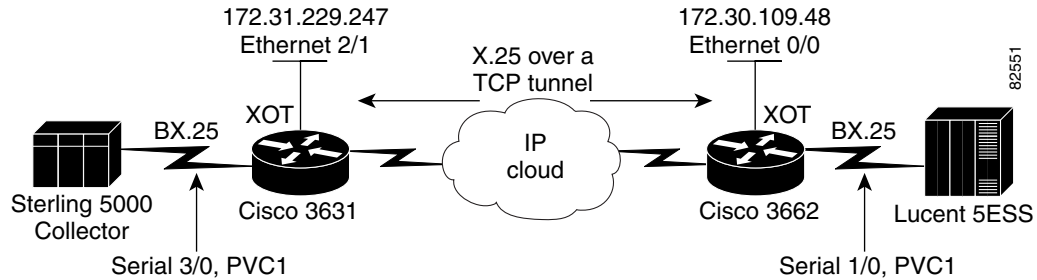*Figure 7*   *Sterling 5000 Collector Polling a Lucent 5ESS Telephone Switch*

Cisco 3631 Edge Router Connected to the Sterling 5000 Collector (Polling Lucent 5ESS Switch): Example

The following partial example shows the configuration for a Cisco 3631 edge router connected to a Sterling 5000 Collector that polls a Lucent 5ESS telephone switch for billing data. In this example the PVCs are mapped to a far-end router. The PVC connections are always established, and the destination is predetermined and is the X.25 equivalent of a leased line.

```
x25 routing
!
interface Ethernet2/1
 description
 ip address 172.31.229.247 255.255.255.0
! Serial 3/0 specifies network module 3 and port 0.
interface Serial3/0
! Serial interface description.
 description AMA Billing FE56
 no ip address
! X.25 DCE encapsulation.
 encapsulation x25 dce
 no ip mroute-cache
 no logging event subif-link-status
! The low two-way channel VC number is 5, making the PVC range 1 through 4.
 x25 ltc 5
! The input and output window size is changed from the default of 2 to 7.
 x25 win 7
 x25 wout 7
! The maximum input and output packet size is changed from the default of 128 to 512.
 x25 ips 512
 x25 ops 512
! The system default is to force X.25 packet-level restarts when the link level resets.
! The no x25 linkrestart command disables this function.
 no x25 linkrestart
! The x25 pvc commands configure different PVC LCNs on the host side that are each
! mapped to a different Class 5 telephone switch. The PVC LCN on the host side is always
! mapped to the PVC with LCN 1 on the Lucent 5ESS telephone switches.
! X.25 input and output window sizes of 3 were specified for this interface.
 x25 pvc 1 tunnel 172.30.109.48 interface Serial 1/0 pvc 1 windowsize 3 3
 x25 pvc 2 tunnel 172.30.115.120 interface Serial 1/0 pvc 1 windowsize 3 3
 x25 pvc 3 tunnel 172.30.128.248 interface Serial 1/0 pvc 1 windowsize 3 3
 x25 pvc 4 tunnel 172.30.136.248 interface Serial 1/0 pvc 1 windowsize 3 3
! The clock rate is set to 56000 baud, to supply clock signaling to the DTE device.
 clockrate 56000
```

Cisco 3662 Edge Router Connected to the Lucent 5ESS Telephone Switch: Example

The following partial example shows the configuration for a Cisco 3662 edge router located in the central office. The router connects to the Lucent 5ESS telephone switch using BX.25.

```
x25 routing
!
interface Ethernet0/0

 description AMA Billing
 ip address 172.30.109.48 255.255.255.192
 no ip directed-broadcast
!
interface Serial1/0
 description AMA Billing 5ESS Lucent
 no ip address
 no ip directed-broadcast
! X.25 DTE encapsulation.
encapsulation x25
 no ip mroute-cache
! The low two-way channel VC number is 5, making the PVC range 1 through 4.
 x25 ltc 5
! The input and output window size is changed from the default of 2 to 7.
 x25 win 7
 x25 wout 7
! The maximum input and output packet size is changed from the default of 128 to 512.
 x25 ips 512
 x25 ops 512
! The system default is to force X.25 packet-level restarts when the link level resets.
! The no x25 linkrestart command disables this function.
 no x25 linkrestart
! PVC 1 from the Lucent 5ESS telephone switch is mapped to PVC 1 at serial interface 3/0.
! X.25 input and output window sizes of 3 were specified for this interface.
 x25 pvc 1 xot 172.31.229.247 interface Serial 3/0 pvc 1 xot-promiscuous window size 3 3
! The clock rate is set to 19200 baud, to supply clock signaling to the DTE device.
 clockrate 56000
```

Sterling 5000 Collector Polling a Siemens EWSD Telephone Switch: Example

The following example shows how to configure XOT in a DCN that uses a Sterling 5000 Collector to poll a Siemens EWSD telephone switch, as shown in Figure 8.

Figure 8   *Sterling 5000 Collector Polling a Siemens EWDS Telephone Switch*
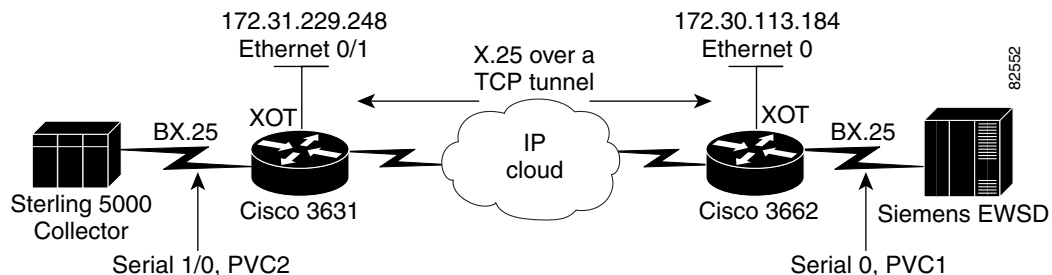
Cisco 3631 Edge Router Connected to the Sterling 5000 Collector (Polling Siemens EWSD Switch): Example

The following partial example shows the configuration for a Cisco 3631 edge router connected to a Sterling 5000 Collector that polls a Siemens EWSD telephone switch for billing data. See the examples for the Lucent 5ESS switch for configuration notes.

```
x25 routing
!
interface Ethernet0/1
 description
 ip address 172.31.229.248 255.255.255.0
 no logging event subif-link-status
!
interface Ethernet0/2
 no ip address
 no logging event subif-link-status
 shutdown
!
interface Ethernet0/3
 no ip address
 no logging event subif-link-status
 shutdown
!
interface Serial1/0
 description AMA Billing FE56
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 no logging event subif-link-status
 x25 ltc 5
 x25 win 7
 x25 wout 7
 x25 ips 512
 x25 ops 512
 x25 pvc 1 tunnel 172.30.108.48 interface Serial 0 pvc 1 windowsize 3 3
 x25 pvc 2 tunnel 172.30.113.184 interface Serial 0 pvc 1 windowsize 3 3
 x25 pvc 3 tunnel 172.30.130.248 interface Serial 1/0 pvc 1 windowsize 3 3
 x25 pvc 4 tunnel 172.30.114.248 interface Serial 0 pvc 1 windowsize 3 3
 clockrate 56000
```

Cisco 3662 Edge Router Connected to the Siemens EWSD Telephone Switch: Example

The following partial example shows the configuration for a Cisco 3662 edge router located in the central office (also referred to as the CO). The router connects to the Siemens EWSD telephone switch using BX.25. See the examples for the Lucent 5ESS switch for configuration notes.

```
x25 routing
!
interface Ethernet0
 description
 ip address 172.30.113.184 255.255.255.192
 no mop enabled
!
interface Serial0
 description AMA Billing Siemens EWSD
 no ip address
 encapsulation x25
 no ip mroute-cache
 x25 ltc 5
 x25 win 7
 x25 wout 7
 x25 ips 512
 x25 ops 512
 no x25 linkrestart
 x25 pvc 1 tunnel 172.31.229.248 interface Serial 1/0 pvc 2 windowsize 3 3
 clockrate 19200
!
```
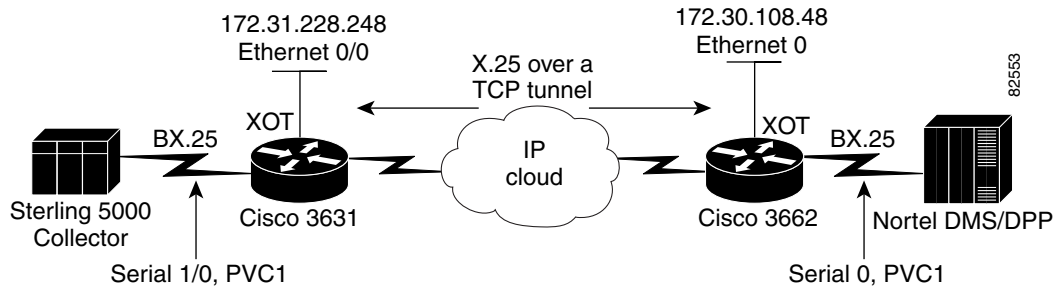
Sterling 5000 Collector Polling a Nortel DMS/DPP Telephone Switch: Example

This example shows how to configure XOT in a DCN that uses a Sterling 5000 Collector to poll a Nortel DMS/DPP telephone switch. The edge routers (the Cisco 3631 and Cisco 3662 routers in Figure 9) encapsulate the BX.25 packets.

Figure 9   Sterling 5000 Collector Polling a Nortel DMS/DPP Telephone Switch

Cisco 3631 Edge Router Connected to the Sterling 5000 Collector (Polling Nortel DMS/DPP Switch)

The following partial example shows the configuration for a Cisco 3631 edge router connected to a Sterling 5000 Collector that polls a Nortel DMS/DPP telephone switch for billing data. See the examples for the Lucent 5ESS switch for configuration notes.

```
x25 routing
!
interface Ethernet0/0
 description to Nortel DMS/DPP Port
 ip address 172.31.228.248 255.255.255.0
 no logging event subif-link-status
!
interface Serial1/0
 description AMA Billing FE56
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 no logging event subif-link-status
 x25 ltc 5
 x25 win 7
 x25 wout 7
 x25 ips 512
 x25 ops 512
 x25 pvc 1 tunnel 172.30.108.48 interface Serial 0 pvc 1 windowsize 3 3
 x25 pvc 3 tunnel 172.30.130.248 interface Serial 1/0 pvc 1 windowsize 3 3
 x25 pvc 4 tunnel 172.30.114.248 interface Serial 0 pvc 1 windowsize 3 3
 clockrate 56000
!
```

Cisco 3662 Edge Router Connected to the Nortel DMS/DPP Telephone Switch: Example

The following partial example shows the configuration for a Cisco 3662 edge router located in the central office. The router connects to the Nortel DMS/DPP telephone switch using BX.25. See the examples for the Lucent 5ESS switch for configuration notes.

```
x25 routing
!
interface Ethernet0
 description - to DCN Bay RR  261.6 Hub
 ip address 172.30.108.48 255.255.255.192
 no ip redirects
```

```
 no mop enabled
!
interface Serial0
 description AMA Billing DPP Nortel
 no ip address
 encapsulation x25
 no ip mroute-cache
 x25 ltc 2
 x25 win 7
 x25 wout 7
 x25 ips 512
 x25 ops 512
 x25 pvc 1 tunnel 172.31.228.248 interface Serial 1/0 pvc 1 windowsize 3 3
 clockrate 56000
```

Configuring a Cisco Router for a Host That Supports XOT

Examples in earlier sections about the Sterling 5000 Collector described methods to create Cisco XOT tunnels with routers at both ends of the network. Another method is to have the OSS support XOT directly on the host. Kansys, Inc. has implemented the SVC portion of XOT in its Mercury Mediation device (see Figure 10).

Figure 10   Kansys CDR Bill Collection Application with XOT on the Host
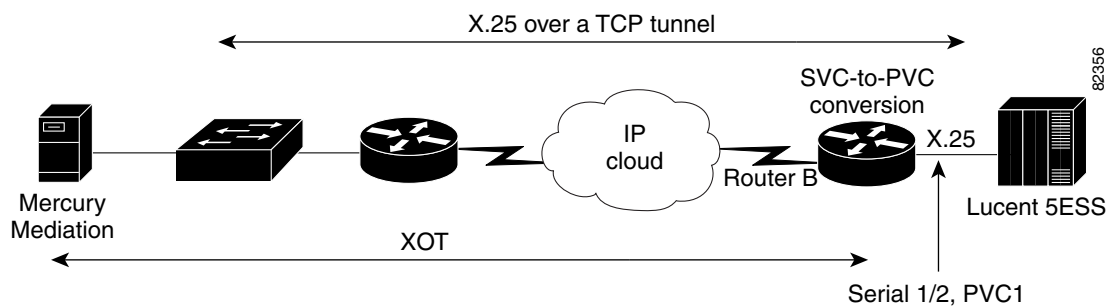
The host makes an X.25 SVC call to the router connected to the Lucent 5ESS telephone switch. The X.25 call is encapsulated in an XOT packet. The TCP/IP session is terminated on the router and the X.25 packet is removed. The X.25 SVC is terminated by the router and converted to a PVC.

To configure a Cisco router to support a bill collector host that supports XOT, see Figure 10 and perform the following steps. See the "Mercury Mediation Bill Collector That Supports XOT: Example" section on page 21 for a configuration example. See the "Verifying the SVC Connection on the Mercury Mediation Device" section on page 21 for a verification example.

Step 1   Verify that you are running Cisco IOS Release 12.1(16) or a later software release that supports telco DCN functions:

```
Router-B# show version
```

Step 2   Enter configuration mode:

```
Router-B# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3   Enable X.25 routing:

```
Router-B(config)# x25 routing
```

Step 4   Start interface configuration mode for serial interface 1/2, which specifies network module 1, port 2:

```
Router-B(config)# interface serial 1/2
```

Step 5   Shut down the interface:

```
Router-B(config-if)# shutdown
```

Step 6   Enter a description for the serial interface:

```
Router-B(config-if)# description AMA connection to Lucent 5ESS switch
```

Step 7   Configure the address for the X.25 serial interface:

```
Router-B(config-if)# x25 address 5555550137
```

Step 8   Configure X.25 DCE encapsulation on the serial interface:

```
Router-B(config-if)# encapsulation x25 dce
```

Step 9   Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 3:

```
Router-B(config-if)# x25 win 3
```

Step 10   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 3:

```
Router-B(config-if)# x25 wout 3
```

Step 11   Change the maximum input X.25 packet size from the default of 128 to 512:

```
Router-B(config-if)# x25 ips 512
```

Step 12   Change the maximum output X.25 packet size from the default of 128 to 512:

```
Router-B(config-if)# x25 ops 512
```

Step 13   The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 56000 baud:

```
Router-B(config-if)# clockrate 56000
```

Step 14   The LAPB N1 parameter sets the maximum bits per frame. Set this timer to 4152:

```
Router-B(config-if)# lapb N1 4152
```

Step 15   The X.25 SVC call to destination 5555550137 is converted to PVC 1. The call must be from address 5555550140. Specify the PVC-to-SVC conversion, an X.25 packet size of 512, and input and output window sizes of 3:

```
Router-B(config-if)# x25 pvc 1 svc 5555550140 packetsize 512 512 windowsize 3 3
```

Step 16   Enable monitoring of the LL pin for DCE mode:

```
Router-B(config-if)# no ignore-hw local-loopback
```

Step 17   Disable fast switching of IP multicast:

```
Router-B(config-if)# no ip mroute-cache
```

Step 18   Disable IP addressing:

```
Router-B(config-if)# no ip address
```

Step 19   Restart the interface:

```
Router-B(config-if)# no shutdown
```

Step 20   Exit interface configuration mode:

```
Router-B(config-if)# end
```

Step 21   Create an entry in the X.25 routing table to map incoming X.25 calls with the destination address 5555550137 to serial interface 1/2:

```
Router-B(config)# x25 route 5555550137 interface serial 1/2
```

Step 22   Create an entry in the X.25 routing table to map an outgoing call from the Lucent 5ESS telephone switch to the host application. The X.121 destination address of the host is 5555550140:

```
Router-B(config)# x25 route 5555550140 xot 192.168.3.20
```

Step 23   Exit global configuration mode:

```
Router-B(config)# end
```

Step 24   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-B# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Mercury Mediation Bill Collector That Supports XOT: Example

The following example shows how to configure a network with a Mercury Mediation bill collector that supports XOT. The Mercury Mediation device is polling a Lucent 5ESS telephone switch. The example configures the router connected to the Lucent 5ESS, which is identified as Router B in Figure 10.

```
interface Serial1/2
 description AMA connection to Lucent 5ESS switch
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 x25 address 5555550137
 x25 win 3
 x25 wout 3
 x25 ips 512
 x25 ops 512
 x25 pvc 1 svc 5555550140 packetsize 512 512 windowsize 3 3
 no ignore-hw local-loopback
 clockrate 56000
 lapb N1 4152
!
x25 route 5555550137 interface Serial1/2
x25 route 5555550140 xot 192.168.3.20
```

Verifying the SVC Connection on the Mercury Mediation Device

It is important that it be the Mercury Mediation device that places the X.25 SVC call to the router interface. The router terminates the SVC call and converts the SVC to a PVC. The X.25 address assigned to serial interface 1/2 (5555550137) must match the destination address of the X.25 call placed by the Mercury Mediation device. The source address of the call (5555550140) must match the X.121 address assigned to the command, to convert between PVC and SVC. Use the **show x25 vc** EXEC command to verify the correct configuration.

The following example output shows that the application with X.121 address 5555550140 is connected to router serial interface 1/2 with X.121 address 5555550137:

```
Router-B # show x25 vc

PVC 1,  State: D1,  Interface: Serial1/2
  Started 01:13:53, last input 00:00:06, output 00:00:06
  Connects 5555550140 <--> 5555550137 from
  XOT between 10.129.48.4, 1998 and 192.168.3.20, 1833
  Window size input: 3, output: 3
  Packet size input: 512, output: 512
  PS: 0  PR: 1  ACK: 1  Remote PR: 0  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 293/153757 packets 32/313 Resets 4/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [192.168.3.20,1833/10.129.48.4,1998]
  Started 00:00:44, last input 00:00:06, output 00:00:06
  Connects 5555550140 <--> 5555550137 from Serial1/2 PVC 1
  Window size input: 3, output: 3
  Packet size input: 512, output: 512
  PS: 1  PR: 0  ACK: 0  Remote PR: 1  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 153651/179 packets 305/24 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

Cisco RBP and RBP Q-Bit Features for Transporting CDR Data

The previous sections described how to collect CDRs using XOT. This section describes how to configure a Cisco router for a CDR host that supports RBP and RBP Q-bit.

The Cisco RBP Feature

Cisco implemented the RBP feature to help the migration of the OSSs to TCP/IP. The RBP feature is a six-byte header inserted at the beginning of the TCP data field that allows the router to pass the end-of-record information between BX.25 and TCP sessions. More information on RBP can be found in the "Adding Cisco X.25 RBP to the Telco DCN Provisioning Connection" section on page 82 and in the *X.25 Record Boundary Preservation for Data Communications Networks* feature module located at this URL:
http://www.cisco.com/en/US/products/ps6350/products_configuration_guide_chapter09186a008045552b.html

The Cisco RBP feature marks the end of record in a TCP session. In the ITU-T Recommendation X.25 standards, the end of record is marked with a more data bit (M-bit). The RBP solution is a six-byte header inserted at the front of the TCP data field that allows the router to pass the end of record information between the BX.25 and the TCP sessions. More information on RBP can be found in the "Adding Cisco X.25 RBP to the Telco DCN Provisioning Connection" section on page 82 and in the *X.25 Record Boundary Preservation for Data Communications Networks* feature module.

The Cisco RBP Q-Bit Feature

The RBP Q-Bit feature offered in Cisco IOS Release 12.4(15)T and later releases downloads Call Detail Records (CDRs) from Class 5 switches. In releases prior to Cisco IOS Release 12.4(15)T, the end of record was lost when mediating between an X.25 transport and a TCP/IP transport. In the ITU-T Recommendation X.25 standards, the end of record is marked with a more data bit (M-bit). RBP was developed to maintain the end of record in a TCP connection for migrating traditional applications

connecting to a Class 5 telephone switch from an X.25 transport to a TCP/IP transport. RBP enables hosts using TCP/IP-based protocols to exchange data with devices that use the X.25 protocol, retaining the logical record boundaries indicated by use of the X.25 M-bit.

RBP and RBP Q-Bit File Type Compatibility

The original RBP feature works with the file types of XFER, Bellcore 385 (BC385) and GEC-Plessey Telecommunications (GPT); however, the file types MNP and MTP are not supported because these protocols require the X.25 M-bit and Q-bit. The Q-bit in an X.25 frame differentiates control frames from data frames. MNP and MTP use control frames in the Call Detail Record transfer. The enhanced RBP Q-bit solution identifies control frames and data frames in the RBP six-byte header.

Cisco has worked with Intec Telecom Systems to implement the RBP Q-bit solution on their Inter-mediatE application. The Inter-mediatE application supports the collections of CDRs using the following file types:

- Bellcore 385 AMATPS
- Nortel XFER
- MNP
- MTP

A key point is that the Bellcore 385 AMATPS file type and the Nortel XFER file type require only end of record or M-bit support. See the "Configuring an Intec Telecom Systems Inter-mediatE System" section on page 35 for more information about configuring the Inter-mediatE application.

Configuring a Cisco Router for a CDR Host That Supports the RBP Feature

The RBP solution implements TCP/IP from the Inter-mediatE host to an access router in the central office. Figure 11 shows a network with RBP configured on a Lucent 5ESS. RBP is transporting Bellcore 385 AMATPS-formatted data.

Figure 11   **Call Detail Record Collection Using RBP Session over TCP/IP**
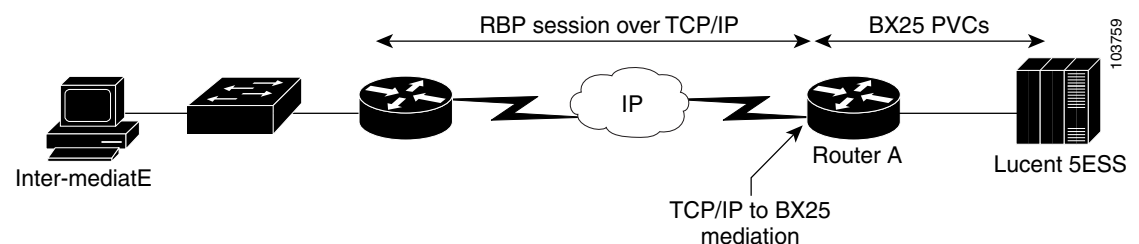
A serial connection from the access router to the Lucent 5ESS switch must be configured for LAPB at Layer 2 and BX.25 at Layer 3. The BX.25 standard specifies an additional I-Frame at the LAPB layer. The additional I-Frame supports a clear text password, which must be turned off. The I-Frame is described in the "The BX.25 Security I-Frame" section on page 8."

To configure the serial ports on the Cisco router to make the connections between the access router and the Lucent 5ESS switch, refer to Figure 11 and perform the following steps. See the "Cisco X.25 RBP with the Inter-mediatE to a Lucent 5ESS Switch: Example" section on page 25 and "Cisco X.25 RBP with the Inter-mediatE to a Nortel DMS 100 Switch: Example" section on page 25 for configuration examples.

Step 1 Verify that you are running Cisco IOS Release 12.2(8)T or later software that supports telco DCN functions and the Cisco X.25 RBP feature:

```
Router-A# show version
```

Step 2 Enter global configuration mode:

```
Router-A# configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3 Configure the loopback interface:

```
Router-A(config)# interface Loopback0
Router-A(config-if)# ip address 10.60.128.8 255.255.255.255
Router-A(config-if)# end
```

Step 4 Enable X.25 routing:

```
Router-A(config)# x25 routing
```

Step 5 Select the serial interface that is connected to the Billing port on the Lucent 5ESS. In the example, serial interface 1/0 is used, which specifies network module 1, port 0:

```
Router-A(config)# interface serial 1/0
```

Step 6 Shut down the interface:

```
Router-A(config-if)# shutdown
```

Step 7 Supply a description for the serial interface:

```
Router-A(config-if)# description Collection of Call Detail Records port
```

Step 8 Configure X.25 DCE encapsulation on the serial interface:

```
Router-A(config-if)# encapsulation x25 dce
```

Step 9 Set the lowest outgoing channel to 4:

```
Router-A(config-if)# x25 loc 4
```

Step 10 Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when the router is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-A(config-if)# x25 threshold 1
```

Step 11 Change the maximum input packet size from the default of 128 to 512:

```
Router-A(config-if)# x25 ips 512
```

Step 12 Change the maximum output packet size from the default of 128 to 512:

```
Router-A(config-if)# x25 ops 512
```

Step 13 Enable the RBP feature on the router. The Inter-mediatE application requires one PVC. The PVC range is from 1 through 3. Because the low two-way channel was set to 4 with the **x25 loc 4** command in an earlier step, PVC 1 is mapped to TCP port 10000. The TCP port was chosen arbitrarily:

```
Router-A(config-if)# x25 pvc 1 rbp local port 10000
```

Step 14 The router is functioning as a DCE device. The DCE must supply clock signaling to the DTE device, which is the billing port on the switch. Set the clock rate to 56000 baud:

```
Router-A(config-if)# clockrate 56000
```

Step 15 Restart the interface:

```
Router-A(config-if)# no shutdown
```

Step 16 Exit the interface and global configuration modes:

```
Router-A(config-if)# end
Router-A(config)# end
```

Step 17 Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-A# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco X.25 RBP with the Inter-mediatE to a Lucent 5ESS Switch: Example

The following example shows how to configure RBP on the serial interface that will connect to the Lucent 5ESS switch:

```
interface Serial1/0
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 x25 ltc 4
 x25 ips 512
 x25 ops 512
 x25 pvc 1 rbp local port 10000
 clockrate 56000
```

Cisco X.25 RBP with the Inter-mediatE to a Nortel DMS 100 Switch: Example

The Inter-mediatE host can be configured to use Nortel's XFER protocol for collecting the call detail records from a DMS 100 switch. You can also use RBP with the XFER protocol. The following example shows how to configure RBP on the serial interface that will connect to the Nortel DMS 100 switch:

```
interface Serial1/0
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 x25 ltc 4
 x25 ips 512
 x25 ops 512
 x25 pvc 1 rbp local port 10000
 x25 map rbp 00006300 cud 0xB0 local port 20000
 clockrate 56000
```

Configuring the Cisco X.25 RBP Q-Bit Feature for the MTP File Type

The Inter-mediatE host can be configured to use MTP file types for collecting the call detail records from a Class 5 switch. MTP is typically used with the collection of call records from the following switch types:

- Ericsson AXE-10

- Ericsson AXE-10 International
- Global System for Mobile Telecommunications mobile switching center (MSC GSM)

The configuration shown in Figure 12 is a test setup for MTP file type retrieval. The Cisco 2651XMBR5 router is connected to the network with the Fast Ethernet interface 0/0. The Inter-mediatE application is connected to the network with a TCP/IP connection over Ethernet. The Inter-mediatE application will connect via a TCP/IP session to the Cisco 2651XMB router.

Figure 12   *TCP/IP-to-X.25 Mediation: MTP File Type Retrieval*
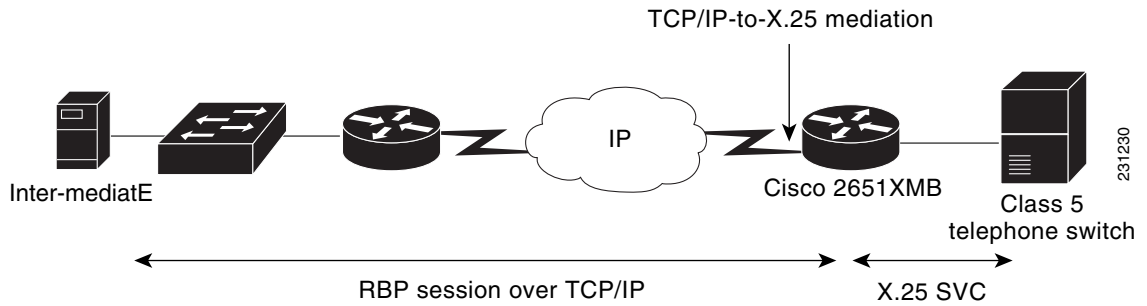
To configure the serial ports on the Cisco router to make the connections between the access router and the Class 5 switch, refer to Figure 12 and perform the following steps. See the "Cisco X.25 RBP Q-Bit Feature with the Inter-mediatE to a Class 5 Switch with MTP File Type: Example" section on page 27 for a configuration example. See the "Debugging Cisco X.25 RBP" section on page 30 for debugging examples.

Step 1   Verify that you are running Cisco IOS Release 12.4(15)T or later software that supports telco DCN functions and the Cisco X.25 RBP feature:

```
Router-A# show version
```

Step 2   Enter global configuration mode:

```
Router-A# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3   Configure the loopback interface:

```
Router-A(config)# interface Loopback0
Router-A(config-if)# ip address 10.60.128.8 255.255.255.255
Router-A(config-if)# end
```

Step 4   Enable X.25 routing:

```
Router-A(config)# x25 routing
```

Step 5   Select the serial interface that is connected to the billing port on the Lucent 5ESS. In the example, serial interface 1/0 is used, which specifies network module 1, port 0:

```
Router-A(config)# interface serial 1/0
```

Step 6   Shut down the interface:

```
Router-A(config-if)# shutdown
```

Step 7   Supply a description for the serial interface:

```
Router-A(config-if)# description Collection of Call Detail Records port
```

Step 8 Configure X.25 DCE encapsulation on the serial interface:

```
Router-A(config-if)# encapsulation x25 dce
```

Step 9 Set the lowest outgoing channel to 4:

```
Router-A(config-if)# x25 loc 4
```

Step 10 Enable the RBP feature on the router. The Inter-mediatE application requires one SVC. The PVC range is from 1 to 3 because the low two-way channel was set to 4 with the **x25 loc 4** command in an earlier step. The SVC range is from 4 to 1024. The router will be calling a destination X.121 address of 3178650503. A calling address is not assigned on this serial interface, so the source address is 0. TCP port 30010 was chosen arbitrarily. The **q-bit** keyword was added to the command, to identify that the header will support the Q-bit:

```
Router-A(config-if)# x25 map rbp 3178650503 local port 30010 q-bit
```

Step 11 The router is functioning as a DCE device. The DCE must supply clock signaling to the DTE device, which is the billing port on the switch. Set the clock rate to 56000 baud:

```
Router-A(config-if)# clockrate 56000
```

Step 12 Restart the interface:

```
Router-A(config-if)# no shutdown
```

Step 13 Exit the interface and global configuration modes:

```
Router-A(config-if)# end
Router-A(config)# end
```

Step 14 Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-A# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco X.25 RBP Q-Bit Feature with the Inter-mediatE to a Class 5 Switch with MTP File Type: Example

The following example shows how to configure RBP and the new Q-bit keyword on the serial interface that will connect to the Class 5 switch. shows the physical configuration.

```
interface Serial0/1
 description X.25 RBP+Q Inter-mediatE
 no ip address
 encapsulation x25 dce
 x25 ltc 4
 x25 map rbp 3178650503 local port 30010 q-bit
 clock rate 56000
```

Configuring the Cisco X.25 RBP Q-Bit Feature for the MNP File Type

The Inter-mediatE host can be configured to use the MNP file for collecting the call detail records from a Class 5 switch. MNP is typically used with the collection of call records from the Nortel MTX, Nortel DMS300, and Nortel DMS 500 switch types. The configuration shown in Figure 13 is a test setup for MNP file type retrieval.

Figure 13 TCP/IP-to-X.25 Mediation: MNP File Type Retrieval
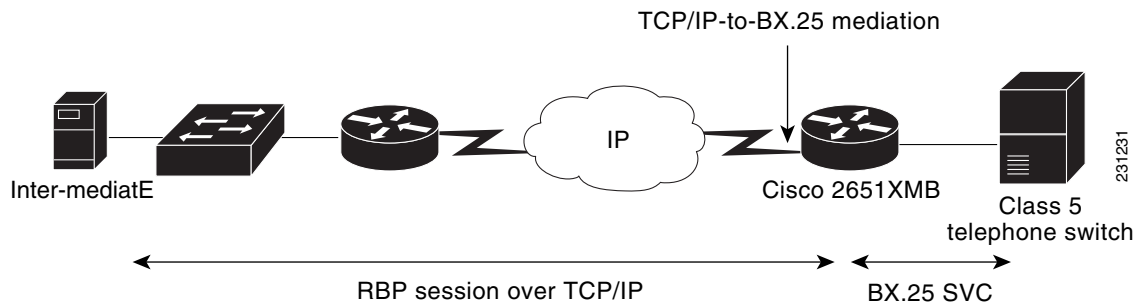
To configure the serial ports on the Cisco router to make the connections between the access router and the Class 5 switch, refer to Figure 13 and perform the following steps. See the "Cisco X.25 RBP Q-Bit Feature with the Inter-mediatE to a Class 5 Switch with MNP File Type: Example" section on page 29 for a configuration example. See the "Debugging Cisco X.25 RBP" section on page 30 for debugging examples.

Step 1 Verify that you are running Cisco IOS Release 12.4(15)T or later software that supports telco DCN functions and the Cisco X.25 RBP feature:

```
Router-A# show version
```

Step 2 Enter global configuration mode:

```
Router-A# configure terminal

Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3 Configure the loopback interface:

```
Router-A(config)# interface Loopback0
Router-A(config-if)# ip address 10.60.128.8 255.255.255.255
Router-A(config-if)# end
```

Step 4 Enable X.25 routing:

```
Router-A(config)# x25 routing
```

Step 5 Select the serial interface that is connected to the billing port on the Lucent 5ESS. In the example, serial interface 1/0 is used, which specifies network module 1, port 0:

```
Router-A(config)# interface serial 1/0
```

Step 6 Shut down the interface:

```
Router-A(config-if)# shutdown
```

Step 7 Supply a description for the serial interface:

```
Router-A(config-if)# description Collection of Call Detail Records port
```

Step 8   Configure X.25 DCE encapsulation on the serial interface:

```
Router-A(config-if)# encapsulation x25 dce
```

Step 9   Set the lowest outgoing channel to 4:

```
Router-A(config-if)# x25 loc 4
```

Step 10   Enable the RBP feature on the router. The Inter-mediatE application requires one SVC. The PVC range is from 1 to 3 because the low two-way channel was set to 4 with the **x25 loc 4** command in an earlier step. The SVC range is from 4 to 1024. The router will be calling a destination X.121 address of 3178650503. A calling address is not assigned on this serial interface, so the source address is 0. TCP port 30010 was chosen arbitrarily. The **q-bit** keyword was added to identify that the header will support the Q-bit:

```
Router-A(config-if)# x25 map rbp 3178650503 local port 30010 q-bit
```

Step 11   The router is functioning as a DCE device. The DCE must supply clock signaling to the DTE device, which is the billing port on the switch. Set the clock rate to 56000 baud:

```
Router-A(config-if)# clockrate 56000
```

Step 12   Restart the interface:

```
Router-A(config-if)# no shutdown
```

Step 13   Exit the interface and global configuration modes:

```
Router-A(config-if)# end
Router-A(config)# end
```

Step 14   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-A# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco X.25 RBP Q-Bit Feature with the Inter-mediatE to a Class 5 Switch with MNP File Type: Example

The following example shows a router configuration for RBP with the new Q-bit option on the serial interface that will connect to the Class 5 switch. Figure 13 on page 28 shows the physical configuration.

```
interface Serial0/1
 description X.25 RBP+Q Inter-mediatE
 no ip address
 encapsulation x25 dce
 x25 ltc 4
 x25 map rbp 3178650503 local port 30010 q-bit
 clock rate 56000
!
```

Debugging Cisco X.25 RBP

This section contains the following procedures that are useful for debugging RBP:

- Debugging a TCP/IP Connection, page 30
- Debugging an X.25 Serial Connection, page 31
- Debugging the RBP Configuration, page 34

The debugging examples in this section are based on the previous configuration example. The test network is shown in Figure 13 on page 28.

> ⚠
> **Caution** Enabling debugging can severely degrade performance of the router. Cisco strongly recommends that debugging be done in a lab and not in a production network.

Debugging a TCP/IP Connection

As shown in the "Cisco X.25 RBP Q-Bit Feature with the Inter-mediatE to a Class 5 Switch with MNP File Type: Example" section on page 29 and Figure 13 on page 28, the Inter-mediatE host is configured to use the MTP file format for collecting the call detail records from a Class 5 switch. The Cisco 2651XMB router is configured with RBP and with the new Q-bit option on the serial interface that will connect to the Class 5 switch.

The following steps were performed in a lab environment and show different portions of the startup and teardown of a data transfer of the MTP file type between the Inter-mediatE application and the Class 5 switch. Not all of the data transfer output is shown, and the debugging output is pulled from various tests.

Step 1 If you are logged in remotely, enable monitoring of the debug output using the **terminal monitor** command:

```
2651XMB# terminal monitor
```

Step 2 Enter the **debug x25 all** command to enable all traffic debugging for X.25:

```
2651XMB# debug x25 all
X.25 packet debugging is on
```

Step 3 (Optional) To enable X.25 data display of the data in the X.25 packets, enter the **debug x25 dump** command:

```
2651XMB# debug x25 dump
X.25 packet debugging is on
X.25 packet dump debugging is on
```

Step 4 Enable the **debug ip packet** command to debug the TCP/IP connection between the Inter-mediatE application and the Cisco 2651XMB router:

```
2651XMB# debug ip packet

IP packet debugging is on
```

Tip An alternative to this step is to enable the **debug ip packet dump detail** command.

```
2651XMB# debug ip packet dump detail
IP packet debugging is on (detailed) (dump)
```

The following examples show a series of debug outputs.

Output 1: The following example lists the TCP connection to port 30010 from IP address 172.16.4.59 and port 51608.

```
Feb  7 07:27:07.628: X25 RBP: Incoming connection for port 30010 from 172.16.4.59 port
51608
```

Output 2: Example Output 1 showed the Inter-mediatE application making a TCP/IP connection to the Cisco 2651XMB router, which is mediated to X.25. In the following example, the Cisco 2651XMB router is making an outbound X.25 call on serial interface 1/0 LCI 4 to destination X.121 address 317650503 from source X.121 address 0. The source address is 0 because no X.121 address was assigned to serial interface 0/1. You can verify that this was outbound data by the "X.25 O" string in the debug; the bold O indicates outbound.

```
Feb  7 07:27:07.628: X25 RBP: Incoming connection for port 30010 from 158.155.4.59 port
51608
Feb  7 07:27:07.632: Serial0/1: X.25 O R1 Call (11) 8 lci 4
Feb  7 07:27:07.632:   From (0):  To (10): 3178650503
Feb  7 07:27:07.632:   Facilities: (0)
Feb  7 07:27:07.632:   Call User Data (1): 0xC0 (unknown)
     0:               10040B0A 31786505         ....1xe.
     8: 0300C0                                  ..@
```

Output 3: The router is receiving an inbound X.25 call confirm on serial interface 1/0 LCI 4. You can verify that this is inbound data by the "X.25 I" string in the debug; the bold I indicates inbound.

```
Feb  7 07:27:07.640: Serial0/1: X.25 I R1 Call Confirm (3) 8 lci 4
     0:           10040F                    ...
```

Step 5 Disable all **debug** commands when you are done.

Debugging an X.25 Serial Connection

Cisco IOS offers the **debug x25** command with various options. Typically, you enable all the options, with the exception of data display, to debug an X.25 application.

Step 1 If you are logged in remotely, enable monitoring of the debug output using the **terminal monitor** command:

```
2651XMB# terminal monitor
```

Step 2 Enter the **debug x25 all** command to enable all traffic debugging for X.25:

```
2651XMB# debug x25 all
X.25 packet debugging is on
```

Step 3 (Optional) To enable X.25 data display of the data in the X.25 packets, enter the **debug x25 dump** command:

```
2651XMB# debug x25 dump
X.25 packet debugging is on
```

```
X.25 packet dump debugging is on
```

The following examples show a series of debug output with only X.25 debugging enabled on serial interface 0/1 on the Cisco 2651XMB router.

Output 1: The report shows an inbound call (I, highlighted in bold text) from the Class 5 switch to the router on LCI 11.

```
*May 24 05:16:06.884: Serial0/1: X.25 I R1 Call (14) 8 lci 11
*May 24 05:16:06.884:   From (10): 3178650503 To (0):
*May 24 05:16:06.884:   Facilities: (0)
*May 24 05:16:06.884:   Call User Data (4): 0xC0000000 (unknown)
       0:           100B0B A0317865 050300C0      ... 1xe...@
      11: 000000                                  ...
```

Output 2: The router sends a call confirm outbound (O, highlighted in bold text) on LCI 11.

```
*May 24 05:16:06.888: Serial0/1: X.25 O R1 Call Confirm (5) 8 lci 11
*May 24 05:16:06.888:   From (0):  To (0):
*May 24 05:16:06.888:   Facilities: (0)
       0:               100B0F00 00               .....
```

Output 3: The Class 5 switch is sending a packet inbound with the Q-bit set.

```
*May 24 05:16:07.658: Serial0/1: X.25 I D1 Data (38) Q 8 lci 11 PS 0 PR 0
       0:           900B00 03650054 5446494C      ....e.TTFIL
      11: 452D3030 30310000 00000000 00000000  E-0001..........
      27: 00000000 00000000 000000             ...........
*May 24 05:16:07.658: X25 RBP: Q-bit received in X25 data packet
```

Output 4: The Inter-mediatE application has sent a TCP/IP packet to the router. TCP/IP debugging is disabled, so you do not see the packet.

```
*May 24 05:16:11.079: X25 RBP: Q-bit received in RBP record
```

Output 5: The router mediated the TCP/IP packet to X.25 and sent it to the Class 5 switch.

```
*May 24 05:16:11.079: Serial0/1: X.25 O D1 Data (5) Q 8 lci 11 PS 0 PR 1
       0:           900B20 0081                   .. ..
```

Out put 6: A data packet is received from the class 5 switch.

```
*May 24 05:16:11.600: Serial0/1: X.25 I D1 RR (3) 8 lci 11 PR 1
       0:           100B21                        ..!
```

Output 7: An X.25 packet is received from the Class 5 switch with the Q-bit set.

```
*May 24 05:16:12.109: Serial0/1: X.25 I D1 Data (5) Q 8 lci 11 PS 1 PR 1
       0:           900B22 00A2                   .."."
*May 24 05:16:12.109: X25 RBP: Q-bit received in X25 data packet
```

Output 8: The Inter-mediatE application has sent a TCP/IP packet to the router. TCP/IP debugging is disabled, so you do not see the packet.

```
*May 24 05:16:15.935: X25 RBP: Q-bit received in RBP record
```

Output 9: The router mediated the TCP/IP packet to X.25 and sends it out the interface to the Class 5 switch.

```
*May 24 05:16:15.939: Serial0/1: X.25 O D1 Data (6) Q 8 lci 11 PS 1 PR 2
       0:           900B42 00A306                 ..B.#.
```

Output 10: An X.25 packet is sent from the Class 5 switch.

```
*May 24 05:16:16.740: Serial0/1: X.25 I D1 RR (3) 8 lci 11 PR 2
       0:           100B41                        ..A
```

Output 11: Another X.25 packet is sent from the Class 5 switch.

```
*May 24 05:16:17.269: Serial0/1: X.25 I D1 Data (131) 8 lci 11 M PS 2 PR 2
      0:            100B54 00000000 00000000        ..T........
     11: 00000000 00000000 00000000 00000000  ................
     27: 00000000 00000000 00000000 00000000  ................
     43: 00000000 00000000 00000000 00000000  ................
     59: 00000000 00000000 00000000 00000000  ................
     75: 00000000 00000000 00000000 00000000  ................
     91: 00000000 00000000 00000000 00000000  ................
    107: 00000000 00000000 00000000 00000000  ................
    123: 00000000 00000000                    ........
```

Output 12: Another X.25 packet sent from the Class 5 switch.

```
*May 24 05:16:17.289: Serial0/1: X.25 I D1 Data (131) 8 lci 11 M PS 3 PR 2
      0:            100B56 00000000 00000000        ..V........
     11: 00000000 00000000 00000000 00000000  ................
     27: 00000000 00000000 00000000 00000000  ................
     43: 00000000 00000000 00000000 00000000  ................
     59: 00000000 00000000 00000000 00000000  ................
     75: 00000000 00000000 00000000 00000000  ................
     91: 00000000 00000000 00000000 00000000  ................
    107: 00000000 00000000 00000000 00000000  ................
    123: 00000000 00000000                    ........
```

Output 13: Another X.25 packet sent to the Class 5 switch.

```
*May 24 05:16:17.293: Serial0/1: X.25 O D1 RR (3) 8 lci 11 PR 4
      0:                    100B81                      ...
```

Output 14: Another X.25 packet sent from the Class 5 switch.

```
*May 24 05:16:17.317: Serial0/1: X.25 I D1 Data (131) 8 lci 11 M PS 4 PR 2
      0:            100B58 00000000 00000000        ..X........
     11: 00000000 00000000 00000000 00000000  ................
     27: 00000000 00000000 00000000 00000000  ................
     43: 00000000 00000000 00000000 00000000  ................
     59: 00000000 00000000 00000000 00000000  ................
     75: 00000000 00000000 00000000 00000000  ................
     91: 00000000 00000000 00000000 00000000  ................
    107: 00000000 00000000 00000000 00000000  ................
    123: 00000000 00000000
```

Note   Not all of the file transfer data is displayed.

Output 15: The file transfer is complete and TCP session is terminated.

```
*May 24 05:16:31.649: [158.155.4.59,12500/158.155.4.100,43760]: TCP receive error, End of
data transfer
```

Output 16: The router terminates the RBP session.

```
*May 24 05:16:31.649: X25 RBP: End of data transfer
*May 24 05:16:31.653: Serial0/1: X.25 O R1 Clear (5) 8 lci 11
*May 24 05:16:31.653:   Cause 9, Diag 122 (Out of order/Maintenance action)
      0:                 100B1309 7A              ....z
```

Output 17: The Class 5 switch confirms the Clear of the SVC.

```
*May 24 05:16:31.889: Serial0/1: X.25 I P7 RR (3) 8 lci 11 PR 5
      0:            100BA1                        ..!
```

```
*May 24 05:16:31.889: Serial0/1: X.25 I R1 Clear Confirm (3) 8 lci 11
        0:              100B17                          ...
```

Step 4   Disable all commands when you are done.

Debugging the RBP Configuration

The following examples show the router configuration followed by the **debug x25 all** command output.

Router Configuration

```
interface FastEthernet0/0
 description SERVIDOR X25
 ip address 192.168.1.254 255.255.255.0
 no ip mroute-cache
 duplex auto
 speed auto
!
!
interface Serial0/1/0
 bandwidth 9
 no ip address
 encapsulation x25
 no ip mroute-cache
 x25 address 074610619
 x25 map rbp 098110661 remote host 192.168.1.100 port 10000
 no cdp enable
!
line vty 0 4
 privilege level 15
 password cisco
 no login
 transport input telnet ssh
 line vty 5 15
 privilege level 15
 login local
 transport input telnet ssh
!
```

debug x25 all Command

With the **debug x25 all** command enabled, you see the following reports when the X.25 call comes in:

Output 1: The call comes into the router. The I in the packet debug output identifies the packet is inbound to the router interface. The calling address is 09811066, which is the X.121 address on the Class 5 switch. The address called is 074610619, which is the address assigned to serial interface 0/1/0.

```
*Oct  2 10:35:32.935: Serial0/1/0: X.25 I R1 Call (18) 8 lci 1
*Oct  2 10:35:32.939:   From (9): 098110661 To (9): 074610619
*Oct  2 10:35:32.939:   Facilities: (0)
*Oct  2 10:35:32.939:   Call User Data (4): 0x01000000 (pad)
```

Output 2: The outgoing packet is identified by the O. The call is cleared by the router because of an invalid destination address. RBP is mediating between TCP/IP and X.25. The **x25 map** command is used to map an incoming TCP/IP session to X.25. There is not a RBP statement to map an incoming X.25 call to a TCP/IP session, so the router has no place to forward the packet and clears the call.

```
*Oct  2 10:35:32.939: Serial0/1/0: X.25 O R1 Clear (5) 8 lci 1
*Oct  2 10:35:32.939:   Cause 0, Diag 67 (DTE originated/Invalid destination address)
```

Output 3: The packet is inbound as identified by the I. The Clear Confirmed packet confirms the call has been cleared.

```
*Oct  2 10:35:32.975: Serial0/1/0: X.25 I R1 Clear Confirm (3) 8 lci 1
```

Configuring an Intec Telecom Systems Inter-mediatE System

Intec's Data Collection and Mediation Platform is called Inter-mediatE. All data enters the system through input data portals. The Portal Definition window examples in the following procedure are from Inter-mediatE's Customer Equipment Data Portal Definition Interface. In the following steps, you will configure the system that will collect call detail records using a data collection protocol (Bellcore 385 or AMATPS, or Nortel's XFER) built on top of RBP.

Configuration of a portal consists of defining the parameters provided by several tabs on the Portal Definition window.

To supply the values required for the Portal Definition, perform the following steps:

Step 1   The Portal tab is the first one on the left. If the Portal parameters are not displayed, click the Portal tab.

In the following example, the System Name is KFSTST and the Portal Name is RBP. The critical fields on this window are Plug-in and Business Logic Name (see Figure 14).

Figure 14   *Portal Window*
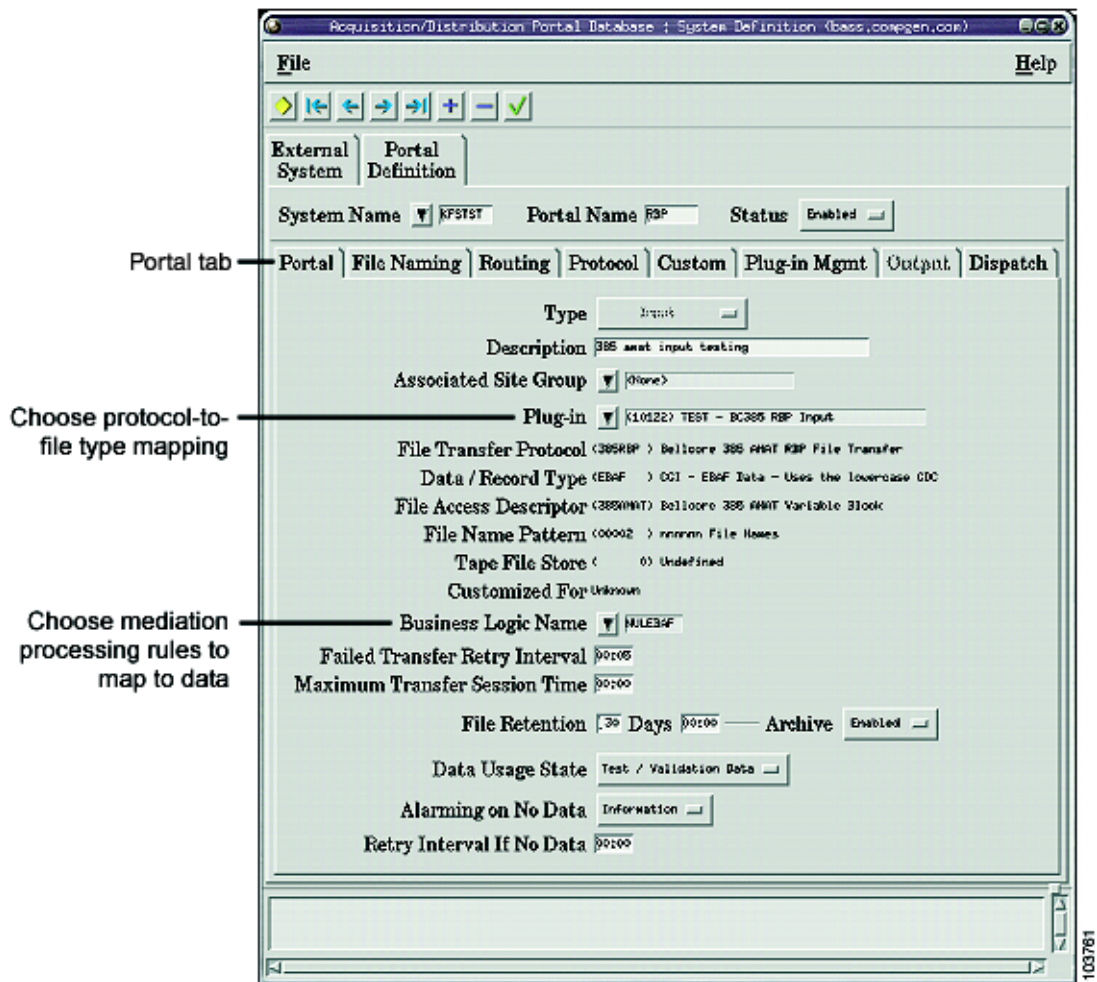
Step 2   Define the Plug-in to be a protocol-to-file type mapping that supports data collection using RBP. Choose a value from the drop-down menu.

Step 3   The Business Logic Name maps mediation processing rules to the data. Choose a value from the Business Logic Name drop-down menu for the system to collect.

Step 4   From the Portal window, click the File Naming tab. Use the File Naming window to choose file types (see Figure 15).

Figure 15 **File Naming Window**
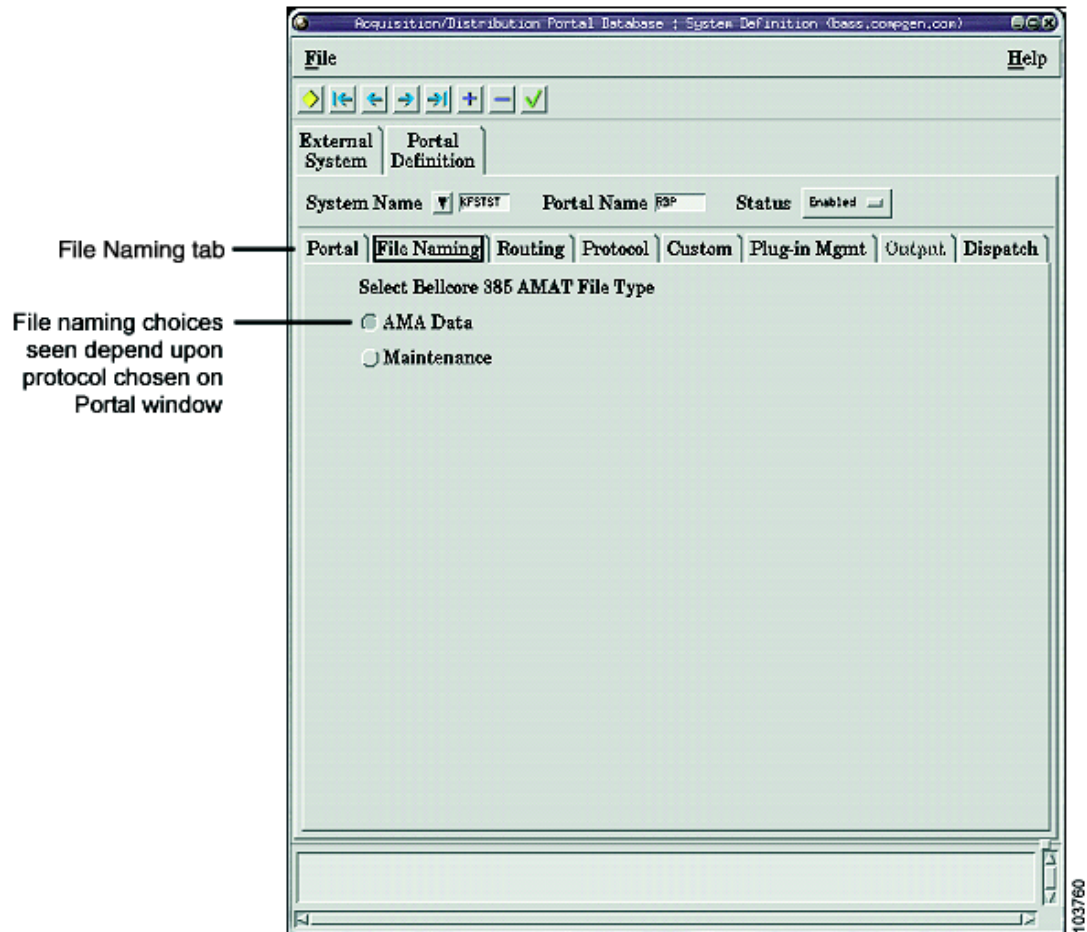
Choices displayed on the File Naming window depend upon the collection protocol chosen on the Portal window. In Figure 14, Bellcore 385 and RBP were chosen. Because Bellcore 385 supports several different file formats, there are two choices for these formats. If XFER had been chosen in the Portal window, the File Naming window would offer a choice of Nortel dirfile filename formats.

Step 5 From the File Naming window, click the Routing tab. Use the Routing window (see Figure 16) to enter the host name or IP address of the router and the TCP socket number that RBP is configured on.

Figure 16   *Routing Window*

Choices displayed on the Routing window depend upon the collection protocol chosen on the Portal window. In Figure 14, Bellcore 385 (AMATPS) and RBP were chosen, so parameters for configuring Bellcore 385 are entered here.

Step 6   In the Route1 tab, enter the host name or IP address of the router in the Host Name/Address field.

Step 7   In the Port Number field, enter the TCP socket port number that RBP is configured on.

The name in the Class Name field is only significant in that it must be available on the host. Refer to Inter-mediatE product documentation for more information. Typically, an Inter-mediatE host initiates the call.

Step 8   From the Routing window, click the Protocol tab. Use the Protocol window (see Figure 17) to define the protocols that ride on top of RBP.
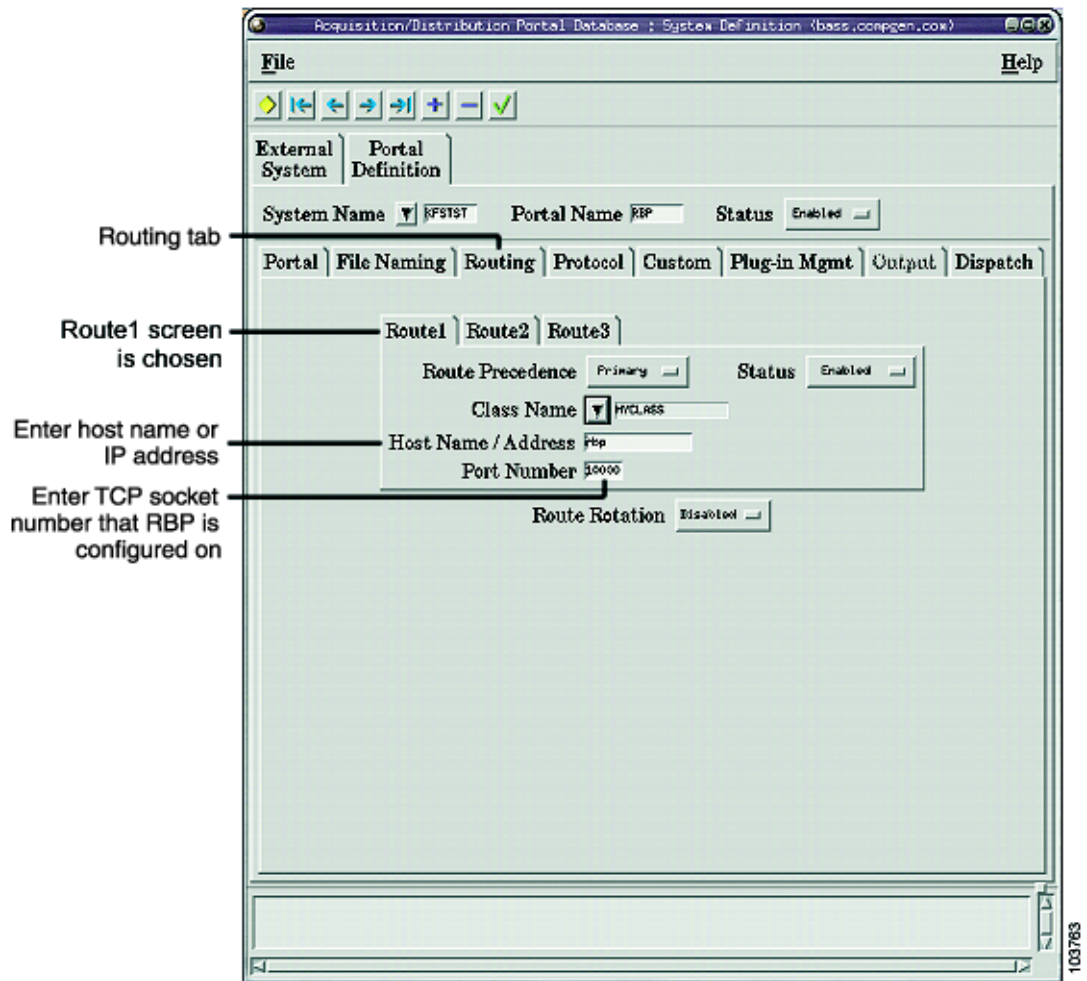
Figure 17 **Protocol Window**
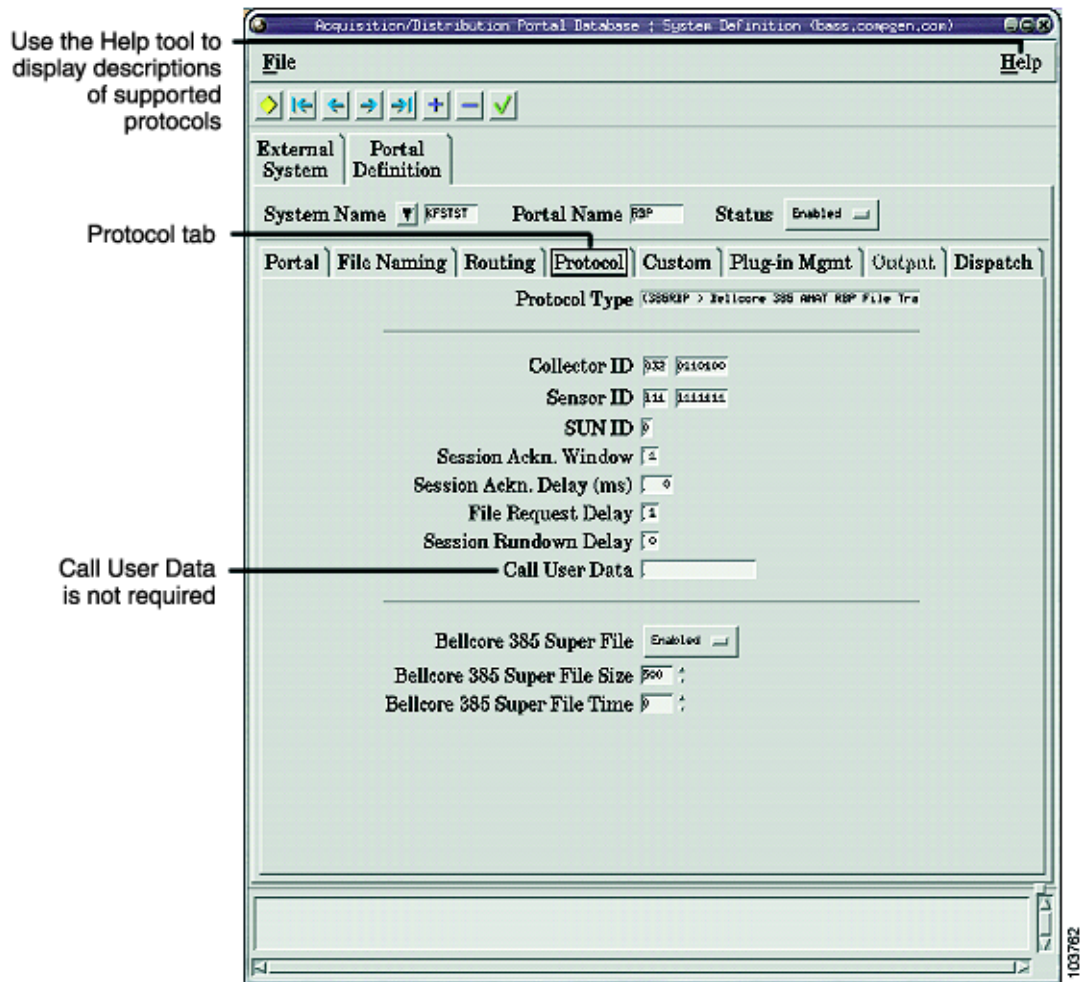
Choices displayed on the Protocol window depend upon the collection protocol chosen on the Portal window. In Figure 14, Bellcore 385 (AMATPS) and RBP were chosen, so parameters for configuring Bellcore 385 are entered here.

Note CUD is not required in the Call User Data field. The system uses 0xC0 by default.

Tip Click the Help tool in the upper right hand corner of the window to understand what is required in each field. The Help tool provides descriptions of the supported protocols, and hardware tips and suggestions for many of the available settings.

Switch Monitoring Networks: Cisco STUN OSS Connectivity Solution

This section describes Cisco telco solutions for legacy telephone switch monitoring networks like the one highlighted in Figure 18.

Figure 18   *Legacy Switch Monitoring Connections*
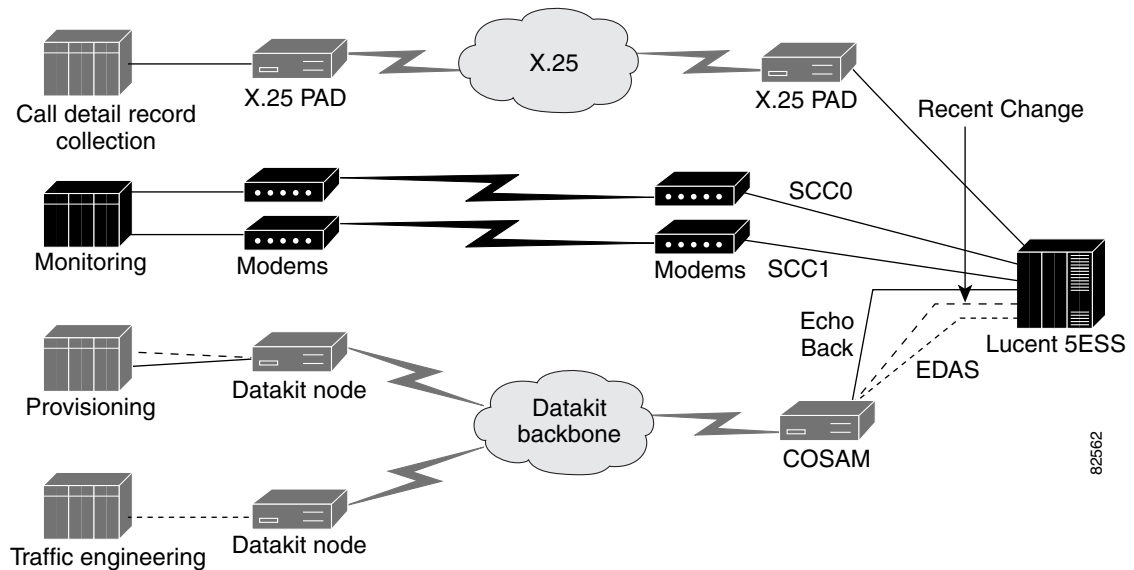
The solutions are described in the following sections:

Switch Monitoring Overview

One of the major functions of the DCN is to enable monitoring of the telephone switch. Monitoring of the Class 5 telephone switches was done originally with modems and dual, private line circuits.

The RBOCs built the private networks in the 1980s and 1990s with Lucent Datakit hardware and used the Datakit networks for monitoring their switches. Also, Lucent and Bellcore often used Datakit nodes as the communications front-end platform for an OSS application. In Figure 21 on page 43, the Lucent Network Fault Management (NFM) application is shown with a Datakit node acting as the communications front end.

The dual connections for monitoring a Lucent 5ESS are designated specialized common carrier 0 (SCC0) and SCC1. There are two circuits as shown in Figure 19 on page 42 for redundancy. One of the connections is active and the second connection remains in standby mode and functions as backup for the active connection. The original design assumed the two links to look like dedicated circuits to the

Lucent 5ESS telephone switch and that design has not changed over the years. The Lucent 5ESS switch expects to see the control leads on the standby connection because this is what a modem would supply. In addition, placing a scope on the standby link shows that the Lucent 5ESS is sending Set Asynchronous Balance Mode (SABM) requests on the standby link. The OSS monitoring applications ignore the SABMs on the standby link. If a network replaces the dedicated circuits, it must provide control leads and ignore the SABMs on the standby link. Some OSS applications will send out SABMs on the standby link that will be ignored by the Lucent 5ESS switch. For example, the Lucent NFM application with a Datakit communications front end will send out SABMs on the standby link.

On the active link, BX.25 is being passed using LAPB. The Lucent 5ESS telephone switch and the monitoring application are typically configured for seven PVCs on both the specialized common carrier 0SCC0) and SCC1 connections. The links can be configured for up to nine virtual channels.

The following list provides the PVCs that the switch can use on the monitoring channels. A definition of the type of data carried on each of the PVCs is also provided.

- PVC 1: Emergency Action Interface (EAI) information

- PVC 2: Summary status data (headers) for alarms (HDR)

- PVC 3: Controls the display of the page (Alarm)

- PVC 4: TTY input (Admin)

- PVC 5: TTY output (logging or maintenance channel, MTC)

- PVC 6: TTY input (Admin 2)

- PVC 7: TTY output (MTC 2)

- PVC 8: TTY input

- PVC 9: TTY output

The central office technician can switch the links from the console on the Lucent 5ESS telephone switch. The fail-over between the links is done at the LAPB layer. Remember that the original design assumed that the connections were over private line circuits, so LAPB was used to control the links. The Lucent telephone switch issues a LAPB disconnect frame to remove a link.

The following example shows information provided in a LAPB disconnect frame:

```
03 61 a0 57                                       .a.W
(EQ) 10      19:15:34.6988116    LAPB: Addr=001 Type=DISC/RD P/F=1(F) FCS=Good
 Record #10      (EQ) Captured on 04.19.01 at 19:15:34.698811606 Length =    4
LAPB:
  Address           = 001
  Frame Type        = 0x53 (DISC/RD)
  Control Information = 0x53
    ...1 .... P/F Bit = 1 (Final)
  FCS               = 0x81-76 (Good)
 Record #10      (EQ) Captured on 04.19.01 at 19:15:34.698811606 Length =    4
```

The LAPB disconnect frame tears down the X.25 layer and causes the Lucent 5ESS telephone switch and a network monitoring application, such as the Lucent NFM application bundle, to respond to SABMs on the standby link (see Figure 19).

Figure 19   *Redundant Serial Links for Telephone Switch Monitoring Applications*
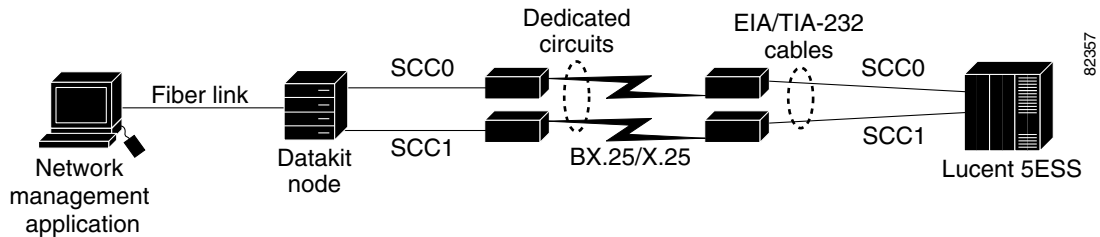
The standby link becomes the active link and the active link becomes the backup. The original configuration assumed by LAPB would be passed between an OSS such as the Lucent NFM, or the Network Management Application (NMA) application by Telcordia, and the Lucent 5ESS telephone switch. Essentially, LAPB is used to verify that the network is up end to end.

The Lucent Datakit Network

A typical Datakit network is shown in Figure 20.

Figure 20   *Typical Datakit Network*
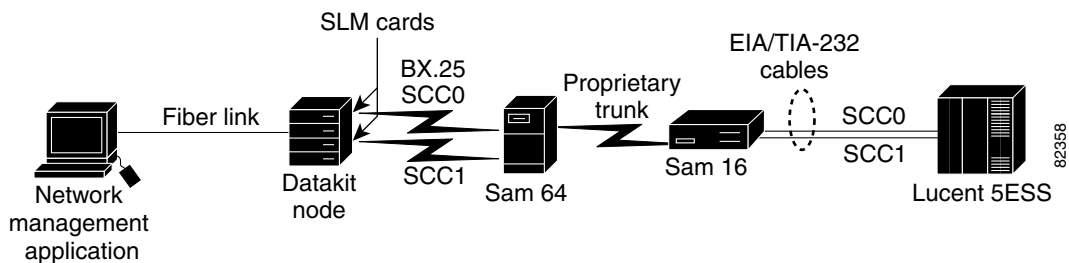
The Datakit node is providing the communications front end to the network management application (NFM or NMA). BX.25 packets are transmitted from Synchronous Line Module (SLM) cards on the Datakit node. The Datakit acts as a transport. The NFM application has two connections, SCC0 and SCC1, for redundancy. The NFM host is supplying leads on both interfaces but ignoring SABMs on the standby interface. The NFM is sending out the SABMs that the Lucent 5ESS switch is ignoring. If communication is lost on the active interface, the NFM host will respond to the SABMs on the standby interface and it will become the active interface. The Lucent 5ESS console indicates which interface is active and which is in standby mode.

Migrating to TCP/IP Using Cisco STUN

The Cisco STUN feature provides another way that customers can migrate the switch monitoring portion of a DCN to a TCP/IP network.

In this solution, the network administrator configures STUN on both the SCC0 and SCC1 connection, thereby enabling both links to act as circuits. The STUN feature looks like a pair of circuits to the OSS and the Lucent 5ESS. The LAPB layer is passed end to end. LAPB will control the link as designed.

The routers are acting as a circuit or a cable extension. The fail-over or recovery mechanism is initiated only by the end devices—the network monitoring application at one end of the network and the Class 5 telephone switch at the other end of the network. A LAPB disconnect frame can be used as the fail-over mechanism when configured for a pair of circuits. The only disadvantage to this solution is that STUN is time sensitive; that is, if another application applies a heavy load to the links, the connection may time out.

Figure 21 shows how some telcos have updated a DCN that uses the Lucent NFM application by removing the Lucent Datakit network with its proprietary trunk and replacing it with Cisco routers and TCP/IP. A Datakit node acts as a front end for the NFM application as described in the previous section. A STUN tunnel is configured for each of the SCC channels, from the Lucent NFM and Datakit node OSS at the NOC across the TCP/IP network, to the Lucent 5ESS telephone switch in the central office.

Figure 21   Lucent NFM Connection to a Lucent 5ESS Switch Using STUN
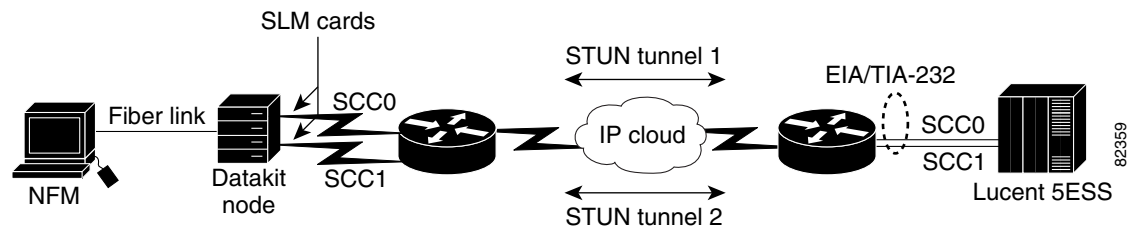
Each STUN tunnel is connected to separate physical interfaces. In Figure 21, the SCC0 interface is connected to STUN tunnel 1. The SCC1 interface is connected to STUN tunnel 2. The routers forward the packets across the network in a way similar to a leased-line circuit with modems. The only places that X.25 parameters can be set are on the Datakit node and the Lucent 5ESS telephone switch.

Lucent has developed a new communications server, the Element Mediation Module (EMM), which is an alternative to using a Datakit node for a communications server (see Figure 22). As with the configuration seen in Figure 21, the end devices control the X.25 exchange; the routers only forward packets across the network. The only places that X.25 parameters can be set are on the EMM and the Lucent 5ESS switch. One difference from the Datakit front end is that the EMM will shut down the standby interface, so the control leads are dropped and no SABMs are sent out from the EMM on the standby interface.

In Figure 22, the NFM/EMM combination and Class 5 telephone switch will set up the X.25 connection on either SCC0 or SCC1. Seven PVCs will be set up across the X.25 connection, sequentially numbered 1 through 7. The STUN-configured routers just forward the LAPB packets. The routers do not participate at the LAPB or X.25 layers. The end devices control the PVCs, and either device can reset the PVCs.

Figure 22   NFM/EMM with Cisco STUN Solution
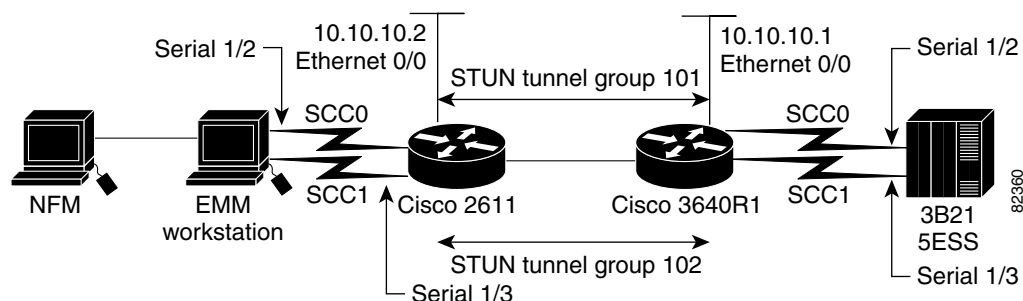
In early testing with the NFM/EMM solution, customers have found that the end devices would not wait long enough for a link to come up before resetting the link and initializing a backup link, so the seven PVCs were never established. There are controls in the EMM for starting and resetting the links. The default delay timer should be increased on the EMM in this situation. This increase is accomplished in the startup script on the EMM. EMM version 6.2 or later is required.

Configuring STUN on the Workstation Side of the Network

To configure the STUN tunnel on the workstation side of the telco DCN, see Figure 22 and perform the following steps. See the "Cisco STUN OSS Connectivity Solution: Examples" section on page 48 for a configuration example. See the "Verifying Links in the Cisco STUN OSS Connectivity Solution" section on page 49 for verification examples. See the "Debugging STUN Connections" section on page 51 for debugging examples.

Step 1 Enter global configuration mode:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
```

Step 2 Define the host name:

```
Router(config)# hostname Router-2611
```

Step 3 Configure the STUN global settings. The peer name is mapped to the IP address of the Ethernet interface on Router-2611 with the **stun peer-name** command, which also enables further STUN configuration. After using this command, define the protocol group in which you want to place this interface with the **stun protocol-group** command. In later steps, you will enable STUN encapsulation on the interface using the **encapsulation stun** command, and then place the interface in a STUN group with the **stun group** command:

```
Router-2611(config)# stun peer-name 10.10.10.2
Router-2611(config)# stun protocol-group 101 basic
Router-2611(config)# stun protocol-group 102 basic
```

Configure the Ethernet Interface

Step 4 Start interface configuration mode for Ethernet interface 0/0:

```
Router-2611(config)# interface ethernet 0/0
```

Step 5 Configure the IP addresses for the interface:

```
Router-2611(config-if)# ip address 10.10.10.2 255.255.255.0
```

Step 6 Disable keepalives. This action prevents the tunnel from being dropped if the protocol goes down on the Ethernet interface:

```
Router-2611(config)# no keepalive
```

Tip An alternative to this step is to use the loopback interface.

Step 7 For this configuration, set the interface to half-duplex mode:

```
Router-2611(config)# half-duplex
```

Step 8 Exit interface configuration mode:

```
Router-2611(config-if)# end
```

Configure Serial Interface 1/2

Step 9   Start interface configuration mode for serial interface 1/2, which specifies network module 1, port 2:

```
Router-2611(config)# interface serial 1/2
```

Step 10   Disable IP addresses on the interface:

```
Router-2611(config-if)# no ip address
```

Step 11   Configure STUN encapsulation:

```
Router-2611(config-if)# encapsulation stun
```

Step 12   The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 9600 baud:

```
Router-2611(config-if)# clockrate 9600
```

Step 13   Assign the interface to STUN group 101:

```
Router-2611(config-if)# stun group 101
```

Step 14   Route all traffic arriving on serial interface 1/2 to Router-3640R1 at IP address 10.10.10.1 (see Figure 22 on page 43):

```
Router-2611(config-if)# stun route all tcp 10.10.10.1
```

Step 15   Exit interface configuration mode:

```
Router-2611(config-if)# end
```

Configure Serial Interface 1/3

Step 16   Start interface configuration mode for serial interface 1/3, which specifies network module 1, port 3:

```
Router-2611(config)# interface serial 1/3
```

Step 17   Disable IP addresses on the interface:

```
Router-2611(config-if)# no ip address
```

Step 18   Configure STUN encapsulation:

```
Router-2611(config-if)# encapsulation stun
```

Step 19   The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 9600 baud:

```
Router-2611(config-if)# clockrate 9600
```

Step 20   Assign the interface to STUN group 102:

```
Router-2611(config-if)# stun group 102
```

Step 21   Route all traffic arriving on serial interface 1/3 to Router-3640R1 at IP address 10.10.10.1 (see Figure 22 on page 43):

```
Router-2611(config-if)# stun route all tcp 10.10.10.1
```

Step 22   Exit the interface and global configuration modes:

```
Router-2611(config-if)# end
Router-2611(config)# end
```

Step 23   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-2611# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Configuring STUN on the Telephone Switch Side of the Network

To configure the STUN tunnel on the telephone switch side of the telco DCN, see Figure 22 on page 43 and perform the following steps. See the "Cisco STUN OSS Connectivity Solution: Examples" section on page 48 for configuration examples. See the "Verifying Links in the Cisco STUN OSS Connectivity Solution" section on page 49 for verification examples. See the "Debugging STUN Connections" section on page 51 for debugging examples.

Step 1   Enter global configuration mode:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#
```

Step 2   Define the host name:

```
Router(config)# hostname Router-3640R1
```

Step 3   Configure the STUN global settings. The peer name is mapped to the IP address of the Ethernet interface on Router-3640R1 with the **stun peer-name** command, which also enables further STUN configuration. After using this command, define the protocol group in which you want to place this interface with the **stun protocol-group** command. In later steps, you will enable STUN encapsulation on the interface using the **encapsulation stun** command, and then place the interface in a STUN group with the **stun group** command:

```
Router-3640R1(config)# stun peer-name 10.10.10.1
Router-3640R1(config)# stun protocol-group 101 basic
Router-3640R1(config)# stun protocol-group 102 basic
```

Configure the Ethernet Interface

Step 4   Start interface configuration mode for Ethernet interface 0/0:

```
Router-3640R1(config)# interface ethernet 0/0
```

Step 5   Configure the IP addresses for the interface:

```
Router-3640R1(config-if)# ip address 10.10.10.2 255.255.255.0
```

Step 6   For this configuration, set the interface to half-duplex mode:

```
Router-3640R1(config-if)# half-duplex
```

Step 7   Exit interface configuration mode:

```
Router-3640R1(config-if)# end
```

Configure Serial Interface 1/2

Step 8   Start interface configuration mode for serial interface 1/2, which specifies network module 1, port 2:

```
Router-3640R1(config)# interface serial 1/2
```

Step 9   Disable IP addresses on the interface:

```
Router-3640R1(config-if)# no ip address
```

Step 10   Configure STUN encapsulation:

```
Router-3640R1(config-if)# encapsulation stun
```

Step 11   Set the clock rate to 9600 baud:

```
Router-3640R1(config-if)# clockrate 9600
```

Step 12   Assign the interface to STUN group 101:

```
Router-3640R1(config-if)# stun group 101
```

Step 13   Route all traffic arriving on serial interface 1/2 to Router-2611 at IP address 10.10.10.2 (see Figure 22 on page 43):

```
Router-3640R1(config-if)# stun route all tcp 10.10.10.2
```

Step 14   Exit interface configuration mode:

```
Router-3640R1(config-if)# end
```

Configure Serial Interface 1/3

Step 15   Start interface configuration mode for serial interface 1/3, which specifies network module 1, port 3:

```
Router-3640R1(config)# interface serial 1/3
```

Step 16   Disable IP addresses on the interface:

```
Router-3640R1(config-if)# no ip address
```

Step 17   Configure STUN encapsulation:

```
Router-3640R1(config-if)# encapsulation stun
```

Step 18   Set the clock rate to 9600 baud:

```
Router-3640R1(config-if)# clockrate 9600
```

Step 19   Assign the interface to STUN group 102:

```
Router-3640R1(config-if)# stun group 102
```

Step 20   Route all traffic arriving on serial interface 1/3 to Router-2611 at IP address 10.10.10.2 (see Figure 22 on page 43):

```
Router-3640R1(config-if)# stun route all tcp 10.10.10.2
```

Step 21   Exit the interface and global configuration modes:

```
Router-3640R1(config-if)# end
Router-3640R1(config)# end
```

Step 22   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3640R1# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco STUN OSS Connectivity Solution: Examples

This section provides examples of the following configurations and status reports:

In the following examples, the communications front end for the NFM application is an EMM server. The SCC links from the EMM server are connected to a Cisco 2611 router named Router-2611, as shown in Figure 23.

Figure 23   NFM/EMM with Cisco STUN Solution
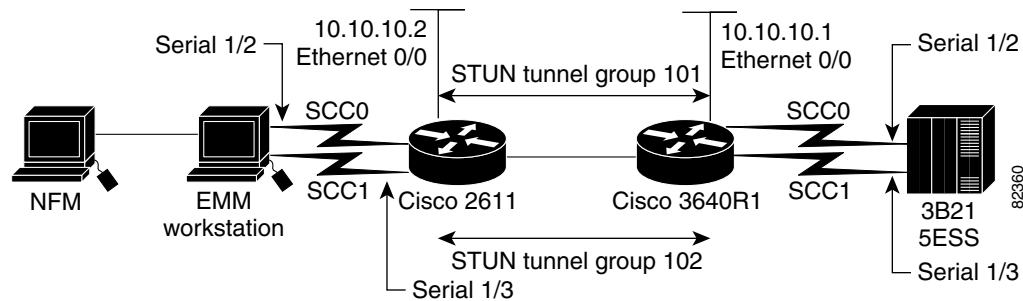
The cables connecting the EMM to the Cisco 2611 router are Cisco V.35 DCE, which is a CAB-V.35MC (cable part number 72-08002-01). The cables connecting the Lucent 5ESS to the Cisco 3640R1 router are Cisco EIA/TIA-232 DCE (cable part number 72-0794-01). The Cisco 2611 router is connected using an Ethernet cross-over cable to a Cisco 3640R1 router, which is connected using SCC0 and SCC1 to the 3B21 device on the Lucent 5ESS.

Note   The EMM Version 6.2 was tested. Earlier versions are not recommended.

The configuration examples show two tunnel groups configured as type basic. Tunnel group 101 is assigned to serial interface 1/2 on the Cisco 2611 router, and serial interface 1/2 on the Cisco 3640R1 router. Tunnel group 102 is assigned to serial interface 1/3 on the Cisco 2611 router, and serial interface 1/3 on the Cisco 3640R1 router.

Cisco 2611 Edge Router STUN Connection to the Workstation: Example

The following example shows the configuration for a Cisco 2611 router named Router-2611. Notice that the peer name is the IP address of the Ethernet interface on the router. Another and better possibility would be to use a loopback IP address that cannot go down instead of the peer name. A STUN group of 101 is assigned to serial interface 1/2. All of the traffic arriving on serial interface 1/2 will be encapsulated in TCP/IP packets and forwarded across the IP cloud to the Cisco 3640R1 router at IP address 10.10.10.1. All of the traffic arriving on serial interface 1/3 is assigned to STUN group 102 and is forwarded across the network to IP address 10.10.10.1.

```
hostname Router-2611
!
stun peer-name 10.10.10.2
stun protocol-group 101 basic
stun protocol-group 102 basic
!
interface Ethernet0/0
```

```
 ip address 10.10.10.2 255.255.255.0
 no keepalive
 half-duplex
!
interface Serial1/2
 no ip address
 encapsulation stun
 clockrate 9600
 stun group 101
 stun route all tcp 10.10.10.1
!
interface Serial1/3
 no ip address
 encapsulation stun
 clockrate 9600
 stun group 102
 stun route all tcp 10.0.10.1
```

Cisco 3640R1 Edge Router STUN Connection to the Telephone Switch: Example

The following example shows the configuration for a Cisco 3640R1 edge router on the telephone switch side of the network. The peer name is the IP address of the Ethernet interface on the router; however, you could use a loopback IP address that cannot go down, instead of the peer name. A STUN group of 101 is assigned to serial interface 1/2. All of the traffic arriving on serial interface 1/2 will be encapsulated in TCP/IP packets and forwarded across the IP cloud to the Cisco 2611 router at IP address 10.10.10.2. All of the traffic arriving on serial interface 1/3 is assigned to STUN group 102 and is forwarded across the network to IP address 10.10.10.2.

```
hostname Router-3640R1
stun peer-name 10.10.10.1
stun protocol-group 101 basic
stun protocol-group 102 basic
!
interface Ethernet0/0
 ip address 10.10.10.1 255.255.255.0
 half-duplex
 tarp enable
!
interface Serial1/2
 no ip address
 encapsulation stun
 clockrate 9600
 stun group 101
 stun route all tcp 10.10.10.2
!
interface Serial1/3
 no ip address
 encapsulation stun
 clockrate 9600
 stun group 102
 stun route all tcp 10.10.10.2
```

Verifying Links in the Cisco STUN OSS Connectivity Solution

The following examples show how to verify the two STUN links. Use the **show interface** EXEC command on the two serial interfaces, and check that the line protocol is up and encapsulation set for the link is STUN.

```
Router-3640R1# show interface serial 1/2

Serial1/2 is up, line protocol is up
```

```
              Hardware is CD2430 in sync mode
              MTU 2104 bytes, BW 128 Kbit, DLY 20000 usec,
                 reliability 255/255, txload 1/255, rxload 1/255
              Encapsulation STUN, loopback not set
              Last input 00:00:02, output 00:00:40, output hang never
              Last clearing of "show interface" counters 00:20:56
              Queueing strategy: fifo
              Output queue 0/40, 0 drops; input queue 0/75, 0 drops
              5 minute input rate 0 bits/sec, 0 packets/sec
              5 minute output rate 0 bits/sec, 0 packets/sec
                 155 packets input, 316 bytes, 0 no buffer
                 Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
                 0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
                 9 packets output, 43 bytes, 0 underruns
                 0 output errors, 0 collisions, 2 interface resets
                 0 output buffer failures, 0 output buffers swapped out
                 0 carrier transitions
                 DCD=up  DSR=up  DTR=up  RTS=up  CTS=up


Router-3640R1# show interface serial 1/3

Serial1/3 is up, line protocol is up
  Hardware is CD2430 in sync mode
  MTU 2104 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation STUN, loopback not set
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:21:00
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 1 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     527 packets input, 3295 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     77 packets output, 275 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     4 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Use the **show stun** EXEC command on the Cisco 3640R1 router to display a report on the two tunnels. As shown in the following example, the peer address for the tunnel is the IP address assigned to Ethernet interface 0/0 on the Cisco 3640R1 router, so the router is peered to itself at IP address 10.10.10.1. The tunnel on serial interface 1/2 is tunnel group 101 and is a basic tunnel. All traffic is routed to IP address 10.10.10.2, which is the IP address of Ethernet interface 0/0 on the Cisco 2611 router.

Group 101 is the SCC0 link. The state of the tunnel is open or up. If the tunnel was down, the state would be marked closed. The number of packets received is 1042, and the number of packets transmitted is 1025.

Group 102 is the SCC1 link. The tunnel is connected to IP address 10.10.10.2, which is the Cisco 2611 router and serial interface 1/3. The state of the tunnel is open or up. The number of packets transmitted is 318, and the number of packets received is 1013. The SCC1 link was not configured correctly, so the interface shows 83 dropped packets.

Looking at the counters is one method of determining if the tunnel is functioning.

```
Router-3640R1# show stun

This peer: 10.10.10.1
```

```
 *Serial1/2 -- scc0 (group 101 [basic])
                               state      rx_pkts    tx_pkts    drops
all    TCP 10.10.10.2          open       1042       1025       0


  Serial1/3 -- scc1 on 5ESS (group 102 [basic])
                               state      rx_pkts    tx_pkts    drops
all    TCP 10.10.10.2          open       318        1013       83
```

Debugging STUN Connections

The possible STUN debugs are shown in the following example, and can be used to perform basic debugging of the STUN tunnels:

```
Router-3640R1# debug stun ?

  events  STUN connections and status
  packet  All STUN activity
  tg      Display stun transmission groups
```

To make sure data is passing across the tunnels, enter the **debug stun packet** command. A sample debug report and a detailed description of the first two packets follow:

```
Router-3640R1# debug stun packet

STUN packet debugging is on
Router-3640R1#
00:40:01: STUN basic: 00:06:16 Serial1/2       NDI:   Data: 0343
00:40:01: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 030f
00:40:05: STUN basic: 00:00:04 Serial1/2       SDI:   Data: 013f
00:40:06: STUN basic: 00:00:00 Serial1/2       NDI:   Data: 0173
00:40:06: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 0111
00:40:06: STUN basic: 00:00:00 Serial1/2       NDI:   Data: 03001000fb0000
00:40:06: STUN basic: 00:00:00 Serial1/2       NDI:   Data: 0111
00:40:06: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 0321
00:40:06: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 0120100205
00:40:06: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 0122100341
00:40:06: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 0124100401
00:40:06: STUN basic: 00:00:00 Serial1/2       NDI:   Data: 0141
```

Following are detailed descriptions of the first two packets from the debug report:

```
00:40:01: STUN basic: 00:06:16 Serial1/2       NDI:   Data: 0343

STUN basic: the encapsulation scheme is basic
00:06:16:  time elapsed from the previous packet .
Serial1/2: Interface reporting the event
NDI: The data is received from the Network
Data: 0343: The data received from the Network

00:40:01: STUN basic: 00:00:00 Serial1/2       SDI:   Data: 030f

STUN basic: the encapsulation scheme is basic
00:00:00:  time elapsed from the previous packet .
Serial1/2: Interface reporting the event
SDI: The data is received from the Serial Link
Data: 030f: The data received from the Serial Link
```

Switch Monitoring Networks: Cisco X.25 BAI OSS Connectivity Solution

The Cisco X.25 BAI OSS connectivity solution is described in the following sections:

- Cisco X.25 BAI OSS Connectivity Overview, page 52

- Adding Cisco X.25 BAI to the Telco DCN, page 53

- Configuring Cisco X.25 BAI on the NMA Side of the Network, page 53

- Configuring Cisco X.25 BAI on the Telephone Switch Side of the Network, page 60

- Configuring SCC0 and SCC1 on the Lucent 5ESS Telephone Switch Form, page 68

- Switch Monitoring Networks: IP and Cisco X.25 BAI and EOR Solutions, page 71

Cisco X.25 BAI OSS Connectivity Overview

One of the downfalls to the STUN solution is scaling. The service provider must dedicate two ports on the OSS for every Lucent 5ESS telephone switch, which makes for many circuits tunneled across an IP network.

Service providers want to take advantage of the scaling inherent in the X.25 protocol. Cisco has developed a solution to allow a customer to configure an OSS with an X.25 SVC to connect the active SCC link on a Lucent 5ESS telephone switch. The key pieces of the solution are the Cisco X.25 Backup Active Interface (BAI) feature, X.25 SVC-to-PVC conversion, and X.25 address substitution. The Cisco X.25 BAI feature preserves the original redundancy and monitoring capability available from SCC0 and SCC1 links in DCN, but uses SVCs to route X.25, thereby greatly reducing the number of interfaces required in the DCN.

In Figure 24, the Datakit node provides the communications front end to a network management application and provides two links, SCC0 and SCC1, for link redundancy. One link is active and passes data across the network; the other remains in standby mode.

Figure 24 *Network Management Application Monitors Lucent 5ESS Switch over Datakit Network*
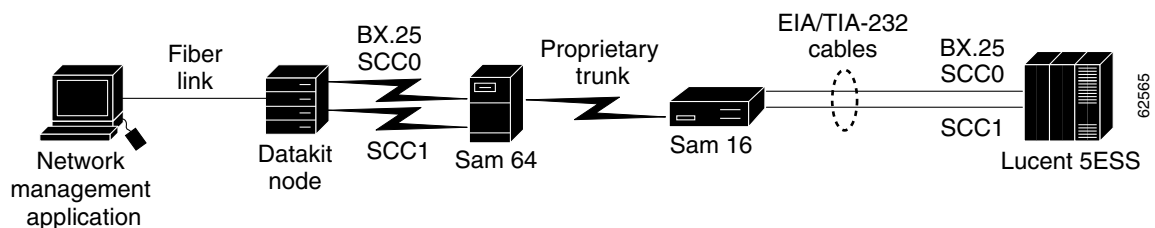
The Datakit node acts as a transport, so that to the network management application and the Lucent 5ESS switch, the node looks like it has two individual circuits. The network management application host is supplying leads on both interfaces but ignoring SABM messages on the standby interface. If communication is lost on the active interface, the network management application host responds to the SABM messages on the standby interface and it becomes the active interface.

As Figure 25 shows, Cisco offers solutions that allow telco service providers to reduce operating costs, translate and migrate existing X.25-based DCNs to IP-based DCNs, and bridge traditional telephony operations to newer ones.

Figure 25 *Network Management Application Monitors Lucent 5ESS Switch over IP Network*
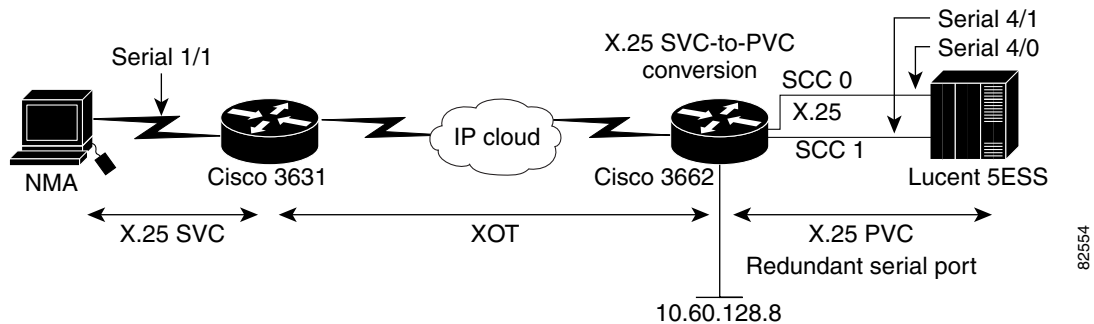
The Cisco X.25 BAI feature is a part of the Cisco IOS Telco Feature Set, a bundle of applications specific to the DCN environment. Specifically, the Cisco X.25 BAI feature provides dual serial interfaces to preserve the redundancy and monitoring capability available from the SCC0 and SCC1 links on the Lucent 5ESS switch in the DCN network.

Adding Cisco X.25 BAI to the Telco DCN

The following sections describe how to incorporate the Cisco X.25 BAI feature in a telco DCN using the Telcordia NMA switch monitoring application.

In Figure 25, a Cisco 3631 router is connected over a serial connection to the NMA application. The Cisco 3631 router is connected over a TCP/IP backbone to a Cisco 3662 router in the central office. The Cisco 3662 router has two serial connections to the Lucent 5ESS telephone switch and the connections are terminated on SCC0 and SCC1, on the switch.

In the configurations included in this section, the NMA host will be configured with seven X.25 SVCs. The SVCs will be put into an XOT tunnel on the Cisco 3631 router and forwarded across the network. The Cisco 3662 router will then terminate the XOT session and convert the seven SVCs to seven PVCS.

The **backup active interface** interface configuration command is configured on the Cisco 3662 router. The **backup active interface** command causes the interface with the standby link on it to go into testing mode. The testing mode brings the leads high but ignores the SABMs from the Lucent 5ESS telephone switch. The **backup active interface** command allows the router to switch between serial ports when a LAPB disconnect frame is received on the active interface.

Configuring Cisco X.25 BAI on the NMA Side of the Network

To configure a backup active interface on the NMA side of the telco DCN, see Figure 25 and perform the following steps. See the "NMA Gateway Configuration: Example" section on page 55 and "NMA-Side Configuration: Example" section on page 56 for configuration examples. See the "Verifying Address Substitutions" section on page 56 for verification examples.

Step 1 Enter configuration mode:

```
Router-3631# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Enable X.25 routing:

```
Router-3631(config)# x25 routing
```

Step 3   Start interface configuration mode for serial interface 1/1, which specifies network module 1, port 1:

```
Router-3631(config)# interface serial 1/1
```

Step 4   Disable IP addresses on the interface:

```
Router-3631(config-if)# no ip address
```

Step 5   Configure X.25 DCE encapsulation on the serial interface:

```
Router-3631(config-if)# encapsulation x25 dce
```

Step 6   Disable fast switching of IP multicast:

```
Router-3631(config-if)# no ip mroute-cache
```

Step 7   Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-3631(config-if)# x25 version 1980
```

Step 8   Set the high two-way channel to 64 so that the SVC range will be from 1 to 64, and will match the OSS:

```
Router-3631(config-if)# x25 htc 64
```

Step 9   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3631(config-if)# x25 wout 4
```

Step 10   Set the clock rate to 56000 baud:

```
Router-3631(config-if)# clockrate 56000
```

Step 11   Configure the XOT route and address substitution for SVC 1:

```
Router-3631(config-if)# x25 route 5550427111101 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222201 xot 10.60.128.8
```

Step 12   Configure the XOT route and address substitution for SVC 2:

```
Router-3631(config-if)# x25 route 5550427111102 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222202 xot 10.60.128.8
```

Step 13   Configure the XOT route and address substitution for SVC 3:

```
Router-3631(config-if)# x25 route 5550427111103 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222203 xot 10.60.128.8
```

Step 14   Configure the XOT route and address substitution for SVC 4:

```
Router-3631(config-if)# x25 route 5550427111104 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222204 xot 10.60.128.8
```

Step 15   Configure the XOT route and address substitution for SVC 5:

```
Router-3631(config-if)# x25 route 5550427111105 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222205 xot 10.60.128.8
```

Step 16   Configure the XOT route and address substitution for SVC 6:

```
Router-3631(config-if)# x25 route 5550427111106 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222206 xot 10.60.128.8
```

Step 17   Configure the XOT route and address substitution for SVC 7:

```
Router-3631(config-if)# x25 route 5550427111107 source 5550427222200 substitute-dest
5550427111100 substitute-source 5550427222207 xot 10.60.128.8
```

Step 18   Exit the interface and global configuration modes:

```
Router-3631(config-if)# end
Router-3631(config)# end
```

Step 19   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3631# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

NMA Gateway Configuration: Example

In the following NMA gateway configuration, the X.121 address assigned to the NMA gateway is 5550427222200. The gateway is configured for no PVCs and SVCs with a range of 1 to 64. The packet size is 128 and the window size is 4. The NMA is set up as a DTE.

```
02-05-17 13:49:51 edt      x25 config (ocs_x25_cnfg)      jump:

 Gateway name: j1g08061                              gateway type: standard
  device name: %nmasp1#j1g08061
 asgnd module: %nmasp1#m1
 gateway stat: enable
     local address: 5550427222200
     station type: dte
     network type: standard        min lcn: 1
            baud: 9600             max lcn: 64
   def thru class: 75     def window size: 4
  max packet size: 128    ack window size: 4
  def packet size: 128           num pvc: 0
 flow control neg: no         pvc origin: 1
      thruput neg: no           defer_dsl: yes
          lap t1: 3           fast select: no
          lap t2: 0       facility marker: no           chan
loopback: no
          lap n2: 20              sys err: yes
trace: no
           lap K: 7        ignore D bit: no             chan
trace: no
```

The following example lists a target configuration for one of the channels. The example shows that the channel will be mapped to PVC 4 on the Lucent 5ESS 5 telephone switch. PVC 4 is a TTY input used as the ADMIN channel. The X.25 called address for the Cisco 3662 router is 5550427111104. The subaddress 04 is used to map the address to PVC 4.

```
02-05-17 14:08:26 edt  target config (ocs_target_cnfg) jump:
    target id: wngrflxads0                         target type: switch
   channel id: admin          platform: vos      alt class:
 target model: 5ess_admin                        surveil mode: direct
  chan status: connect                           monitor timer: 0
always
 channel type:                                    raw msg log: yes
 target group:
   ne user id:                                    ne password: *
  init script: no                        deactivation script: no

     protocol: native x25_svc     parity: no      line type: non_dial
   cls user grp:
```

```
            gateway name: j1g08061
            call address: 5550427111104
```

NMA-Side Configuration: Example

In the following example, the NMA is connected to serial interface 1/1 on a Cisco 3631 router. The interface is configured for X.25 SVCs only, and the SVC range is 1 to 64. The incoming and outgoing X.25 packet size is the Cisco IOS default 128; the X.25 window size is 4.

```
x25 routing
!
interface Serial1/1
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 x25 version 1980
 x25 htc 64
 x25 win 4
 x25 wout 4
 clockrate 56000
```

Verifying Address Substitutions

The NMA will place seven X.25 calls to the Cisco 3662 router, but the router interface can have only one X.121 address and does not support subaddressing. The configuration must work around this restriction, and does so using X.121 address substitution.

NMA is set up to distinguish between virtual circuits by the unique called X.121 address. The X.121 address of the Cisco 3662 router interface is 5550427111100, and NMA adds a subaddress to make each X.121 call unique, so the example target configuration for the ADMIN channel contains an X.121 call to 5550427111104.

Remember that the Cisco 3662 router interface supports only one X.121 address and does not support subaddressing, so the Cisco 3631 router configuration substitutes the X.121 called address with the X.121 address on serial interface 4/0 of the Cisco 3662 router. The same X.121 address is assigned to serial interface 4/1 because serial interface 4/1 is the backup active interface for serial interface 4/0.

In addition, the Cisco 3662 router needs a unique source X.121 address for each SVC to map to the appropriate PVC; the configuration adds a unique subaddress to each calling address. Table 4 lists the address substitutions.

Table 4　　　*X.121 Address Substitution*

NMA Calling Address	NMA Called Address	Substituted Calling Address	Substituted Called Address	PVC	Channel Description
5550427222200	5550427111101	5550427222201	5550427111100	1	EIA
5550427222200	5550427111102	5550427222202	5550427111100	2	Alarm
5550427222200	5550427111103	5550427222203	5550427111100	3	Header
5550427222200	5550427111104	5550427222204	5550427111100	4	MTC
5550427222200	5550427111105	5550427222205	5550427111100	5	Admin
5550427222200	5550427111106	5550427222206	5550427111100	6	MTC2
5550427222200	5550427111107	5550427222207	5550427111100	7	Admin2

The configuration moves the subaddress from the called address to the calling address. The configuration is accommodating the limitations of the host and the Cisco IOS software.

The following partial example lists the global commands that perform the address substitution:

```
x25 route 5550427111101 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222201 xot 10.60.128.8
!
x25 route 5550427111102 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222202 xot 10.60.128.8
!
x25 route 5550427111103 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222203 xot 10.60.128.8
!
x25 route 5550427111104 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222204 xot 10.60.128.8
!
x25 route 5550427111105 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222205 xot 10.60.128.8
!
x25 route 5550427111106 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222206 xot 10.60.128.8
!
x25 route 5550427111107 source 5550427222200 substitute-dest 5550427111100
substitute-source 5550427222207 xot 10.60.128.8
```

To verify the X.121 address substitutions, perform the following steps:

Step 1   Enter the **show x25 route** EXEC command to list the X.25 route table and the address substitution shown in Table 4. The following example shows a sample X.25 route table:

```
Router# show x25 route

   # Match                          Substitute         Route to
   1 dest 5550427111101 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222201
                                                       xot 10.60.128.8
   2 dest 5550427111102 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222202
                                                       xot 10.60.128.8
   3 dest 5550427111103 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222203
                                                       xot 10.60.128.8
   4 dest 5550427111104 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222204
                                                       xot 10.60.128.8
   5 dest 5550427111105 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222205
                                                       xot 10.60.128.8
   6 dest 5550427111106 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222206
                                                       xot 10.60.128.8
   7 dest 5550427111107 source 5550427222200
                                    Sub-dest 5550427111100
                                    Sub-source 5550427222207
                                                       xot 10.60.128.8
```

Step 2 Enter the **show x25 vc** EXEC command to display the state of the X.25 SVCs and what the SVCs are connected to. The following example shows a typical report:

```
Router#  show x25 vc

SVC 58,  State: D1,  Interface: Serial1/1
  Started 00:15:54, last input 00:15:37, output 00:00:03
  Connects 5550427222205 <--> 5550427111100 to
  XOT between 10.59.251.66, 11102 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 5  PR: 0  ACK: 0  Remote PR: 5  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 111340/2 packets 1021/2 Resets 1/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 59,  State: D1,  Interface: Serial1/1
  Started 00:15:57, last input 00:15:40, output 00:00:58
  Connects 5550427222203 <--> 5550427111100 to
  XOT between 10.59.251.66, 11101 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 5  PR: 3  ACK: 3  Remote PR: 5  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 1130/4 packets 13/3 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 60,  State: D1,  Interface: Serial1/1
  Started 00:15:57, last input 00:15:39, output 00:00:58
  Connects 5550427222202 <--> 5550427111100 to
  XOT between 10.59.251.66, 11100 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 2  ACK: 0  Remote PR: 2  RCNT: 2  RNR: Tx
  P/D state timeouts: 0  timer (secs): 0
  data bytes 680/2 packets 10/2 Resets 0/0 RNRs 7/0 REJs 0/0 INTs 0/0
SVC 61,  State: D1,  Interface: Serial1/1
  Started 00:15:59, last input 00:15:14, output 00:00:00
  Connects 5550427222201 <--> 5550427111100 to
  XOT between 10.59.251.66, 11099 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 0  ACK: 0  Remote PR: 2  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 9000/10 packets 450/6 Resets 2/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 62,  State: D1,  Interface: Serial1/1
  Started 00:15:59, last input 00:15:36, output 00:15:38
  Connects 5550427222207 <--> 5550427111100 to
  XOT between 10.59.251.66, 11098 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 1  PR: 2  ACK: 2  Remote PR: 1  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 103/2 packets 1/2 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 63,  State: D1,  Interface: Serial1/1
  Started 00:16:01, last input 00:12:18, output 00:12:16
  Connects 5550427222204 <--> 5550427111100 to
  XOT between 10.59.251.66, 11097 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 6  PR: 7  ACK: 7  Remote PR: 6  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 224/13 packets 14/7 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 64,  State: D1,  Interface: Serial1/1
  Started 00:16:01, last input 00:15:37, output 00:15:37
  Connects 5550427222206 <--> 5550427111100 to
  XOT between 10.59.251.66, 11096 and 10.60.128.8, 1998
  Window size input: 4, output: 4
```

```
    Packet size input: 128, output: 128
    PS: 6  PR: 3  ACK: 3  Remote PR: 6  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 70/9 packets 6/3 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11096]
    Started 00:16:01, last input 00:15:37, output 00:15:37
    Connects 5550427222206 <--> 5550427111100 from Serial1/1 SVC 64
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 3  PR: 6  ACK: 6  Remote PR: 3  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 9/70 packets 3/6 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11097]
    Started 00:16:01, last input 00:12:18, output 00:12:18
    Connects 5550427222204 <--> 5550427111100 from Serial1/1 SVC 63
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 7  PR: 6  ACK: 6  Remote PR: 7  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 13/224 packets 7/14 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11098]
    Started 00:15:59, last input 00:15:39, output 00:15:36
    Connects 5550427222207 <--> 5550427111100 from Serial1/1 SVC 62
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 2  PR: 1  ACK: 1  Remote PR: 2  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 2/103 packets 2/1 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11099]
    Started 00:15:59, last input 00:00:01, output 00:15:15
    Connects 5550427222201 <--> 5550427111100 from Serial1/1 SVC 61
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 0  PR: 2  ACK: 2  Remote PR: 0  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 10/9000 packets 6/450 Resets 0/2 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11100]
    Started 00:15:59, last input 00:00:59, output 00:15:40
    Connects 5550427222202 <--> 5550427111100 from Serial1/1 SVC 60
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 2  PR: 2  ACK: 2  Remote PR: 0  RCNT: 0  RNR: Rx
    P/D state timeouts: 0  timer (secs): 0
    data bytes 2/680 packets 2/10 Resets 0/0 RNRs 0/7 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11101]
    Started 00:15:59, last input 00:00:59, output 00:15:41
    Connects 5550427222203 <--> 5550427111100 from Serial1/1 SVC 59
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 3  PR: 5  ACK: 5  Remote PR: 3  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 4/1130 packets 3/13 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.60.128.8,1998/10.59.251.66,11102]
    Started 00:15:56, last input 00:00:00, output 00:15:38
    Connects 5550427222205 <--> 5550427111100 from Serial1/1 SVC 58
    Window size input: 4, output: 4
    Packet size input: 128, output: 128
    PS: 0  PR: 7  ACK: 7  Remote PR: 0  RCNT: 0  RNR: no
    P/D state timeouts: 0  timer (secs): 0
    data bytes 2/111560 packets 2/1023 Resets 0/1 RNRs 0/0 REJs 0/0 INTs 0/0
```

Step 3 Examine the report. A closer look at the connection that will map to PVC 4 or the ADMIN channel reveals that SVC 63 is the connection. The following example shows a calling address of 5550427222204 and a called address of 5550427111100:

```
SVC 63,  State: D1,  Interface: Serial1/1
  Started 00:16:01, last input 00:12:18, output 00:12:16
  Connects 5550427222204 <--> 5550427111100 to
  XOT between 10.59.251.66, 11097 and 10.60.128.8, 1998
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 6  PR: 7  ACK: 7  Remote PR: 6  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 224/13 packets 14/7 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

In the following example, SVC 63 is mapped to SVC 1 on the XOT connection:

```
SVC 1,  State: D1,  Interface:
[10.60.128.8,1998/10.59.251.66,11097]
  Started 00:16:01, last input 00:12:18, output 00:12:18
  Connects 5550427222204 <--> 5550427111100 from Serial1/1 SVC 63
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 7  PR: 6  ACK: 6  Remote PR: 7  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 13/224 packets 7/14 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

Configuring Cisco X.25 BAI on the Telephone Switch Side of the Network

To configure a backup active interface on the telephone switch side of the telco DCN, see Figure 25 on page 53 and perform the following steps. See the "X.25 BAI Telephone Switch Side Configuration: Example" section on page 63 for a configuration example. See the "Verifying PVC-to-SVC Conversions" section on page 65 for a verification example.

Step 1 Enter configuration mode:

```
Router-3662# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Enable X.25 routing:

```
Router-3662(config)# x25 routing
```

Configure the Active Serial Interface

Step 3 Start interface configuration mode for serial interface 4/0, which specifies network module 4, port 0:

```
Router-3662(config)# interface serial 4/0
```

Step 4 Enter a description for the serial interface:

```
Router-3662(config-if)# SCC0 Link to 5ESS (UnManaged)
```

Step 5 Disable IP addresses on the interface:

```
Router-3662(config-if)# no ip address
```

Step 6 Configure X.25 DCE encapsulation on the serial interface:

```
Router-3662(config-if)# encapsulation x25 dce
```

Step 7   Configure serial interface 4/1 as the backup to serial interface 4/0:

```
Router-3662(config-if)# backup active interface serial 4/1
```

Step 8   Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-3662(config-if)# x25 version 1980
```

Step 9   Configure the address for the X.25 serial interface:

```
Router-3662(config-if)# x25 address 5550427111100
```

Step 10   Set the low two-way VC channel to 8:

```
Router-3662(config-if)# x25 ltc 8
```

Step 11   Set the X.25 T10 timer to 30:

```
Router-3662(config-if)# x25 t10 30
```

Step 12   Set the X.25 T12 timer to 30:

```
Router-3662(config-if)# x25 t12 30
```

Step 13   Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 win 4
```

Step 14   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 wout 4
```

Step 15   Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-3662(config-if)# x25 threshold 1
```

Step 16   Configure seven SVC-to-PVC conversions. Notice how the PVC number and the last digit of the X.121 address match in this example. The X.121 address is used to map to the appropriate PVC. Specify an X.25 packet size of 128, and input and output window sizes of 4 for these interfaces:

```
Router-3662(config-if)# x25 pvc 1 svc 5550427222201 packetsize 128 128 windowsize 4 4
Router-3662(config-if)# x25 pvc 2 svc 5550427222202 packetsize 128 128 windowsize 4 4
Router-3662(config-if)# x25 pvc 3 svc 5550427222203 packetsize 128 128 windowsize 4 4
.
.
.
Router-3662(config-if)# x25 pvc 7 svc 5550427222207 packetsize 128 128 windowsize 4 4
```

Step 17   Set the clock rate to 9600 baud:

```
Router-3662(config-if)# clockrate 9600
```

Step 18   Set the LAPB T1 timer to 5000:

```
Router-3662(config-if)# lapb t1 5000
```

Step 19   Set the LAPB T2 timer to 200:

```
Router-3662(config-if)# lapb t2 200
```

Step 20   Set the LAPB T4 timer to 10:

```
Router-3662(config-if)# lapb t4 10
```

Step 21   Set the LAPB N2 timer to 7:

```
Router-3662(config-if)# lapb n2 7
```

Step 22 Set the LAPB K timer to 4:

```
Router-3662(config-if)# lapb k 4
```

Step 23 Exit interface configuration mode:

```
Router-3662(config-if)# end
```

Configure the Backup Serial Interface

Step 24 Start interface configuration mode for serial interface 4/1, which specifies network module 4, port 1:

```
Router-3662(config)# interface serial 4/1
```

Step 25 Enter a description for the serial interface:

```
Router-3662(config-if)# SCC1 Link (UnManaged)
```

Step 26 Disable IP addresses on the interface:

```
Router-3662(config-if)# no ip address
```

Step 27 Configure X.25 DCE encapsulation on the serial interface:

```
Router-3662(config-if)# encapsulation x25 dce
```

Step 28 Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-3662(config-if)# x25 version 1980
```

Step 29 Configure the address for the X.25 serial interface:

```
Router-3662(config-if)# x25 address 5550427111100
```

Step 30 Set the low two-way VC channel to 8:

```
Router-3662(config-if)# x25 ltc 8
```

Step 31 Set the X.25 T10 timer to 30:

```
Router-3662(config-if)# x25 t10 30
```

Step 32 Set the X.25 T12 timer to 30:

```
Router-3662(config-if)# x25 t12 30
```

Step 33 Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 win 4
```

Step 34 Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 wout 4
```

Step 35 Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-3662(config-if)# x25 threshold 1
```

Step 36 Configure seven SVC-to-PVC conversions. Specify an X.25 packet size of128, and input and output window sizes of 4 for these interfaces:

```
Router-3662(config-if)# x25 pvc 1 svc 5550427222201 packetsize 128 128 windowsize 4 4
Router-3662(config-if)# x25 pvc 2 svc 5550427222202 packetsize 128 128 windowsize 4 4
Router-3662(config-if)# x25 pvc 3 svc 5550427222203 packetsize 128 128 windowsize 4 4
```

```
        .
        .
        .
        Router-3662(config-if)# x25 pvc 7 svc 5550427222207 packetsize 128 128 windowsize 4 4
```

Step 37 Set the clock rate to 9600 baud:

```
Router-3662(config-if)# clockrate 9600
```

Step 38 Set the LAPB T1 timer to 5000:

```
Router-3662(config-if)# lapb t1 5000
```

Step 39 Set the LAPB T2 timer to 200:

```
Router-3662(config-if)# lapb t2 200
```

Step 40 Set the LAPB T4 timer to 10:

```
Router-3662(config-if)# lapb t4 10
```

Step 41 Set the LAPB N2 timer to 7:

```
Router-3662(config-if)# lapb n2 7
```

Step 42 Set the LAPB K timer to 4:

```
Router-3662(config-if)# lapb k 4
```

Step 43 Exit interface configuration mode:

```
Router-3662(config-if)# end
```

Enable X.25 Routing

Step 44 Create an entry in the X.25 routing table for X.25 address 55504271111 on serial interface 4/0:

```
Router-3662(config)# x25 route 55504271111 interface serial 4/0
```

Step 45 Create an entry in the X.25 routing table for X.25 address 55504271111 on serial interface 4/1:

```
Router-3662(config)# x25 route 55504271111 interface serial 4/1
```

Step 46 Exit global configuration mode:

```
Router-3662(config)# end
```

Step 47 Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3662# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

X.25 BAI Telephone Switch Side Configuration: Example

The Cisco 3662 router in Figure 25 on page 53 terminates the X.25 SVCs and converts them to the appropriate PVC. A unique calling address is used to map the SVC to the correct PVC mapping. Because the NMA does not actually generate a unique calling address, the unique calling address was created on the Cisco 3631 router using address substitution. The SVC-to-PVC conversion command is shown in the following example report for each interface.

In the following example, the ADMIN channel is mapped to PVC 4 by the calling address 5550427222204. The **backup active interface** command configures serial interface 4/1 as the backup to serial interface 4/0. The X.25 SVC call will be routed to the interface that is up (active). The X.25 routing table is built with the **x25 route** commands listed in the following example.

Serial interfaces 4/0 and 4/1 are set to a packet size of 128 and a window size of 4. Because BX.25 Issue 3 supports the 1980 version of X.25 code, you need to use the **x25 version** command (a hidden command) to set the interface to 1980. In addition, the router is configured to acknowledge every packet received with an X.25 threshold setting of one.

The following partial example lists the relevant router configuration commands for the Cisco 3662 router:

```
x25 routing
!
interface Serial4/0
 description SCC0 Link to 5ESS (UnManaged)
 no ip address
 encapsulation x25 dce
 backup active interface Serial4/1
 x25 version 1980
 x25 address 5550427111100
 x25 ltc 8
 x25 t10 30
 x25 t12 30
 x25 win 4
 x25 wout 4
 x25 threshold 1
 x25 pvc 1 svc 5550427222201 packetsize 128 128 windowsize 4 4
 x25 pvc 2 svc 5550427222202 packetsize 128 128 windowsize 4 4
 x25 pvc 3 svc 5550427222203 packetsize 128 128 windowsize 4 4
 x25 pvc 4 svc 5550427222204 packetsize 128 128 windowsize 4 4
 x25 pvc 5 svc 5550427222205 packetsize 128 128 windowsize 4 4
 x25 pvc 6 svc 5550427222206 packetsize 128 128 windowsize 4 4
 x25 pvc 7 svc 5550427222207 packetsize 128 128 windowsize 4 4
 clockrate 9600
 lapb T1 5000
 lapb T2 200
 lapb T4 10
 lapb N2 7
 lapb k 4
!
interface Serial4/1
 description SCC1 link (UnManaged)
 no ip address
 encapsulation x25 dce
 x25 version 1980
 x25 address 5550427111100
 x25 ltc 8
 x25 t10 30
 x25 t12 30
 x25 win 4
 x25 wout 4
 x25 threshold 1
 x25 pvc 1 svc 5550427222201 packetsize 128 128 windowsize 4 4
 x25 pvc 2 svc 5550427222202 packetsize 128 128 windowsize 4 4
 x25 pvc 3 svc 5550427222203 packetsize 128 128 windowsize 4 4
 x25 pvc 4 svc 5550427222204 packetsize 128 128 windowsize 4 4
 x25 pvc 5 svc 5550427222205 packetsize 128 128 windowsize 4 4
 x25 pvc 6 svc 5550427222206 packetsize 128 128 windowsize 4 4
 x25 pvc 7 svc 5550427222207 packetsize 128 128 windowsize 4 4
 clockrate 9600
 lapb T1 5000
```

```
 lapb T2 200
 lapb T4 10
 lapb N2 7
 lapb k 4
!
x25 route 55504271111 interface Serial4/0
x25 route 55504271111 interface Serial4/1
```

Verifying PVC-to-SVC Conversions

The X.25 PVCs are mapped to the X.25 SVCs. For example, PVC 4 is connected to SVC 5550427222204 mapped to 5550427111100. The calling address is 5550427222204, which is the NMA address with the subaddress 04 on the end. The called address is the X.121 address assigned to serial interface 4/0 and 4/1, which is the X.121 address 5550427111100. In the following example, serial interface 4/0 is up and serial interface 4/1 is in testing mode:

```
Router# show x25 vc

PVC 1,  State: D1,  Interface: Serial4/0
  Started 02:58:25, last input 00:00:00, output 00:01:39
  Connects 5550427222201 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11161
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 0  ACK: 7  Remote PR: 2  RCNT: 1  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 20/24720 packets 16/1236 Resets 687/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 2,  State: D1,  Interface: Serial4/0
  Started 02:58:25, last input 00:01:45, output never
  Connects 5550427222202 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11163
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 0  PR: 4  ACK: 4  Remote PR: 0  RCNT: 0  RNR: Rx
  P/D state timeouts: 0  timer (secs): 0
  data bytes 0/2924 packets 0/43 Resets 24/0 RNRs 0/46 REJs 0/0 INTs 0/0
PVC 3,  State: D1,  Interface: Serial4/0
  Started 02:58:25, last input 00:01:45, output 00:01:38
  Connects 5550427222203 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11166
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 4  ACK: 4  Remote PR: 2  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 24/4831 packets 16/63 Resets 10/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 4,  State: D1,  Interface: Serial4/0
  Started 02:58:30, last input 00:01:34, output 00:01:35
  Connects 5550427222204 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11164
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 3  PR: 6  ACK: 6  Remote PR: 3  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 67/400 packets 19/38 Resets 5/0 RNRs 0/1 REJs 0/0 INTs 0/0
PVC 5,  State: D1,  Interface: Serial4/0
  Started 02:57:35, last input 00:00:00, output 00:01:39
  Connects 5550427222205 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11165
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 0  ACK: 5  Remote PR: 2  RCNT: 3  RNR: no
  P/D state timeouts: 0  timer (secs): 0
```

```
     data bytes 8/202550 packets 8/1806 Resets 872/0 RNRs 0/2 REJs 0/0 INTs 0/0
PVC 6,  State: D1,  Interface: Serial4/0
  Started 02:58:32, last input 00:01:34, output 00:01:37
  Connects 5550427222206 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11162
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 3  PR: 6  ACK: 6  Remote PR: 3  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 23/300 packets 11/22 Resets 6/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 7,  State: D1,  Interface: Serial4/0
  Started 02:58:32, last input 00:01:35, output 00:01:38
  Connects 5550427222207 <--> 5550427111100 from
  XOT between 10.60.128.8, 1998 and 10.59.251.66, 11160
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  PS: 2  PR: 1  ACK: 1  Remote PR: 2  RCNT: 0  RNR: no
  P/D state timeouts: 0  timer (secs): 0
  data bytes 8/206 packets 8/2 Resets 6/0 RNRs 0/17 REJs 0/0 INTs 0/0
PVC 1,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:32, last input 00:01:59, output 00:08:30
  PVC <--> SVC to 5550427222201, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 1  timer (secs): 0
  data bytes 16/67500 packets 12/3375 Resets 102/1 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 2,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:34, last input 00:03:20, output never
  PVC <--> SVC to 5550427222202, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 0  timer (secs): 0
  data bytes 0/4624 packets 0/68 Resets 4/0 RNRs 0/66 REJs 0/0 INTs 0/0
PVC 3,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:34, last input 00:16:27, output 00:07:03
  PVC <--> SVC to 5550427222203, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 0  timer (secs): 0
  data bytes 49/7378 packets 27/131 Resets 4/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 4,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:34, last input 00:06:55, output 00:06:56
  PVC <--> SVC to 5550427222204, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 0  timer (secs): 0
  data bytes 53/632 packets 23/46 Resets 4/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 5,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:36, last input 00:02:02, output 00:07:02
  PVC <--> SVC to 5550427222205, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 0  timer (secs): 0
  data bytes 9/719695 packets 9/6672 Resets 118/0 RNRs 0/1 REJs 0/0 INTs 0/0
PVC 6,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:36, last input 00:07:01, output 00:07:01
  PVC <--> SVC to 5550427222206, not connected
  Window size input: 4, output: 4
  Packet size input: 128, output: 128
  P/D state timeouts: 0  timer (secs): 0
  data bytes 280/532 packets 28/56 Resets 5/0 RNRs 0/0 REJs 0/0 INTs 0/0
PVC 7,  State: P/Inactive,  Interface: Serial4/1
  Started 02:58:36, last input 00:07:03, output 00:07:00
  PVC <--> SVC to 5550427222207, not connected
```

```
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     P/D state timeouts: 0  timer (secs): 0
     data bytes 11/17298 packets 11/142 Resets 5/0 RNRs 0/57 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11160/10.60.128.8,1998]
     Started 00:02:01, last input 00:01:43, output 00:01:40
     Connects 5550427222207 <--> 5550427111100 from Serial4/0 PVC 7
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 1  PR: 2  ACK: 2  Remote PR: 1  RCNT: 0  RNR: no
     P/D state timeouts: 0  timer (secs): 0
     data bytes 103/2 packets 1/2 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11161/10.60.128.8,1998]
     Started 00:02:01, last input 00:01:51, output 00:00:00
     Connects 5550427222201 <--> 5550427111100 from Serial4/0 PVC 1
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 6  PR: 2  ACK: 2  Remote PR: 4  RCNT: 0  RNR: no
     P/D state timeouts: 0  timer (secs): 0
     data bytes 1240/2 packets 62/2 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11162/10.60.128.8,1998]
     Started 00:02:01, last input 00:01:42, output 00:01:39
     Connects 5550427222206 <--> 5550427111100 from Serial4/0 PVC 6
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 6  PR: 3  ACK: 3  Remote PR: 6  RCNT: 0  RNR: no
     P/D state timeouts: 0  timer (secs): 0
     data bytes 70/9 packets 6/3 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11163/10.60.128.8,1998]
     Started 00:02:02, last input never, output 00:01:58
     Connects 5550427222202 <--> 5550427111100 from Serial4/0 PVC 2
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 4  PR: 0  ACK: 0  Remote PR: 4  RCNT: 0  RNR: Tx
     P/D state timeouts: 0  timer (secs): 0
     data bytes 272/0 packets 4/0 Resets 0/0 RNRs 2/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11164/10.60.128.8,1998]
     Started 00:02:03, last input 00:01:44, output 00:01:42
     Connects 5550427222204 <--> 5550427111100 from Serial4/0 PVC 4
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 6  PR: 3  ACK: 3  Remote PR: 6  RCNT: 0  RNR: no
     P/D state timeouts: 0  timer (secs): 0
     data bytes 70/9 packets 6/3 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11165/10.60.128.8,1998]
     Started 00:02:03, last input 00:01:48, output 00:00:00
     Connects 5550427222205 <--> 5550427111100 from Serial4/0 PVC 5
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 7  PR: 2  ACK: 2  Remote PR: 3  RCNT: 0  RNR: no
     Window is closed
     P/D state timeouts: 0  timer (secs): 0
     data bytes 20826/2 packets 191/2 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
SVC 1,  State: D1,  Interface: [10.59.251.66,11166/10.60.128.8,1998]
     Started 00:02:05, last input 00:01:54, output 00:02:01
     Connects 5550427222203 <--> 5550427111100 from Serial4/0 PVC 3
     Window size input: 4, output: 4
     Packet size input: 128, output: 128
     PS: 4  PR: 2  ACK: 2  Remote PR: 4  RCNT: 0  RNR: no
     P/D state timeouts: 0  timer (secs): 0
     data bytes 48/2 packets 4/2 Resets 0/0 RNRs 0/0 REJs 0/0 INTs 0/0
```

The X.25 routing table for the 3662 router follows. A call placed to 5550427111100 will try serial interface 4/0 first. If serial interface 4/0 is in testing mode or is down, the Cisco IOS software examines serial interface 4/1 next. If serial interface 4/1 is up the call will be routed on serial interface 4/1.

```
Router# show x25 route

#   Match                         Substitute            Route to
1   dest 55504271111                                    Serial4/0
2   dest 55504271111                                    Serial4/1
```

Configuring SCC0 and SCC1 on the Lucent 5ESS Telephone Switch Form

The Lucent 5ESS cpblx form follows with an example configuration of the SCC0 and SCC1 ports in bold text. (See the "Lucent cpblx Form Parameter Descriptions" section on page 110 for descriptions of important fields in this form.) The configuration in the form was used with the testing described for the Cisco X.25 BAI feature. The switch technician configures the port setup from the switch console. Notice that field 65 has an X.25 packet size of 128. Fields 59 and 61 are the output and input buffer sizes, respectively. These fields must be three bytes larger than the packet size. In the example, the packet size is 128 and the buffer size is 131.

```
                                        cpblx3
Communications Protocol Option Block                  (Recent Change and Verify)

     1.option_name:cpblx300

     2.speed:9600              3.duplex:full           4.ds_type:201CPL

     5.carrier:s               6.line_access:direct    7.mode_op:b

     8.pdtime1:30              9.pdtime2:50            10.window:4

    11.rexmit:7               12.dcedte:0             13.pcsd_stat:active

    14.config:duplex

    15.ldtel        sid           tlim           telno
                1)_____        ____        _____
                2)_____        ____        _____
                3)_____        ____        _____
                4)_____        ____        _____

    19.security:n          20.link_id:0

    21.feid_len:0          22.neid_len:0          23.password_len:0

    24.feid.fend
            1)_____    4)_____    7)_____    10)_____    13)_____
            2)_____    5)_____    8)_____    11)_____    14)_____
            3)_____    6)_____    9)_____    12)_____    15)_____

    35.neid.nend
            1)_____    4)_____    7)_____    10)_____    13)_____
            2)_____    5)_____    8)_____    11)_____    14)_____
            3)_____    6)_____    9)_____    12)_____    15)_____

    46.pswrd.pwrd
            1)_____    4)_____    7)_____    10)_____    13)_____
            2)_____    5)_____    8)_____    11)_____    14)_____
            3)_____    6)_____    9)_____    12)_____    15)_____
```

```
57.perm_state:allow        58.outscrsiz:3300        59.outpktsiz:131

                           60.inscrsiz:3300         61.inpktsiz:131

62.hup:n      63.spckt:0   64.x3wsize:4             65.x3psize:128

66.x3pvcn.ldinno

        1)_____    6)5      11)_____    16)_____    21)_____    26)_____    31)_____
        2)_____    7)6      12)_____    17)_____    22)_____    27)_____    32)_____
        3)2        8)7      13)_____    18)_____    23)_____    28)_____
        4)3        9)_____  14)_____    19)_____    24)_____    29)_____
        5)4       10)_____  15)_____    20)_____    25)_____    30)_____

81.time_ti:180   82.time_tj:60    83.time_tf:60    84.time_tl:60

85.time_td:180   86.time_ts:180   87.time_ack:5
```
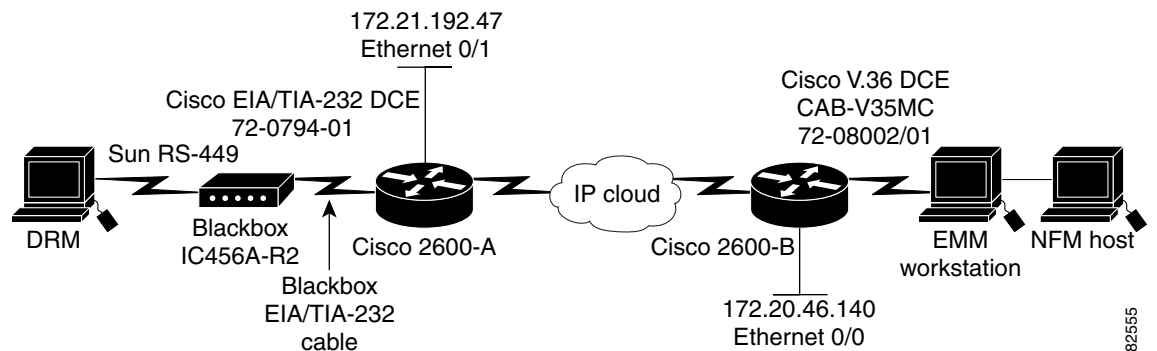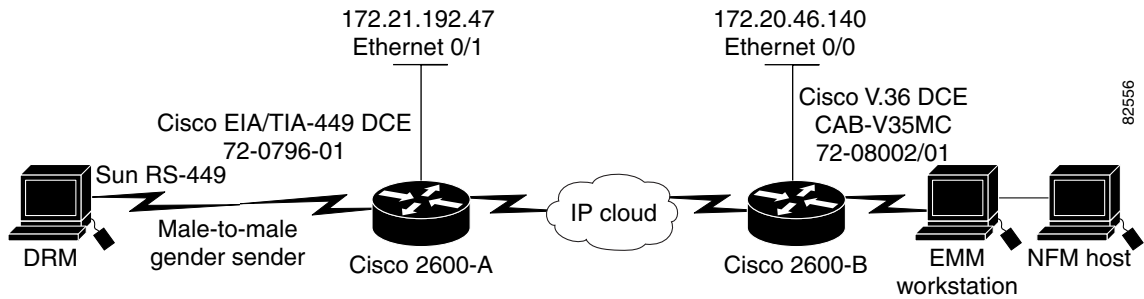
Monitoring the Lucent DRM

The Lucent Distinctive Remote Module (DRM) is a small remote switch that is a slave to the Lucent 5ESS telephone switch. The DRM is used to service small office parks. The DRM is based on a Sun Microsystems workstation platform. The monitoring of the DRM is done over one physical connection, so there is no standby connection to be configured like there is for the Lucent 5ESS telephone switch. The connection from the Lucent DRM is EIA/TIA-449 (RS-449). The typical Lucent installation is done with an (EIA/TIA) RS-449-to-RS-232 convertor from Blackbox Corporation. Figure 27 shows an initial sample test network that was set up to test a Cisco STUN implementation and an XOT implementation.

Figure 26   *Lucent DRM Preliminary Test Configurations*

The actual network also was tested with an EIA/TIA-449 connection between the DRM and the router. The test setup is shown in Figure 27.

Figure 27   Lucent DRM Network Test Configurations

Configuring the Lucent DRM

Examples of the STUN configurations for the routers labeled 2600-A and 2600-B are listed in the following sections:

- Lucent DRM-Side Configuration: Example, page 70
- Application Host Configuration: Example, page 70

Troubleshooting a single connection is the same process as described in the "Verifying Links in the Cisco STUN OSS Connectivity Solution" section on page 49, which describes enabling two STUN links for the SCC0 and SCC1 connections to a Lucent 5ESS telephone switch.

Note   Another method to extend the single monitoring connection over an IP backbone would be to use XOT. XOT was described in the "CDR Bill Collection Networks: Cisco XOT and RBP Solutions" section on page 7.

Lucent DRM-Side Configuration: Example

In the following configuration example, the STUN peer name is the IP address of the Ethernet port. The loopback address would also be another and possibly better choice.

```
stun peer-name 172.21.192.47
stun protocol-group 103 basic
!
interface Ethernet0/1
 ip address 172.21.192.47 255.255.255.0
!
interface Serial1/0
 no ip address
 encapsulation stun
 clockrate 9600
 stun group 103
 stun route all tcp 172.20.46.140
```

Application Host Configuration: Example

In the following configuration example, the STUN peer name is the IP address of the Ethernet port:

```
stun peer-name 172.20.46.140
stun protocol-group 103 basic
!
interface Ethernet0/0
```

```
 ip address 172.20.46.140 255.255.255.0
!
interface Serial1/6
 description CO1 to CO2
 no ip address
 encapsulation stun
 no ignore-hw local-loopback
 clockrate 9600
 stun group 103
 stun route all tcp 172.21.192.47
```

Switch Monitoring Networks: IP and Cisco X.25 BAI and EOR Solutions

The obvious next step in migrating to the next generation operations network is to move applications to TCP/IP. The solutions described in earlier sections for monitoring the Lucent 5ESS switch used dual serial BX.25 ports or a serial X.25 port on the OSS. Service providers and vendors are working with Cisco to make the transition to TCP/IP on the OSS. The two OSS solutions that have migrated to TCP/IP for monitoring Class 5 switches are described in the following section:
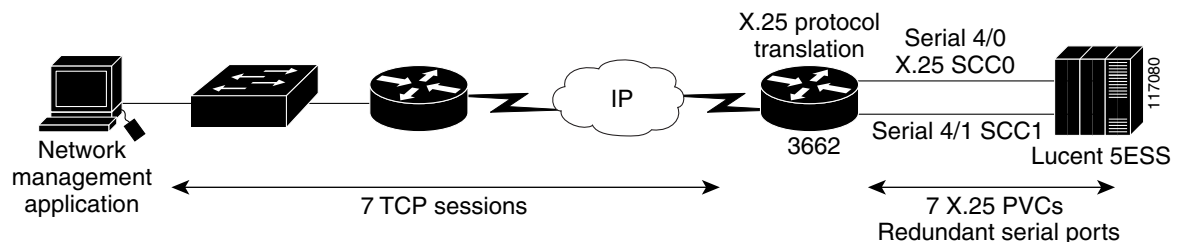
- Configuring a Cisco Router with X.25 BAI and EOR on the Telephone Switch Side of the Network, page 71
- TTI Telecom Monitoring Application Cisco X.25 BAI Solution, page 79

The examples for the solutions described in this section focus on the Lucent 5ESS switch because of the unique properties of its SCC0 and SCC1 ports. This section also highlights solutions for the Telcordia NMA application and the TTI Telecom monitoring application.

Configuring a Cisco Router with X.25 BAI and EOR on the Telephone Switch Side of the Network

Previous sections described a solution using the **backup active interface** command (see the "Adding Cisco X.25 BAI to the Telco DCN" section on page 53). This section builds on that configuration. The NMA application is configured for an IP gateway. The router is configured with Cisco protocol translation and the X.25 BAI feature. The PVCs are configured as dynamic. Additionally, the configuration described in this section requires use of the End of Record (EOR) feature. A hexadecimal value of 19 is configured as the end of record. The NMA profile is configured to parse for the EOR character and to forward the data from an optical convergence switch (OCS) module to the application upon receipt of the EOR.

Figure 28   *Cisco IP to X.25 BAI with EOR Solution for OSS Connectivity*

To configure the X.25 BAI and EOR solution on a Cisco 3662 router in front of the Lucent 5ESS switch, see Figure 28 and perform the following steps. See the "Cisco Router with X.25 BAI and EOR on the Telephone Switch Side of the Network: Example" section on page 75 for a configuration example. See the "Verifying Cisco X.25 BAI and EOR Configurations" section on page 76 for a verification example.

Step 1 Enter configuration mode:

```
Router-3662# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 2 Enable X.25 routing:

```
Router-3662(config)# x25 routing
```

Configure the Active Serial Interface

Step 3 Start interface configuration mode for serial interface 4/0, which specifies network module 4, port 0:

```
Router-3662(config)# interface serial 4/0
```

Step 4 Enter a description for the serial interface:

```
Router-3662(config-if)# SCC0 Link to 5ESS (UnManaged)
```

Step 5 Disable IP addresses on the interface:

```
Router-3662(config-if)# no ip address
```

Step 6 Configure X.25 DCE encapsulation on the serial interface:

```
Router-3662(config-if)# encapsulation x25 dce
```

Step 7 Configure serial interface 4/1 as the backup to serial interface 4/0:

```
Router-3662(config-if)# backup active interface serial 4/1
```

Step 8 Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-3662(config-if)# x25 version 1980
```

Step 9 Configure the address for the X.25 serial interface:

```
Router-3662(config-if)# x25 address 12345678
```

Step 10 Set the low two-way VC channel to 8:

```
Router-3662(config-if)# x25 ltc 8
```

Step 11 Set the X.25 T10 timer to 30:

```
Router-3662(config-if)# x25 t10 30
```

Step 12 Set the X.25 T12 timer to 30:

```
Router-3662(config-if)# x25 t12 30
```

Step 13 Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 win 4
```

Step 14 Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 wout 4
```

Step 15 Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-3662(config-if)# x25 threshold 1
```

Step 16 Set the clock rate to 9600 baud:

```
Router-3662(config-if)# clockrate 9600
```

Step 17 Set the LAPB T1 timer to 5000:

```
Router-3662(config-if)# lapb t1 5000
```

Step 18 Set the LAPB T2 timer to 200:

```
Router-3662(config-if)# lapb t2 200
```

Step 19 Set the LAPB T4 timer to 10:

```
Router-3662(config-if)# lapb t4 10
```

Step 20 Set the LAPB N2 timer to 7:

```
Router-3662(config-if)# lapb n2 7
```

Step 21 Set the LAPB K timer to 4:

```
Router-3662(config-if)# lapb k 4
```

Step 22 Exit interface configuration mode:

```
Router-3662(config-if)# end
```

Configure the Backup Serial Interface

Step 23 Start interface configuration mode for serial interface 4/1, which specifies network module 4, port 1:

```
Router-3662(config)# interface serial 4/1
```

Step 24 Enter a description for the serial interface:

```
Router-3662(config-if)# SCC1 Link (UnManaged)
```

Step 25 Disable IP addresses on the interface:

```
Router-3662(config-if)# no ip address
```

Step 26 Configure X.25 DCE encapsulation on the serial interface:

```
Router-3662(config-if)# encapsulation x25 dce
```

Step 27 Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-3662(config-if)# x25 version 1980
```

Step 28 Configure the address for the X.25 serial interface:

```
Router-3662(config-if)# x25 address 12345678
```

Step 29 Set the low two-way VC channel to 8:

```
Router-3662(config-if)# x25 ltc 8
```

Step 30 Set the X.25 T10 timer to 30:

```
Router-3662(config-if)# x25 t10 30
```

Step 31   Set the X.25 T12 timer to 30:

```
Router-3662(config-if)# x25 t12 30
```

Step 32   Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 win 4
```

Step 33   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 4:

```
Router-3662(config-if)# x25 wout 4
```

Step 34   Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-3662(config-if)# x25 threshold 1
```

Step 35   Set the clock rate to 9600 baud:

```
Router-3662(config-if)# clockrate 9600
```

Step 36   Set the LAPB T1 timer to 5000:

```
Router-3662(config-if)# lapb t1 5000
```

Step 37   Set the LAPB T2 timer to 200:

```
Router-3662(config-if)# lapb t2 200
```

Step 38   Set the LAPB T4 timer to 10:

```
Router-3662(config-if)# lapb t4 10
```

Step 39   Set the LAPB N2 timer to 7:

```
Router-3662(config-if)# lapb n2 7
```

Step 40   Set the LAPB K timer to 4:

```
Router-3662(config-if)# lapb k 4
```

Step 41   Exit interface configuration mode:

```
Router-3662(config-if)# end
```

Enable Protocol Translation

Step 42   Configure protocol translations statements to convert the incoming TCP session to an X.25 PVC. The **dynamic** keyword works with the **backup active interface** command to allow the switching between SCC0 and SCC1. The **EOR** keyword inserts a hexadecimal value of 19 at the end of a record being sent to the NMA application. The NMA application must be set up to parse for the EOR.

```
Router-3662(config-if)# translate tcp 10.60.150.128 port 1031 x25 12345678 pvc 1 dynamic
max-users 1 EOR 0x19 insert
Router-3662(config-if)# translate tcp 10.60.150.128 port 1032 x25 12345678 pvc 2 dynamic
max-users 1 EOR 0x19 insert
Router-3662(config-if)# translate tcp 10.60.150.128 port 1033 x25 12345678 pvc 3 dynamic
max-users 1 EOR 0x19 insert
Router-3662(config-if)# translate tcp 10.60.150.128 port 1034 x25 12345678 pvc 4 dynamic
max-users 1 EOR 0x19 insert
Router-3662(config-if)# translate tcp 10.60.150.128 port 1035 x25 12345678 pvc 5 dynamic
max-users 1 EOR 0x19 insert
Router-3662(config-if)# translate tcp 10.60.150.128 port 1036 x25 12345678 pvc 6 dynamic
max-users 1 EOR 0x19 insert
```

```
Router-3662(config-if)# translate tcp 10.60.150.128 port 1037 x25 12345678 pvc 7 dynamic
max-users 1 EOR 0x19 insert
```

Enable X.25 Routing

Step 43   Create an entry in the X.25 routing table for X.25 address 12345678 on serial interface 4/0:

```
Router-3662(config)# x25 route 12345678 interface Serial4/0
```

Step 44   Create an entry in the X.25 routing table for X.25 address 12345678 on serial interface 4/1:

```
Router-3662(config)# x25 route 12345678 interface Serial4/1
```

Step 45   Exit global configuration mode:

```
Router-3662(config)# end
```

Step 46   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-3662# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco Router with X.25 BAI and EOR on the Telephone Switch Side of the Network: Example

The following shows an example of the configuration once the steps listed in the "Configuring a Cisco Router with X.25 BAI and EOR on the Telephone Switch Side of the Network" section are completed. Remember that the configuration on the router must match the configuration on the Lucent 5ESS; therefore, the X.25 and LAPB parameters must match.

```
x25 routing

interface Serial4/0
 description SCC0 Link to 5ESS (UnManaged)
 no ip address
 encapsulation x25 dce
 backup active interface Serial4/1
 x25 version 1980
 x25 address 12345678
 x25 ltc 8
 x25 t10 30
 x25 t12 30
 x25 win 4
 x25 wout 4
 x25 threshold 1
 clockrate 9600
 lapb T1 5000
 lapb T2 200
 lapb T4 10
 lapb N2 7
 lapb k 4
!
interface Serial4/1
 description SCC1 link (UnManaged)
 no ip address
 encapsulation x25 dce
 x25 version 1980
 x25 address 12345678
 x25 ltc 8
 x25 t10 30
```

```
        x25 t12 30
        x25 win 4
        x25 wout 4
        x25 threshold 1
        clockrate 9600
        lapb T1 5000
        lapb T2 200
        lapb T4 10
        lapb N2 7
        lapb k 4

x25 route 12345678 interface Serial4/0
x25 route 12345678 interface Serial4/1
!
translate tcp 10.60.150.128 port 1031 x25 12345678 pvc 1 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1032 x25 12345678 pvc 2 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1033 x25 12345678 pvc 3 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1034 x25 12345678 pvc 4 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1035 x25 12345678 pvc 5 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1036 x25 12345678 pvc 6 dynamic max-users 1 EOR 0x19
insert
translate tcp 10.60.150.128 port 1037 x25 12345678 pvc 7 dynamic max-users 1 EOR 0x19
insert
```

Verifying Cisco X.25 BAI and EOR Configurations

The following sections contain useful information for verifying the Cisco X.25 BAI and EOR configurations:

- Verifying the Active Interface with the show interface Command, page 76
- Verifying the Interface Type and Clock Rate with the show controllers Command, page 78
- Verifying the Active TCP Connection with the show tcp brief Command, page 79

Following is a list of additional EXEC commands that can be used to troubleshoot the configurations:

- **debug pad**
- **debug translate**
- **debug x25 event**
- **show controllers**
- **show debug**
- **show interface**
- **show running configuration**
- **show tcp brief**
- **show version**

Verifying the Active Interface with the show interface Command

The **show interface** command can be used to determine which router interface is active to the Lucent 5ESS switch and which interface is in the Standby mode. The active interface will be listed as up and line protocol as up. The following is sample output from the **show interface serial 4/0** command:

```
Router-3662# show interface serial 4/0

Serial4/0 is up, line protocol is up
  Hardware is CD2430 in sync mode
  Description: SCC0 Link to 5ESS (UnManaged)
  Backup interface Serial4/1, failure delay 0 sec, secondary disable delay 0 sec,
  kickin load not set, kickout load not set
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
      reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation X25, loopback not set
  X.25 DCE, address 12345678, state R1, modulo 8, timer 0
      Defaults: idle VC timeout 0
        cisco encapsulation
        input/output window sizes 4/4, packet sizes 128/128
      Timers: T10 30, T11 180, T12 30, T13 60
      Channels: Incoming-only none, Two-way 8-1024, Outgoing-only none
      RESTARTs 25/0 CALLs 0+0/0+0/0+0 DIAGs 2/0
  LAPB DCE, state CONNECT, modulo 8, k 4, N1 12056, N2 7
      T1 5000, T2 200, interface outage (partial T3) 0, T4 10
      VS 0, VR 3, tx NR 3, Remote VR 0, Retransmissions 0
      Queues: U/S frames 0, I frames 0, unack. 0, reTx 0
      IFRAMEs 4042/4218 RNRs 0/0 REJs 0/0 SABM/Es 11/23 FRMRs 0/0 DISCs 0/2
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters 01:21:32
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue :3/40 (size/max)
  5 minute input rate 1000 bits/sec, 4 packets/sec
  5 minute output rate 0 bits/sec, 2 packets/sec
     8553 packets input, 383358 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     4497 packets output, 21498 bytes, 0 underruns
     0 output errors, 0 collisions, 3 interface resets
     0 output buffer failures, 0 output buffers swapped out
     4 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

The interface supporting the SCC channel in Standby mode will be listed as "testing." In the following example, serial interface 4/1 is connected to SCC1, which is in Standby mode. The report from the **show interface serial 4/1** command shows the interface is in testing mode (highlighted for purpose of example in bold text), instead of up or down. The line protocol is down.

```
Router-3662# show interface serial 4/1

Serial4/1 is testing, line protocol is down
  Hardware is CD2430 in sync mode
  Description: SCC1 link (UnManaged)
  Backup interface Serial4/0, failure delay 0 sec, secondary disable delay 0 sec,
  kickin load not set, kickout load not set
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
      reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation X25, loopback not set
  X.25 DCE, address 12345678, state R/Inactive, modulo 8, timer 0
      Defaults: idle VC timeout 0
        cisco encapsulation
        input/output window sizes 4/4, packet sizes 128/128
      Timers: T10 30, T11 180, T12 30, T13 60
      Channels: Incoming-only none, Two-way 8-1024, Outgoing-only none
      RESTARTs 23/0 CALLs 0+0/0+0/0+0 DIAGs 0/0
  LAPB DCE, state DISCONNECT, modulo 8, k 4, N1 12056, N2 7
      T1 5000, T2 200, interface outage (partial T3) 0, T4 10
      VS 0, VR 0, tx NR 0, Remote VR 0, Retransmissions 0
```

```
        Queues: U/S frames 0, I frames 0, unack. 0, reTx 0
        IFRAMEs 20/0 RNRs 0/0 REJs 0/0 SABM/Es 0/23 FRMRs 0/0 DISCs 0/0
   Last input 00:00:00, output 00:00:23, output hang never
   Last clearing of "show interface" counters 01:21:41
   Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
   Queueing strategy: fifo
   Output queue :0/40 (size/max)
   5 minute input rate 0 bits/sec, 0 packets/sec
   5 minute output rate 0 bits/sec, 0 packets/sec
       57 packets input, 114 bytes, 0 no buffer
       Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
       0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
       60 packets output, 220 bytes, 0 underruns
       0 output errors, 0 collisions, 3 interface resets
       0 output buffer failures, 0 output buffers swapped out
       0 carrier transitions
       DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Verifying the Interface Type and Clock Rate with the show controllers Command

Another useful command to verify the interface type and the interface clock rate is the **show controllers** command. Sample output from the **show controllers serial 4/0** command follows. The third line of the output (in bold text) shows that the cable type on the interface is RS-232 DCE and the clock rate is 9600 baud.

```
Router-3662# show controllers serial 4/0

CD2430 Slot 4, Port 0, Controller 0, Channel 0, Revision 18
Channel mode is synchronous serial
idb 0x61B1445C, buffer size 1524, RS-232 DCE cable, clockrate 9600

Global registers
  rpilr 0x2, rir 0x0, risr 0x0, rfoc 0x0, rdr 0x0
  tpilr 0x1, tir 0x0, tisr 0x68, tftc 0x0, tdr 0x90
  mpilr 0x3, mir 0x0, misr 0x60
  bercnt 0xFF, stk 0x0
Per-channel registers for channel 0
  Option registers
  0x02 0x00 0x42 0x67 0x60 0x00 0x00
  Command and status registers
  cmr 0xC0, ccr 0x00, csr 0xCC, msvr-rts 0xF1, msvr-dtr 0xF1
  Clock option registers
  rcor 0x86, rbpr 0x01, tcor 0xC0, tbpr 0x77
  Interrupt registers
  ier 0x89, livr 0x00, licr 0x00
  DMA buffer status 0x22
  DMA receive registers
  arbaddr 0xFA370E4, arbcnt 1548, arbsts 0x1
  brbaddr 0xFA36A64, brbcnt 1548, brbsts 0x1
  rcbaddr 0xFA363E6
  DMA transmit registers
  atbaddr 0xF8014D6, atbcnt 5, atbsts 0x62
  btbaddr 0xFCADDF6, btbcnt 5, btbsts 0x62
  tcbaddr 0xFCADDFB
  Special character registers
  schr1 0x00, schr2 0x00, schr3 0x00, schr4 0x00
  scrl 0x0, scrh 0x0, lnxt 0xF1
Driver context information
  Context structure 0x61B16C78, Register table 0x3E800400
  Serial Interface Control 5:1 Register (0x3E800802) is 0x80
  Adaptor Flags 0x0
  Serial Modem Control Register (0x3E800804) is 0x1D
  Receive static buffer 0x61A520B0
```

```
    Receive particle buffers 0x61B17240, 0x61B17200
    Transmit DMA buffers 0x0, 0x0, 0x0, 0x0
    Transmit packet with particles 0x0, first word is 0x0
    Interrupt rates (per second) transmit 1, receive 3, modem 0
    True fast-switched packets    0
    Semi fast-switched packets    0
    Transmitter hang count        0
    Residual indication count     0
    Bus error count        0
    Aborted short frames count    0
    CRC short frames count        0
Error counters
    CTS deassertion failures      0
    Nested interrupt errors transmit 0, receive 0, modem 0
```

Verifying the Active TCP Connection with the show tcp brief Command

To verify the TCP connections from the NMA, use the **show tcp brief** command. The following is
sample output from this command. The output shows TCP connections to IP address 10.6.15.128, which
is the virtual IP address for protocol translation. There are seven TCP sessions, which translate into the
seven PVCs. The seven TCP port numbers are 1031, 1032, 1033, 1034, 1035, 1036, and 1037.

```
Router# show tcp brief

TCB       Local Address         Foreign Address       (state)
6220F464  10.6.15.128.1037      nma.nn.4510           ESTAB
62217D44  10.6.15.128.1033      nma.nn.4508           ESTAB
6220AE70  10.6.15.128.1035      nma.nn.4505           ESTAB
622101BC  10.6.15.128.1034      nma.nn.4504           ESTAB
6221731C  10.6.15.128.1032      nma.nn.4507           ESTAB
621FE0AC  10.6.15.128.1036      nma.nn.4503           ESTAB
621F1EF8  10.6.15.128.1031      nma.nn.4512           ESTAB
```

Note   The IP address used in protocol translation must come from a locally attached subnet to the router. The
IP address cannot be assigned to an interface on the router. In this example, the IP address is a free
address from Fast Ethernet interface 0/0. The configuration for Fast Ethernet interface 0/0 is listed next.

```
interface FastEthernet0/0
 ip address 10.6.15.1 255.255.255.0
 speed 100
 full-duplex
```

TTI Telecom Monitoring Application Cisco X.25 BAI Solution

The TTI Telecom monitoring application has an IP interface that can be used with a Cisco router to
monitor the BX.25 ports SCC0 and SCC1 on a Lucent 5ESS switch. The application is shown in
Figure 29. The router configuration for converting between TCP/IP and BX.25 utilizes Cisco protocol
translation. The configuration is very similar to the configuration used in the last section for the
Telcordia NMA application. The configuration requires two serial interfaces that are paired with the
backup active interface command. The PVCs in the protocol translation statements must be set up as
dynamic. The TTI application does not use the End of Record (EOR) feature. There must be an X.25
route statement that points to each serial interface. Use the commands in the "Verifying Cisco X.25 BAI
and EOR Configurations" section on page 76 to verify and troubleshoot this configuration.

Figure 29   *Cisco IP to BX.25 BAI Solution for OSS Connectivity*
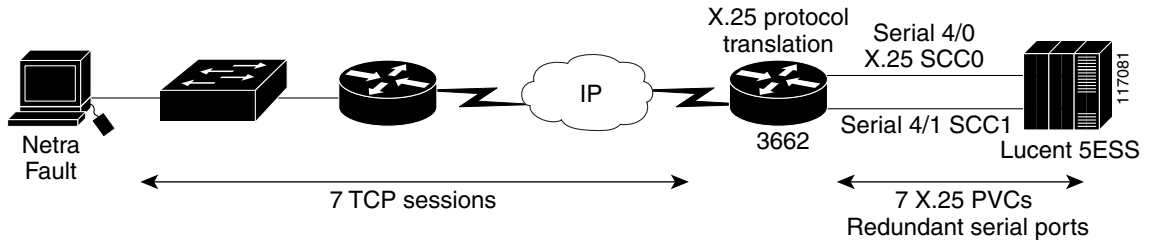
The following is a sample configuration for the TTI Telecom monitoring application. Remember that the configuration on the router must match the configuration on the Lucent 5ESS; therefore, the X.25 and LAPB parameters must match.

```
x25 routing

interface Serial4/0
 description SCC0 Link to 5ESS (UnManaged)
 no ip address
 encapsulation x25 dce
 backup active interface Serial4/1
 x25 version 1980
 x25 address 12345678
 x25 ltc 8
 x25 t10 30
 x25 t12 30
 x25 win 4
 x25 wout 4
 x25 threshold 1
 clockrate 9600
 lapb T1 5000
 lapb T2 200
 lapb T4 10
 lapb N2 7
 lapb k 4
!
interface Serial4/1
 description SCC1 link (UnManaged)
 no ip address
 encapsulation x25 dce
 x25 version 1980
 x25 address 12345678
 x25 ltc 8
 x25 t10 30
 x25 t12 30
 x25 win 4
 x25 wout 4
 x25 threshold 1
 clockrate 9600
 lapb T1 5000
 lapb T2 200
 lapb T4 10
 lapb N2 7
 lapb k 4

x25 route 12345678 interface Serial4/0
x25 route 12345678 interface Serial4/1
!
translate tcp 10.60.150.128 port 1031 stream x25 12345678 pvc 1 dynamic max-users 1
translate tcp 10.60.150.128 port 1032 stream x25 12345678 pvc 2 dynamic max-users 1
```

```
translate tcp 10.60.150.128 port 1033 stream x25 12345678 pvc 3 dynamic max-users 1
translate tcp 10.60.150.128 port 1034 x25 12345678 pvc 4 dynamic max-users 1
translate tcp 10.60.150.128 port 1035 x25 12345678 pvc 5 dynamic max-users 1
translate tcp 10.60.150.128 port 1036 x25 12345678 pvc 6 dynamic max-users 1
translate tcp 10.60.150.128 port 1037 x25 12345678 pvc 7 dynamic max-users 1
```

Provisioning Networks: Cisco X.25 RBP Solution

This section describes Cisco telco solutions for telephone switch provisioning networks like the one highlighted in Figure 30.

Figure 30   Legacy Switch Provisioning Network
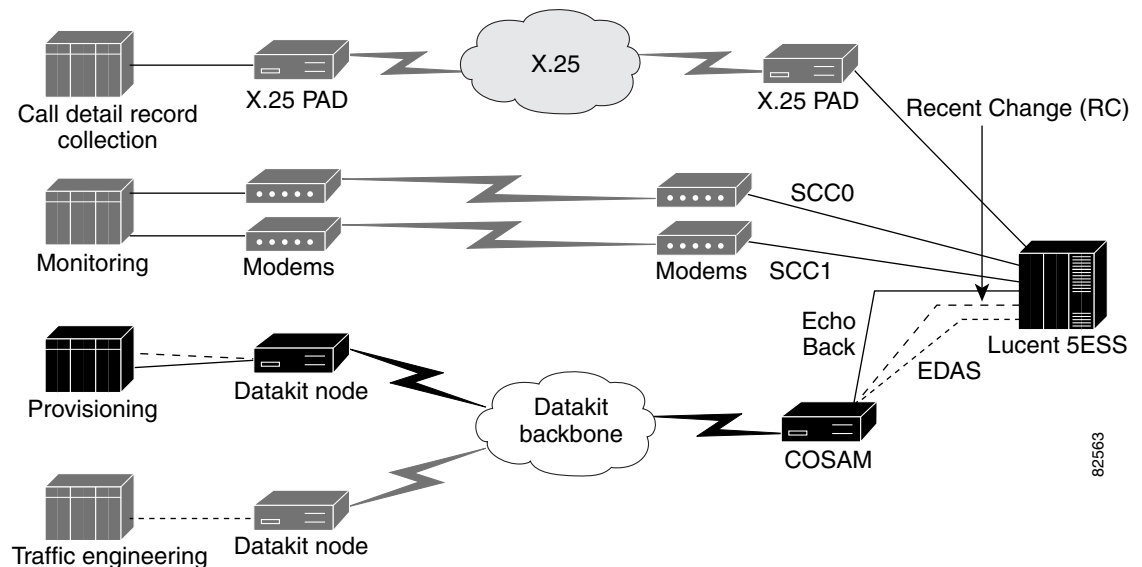
The Cisco X.25 RBP solution is described in the following sections:

Cisco X.25 RBP Solution Overview

Telco provisioning applications automate the assignment of Class 5 telephone switch resources for new voice services and connections.

Both Figure 30 and Figure 31 show a Recent Change (RC) port and Echo Back (EB) port on the Lucent 5ESS telephone switch connected over a Datakit network. The goal is to replace the Lucent Datakit network with a TCP/IP network, and one method available is XOT. However, a better method would be for the host to migrate to TCP/IP and to implement the Cisco X.25 RBP feature. Later in this section, CONNECTVU-ATP and the ADC Service Activation examples will focus on the Cisco X.25 RBP solution for migrating to TCP/IP. Figure 31 also shows the Cisco X.25 RBP implementation that was designed to replace the network seen in Figure 30.

The Cisco X.25 RBP feature enables hosts on a DCN using TCP/IP-based protocols to exchange data with devices that use the X.25 protocol, and to retain the logical record boundaries indicated, by use of the X.25 "more data" bit (M-bit).

The Cisco DCN solution provides a flexible design for TCP/IP-to-X.25 protocol mediation or TCP/IP-to-asynchronous conversion. The challenge is to preserve the M-bit of the X.25 session across the TCP/IP session, and the Cisco X.25 RBP feature does exactly that. The Cisco X.25 RBP allows a long list of changes to be submitted at one time to the Lucent 5ESS switch. As Figure 31 shows, a TCP/IP session is initiated in the CONNECTVU-APX application to the access router in the central office. The central office router terminates the TCP session and initiates an X.25 session. The CONNECTVU-APX application data is transferred between the TCP/IP session and the X.25 session by the access router in the central office. Refer to the *X.25 Record Boundary Preservation for Data Communications Networks* feature document for more information about the Cisco X.25 RBP feature. The solution is open to any vendor.

Before the introduction of the Cisco X.25 RBP feature, Cisco IOS software provided two methods for enabling the exchange of data between X.25 hosts and hosts using TCP/IP-based protocols: protocol translation and XOT. Protocol translation supports a variety of configurations, including translation of a data stream between an X.25 circuit that is using X.29 and a TCP session. The X.29 protocol is an integral part of protocol translation. One aspect of X.29 is that it is asymmetric and allows the packaging of data into X.25 packets to be controlled in one direction only. The TCP protocol is stream-oriented, rather than packet-oriented. TCP does not attach significance to TCP datagram boundaries, and those boundaries can change when a datagram is retransmitted. This inability to preserve boundaries makes protocol translation appropriate only for configurations in which the X.25 packet boundary is not significant.

XOT allows X.25 packets to be forwarded over a TCP session. This functionality allows full control over the X.25 circuit, but the host terminating the TCP session must implement the XOT protocol and the X.25 packet layer protocol.

The Cisco X.25 RBP feature offers a solution positioned between these two options: It allows logical message boundaries to be indicated without requiring the TCP host to be aware of X.25 protocol details.

The TCP protocol does not attach significance to datagram boundaries, so a protocol must be layered over a TCP session to convey record boundary information. The Cisco X.25 RBP feature uses a 6-byte record header that specifies the amount of data following and indicates whether that data should be considered the final part of a logical record.

Adding Cisco X.25 RBP to the Telco DCN Provisioning Connection

This section uses the Lucent CONNECTVU-ATP application to show how to add the Cisco X.25 RBP feature to the telco DCN.

The Lucent CONNECTVU-ATP solution shown in Figure 31 is designed to manage and provision telephony switch resources.

Figure 31   CONNECTVU-ATP Connected Using Cisco X.25 RBP
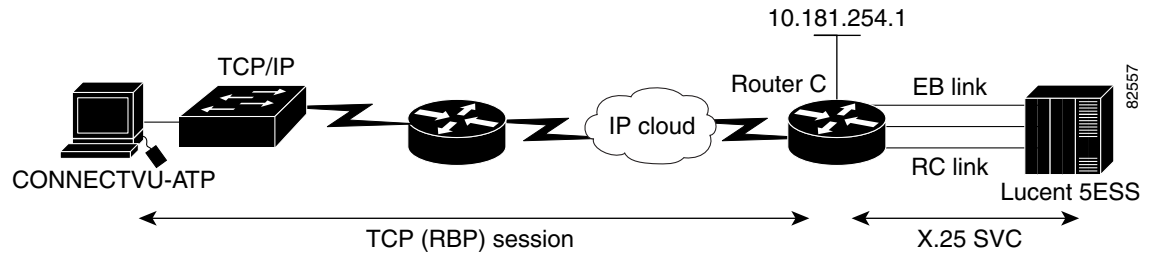
The Cisco telco DCN solutions are designed to provide all communications needs between the CONNECTVU-APX application and the Lucent 5ESS. All Cisco telco DCN solutions hardware is fully Network Equipment Building Systems (NEBS) 3-compliant. The Cisco telco DCN solution supports the CONNECTVU-APX application by providing protocol conversion and mediation for both the EB and RC connections to the Lucent 5ESS telephone switch.

Configuring the CONNECTVU-ATP Application

The CONNETVU-ATP application must be configured for the TCP/IP and the Record Boundary Preservation (RBP) header. Sample screen configurations follow, with user input in bold text. The RBP header is configured by setting the RC LINK INTF field and the EB LINK INTF to IP-X25-DY. The IP address of the router connected to the Echo Back and Recent Change ports is 10.181.254.1 and is listed in the address fields.

CONNECTVU-ATP Switch Administration

```
SWITCH CLLI:  LAB00 SWITCH NAME:  LAB00

GENERIC:  5E14       RC SERV:  LAB00RC     EB SERV:  LABD00EB

DMS LOGIN:DMS PASSWORD:          ASM LOGIN:

ASM MACHINE NAME (D&L):

INHIBIT RETRU INTVL:  10OFFICE ID: CVUNOVERIFY     MAX RC VCS: 4

RC LINK INTF:IP-X25-DY           EB LINK INTF: IP-X25-DY

RC DIALSTRING/IP ADDRESS:   10.181.254.1

EB DIALSTRING/IP ADDRESS:   10.181.254.1
```

Attributes for Recent Change Links TCP/IP Connectivity

```
    LINK ID 1 LINK ID 2 LINK ID 3 LINK ID 4

LOGIN:

PASSWORD:

SECURITY
CLASS:

TCP/IP
```

```
PORT: 20002        ?        ?            ?
```

Attributes for Echo Back Links TCP/IP Connectivity

```
     LINK ID 1 LINK ID 2 LINK ID 3 LINK ID 4

LOGIN:


PASSWORD:


SECURITY
CLASS:


TCP/IP
PORT: 20001      ?         ?  ?
```

Configuring the Lucent 5ESS Echo Back Port

This section describes configuration of the EB port on the Lucent 5ESS telephone switch. The parameters required for the CONNECTVU-APX application are listed in the following configuration examples, with user input in bold text. See the "Configuring the Echo Back Port on the Cisco Router" section on page 84 for the procedure to configure a Cisco router for the EB port.

The EB port X.25 administration table is as follows:

```
Interface Type:  RS232 / RS449
X121 local address: 5553501136_____
Baud Rate: 4800_____
Window Size: 128_____
Packet Size: 2_____
High two-way virtual circuit number: 3_____
T10: 60_____(Default) T11: 180___(Default)
T12: 60_____(Default) T13: 60 ___(Default)
T20: 180___(Default) T21: 200___(Default)
T22: 180___(Default) T23: 180___(Default)
```

The EB port LAPB administration table is as follows:

```
N1 Frame Size: 4136_____
Window Size:  7 (Default)
Interface Mode: DCE / DTE
Timers:
N2: 20____ (Default)
T1: 3000_ (Default)
T2: 400__
T4: 25____
```

Configuring the Echo Back Port on the Cisco Router

To configure the EB port on a Cisco router, see Figure 31 on page 83 and perform the following steps. See the "Echo Back Port Configuration: Example" section on page 86 for a configuration example.

Step 1   Verify that you are running Cisco IOS Release 12.2(8)T or a later software release that supports telco DCN functions:

```
Router-C# show version
```

Step 2   Enter configuration mode:

```
Router-C# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3 Select the serial interface for the EB port. In the example, serial interface 1/0 is used, which specifies network module 1, port 0:

```
Router-C(config)# interface serial 1/0
```

Step 4 Shut down the interface:

```
Router-C(config-if)#  shutdown
```

Step 5 Enter a description for the serial interface:

```
Router-C(config-if)# description EchoBack
```

Step 6 Enable X.25 DTE encapsulation on the interface. DTE is the default value for the interface:

```
Router-C(config-if)# encapsulation x25
```

Step 7 Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-C(config-if)# x25 version 1980
```

Step 8 Set the high two-way channel to 3 so that the SVC range will be from 1 to 3:

```
Router-C(config-if)# x25 htc 3
```

Step 9 Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-C(config-if)# x25 threshold 1
```

Step 10 Enable the RBP feature on the router. The Call User Data (CUD) field must be set to 0xC1. The customer sets the called X.121 address. In this example, the called X.121 address is 5553501136. You can specify the TCP port. In this example, the TCP port is set to 20001:

```
Router-C(config-if)# x25 map rbp 5553501136 cud 0xC1 local port 20001
```

Step 11 The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 9600 baud:

```
Router-C(config-if)# clockrate 9600
```

Step 12 Set the T2 parameter to 400 milliseconds, which specifies the length of time the DTE or DCE has before acknowledging a frame:

```
Router-C(config-if)# lapb t2 400
```

Step 13 Set the LAPB T4 timer to 25 seconds, which specifies the length of time the link can sit idle. The Cisco default for the LAPB T4 timer is 0, which disables the feature.

```
Router-C(config-if)# lapb t4 25
```

Step 14 The LAPB N1 parameter sets the maximum bits per frame. Set this timer to 4136:

```
Router-C(config-if)# lapb n1 4136
```

Step 15 Restart the interface:

```
Router-C(config-if)# no shutdown
```

Step 16 Exit the interface and global configuration modes:

```
Router-C(config-if)# end
Router-C(config)# end
```

Step 17 Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-C# copy run start(saves the configuration to non-volatile memory)
Destination filename [startup-config]?
Building configuration...
[OK]
```

Echo Back Port Configuration: Example

The following example shows the configuration of the EB port:

```
interface Serial1/0
 description EchoBack
 no ip address
 encapsulation x25
 no ip route-cache
 no ip mroute-cache
 x25 version 1980
 x25 htc 3
 x25 threshold 1
 x25 map rbp 5553501136 cud 0xC1 local port 20001
 clockrate 9600
 lapb T2 400
 lapb T4 25
 lapb N1 4136
```

Configuring the Lucent 5ESS Recent Change Port

This section describes configuration of the RC port on the Lucent 5ESS telephone switch. The parameters required for the CONNECTVU-APX application are listed in the following configuration examples, with user input in bold text. See the "Configuring the Recent Change Port on the Cisco Router" section on page 87 for the procedure to configure a Cisco router for the RC port.

The RC port X.25 administration table is as follows:

```
X.25 Connection Parameters for the Router: Recent Change  (Port Number: ____)
Interface Type:  RS232 / RS449
X121 local address: 5553501135_____
Baud Rate: 4800_____
Window Size: 128_____
Packet Size: 2_____
High two-way virtual circuit number: 4_____
T10: 60 ___(Default) T11: 180___(Default)
T12: 60____(Default) T13: 60____(Default)
T20: 180___(Default) T21: 200___(Default)
T22: 180___(Default) T23: 180___(Default)
```

The RC port LAPB administration table is as follows:

```
N1 Frame Size: 4136_____
Window Size:  7_(Default)
Interface Mode: DCE / DTE
Timers:
N2: 20____ (Default)
```

```
T1: 3000_ (Default)
T2: 400__
T4: 25___
```

Configuring the Recent Change Port on the Cisco Router

To configure the RC port on a Cisco router, see Figure 31 on page 83 and perform the following steps. See the "Recent Change Port Configuration: Example" section on page 88 for a configuration example. See the "Debugging the Echo Back and Recent Change Ports" section on page 88 for a debugging examples.

Step 1   Verify that you are running Cisco IOS Release 12.2(8)T or a later software release that supports telco DCN functions:

```
Router-C# show version
```

Step 2   Enter global configuration mode:

```
Router-C# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3   Select the serial interface for the RC port. In the example, serial interface 1/1 is used, which specifies network module 1, port 1:

```
Router-C(config-if)# interface serial 1/1
```

Step 4   Shut down the interface:

```
Router-C(config-if)# shutdown
```

Step 5   Enter a description for the serial interface:

```
Router-C(config-if)# description RecentChange
```

Step 6   Enable X.25 DTE encapsulation on the interface. DTE is the default X.25 encapsulation.

```
Router-C(config-if)# encapsulation x25 dte
```

Step 7   Set the X.25 version to 1980 using the **x25 version 1980** hidden command:

```
Router-C(config-if)# x25 version 1980
```

Step 8   Set the high two-way channel to 4 so that the SVC range will be from 1 to 4:

```
Router-C(config-if)# x25 htc 4
```

Step 9   Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-C(config-if)# x25 threshold 1
```

Step 10   Enable the RBP feature on the router. The CUD field must be set to 0xC1. The customer sets the called X.121 address. In this example, the called X.121 address is 5553501135. You can specify the TCP port. In this example, the TCP port is set to 20002:

```
Router-C(config-if)# x25 map rbp 5553501135 cud 0xC1 local port 20002
```

Step 11   Set the clock rate to 9600 baud:

```
Router-C(config-if)# clockrate 9600
```

Step 12   Set the T2 parameter to 400 milliseconds, which specifies the length of time the DTE or DCE has before acknowledging a frame:

```
Router-C(config-if)# lapb t2 400
```

Step 13   Set the LAPB T4 timer to 25 seconds, which is the length of time the link can sit idle. The Cisco default for the LAPB T4 timer is 0, which disables the feature.

```
Router-C(config-if)# lapb t4 25
```

Step 14   Set the LAPB N1 parameter to 4136, which determines the maximum bits per frame:

```
Router-C(config-if)# lapb n1 4136
```

Step 15   Restart the interface:

```
Router-C(config-if)# no shutdown
```

Step 16   Exit the interface and global configuration modes:

```
Router-C(config-if)# end
Router-C(config)# end
```

Step 17   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-C# copy run start
Destination filename [startup-config]?
Building configuration...
[OK]
```

Recent Change Port Configuration: Example

The following example shows the configuration of the RC port:

```
interface Serial1/1
 description RecentChange
 no ip address
 encapsulation x25
 no ip route-cache
 no ip mroute-cache
 x25 version 1980
 x25 htc 4
 x25 threshold 1
 x25 map rbp 5553501135 cud 0xC1 local port 20002
 clockrate 9600
 lapb T2 400
 lapb T4 25
 lapb N1 4136
```

Debugging the Echo Back and Recent Change Ports

The following procedure provides helpful hints on debugging problems with EB and RC port connectivity:

Step 1   Verify that the serial cable is correct. The **show controllers** EXEC command will display the type of cable connected to the router. In the example, the cable is connected to slot 1, port 2 on the router. The correct cable type is EIA/TIA-232 DCE for the EB and RC ports. A clock rate of 9600 baud can also be verified.

```
Router-C# show controllers serial 1/2

CD2430 Slot 1, Port 2, Controller 0, Channel 2, Revision 16
Channel mode is synchronous serial
idb 0x819D6014, buffer size 1524, RS-232 DCE cable, clockrate 9600

Global registers
  rpilr 0x2, rir 0x0, risr 0x0, rfoc 0x0, rdr 0x0
  tpilr 0x1, tir 0x0, tisr 0x0, tftc 0x0, tdr 0x0
  mpilr 0x3, mir 0x0, misr 0x0
  bercnt 0xFF, stk 0x0
Per-channel registers for channel 2
  Option registers
  0x02 0x00 0x42 0x67 0x60 0x00 0x00
  Command and status registers
  cmr 0xC0, ccr 0x00, csr 0x04, msvr-rts 0x10, msvr-dtr 0x10
  Clock option registers
  rcor 0x86, rbpr 0x01, tcor 0xC0, tbpr 0x77
  Interrupt registers
  ier 0x00, livr 0x08, licr 0x08
  DMA buffer status 0x00
  DMA receive registers
  arbaddr 0x35A8D04, arbcnt 1548, arbsts 0x1
  brbaddr 0x35A8684, brbcnt 1548, brbsts 0x1
  rcbaddr 0x0
  DMA transmit registers
  atbaddr 0x0, atbcnt 0, atbsts 0x0
  btbaddr 0x0, btbcnt 0, btbsts 0x0
  tcbaddr 0x0
  Special character registers
  schr1 0x00, schr2 0x00, schr3 0x00, schr4 0x00
  scrl 0x0, scrh 0x0, lnxt 0x0
Driver context information
  Context structure 0x819D8888, Register table 0x40800400
  Serial Interface Control 5:1 Register (0x4080080A) is 0x80
  Adaptor Flags 0x0
  Serial Modem Control Register (0x4080080C) is 0x14
  Receive static buffer 0x81919A04
  Receive particle buffers 0x819D9100, 0x819D90C0
  Transmit DMA buffers 0x0, 0x0, 0x0, 0x0
  Transmit packet with particles 0x0, first word is 0x0
  Interrupt rates (per second) transmit 0, receive 0, modem 0
  True fast-switched packets      0
  Semi fast-switched packets      0
  Transmitter hang count          0
  Residual indication count       0
  Bus error count          0
  Aborted short frames count      0
  CRC short frames count          0
Error counters
  CTS deassertion failures        0
  Nested interrupt errors transmit 0, receive 0, modem 0
```

Step 2   Verify that the interface is up. In the sample output, the physical interface is up but the line protocol is down. Notice at the bottom of the output shown, the physical leads are up. The physical cable connection is good, but Layer 2 is not up. You know that Layer 2 is down because line protocol is down.

```
Router-C# show interface serial 1/1

Serial1/1 is up, line protocol is down
  Hardware is CD2430 in sync mode
  Description: RecentChange
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
```

```
Encapsulation X25, loopback not set
X.25 DCE, address 5555275555, state R/Inactive, modulo 8, timer 0
    Defaults: idle VC timeout 0
      cisco encapsulation
      input/output window sizes 2/2, packet sizes 128/128
    Timers: T10 60, T11 180, T12 60, T13 60
    Channels: Incoming-only none, Two-way 1-1024, Outgoing-only none
    RESTARTs 0/0 CALLs 0+0/0+0/0+0 DIAGs 0/0
LAPB DCE, state SABMSENT, modulo 8, k 7, N1 12056, N2 20
    T1 3000, T2 0, interface outage (partial T3) 0, T4 0
    VS 0, VR 0, tx NR 0, Remote VR 0, Retransmissions 10
    Queues: U/S frames 0, I frames 0, unack. 0, reTx 0
    IFRAMEs 0/0 RNRs 0/0 REJs 0/0 SABM/Es 11/0 FRMRs 0/0 DISCs 0/0
Last input 00:00:02, output 00:00:00, output hang never
Last clearing of "show interface" counters 00:17:12
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue :0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
   14 packets input, 31 bytes, 0 no buffer
   Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
   0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
   13 packets output, 26 bytes, 0 underruns
   0 output errors, 0 collisions, 0 interface resets
   0 output buffer failures, 0 output buffers swapped out
   3 carrier transitions
   DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Step 3   Enable LAPB debugging to help determine the problem. If you are logged in to the router remotely, you will need to use the **terminal monitor** EXEC command to display the output on your terminal. The following output shows SABMs being sent out of the router. The bold LABP O report indicates that a packet is being sent out of the interface.

```
Router-C# terminal monitor

Router-C# debug lapb

LAPB link debugging is on
Router-C#
00:07:53: Serial1/1: LAPB T1 SABMSENT 473 17
00:07:53: Serial1/1: LAPB O SABMSENT (2) SABM P
00:07:56: Serial1/1: LAPB T1 SABMSENT 476 18
00:07:56: Serial1/1: LAPB O SABMSENT (2) SABM P
00:07:59: Serial1/1: LAPB T1 SABMSENT 479 19
00:07:59: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:02: Serial1/1: LAPB T1 SABMSENT 482 0
00:08:02: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:05: Serial1/1: LAPB T1 SABMSENT 485 1
00:08:05: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:08: Serial1/1: LAPB T1 SABMSENT 488 2
00:08:08: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:11: Serial1/1: LAPB T1 SABMSENT 491 3
00:08:11: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:14: Serial1/1: LAPB T1 SABMSENT 494 4
00:08:14: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:17: Serial1/1: LAPB T1 SABMSENT 497 5
00:08:17: Serial1/1: LAPB O SABMSENT (2) SABM P
00:08:20: Serial1/1: LAPB T1 SABMSENT 500 6
```

Step 4 The problem in the sample output is lack of clocking on the serial interface, so enable the clock rate and you should see the interface come up:

```
Router-C(config)# interface serial 1/1
Router-C(config-if)# shutdown

00:10:40: %LINK-5-CHANGED: Interface Serial1/1, changed state to administrative

Router-C(config-if)# clockrate 9600
Router-C(config-if)# no shutdown
Router-C(config-if)# end

00:11:25: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
00:11:26: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed stp
00:11:27: %SYS-5-CONFIG_I: Configured from console by console
```

Step 5 Check the LAPB output again. The report shows receiver ready packets going in (I) and out (O) of the serial interface, indicating that the protocol is up at Layer 2:

```
00:12:38: Serial1/1: LAPB I CONNECT (2) RR P 1
00:12:38: Serial1/1: LAPB O CONNECT (2) RR F 1
00:13:03: Serial1/1: LAPB I CONNECT (2) RR P 1
00:13:03: Serial1/1: LAPB O CONNECT (2) RR F 1

00:13:28: Serial1/1: LAPB I CONNECT (2) RR P 1
00:13:28: Serial1/1: LAPB O CONNECT (2) RR F 1
00:13:53: Serial1/1: LAPB I CONNECT (2) RR P 1
00:13:53: Serial1/1: LAPB O CONNECT (2) RR F 1
00:14:18: Serial1/1: LAPB I CONNECT (2) RR P 1
00:14:18: Serial1/1: LAPB O CONNECT (2) RR F 1
00:14:43: Serial1/1: LAPB I CONNECT (2) RR P 1
00:14:43: Serial1/1: LAPB O CONNECT (2) RR F 1
```

Step 6 Enter the **show interface** EXEC command to verify that the line protocol is up:

```
Router-C# show interface serial 1/1

Serial1/1 is up, line protocol is up
  Hardware is CD2430 in sync mode
  Description: RecentChange
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation X25, loopback not set
  X.25 DTE, address <none>, state R1, modulo 8, timer 0
     Defaults: idle VC timeout 0
       cisco encapsulation
       input/output window sizes 2/2, packet sizes 128/128
     Timers: T20 180, T21 200, T22 180, T23 180
     Channels: Incoming-only none, Two-way 1-4, Outgoing-only none
     RESTARTs 4/0 CALLs 0+10/0+0/0+0 DIAGs 0/0
  LAPB DTE, state CONNECT, modulo 8, k 7, N1 12056, N2 20
     T1 3000, T2 0, interface outage (partial T3) 0, T4 0
     VS 1, VR 1, tx NR 1, Remote VR 1, Retransmissions 0
     Queues: U/S frames 0, I frames 0, unack. 0, reTx 0
     IFRAMEs 38/4 RNRs 0/0 REJs 0/0 SABM/Es 74/3 FRMRs 0/0 DISCs 0/1
  Last input 00:00:21, output 00:00:21, output hang 02:36:08
  Last clearing of "show interface" counters 02:33:07
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue :0/40 (size/max)
```

Step 7 Debug the X.25 layer. There are a number of options for X.25 debugging.

⚠

Caution   If the routers are loaded with a production release of the software, be careful of which debugging features are used. You can enable debugging for a specific serial interface or events; the commands are shown.

```
Router-C# debug x25 ?

  all        Show all X.25 traffic (default)
  annexg     X.25 over Frame-Relay (Annex-G) Events
  aodi       Always On/Direct ISDN (PPP over X.25) events
  cmns       Show only CMNS traffic
  events     Show X.25 traffic without normal Data and RR packets
  interface  Show X.25 or CMNS traffic on one interface
  only       Show only X.25 traffic
  vc         X.25 traffic across a specific virtual circuit
  xot        Show only XOT (X.25-Over-TCP) traffic
  <cr>


Router-C# debug x25 interface serial 1/2

X.25 packet debugging is on
X.25 debug output restricted to interface Serial1/2
Router-C#


Router-C# debug x25 events

X.25 special event debugging is on
```

In the following output, the LAPB layer is up. An X.25 RBP call comes onto serial interface 1/1. The call is destined for port 20001. In the example, an RPB statement had not been set up for TCP port 20001 (see bold text).

```
Router-C# debug x25 all

X.25 packet debugging is on
00:19:18: Serial1/1: LAPB O CONNECT (2) RR F 1
00:19:43: Serial1/1: LAPB I CONNECT (2) RR P 1
00:19:43: Serial1/1: LAPB O CONNECT (2) RR F 1
00:19:55: X25 RBP: Incoming connection for port 20001 from 172.22.45.49 port 639
00:19:55: X25 RBP: no usable map found for port 20001
```

Step 8   Place a call to TCP port 20002 and then watch the debug report. The report indicates that the LAPB layer is up. Next, place an X.25 RPB call to TCP port 20002, which is a valid TCP port for an X.25 RBP statement. The TCP session is accepted and an X.25 call is placed to the switch. Notice that the router is calling the X.121 address 5557777777 on logical channel identifier (LCI) 1024, but LCI 1024 is not correct. To make it correct, lower the highest two-way channel to 3 for the EB link, or 4 for the RC link, depending on the port:

```
00:20:33: Serial1/1: LAPB O CONNECT (2) RR F 1
00:20:58: Serial1/1: LAPB I CONNECT (2) RR P 1
00:20:58: Serial1/1: LAPB O CONNECT (2) RR F 1
00:21:15: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 636
00:21:15: x25rbp_place_call: calling (10) 5557777777 from (0)
00:21:15: Serial1/1: X.25 O R1 Call (10) 8 lci 1024
00:21:15:   From (0):  To (10): 5557777777
```

Step 9   Set the high two-way channel to 4 for the RC link on serial interface 1/1:

```
Router-C(config-if)# x25 htc 4
```

Monitor the outgoing call to the switch again. You can see the call go out on logical channel 4. The call is cleared by the switch. You can also can see the Clear Request sent to the switch. The router confirms the clear. Notice the I on the debug output. The I stands for incoming packet to the interface. The O stands for the packet being sent out the interface to the Lucent 5ESS telephone switch.

```
02:39:27: Serial1/1: LAPB I CONNECT (2) RR P 1
02:39:27: Serial1/1: LAPB O CONNECT (2) RR F 1
02:39:32: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 602
02:39:32: x25rbp_place_call: calling (10) 5553501135 from (0)
02:39:32: Serial1/1: X.25 O R1 Call (13) 8 lci 4
02:39:32:   From (0):  To (10): 5553501135
02:39:32:   Facilities: (0)
02:39:32:   Call User Data (3): 0x313933 (unknown)
02:39:32: Serial1/1: LAPB O CONNECT (15) IFRAME 1 1
02:39:33: Serial1/1: LAPB I CONNECT (2) RR (R) 2
02:39:33: Serial1/1: LAPB I CONNECT (7) IFRAME 1 2
02:39:33: Serial1/1: X.25 I R1 Clear (5) 8 lci 4
02:39:33:   Cause 0, Diag 0 (DTE originated/No additional information)
02:39:33: x25rbp_clear: context 8196B5AC, state 2, packet 81A9B264, reason 8127)
02:39:33: X25 RBP: X.25 circuit cleared
02:39:33: Serial1/1: X.25 O R1 Clear Confirm (3) 8 lci 4
02:39:33: Serial1/1: LAPB O CONNECT (5) IFRAME 2 2
```

Step 10   Place a call with the wrong CUD field. Notice that the call is now placed on LCI 4. The CUD field was set to 193 decimal.

```
Router-C(config)# interface serial 1/1
Router-C(config-if)# no x25 map rbp 5553501135 local port 20002
Router-C(config-if)# x25 map rbp 5553501135 cud 193 local port 20002
Router-C(config-if)# no shutdown

02:37:47: %LINK-3-UPDOWN: Interface Serial1/1, changed state to up
02:37:48: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed stp

interface Serial1/1
 description RecentChange
 no ip address
 encapsulation x25
 no ip route-cache
 no ip mroute-cache
 x25 htc 4
 x25 map rbp 5553501135 cud 193 local port 20002
 clockrate 9600
```

The call was rejected because of an unknown CUD:

```
02:39:32: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 602
02:39:32: x25rbp_place_call: calling (10) 5553501135 from (0)
02:39:32: Serial1/1: X.25 O R1 Call (13) 8 lci 4
02:39:32:   From (0):  To (10): 5553501135
02:39:32:   Facilities: (0)
02:39:32:   Call User Data (3): 0x313933 (unknown)
02:39:32: Serial1/1: LAPB O CONNECT (15) IFRAME 1 1
02:39:33: Serial1/1: LAPB I CONNECT (2) RR (R) 2
02:39:33: Serial1/1: LAPB I CONNECT (7) IFRAME 1 2
02:39:33: Serial1/1: X.25 I R1 Clear (5) 8 lci 4
02:39:33:   Cause 0, Diag 0 (DTE originated/No additional information)
02:39:33: x25rbp_clear: context 8196B5AC, state 2, packet 81A9B264, reason 8127)
02:39:33: X25 RBP: X.25 circuit cleared
02:39:33: Serial1/1: X.25 O R1 Clear Confirm (3) 8 lci 4
```

Step 11   Attempt to fix the rejected call by changing the CUD to hexadecimal number C1:

```
Router-C(config)# interface serial 1/1
```

```
Router-C(config-if)# shutdown
Router-C(config-if)# no shutdown

02:44:38: %LINK-5-CHANGED: Interface Serial1/1, changed state to administrativen
02:44:39: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1/1, changed st2
%Map not found

Router-C(config-if)# no x25 map rbp 5553501135 cud c1 local port 20002
Router-C(config-if)# x25 map rbp 5553501135 cud 0xc1 local port 20002
Router-C(config-if)# no shutdown
Router-C(config-if)# end
```

The following report indicates this fix worked. The call was not rejected due to the CUD. You see the router give an error message that the Cisco IOS software does not recognize a CUD of 0XC1.

```
02:46:58: Serial1/1: LAPB I CONNECT (2) RR P 1
02:46:58: Serial1/1: LAPB O CONNECT (2) RR F 1
02:47:18: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 606
02:47:18: x25rbp_place_call: calling (10) 5553501135 from (0)
02:47:18: Serial1/1: X.25 O R1 Call (11) 8 lci 4
02:47:18:   From (0):  To (10): 5553501135
02:47:18:   Facilities: (0)
02:47:18:   Call User Data (1): 0xC1 (unknown)
02:47:18: Serial1/1: LAPB O CONNECT (13) IFRAME 1 1
02:47:18: Serial1/1: LAPB I CONNECT (2) RR (R) 2
02:47:18: Serial1/1: LAPB I CONNECT (7) IFRAME 1 2
02:47:18: Serial1/1: X.25 I R1 Clear (5) 8 lci 4
02:47:18:   Cause 0, Diag 0 (DTE originated/No additional information)
02:47:18: x25rbp_clear: context 8196B5AC, state 2, packet 81A9B264, reason 8127)
02:47:18: X25 RBP: X.25 circuit cleared
02:47:18: Serial1/1: X.25 O R1 Clear Confirm (3) 8 lci 4
```

The following debug report shows all four channels connected on the RC port. LCI 4 will be brought up first. The router places the call on the highest available channel first.

```
02:57:15: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 614
02:57:15: x25rbp_place_call: calling (10) 5553501135 from (0)
02:57:15: Serial1/1: X.25 O R1 Call (11) 8 lci 4
02:57:15:   From (0):  To (10): 5553501135
02:57:15:   Facilities: (0)
02:57:15:   Call User Data (1): 0xC1 (unknown)
02:57:15: Serial1/1: LAPB O CONNECT (13) IFRAME 7 2
02:57:16: Serial1/1: LAPB I CONNECT (2) RR (R) 0
02:57:16: Serial1/1: LAPB I CONNECT (7) IFRAME 2 0
02:57:16: Serial1/1: X.25 I R1 Call Confirm (5) 8 lci 4
02:57:16:   From (0):  To (0):
02:57:16:   Facilities: (0)
02:57:16: x25rbp_enter_p4: context 81BB2304, state 2, packet 81A9B264, reason 8)
02:57:16: x25rbp_enter_d1: context 81BB2304, state 0, packet 81A9B264, reason 8)
02:57:16: Serial1/1: LAPB O CONNECT (2) RR (R) 3
02:57:22: Serial1/1: X.25 O D1 Data (40) 8 lci 4 PS 0 PR 0
02:57:22: Serial1/1: LAPB O CONNECT (42) IFRAME 0 3
02:57:23: Serial1/1: LAPB I CONNECT (2) RR (R) 1
02:57:23: Serial1/1: LAPB I CONNECT (5) IFRAME 3 1
02:57:23: Serial1/1: X.25 I D1 RR (3) 8 lci 4 PR 1
02:57:23: Serial1/1: LAPB O CONNECT (2) RR (R) 4
02:57:24: Serial1/1: LAPB I CONNECT (15) IFRAME 4 1
02:57:24: Serial1/1: X.25 I D1 Data (13) 8 lci 4 PS 0 PR 1
02:57:24: Serial1/1: LAPB O CONNECT (2) RR (R) 5
02:57:25: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 617
02:57:25: x25rbp_place_call: calling (10) 5553501135 from (0)
02:57:25: Serial1/1: X.25 O R1 Call (11) 8 lci 3
```

```
02:57:25:   From (0):  To (10): 5553501135
02:57:25:   Facilities: (0)
02:57:25:   Call User Data (1): 0xC1 (unknown)
02:57:25: Serial1/1: LAPB O CONNECT (13) IFRAME 1 5
02:57:25: Serial1/1: LAPB I CONNECT (2) RR (R) 2
02:57:26: Serial1/1: LAPB I CONNECT (7) IFRAME 5 2
02:57:26: Serial1/1: X.25 I R1 Call Confirm (5) 8 lci 3
02:57:26:   From (0):  To (0):
02:57:26:   Facilities: (0)
02:57:26: x25rbp_enter_p4: context 81C0FC8C, state 2, packet 81A9B264, reason 8)
02:57:26: x25rbp_enter_d1: context 81C0FC8C, state 0, packet 81A9B264, reason 8)
02:57:26: Serial1/1: LAPB O CONNECT (2) RR (R) 6
02:57:31: Serial1/1: X.25 O D1 Data (40) 8 lci 3 PS 0 PR 0
02:57:31: Serial1/1: LAPB O CONNECT (42) IFRAME 2 6
02:57:32: Serial1/1: LAPB I CONNECT (2) RR (R) 3
02:57:32: Serial1/1: LAPB I CONNECT (5) IFRAME 6 3
02:57:32: Serial1/1: X.25 I D1 RR (3) 8 lci 3 PR 1
02:57:32: Serial1/1: LAPB O CONNECT (2) RR (R) 7
02:57:33: Serial1/1: LAPB I CONNECT (16) IFRAME 7 3
02:57:33: Serial1/1: X.25 I D1 Data (14) 8 lci 3 PS 0 PR 1
02:57:33: Serial1/1: LAPB O CONNECT (2) RR (R) 0
02:57:33: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 613
02:57:33: x25rbp_place_call: calling (10) 5553501135 from (0)
02:57:33: Serial1/1: X.25 O R1 Call (11) 8 lci 2
02:57:33:   From (0):  To (10): 5553501135
02:57:33:   Facilities: (0)
02:57:33:   Call User Data (1): 0xC1 (unknown)
02:57:33: Serial1/1: LAPB O CONNECT (13) IFRAME 3 0
02:57:34: Serial1/1: LAPB I CONNECT (2) RR (R) 4
02:57:34: Serial1/1: LAPB I CONNECT (7) IFRAME 0 4
02:57:34: Serial1/1: X.25 I R1 Call Confirm (5) 8 lci 2
02:57:34:   From (0):  To (0):
02:57:34:   Facilities: (0)
02:57:34: x25rbp_enter_p4: context 81C101C0, state 2, packet 81A9B264, reason 8)
02:57:34: x25rbp_enter_d1: context 81C101C0, state 0, packet 81A9B264, reason 8)
02:57:34: Serial1/1: LAPB O CONNECT (2) RR (R) 1
02:57:40: Serial1/1: X.25 O D1 Data (40) 8 lci 2 PS 0 PR 0
02:57:40: Serial1/1: LAPB O CONNECT (42) IFRAME 4 1
02:57:41: Serial1/1: LAPB I CONNECT (2) RR (R) 5
02:57:41: Serial1/1: LAPB I CONNECT (5) IFRAME 1 5
02:57:41: Serial1/1: X.25 I D1 RR (3) 8 lci 2 PR 1
02:57:41: Serial1/1: LAPB O CONNECT (2) RR (R) 2
02:57:42: Serial1/1: LAPB I CONNECT (17) IFRAME 2 5
02:57:42: Serial1/1: X.25 I D1 Data (15) 8 lci 2 PS 0 PR 1
02:57:42: Serial1/1: LAPB O CONNECT (2) RR (R) 3
02:57:42: X25 RBP: Incoming connection for port 20002 from 172.22.45.49 port 617
02:57:42: x25rbp_place_call: calling (10) 5553501135 from (0)
02:57:42: Serial1/1: X.25 O R1 Call (11) 8 lci 1
02:57:42:   From (0):  To (10): 5553501135
02:57:42:   Facilities: (0)
02:57:42:   Call User Data (1): 0xC1 (unknown)
02:57:42: Serial1/1: LAPB O CONNECT (13) IFRAME 5 3
02:57:43: Serial1/1: LAPB I CONNECT (2) RR (R) 6
02:57:43: Serial1/1: LAPB I CONNECT (7) IFRAME 3 6
02:57:43: Serial1/1: X.25 I R1 Call Confirm (5) 8 lci 1
02:57:43:   From (0):  To (0):
02:57:43:   Facilities: (0)
02:57:43: x25rbp_enter_p4: context 818A4724, state 2, packet 81A9B264, reason 8)
02:57:43: x25rbp_enter_d1: context 818A4724, state 0, packet 81A9B264, reason 8)
02:57:43: Serial1/1: LAPB O CONNECT (2) RR (R) 4
02:57:49: Serial1/1: X.25 O D1 Data (40) 8 lci 1 PS 0 PR 0
02:57:49: Serial1/1: LAPB O CONNECT (42) IFRAME 6 4
02:57:50: Serial1/1: LAPB I CONNECT (2) RR (R) 7
02:57:50: Serial1/1: LAPB I CONNECT (5) IFRAME 4 7
```

```
02:57:50: Serial1/1: X.25 I D1 RR (3) 8 lci 1 PR 1
02:57:50: Serial1/1: LAPB O CONNECT (2) RR (R) 5
02:57:51: Serial1/1: LAPB I CONNECT (17) IFRAME 5 7
02:57:51: Serial1/1: X.25 I D1 Data (15) 8 lci 1 PS 0 PR 1
02:57:51: Serial1/1: LAPB O CONNECT (2) RR (R) 6
02:57:51: Serial1/1: X.25 O D1 Data (45) 8 lci 4 PS 1 PR 1
02:57:51: Serial1/1: LAPB O CONNECT (47) IFRAME 7 6
02:57:51: Serial1/1: LAPB I CONNECT (2) RR (R) 0
02:57:52: Serial1/1: LAPB I CONNECT (5) IFRAME 6 0
02:57:52: Serial1/1: X.25 I D1 RR (3) 8 lci 4
```

Step 12   Enter the **show debug** EXEC command to display which debug statements have been started on the
router. Use the **no** form of a debug command to disable the command.

```
Router-C# show debug

LAPB:
  LAPB link debugging is on
TCP:
  TCP special event debugging is on
X.25:
  X.25 packet debugging is on

Router-C# no debug lapb

LAPB link debugging is off

Router-C# show debug

TCP:
  TCP special event debugging is on
X.25:
  X.25 packet debugging is on

Router-C# no debug all

All possible debugging has been turned off
```

Step 13   Debug the TCP session on the router. The list of TCP sessions that can be debugged is shown in the
following example. Enter the **debug ip tcp transactions** command to start the test:

```
Router-C# debug ip tcp ?

  driver             TCP driver events
  driver-pak         TCP driver verbose
  header-compression Header compression statistics
  intercept          TCP intercept
  packet             TCP packets
  rcmd               Rcmd transactions
  sack               Selective-ACK
  transactions       Significant TCP events

Router-C# debug ip tcp transactions

TCP special event debugging is on
```

Step 14   Check the router configuration by entering the **show running-config** EXEC command:

```
Router-C# show running-config

Building configuration...
Using 1994 out of 29688 bytes
!
version 12.1
```

```
service config
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Router-C
!
enable secret 5 $1$a/sP$r9xXAWz0d7XZnpzApk1831
enable password cisco
!
!
memory-size iomem 10
ip subnet-zero
no ip routing
no ip finger
!
!
interface FastEthernet0/0
 ip address 172.22.45.102 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 speed auto
 half-duplex
 no cdp enable
!
interface FastEthernet0/1
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 duplex auto
 speed auto
 no cdp enable
!
interface Serial1/0
 description EchoBack
 no ip address
 encapsulation x25
 no ip route-cache
 no ip mroute-cache
 x25 version 1980
 x25 htc 3
 x25 threshold 1
 x25 map rbp 5553501136 cud 0xC1 local port 20001
 clockrate 9600
 lapb T2 400
 lapb T4 25
 lapb N1 4136
!
interface Serial1/1
 description RecentChange
 no ip address
 encapsulation x25
 no ip route-cache
 no ip mroute-cache
 x25 version 1980
 x25 htc 4
 x25 threshold 1
 x25 map rbp 5553501135 cud 0xC1 local port 20002
 clockrate 9600
 lapb T2 400
 lapb T4 25
 lapb N1 4136
!
```

```
interface Serial1/2
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
interface Serial1/3
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
interface Serial1/4
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
interface Serial1/5
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
interface Serial1/6
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
interface Serial1/7
 no ip address
 no ip route-cache
 no ip mroute-cache
 shutdown
 no cdp enable
!
ip classless
no ip http server
!
!
snmp-server engineID local 00000009020000036B490D00
snmp-server community public RO
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 password cisco
 login
line vty 5 50
 login
!
no scheduler allocate
end
!
```

**Step 15**   End the display and debugging session:

```
Router-C# quit
```

Configuring ADC Service Activation Provisioning

This section describes the ADC Service Activation application for provisioning Class 5 telephone switches. This section will demonstrate provisioning of a Lucent 5ESS telephone switch as an example of how to add the Cisco X.25 RBP feature to the telco DCN.

In the sample scenario shown in Figure 32, the ADC Service Activation application has implemented the Cisco X.25 RBP feature and is connecting using TCP/IP to the router in the CO. The router in the central office is starting an X.25 session out to the Lucent 5ESS telephone switch. The end of the data record is marked by the M-bit on the X.25 side of the network. The X.25 RBP header marks the end of record on the TCP/IP side of the network. This scenario was tested with the default X.25 CCITT version of 1984.

Figure 32   *ADC and Cisco X.25 RBP*
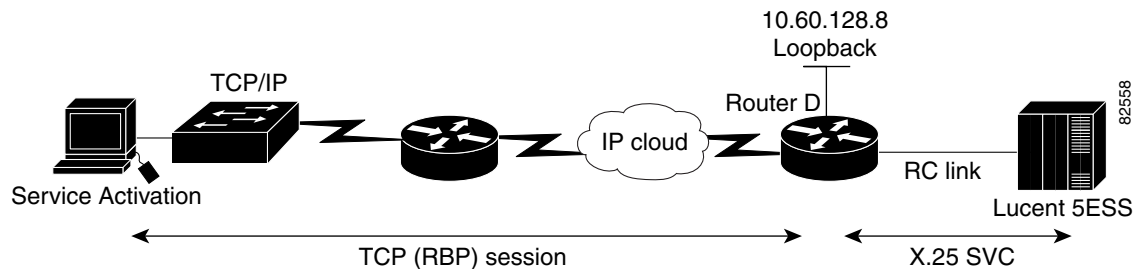
To configure the Cisco X.25 RBP feature in ADC Service Activation provisioning, see Figure 32 and perform the following steps. See the "ADC Service Activation Provisioning: Example" section on page 101 for a configuration example.

Step 1   Verify that you are running Cisco IOS Release 12.2(8)T or a later software release that supports telco DCN functions:

```
Router-D# show version
```

Step 2   Enter global configuration mode:

```
Router-D# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3   Select the serial interface for the EB port. In the example, serial interface 1/0 is used, which specifies network module 1, port 0:

```
Router-D(config)# interface serial 1/0
```

Step 4   Shut down the interface:

```
Router-D(config-if)# shutdown
```

Step 5   Enter a description on the serial interface:

```
Router-D(config-if)# description Voice Activation
```

Step 6   Configure X.25 DCE encapsulation on the serial interface:

```
Router-D(config-if)# encapsulation x25 dce
```

Step 7   Set the X.25 address on the interface. This address is the calling address for the inbound SVC to the switch:

```
Router-D(config-if)#  x25 address 5553501130
```

Step 8   Set the high two-way channel to 7 so that the SVC range will be from 1 to 7:

```
Router-D(config-if)# x25 htc 7
```

Step 9   Change the input window size (maximum unacknowledged X.25 packets) from the default of 2 to 3:

```
Router-D(config-if)# x25 win 3
```

Step 10   Change the output window size (maximum unacknowledged X.25 packets) from the default of 2 to 3:

```
Router-D(config-if)# x25 wout 3
```

Step 11   Change the maximum input packet size from the default of 128 to 256:

```
Router-D(config-if)# x25 ips 256
```

Step 12   Change the maximum output packet size from the default of 128 to 256:

```
Router-D(config-if)# x25 ops 256
```

Step 13   Set the X.25 optional user facility. The command will permit or deny flow control parameter negotiation of the packet or window size:

```
Router-D(config-if)# x25 subscribe flow-control always
```

Step 14   Set the X.25 threshold to 1. This command instructs the router to send acknowledgment packets when it is not busy sending other packets, even if the number of input packets has not reached the input window size count:

```
Router-D(config-if)# x25 threshold 1
```

Step 15   Enable the RBP feature on the router. The CUD field must be set to 0xC1. The customer sets the called X.121 address. In this example, the called X.121 address is 5553501136. You can specify the TCP port. In this example, the TCP port is set to 10006:

```
Router-D(config-if)# x25 map rbp 5553501136 cud 0xC1 local port 10006
```

Step 16   The router is functioning as a DCE device and must supply clock signaling to the DTE device. Set the clock rate to 56000 baud:

```
Router-D(config-if)# clockrate 56000
```

Step 17   Restart the interface:

```
Router-D(config-if)# no shutdown
```

Step 18   Exit the interface and global configuration modes:

```
Router-D(config-if)# end
Router-D(config)# end
```

Step 19   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
Router-D# copy run start
Destination filename [startup-config]?
```

```
Building configuration...
[OK]
```

## ADC Service Activation Provisioning: Example

The following example shows the configuration for serial interface 1/6:

```
interface Serial1/6
 no ip address
 encapsulation x25 dce
 x25 address 5553501130
 X25 htc 7
 x25 win 3
 x25 wout 3
 x25 ips 256
 x25 ops 256
 x25 threshold 1
 x25 subscribe flow-control always
 x25 map rbp 5553501136 cud 0xC1 local port 10006
 no ignore-hw local-loopback
 clockrate 56000
```

Traffic Data Collection Networks: Cisco X.25 RBP and XOT Solutions

This section describes Cisco telco solutions for traffic data collection networks like the one highlighted in Figure 33.

Figure 33   *Legacy Traffic Data Collection Network*
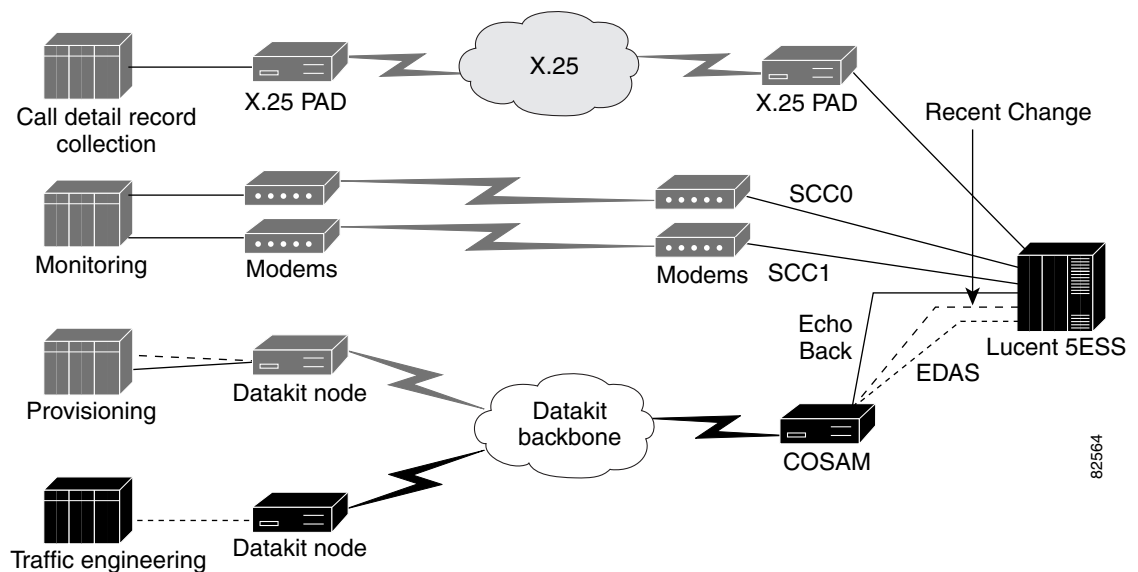
Use of the Cisco X.25 RBP feature with the Traffic Data Management System (TDMS) software application is described in the following sections:
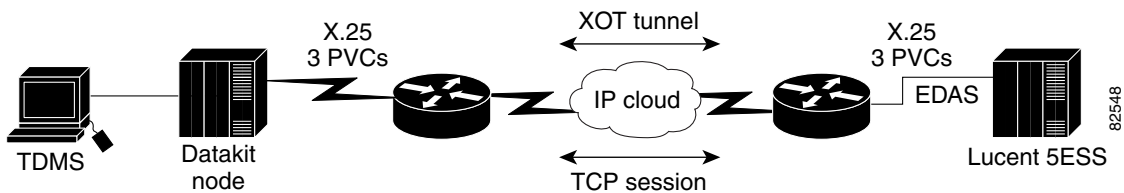
- Adding Cisco X.25 RBP to the Telco DCN Traffic Data Collection Connection, page 102
- Configuring Cisco X.25 RBP for Traffic Data Collection Applications, page 103
- Debugging the Traffic Data Collection Connection, page 105

Adding Cisco X.25 RBP to the Telco DCN Traffic Data Collection Connection

TDMS software is an OSS solution for network traffic monitoring, data collection, forecasting, and performance management. Originally developed by Lucent Technologies, TDMS collects, processes, analyzes, and generates reports of traffic performance. Traffic data collection applications are used for monitoring and troubleshooting the voice portion of the network. The traffic data is collected from the EDAS port on the telephone switch.

The TDMS application uses a Lucent Datakit node as the communications front end with BX.25 as the transport method (see Figure 34). The TDMS application pulls its data off the EDAS port on the Lucent 5ESS telephone switch. The EDAS port on the switch is a serial connection. The XOT solution can be used with versions of TDMS that use the Lucent Datakit node.

Figure 34   *Traffic Data Collection Connection with XOT*

The TDMS application supports the Cisco X.25 RBP feature, as of Release 4.3. This support eliminates the need for a Datakit node to serve as a front end for the application. A TCP/IP stack resides on the TDMS application. The Cisco X.25 RBP feature marks the end of a record on the TCP/IP sides of the network (see Figure 35).

Figure 35   *Traffic Data Collection Connection with Cisco X.25 RBP*
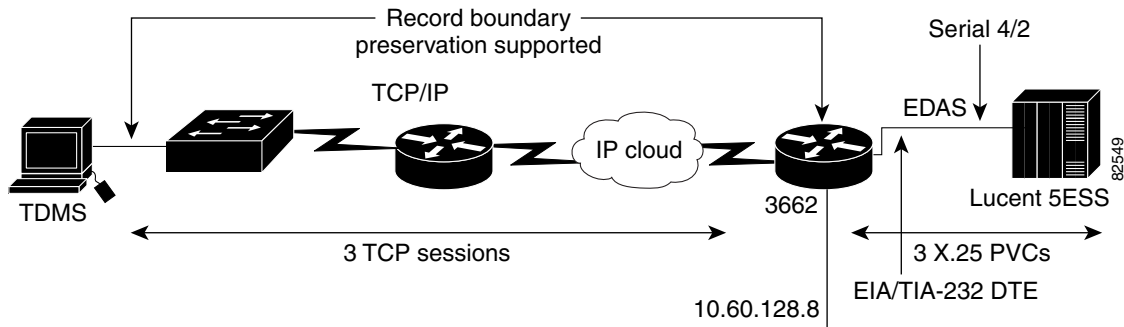
Configuring Cisco X.25 RBP for Traffic Data Collection Applications

The procedure in this section sets the low two-way channel to 4 for the router configuration. This configuration allocates space for PVC 1, PVC 2, and PVC 3. The router is set up to be a DCE at Layer 3. The packet size is changed from a default of 128 to 256. The router is acknowledging every packet with the **x25 threshold** command. The X.25 version is 1984, which is the default. The TCP ports are mapped as follows:

```
TCP Port NumberPVC Number
100011
100022
100033
```

The router supplies the interface clocking. The router clock rate is 9600 baud. The physical cable is an EIA/TIA-232 DCE.

To configure Cisco X.25 RBP on a Cisco 3662 edge router in the traffic data collections portion of the telco DCN, see Figure 35 and perform the following steps. See the "Cisco X.25 RBP in the Traffic Data Collection Application: Example" section on page 104 for a configuration example. See the "Debugging the Traffic Data Collection Connection" section on page 105 for a debugging example.

Step 1 Verify that you are running Cisco IOS Release 12.2(8)T or a later software release that supports telco DCN functions and the Cisco X.25 RBP feature:

```
3662-router# show version
```

Step 2 Enter global configuration mode:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
```

Step 3 Enable X.25 routing:

```
3662-router(config)# x25 routing
```

Step 4 Select the serial interface that is connected to the EDAS port on the Lucent 5ESS. In the example, serial interface 4/2 is used, which specifies network module 4, port 2:

```
3662-router(config)# interface serial 4/2
```

Step 5 Shut down the interface:

```
3662-router(config-if)# shutdown
```

Step 6 Enter a description for the serial interface:

```
3662-router(config-if)# description EDAS port
```

Step 7 Configure X.25 DCE encapsulation on the serial interface:

```
3662-router(config-if)# encapsulation x25 dce
```

Step 8 Set the lowest outgoing channel to 4:

```
3662-router(config-if)# x25 loc 4
```

Step 9 Set the X.25 threshold to 1. This command instructs the router to send packets when the router is not busy sending other packets, even if the number of input packets has not reached the input window size count.

```
3662-router(config-if)# x25 threshold 1
```

Step 10   Change the maximum input packet size from the default of 128 to 256:

```
3662-router(config-if)# x25 ips 256
```

Step 11   Change the maximum output packet size from the default of 128 to 256:

```
3662-router(config-if)# x25 ops 256
```

Step 12   Enable the RBP feature on the router. The TDMS application requires three PVCs. The PVC range is from 1 through 3. PVC 1 is mapped to TCP port 10001. PVC 2 is mapped to TCP port 10002. PVC 3 is mapped to TCP port 10003. The TCP ports were chosen arbitrarily.

```
3662-router(config-if)# x25 pvc 1 rbp local port 10001
3662-router(config-if)# x25 pvc 2 rbp local port 10002
3662-router(config-if)# x25 pvc 3 rbp local port 10003
```

Step 13   The router is functioning as a DCE device. The DCE must supply clock signaling to the DTE device, which is the EDAS port on the switch. Set the clock rate to 9600 baud:

```
3662-router(config-if)# clockrate 9600
```

Step 14   Restart the interface:

```
3662-router(config-if)# no shutdown
```

Step 15   Exit the interface and global configuration modes:

```
3662-router(config-if)# end
3662-router(config)# end
```

Step 16   Copy the running configuration to the startup configuration. This step saves the configuration in nonvolatile memory so that it will be available the next time the router boots up:

```
3662-router# copy running-config startup-config
Destination filename [startup-config]?
Building configuration...
[OK]
```

Cisco X.25 RBP in the Traffic Data Collection Application: Example

The following example shows the configuration for serial interface 4/2:

```
x25 routing

interface Serial4/2
 description EADAS
 no ip address
 encapsulation x25 dce
 no ip mroute-cache
 x25 ltc 4
 x25 ips 256
 x25 ops 256
 x25 threshold 1
 x25 pvc 1 rbp local port 10001
 x25 pvc 2 rbp local port 10002
 x25 pvc 3 rbp local port 10003
 no ignore-hw local-loopback
 clockrate 9600
```

Debugging the Traffic Data Collection Connection

To debug the traffic data collection connection, perform the following steps:

Step 1   Enter the **show interface serial** EXEC command on the interface connected to the EDAS port on the switch. The report indicates that the physical interface is up and all of the control leads are up. The line protocol is up, which means that LAPB is up.

```
3662-router# show interface serial 4/2

Serial4/2 is up, line protocol is up
  Hardware is CD2430 in sync mode
  Description: EADAS
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation X25, loopback not set
  X.25 DCE, address <none>, state R1, modulo 8, timer 0
     Defaults: idle VC timeout 0
       cisco encapsulation
       input/output window sizes 2/2, packet sizes 256/256
     Timers: T10 60, T11 180, T12 60, T13 60
     Channels: Incoming-only none, Two-way 4-1024, Outgoing-only none
     RESTARTs 2/0 CALLs 0+0/0+0/0+0 DIAGs 0/0
  LAPB DCE, state CONNECT, modulo 8, k 7, N1 12056, N2 20
     T1 3000, T2 0, interface outage (partial T3) 0, T4 0
     VS 2, VR 3, tx NR 3, Remote VR 2, Retransmissions 0
     Queues: U/S frames 0, I frames 0, unack. 0, reTx 0
     IFRAMEs 663/1627 RNRs 0/0 REJs 0/0 SABM/Es 0/2 FRMRs 0/0 DISCs 0/0
  Last input 00:00:07, output 00:00:07, output hang never
  Last clearing of "show interface" counters 2d04h
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue :0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     4027 packets input, 128719 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     3481 packets output, 9246 bytes, 0 underruns
     0 output errors, 0 collisions, 20 interface resets
     0 output buffer failures, 0 output buffers swapped out
     3 carrier transitions
     DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

Step 2   Enter the **show controller serial** EXEC command to verify the cable type being used. The following report shows an EIA/TIA-232 DCE cable type with the clock rate set to 9600 baud:

```
3662-router# show controller serial 4/2

CD2430 Slot 4, Port 2, Controller 0, Channel 2, Revision 18
Channel mode is synchronous serial
idb 0x62F0AD64, buffer size 1524, RS-232 DCE cable, clockrate 9600

Global registers
  rpilr 0x2, rir 0x2, risr 0x0, rfoc 0x0, rdr 0x2
  tpilr 0x1, tir 0x2, tisr 0x68, tftc 0x0, tdr 0xFF
  mpilr 0x3, mir 0x2, misr 0x60
  bercnt 0xFF, stk 0x0
Per-channel registers for channel 2
  Option registers
  0x02 0x00 0x42 0x67 0x60 0x00 0x00
  Command and status registers
```

```
                   cmr 0xC0, ccr 0x00, csr 0xCC, msvr-rts 0xF1, msvr-dtr 0xF1
                   Clock option registers
                   rcor 0x86, rbpr 0x01, tcor 0xC0, tbpr 0x77
                   Interrupt registers
                   ier 0x89, livr 0x08, licr 0x08
                   DMA buffer status 0x20
                   DMA receive registers
                   arbaddr 0x3C90064, arbcnt 1548, arbsts 0x1
                   brbaddr 0x3C8F9E4, brbcnt 1548, brbsts 0x1
                   rcbaddr 0x3C8F369
                   DMA transmit registers
                   atbaddr 0x3CD4EF6, atbcnt 2, atbsts 0x62
                   btbaddr 0x3A01B18, btbcnt 2, btbsts 0x62
                   tcbaddr 0x3A01B1A
                   Special character registers
                   schr1 0x00, schr2 0x00, schr3 0x00, schr4 0x00
                   scrl 0x0, scrh 0x0, lnxt 0xF1
             Driver context information
                   Context structure 0x62F0DB68, Register table 0x3E800400
                   Serial Interface Control 5:1 Register (0x3E80080A) is 0x80
                   Adaptor Flags 0x0
                   Serial Modem Control Register (0x3E80080C) is 0x1D
                   Receive static buffer 0x62DB54C8
                   Receive particle buffers 0x62F0E1C0, 0x62F0E180
                   Transmit DMA buffers 0x0, 0x0, 0x0, 0x0
                   Transmit packet with particles 0x0, first word is 0x0
                   Interrupt rates (per second) transmit 0, receive 0, modem 0
                   True fast-switched packets     0
                   Semi fast-switched packets     0
                   Transmitter hang count         0
                   Residual indication count      0
                   Bus error count        0
                   Aborted short frames count     0
                   CRC short frames count         0
             Error counters
                   CTS deassertion failures       0
                   Nested interrupt errors transmit 0, receive 0, modem 0
```

Step 3   Enable debugging using the **debug x25 all** EXEC command and watch for a TCP session connect. In this configuration example, the host will connect to TCP port 10003:

```
3662-router# debug X25 all
```

The following reports show the X.25 connection to the EDAS port. The debug report indicates the TCP connections from the TDMS as recognized by the Cisco X.25 RBP feature. A TCP session to port 10003 is coming in from the TDMS host, which has the IP address 172.20.7.6.

```
*Mar  3 20:28:30.779: X25 RBP: Incoming connection for port 10003 from 172.20.7.6
```

The router reset PVC 3, as expected:

```
*Mar  3 20:28:30.779: Serial4/2: X.25 O D1 Reset (5) 8 lci 3
*Mar  3 20:28:30.779:   Cause 9, Diag 0 (Remote DTE operational (PVC)/No additi)
```

The switch confirms the reset:

```
*Mar  3 20:28:30.819: Serial4/2: X.25 I D3 Reset Confirm (3) 8 lci 3
```

The router sends out data to the switch:

```
*Mar  3 20:28:30.819: Serial4/2: X.25 O D1 Data (5) 8 lci 3 PS 0 PR 0
```

Data is being sent from the switch on LCI 3, which is PVC 3:

```
*Mar  3 20:28:32.411: Serial4/2: X.25 I D1 Data (127) 8 lci 3 PS 0 PR 1
```

Step 4   Enable X.25 debugging using the **debug X25 all** command to check the PVCs when no data is being set.

```
3662-router# debug X25 all
```

The report should indicate that PVC 3 is up. You see Receiver Ready messages being sent by the router on PVC 3, only because the router has a complete path only for PVC 3. Receiver Ready messages are being sent in on PVC 1, PVC 2, and PVC 3 from the Lucent 5ESS telephone switch:

```
*Mar  3 20:28:32.411: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:28:44.367: Serial4/2: X.25 I D1 RR (3) 8 lci 2 PR 0
*Mar  3 20:29:27.035: Serial4/2: X.25 I D1 RR (3) 8 lci 1 PR 0
*Mar  3 20:29:34.571: Serial4/2: X.25 I D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:29:44.607: Serial4/2: X.25 I D1 RR (3) 8 lci 2 PR 0
```

Step 5   Enable X.25 debugging using the **debug X25 all** command to check the data going back and forth on PVC 3 between the host application and the switch:

```
3662-router# debug X25 all
```

The report should indicate that data is being sent from the router on LCI 3, which is PVC 3:

```
*Mar  3 20:30:18.843: Serial4/2: X.25 O D1 Data (5) 8 lci 3 PS 1 PR 1
```

The report should indicate that data is being sent from the switch on LCI 3, which is PVC 3:

```
*Mar  3 20:30:20.111: Serial4/2: X.25 I D1 Data (127) 8 lci 3 PS 1 PR 2
*Mar  3 20:30:20.111: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:30:27.295: Serial4/2: X.25 I D1 RR (3) 8 lci 1 PR 0
*Mar  3 20:30:44.867: Serial4/2: X.25 I D1 RR (3) 8 lci 2 PR 0
*Mar  3 20:31:20.006: Serial4/2: X.25 I D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:31:20.950: Serial4/2: X.25 O D1 Data (5) 8 lci 3 PS 2 PR 2
*Mar  3 20:31:23.246: Serial4/2: X.25 I D1 Data (135) 8 lci 3 PS 2 PR 3
*Mar  3 20:31:23.246: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
```

Step 6   Enable X.25 debugging using the **debug X25 all** command to check that a connection is being started on TCP port 10001 and PVC 1:

```
3662-router# debug X25 all
```

The report should indicate that a TCP session to port 10001 is coming in from the TDMS host, which has IP address 172.20.7.6:

```
*Mar  3 20:39:23.202: X25 RBP: Incoming connection for port 10001 from 172.20.7.6
```

The report should indicate that the router reset PVC 1, as expected:

```
*Mar  3 20:39:23.202: Serial4/2: X.25 O D1 Reset (5) 8 lci 1
*Mar  3 20:39:23.202:   Cause 9, Diag 0 (Remote DTE operational (PVC)/No additi)
```

The report should indicate that the switch confirms the reset:

```
*Mar  3 20:39:23.246: Serial4/2: X.25 I D3 Reset Confirm (3) 8 lci 1
```

The report should indicate that data is being sent from the switch on LCI 1, which is PVC 1:

```
*Mar  3 20:39:23.246: Serial4/2: X.25 O D1 Data (6) 8 lci 1 PS 0 PR 0
*Mar  3 20:39:23.822: Serial4/2: X.25 I D1 Data (31) 8 lci 1 PS 0 PR 1
```

Step 7   The last check is a debugging session with a long data transfer on PVC 3. A TCP session to port 10003 is coming in from the TDMS host, which has IP address 172.20.7.6. Enable X.25 debugging again. You should see a long report similar to the following example:

```
3662-router# debug X25 all
```

```
*Mar  3 20:47:21.058: X25 RBP: Incoming connection for port 10003 from 172.20.7.6
```

```
*Mar  3 20:47:21.058: Serial4/2: X.25 O D1 Reset (5) 8 lci 3
*Mar  3 20:47:21.058:   Cause 9, Diag 0 (Remote DTE operational (PVC)/No additi)
*Mar  3 20:47:21.102: Serial4/2: X.25 I D3 Reset Confirm (3) 8 lci 3
*Mar  3 20:47:21.102: Serial4/2: X.25 O D1 Data (5) 8 lci 3 PS 0 PR 0
*Mar  3 20:47:22.366: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:22.366: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:22.590: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:22.590: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:22.826: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:22.826: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:23.066: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 3 PR 1
*Mar  3 20:47:23.066: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:23.306: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 4 PR 1
*Mar  3 20:47:23.306: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 5
*Mar  3 20:47:23.542: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 5 PR 1
*Mar  3 20:47:23.542: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 6
*Mar  3 20:47:23.778: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 6 PR 1
*Mar  3 20:47:23.778: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 7
*Mar  3 20:47:24.014: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 7 PR 1
*Mar  3 20:47:24.014: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 0
*Mar  3 20:47:24.250: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:24.250: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:24.486: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:24.486: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:24.722: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:24.722: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:24.958: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 3 PR 1
*Mar  3 20:47:24.958: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:25.194: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 4 PR 1
*Mar  3 20:47:25.194: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 5
*Mar  3 20:47:25.430: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 5 PR 1
*Mar  3 20:47:25.430: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 6
*Mar  3 20:47:25.666: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 6 PR 1
*Mar  3 20:47:25.666: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 7
*Mar  3 20:47:25.902: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 7 PR 1
*Mar  3 20:47:25.902: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 0
*Mar  3 20:47:26.138: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:26.138: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:26.374: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:26.374: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:26.610: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:26.610: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:26.846: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 3 PR 1
*Mar  3 20:47:26.846: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:27.082: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 4 PR 1
*Mar  3 20:47:27.082: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 5
*Mar  3 20:47:27.318: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 5 PR 1
*Mar  3 20:47:27.318: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 6
*Mar  3 20:47:27.554: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 6 PR 1
*Mar  3 20:47:27.554: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 7
*Mar  3 20:47:27.790: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 7 PR 1
*Mar  3 20:47:27.790: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 0
*Mar  3 20:47:28.034: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:28.034: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:28.286: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:28.286: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:28.538: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:28.538: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:28.790: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 3 PR 1
*Mar  3 20:47:28.790: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:29.042: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 4 PR 1
*Mar  3 20:47:29.042: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 5
*Mar  3 20:47:29.294: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 5 PR 1
*Mar  3 20:47:29.294: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 6
```

```
*Mar  3 20:47:29.542: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 6 PR 1
*Mar  3 20:47:29.546: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 7
*Mar  3 20:47:29.794: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 7 PR 1
*Mar  3 20:47:29.794: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 0
*Mar  3 20:47:30.046: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:30.046: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:30.290: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:30.290: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:30.534: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:30.534: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:30.770: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 3 PR 1
*Mar  3 20:47:30.774: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:31.006: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 4 PR 1
*Mar  3 20:47:31.010: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 5
*Mar  3 20:47:31.246: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 5 PR 1
*Mar  3 20:47:31.246: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 6
*Mar  3 20:47:31.482: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 6 PR 1
*Mar  3 20:47:31.482: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 7
*Mar  3 20:47:31.718: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 7 PR 1
*Mar  3 20:47:31.718: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 0
*Mar  3 20:47:31.954: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 0 PR 1
*Mar  3 20:47:31.954: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:47:32.194: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 1 PR 1
*Mar  3 20:47:32.194: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 2
*Mar  3 20:47:32.430: Serial4/2: X.25 I D1 Data (259) 8 lci 3 M PS 2 PR 1
*Mar  3 20:47:32.430: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 3
*Mar  3 20:47:32.558: Serial4/2: X.25 I D1 Data (127) 8 lci 3 PS 3 PR 1
*Mar  3 20:47:32.558: Serial4/2: X.25 O D1 RR (3) 8 lci 3 PR 4
*Mar  3 20:47:48.482: Serial4/2: X.25 I D1 RR (3) 8 lci 2 PR 0
*Mar  3 20:48:16.042: Serial4/2: X.25 I D1 RR (3) 8 lci 1 PR 1
*Mar  3 20:48:33.574: Serial4/2: X.25 I D1 RR (3) 8 lci 3 PR 1
*Mar  3 20:48:48.622: Serial4/2: X.25 I D1 RR (3) 8 lci 2 PR 0
```

Configuring the Lucent 5ESS EDAS Port

Note The service provider must be using release 4.3 of the port configuration application and must select the Cisco option.

Following is a sample of the Lucent 5ESS EDAS port configuration form with the required field values shown in bold text. (See the "Lucent cpblx Form Parameter Descriptions" section on page 110 for descriptions of important fields in this form.) Notice that field 65 has an X.25 packet size of 256. Fields 59 and 61 are the input and output buffer sizes. These fields must be three bytes larger than the packet size. In the example, the packet size is 256 and the buffer size is 259.

```
Communications Protocol Option Block               (Recent Change and Verify)

    1.option_name:cpblx33

    2.speed:9600          3.duplex:full          4.ds_type:2024A

    5.carrier:c           6.line_access:private  7.mode_op:b

    8.pdtime1:60          9.pdtime2:100          10.window:4

    11.rexmit:3           12.dcedte:013.pcsd_stat:active
```

```
14.config:simplex


                                                    (3/4)

35.neid.nend
        1)_____    4)_____    7)_____    10)_____    13)_____
        2)_____    5)_____    8)_____    11)_____    14)_____
        3)_____    6)_____    9)_____    12)_____    15)_____

46.pswrd.pwrd
        1)_____    4)_____    7)_____    10)_____    13)_____
        2)_____    5)_____    8)_____    11)_____    14)_____
        3)_____    6)_____    9)_____    12)_____    15)_____

57.perm_state:allow       58.outscrsiz:4062       59.outpktsiz:259

                          60.inscrsiz:406261.inpktsiz:259



                              cpblx3      (4/4)

62.hup:n     63.spckt:0      64.x3wsize:2      65.x3psize:256

66.x3pvcn.ldinno

      1)_____    6)_____   11)_____   16)_____   21)_____   26)_____31)_____
      2)1         7)_____   12)_____   17)_____   22)_____   27)_____32)_____
      3)3         8)_____   13)_____   18)_____   23)_____   28)_____
      4)2         9)_____   14)_____   19)_____   24)_____   29)_____
      5)_____   10)_____   15)_____   20)_____   25)_____   30)_____

81.time_ti:180   82.time_tj:60    83.time_tf:60    84.time_tl:60

85.time_td:180   86.time_ts:180   87.time_ack:5
```

Lucent cpblx Form Parameter Descriptions

This section describes important fields in the Lucent cpblx form and lists values that can be entered in the fields.

1. option_name: (OPTIONNAME) Required

   Option block name. This is a key field. Legal values: alphanumeric characters.

2. speed: (SPEED)

   Data rate of associated communications equipment.

   Legal values: 110, 300, 1200, 1800, 2400, 4800, 9600, 56000, 64000, null.

3. duplex: (DUPLEX)

   Full or half-duplex.

   Legal values: full, half, null.

4. ds_type: (DSTYPE)

   PC modem type.

Legal values: 201CDDD, 209A, NOPORT, 201CPL, 212A, PL201C, 202/108, 2024A, RS449, 208A, 2048A, ITAPAC, 703COU, 703CCUL, 703CCUH, 703CDO, RS232, RS422, RS423, 208ADDD, CCITT 208B, NODS, NULL.

Note Enter RS449 when the PC modem is a 500B data set.

Multiple values may be considered equivalent in the database. Any legal value may be entered, but the value may not be shown in the Recent Change and Verify displays.

Table 5 lists which values are displayed for the set of equivalent values.

Table 5   *Equivalent Values*

Displayed Value	Equivalent Values
703COU	703COU, 212A
703CCUL	703CCUL, 208A
703CCUH	703CCUH, 208B
703CDO	703CDO, 209A
RS232	RS232, RS449
RS422	RS422, RS423, NODS, NULL

5. carrier: (CARRIER)

    Continuous or switched carrier.

    Legal values: c, s, null.

6. line_access: (LINEACCESS)

    Type of line access.

    Legal values: direct, private, noACU, ACU, null.

7. mode_op: (MODEOP)

    Mode operation. Block or send/receive mode of operation.

    Legal values: b, s, null.

8. pdtime1: (PDTIME1) Required

    Maximum time to wait for level 2 protocol acknowledgment. Values entered represent tenths of a second.

    Legal values: 0 to 255, HEX.

9. pdtime2: (PDTIME2) Required

    Maximum time to allow the data link to be idle. Values entered represent tenths of a second.

    Legal values: 0 to 255, HEX.

10. window: (WINDOW) Required

    Maximum number of I-Frames a station may have outstanding.

    Legal values: 0 to 7.

11. rexmit: (REXMIT) Required

    Maximum number of retransmissions of an individual frame.

Legal values: 0 to 7.

12. dcedte: (DCEDTE) Required

Data terminal equipment or data circuit-terminating equipment (DCE).

Legal values: 0 (data terminal equipment); 1 (data circuit-terminating equipment).

13. pcsd_stat: (PCSDSTAT)

Normal status for this pcsd.

Legal values: active (active device of duplex pair); standby (standby device of duplex pair); null.

14. config: (CONFIG)

Simplex, duplex, or multiple configuration.

Legal values: duplex (one of a duplex pair); null: multiple; simplex (simplex Peripheral Controller Subdevice or PCSD).

15. ldtel (LDTEL)

System identification (id), time limit, telephone number.

16. ldtel.sid (*LDTEL.SID[ROW])

System identifier.

Legal values: 0 to 65535, HEX, null.

Note A value of 65535 in row 1 will deactivate the Communications Protocol Handler (CPH) packet retransmission facility. This action will result in no packets being retransmitted. Any other value will result in the default action of retransmitting a packet up to two times by CPH.

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17. ldtel.tlim (*LDTEL.TLIM[ROW])

Time limit (seconds).

Legal values: 0 to 255, HEX, null.

18. ldtel.telno (*LDTEL.TELNO[ROW])

Telephone number.

Legal values: alphanumeric or null.

19. security: (SECURITY)

Check security information.

Legal values: y, n, null.

20. link_id: (LINKID)

Link identification number.

Legal values: 0 to 7; default value: 0.

21. feid_len: (FEIDLEN)

Length of far-end system identifier.

Legal values: 0 to 15; default value: 0.

22. neid_len: (NEIDLEN)

Length of near-end system identifier.

Legal values: 0 to 15; default value: 0.

23. password_len: (PASSWORDLEN)

    Length of password.

    Legal values: 0 to 15; default value: 0.

24. feid.fend (*FEID.FEND[ROW])

    Far-end system identifier.

    Legal values: 0 to 255, HEX, null; default value: 0.

25. neid.nend (*NEID.NEND[ROW])

    Near-end system identifier.

    Legal values: 0 to 255, HEX, null; default value: 0.

26. pswrd.pwrd (*PSWRD.PWRD[ROW])

    Password.

    Legal values: 0 to 255, HEX, null; default value: 0.

27. perm_state: (PERMSTATE) Required

    Dialup permission state.

    Legal values: allow (allow dialup connection); condalw (if duplex and primary not active; allow dialup connection); inhibit (inhibit dialup connection).

28. outscrsiz: (OUTSCRSIZ) Required

    Output buffer area size (words).

    Legal values: 0 to 65535, HEX.

> **Note** When the size of the outscrsiz buffer is increased, the growth and degrowth procedures for the SDL must be followed. Failure to follow the procedures will cause the IOPs to initialize.

29. outpktsiz: (OUTPKTSIZ) Required

    Data portion of output buffer (bytes).

    Legal values: 0 to 640, 0x0 to 0x280, null.

30. inscrsiz: (INSCRSIZ) Required

    Input buffer area size (words).

    Legal values: 0 to 65535, HEX.

> **Note** When the size of the inscrsiz buffer is increased, the growth and degrowth procedures for the SDL must be followed. Failure to follow the procedures will cause the IOPs to initialize.

31. inpktsiz: (INPKTSIZ) Required

    Data portion of input buffer (bytes).

    Legal values: 0 to 640, 0x0 to 0x280, null.

32. hup: (HUP)

    Hang up on last close.

    Legal values: y, n, null.

33. spckt: (SPCKT) Required

    Link data packet size.

    Legal values: 0 to 255.

34. x3wsize: (X3WSIZE) Required

    Level 3 protocol window size.

    Legal values: 0 to 7, 0x0 to 0x7, null.

35. x3psize: (X3PSIZE) Required

    Level 3 protocol packet size.

    Legal values: 0 to 637, 0x0 to 0x27D, null.

36. x3pvcn.ldinno (*X3PVCN.LDINNO[ROW])

    Logical channel number corresponding to the partition number.

    Legal values: 0 to 4095, 0x0 to 0xFFF, null.

37. time_ti (TIMETI)

    Interrupt packet timer.

    Legal values: 180 to 600 seconds; default value: 180.

38. time_tj: (TIMETJ)

    Reject packet timer.

    Legal values: 60 to 600 seconds; default value: 60.

39. time_tf: (TIMETF)

    Flow control packet timer.

    Legal values: 10 to 600 seconds; default value: 60.

40. time_tl: (TIMETL)

    Unacknowledged data packet timer.

    Legal values: 60 to 600 seconds; default value: 60.

41. time_td: (TIMETD)

    Reset request timer.

    Legal values: 180 to 600 seconds; default value: 180.

42. time_ts: (TIMETS)

    Restart request timer.

    Legal values: 180 to 600 seconds; default value: 180.

43. time_ack: (TIMEACK)

    Acknowledgment timer.

    Legal values: 5 to 300 seconds; default value: 5.

Additional References

This section provides the following additional reference information:

Related Documents

Related Topic	Document Title
AMATPS generic requirements	*TR-TSY-000385, AUTOMATIC MESSAGE ACCOUNTING TELEPROCESSING SYSTEM (AMATPS) GENERIC REQUIREMENTS*, September 1986
AMATPS PPSN generic requirements	TA-TSY-000787, *AMATPS GENERIC REQUIREMENTS FOR USE WITH PUBLIC PACKET SWITCHED NETWORKS (PPSN)*
BX.25 protocol specification	Pub 54001, *Operations Systems Network Communications Protocol Specification*, BX.25, Issue 3 Addendum A, August 1983
TCP/IP-to-X.25 protocol mediation	*X.25 Record Boundary Preservation for Data Communications Networks* Cisco IOS Release 12.2(8)T feature module
X.25	• CCITT 1980 Recommendation X.25 • CCITT 1984 Recommendation X.25 • CCITT 1988 Recommendation X.25 • ITU-T 1993 Recommendation X.25
X.25 troubleshooting	Appendix A, "Cisco IOS X.25 Toolkit" in the *Cisco Network Solutions for the Telco DCN* document.

Related Websites

Related Topic	Link
4Tel	http://www.edb4tel.com/
EVOLVING Systems (TDMS support)	http://www.evolving.com/site/home/
Kansys, Inc	http://www.kansys.com
Lucent OS	http://www.lucent.com/
Lucent Billdats	http://www.lucent.com/solutions/
Intec	http://www.intec-telecom-systems.com/
Telesciences	http://www.telesciences.com/
TTI Telecom	http://www.tti-telecom.com

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/techsupport

Glossary

ADM—add/drop multiplexer

BAI—Backup Active Interface

BX.25—AT&T Bell Laboratories' variation of the ITU X.25 standard

CCITT—Consultative Committee for International Telegraph and Telephone

CDR—call detail record

CLEC—competitive local exchange carrier

CUD—Call User Data

DCE—data communications equipment (EIA expansion); data circuit-terminating equipment (ITU-T expansion)

DCN—data communications network

DRM—Lucent Distinctive Remote Module

DSLAM—digital subscriber line access multiplexer

DTE—data terminal equipment

EB—Echo Back

EDAS—Engineering Data Acquisition System

EIA/TIA—Electronic Industries Alliance/Telecommunications Industry Alliance

EMM—Element Mediation Module

EOR—End of Record

GPT—GEC-Plessey Telecommunications, manufacturers of System-X

I-Frame—Information Frame

ILEC—incumbent local exchange carrier

ITU—International Telecommunication Union

LAPB—Link Access Procedure, Balanced

LCI—logical channel identifier

M-bit—more data bit

MNP—Multi Network Protocol

MTP—Message Transfer Protocol

MUX—multiplexer

NEBS—Network Equipment Building Systems

NFM—Network Fault Management

NMA—Network Management Application from Telcordia

NOC—network operations center

OCS—optical convergence switch

OSS—Operations Support Systems

PAD—packet assembler/disassembler

PTT—Post, Telephone, and Telegraph

PVC—permanent virtual circuit

RBOC—regional Bell operating company

RBP—Record Boundary Preservation

RC—Recent Change

SABM—Set Asynchronous Balance Mode

SCC—specialized common carrier

SDH—Synchronous Digital Hierarchy

SLM—Synchronous Line Module

SONET—Synchronous Optical Network

STUN—serial tunnel

SVC—switched virtual circuit

TDMS—Traffic Data Management System

telco—telephone company

VC—virtual circuit; virtual connections (XOT)

X.25—ITU-T standard

XFER—DMS-100 Data Transferral Application Protocol

XOT—X.25 over TCP