CHAPTER 1

Introduction to the Cisco 90 Series

The Cisco 90 Series product provides telecommunications carriers with a cost-effective solution to deliver high-speed data services for Frame Relay, Internet, and intranet access applications. The Cisco 90 Series provides connections to the Internet, private corporate networks, and more. It also extends fast packet access using Frame Relay to the telephone company end office. The resulting service is ideal for small business users, telecommuters and residential Internet access.

Cisco provides the industry's most cost-effective digital access solution: a new channel unit for D4 channel banks—the Cisco 90i. The Cisco 90i is unique in that it turns existing time-division-multiplexing (TDM) D4 channel banks, which are deployed in nearly all North American central offices (COs), into DSL frame multiplexers. Given this approach, the Cisco 90i provides the lowest capital and operational cost solution for large-scale digital access.

Carrier Benefits

The Cisco 90i channel unit is based on Integrated Services Digital Network (ISDN) Digital Subscriber Line (IDSL) technology. Key carrier benefits are:

- Lower Capital and Operational Costs—Carriers simply add Cisco 90i Channel Units to existing D4 channel banks in the CO, optimizing existing spare capacity and thereby reducing equipment costs. In addition, because of the operational simplicity of the product, training and personnel costs are minimized. All management is done through a centrally located management system.
- Dial Offload—With IDSL, carriers can offload their data traffic from their existing voice networks, thereby reducing stress on the public switched telephony networks, which were designed for short duration voice calls. In addition, carriers will now have the ability to offer users an "always connected" model.
- Rapid Deployment—IDSL uses the same loop provisioning process as basic rate ISDN and hence is ready for rapid deployment. In addition, fast time to market is achieved as carriers do not need a large number of users to justify equipping an end-office to start service because the infrastructure already exists. The Cisco 90i can operate with any Frame Relay backbone network.
- Widespread Access—The Cisco 90i resides not only in existing D4 channel banks, but can leverage existing ISDN Basic Rate Interface (BRI) loop technology to provide access over embedded digital loop carriers to extend the service range with copper or optical fiber sections.
- End-To-End Networking Compatibility—The Cisco 90i is to be included in Cisco's end-to-end architecture and management strategy to simplify provisioning and support.
- Plug and Play in the CO—Most COs in North America have D4 channel banks pre-wired, ready to turn on service. The Cisco 90i is also fully NEBS compliant.

End-User Benefits

When carriers offer IDSL services over the Cisco 90i, users can achieve the following benefits:

- High-Speed Access—Users can obtain 144 kbps today, double the speed of existing single B-channel ISDN data services and many times faster than 28.8 and 56 kbps modems.
- Uninterrupted Access—Dial-up procedures are eliminated with end users enjoying the benefits of a leased-line type of connection, allowing e-mail to be immediately sent and received and enabling local web hosting.
- Reduced Costs—With carriers looking to offload data from their voice networks and with the low total cost of ownership for the Cisco 90i, users can expect aggressive pricing for IDSL services.

Terms and Acronyms

The following terms and acronyms are referred to in this guide, and are related to IDSL technology, the Cisco 90 Series Channel Units, and the Cisco 90 Series DSL Management Agent:

2B1Q line encoding
The 2B1Q (two binary, one quaternary) line encoding was intended for use by the ISDN DSL. 2B1Q is a four-level line code that represents two binary bits (2B) as one quaternary symbol (1Q). (“Quaternary” means consisting of four, in this case, a four-level line code.) The 2B1Q line coding was seen as a major enhancement over the original T1 line coding, because 2B1Q encoded two bits instead of just one with every signaling state (baud).

Annex-D LMI Protocol
See *T1.617 Annex-D PVC Management Protocol*.

bandwidth
Used to indicate the frequency range that the analog signal operates in, so it is common to say that “analog television signals occupy a 6 MHz bandwidth”, or millions of cycles per second, where a cycle is the total range of analog values that the signal can take on.

BECN
Backward Explicit Congestion Notification, per the T1.617 Frame Relay specification for FECN/BECN and DE frame control.

BER
bit error rate (BER) traditionally has been used to describe the performance of digital transmission systems. BER is an average over a selected measurement period and, as such, does not fully describe performance over shorter periods or during periods outside the measurement interval. During this time, BER states the approximate probability that any given transmitted bit will be erroneously received.

BRI
Basic Rate Interface. BRI is a digital service which provides 160 kbps over phone wire up to 18,000 feet of 24 gauge wire. Its standard implementation (ANSI T1.601 or ITU 1.431) uses echo cancellation to separate the transmit signal from the received signal. It uses bandwidth from 0 to about 80 kHz. (Some European systems use 120 kHz of bandwidth.) Therefore, provisioning of ISDN and analog POTS on the same local loop is not possible because both services use frequencies in the same range.

BRITE card
Basic Rate Interface Terminal Extender. A D4 channel unit used to extend the reach of an ISDN DSL.

broadband
A telecommunications link that runs at more than 1.5 Mbps in the United States and more than 2 Mbps almost everywhere else. Today, most people consider broadband speeds to be much higher, perhaps as high as 5 or 10 Mbps.

channel
A portion of the total capacity of a communication link. The channel may be established by an analog or digital technique using a multiplexer. The channel can be delineated physically or virtually.

codec
The interface device required to carry analog information such as voice across a link using digital signaling. Coder/decoder.

CPEe
customer premises Equipment. From the public switched telephone network, customer premises equipment might include user devices such as telephones, fax machines, or computers with modems. Any approved device by any manufacturer may be used, as long as it conforms to some basic electrical guidelines. The CPE in the United States is owned and operated by the user and is beyond the direct control of the network service provider. In other countries, the CPE can be provided and owned by the service provider under a strict set of regulations. The process of giving users more control over the CPE is part of the general movement towards deregulation.

In terms of IDSL customer premises equipment, this might be an IDSN BRI terminal adapter or router such as a Cisco 772, Cisco 1004, or Cisco 1604.

CIR
committed information rate. The CIR can be set per PVC on the Cisco 90i channel unit card as part of the configuration process of the Cisco 90i card.

circuit
A path through a network from source to destination. In a circuit-switched network, this path uses a fixed route and a fixed amount of bandwidth for the duration of the connection between end points. Circuits are efficient for voice use. Also see *packet*.

Cisco 90i IDSL Channel Unit
A Cisco 90i IDSL Channel Unit card transforms the D4 channel bank used in telephone central offices from its traditional use as a TDM (time-division multiplexer) into a Frame Relay multiplexer. It supports four Integrated Services Digital Network (ISDN) Digital Subscriber Loops (IDSLs) running user data at 56, 64, 128, or 144 kbps. The Cisco 90i IDSL Channel Unit only supports leased-line connections, not switched or dial-up connections.

CLEC
Competitive Local Exchange Carrier. Since the Telecommunications Act of 1996, service providers may be any entity approved or “certified” by the individual states to become a LEC. Newer companies are Competitive LECs, and the former service provider in a given area becomes the Incumbent LEC (ILEC).

CO
central office. Term most often used in the United States to describe the place where local loops (access lines) are terminated and connect to the public switched telephone network (PSTN). Used to attach *local loops* (or *access lines*) to users.

crosstalk
Interference caused by signals on adjacent circuits in a network.

CSU/DSU
channel service unit/data service unit. Interface device required to change one form of digital signal to another.

DLCI
data link connection identifier. Portion of the Frame Relay message header used to carry PVC identification information. The DLCI can range from 0 to 1023 with some values reserved. DLCIs 30 and 31 are reserved for Cisco 90 Series DSL Management Agent PVCs on D4 Digroups containing Cisco 90i Channel Units. DLCI 0 is reserved for ANSI T1.617 Annex D LMI protocol traffic.

DTE/DCE
data terminating equipment/data communications equipment.

D4 channel bank
A card cage and backplane developed by AT&T in the 1970s for TDM T1 line aggregation of voice local loops.

digital
Having only discrete values, such as 0 or 1. Opposite of analog, which is continuously varying over time. For example, a text file on a computer is good example of digital information and voice is the prime example of analog information. However, either can be sent over a telecommunications link with an analog or digital signal.

digroup
digital group. A collection of slots in a D4 channel bank that are connected to one T1 line.

DE
discard eligible. Frame relay frames marked by the user as discardable, per the T1.617 Frame Relay specification for FECN/BECN and DE frame control.

DSL
Digital Subscriber Line. Sometimes referred to as “Digital Subscriber Loop.” DSL techniques allow high data rates over standard telephone lines.

ESF
Extended Superframe format. One variation of T1 framing.

FECN
Forward Explicit Congestion Notification, per the T1.617 Frame Relay specification for FECN/BECN and DE frame control.

IDSL
ISDN Digital Subscriber Line. A digital subscriber line using ISDN line encoding.

ILEC
Incumbent Local Exchange Carrier. See CLEC.

local exchange
Another term for central office. The term most often used outside of the United States to describe the basic public switched telephone network’s network node. Used to attach local loops (or access lines) to users.

LEC
Local Exchange Carrier. Due to the split of the Bell System into AT&T Long Lines and seven Regional Bell Operating Companies (RBOCs), the local companies, RBOCs and independents, were collectively termed the "Local Exchange Carriers" (LECs).

local loop
The copper wire circuit that connects the central office equipment with the customer premises equipment.

multiplexer
Multiplexing is the process of combining multiple channels of information into a single larger network channel.

POTS
plain old telephone service. Telephone switching equipment, which create the phone connections, are located in buildings called central offices (CO). Customers are connected to the CO over copper wire pairs, also referred to as "local loops." These copper wire pairs are segmented in lengths of 500 feet. Lengths are spliced together as needed to reach from the central office to the customer's premises.

POTS splitter
Enables the simultaneous carrying of analog telephone service on the same line as digital data service. A POTS splitter is a low pass filter which separates analog voice from ADSL frequencies.

PSTN
Public Switched Telephone Network. The telecommunications network that was designed for short duration voice calls. The PSTN is designed for a world of intermittent, independent telephone line use. In the PSTN, a typical network node is called a local exchange switch; a user device is typically a telephone; a user-to-network interface is called a "local loop;" and a network node interface is called a "trunk."

The major components of the PSTN are called switches and the major components of the Internet are called routers.

RBOC
Regional Bell Operating Company. All the regional Bell operating companies that are former pieces of the huge AT&T network spun off in 1984 to operate independently.

router
The network node of the Internet. Routers forward packets to other routers until they reach their destination. Internet routers use TCP/IP as the protocol for transmitting packets of data.

signaling
Signaling can mean different things in different contexts. In the tradition of telecommunications terms, this use of the term "signaling" is distinct from the same term when applied to the form that information takes when travelling on a telephone line (analog signaling versus digital signaling). It can also apply to a form of control information and supervisory processes that prevent special trunk problems from occurring. In this context, signaling means call control procedures, which govern the setting up, maintenance, and taking down of voice conversations on circuits.

SF
Superframe Format. Refer to *ESF (Extended Superframe Format)*.

SOHO
Small Office/Home Office.

SONET
Synchronous Optical Network.

subscriber
In terms of IDSL, can be individuals or businesses. Can be used interchangeably with end-user, or just "user." A subscriber is a user of an IDSL loop, a loop being that part of a telecommunications transmission system between a subscriber's physical premises and the serving central office, or a DSL service provider site.

switch
In a data network, switches forward packets to other switches until they reach their destinations. The packets can take on a variety of forms, and usually follow a fixed path through the switched network, as opposed to packets in router networks.

T1.617 Annex-D PVC Management Protocol
Annex-D of ANSI T1.617 describes an in-band management protocol used to distribute and manage information regarding PVCs established in a Frame Relay network.

Cisco 90 Series System

The Cisco 90 Series system is composed of the following:

- Cisco 90 Series DSL Management Agent
- Cisco 90i IDSL Channel Units
- Cisco 90 Series SNMP MIB

The Cisco 90 Series provides access to Frame Relay and ATM networks using Cisco 90i IDSL Channel Units installed in standard D4-compliant channel banks. The D4 channel bank, traditionally used to provide time-division multiplexing (TDM) concentration for digitized voice circuits, is turned into a high-performance frame-based Frame Relay concentrator.

The Cisco 90i has four ISDN 2B1Q access loops (supporting speeds of 56, 64, 128, and 144 kbps), each supporting up to eight Frame Relay permanent virtual circuits (PVCs) or one Point-to-Point Protocol (PPP) circuit. Up to 96 IDSL ports can be supported on the D4 DSL Frame Relay multiplexer with a single economical T1 Frame Relay uplink.

The Cisco 90i complements Cisco's existing dial offload solution, which is based on the Cisco AS5200 universal access server, and a virtual dial solution using the Layer 2 Forwarding (L2F) protocol. Whereas the Cisco AS5200 provides support for existing users of dial-up modems and ISDN, the Cisco 90i is targeted at users looking for higher speed or dedicated access. These two products can be combined to form a single solution providing complete heterogeneous access capability. Cisco is also making available customer premises offerings that support IDSL. These products include the Cisco 700 series SOHO router and the Cisco 1600 series modular access routers.

Typical Application

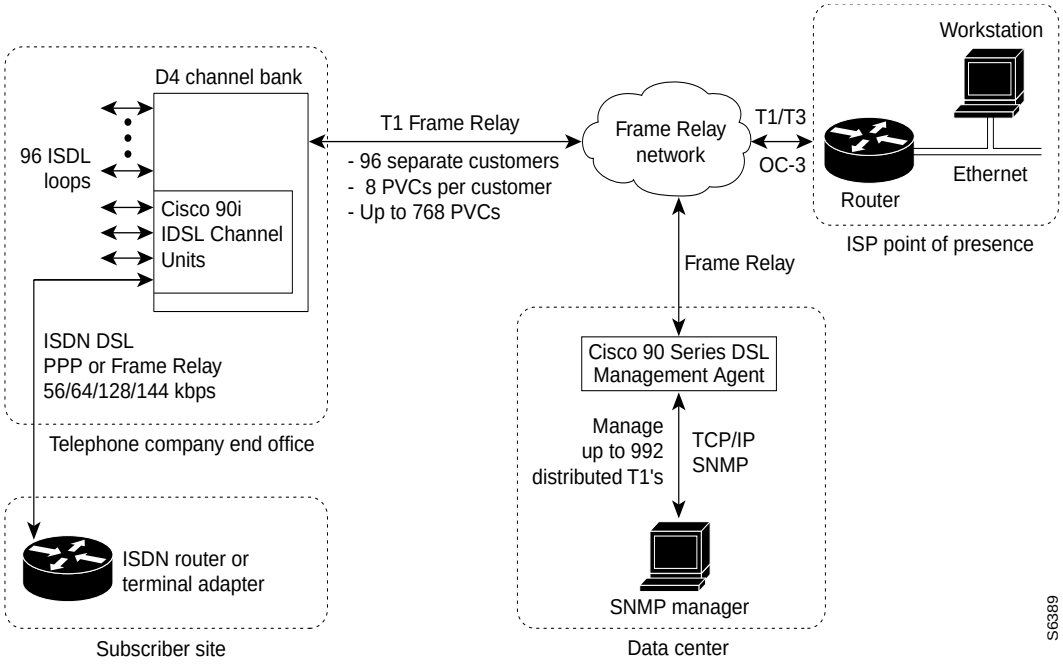
In a typical application (see Figure 1-1), a standard D4 channel bank using Cisco 90i IDSL Channel Units is connected to a Frame Relay network through a T1 line. The frames are routed through a Frame Relay network, which connects to an Internet service provider (ISP) using, for example, a T1 or T3 connection.

The Cisco 90i IDSL Channel Unit is connected to an ISDN router or terminal adapter on the customer premises.

The Cisco 90 Series DSL Management Agent is connected to the Frame Relay network and communicates with the Cisco 90i IDSL Channel Units installed in the D4 channel banks. It can remotely manage a network of up to 992 Cisco 90i IDSL channel bank digroups, with each digroup potentially containing up to 24 Cisco 90i IDSL Channel Units.

The Cisco 90 Series DSL Management Agent is also connected to a Simple Network Management Protocol (SNMP) manager application through a network running TCP/IP. The manager application communicates with the management agent using SNMP.

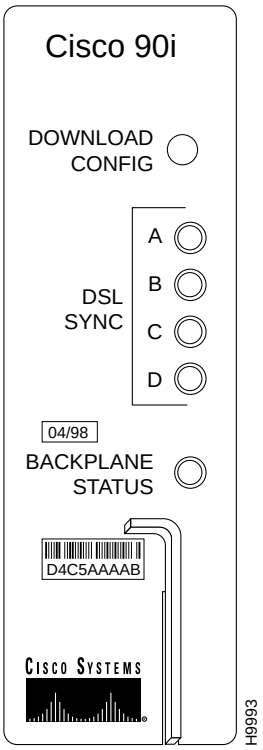
Figure 1-1 Cisco 90 Series Application



Cisco 90i IDSL Channel Unit

The Cisco 90i IDSL Channel Units are circuit cards that are installed in a standard D4 channel bank to provide ISDN access to subscribers. Figure 1-2 shows the front panel of a Cisco 90i IDSL Channel Unit. The Cisco 90i IDSL Channel Unit front panel has manufacture date and CLEI Common Language Equipment Coding) code labels. For example, 04/98 indicates the Cisco 90i IDSL Channel Unit was manufactured in April 1998. The CLEI code is a method used by communications companies and central offices to track circuit design and layout versions and manage inventory. In this case, the CLEI code identifies and catalogs the version of the Cisco 90i Channel Unit card and firmware.

Figure 1-2 Cisco 90i IDSL Channel Unit Front Panel



The Cisco 90i is a single-width D4 channel unit that is compatible with existing D4 channel banks, using standard common equipment. It supports four ISDN Digital Subscriber Lines (IDSLs) running user data at either 56, 64, 128, or 144 kbps. Each of the four subscriber interfaces supports standard twisted-pair 2B1Q loops of up to 18 kilofeet.

The Cisco 90i converts a standard D4 time-division multiplexing (TDM) channel bank into a D4 DSL frame multiplexer. By converting incoming data to or accepting data in a Frame Relay format, the Cisco 90i supports up to 96 subscriber circuits on each 24 channel digroup on a D4 DSL frame multiplexer with a single T1 Frame Relay uplink.

The Cisco 90i supports both Frame Relay and Point-to-Point Protocol (PPP) on the IDSL per ANSI and CCITT standards. It is compatible with standard ISDN CPE with leased-line support. Low-end CPE such as terminal adapters and personal routers use PPP to establish a single PVC to the network. Frame Relay-capable routers can support multiple users with up to eight PVCs over IDSL to connect to both ISP and corporate locations for Internet and intranet access.

The Cisco 90i handles forward and backward congestion control and data discard per the T1.617 Frame Relay specification for FECN/BECN and DE frame control. Traffic management rules are enforced based on the committed information rate (CIR) set per PVC. It also supports Annex D of ANSI T1.617 to communicate with both the CPE and the Frame Relay switch regarding the health of the Frame Relay link and the PVC assignments. To support PPP from the subscriber side, the Cisco 90i encapsulates PPP in Frame Relay using IETF RFC 1973.

The Cisco 90i has a built-in bit error rate test (BERT), the ability to loop itself back and remotely loop a Network Termination 1 (NT1) device or any downstream ISDN BRITE channel unit, for the purpose of running diagnostic tests. It also maintains an extensive set of statistics for the physical and data link layers for the channel unit and uses the embedded operations channel (EOC) as specified in the Bellcore TR-TSY-000829 ISDN protocol format to retrieve loop performance data for downstream BRITE units.

Features of the Cisco 90i IDSL Channel Unit

Features of the Cisco 90i IDSL Channel Unit are as follows:

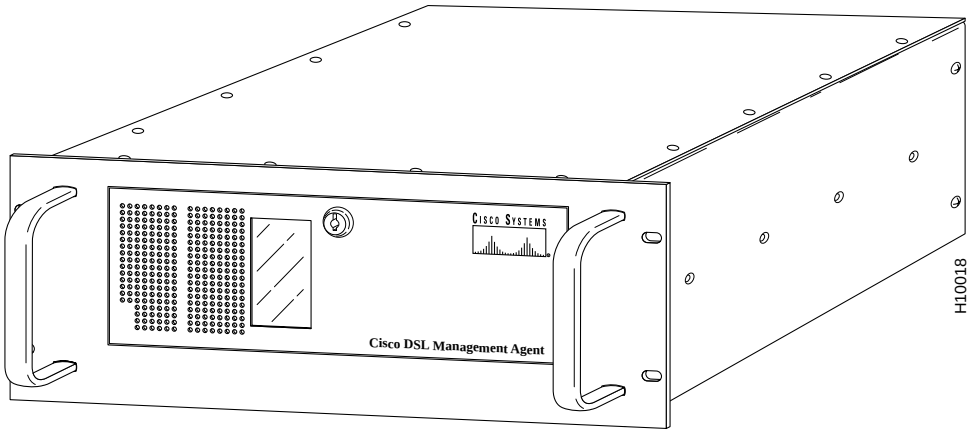
- Conforms to American National Standards Institute (ANSI) T1.618, T1.617 Annex D, T1.606 Add. 1, 2B1Q protocols, and Bellcore TR-NWT-000393 ISDN loop specifications
- Compatible with Bellcore TR-TSY-000829 EOC protocol formats
- Compatible with D4-compliant channel banks
- Simple “plug and play” field installation
- Supports multiple rates: 56, 64, 128, and 144 kbps
- The four 2-wire 2B1Q subscriber interfaces provide 18,000 ft service range and compatibility with ISDN repeaters, extenders, and next generation DLC (NGDLC) transmission
- Designed to directly integrate to inexpensive, unchannelized Frame Relay switch ports
- Built-in bit error rate test with the ability to remotely loop customer equipment or BRITE cards/repeaters
- Maintains performance monitoring information and can retrieve information from downstream BRITE cards or repeaters
- Supports PPP or Frame Relay from the subscriber side
- Up to 8:1 concentration for network transmission savings

Cisco 90 Series DSL Management Agent

Cisco 90i configuration, monitoring, and maintenance functions are accessible through the Cisco 90 Series DSL Management Agent (see Figure 1-3) using SNMP. Through the Cisco 90 Series DSL Management Agent, up to 992 Cisco 90i IDSL channel bank digroups can be managed remotely from a centralized location. You can install a redundant, or backup, Cisco 90 Series DSL Management Agent to use in the event the primary agent fails.

Note Each D4 channel bank may have two digroups, with each digroup containing up to 24 available slots for channel units. The DSL Management Agent can manage any channel bank digroup that has a management DLCI assigned in the available 992 DLCIs.

Figure 1-3 Cisco 90 Series DSL Management Agent



The Cisco 90 Series DSL Management Agent is an embedded SNMP agent, which provides efficient management, troubleshooting, and diagnostic tools to control and monitor the system through the SNMP manager application and the Cisco 90 Series SNMP MIB.

The Cisco 90 Series DSL Management Agent is a rack-mounted system that can be located anywhere in the network that has Frame Relay access. It allows up to 992 T1 channel bank digroups populated by Cisco 90i IDSL Channel Units to be managed remotely. It can manage any channel bank digroup with a management DLCI assigned in the available 992 DLCIs. It communicates to each D4 DSL frame multiplexer through a Frame Relay PVC connection over a synchronous T1 port. It requires a V.35 or EIA-530 connection to the Frame Relay network and a TCP/IP connection to the network where an SNMP manager, such as HP OpenView, resides.

Cisco 90 Series DSL Management Agent Equipment

The Cisco 90 Series DSL Management Agent shipping carton contains the following:

- Rack-mountable Cisco 90 Series DSL Management Agent:
  - 19-in. rack-mount enclosure
  - Ethernet 10BaseT network interface
  - High-speed synchronous EIA-530/V.35 serial WAN interface
  - DB-9 EIA/TIA-232 console interface port
  - PCMCIA Flash memory disk
  - 3.5-in. floppy drive
- Keys for the front panel lock
- EIA/TIA-232 serial cable
- Power cord
- This guide
- *Regulatory Compliance and Safety Information for the Cisco 90 Series DSL Management Agent*
- *Cisco Information Packet*

Installing the Cisco 90 Series System

The Cisco 90 Series system consists of three major components:

- A Cisco 90 Series DSL Management Agent (or more if you are configuring a backup, or "standby" agent)
- Cisco 90i IDSL Channel Units
- Cisco 90 Series MIB

Refer to the "Terms and Acronyms" section earlier in this chapter for a brief description of the Cisco 90 Series system.

Installing the Cisco 90 Series system is a simple three-step process:

1. Install the Cisco 90 Series DSL Management Agent

   When installing a new network, the first step is to install the Cisco 90 Series DSL Management Agent. The DSL Management Agent allows the entire network to be remotely managed through the Frame Relay network. There is no need to run Ethernet to each channel bank in every local central office or to configure each bank with IP addresses or any other parameters. You may also want to install a redundant backup Cisco 90 Series DSL Management Agent.

2. Install a D4-compliant channel bank

   The second step is to install the D4 channel banks. The physical installation follows standard operation and maintenance procedures because the Cisco 90 Series uses ordinary D4-compatible channel banks.

3. Install Cisco 90i IDSL Channel Units

   The final step is to install Cisco 90i IDSL Channel Units for new subscribers. At the subscriber's central office, this involves little more than inserting the card and connecting the loop wiring. You do all of the configuration and testing from the centralized SNMP manager.

These three steps are described in detail in the next chapter, "Installing the Cisco 90 Series DSL Management Agent."