NetWare Link/X.25
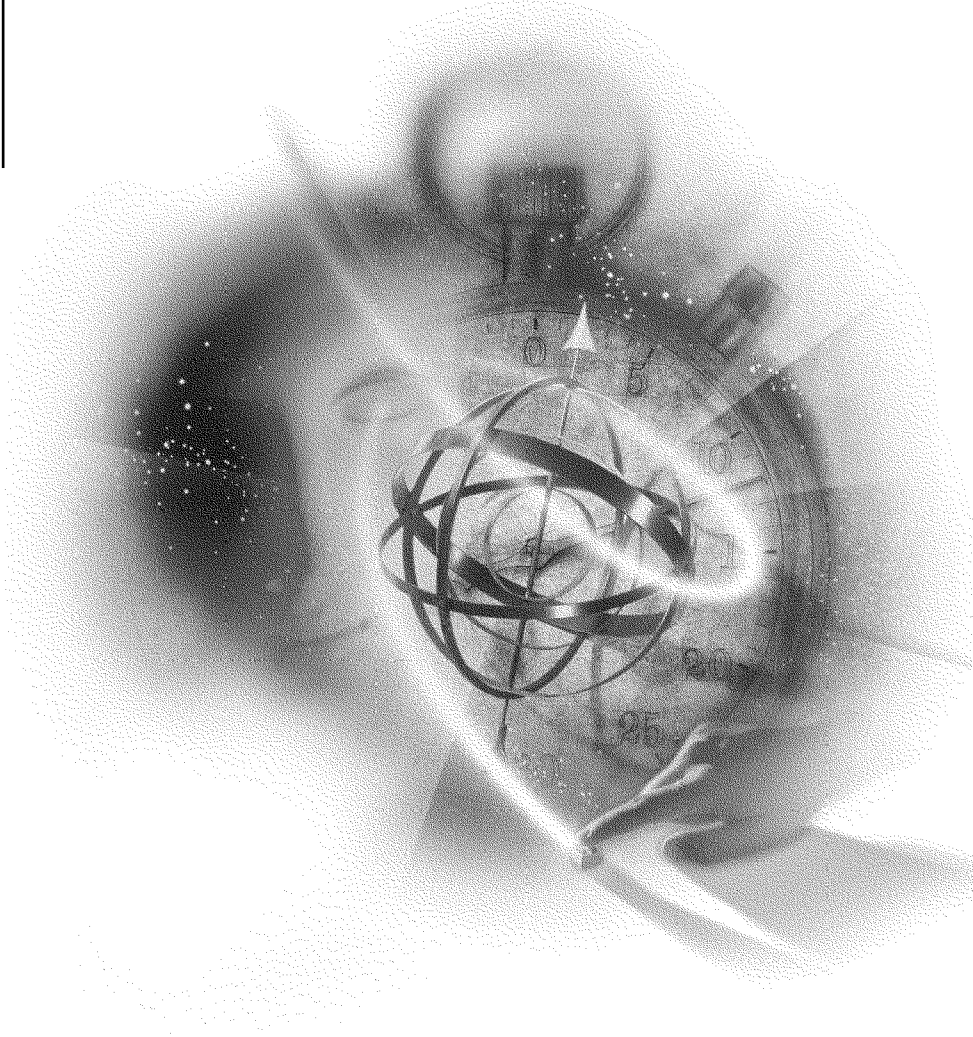
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Contents

About This Guide

This guide provides the information you need to configure and manage the Novell Internet Access Server 4.1 NetWare Link/X.25 software. In addition to planning information, this guide provides troubleshooting tips, techniques, and tools, as well as the symptoms of and solutions to commonly occurring problems for the NetWare Link/X.25 components of Novell Internet Access Server 4.1.

1 Understanding

This section introduces the basic functions of the NetWare® Link/X.25™ software, and describes the architecture and the different services and facilities that the software offers.

NetWare Link/X.25 Background

The NetWare Link/X.25 software subsystem operates in the NetWare 3™ server or NetWare 4™ server standalone router/bridge PC environments.

NetWare Link/X.25 is based on the X.25 standard, which is a set of network interface specifications for packet-switched networks recommended by the ITU-T (International Telecommunications Union, Telecommunications Standardization sector), previously CCITT, in its Recommendation X.25. (The most recent recommendation was the 1988 revision.) The X.25 standard has been adopted by the International Standards Organization (ISO) as the Open Systems Interconnection (OSI) standard for WANs.

NetWare Link/X.25 provides services for NetWare products and other applications (including independent developer applications) requiring wide area connectivity. It uses the 1980, 1984, or 1988 ITU-T Recommendation X.25, which defines the interaction between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) of a packet-switched network. NetWare Link/X.25 implements the X.25 protocol as described in these recommendations, including the Physical layer, Frame layer, and Packet layer, along with several library modules used as an interface to the user applications.

NOTE: DTE is a generic term for any network-attached, customer-premises, or end-user equipment operating in packet mode. A DCE can be any one of the devices that is not a DTE but is associated with a single network port. It is responsible for establishing,

maintaining, and terminating the connection with a DTE. X.25 requires a DTE/DCE pair to operate.

Figure 1 shows the wide area connectivity products that NetWare Link/X.25 supports as a software subsystem. These include the following:

  ◆ Novell® Internet Access Server 4.1 routing software

  ◆ SNA/QLLC (NetWare for SAA 2.0) software

  ◆ Novell Internet Access Server 4.1 remote access software

Figure 1   Novell Software Supported by NetWare Link/X.25
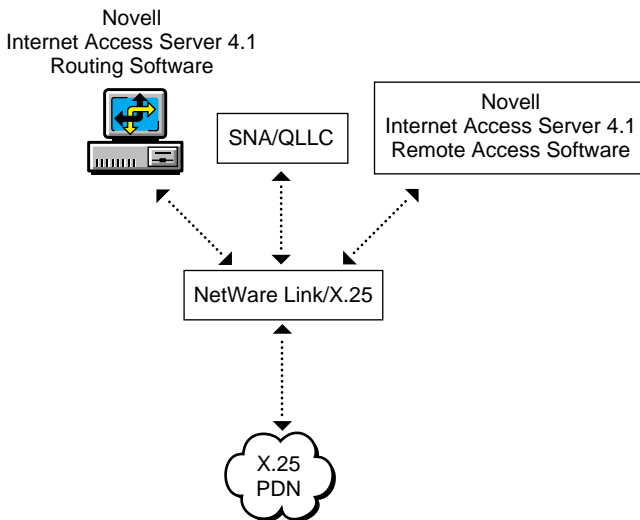
NetWare Link/X.25 Features

NetWare Link/X.25 offers the following features:

  ◆ Concurrent communications over a single port

  ◆ Resource sharing

  ◆ Transparent linking

  ◆ Multiple protocol routing

  ◆ Bridge support

These features are described in the following paragraphs.

Concurrent Communications over a Single Port

NetWare Link/X.25 enables NetWare users to communicate concurrently with up to 256 distinct remote destinations over a single port (through a V.35, RS-422, or RS-232 interface). This allows users from geographically dispersed networks to share resources as if they were using one network.

NOTE: The number of distinct remote destinations is limited to 42 when the Internetwork Packet Exchange™ (IPX™) protocol is used.

Resource Sharing

NetWare Link/X.25 allows any internetworked LAN to share resources with any other LAN, even if the LANs are based on different technologies or use equipment from different manufacturers. The connection to a remote LAN is a virtual connection made over an X.25 public data network (PDN). You can establish or terminate the connection at any time. Often, this means that you pay only for the connect time and the amount of information you send while using the service.

NetWare Link/X.25 allows gateway applications (for example, SNA terminal-to-host) to communicate over X.25 PDNs.

Transparent Linking

NetWare Link/X.25 establishes a transparent link between LANs. By using connections called *virtual circuits* , the user with a DTE appears to have an exclusive connection with another DTE, when in reality, the communications links are being shared. The path or routing of information through networks is transparent and usually of no interest or concern to the user.

Multiple Protocol Routing

NetWare Link/X.25 allows you to route multiple protocols simultaneously across a single WAN link. NetWare servers gain the ability to route IPX, IP, and AppleTalk protocols simultaneously.

Bridge Support

NetWare Link/X.25 supports bridging over X.25 consistent with RFC 1356, *Multiprotocol Interconnect on X.25 and ISDN in the Packet Mode*. A null protocol ID (0x00) is used in the Call User Data field to indicate the use of a multiplexed virtual circuit. Only bridged data can use this multiplexed virtual circuit. The multiplexed virtual circuit does not support routed data.

X.25 Advantages

This section covers the following two main advantages of using the X.25 protocol:

- Global networking
- Connection quality

Global Networking

The ITU-T Recommendation X.25 has become an international standard for PDN vendors. Packet-switched data connections can cross national boundaries, effectively creating a worldwide PDN environment. This means that X.25, as a well-established network protocol, offers reliable connectivity at a lower cost.

Connection Quality

Conventional analog dial-up connections are susceptible to the inherent limitations of circuit-switched analog lines, especially over international connections. Examples of such limitations include echo and attenuation. PDN vendors can provide better quality end-to-end data connections over NetWare Link/X.25 than over conventional analog dial-up connections. A NetWare Link/X.25 network guarantees reliable data transmission between two points.

NetWare Link/X.25 Architecture

NetWare Link/X.25 implements the X.25 standard, which spans the bottom three layers in the OSI reference model for networking. Figure 2 represents the standard OSI layers and the corresponding X.25 layers.

Figure 2   OSI and X.25 layers

OSI

Application
Presentation
Session
Transport
Network
Data Link
Physical

X.25

Packet
Link (or Frame)
Physical
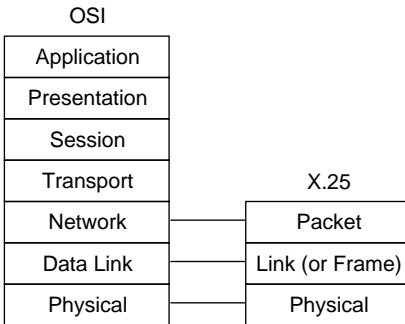
Table 1 lists the X.25 layers and provides their corresponding descriptions and protocols.

Table 1   X.25 Architecture

OSI X.25 Layer	Function	Protocol
Packet	Multiplexing (relay, routing, and switching)	X.25 Packet Layer Protocol
Link (or Frame)	Point-to-point synchronization, error detection and correction, and flow control	HDLC and LAPB
Physical	Bit transmission and media interface	X.21 bis in the U.S. X.21 in Europe

NetWare Link/X.25 consists of the following three layers:

- Packet—Corresponds to the Network layer in the OSI model. The most important feature of this layer is *multiplexing*. It controls call setup and clearing, packet transfer, and network facility selection. The Packet layer specifies the virtual circuit service for both switched virtual circuits (SVCs) and permanent virtual circuits (PVCs). It conforms to the ITU-T X.25 Packet-layer specification.

- Link—Transports data across the physical link, controls the interchange between the DTE and the DCE, and corrects any link errors. This is a subset of the ISO standard High-level Data Link Control (HDLC) protocol, known as Link Access Procedure-Balanced (LAPB). It

conforms to the ITU-T X.25 Link-layer specification, except for the multilink procedure.

◆ Physical—Defines the physical interface between a DTE and DCE (the X.21 and X.21 bis specifications for physical attachment to the packet network). Recommendations include voltages, signaling, plug types, and pin connections.

For more information about NetWare Link/X.25 architecture, refer to "NetWare Link/X.25 Components."

NetWare Link/X.25 Components

Figure 3 shows the components of NetWare Link/X.25.

Figure 3   NetWare Link/X.25 Components
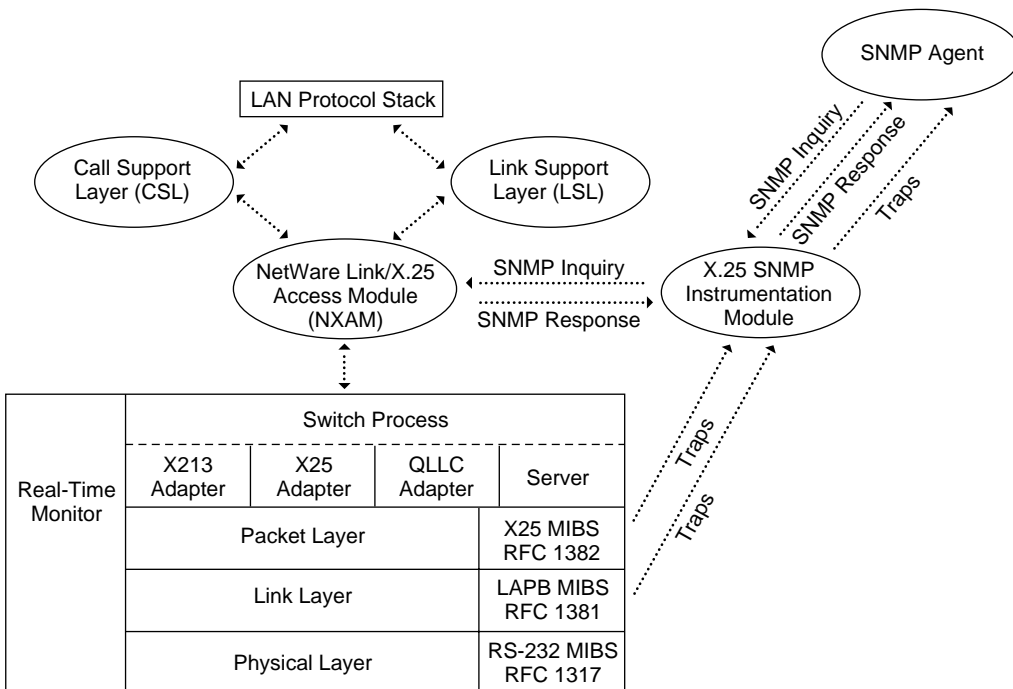
The following components make up NetWare Link/X.25:

- Call Support Layer (CSL) software—Provides the interface for call controls to establish, maintain, and disconnect a connection. The CSL also maintains the configuration and target databases.

- Link Support Layer™ (LSL™) software—Provides a general user interface between LAN, WAN, and Open Data-Link Interface™ (ODI™) component modules for data transfer.

- NetWare SNMP Agent—Provides access to management data about a particular network device or application and responds to the inquiries received from the SNMP management station. The NetWare SNMP Agent also transmits the traps to the destinations specified in the TRAPTARG.CFG file.

- X.25 SNMP Instrumentation Module—Processes the incoming SNMP inquiries, accesses the X.25 MIB and LAPB MIB, and responds to the SNMP inquiries. The module also generates the various traps upon detection of significant NetWare Link/X.25 events.

- X.25 MIB (RFC 1382)—Management Information Base (MIB) implemented for the NetWare Link/X.25 Packet layer to support SNMP.

- LAPB MIB (RFC 1381)—MIB implemented for the NetWare Link/X.25 Link layer (LAPB) to support SNMP.

- RS-232 MIB (RFC 1319)—MIB implemented for the NetWare Link/X.25 Physical layer to support SNMP.

- NetWare Link/X.25 Access Method (NXAM)—Implements Call Control Agent (CCA) functions to provide an interface with the CSL for X.25 connection management, and an ODI interface with the LSL for X.25 data transfer.

- Real-Time Monitor—Controls the tasks implemented within X.25: the Switch process, the Packet layer, and the Link layer.

- Switch process—Manages the queues used to communicate between the X.25 software and the NXAM software.

- X.25 Adapter—Provides users with the standard X.25 interface.

- X213 Adapter—Provides users with the ITU-T X.213 Network Service interface.

- QLLC Adapter—Selected by the user to transmit or receive SNA data traffic over the X.25 data link.

- Server—Controls the virtual circuit and handles all incoming calls.

The Packet, Link, and Physical layers are described in the following sections.

NetWare Link/X.25 Physical Layer

The Physical layer of NetWare Link/X.25 defines the physical interface between a DTE and DCE. In particular, it provides the following specifications to activate, maintain, and deactivate the physical path between the DTE and DCE:

- Functional—The function of the pins in a connector

- Procedural—How control is achieved

- Electrical—Voltages, currents, and speed

- Mechanical—Type of physical connector

The Physical layer specifies the procedures to establish, maintain, and release the physical connections (or data circuits) between network end points.

The Physical layer specifies the connection of a DTE to a DCE through a dedicated (leased) or dial-up data link, which can be one or more full-duplex, synchronous circuits. NetWare Link/X.25 supports the following physical interfaces:

- X.21

- X.21 bis

- EIA 232-C (ITU-T V.24/V.28)

- EIA 449/423/422 (ITU-T V.24/V10/V/11)

- V.35

- DTR Dial Up

A leased line is a dedicated communications line usually leased from a telephone company vendor on a monthly basis. Current modem technology permits data transmission up to 19.2 Kbps on an analog line. Direct digital service (DDS) lines are available up to 64 Kbps.

A dial-up connection to a PDN is used primarily by PC users to access data that is on remote hosts. The data transmission rate is usually slower than that of leased lines and commonly has an upper limit of 9,600 bps.

NetWare Link/X.25 Link Layer

The Link layer (sometimes called the Frame layer) defines the protocol used to ensure reliable data interchange and proper data-link control between the DTE and the network DCE. The NetWare Link/X.25 Link layer performs the following tasks:

- Efficiently transfers data across the link

- Synchronizes the link

- Performs flow control when a local busy condition is detected

- Checks for errors and performs error recovery

- Provides link-up and link-down information to the packet layer

Using the services of the Physical layer, the Link layer is responsible for synchronizing data and for ensuring that the data is error-free.

Data is sent across the access link in transmission units called *frames*. User data is loaded into the packets at the Packet layer, then passed to the Link layer for transmission. The packets are wrapped with control information and are sent in a continuous segment or frame. The framing is specified by an ITU-T bit-oriented protocol called the High-level Data Link Control (HDLC).

For more information about the NetWare Link/X.25 Link layer, refer to "NetWare Link/X.25 Link Layer Characteristics."

NetWare Link/X.25 Link Layer Characteristics

The NetWare Link/X.25 Link layer conforms to the X.25 LAPB procedure and to the HDLC framing format. The NetWare Link/X.25 Link layer has the following characteristics:

- Modulo 8 or 128 numbering scheme

- User-defined window size 1 and 7 (or 1 and 127 for modulo 128 numbering)

- Automatic flow control through RNR frames in case of X.25 overload

- User-configurable retransmission timer (T1)

- User-configurable maximum retransmission counter (N2)

- User-configurable maximum number of bits in an Information (I) frame (N1)

* Automatic frame retransmission in case of transmission errors

* ITU-T 1976, 1980, 1984, 1988 compliance, except for the multilink procedure

NetWare Link/X.25 Packet Layer

The primary function of the NetWare Link/X.25 Packet layer is to multiplex the single interface onto multiple channels called *virtual circuits*.

The Packet layer performs the following functions:

* Establishes and clears virtual calls

* Manages permanent virtual circuits

* Provides procedures to transfer packets

* Controls flow

* Recovers from errors

* Puts user data in packets and removes user data from packets

The Packet layer defines the interface that gives users (or network applications) access to a packet-switched network. It is responsible for establishing network connections and providing communications paths between end systems. It uses the statistical time-division multiplexing (STDM) technique to multiplex simultaneous connections over a single physical link. The Packet layer is responsible for establishing, maintaining, and disconnecting end-to-end logical calls or connections.

For more information about the NetWare Link/X.25 Packet layer, refer to:

* NetWare Link/X.25 Packet Layer Characteristics

* NetWare Link/X.25 Virtual Circuit Service

* Logical Channel

* Logical Channel Number

NetWare Link/X.25 Packet Layer Characteristics

The NetWare Link/X.25 Packet layer has the following characteristics:

* Modulo 8 or 128 numbering scheme

- User-configurable default and maximum packet windows between 1 and 7 (or 1 and 127 for modulo 128 numbering)

- User-configurable default and maximum packet sizes between 16 and 4,096 bytes

- User-configurable virtual circuit ranges for PVCs, and switched incoming, outgoing, and two-way virtual circuits

- Negotiation at call setup time of the packet window, packet size, throughput class, and reverse charging

- Full facility checking

- ITU-T 1988 compliant

- Downgradeable to an ITU-T 1976, ITU-T 1980, or ITU-T 1984 version

- Network-specific support through network definition in the configuration table

- Unsupported packet retransmission

NetWare Link/X.25 Virtual Circuit Service

The NetWare Link/X.25 Packet layer multiplexes a physical link onto multiple channels using a virtual circuit. A virtual circuit gives the DTE user the impression that the connection with another DTE is unique and not shared. In reality, the user is sharing communication links with other virtual circuits or connections.

X.25 provides for two types of virtual circuits: SVCs and PVCs. For more information about virtual circuits, refer to:

- Switched Virtual Circuits
- Permanent Virtual Circuits
- Supported Connections
- Permanent and On-Demand SVCs
- Supported Connections

Switched Virtual Circuits

An SVC is a dynamically established on-demand virtual circuit that uses call setup and call-clearing procedures. A call is made between DTEs, a connection is established, data packets are sent, and the call is disconnected

when the transmission is complete. This is similar to using an ordinary telephone, whereby the user dials any number. The connection lasts only for the duration of the call.

Three types of SVCs are available:

◆ One-way incoming—Specified logical channels are restricted to receive incoming virtual calls only.

◆ One-way outgoing—Logical channel is restricted to outgoing virtual calls only.

◆ Two-way—Outgoing and incoming calls are allowed.

Permanent Virtual Circuits

A PVC is a permanent, network-assigned virtual circuit that requires no call setup or clearing. PVCs are like leased lines, whereby two phones are permanently connected to each other. There is no overhead in call setup for PVCs because no call setup is required. They are expensive, however, because they are permanent connections.

Figure 4 and Figure 5 show examples of an SVC and a PVC, respectively.

In Figure 4, a virtual call is initiated with a Call Request packet sent by the local DTE. The network routes the request to the DCE to which the destination DTE is connected. The DCE selects a free logical channel and sends an incoming Call Request packet to the called DTE. If the called DTE accepts the call, it sends a Call Accepted packet through the same logical channel number (LCN) as the Call Request packet. The call is established and the data exchange takes place.

Figure 4   Switched Virtual Circuit
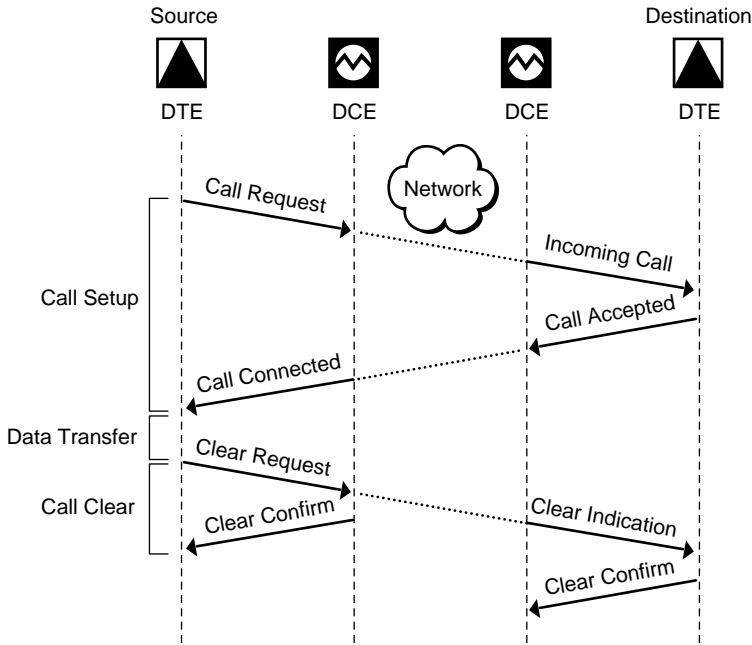
As shown in Figure 5, there is no need for a call setup procedure. After the restart procedure is complete, the DTEs can exchange data immediately.

Figure 5   Permanent Virtual Circuit
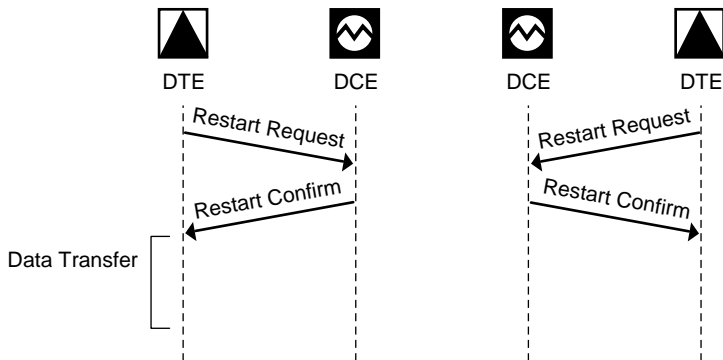
Supported Connections

NetWare Link/X.25 can route IPX and SNA traffic over PVCs. You can set up SVCs that can be connected manually or automatically. The router can maintain IP, IPX, and AppleTalk connections manually by using SVCs between multiple sites. Links that are set up manually are easy to install and maintain because they use routing table updates to discover end-user stations and hosts for each X.25 destination automatically. The router can establish and disconnect IP connections automatically using SVCs. The types of connections supported by NetWare Link/X.25 are shown in Table 2.

	Table 2	Connections Supported by NetWare Link/X.25	
Connection	**PVC**	**Permanent SVC**	**On-Demand SVC**
IPX	X	X	X
IP	X	X	X (RFC 1356)
AT	X	X	X
SNA	X	X	
BRIDGE	X	X	

Permanent and On-Demand SVCs

A permanent SVC is left in a connected state until the user or application brings it down.

An on-demand SVC is brought down when the idle timer has expired. The idle timer is user-configurable. The circuit remains down until more data is queued up to be sent, which is when the connection is reestablished.

Logical Channel

Setting up a logical connection requires establishing a logical channel or path. Once the logical channel is established between two DTEs, the packets are transferred between connected ends as needed.

Each packet is associated with a logical channel, which is mapped to the appropriate destination of the virtual circuit. The virtual circuit is assigned a unique number between 1 and 4,095, called the *logical channel number (LCN)*. This enables a more effective use of the access circuit for the available bandwidth and the traffic density for each logical channel. The logical channel

is the mechanism that allows multiple simultaneous virtual circuits across a physical link.

A DTE can establish up to 4,095 simultaneous virtual circuits with other DTEs on a single physical DTE/DCE link. A packet associated with a virtual circuit can be sent in either direction on a circuit at any time. This is called full-duplex statistical multiplexing. The packets are statistically multiplexed with packets of other communicating users, thus optimizing the transmission media of the network.

The data packets are routed automatically to the appropriate destination, as shown in Figure 6.

Figure 6   Virtual Circuit Setup
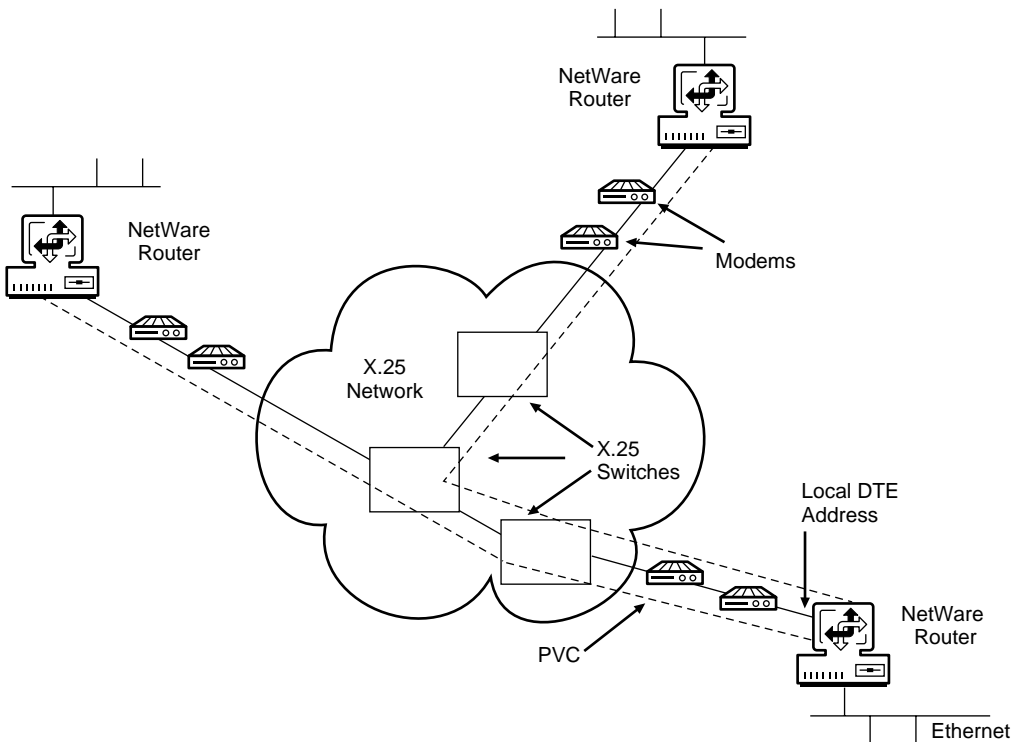
Logical channels differentiate among the virtual circuits supported at the packet level. Multiple communications are provided simultaneously by multiplexing virtual circuits over the access line. One PVC or SVC is established at a time on each logical channel.

Logical Channel Number

To determine which packet goes on which circuit, each packet flowing across the X.25 interface contains a 12-bit virtual circuit number. This number identifies a logical channel and is called the *LCN*. The 12-bit number is expressed as a 4-bit logical group number and an 8-bit LCN number.

Virtual circuit numbers are assigned according to a preset network arrangement, in which zero is reserved for restart and diagnostic packets for all circuits. Contiguous ranges of numbers are assigned for four categories of virtual circuits: PVCs, one-way incoming virtual circuits, one-way outgoing virtual circuits, and two-way virtual circuits.

For SVCs, the association between a logical channel identifier and a particular virtual circuit is accomplished at call setup time, when the identifier is chosen from a pool of unused identifiers. For PVCs, this association is by network subscription. At network subscription time, the user specifies the number of logical channels needed for both SVCs and PVCs (up to 255). The user also must specify the ranges for the incoming virtual circuit, the two-way virtual circuit, and the outgoing virtual circuit.

NetWare Link/X.25 Basic Attributes

There are two types of packet formats: *data packets* and *control packets*. Data packets contain the user data, the LCN, the send and receive sequence numbers, and the M-, D-, and Q-bits. Control packets contain the LCN, a packet type identifier, and additional information, depending on the control information.

The following basic packet attributes are supported by NetWare Link/X.25:

- ◆ Data packet user data field length
- ◆ Qualifier bit (Q-bit)
- ◆ Delivery confirmation bit (D-bit)
- ◆ More data mark (M-bit)

User Data Field Length

After a call or virtual circuit is established between two DTEs, the logical channel is in the data transfer phase. Data is sent through the network in packets. The sending DTE breaks up data into units of maximum length. X.25 specifies that a network must support a maximum user data field length of at

least 128 bytes. The network can also allow a different maximum field length of 16 to 4,096 bytes. The length requirement can be different at either end of a virtual circuit.

NetWare Link/X.25 supports the standard maximum user data size of 128 bytes. Other, nonstandard default maximum user data fields between 16 and 4,096 bytes are also available.

Qualifier Bit (Q-bit)

When the Q-bit is set to 0, the user data field contains data for the receiving user. When the Q-bit is set to 1, the user data field contains high-level control information that is used in packet assembler/disassembler (PAD) operations or other protocols.

Delivery Confirmation Bit (D-bit)

When the D-bit is set to 0, delivery is acknowledged locally. When the D-bit is set to 1, the remote DTE acknowledges delivery (end-to-end acknowledgment). This is an acknowledgment of the entire complete packet sequence. The DTE can set the D-bit to 1 for individual packets or all packets. The D-bit set on all packets gives the maximum security, but also adds delay.

More Data Mark (M-bit)

When the M-bit is set to 1, additional complete packet sequences follow, and the next packet is a logical continuation of the data in the current packet. This is useful for long information streams that do not fit in one data packet. Smaller sequences can form a part of a large sequence, and end-to-end acknowledgment can occur before the end of a larger sequence. The M-bit can also be set by the network if the network truncates a large packet into smaller ones.

NetWare Link/X.25 Optional User Facilities

The Recommendation X.25 provides a set of optional *user facilities* that addresses the need for versatility in network requirements. These facilities include the following:

- Flow control parameter negotiation
- Throughput class negotiation
- Closed user groups

- Bilateral closed user groups

- Fast select

- Fast select acceptance

- Reverse charging

- Reverse charging acceptance

- Default packet and window size configuration

These facilities give you the option of tailoring NetWare Link/X.25 to meet your network and user requirements. In addition, these facilities allow a network planner (or installer) to fine-tune the network's handling of specific areas (such as security, accounting, routing, and performance). You can select and incrementally specify these facilities to the particular needs of the users on a network. Many facilities can be used within an X.25 connection to a PDN.

For more information, refer to:

- Flow Control Parameter Negotiation

- Throughput Class Negotiation

- Closed User Group

- Bilateral Closed User Group

- Fast Select

- Fast Select Acceptance

- Reverse Charging

- Reverse Charging Acceptance

- Default Packet and Window Size Configuration

Flow Control Parameter Negotiation

Two parameters directly affect the flow of data across a virtual circuit: Window Size and Packet Size. Window Size is the maximum number of unacknowledged packets that can occur in a call. Packet Size is the maximum number of data bytes that can fit in the user data field of a packet.

You can use the Flow Control Parameter Negotiation facility to allow the Window Size and Maximum User Packet Size parameters to be negotiated in each direction on a per-call basis.

See Default Packet and Window Size Configuration for more information about setting default packet and window sizes.

Throughput Class Negotiation

Throughput Class Negotiation is the number of bits per second that can be sent on a virtual circuit on a per-call basis. The range is between 75 bps and 64 Kbps.

Closed User Group

The Closed User Group (CUG) allows the configuration of one or more *virtual* private networks within a larger public network. The CUG allows a user to collect a number of DTEs into a single logical group, and it restricts access to the group's ability to receive incoming calls from or make outgoing calls to the restricted open portion of the network. The number of CUGs is network-dependent. A single DTE can belong to one or more CUGs.

Within the CUG category, you can specify the following access for a user connection:

- Incoming access (CUG with Incoming Access), in which a DTE can communicate with other DTEs within the CUG and receive incoming calls from outside the CUG

- Outgoing access (CUG with Outgoing Access), in which a DTE can initiate calls to other DTEs outside the CUG

- Both incoming and outgoing access

If a DTE belongs to more than one CUG, you must also specify a *preferred* (or primary) CUG.

Bilateral Closed User Group

The Bilateral Closed User Group (BCUG) offers a finer degree of access control than the CUG offers. *Bilateral* signifies a CUG relationship that has been limited to a pair of DTEs. Access between the pair of DTEs is unrestricted. However, access to or from any other DTE is not possible. A DTE can belong to one or more bilateral CUGs, but cannot call DTEs that do not belong to a BCUG.

Fast Select

Fast Select is an optional user facility that can be set on a per-call basis. This facility allows the exchange of user data while the virtual call is being established. Usually, the user must initiate a call and get a *connection established* message before sending data. With Fast Select, the user can include data in the initial Call Request packet.

NOTE: The user can include data in the Call Request packet without using Fast Select. Without Fast Select, the user can put up to 16 bytes in the Call Request packet.

When Fast Select is indicated in a Call Request packet, the packet can contain a Call User Data field of up to 128 bytes. An additional field of up to 128 bytes of called or clear user data can also be included by the called DTE in the Call Accepted or Clear Request packet.

Two options are available with Fast Select :

- ◆ Restriction on response (the called DTE must respond with a Clear Request packet)

- ◆ No restriction on response (the called DTE responds with any valid response)

Fast Select makes the data field more useful for short-duration, low-volume, transaction-oriented applications. This facility often is used in the environment of retail point-of-sale and credit card authorization terminals.

Fast Select Acceptance

The Fast Select Acceptance facility is an optional user facility that can be established for a period of time. When subscribed, the DCE can transmit to the DTE all incoming calls that request the Fast Select facility. When Fast Select Acceptance is not subscribed, the DCE rejects all incoming calls that request the Fast Select facility.

Reverse Charging

The Reverse Charging facility offers the equivalent of a collect or reverse charge call. This facility is allowed on a per-call basis and is specified in the Call Request packet by the calling DTE. The facility lets the called DTE accept the charges for a call.

A DTE subscription with a PDN can include a provision to allow (or disallow) a remotely originated reverse-charged call from reaching that DTE (Reverse Charging Acceptance).

NetWare Link/X.25 also provides local configurable options for both of the preceding items. That is, regardless of a customer's PDN subscription, all inbound reverse-charged calls can be rejected.

Reverse Charging Acceptance

Reverse Charging Acceptance is an optional user facility that is established for a specified period of time. This facility authorizes the network to present incoming reverse-charged calls to the called DTE. When Reverse Charging Acceptance is not set, the DCE does not transmit incoming calls that request Reverse Charging.

Default Packet and Window Size Configuration

The Packet Size and Window Size parameters directly affect data flow across a virtual circuit. By increasing the packet and window sizes in any direction of a call, you can increase the throughput of data across the circuit.

Recall that packet size is the maximum number of data bytes allowed in the user data field of a packet. PDNs have a default packet size of 128 bytes. A DTE can select a nonstandard default packet size ranging between 16 and 4,096 bytes.

The window size is the maximum number of unacknowledged packets that can occur in a call, usually between 1 and 7. A large window size improves network efficiency because fewer acknowledgment packets need to be sent. The standard default window size is 2. A DTE can select a nonstandard default window size from 0 to 7.

Some networks might require that the default packet and window size be the same for each data flow direction. Values other than the default can be negotiated using the Flow Control Parameter Negotiation facility.

Non-ITU-T X.25-Specific Parameters

This section covers the NetWare Link/X.25 parameters that are not specified by ITU-T and are specific to the Novell Internet Access Server 4.1 routing software. For information on specific parameters, refer to:

- Maximum Physical Receive Packet Size
- User Data Size
- Port Connections
- Interface Queue Limit
- Authentication Options
- Call Types

Maximum Physical Receive Packet Size

The Maximum Physical Receive Packet Size is a parameter that you can set in the STARTUP.NCF file. This parameter determines the maximum size of the packet that can be transmitted or received. It can be configured using the SERVMAN utility in NetWare 4.11.

User Data Size

The User Data Size can be set as a maximum size, in bytes, for the size of the data you expect to transmit and receive on the interface. You can set the user data size to be unlimited.

Port Connections

The physical connection between the local DTE and the DCE or the remote DTE can be specified in the Port Connections setting. Options for port connections include DTR-dialed and hard-wired.

Interface Queue Limit

You can specify the maximum number of user messages that can be queued to each port on the board. The range is from 0 (unlimited) to 1,024 messages. The message will be discarded when the number of messages in the queue reaches the queue limit.

Authentication Options

You can specify whether incoming calls are subject to authentication based on a list of specific DTE addresses. This list is called an *authentication database*. When you set it up, you include the name, remote system ID, and remote DTE address for each valid partner DTE that can communicate with an interface. Only the DTEs listed in the database are allowed to communicate with the selected interface.

Call Types

NetWare Link/X.25 calls can be one of two types:

- Permanent, or continuously active

- On-demand, or activated by the presence of data traffic directed to or through the remote peer system

For a permanent call type, you must also specify the following parameters:

- Retry Mode —Specifies whether a failed permanent connection is retried automatically.

- Retry Limit Handling —Specifies whether retries continue when a configured interval limit is reached.

- Retry Interval Limit —Specifies a maximum delay interface between attempts to establish a permanent connection.

For an on-demand call type, you must also specify the idle-line timeout value. This indicates how long a virtual circuit is inactive before the connection is closed.

X.25 SNMP Trap Generation

X.25 generates diagnostic SNMP trap control, which provides an indication of typically abnormal conditions and network access problems on the X.25 network interface.

You can set the following traps for X.25:

- LAPB Link Up Trap—Indicates that the X.25 LAPB interface initialization procedure has completed and the data link has entered the information transfer state as indicated by RFC 1381, *SNMP lapbFlowCurrentMode object value of something other than informationTransfer (5)*. The trap PDU variable binding list contains

information identifying the date, time, dial access router (DAR) system ID, interface name, and the ifIndex value of the interface that entered the link-up state.

- ◆ LAPB Link Down Trap—Indicates that the X.25 LAPB interface has exited the information transfer state as indicated by RFC 1381, *SNMP lapbFlowCurrentMode object value of something other than informationTransfer (5)*. The trap PDU variable binding list contains information identifying the date, UTC time, DAR system ID, interface name, and the ifIndex value of the interface that entered the link-down state.

- ◆ X.25 Call Attempt Failure Trap—Indicates the failure of a DTE (Call Request) or DCE (Incoming Call) attempt to establish an SVC connection. The trap PDU variable binding list contains information identifying the date, time, DAR system ID, interface name, ifIndex value, logical channel number (LCN), call direction (inbound or outbound), and the cause and diagnostic codes associated with the failure cause and diagnostic codes defined in the Recommendation X.25.

- ◆ X.25 Call Clear Trap (Call Termination)—Indicates an inbound (Clear Indication) or outbound (Clear Request) attempt to terminate a previously established SVC connection. This can be either a normal or an unexpected clear. The trap PDU variable binding list contains information identifying the date, time, DAR system ID, interface name, ifIndex value, LCN, call direction (inbound or outbound), and the cause and diagnostic codes associated with the clear cause and diagnostic codes defined in the Recommendation X.25.

- ◆ X.25 Restart Trap—Indicates a DTE (Restart Request) or DCE (Restart Indication) attempt to reinitialize the DTE/DCE interface. Although similar in function to the restart trap defined by RFC 1382, this trap contains additional information. The trap PDU variable binding list contains information identifying the date, time, DAR system ID, interface name, ifIndex value, and the cause and diagnostic codes associated with the restart. This trap should always be suppressed during the first initialization of the DTE/DCE interface.

- ◆ X.25 Reset Trap—Indicates a DTE (Reset Request) or DCE (Request Indication) attempt to reinitialize a specific PVC connection. Although similar in function to the reset trap defined by RFC 1382, this trap contains additional information. The trap PDU variable binding list contains information identifying the date, time, DAR system ID, interface name, ifIndex, LCN, and the cause and diagnostic codes associated with the reset.

2 Planning

NetWare Link/X.25 operates in a NetWare server or NetWare router/bridge PC environment and provides services for NetWare products and other applications (including independent developer applications) requiring wide area connectivity.

NetWare Link/X.25 uses the ITU-T Recommendation X.25, which defines the interaction between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) of a packet-switching network. The most recent ITU-T Recommendation X.25 is the 1992 revision.

DTE is a generic term for any network-attached, customer-premises, or end-user equipment operating in packet mode. DCE can be any one of the devices that is not a DTE but is associated with a single network port and is responsible for establishing, maintaining, and terminating the connection with a DTE. The X.25 protocol requires a DTE/DCE pair to operate.

NetWare Link/X.25 implements the X.25 protocol as described in these recommendations, including the physical level, frame level, and packet level, along with several library modules used in interfacing with the user applications.

The wide area connectivity products that NetWare Link/X.25 supports include Novell Internet Access Server 4.1 routing and remote access functionality, and SNA/QLLC (NWSAA product).

For more information about features, functions, and how NetWare Link/X.25 works, refer to "Understanding."

Configuration Decisions

The ITU-T (International Telecommunications Union, Telecommunications Standardization sector), previously CCITT, Recommendation X.25 addresses users' needs for versatility in their network requirements through a set of optional user facilities. With these facilities, you can tailor X.25 to meet your network and user requirements, and fine-tune how the network handles such areas as security, accounting, routing, and performance. These facilities can be selectively and incrementally adapted to the needs of the users on the network.

You can use many of the user facilities within an X.25 connection to a public data network (PDN). The following user facilities are available with NetWare Link/X.25:

- *Flow Control Negotiation* —Allows negotiation, on a per-call basis, of the window size and maximum user data field length that can be used on the call in each direction.

- *Throughput Class Negotiation* —Specifies, on a per-call basis, the throughput of data that can be transferred on a virtual circuit. The range is 75 bps to 64 Kbps.

- *Fast Select* —Expands the Call and Clear user data fields from the normal 16 octets to 128 octets, enhancing the data field's usefulness for short-duration, low-volume, transaction-oriented applications. This facility is often used in the retail point-of-sale and credit card authorization terminal environment.

- *Reverse Charging* —Offers the equivalent of a collect call. It is allowed on a per-call basis and is specified in the Call Request packet by the calling data terminal equipment (DTE).

- *Closed User Group (CUG)* —Allows the configuration of one or more *virtual* private networks within a larger public network. It allows a user to collect a number of DTEs into a single logical group and restrict access to the group's ability to receive incoming calls from or make outgoing calls to the restricted open portion of the network. The number of CUGs is network-dependent. A single DTE can belong to one or more CUGs.

  Within the CUG category, you can specify whether a user connection has incoming access (CUG with Incoming Access), outgoing access (CUG with Outgoing Access), or both. If a DTE belongs to more than one CUG, you must also specify a *preferred* (or primary) CUG.

- *Bilateral Closed User Group (BCUG)* —Offers a finer degree of access control than the CUG offers. Bilateral signifies a CUG relationship that

has been limited to a pair of DTEs. Access between the pair of DTEs is unrestricted; however, access to or from any other DTE is not possible.

A DTE subscription with a PDN can include a provision to allow or disallow a remotely originated, reverse-charged call from reaching that DTE (*Reverse Charging Acceptance*). Additionally, a DTE subscription with a PDN can include a provision to disallow any locally charged calls; that is, all locally generated call requests *must* specify reverse charging.

NetWare Link/X.25 also provides additional local configurable options for both of the above items; that is, regardless of a customer's PDN subscription, all inbound reverse-charged calls can be rejected.

For more information about NetWare Link/X.25, refer to "Understanding."

Virtual Circuit Service

X.25 provides for two types of virtual circuits: *switched virtual circuits* (SVCs) and *permanent virtual circuits* (PVCs). An SVC is a dynamically established virtual circuit using call setup and call clearing procedures. A PVC is a permanent, network-assigned virtual circuit that requires no call setup or clearing.

A virtual circuit provides a connection-oriented service, similar to that of circuit switching but with the following exceptions:

- It is limited to a connection between two end points.

- It has the advantage of economical statistical multiplexing for establishing a logical path through the network.

This logical path can be provided either on a permanent basis by a PVC, which is equivalent to a leased circuit, or on a request basis by an SVC. Once the logical path is established, the packets are transferred between connected ends, as desired.

The packets are statistically multiplexed with packets of other users, optimizing the transmission media of the network.

Each packet is associated with a logical channel, which is mapped to the appropriate destination of the virtual circuit. This enables a more effective use of the access circuit for the available bandwidth and the traffic density for each logical channel.

The router can manually maintain IPX, IP, and AppleTalk connections using SVCs between multiple sites. You can set up SVCs that can be connected manually or automatically. Links that are set up manually are easy to install and maintain because they use routing table updates to discover end-user stations and hosts for each X.25 destination automatically. The router can automatically establish and disconnect on-demand IP connections using SVCs.

The types of connections supported by NetWare Link/X.25 for various protocols are shown in the following table.

Protocol	PVC	Permanent SVC	On-Demand SVC
IPX	X	X	X
IP	X	X	RFC 1356
AT	X	X	X
Source route bridge		X	X

A permanent SVC is established at initialization and is left in a connected state until the user or application brings it down. An on-demand SVC is established only when data is present for the associated virtual circuit and is brought down after the data has been transmitted and the configured idle timer has expired. An on-demand SVC remains down until more data is queued up to be sent, then the connection is reestablished.

The procedure for setting up a virtual call is to establish a logical path, then the data packets are automatically sent to the appropriate destination.

The packet level provides the virtual circuit service of PVCs and SVCs. Logical channels differentiate the virtual circuits supported by the packet level. Multiple connections are provided simultaneously by multiplexing virtual circuits over the access line. Only one PVC or SVC can be established at a time on each logical channel.

Logical Channel Numbers

The identification of a logical channel is present in every packet flowing across the X.25 interface. This identification is in the form of a field within the packet consisting of 12 bits. For SVCs, the association between a logical channel identifier and a particular virtual circuit is accomplished at call setup

time when the identifier is chosen from a pool of unused identifiers. For PVCs, this association is by network subscription.

At network subscription time, the user specifies the number of logical channels needed for both SVCs and PVCs by designating ranges of logical channel numbers. NetWare Link/X.25 configuration uses the decimal equivalent of the complete 12-bit Logical Channel Identifier in terms of two subfields: the Logical Channel Group (4 bits) and the Logical Channel Number (8 bits).

Within any of the following categories, the range of available logical channels must be contiguous. Each successive range of logical channel numbers must be numerically higher than the previous range.

In increasing order, the logical channel ranges include the following:

1. PVCs

2. SVCs supporting only calls from the network (inbound SVCs)

3. SVCs supporting calls from and to the network (two-way SVCs)

4. SVCs supporting only calls to the network (outbound SVCs)

NetWare Link/X.25 User Facilities

The ITU-T Recommendation X.25 addresses users' needs for versatility in their network requirements through a set of optional *user facilities* . These facilities give X.25 the capability of being tailored to meet varied network and user requirements, and allow a network installer to fine-tune the network's handling of such areas as security, accounting, routing, and performance. These facilities can be selectively and incrementally specified to the needs of the users on that network.

Many user facilities can be used within an X.25 connection to a PDN. The user facilities available with NetWare Link/X.25 include the following:

- ◆ Flow Control Negotiation —Allows negotiation, on a per-call basis, of the window size and maximum user data field length that can be used on the call in each direction.

- ◆ Throughput Class Negotiation —Specifies, on a per-call basis, the throughput of data that can be transferred on a virtual circuit. The range is 75 bps to 64 Kbps.

- Fast Select —Expands the Call and Clear user data fields from the normal 16 octets to 128 octets, enhancing the data field's usefulness for short-duration, low-volume, transaction-oriented applications. This facility is often used in the retail point-of-sale and credit card authorization terminal environment.

- Reverse Charging —Offers the equivalent of a collect call. It is allowed on a per-call basis and is specified in the Call Request packet by the calling DTE.

- Closed User Group (CUG) —Allows the configuration of one or more *virtual* private networks within a larger public network. It allows a user to collect a number of DTEs into a single logical group and restrict access to the group having the ability to receive incoming calls from or to make outgoing calls to the restricted open portion of the network. The number of CUGs is network-dependent. A single DTE can belong to one or more CUGs.

  Within the CUG category, you can specify whether a user connection has incoming access (CUG with Incoming Access), outgoing access (CUG with Outgoing Access), or both. If a DTE belongs to more than one CUG, you must also specify a *preferred* (or primary) CUG.

- Bilateral Closed User Group (BCUG) —Offers a finer degree of access control than the CUG offers. *Bilateral* signifies a CUG relationship that has been limited to a pair of DTEs. Access between the pair of DTEs is unrestricted; however, access to or from any other DTE is not possible.

A DTE subscription with a PDN can include a provision to allow or disallow a remotely originated, reverse-charged call from reaching that DTE (Reverse Charging Acceptance). Additionally, a DTE subscription with a PDN can include a provision to disallow any locally charged calls; that is, all locally generated call requests *must* specify reverse charging.

NetWare Link/X.25 additionally provides local configurable options for both of the preceding items; that is, regardless of a customer's PDN subscription, all inbound reverse-charged calls can be rejected and all outbound call attempts that do not specify reverse charging can be disallowed.

Diagramming Your X.25 Network

To ensure that all connections to the X.25 network are properly diagrammed, complete the following steps:

1. Diagram the existing X.25 network showing all Novell Internet Access Server 4.1 routing access points and mark the X.25 addresses.

   Figure 7 shows a simple example of a planning diagram.

2. Draw in and show each type of connection from the local Novell Internet Access Server 4.1 router to its corresponding partner.

   For PVC-type connections, show the LCN assigned by the X.25 network service provider and the partner name.

   For SVC-type connections, list the partner names.

Figure 7   X.25 Planning Diagram Example
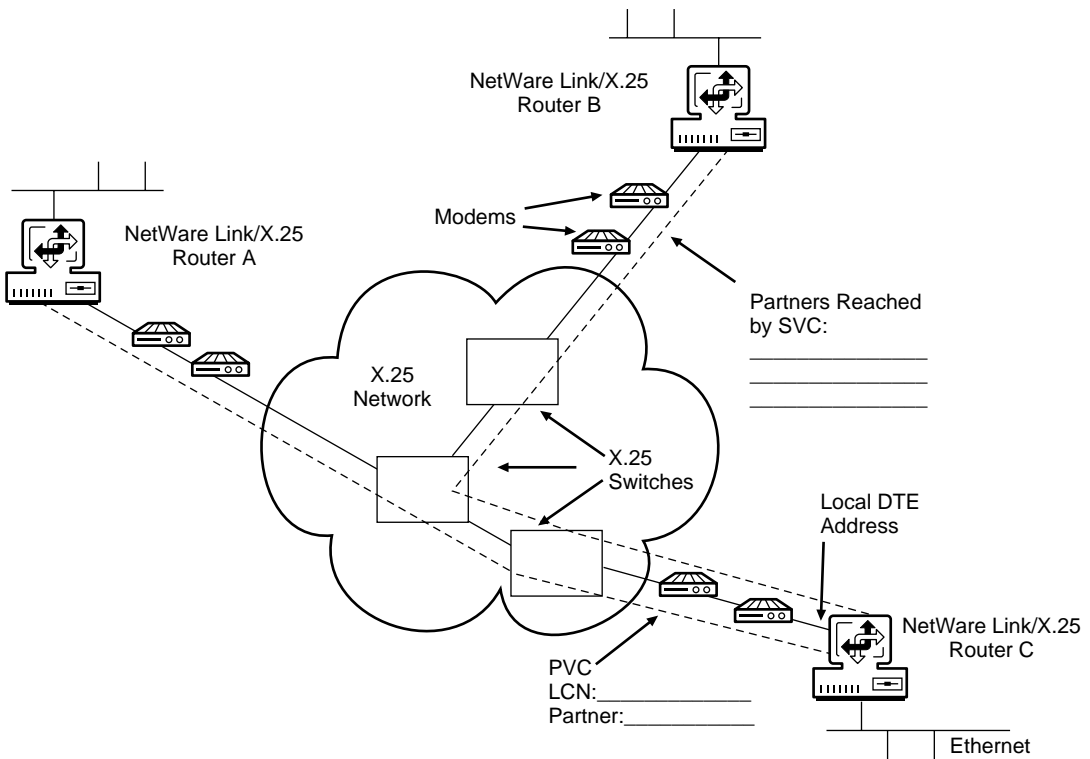
Planning Your X.25 Network

To ensure that all aspects of your planned connections to the X.25 network are covered, complete the following steps:

1. For each location that a router attaches to the X.25 network, specify the following parameters:

   ◆ Physical interface required (for example, V.35 or RS-232)

   ◆ Internal interface speed required (for example, 9,600 or 19,200)

     This value is required only when the clocking is generated internally. Otherwise, clocking comes from the modem.

   ◆ Number of partner routers that will be connected using X.25

   ◆ For each partner, whether a PVC or an SVC is required

   ◆ Packet size required (for example, 128 bytes or 256 bytes)

2. Using the information from Step 1, fill in the NetWare Link/X.25 Network Access Worksheet.

   Figure 8 shows the NetWare Link/X.25 Network Access Worksheet.

   The NetWare Link/X.25 Network Access Worksheet fields are described following the worksheet.

3. Contact your X.25 network service provider and request the specific parameter values you require.

   These values correspond to those specified on the worksheet.

   The X.25 network service provider will set up your service and assign a range of virtual circuit numbers to meet your requirements.

4. Using the information from Step 3, fill in the NetWare Link/X.25 Connections Worksheet.

   Figure 9 shows the NetWare Link/X.25 Connections Worksheet.

Figure 8   NetWare Link/X.25 Network Access Worksheet

NetWare Link/X.25 Network Access Worksheet   Router ID: _____

Complete a copy of this worksheet for each NetWare router.

Frame-Level Parameters

Sequencing Modulo (circle one)	8 | 128
Window Size (k)	_____
Maximum Frame Size (N1)	_____
Retry Count (N2)	_____
Retry Timeout (T1)	_____
Disconnect Timeout (T3)	_____
Idle Timeout (T4)	_____

Packet-Level Parameters

Local DTE Address	_____
Version (circle one)	1980 | 1980 Min | 1984 | 1988
Role (circle one)	DTE | DCE
Default Inbound Packet Size	_____
Default Outbound Packet Size	_____
Packet Sequencing Modulo (circle one)	8 | 128
Default Inbound Window Size	_____
Default Outbound Window Size	_____

T20 _____ T21 _____ T22 _____ T23 _____ T24 _____
T25 _____ T26 _____ R20 _____ R22 _____ R23 _____

Logical Channel Numbers

	Lowest LCN	Number of LCNs
PVC	_____	_____
Inbound SVC	_____	_____
Two-way SVC	_____	_____
Outbound SVC	_____	_____

User Facilities

Allow Flow Control Negotiation (circle one)   Yes \| No

Maximum Inbound Packet Size	_____
Maximum Outbound Packet Size	_____
Maximum Inbound Window Size	_____
Maximum Outbound Window Size	_____

Fast Select (circle one)   Yes \| No

The following list describes the fields in the NetWare Link/X.25 Network Access Worksheet:

NetWare Link/X.25 Router ID (at top of page)—Symbolic name assigned by the system administrator to identify a particular NetWare Link/X.25 router.

The ID provides a way to track or reference a particular NetWare Link/X.25 router.

This topic contains the following sections:

◆ Frame-Level Parameters

◆ Packet-Level Parameters

◆ Logical Channel Numbers

◆ User Facilities

Frame-Level Parameters

◆ Sequencing Modulo —Specifies the numbering of sequential frames allowed in a Data-Link layer window. For most networks, Modulo 8 should be used. For special networks, Modulo 128 can be used; this allows users to select a larger window size.

   NOTE: The Default Window Size field is dependent on which Modulo method you select here.

◆ Window Size (k) —Determines the maximum number of sequential frames that can be received or sent before the server or router sends (or waits for) an acknowledgment.

◆ Maximum Frame Size (N1) —Determines the maximum frame size allowed to be received on the link (in octets).

◆ Retry Count (N2) —Determines the maximum number of times a frame should be retransmitted because of the expiration of the Retry Timer (T1). A large value for this parameter increases the probability of a correct transfer between the DTE and DCE. A small value permits faster detection of a permanent error condition.

◆ Retry Timeout (T1) —Determines the time, in seconds, to wait for an acknowledgment of the oldest transmitted frame. If no acknowledgment is received within this set time, an attempt is made to determine the status of the remote device.

   Set this parameter to a value slightly greater than twice the transmission time of the longest frame, including anticipated delay time to the peer node.

◆ Disconnect Timeout (T3) —Displays the value of the T3 timer. After attempting to connect the link by sending N2 Set Asynchronous Balanced Mode (SABM) frames on T1 expiration, the Data-Link layer continues sending SABM frames when the T3 timer expires.

◆ Idle Timeout (T4) —Specifies the amount of time the local DTE waits (when a link becomes idle) before attempting to poll the partner node for status. If the partner node does not respond to the polls, the link is reset and all current virtual calls are cleared or reset.

Packet-Level Parameters

◆ Local DTE Address —Specifies the X.121 address (up to 15 digits) of the local DTE. It should match the address assigned by your attached network. This address in included in the Calling Address field of the outbound Call Request packets.

◆ Version —Determines the specific conformance year for the X.25 specification you use for this port.

◆ Role —Determines whether you use DTE or DCE procedures for packet-level operation in the logical channel number (LCN) assignment.

When establishing a connection to an X.25 network, you must set this parameter to DTE (the default value) to avoid call collisions.

◆ Default Inbound Packet Size —Determines the default packet size that is used for a call. Unless another packet size is specified when the call is made, the default packet size value is used. Set this value to correspond to your network subscription.

◆ Default Outbound Packet Size —Determines the maximum outgoing data packet size when a call is established without the Flow Control Negotiation parameter. The Default Outbound Packet Size should be a value that is agreed on by the PDN and the remote DTE.

◆ Sequencing Modulo —Provides control over the numbering of sequential data packets allowed in a window. For most networks, Modulo 8 should be used.

NOTE: The Default Window Size field is dependent on which Modulo method you select here.

◆ Default Inbound Window Size —Specifies the default number of sequential incoming or outgoing data packets that can be sent before an acknowledgment is required.

NOTE: The Packet Sequencing Modulo and Window Size fields are independent of the Frame Sequencing Modulo and Window Size parameters.

◆ Default Outbound Window Size —Specifies the default value of the maximum number of sequentially numbered data packets that can be

transmitted by the local DTE without receiving an acknowledgment at any given time.

When a virtual circuit is established without flow control negotiation, this value is used as an outbound window size. You should set this parameter to the value agreed on by the PDN.

◆ T20 (Restart Response Timer) —Determines the amount of time, in seconds, that the local DTE waits when it issues a Restart Request packet to receive a restart confirmation or restart indication.

When the time limit expires, the Restart Request packet is retransmitted.

◆ T21 (Call Response Timer) —Specifies the amount of time, in seconds, that the DTE waits for a response to an outbound Call Request packet.

◆ T22 (Reset Response Timer) —Specifies the amount of time, in seconds, that the DTE waits for a response to a Reset Request packet.

◆ T23 (Clear Response Timer) —Specifies the amount of time, in seconds, that the DTE waits for a response to a Clear Request packet.

◆ T24 (Ack-Send Timer) —Specifies the amount of time, in seconds, that a DTE waits when a packet carrying a valid acknowledgment is sent.

This timer is used to ensure that no acknowledgment is lost. If the timer expires, an RR (Receiver Ready) packet is sent.

◆ T25 (Data Packet Retransmission Timer) —Specifies the amount of time, in seconds, that the DTE waits for the appropriate acknowledgment after transmitting a data packet.

If the T25 timer expires, the packet layer resets the virtual circuit.

◆ T26 (Interrupt Timer) —Specifies the amount of time, in seconds, that the DTE waits when an Interrupt Request packet is sent for an interrupt confirmation to be received.

If the T26 timer expires, the packet layer resets the virtual circuit.

◆ R20 (Restart Retransmission Timer) —Specifies the maximum number of times the local DTE retransmits, upon expiration of the T20 timer, before notifying the user that the associated link is inoperative.

◆ R22 (Restart Retransmission Count) —Determines the maximum number of times the local DTE retransmits a Reset Request packet, upon expiration of the T22 timer, before initiating a Clear procedure for SVC or a Restart procedure for PVC.

- R23 (Clear Retransmission Count) —Determines the maximum number of times the local DTE retransmits a Clear Request packet, upon expiration of the T23 timer, before initiating a Restart procedure on the associated link.

Logical Channel Numbers

- PVC, Lowest LCN —Determines the lowest LCN that can be used for a PVC.

- PVC, Number of LCNs —Determines the number of logical channels supporting PVCs.

  This number must agree with your network subscription.

- Inbound SVC, Lowest LCN —Determines the lowest LCN that can be used for one-way incoming logical channels for SVCs.

  This value must be greater than or equal to the Lowest PVC LCN parameter value.

- Inbound SVC, Number of LCNs —Determines the number of incoming channels assigned for inbound-only SVCs.

  This number must agree with your network subscription.

- Two-Way SVC, Lowest LCN —Determines the lowest number of two-way channels assigned for SVCs that can be used for both inbound and outbound calls.

- Two-Way SVC, Number of LCNs —Determines the lowest LCN that can be used for two-way SVCs.

  This number must agree with your network subscription.

- Outbound, Lowest LCN —Determines the lowest LCN that can be used for outgoing logical channels for SVCs.

  The value must be greater than or equal to the Lowest Two-Way SVC LCNs value plus the Number of Two-Way LCNs value.

- Outbound, Number of LCNs —Determines the number of logical channels reserved for outbound-only SVCs.

  This number must agree with your network subscription.

User Facilities

- Allow Flow Control Negotiation —If set to Yes , negotiates (downgrades) incoming calls containing either Window Size or Packet Size facility values that are greater than those specified.

  If set to No , rejects incoming calls containing either Window Size or Packet Size facility values that are greater than those specified.

- Maximum Inbound Packet Size —Specifies the largest incoming packet size that can be negotiated on a per-virtual-circuit basis.

- Maximum Outbound Packet Size —Specifies the largest outgoing packet size that can be negotiated on a per-virtual-circuit basis.

- Maximum Inbound Window Size —Specifies the largest value, per virtual circuit, to be negotiated in a Window Size facility parameter field.

  The maximum value for this parameter is dependent on which Packet Sequencing Modulo method you selected.

- Maximum Outbound Window Size —Specifies the largest value, per virtual circuit, to be negotiated in a Window Size facility parameter field.

  The maximum value for this parameter is dependent on which Packet Sequencing Modulo method you selected.

- Fast Select —If set to Yes , allows up to 128 bytes of user data to be included in Call Request packets. If set to No , user data is not included in Call Request packets.

Figure 9   NetWare Link/X.25 Connections Worksheet

NetWare Link/X.25 Connections Worksheet	Local Router ID:	
Destination (Partner)	Type (SVC/PVC)	DTE Address (SVC) / LCN (PVC)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
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_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Where to Go from Here

When you have completed all the planning steps for your frame relay
connections, verify that the appropriate WAN interface boards are installed
and configured as described in Setting Up in the *Boards* documentation.

After the WAN interface boards are installed and configured, refer to "Setting Up" on page 51 for configuration information.

3 Setting Up

This section describes how configure the NetWare® Link/X.25™ server software.

Configuring the Network Interface

After you have configured a NetWare Link/X.25 board, as described in Setting Up in the *Boards* documentation, you need to configure an X.25 network interface.

How to Configure the Network Interface

Before you begin, make sure you have planned your X.25 network. Refer to "Planning" on page 35 for X.25 checkpoints and planning information.

To configure network interface parameters for NetWare Link/X.25, complete the following steps:

1 Load NIASCFG, then select the following parameter path:

Select Configure NIAS > Protocols and Routing > Network Interfaces

2 Select an unconfigured port on a WAN interface board, then press Enter.

The Select A Medium screen is displayed.

3 Select X.25-Host , then press Enter.

The X.25 Network Interface configuration menu is displayed. The cursor is positioned in the Profile field, but you should first consider the information in the two fields that precede it.

The Interface Name field is a read-only field. It displays an interface name that is a combination of the board name defined in the Board

Configuration menu, underline characters used as separators, and a port number (typically 1 through 4).

The Interface Group field initially displays a value of None. You can use this field to assign this interface to a defined group of WAN interfaces. WAN call destinations can be configured to use interface groups, which allow protocols such as the IP or Internetwork Packet Exchange™ (IPX™) protocols to request that an on-demand X.25 virtual circuit be made through any available interface within the group. The interface actually used for the call is determined at the time the call is made.

4 If you decide to assign this interface to a group, select the Interface Group field, then press F3 or Enter to display a list of configured groups.

5 Select an interface group from the list, then press Enter , or press Ins to create a new interface group.

All network interfaces in a group must have the same configuration characteristics.

6 In the Interface Status field, accept Enabled by pressing the Down-arrow key to skip to the next field, or press Enter to select Disabled from a pop-up menu.

This field is most often used to test a particular board configuration by disabling other boards, which prevents them from loading.

7 In the Profile field, press Enter to display a list of standard profiles for X.25 service providers.

8 Select the standard profile for your X.25 service provider from the list, then press Enter to use the values in the standard profile, or press F2 to make a copy of the profile.

We recommend that you use the standard profiles whenever possible. Standard profiles are read-only; you cannot modify the values in them.

You can modify the values in a copy of a standard profile to match any custom requirements imposed by your local X.25 network service provider. If you make a copy of a standard profile, you must give the copy a unique (local) name.

9 If you make a copy of a standard profile and you need to modify the values assigned to one or more parameters, press Ins or F3 to display the X.25 Profile Configuration menu and access menus for the following:

◆ Frame-level parameters

◆ Packet-level parameters

- ◆ Virtual circuit setup

- ◆ User facility setup

- ◆ Conformance options

The parameters found in these menus correspond to many of the fields found on the NetWare Link/X.25 Network Access Worksheet. Refer to "Planning" on page 35 for detailed information about setting the values of these parameters.

10 In the Local DTE Address field, enter the address assigned by your local X.25 network service provider, then press Enter.

NOTE: You can exit the configuration at this point by accepting the default values for the remaining parameters. To save this configuration and return to the Internetworking Configuration menu, press Esc , select Yes when prompted, then press Enter. Otherwise, continue with Step 11.

11 In the Statistics Period field, accept the default value or enter a new value.

This value specifies the interval, in seconds, at which the interface board is polled by the driver to gather statistical data. The range of values is 1 to 1,024 seconds; the default value is 1 second.

12 In the User Data Size field, accept the default value or enter a new value.

This value specifies the maximum user data size, in bytes, that the interface supports. The range of values is 500 to 4,096 bytes; the default value is 1,500 bytes.

13 In the Interface Queue Limit field, accept the default value shown or enter a new value.

This value specifies the maximum number of data packets that can be queued to this port. The range of values is 0 (unlimited) through 1,024 packets. The default value is 100 packets.

The Interface Queue Limit value should be less than the configured Maximum Packet Receive Buffers value.

14 In the Physical Options field, press Enter to view or modify the following parameters:

- ◆ Interface Name —Specifies the name of the interface.

- ◆ Physical Type —Specifies this port's electrical interface standard. This parameter must reflect the actual port type installed. The

possible physical interface types are RS-232 , RS-422 , V.35 , and X.21.

- ◆ Port Connection —Specifies the physical connection between the local DTE and the remote end. The options are Hard-wired , DTR Dialed , and Pseudo-Switched. The default value is Hard-wired.

- ◆ Interface Speed —Specifies the line speed, in bits per second, of this port if the clocking is generated internally. The internal board rates vary, depending on the driver.

- ◆ Simulate DSR On —Specifies whether to simulate DSR signal on.

- ◆ Simulate DCD On —Specifies whether to simulate DCD signal on.

- ◆ Simulate CTS On —Specifies whether to simulate CTS signal on.

15 Press Esc to return to the X.25 Network Interface menu.

16 In the Authentication Options field, press Enter to view or modify the X.25 authentication options.

The X.25 Authentication Options menu is displayed. The Interface Name field is a read-only field. It displays an interface name that is a combination of the board name defined in the Board Configuration menu, underline characters used as separators, and a port number (typically 1 through 4).

17 In the Inbound Authentication field, accept the default value, Disabled , by pressing the Down-arrow key to skip to the next field, or press Enter to select Enabled from a pop-up menu.

The setting of this parameter specifies whether incoming calls are subject to authentication. If you cannot control access to this X.25 interface, you should enable authentication.

If Inbound Authentication is set to Enabled , only incoming calls with a DTE address specified in the authentication database are accepted.

If Inbound Authentication is set to Disabled , the interface will accept all inbound calls.

NOTE: If Inbound Authentication is set to Disabled , the values of the other parameters in this menu are irrelevant. To return to the Internetworking Configuration menu, press Esc and skip to Step 22. Otherwise, continue with Step 18.

18 In the Authentication Database Name field, accept the name shown or enter a new name, then press Enter.

This field allows you to enter the name of an existing authentication database or supply the name for a new authentication database.

19 In the Authentication Database field, press Enter to view or modify the entries in the authentication database specified in the previous field.

The X.25 Inbound Authentication Database screen displays a list of currently defined valid partners and their DTE addresses. If this is a new database, the list will be empty.

You can add new entries, or you can edit or delete existing entries.

20 To add a new entry to an authentication database, press Ins. To edit an existing entry, select the entry and press Enter.

In either case, the X.25 Inbound Authentication Entry menu is displayed. The Interface Name field is a read-only field. It displays an interface name that is a combination of the board name defined in the Board Configuration screen, underline characters used as separators, and a port number (typically 1 through 4).

The Database Name field is also a read-only field. It displays the database name that you specified in Step 18.

21 In the Remote System ID field, press Enter to display a list of existing remote system IDs. With the list displayed, press Ins to enter a new ID or Del to delete an existing ID.

The Remote System ID parameter specifies the local handle for a partner system (such as another Novell router). It is not verified or exchanged with the remote system. The remote system ID is used by protocols such as IP and IPX to identify a connection to a partner system.

22 Press Enter to select a remote system ID, then enter a valid DTE address for the system in the Remote DTE Address field.

The Remote DTE Address parameter specifies the 15-digit X.121 DTE address assigned to the remote system. This address must correspond exactly to the calling DTE address, included in the Incoming Call packet received from the remote system. Otherwise, authentication fails and the incoming call is rejected.

23 In the X.25 Enterprise Specific Traps field, press Enter to view or modify the SNMP traps.

The X.25 Enterprise Traps Configuration menu is displayed.

23a In the Physical Bandwidth Threshold Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps while the Physical layer's send or receive utilization exceeds the Bandwidth Upper Threshold value. SNMP traps continue being generated until the Physical layer's send or receive utilization falls below the Bandwidth Lower Threshold value.

23b In the Bandwidth Lower Threshold field, set the value to any number greater than or equal to zero, but less than the Bandwidth Upper Threshold value.

Once the Physical layer's send or receive utilization exceeds the Bandwidth Upper Threshold value, the WAN driver continues to generate SNMP traps until the utilization falls below this value.

23c In the Bandwidth Upper Threshold field, set the value to any number greater than the Bandwidth Lower Threshold value.

Once the Physical layer's send or receive utilization exceeds this value, the WAN driver generates SNMP traps until the utilization falls below the Bandwidth Lower Threshold value.

23d In the Link State Trap field, accept the default value, Disabled, or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps when the Data-Link layer initialization is completed or a link failure is detected.

23e In the Packet Layer Restart Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps when the Packet layer receives or transmits a Restart Indication or Restart Request packet.

23f In the Packet Layer Reset Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps when the Packet layer receives or transmits a Reset Indication or Reset Request packet.

23g In the Call Setup Failure Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps when an X.25 call setup fails.

23h In the Virtual Circuit Cleared Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes the WAN driver to generate SNMP traps when an X.25 call is terminated.

24 Press Esc and save your changes.

25 Press Esc to return to the Internetworking Configuration menu.

Configuring the WAN Call Directory

The WAN Call Directory is a list of WAN call destination configurations that you want to use for each virtual circuit. You must create at least one WAN call destination configuration for each destination you want to communicate with. WAN call destination configurations contain parameters that NetWare Link/X.25 applies when establishing and maintaining calls to the destination.

Two basic types of call configurations are possible: *permanent* and *on-demand*. You can specify permanent calls for switched or dial-up circuits, as well as for leased lines. If the connection fails, it is retried at periodic intervals. This type of connection is suited for use with dynamic routing protocols, such as RIP or the NetWare Link Services Protocol™ (NLSP™) software.

On-demand calls specify that the connection should be established only when needed. Maintenance data, such as routing updates, is suppressed. These types of connections are terminated when the link is void of network data longer than the configured Idle Line Timeout value. A connection failure is retried only when more network data is directed to the remote destination.

For more information, refer to "Understanding."

How to Configure the WAN Call Directory

Before you begin, make sure you have installed a WAN board and configured a NetWare Link/X.25 interface.

To configure WAN call destinations for X.25 interfaces, complete the following steps:

1 Load NIASCFG, then select the following parameter path:

Select Configure NIAS > Protocols and Routing > WAN Call Directory

2 Press Ins to configure a new WAN call destination.

3 Enter a name of up to 47 alphanumeric characters for the new WAN call destination, then press Enter.

The WAN call destination name you enter here is used in other menu options when a WAN call destination name needs to be identified. You should use a descriptive name such as the name of the remote destination or a branch office or store number.

A list of supported wide area media is displayed. These media are available on previously configured interfaces. X.25 is not available if you have not yet configured an X.25 interface.

NOTE: If you did not install a WAN board and configure an interface before attempting to configure a WAN call destination, the following message is displayed:

```
WAN network interfaces must be configured before WAN Call
   Destinations may be created.
```

You must install a WAN board and configure an X.25 interface, as described in the previous section.

4 Select X.25-Host as the wide area medium, then press Enter.

The X.25 Call Destination Configuration menu is displayed. The Call Destination Name field is a read-only field. It displays the name you entered in the WAN Call Destination menu.

5 In the Call Type field, accept the default value, Permanent, or press Enter to select On-Demand from a pop-up list.

Permanent calls can be specified for switched or dial-up circuits, as well as for leased lines. If the connection fails, it is retried at periodic intervals.

On-demand calls specify that the connection is established only when needed. The connection is terminated when the link is void of network data longer than the configured Idle Line Timeout value. A connection failure is retried only when more network data is directed to the remote destination.

Permanent calls can be placed only through a specific interface; they cannot be directed to an interface group.

On-demand calls can be placed through either a specific interface or an interface group, but not both.

NOTE: For on-demand calls, the Interface Group and Interface Name parameters are mutually exclusive. If you specify an interface group, you cannot specify an interface name.

If you specify On-Demand *as the* Call Type *and have defined an interface group, do the following:*

◆ Press Enter to display a list of interface group names.

The X.25 Interface Group pop-up menu is displayed, listing the configured X.25 interface groups, if any. This is a read-only list that allows you to select the name of the X.25 interface group through which this WAN call destination can be accessed.

◆ Select an X.25 interface group from the list, then press Enter. Continue with Step 6.

If you specify On-Demand *as the* Call Type *but you have not specified an Interface Group name, or if you specify* Permanent *as the* Call Type, *do the following:*

◆ Select Interface Name , then press Enter to display a list of X.25 interfaces.

The Select Interface pop-up menu is displayed, listing the configured X.25 interfaces. This is a read-only list that allows you to select the name of the specific X.25 interface through which this WAN call destination can be accessed.

◆ Select an X.25 interface from the list, then press Enter.

6 In the Circuit Type field, accept the default value, Switched Virtual Circuit , or press Enter to select Permanent Virtual Circuit from a pop-up list.

The pop-up list allows you to select the type of virtual circuit used to establish a connection to the destination: permanent (PVC) or switched (SVC).

PVCs are active whenever the interface is active. SVCs must be explicitly established by a call request or by an incoming call.

NOTE: The source route bridge software does not support PVCs.

The PVC Number and Destination DTE Address parameters that follow are mutually exclusive.

If you specify a permanent virtual circuit, then you must specify a PVC number. You cannot specify a destination DTE address because it is not required.

If you specify a switched virtual circuit, then you must specify a destination DTE address. You cannot specify a PVC number because it is not required.

7 In the PVC Number field (if Circuit Type is permanent), enter the circuit number.

The PVC number must match the logical channel number (LCN) assigned by the X.25 network service provider at subscription time.

8 In the Destination DTE Address field (if Circuit Type is switched), enter the address.

This is the X.121 DTE address (up to 15 digits, 0 through 9) assigned to the specific destination DTE.

9 In the Retry Mode field, accept the mode shown, or press Enter to select another option from a pop-up list.

This parameter specifies the conditions under which a failed connection is retried. All connection failures are reported to the system console and to the Call Manager utility (CALLMGR).

The available options are Never Retry , Retry All Failures , and Retry Self-Correcting Failures. The default is Retry Self-Correcting Failures.

Retry All Failures attempts successive connections with an increasing delay between attempts. The retry interval is initially set to 8 seconds and increases exponentially to the limit.

The maximum delay is set by the Retry Interval Limit parameter (described in Step 11). Depending on the Call Type status (permanent or on-demand), the Retry Limit Handling parameter (described in Step 10) allows retries to either continue at the maximum retry interval or stop when the Retry Interval Limit is reached.

If you select Retry Self-Correcting Failures , X.25-supplied error information is used to differentiate between errors that are self-correcting, such as a busy telephone number, and errors that require user intervention, such as a call authentication failure.

Self-correcting errors are retried, as described for the Retry All Failures option. Errors that require user intervention are not retried.

10 In the Retry Limit Handling field, press Enter to select the appropriate option from a pop-up list.

This parameter specifies the action taken when the connection retry interval exceeds the Retry Interval Limit (described in Step 11).

For permanent calls, connection retries can either continue indefinitely at the maximum retry interval (which supports unattended operation) or be terminated (the connection fails).

On-demand calls can accept only Stop At Limit , which means that the connection fails when the retry interval reaches the limit.

11 In the Retry Interval Limit field, accept the displayed value or press Enter to change it.

This parameter specifies the maximum delay between attempts to establish a connection (the retry interval). The delay is set initially to 8 seconds and increases exponentially until the maximum retry interval is reached.

The range of time intervals is 00:00:00 to 23:59:59 (hh:mm:ss). For permanent calls, the default value is 10 minutes (00:10:00). For on-demand calls, the default value is 2 minutes (00:02:00).

12 In the Idle Line Timeout field (if Call Type is set to On-Demand), accept the value shown or press Enter to change it.

This parameter specifies the time, in hh:mm:ss format, that an on-demand call can be inactive before closing the connection.

The range of values is 00:00:00 through 23:59:59. The default value is 10 minutes (00:10:00).

13 In the Remote System ID field, press Enter to display a list of X.25 remote system IDs.

This parameter specifies the symbolic name (from 1 to 47 ASCII characters) of the remote peer system associated with this WAN call destination entry. This name is typically the remote system server name.

14 Use the arrow keys to select a remote system ID, then press Enter , or press Ins to create a new remote system ID.

If you pressed Ins , enter the symbolic name (from 1 to 47 ASCII characters) of the remote peer system associated with this WAN call destination entry in the screen that is displayed, then press Enter and repeat the first part of this step.

The remote system ID value is accessed by the X.25 protocol stack to identify the proper WAN call destination needed to restore an on-demand connection to a remote system that previously initiated a connection to this system.

15 In the Expert Call Configuration field (if Circuit Type is SVC), press Enter to view or modify the Expert Call Configuration parameters.

The X.25 Expert Call Configuration menu is displayed. The parameters in this menu are applicable only for SVCs.

The Call Destination Name field is a read-only field. It displays the name of the WAN call destination you entered in Step 3.

16 In the Request Reverse Charging field, accept the default value, No , or press Enter to change it.

This parameter specifies whether reverse charging is requested for calls to and from this destination. The default, No , prevents reverse charging.

17 In the Window Size field, accept the default value, 0 (no Window Size Negotiation packet layer), or press Enter to change it.

This parameter specifies the size of the window that is negotiated for calls to or from this destination. This value overrides the inbound or outbound window size specified in the X.25 Packet Level Parameters menu. The range of values is 1 to 7 (Modulo 8) or 1 to 127 (Modulo 128).

18 In the Packet Size field, accept the default value, Not Selected , or press Enter to change it.

This parameter specifies the size of the packet that is negotiated for calls to or from this destination. If this parameter is used, it overrides the inbound and outbound packet sizes specified in the X.25 Packet Level Parameters menu. The optional values are 16 , 32 , 64 , 128 , 256 , 512 , 1024 , 2048 , 4096 , and Not Selected.

19 In the Throughput Class field, accept the default value, Not Selected , or press Enter to change it.

This parameter specifies the throughput, in bits per second, that is negotiated for calls to or from this destination. The optional values are 75 , 150 , 300 , 600 , 1200 , 2400 , 4800 , 9600 , 19200 , 48000 , 64000 , and Not Selected.

20 In the CUG Facility field, accept the default value, Not Selected , or press Enter to change it.

This parameter specifies the type of Closed User Group (CUG) used for calls to or from this destination. A CUG permits DTEs belonging to the group to communicate with each other, but precludes communication with all other DTEs. The options are Bilateral , Incoming , Outgoing , and Not Selected.

21 In the CUG Number field, accept the default value, Not Selected , or press Enter to change it.

This parameter specifies a one- or four-digit hexadecimal number for a specific CUG. If the CUG Facility parameter is set to Incoming or Outgoing , you can enter a two-digit number. If the CUG Facility parameter is set to Bilateral , you can enter up to four digits.

WARNING: Refer to the ITU-T Recommendation X.25 before you set this parameter.

22 In the Fast Select field, accept the default value, No , or press Enter to change it.

This parameter specifies an optional parameter that a DTE can request for a virtual circuit to allow the use of up to 128 bytes of user data in Call Request packets. You can specify whether the Fast Select option is used for calls to this destination. The options are Yes and No.

23 In the With Restriction field, accept the default value, No , or press Enter to change it.

This is an addition to the Fast Select parameter that is available only if the Fast Select parameter is set to *Yes*. This parameter specifies whether the called DTE can accept a call with the Fast Select option. The options are Yes and No.

If this parameter is set to *Yes* and a call is made using Fast Select with the restriction on, the called DTE must clear the incoming call.

24 In the Call User Data field, accept the default value, None , or press Enter to change it.

This parameter specifies the actual user data that is sent in the Call Request packet user data field. The length of the user data field depends on whether you use Fast Select.

The following table shows the field lengths, in bytes, that are available, depending on two aspects: whether you are using Fast Select and the specific protocol being used.

Protocol	With Fast Select	Without Fast Select
IPX	122 bytes	10 bytes
AppleTalk	122 bytes	10 bytes
CLNS	124 bytes	12 bytes
IP	124 bytes	12 bytes

25 In the Generic ITU-T Facilities Entry field, accept the default value or press Enter to change it.

This parameter lets you add new facilities codes to your current configuration in addition to the facilities already specified.

WARNING: Enter this parameter in hexadecimal format. Refer to the ITU-T Recommendation X.25 before setting this parameter.

26 In the Generic National Facilities Entry field, accept the default value or press Enter to change it.

This parameter is provided as a convenience for customers requiring the specification of National or Proprietary facilities. A provision for a Facilities Parameter Marker value is also included. This field is convenient for use across an X.25 gateway.

WARNING: Enter this parameter in hexadecimal format consistent with the ITU-T Recommendation X.25. Consult your network representative or technical support for further information.

27 In the Suppress Calling DTE Address field, accept the default value or press Enter to change it.

This parameter determines whether the calling DTE address is included in the outgoing Call Request packets. The options are Yes and No.

If set to Yes , the called DTE address is not included in the Call Request packet (it is suppressed).

28 When you have completed all changes to the X.25 Expert Call Configuration parameters, press Esc to return to the X.25 Call Destination Configuration menu.

29 In the Inbound Authentication Update field, accept the default value, Enabled , or press Enter to select Disabled.

When this parameter is enabled, an update of the inbound authentication database for the X.25 interface (or interface group) associated with this WAN call destination is automatic.

30 Press Esc ; if prompted, select Yes to save the changes to the WAN call destination, then press Enter.

The WAN call destination you just configured appears in the list of configured WAN call destinations.

31 To configure another WAN call destination, repeat Step 2 through Step 30.

32 Press Esc to return to the Internetworking Configuration menu.

4 **Managing**

This section describes the utilities used to monitor NetWare® Link/X.25 WAN connections.

Using the X25CON Utility

X25CON is an NLM management console utility that provides access to the interface configuration and statistical information of all Novell Internet Access Server routing X.25 interfaces. It uses SNMP to access this information from a local or remote NetWare router on the network.

To launch X25CON, enter **LOAD X25CON** at the system console prompt or load NIASCFG and follow this path:

Select View Status for NIAS > Protocols and Routing > X.25

You can use X25CON to obtain the following information:

- ◆ Connectivity display
    - ◆ Total number of X.25 interfaces configured
    - ◆ Total number of active X.25 interfaces
    - ◆ Total number of active virtual circuits
- ◆ SNMP access configuration and control
- ◆ X.25 interface and activity summary
    - ◆ Packet-layer, Link-layer, and Physical-layer statistics of the X.25 interface
    - ◆ Operating parameters of the Packet layer, Link layer, and Physical layer of the X.25 interface

- X.25 call target for the WAN connection
- Entries of the cleared circuit table
- Local SNMP trap log created by SNMPLOG.NLM

X25CON also provides an X.25 ping diagnostic utility that is used to perform connection checks or troubleshooting of an X.25 data link (available for switched virtual circuits only). To perform a ping test on an X.25 destination, select a destination (configured in the WAN call destination database) and select F3 to execute a test.

Upon completion of the test, the X.25 ping displays the following:

- Average call setup time
- Number of messages transmitted and received
- Number of transmit errors and receive errors
- Average elapsed time for a message round trip
- Cause and diagnostic codes received in the Clear Request/Indication packets if the call setup failed

We highly recommend that you perform a test using X.25 ping to verify X.25 connectivity before you integrate the X.25 interface with the LAN protocol stack.

Using the X25TRACE Utility

X25TRACE is an NLM utility that enables you to view and capture the X.25 traffic in real time. This utility provides the following options:

- Network Interface Information—Displays the available X.25 interfaces and the hardware configuration information of each interface, such as port address, interrupt level, base memory address, and so on.
- Real-Time Monitor—Enables you to monitor the X.25 traffic on a specific X.25 interface in real time. You can capture the data to RAM or disk. You can display X.25 traffic in raw, frame, or packet mode.
- Playback—Captured data is replayed when this option is used.
- Configuration—Enables you to configure the capturing option, RAM or disk, and the filename if the data is captured to disk.

Using X25DISP

X25TRACE works with X25DISP to provide a way to analyze the output of X25TRACE. X25DISP is a DOS executable utility that decodes the X25TRACE output file and generates an ASCII format file. X25DISP.EXE is located in SYS:SYSTEM\UTILS.

For example, to write the captured data to an output file to display in ASCII, complete mode, and frame mode, enter the following command:

```
X25DISP -ifilename  -ofilename  -a -c -m1
```

If specified, the contents of the file are converted so that they are displayed in ASCII or hex format, in complete or short display mode, and in one of three decode modes: raw, frame, or packet mode. Table 3 shows the arguments that can be used with this DOS executable file. These arguments are case-sensitive.

Table 3   X25DISP Arguments

Argument	Meaning
X25DISP	Runs the DOS executable file
-i<*filename*>	Specifies the name of the input file
-o<*filename*>	Specifies the name of the output file
-a	Displays the data in ASCII
-h	Displays the data in hex
-c	Displays the data in complete mode
-s	Displays the data in short mode
-m0	Decodes the data to display in raw mode
-m1	Decodes the data to display in frame mode
-m2	Decodes the data to display in packet mode

Viewing X.25 Configuration Information

To see how X.25 is configured, load X25CON. The main window provides a summary display identifying the target system, the number of X.25 interfaces

configured, the active X.25 interfaces, and the total number of active virtual circuits (VC).

For more information, select one of the following options:

- SNMP for SNMP access parameters such as desired host and polling interval.

- X.25 Interfaces for summary information about all X.25 interfaces reported by the specified host system.

- X.25 Call Target Summary for all configured call targets including destination name, X.121 address of the destination DTE, the interface through which a call is attempted, and whether the interface is enabled.

- Clear Circuit Summary for summary information about circuits cleared abnormally, including destination name, logical channel number (LCN), and the clearing cause code and diagnostic code in the cleared packet.

- Display Traps to access the trap log file created by SNMPLOG.NLM.

Monitoring Overall Link Performance

To monitor the performance of a particular interface, load MONITOR and follow this path:

Select LAN/WAN Information > interface you want to view

Check the following fields:

- Send Line Utilization

- Receive Line Utilization

- Receive Overruns

- Data Q Backup in 1/1000 second

Consistently high values in these fields indicate that the link is busy and that performance has probably degraded. In this case, consider using a higher line speed. Note that occasional increases in the values for these fields are normal in all networks.

5 Troubleshooting

This section contains NetWare Link/X.25 troubleshooting information that is divided into four categories:

- ◆ Troubleshooting tools
- ◆ Configuration tips
- ◆ Troubleshooting checkpoints
- ◆ Common problems

If a problem that is general in nature occurs, the procedure described in "Troubleshooting Checkpoints" on page 74 will help you isolate and resolve the problem. If a problem with a specific symptom occurs, see "Common Problems."

Troubleshooting Tools

The following utilities that can be used to troubleshoot NetWare Link/X.25 links:

- ◆ X25CON
- ◆ X25TRACE
- ◆ MONITOR
- ◆ Loopback Tests

X25CON

X25CON is an NLM management console utility that provides access to the interface configuration and statistical information of all X.25 interfaces. It

uses SNMP to access this information from a local or remote router on the network.

You can use X25CON to obtain the following information:

- Connectivity display

    - Total number of X.25 interfaces configured

    - Total number of active X.25 interfaces

    - Total number of active virtual circuits

- SNMP access configuration and control

- X.25 interface and activity summary

    - Packet-layer, Link-layer, and Physical-layer statistics of the X.25 interface

    - Operating parameters of the Packet layer, Link layer, and Physical layer of the X.25 interface

- X.25 call target for the WAN connection

- Entries of the cleared circuit table

- Local SNMP trap log created by SNMPLOG.NLM

X25CON also provides an X.25 PING diagnostic utility that is used to perform connection checks or troubleshooting of an X.25 data link (available for SVCs only). To perform a PING test on an X.25 destination, select a destination (configured in the WAN call destination database) and press F3 to execute the test.

Upon completion of the test, the X.25 PING displays the following:

- Average call setup time

- Number of messages transmitted and received

- Number of transmit errors and receive errors

- Average elapsed time for a message round trip

- Cause and diagnostic codes received in the Clear Request/Indication packets if the call setup failed

We highly recommend that you perform a test using X.25 PING to verify X.25 connectivity before you integrate the X.25 interface with the LAN protocol stack.

X25TRACE

X25TRACE is an NLM utility that allows you to view and capture the X.25 traffic in real time. This utility provides the following options:

- Network Interface Information—Displays the available X.25 interfaces and the hardware configuration information about each interface, such as port address, interrupt level, and base memory address.

- Real-Time Monitor—Enables you to monitor the X.25 traffic on a specific X.25 interface in real time. You can capture the data to RAM or disk. You can display X.25 traffic in raw, frame, or packet mode.

- Playback—Replays captured data.

- Configuration—Enables you to configure the capturing option, RAM or Disk, and the filename if the data is captured to disk.

X25TRACE also includes a print utility, X25DISP, that reads an X25TRACE capture file and writes the contents to an output file that can be printed or viewed with an ASCII editor or browser. If specified, the contents of the file are converted so that they are displayed in ASCII or hexadecimal format, in complete or short display mode, and in one of three decode modes: raw, frame, or packet mode. Table 4 shows the arguments that can be used with this DOS executable file. These arguments are case-sensitive.

Table 4   X25DISP Arguments

Argument	Meaning
X25DISP	Runs the DOS executable file.
-i<*filename*>	Specifies the name of the input file.
-o<*filename*>	Specifies the name of the output file.
-a	Displays the data in ASCII.
-h	Displays the data in hexadecimal.
-c	Displays the data in complete mode.
-s	Displays the data in short mode.
-m0	Decodes the data to display in raw mode.
-m1	Decodes the data to display in frame mode.

Argument	Meaning
-m2	Decodes the data to display in packet mode.

For example, to write the captured data to an output file to display in ASCII, complete mode, and frame mode, enter the following command:

```
X25DISP -ifilename  -ofilename  -a -c -m1
```

MONITOR

The LAN/WAN Information option of MONITOR allows you to monitor the various statistics of LAN or WAN drivers. For the X.25 interface, there are several X.25 interface statistics displayed only by MONITOR. These include the following:

- ◆ No ECB Available Count—Number of times the message transmission or reception failed because an ECB is not available.

- ◆ Send Packet Too Big Count—Number of times the message transmission failed because the packet size was greater than the specified maximum packet size.

- ◆ Receive Packet Too Big Count—Number of times the message reception aborted because the received packet size was greater than the specified maximum packet size.

- ◆ Checksum Error—Number of times a checksum error occurred.

- ◆ Over Queue Limit—Number of times a transmit message was discarded because of the queue overflow condition. You can configure the Transmit Queue Limit parameter by loading NIASCFG and selecting Protocols and Routing > Network Interface.

Loopback Tests

When you experience an X.25 link failure, we recommend performing one or more of the three loopback tests described in this section, depending on the nature of the problem. This testing can help you identify the cause of the failure.

Dual-Port Loopback Test

To perform this test, connect two ports of a server through a modem eliminator, a modem, a DSU/CSU, or crossover cables. The loopback test is performed with X.25 PING in X25CON.

Loopback Test to the Local DTE Through a PDN

You can perform this loopback test when the server is connected to the X.25 public data network (PDN). You can perform an X.25 PING test to any remote server running the routing software that is connected to the X.25 PDN. Connect a port to the PDN, then establish a virtual circuit back to the originating port by calling the local DTE with X.25 PING in X25CON.

Loopback Test to the Remote DTE Through a PDN

Execute this loopback test when the source and destination DTEs are connected to the X.25 PDN. You can perform an X.25 PING test to any remote server running the routing software that is connected to the X.25 PDN.

Configuration Tips

This section lists recommendations for configuring NetWare Link/X.25.

⬥ When routing AppleTalk over an on-demand X.25 link SVC or PVC, you must specify a WAN call destination under Bindings on both sides of the WAN connection.

⬥ When configuring source route bridging over a WAN, make sure you enable and configure the route end station on all WAN ports that allow clients to access the NetWare file server. If the node is a dedicated router, the route end station is not required.

⬥ To route IPX over a WAN, you must always bind IPX to a WAN board.

⬥ For IP or IPX WAN connections over X.25, inbound authentication should always be enabled.

⬥ When using IP RIP over a WAN in multiaccess mode, you must configure at least one neighbor in the Neighbor List option in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Protocols > TCP/ IP > RIP Bind Option).

⬥ When routing or source route bridging over an X.25 connection, you must configure a WAN call destination.

⬥ You can define only one WAN call destination for all protocols going to the same destination. Each protocol can use the same WAN call destination name when it is bound to the WAN interface.

⬥ When routing AppleTalk over an X.25 connection to a Cisco router, select Multi-Access for the WAN Network Mode option (parameter path: Select

Configure NIAS > Protocols and Routing > Bindings > a specific AppleTalk binding) and select Cisco to specify the manufacturer of the remote router (parameter path: Select Configure NIAS > Protocols and Routing > Protocols > AppleTalk > Expert Configuration Options).

- ◆ When routing AppleTalk over an X.25 connection to a 3Com* router, select Unnumbered Point-to-Point or Multi-Access for the WAN Network Mode option (parameter path: Select Configure NIAS > Protocols and Routing > Bindings > a specific AppleTalk binding) and select 3Com to specify the manufacturer of the remote router (parameter path: Select Configure NIAS > Protocols and Routing > Protocols > AppleTalk > Expert Configuration Option).

- ◆ If your DCE device (DSU/CSU, modem, multiplexer, and so on) has both single and dual clocking configuration options, make sure you configure your DCE to provide both transmit and receive clocks when a Synchronous/+ or NW2000 board is being used.

Troubleshooting Checkpoints

To isolate and resolve problems with X.25 links, complete the following steps:

1 Verify that the X.25 software and drivers are installed properly.

You can enter the MODULES command at the console and check the version number of each X.25 module and driver (such as SYNCPLUS.LAN, NW2000.LAN, and ARTIC.LAN).

2 Load X25CON and select X.25 Network Interface.

Make sure that the X.25 Network Interface window displays all configured X.25 interfaces. If the X.25 Network Interface window does not display all configured X.25 interfaces, identify the cause of the problem and correct it (refer to "Common Problems" on page 79).

3 Check whether the Physical layer, the Link layer, and the Packet layer of each interface are in the Up state.

If they are not in the Up state, identify the cause of the problem and correct it (refer to "Common Problems" on page 79).

4 Check the status of each LAN protocol connection using CALLMGR.

If all connections are established, then go to Step 11. Otherwise, continue with Step 5.

5 Select Ping Remote System.

Perform an X.25 PING test to the destinations to which the connection cannot be established.

5a Verify whether a call is established successfully within reasonable delay.

5b Verify whether the messages are transmitted and received error free.

5c Verify whether the average delay for a message's round trip is reasonable.

5d Verify whether the call is cleared successfully.

6 Load NIASCFG and select Bindings (parameter path: Select Configure NIAS > Protocols and Routing > Bindings). Check the binding of the LAN protocol to a WAN Interface.

Make sure that the Permanent WAN Call Destination field is specified at both ends if the associated virtual circuit is a PVC. You must ensure that the Authentication option is enabled if the Call Type option of the associated X.25 Call Destination is set to
On-Demand.

7 Load CONLOG, if it is not loaded, and enter **REINITIALIZE SYSTEM** at the console.

8 Enter **CONFIG** at the console and verify that the specific LAN protocol is bound to the correct WAN.

If it is not, examine the console log and correct the problem.

9 Check the status of each LAN protocol connection using CALLMGR.

10 If a connection is not established, then select the Cleared Circuit Summary of X25CON and check whether the call has been rejected by the Packet layer.

If the call has been rejected, correct the problem according to the cause code and diagnostic code (refer to Table 5 on page 76 and Table 6 on page 77) and return to Step 7. If no calls have been rejected, then check the LAN protocol configuration on the local and remote routers. If you find compatibility problems, correct them and then return to Step 7. If you do not find any problems, continue with Step 11.

11 Select X.25 Active Virtual Circuit and check whether the data packets are exchanged.

Cause Codes

Table 5 describes the meaning of each X.25 cause code.

Table 5   X.25 Cause Codes

Cause Code	Description
1(0x01)	Number busy. This cause code indicates that the data link between the local DTE and the network is not operational.
9(0x09)	Out of order. This cause code indicates that the data link between the remote DTE and the network is not operational.
17(0x11)	Remote procedure error. This cause code indicates that the virtual circuit was cleared because of a procedure error caused by the remote DTE. More specific information can be obtained by examining the diagnostic code.
25(0x19)	Reverse Charging acceptance not subscribed. The call was cleared because the Reverse Charging facility is requested while the called DTE does not subscribe to the Reverse Charging acceptance facility. This problem should occur only when the calling DTE requests the Reverse Charging facility.
41(0x29)	Fast Select acceptance not subscribed. This cause code indicates that the calling DTE includes the Fast Select facility in the Call Request packet while the called DTE does not subscribe to the Fast Select acceptance facility. When a call is cleared with this cause code, the Fast Select option should be disabled from the associated WAN call destination database.
3(0x03)	Invalid facility request. This cause code indicates that the invalid facility is included in the Call Request packet or Call Accept packet. More specific information can be obtained by examining the diagnostic code.
11(0x0b)	Access barred. This cause code indicates that the call setup is requested on the line on which the virtual circuit call setup is prohibited.
19(0x13)	Local procedure error. This cause code indicates that the virtual circuit was cleared because of a procedure error caused by the local DTE. More specific information can be obtained by examining the diagnostic code.
5(0x5)	Network congestion. The call is cleared with this cause code when the network is saturated. Because this situation is temporary, we highly recommend that you retry later.
13(0xd)	Not obtainable. The network rejects a call with this cause code when the destination DTE is disabled. Therefore, if a call is cleared with this cause code consistently, we highly recommend that you check the current status of the remote DTE.

Diagnostic Codes

Table 6 describes the meaning of each X.25 diagnostic code.

Table 6   X.25 Diagnostic Codes

Diagnostic Code	Description
34(0x22)	Call on one-way logical channel. Check that the LCN range assignments are the ranges agreed on with the network. If necessary, use NIASCFG to configure the correct values.
39(0x27)	Packet too long. Check whether the following conditions exist: 1. The default packet size is the one agreed on with the network. If this diagnostic is received in a Reset Request packet, use NIASCFG to configure the correct value. 2. The user data size of the Call Request packet exceeds 16 bytes without enabling the FSF option, or the User Data field is present in the Call Accepted /Call Connected packet but the FSF is not specified. In this case, the FSF option should be enabled, if it is allowed, or the WAN call destination database should be configured to reduce the User Data Size value.
42(0x2A)	Packet type not compatible with facility. The call is cleared with this diagnostic code when the called DTE attempts to accept an incoming call with the Response option set to Fast Select. This option should not be used in the NetWare environment.
49(0x31)	Call Request timer expired. A call can be cleared with this diagnostic code under the following circumstances: 1. Incompatible LCN assignment; therefore, the call request/incoming call is ignored by the network or the called DTE. 2. The called DTE is too busy to respond to the incoming call within the specified T21 timeout value. In this case, the calling DTE should increase the T21 timeout value.

Diagnostic Code	Description
65(0x41)	Facility Code not allowed. A call is cleared with this diagnostic code when an invalid facility is included in the Call Request packet or Call Connected packet. Examples are as follows:

1. An unknown facility is specified in the Call Request packet or the Call Connected packet.

2. Duplicate Closed User Groups are specified, such as CUG and BCUG, or CUG and CUGOA.

3. Fast Select, Reverse Charging, or CUG Facility is specified in the Call Connected packet.

4. Window Size Negotiation is specified and the ITU-T (International Telecommunication Union, Telecommunication Standardization Sector), previously CCITT, 1976 version is supported.

5. Closed User Group Facility is specified where this option is not allowed.

6. NUI is specified in the ITU-T 1976 and 1980 versions. |
| 66(0x42) | Invalid facility parameters are specified. This diagnostic code indicates the call was cleared because invalid facility parameters are included in the Call Request packet or Call Connected packet. Examples are as follows:

1. The requested window size or packet size is greater than the maximum window size or packet size allowed, respectively, and flow control negotiation is not allowed.

2. An invalid packet size is specified for the specified ITU-T version. The maximum packet size was 1,024 bytes up to and including the ITU-T X.25 1980 version. It was increased to 4,096 bytes in the ITU-T X.25 1984 version.

3. An invalid packet size that is greater than 7 is specified for the ITU-T X.25 1976 version.

4. The requested throughput is greater than the maximum allowed, and the throughput negotiation is not allowed. |
| 68(0x44) | Invalid calling DTE address. This diagnostic code indicates that the Calling DTE address included in the Call Request packet is invalid. Check with the network whether the specified local DTE address is correct. If necessary, modify the calling DTE address using NIASCFG. |
| 71(0x47) | No logical channel available. This diagnostic code indicates that the total number of virtual circuits exceeds the maximum number of virtual circuits configured. Therefore, increase the maximum number of virtual circuits of the associated line. |

Diagnostic Code	Description
72(0x48)	Call collision occurred. Usually, a call collision occurs when insufficient LCNs are allocated for SVCs. Therefore, when a call is cleared with this diagnostic code, we highly recommend assigning more LCNs for SVCs.
77(0x4d)	Invalid ITU-T-specified DTE facility. This diagnostic code indicates that the size of the Called or Calling Address Extension Facility exceeds the maximum size allowed (40 digits for 1988 version, 32 for 1984 version).
146(0x92)	Data Retransmission Timer (T25) expired. This problem occurs under the following circumstances: 1. The Maximum Receive Buffer Size is configured smaller than the packet size. Therefore, the incoming data packets are dropped by the driver. In this case, an exceptionally high number of reject frames are transmitted or received. 2. The T25 timeout value is too small; therefore, the timer expired. When you configure the T25 timeout value, consider the anticipated delay.
166(0xa6)	D-bit procedure not supported. This diagnostic code indicates that a Call Request packet or a data packet with the D-bit set was received where it is not allowed.
240(0xF0)	Normal termination. The SVC has been cleared per the upper layer's request.
241(0xF1)	Out of resources. The incoming packet is rejected because the local DTE is running out of resources.
242(0xF2)	Authentication failure. The call is rejected with this diagnostic code when the authentication fails. Make sure the calling address is in the Authentication Database of the associated interface and try again.
243(0xF3)	Inbound user data too large. The size of the incoming user data is greater than the configured Maximum Physical Receive Packet Size value or the configured User Data Size value.
244(0xF4)	Idle timer expired. This diagnostic code indicates that the call is cleared because the Idle Line Timer expired. The Idle Line Timer is active only when the associated Call Type is set to On Demand. Both parameters can be configured with NIASCFG.

Common Problems

This section lists various symptoms of common problems and the associated solutions.

- The number of the configured X.25 interfaces displayed by X25CON is incorrect.

  Cause 1 —Board is misconfigured.

  - In NIASCFG under Configure NIAS > Protocols and Routing > Boards, verify that each board is configured and enabled.

  - In NIASCFG under Configure NIAS > Protocols and Routing > Network Interfaces, verify that the media type of a specific board is X.25-HOST.

  Cause 2 —Board driver did not load.

  To determine whether a problem occurred while loading the WAN driver (SYNCPLUS.LAN, NW2000.LAN, ARTIC.LAN), check the console log using NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing >View Configuration > Console Messages). The driver is not loaded under the following circumstances:

  - A particular WAN driver is not installed.

  - There is a conflict in the board configuration, such as interrupt level, base I/O address, and memory base address.

  - A port registration failed because the version number of the configuration record is not the one expected by X25TSM. In this case, you need to re-create a specific configuration record.

  Correct the problem and issue the REINITIALIZE SYSTEM command. Attempt the connection again.

- The port status shows unavailable after Novell Internet Access Server 4.1 is running.

  Verify that AIOPAD.NLM is loaded.

- The number of active X.25 interfaces displayed by X25CON is less than the number of X.25 interfaces configured. The number of active X.25 interfaces represents X.25 interfaces whose Link layer is up and running. Therefore, if this number is less than the number of the X.25 interfaces configured, the Link layer of some X.25 interfaces failed to initialize.

  Load X25CON, select X.25 Interface, identify the interface whose Link layer is in the Down state, and take corrective actions, as described in The Link layer is in the Down state.

- The Physical layer is in the Down state.

- Check the cabling. Make sure the cable from the adapter to the modem is seated correctly.

- Check the configuration as follows:

  Clock Source

  Check whether the clock source is configured correctly. When the transmit and receive clocks are supplied externally (that is, from a DSU/CSU or DCE), then Interface Speed should be configured as External.

  To supply the transmit and receive clocks internally in the back-to-back testing environment, you must use the appropriate crossover cables, as described in Back-to-Back Testing in the *Overview* documentation. When these cables are used, only one side should be configured to generate the transmit and receive clocks.

  Port Connection

  If a leased line is used for connection between the NetWare server and the DCE, the Port Connection option should be configured as Hard-wired. When a DTR dialed modem is used, the Port Connection option should be configured as DTR Dialed.

- Check whether the correct cable is used for the specific revision of the Synchronous/+ adapter board. Different cables are required for Rev. D and Rev. E of the Synchronous/+ adapter board.

- Check the modem as follows:

  CSU/DSU

  Check whether the hardware options are set correctly.

  Perform local and remote loopback tests and verify that the CSU/DSU is functional.

  DTR Dialed

  Check whether the modem dials when the DTR is raised. If it does not, then you used the wrong type of modem.

  Check whether the modem is programmed with the correct phone number.

  Verify the phone number.

- The Link layer is in the Down state.

  - **Cause 1** —Link Layer Address is not properly configured.

Load X25TRACE and select Decode mode for the display of frames. Make sure that the Set Asynchronous Balanced Mode (SABM) frames transmitted and received contain two different Link-layer addresses (03 or 01). If the same address is included in the SABM frames transmitted and received, reconfigure the Link-layer address with the correct one and issue the REINITIALIZE SYSTEM command.

◆ **Cause 2** —Two different values are configured for the Link-layer modulo at the DTE and DCE (for example, modulo 8 and modulo 128). This prevents the Link layer from initializing.

Make sure that both the DTE and DCE are configured with the same modulo.

◆ **Cause 3** —No response from the DCE.

Load X25TRACE and select Decode mode for the display of frames. Check whether the local DTE is receiving any frames from the DCE. If the local DTE does not receive any frames from the DCE, then you should notify the network administrator of the problem.

◆ The Packet layer is in the Down state.

The Packet layer enters the Up state on completion of a restart procedure. This procedure is initiated when the Link layer is reinitialized. Therefore, if the Packet layer is in the Down state for an extended period of time after the Link layer is initialized, this usually indicates that one of the following Packet-layer parameters is not configured properly.

Suppress Restart Packet

When the Suppress Restart Packet option is enabled, the Packet layer does not transmit a Restart Request packet on completion of the Link-layer reinitialization. Instead, it waits until the DCE or remote DTE initiates the restart procedure. Make sure that the Suppress Restart Packet option is not enabled on both sides. Typically, it is the DTE that initiates the restart procedure.

Packet Sequencing Modulo

Check whether both the DTE and DCE are configured with the same packet sequencing modulo. Because the format of the Restart Request packet of modulo 8 is different from that of modulo 128, the incoming Restart Indication packet is ignored if the DTE and DCE are configured incorrectly.

Extensive Restart Request Timer (T20)

When a Restart Request packet collision occurs, the station that transmits the Restart Request packet last must retransmit the Restart Request packet on expiration of the T20 timer. Therefore, we recommend that you do not configure the T20 timer timeout value for longer than three minutes. This is the ITU-T recommended default.

◆ There is call connection failure. When a call setup procedure fails, an error message is displayed on the console.

The corrective actions that need to be taken are dependent on the circuit type, the cause code, and the diagnostic code, as described in the following sections.

Permanent Virtual Circuits

◆ Check whether the protocol is properly bound to the WAN interface. You can verify this by entering the CONFIG command at the console.

◆ Check whether the WAN call destination is specified for both ends. Unlike when an SVC is used, the call setup procedure should be initiated by both ends when the associated circuit is a PVC. If the call setup procedure is initiated at one side only and there is an attempt to transmit data, the virtual circuit is reset. A cause code of zero (DTE originated) and a diagnostic code of D1 in hexadecimal are included in the Reset Request packet.

◆ Check whether the PVC number specified in the associated WAN call destination is within the PVC range configured for the associated interface.

◆ Check whether the PVC range assignment is the one agreed on with the network or the remote DTE in the DTE-to-DTE environment.

◆ Check whether the destination of a specific PVC is the one specified when you subscribed to the network.

Switched Virtual Circuits

◆ Check whether the protocol is properly bound to the WAN interface. You can verify this by entering the CONFIG command at the console.

◆ Check whether the LCN range assignment is the one agreed on with the network or remote DTE in the DTE-to-DTE environment. The incoming call is ignored by the called DTE when it is received with an LCN assigned to a PVC or with an unassigned LCN.

Therefore, if the calling DTE does not receive any response (either a Call Connected packet or a Clear Indication packet) until the Call Response timer (T21) is expired, this usually indicates that the LCN range assignment is not compatible between either the local DTE and remote DTE or the local DCE and remote DTE in the DTE-to-DTE environment. The calling DTE transmits a Clear Request packet with the cause code of 0x13 and the diagnostic code of 0x31 when the Call Response Timer (T21) expires.

◆ Examine the entries of the X.25 Cleared Circuit Table using X25CON (parameter path: Select Cleared Circuit Summary). Take corrective actions, as described in Table 5 on page 76 and Table 6 on page 77, depending on the cause and the diagnostic codes included in the Clear Request/Indication packets.

◆ There are failures during the data transfer. These failures result from a Link-layer problem.

Cause 1 —Excessive number of Receive Not Ready (RNR) frames are transmitted. The NetWare Link/X.25 Link layer transmits an RNR frame on detection of a local busy condition. In the Novell Internet Access Server 4.1 and NetWare Link/X.25 environment, if the X.25 software cannot allocate a packet receive buffer (ECB), this is considered as a local busy condition.

Therefore, if the local DTE transmits an excessive number of RNR frames, it is imperative that the maximum number of packet receive buffers be increased.

Cause 2 —Excessive number of RNR frames are received. If the local DTE receives a large number of RNR frames, this indicates that the DCE or remote DTE cannot handle the traffic generated by the local DTE.

Therefore, if this problem is observed, reduce the Link-layer window size, the Packet-layer window size, or both.

Cause 3 —Excessive number of reject frames are transmitted. The DTE/DCE transmits a reject frame when it receives an I frame that is out of sequence. When a large number of reject frames are transmitted, this indicates that incoming I frames are lost or discarded. The frames can be lost because of one of the following reasons:

◆ MONITOR shows a large number for the No ECB Available Count statistic. The reason is that the driver is discarding the incoming I frames because it cannot allocate an ECB. In this case, increase the Maximum Packet Receive Buffer value to correct the problem.

◆ MONITOR shows a value of zero for the No ECB Available Count statistic. The reason is that there is a misconfiguration of the Maximum I Frame Size (N1). When the driver receives a frame whose size is greater than the configured Maximum Physical Receive Packet Size, it discards the frame. Reconfigure the DCE's N1 value so that it is less than the Maximum Physical Receive Packet Size of the server.

◆ MONITOR shows a value of zero for the No ECB Available Count statistic. The reason is that there are CRC errors due to a noisy link, which is caused by malfunctioning hardware. In this case, MONITOR also displays a high number of checksum errors. Contact your ISP to solve the problem.

Cause 4 —Frame Reject (FRMR) frame is transmitted or received. When the DTE or DCE detects an error condition that is not recoverable by the retransmission of the identical frame, it transmits an FRMR frame. Upon receipt of an FRMR frame, the DTE or DCE reinitializes the Link layer by transmitting an SABM frame. In this case, all SVCs are cleared and all PVCs are reset.

When the link is reset during the data transfer, check whether the local DTE receives or transmits an FRMR frame; you can do this by selecting the Link Layer Flow Table option of X25CON. The error condition that results in a link reset is specified in the third byte (or fifth byte for modulo 128) of the FRMR Information field, as follows:

01—The DTE/DCE received an unidentified frame. This problem can occur when the Link-layer sequencing modulo is not configured properly.

02—DTE/DCE received a frame with an information field that is not permitted, or it received a supervisory or unnumbered frame with an incorrect length.

04—The information field received exceeded the specified N1.

08—An I frame with an invalid N(R) was received.

Cause 5 —Excessive value for the T1 Timer Expired statistic. The DTE or DCE retransmits a frame when the T1 timer expires before it receives an acknowledgment. Therefore, if the X25CON Link Layer Flow Table displays a large number of T1 expirations, either the data link is noisy or an insufficient T1 timeout value is set.

Reconfigure the T1 value or contact your ISP.

Cause 6 —Over Queue Limit has been exceeded. One transmit queue is provided for each X.25 interface. The X.25 software (X25TSM) discards the user message when the total number of transmit messages exceeds the specified queue limit. MONITOR displays the number of messages that have been discarded because of a queue overflow condition (Over Queue Limit).

Increase the Interface Queue Limit value for the associated X.25 interface in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > select a specific X.25 interface).

Cause 7 —User Data Size value is too large. The X.25 software discards the message when a user attempts to transmit a message whose size is greater than the configured User Data Size or the Maximum Physical Receive Packet Size. In this case, the console displays the following error message:

```
Attempt to transmit a packet that is greater than maximum
  packet size configured on the board X25_1(packet size =
  2048, maximum packet size = 1507). Packet will be
  discarded.
```

 * Increase the User Data Size value or the Maximum Physical Receive Packet Size value. You can reconfigure the User Data Size with NIASCFG and the Maximum Physical Receive Packet Size with the SET command.

 * Reduce the User Data Size value.

* The virtual circuit has been reset. The console displays the following error message:

```
Virtual circuit reset on the board board_name  LCN lcn.
  Cause: 0x13, Local Procedure Error. Diagnostic: 0XA6,
  D-bit Procedure not Supported.
```

The appropriate corrective action depends on the cause code and diagnostic code that is displayed. Refer to Table 5 on page 76 and Table 6 on page 77.

* There is no apparent cause for an error message that is received after WSM.NLM is automatically loaded. The following message appears:

```
SERVER-4.10-30: This modulo is using 6 outdated API calls.
  You should upgrade to a newer modulo when it becomes
  available.
```

No action is necessary. This message is erroneous.

- A permanent WAN call destination has the Retry Mode option set to Never Retry; however, when the link goes down, there is one attempt to reestablish the link.

  This is normal operation. The Retry Mode option does not influence the operation of the network protocol stacks. Therefore, when a permanent link goes down, the network protocols make one attempt to reestablish the link.

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