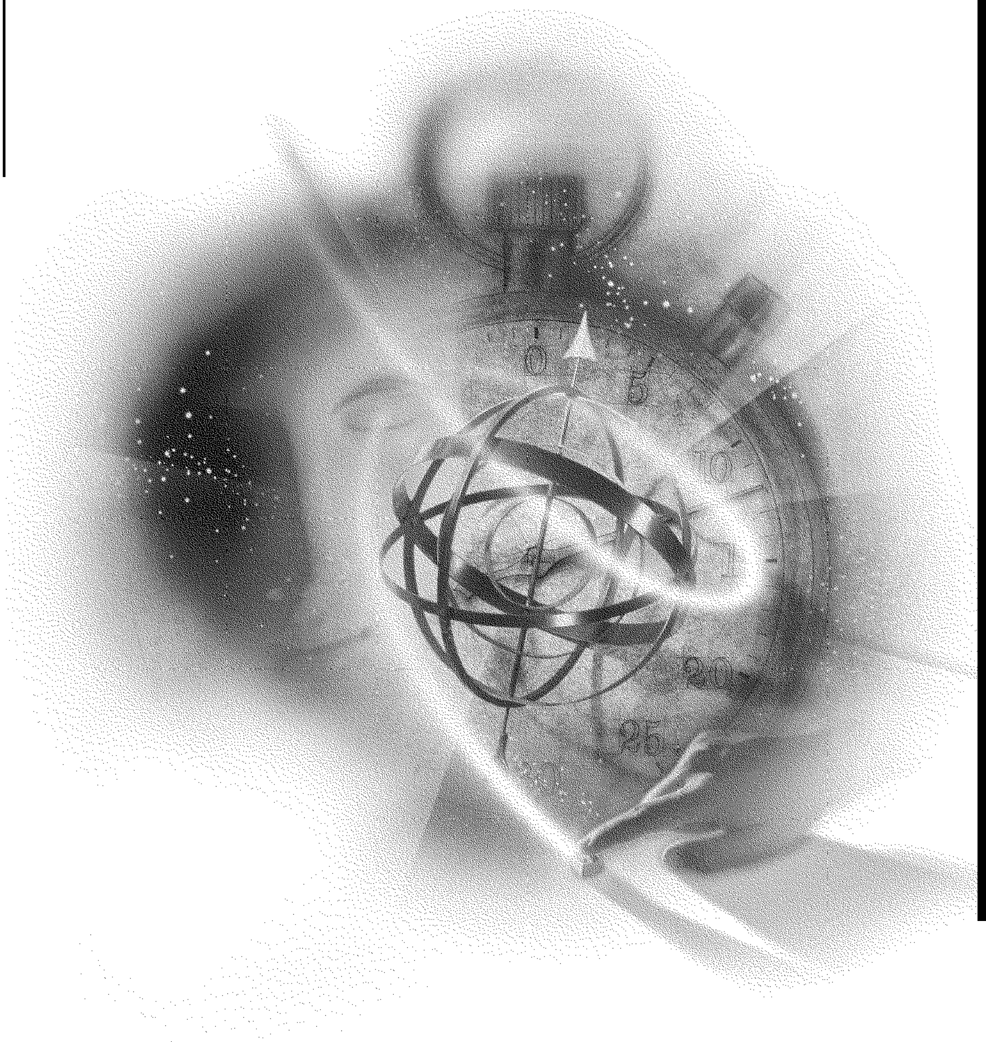
NetWare Link/Frame Relay



Connectivity Services

Novell®

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About This Guide

This guide provides the information you need to configure and manage the Novell Internet Access Server 4.1 NetWare Link/Frame Relay 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/Frame Relay components of Novell Internet Access Server 4.1.

1 Understanding

The NetWare® Link/Frame Relay™ WAN software is a streamlined, connection-oriented *frame-mode* data service. It is based on frame switching/relaying technology, the process of quickly transporting High-level Data Link Control (HDLC) frames through a network. NetWare Link/Frame Relay is based on frame relay, a WAN telecommunications protocol standard specified by the ITU-T (International Telecommunications Union, Telecommunications Standardization sector), previously CCITT, and American National Standards Institute (ANSI). Frame relay was originally specified by ITU-T as an Integrated Services Digital Network (ISDN) frame-mode service.

NetWare Link/Frame Relay supports AppleTalk, Transport Control Protocol/Internet Protocol (TCP/IP), the Internetwork Packet Exchange™ (IPX™) protocol, and the source route bridge of the Novell® Internet Access Server 4.1 routing software.

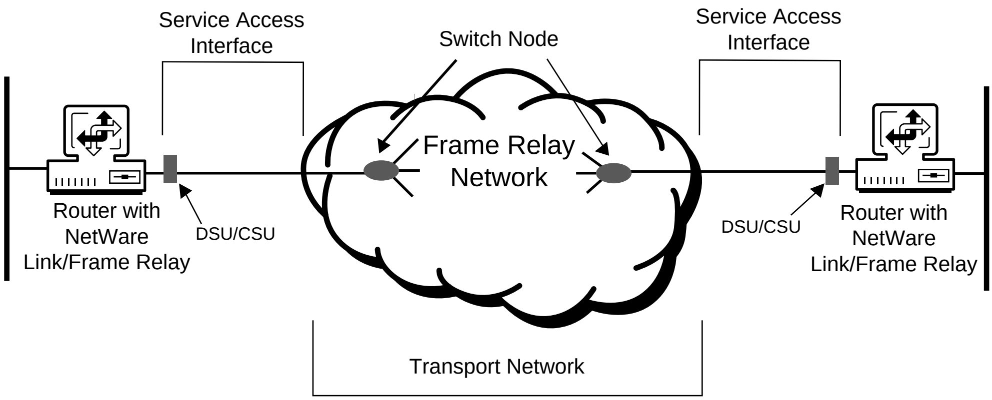
Introduction to NetWare Link/Frame Relay

At the basic level, to do statistical multiplexing, NetWare Link/Frame Relay uses intelligent end points over high-quality, highly reliable transmission facilities to connect switches in a shared frame relay network. This network eliminates as much protocol overhead as possible and also eliminates the error control usually needed in data transfers, such as in X.25.

NetWare Link/Frame Relay provides unreliable connectivity with throughput rates of up to T1/E1 access (1.544 Mbps/2.048 Mbps).

NetWare Link/Frame Relay is essentially a *service access interface* that connects to a *transport network* to transfer data from one end node (router) to one or more remote end nodes, as shown in Figure 1. The service access interface determines what happens between bridges or routers and the edge nodes of the frame relay transport network. The transport network can use any internal frame formats, protocol procedures, and routing algorithms.

Figure 1 Frame Relay Components



NetWare Link/Frame Relay is an interface protocol between a router and the actual frame relay network. Frame relay network standards do not stipulate how transport networks should be implemented internally (except for congestion behavior). Thus, these networks are usually represented graphically as clouds.

End-to-end performance of data transfer is determined by the implementation and operation of the end nodes, for both service access interfaces, and by the intervening transport network.

The following major components are required for frame relay access:

- NetWare Link/Frame Relay protocol stack
- Synchronous interface, or synchronous interface with integrated digital service unit/channel service unit (DSU/CSU)
- DSU/CSU
- Local access circuit
- Frame relay edge node DSU/CSU (switches)
- Frame relay network

How Frame Relay Works

Typical WANs use less than 20 percent of the available bandwidth. However, because of the bursty nature of WAN traffic, they need the added capacity to handle bursts of traffic much greater than the average line utilization. This means that these expensive WAN circuits are idle approximately 80 percent of the time.

NetWare Link/Frame Relay helps save on connection access rates. Packet switching using NetWare Link/Frame Relay is bandwidth-efficient, allowing multiple virtual circuits to share one physical line. In addition, carriers allow oversubscription, which is the total bandwidth for all configured virtual circuits that might exceed the physical circuit bandwidth.

You can set up each virtual circuit with the frame relay service provider to support the bandwidth needed for that connection. With multiple virtual circuits, each sharing a percentage of the bandwidth, the aggregate line usage can approach 100 percent. Individual virtual circuits can also burst above the committed information rate; this capability is referred to as *bandwidth-on-demand* or *dynamic allocation of bandwidth*.

Frame relay service supports permanent virtual circuits (PVCs). PVCs require network administrative setup at subscription time. NetWare Link/Frame Relay (based on the ITU-T LAP-D or LAP-F protocol) provides bandwidth-on-demand and, by providing multiple virtual circuits per physical access port, reduces the connection access cost and customer investment in equipment.

This frame-switching protocol is optimized for modern reliable digital and fiber-optic transmission networks. It is a LAN-to-WAN interconnection technology for routers and bridges. In addition to containing high-bandwidth and low-delay characteristics, NetWare Link/Frame Relay is also an effective way to optimize bandwidth, consolidate networks, and do multiprotocol bridging and routing. You can multiplex multiple protocols over a Data Link Connection Identifier (DLCI), which identifies the preestablished path (the PVC) through the frame relay network to the correct destination. The DLCI constitutes the virtual circuit number.

Because of the high-speed requirement and the highly reliable transmission media, the NetWare Link/Frame Relay protocol design has very little protocol overhead. Only level 2, the Data-Link layer in the Open Systems Interconnection (OSI) model, is involved in the actual data transfer.

Because acknowledgment and retransmission requirements are eliminated, the internodal processing and its associated delay are minimized. NetWare

Link/Frame Relay leaves it up to the higher-level protocols at the end-user devices to ensure reliable end-to-end data transfer. Because of this, NetWare Link/Frame Relay requires both reliable transmission media and higher-level protocols to operate efficiently and reliably.

The frame relay network does not correct or recover errors in frames or retransmit discarded frames. Frames can be discarded along the way because of transmission error, illegal frames, or network congestion. NetWare Link/Frame Relay assumes that the end point's higher-level protocols are responsible for end-to-end delivery. These devices operate with multiple-level protocols that can detect and recover from data loss in the connection.

Once the router is set up and initialized, it listens for an incoming call from the frame relay network to establish the connection. Whenever an end point needs to send data, it uses a DLCI (or virtual circuit number) to identify the preestablished path (the PVC) through the frame relay network to the correct destination.

However, an end point cannot use PVCs dynamically to communicate with other end points on a network. DLCIs are assigned by the frame relay network provider at setup to define each destination. A logical mesh can also be formed with only one physical connection to the network. This is a cost savings feature for LAN interconnections. Figure 2 shows four routers connected in a logical partial mesh in a frame relay network.

Figure 2 DLCI Connections Creating a Logical Partial Mesh

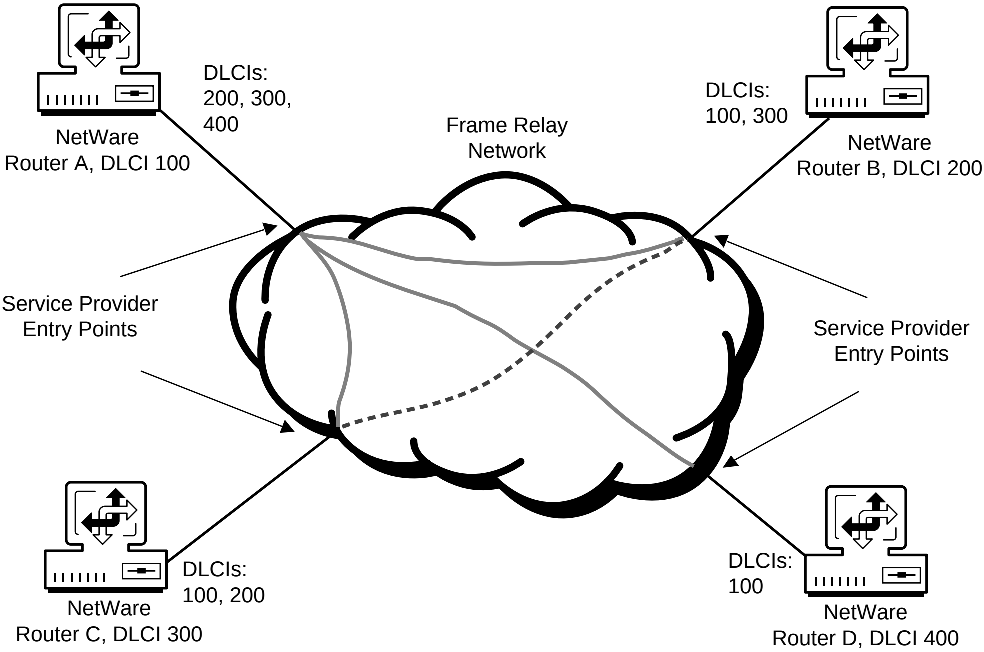


Table 1 shows the actual connections available in Figure 2, based on the DLCIs assigned for each router's connection.

Table 1 DLCI Connections

Router	DLCIs	Connections to Routers
A	200, 300, 400	B, C, D
B	100, 300	A, C
C	100, 200	A, B
D	100	A

Protocols Supported by NetWare Link/Frame Relay

NetWare Link/Frame Relay supports the multiple protocol traffic of Novell Internet Access Server 4.1 routing software through the frame relay network.

For brief descriptions of each protocol supported by NetWare Link/Frame Relay, refer to:

- AppleTalk
- TCP/IP
- IPX
- Source Route Bridge

AppleTalk

AppleTalk has been enhanced to support NetWare Link/Frame Relay PVCs. AppleTalk does not require user configuration for connections over PVCs, other than binding the protocol to a WAN board.

When AppleTalk is bound to a board, it posts a listen to the NetWare Link/Frame Relay driver and waits for incoming call indications. AppleTalk accepts all incoming calls and starts to send routing packets down the link as soon as it receives the ready to send signal for the link. AppleTalk does not always voluntarily disconnect a link. If a PVC is down, the NetWare Link/Frame Relay must send disconnect indications to the network protocols.

Currently, AppleTalk supports both Multi-Access and unnumbered point-to-point links over NetWare Link/Frame Relay, the same support that AppleTalk provides for the NetWare Link/X.25™ software and NetWare Link/PPP™ software.

TCP/IP

TCP/IP has been enhanced for NetWare Link/Frame Relay support. TCP/IP uses Inverse ARP (Address Resolution Protocol) to learn the IP address of the remote node on a frame relay link. You can use the Novell Internet Access Server Configuration utility (NIASCFG) to interstatically configure IP addresses to WAN call destination mappings.

When TCP/IP is bound to a WAN board, it is notified of all configured PVCs. TCP/IP attempts to associate an IP address with the remote node of each PVC. First, TCP/IP uses any configured IP address-to-WAN call destination mappings. If no mapping exists for a PVC, TCP/IP uses Inverse ARP to learn the IP address of the remote node. If both nodes on a frame relay PVC use Inverse ARP, you do not need to map IP addresses to NetWare Link/Frame Relay WAN call destinations.

If required, you can use NIASCFG to configure IP address-to-WAN call destination mappings, as follows:

- Use the Protocols Binding option from the Internetworking Configuration menu to select TCP/IP.
- In the TCP/IP Configuration screen, enable the WAN call destination database, and use the WAN Call Destination configuration screen to map the IP address to the NetWare Link/Frame Relay WAN call destination.

TCP/IP allows one or more IP addresses to be associated with a NetWare Link/Frame Relay interface. If PVCs have been configured between all nodes that must communicate over a frame relay network, only a single IP address is usually required. You should give each node an IP address on the same IP network. If all nodes are not connected with PVCs, you can associate a different network with each group of two or more nodes that are interconnected with PVCs.

IPX

IPX has been enhanced to support NetWare Link/Frame Relay PVCs. When NetWare Link/Frame Relay registers with the WAN Call Support Layer (CSL), IPX automatically posts a listen for call requests with the CSL. The NetWare Link/Frame Relay driver notes this and generates incoming call indications on all configured PVCs.

Because NetWare Link/Frame Relay uses protocol ID matching as its default, all incoming calls are accepted, and these links are treated as permanent links. In attempting to establish the IPX-level link, NetWare Link/Frame Relay exchanges IPX Wide Area Network (IPXWAN™) packets. Novell's IPXWAN determines what is at the remote side of the connection. Each PVC must have a unique network number for negotiation on each PVC.

IPX does not always voluntarily disconnect a link to NetWare Link/Frame Relay, except when configuration errors occur, or if a user manually issues a disconnect through the Call Manager utility (CALLMGR). In each case, to try to reestablish the link, NetWare Link/Frame Relay generates incoming calls later. If a Frame Relay link becomes inoperative, NetWare Link/Frame Relay must generate disconnects to the protocol and reestablish the link when it is working again. When the link is reestablished, NetWare Link/Frame Relay generates incoming calls again.

Source Route Bridge

The source route bridge treats NetWare Link/Frame Relay as a switched virtual circuit (SVC) rather than a PVC. The bridge uses a Call Target Name to connect to a particular target, as in NetWare Link/X.25 or NetWare Link/PPP. Bridging does not need to be configured on every router that is connected to the frame relay switch across the frame relay network. You must bind to each target (DLCI) independently, regardless of the number of DLCIs configured at that site. Use NIASCFG to enter DLCIs for configuring a WAN call destination. This process is similar to adding a DTE address in X.25 configurations.

When you bind the bridge to a DLCI, the bridge logic binds and posts a listen on that NetWare Link/Frame Relay interface. To inform the bridge about the availability of all the DLCIs that are configured for that interface, NetWare Link/Frame Relay calls the bridge with multiple incoming calls. The bridge accepts all the DLCIs and saves them in a table.

However, the bridge establishes a link only with the DLCI that has been configured by the user. The next time, if there is another bind to a different DLCI, and if the bridge already has that DLCI in its table, it brings up the link; otherwise, the bridge retains the bind for that DLCI and waits until that DLCI is given as an incoming call by the NetWare Link/Frame Relay logic.

Therefore, even though the bridge accepts all the DLCIs given by NetWare Link/Frame Relay from a bridge/spanning tree perspective, only the links whose DLCIs are configured through the Call Target configuration in NIASCFG are brought up. Each DLCI connection is treated as a separate bridge port; any loops inside the frame relay network are detected, and the appropriate bridge port is blocked. This method also lets you configure various source routing parameters, such as ring number, to be configured on a per-bridge port basis. Make sure you configure the right combination of DLCIs and ring numbers on the frame relay links.

You can configure concurrent bridging and routing on the same DLCI. When you do this, routing is done for one protocol, and bridging handles the rest of the protocols that are not configured for routing.

IMPORTANT: If you define more than one PVC between two routers for bridging, you cannot use the VWR=NO option. When binding a source route bridge to a NetWare Link/Frame Relay interface, you must select the VWR=YES option on all PVCs that are defined between the two routers.

Features of NetWare Link/Frame Relay

The NetWare Link/Frame Relay software includes support for the following features:

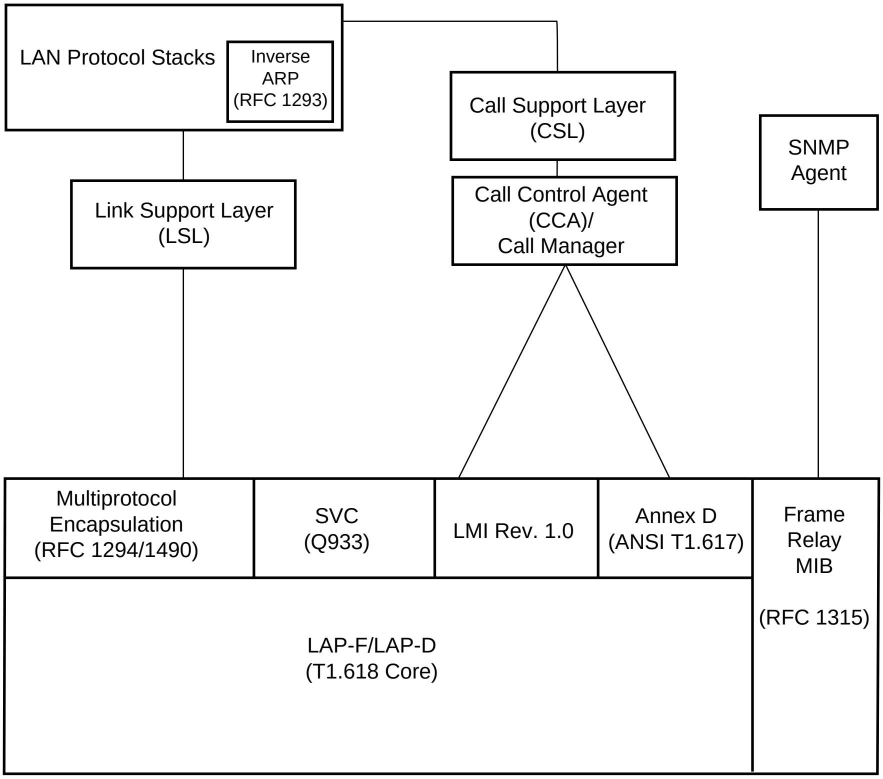
- Subscriber access rate up to T1 (1.544 Mbps) or E1 (2.048 Mbps)
- PVC only
- DTE/DCE operation
- Two-octet address format
- Maximum frame size up to 4520 octets
- Forward Explicit Congestion Notification (FECN) and Backward Explicit Congestion Notification (BECN) indications (read-only)
- Discard Eligibility (DE) bit
- The following local management protocols (configurable on a per-port basis):
  - Local Management Interface (LMI)
  - ANSI T1 617 Annex D
- Up to 1,024 virtual circuits per port (maximum of 975 PVCs for data transfer)
- Back-to-back testing mode
- RFC 1490 multiprotocol encapsulation over NetWare Link/Frame Relay
- IPXWAN version 2
- System configuration consistent with other Novell WAN connectivity products (NetWare Link/X.25 and NetWare Link/PPP)
- Novell Open Data-Link Interface™ (ODI™) specification, Media Support Module™ (MSM™) software, Topology Specific Module™ (TSM™) software, and WHSM (WAN Hardware Specific Module™ [HSM™]) software
- Protocol trace utility
- Instrumentation to SNMP Agent
- Frame relay MIB
- Certification by most public network providers

- Interoperation with other standards-based routers, such as Cisco Systems, IBM, Proteon*, 3Com Corporation, and Wellfleet

NetWare Link/Frame Relay Architecture

The NetWare Link/Frame Relay software enables the router to send data frames through the frame relay network. Figure 3 shows the NetWare Link/Frame Relay protocol architectural model.

Figure 3 Protocol Architectural Model



Note that the SVC service is not currently implemented.

Table 2 explains each module in the architecture.

Table 2 Architectural Module Description

Module	Description
LAN Protocol Stacks	The LAN protocols supported with this release of NetWare Link/Frame Relay include IPX, AppleTalk, TCP/IP, and source route bridge.
Link Support Layer (LSL)	An implementation of the Open Data-Link Interface (ODI) specification, the Link Support Layer™ (LSL™) software serves as an intermediary between the server/router LAN drivers and the communication protocol, such as IPX, TCP/IP, and AppleTalk. LSL allows one network board to service several communication protocol stacks.
Inverse ARP	Determines the Network-layer address from the specific DLCI.
Multiprotocol Encapsulation	An encapsulation method, based on RFC 1490, of higher-level Protocol Data Units (PDUs) that allows multiplexing of multiprotocol LAN traffic over a single frame relay link, so that receiving nodes can interpret and demultiplex the PDUs properly.
Call Support Layer (CSL)	The call processing coordination between NetWare Link/Frame Relay and the higher-level protocol stack. The configuration and target databases specify connection requests. The CSL target database maintains a directory of remote network/ router destinations for each configured WAN media type. The CSL configuration database maintains all configuration information on the specific aspects of each type of transport media. Each target database entry contains the media-specific information needed to establish a call using a specific media type to one remote system.
Call Control Agent (CCA)	Works in tandem with the CSL; the CCA contains WAN media-specific connection management logic.
SVC	The switched virtual circuit (SVC) is not implemented in this release.
LMI Rev. 1.0	The Local Management Interface (LMI) is an implementation agreement that addresses signaling and other network management functions.
Annex D	An implementation standard (ANSI T1.617) that addresses signaling and other network management functions.
SNMP Agent	Initiates and responds to requests for management information.
Frame Relay MIB	A Management Information Base (MIB) implemented for NetWare Link/ Frame Relay to allow it to support SNMP.

Module	Description
LAP-F/LAP-D	T1.618 core protocols used as the basis for the NetWare Link/Frame Relay software.

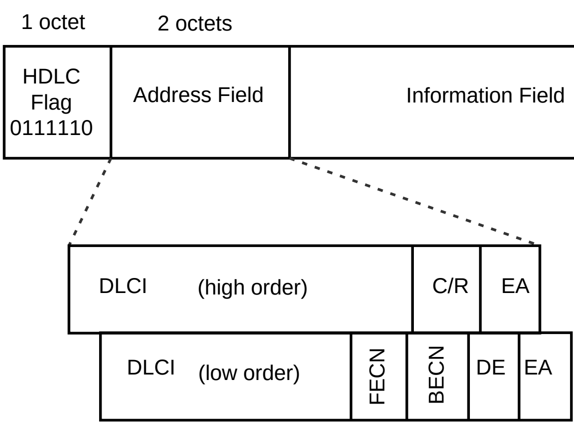
For more information about NetWare Link/Frame Relay architecture, refer to:

- Data Frame Format
- Frame Relay Network

Data Frame Format

Figure 4 shows the general NetWare Link/Frame Relay data frame format.

Figure 4 Data Frame Format



For more information about data frame format, refer to:

- HDLC Flags
- Address Field
- Information Field
- FCS

HDLC Flags

The High-level Data Link Control (HDLC) flags are the first and last octet, and indicate the beginning and end of the frame. If there is only one flag between two consecutive frames, the closing flag of the first frame serves as the opening flag of the next frame.

Address Field

The Address field consists of the NetWare Link/Frame Relay control and management fields. These fields specify the virtual circuit numbering, flow control, and frame discard eligibility.

DLCI

The Data Link Connection Identifier (DLCI) is a 10-bit routing address. The DLCI consists of two noncontiguous bit fields in the header, the most significant bit (MSB) or high order bit field and the least significant bit (LSB) or low order bit field. The DLCI is the address of the virtual circuit at either the User-Network Interface (UNI) or the Network-Network Interface (NNI). It allows the user and network management to identify the frame as being from a particular PVC. The DLCI is used for multiplexing several PVCs over one physical link. The router DLCI specifies a local virtual circuit.

For both ANSI T1.618 and the LMI standards, the DLCI addressing space allows 1,024 values at each local interface. Because some DLCIs are used for signaling, management, and future specification, 992 of 1,024 DLCIs (16 through 1,007) are available to address frame relay virtual circuits at each local interface, as shown in Table 3 and Table 4.

Table 3 ANSI T1.618 Numbering

DLCI Number	ANSI T1.618 Specification
0	In-channel signaling
1 to 15	Reserved
16 to 991	Assigned using frame relay connection procedures
992 to 1,007	Layer 2 management
1,008 to 1,022	Reserved
1,023	In-channel layer management

Table 4 LMI Rev 1.0 DLCI Numbering

DLCI Number	LMI Rev 1.0 Specification
0	Reserved for call control signaling (in-channel)
1 to 15	Reserved
16 to 991	Assigned using frame relay connection procedures
992 to 1,007	Assignable to frame relay PVCs
1,008 to 1,022	Reserved
1,023	Local management of interface

C/R

The Command/Response (C/R) is not used in this industry-standard implementation. It is always set to 0.

EA

By enabling the NetWare Link/Frame Relay header to extend to either 3 or 4 octets, the Extended Address (EA) allows for a DLCI longer than 10 bits and greatly expands the number of possible addresses.

FECN

Forward Explicit Congestion Notification (FECN) is set by the frame relay network to indicate that it has experienced congestion in the packet forwarding direction of the frame.

When this bit is set to 1, the frame relay network notifies the user receiving the frames that congestion is occurring in the direction in which the frame is being sent.

BECN

Backward Explicit Congestion Notification (BECN) is set by the frame relay network to indicate that the network has experienced congestion in the reversed packet forwarding direction of the frame.

When this bit is set to 1, the frame relay network notifies the user sending the frames that congestion is occurring in the direction opposite to that in which the frame is being sent.

DE

The Discard Eligibility (DE) bit is set by the end node and, when set and supported by the frame relay network, allows frames to be discarded in preference to other frames when a network is congested.

The frame relay network edge node might discard transmitted data exceeding the Committed Information Rate (CIR) on a PVC. (The CIR is the data rate at which the frame relay network agrees to transfer data.) Internally, the frame relay network might prefer to discard data with the DE set when it encounters congestion. If the congestion condition persists after discarding all frames with the DE set, the congested node can start discarding frames with the DE cleared.

Network edge nodes can also set DE bits in response to user data that exceeds the committed burst size during a fixed measured interval.

Information Field

The Information field (also called the Data field) contains the protocol data packet being transmitted. The field can contain a maximum of 4,520 octets; however, the 16-bit Frame Check Sequence (FCS) is more effective with frames smaller than 4K. You should ensure that the network can handle the maximum frame size sent by the router. If not, you must adjust the Maximum Frame Size parameter in NIASCFG.

Different network and frame relay switches are expected to support varying sizes. However, the maximum size of 4,520 octets should accommodate most LAN traffic and frame relay network variations. The maximum information field size is configurable on a per-port basis. To avoid or minimize segmentation and reassembly of higher-level PDUs, you should choose an optimal frame size.

Novell supports the multiprotocol encapsulation scheme described in RFC 1490 to multiplex multiprotocol LAN traffic over a single frame relay link. This means that higher-level PDUs must be encapsulated so that receiving nodes can interpret and demultiplex them properly.

FCS

The Frame Check Sequence (FCS) is the standard 16-bit cyclic redundancy check (CRC) used by HDLC. This field detects bit errors that occur in the bits of the frame between the opening flag and the FCS. The WAN board performs a 16-bit CRC to ensure data integrity.

Frame Relay Network

Private line networks permanently allocate dedicated transmission resources between communication end points, regardless of the traffic conditions. Because the frame relay network uses statistical multiplexing, the transmission resources are not allocated until there are active communications. Network resources are shared dynamically among participating end points.

Frame relay networks provide the best features of time-division multiplexing (TDM) high-speed, low-delay circuit switching and the statistical multiplexing and port sharing of X.25 packet-switching technologies. These features guarantee bandwidth according to the set CIR, and allow bandwidth-on-demand bursts, when available.

The frame relay network consists of frame relay switches, which usually are owned and administered by the carriers. The access connection to the frame relay network is typically provided by a Local Exchange Carrier (LEC); it can also be bundled into the frame relay provider's service. The network provider can be an LEC; a metropolitan frame relay service; an Interexchange Carrier (IXC); or an interstate, national, or global frame relay service.

NetWare Link/Frame Relay encapsulates data frames and routes them through the frame relay network based on the DLCI, which identifies the local PVC end point of the router. DLCIs are configured through the configuration process or learned through the NetWare Link/Frame Relay link management protocol.

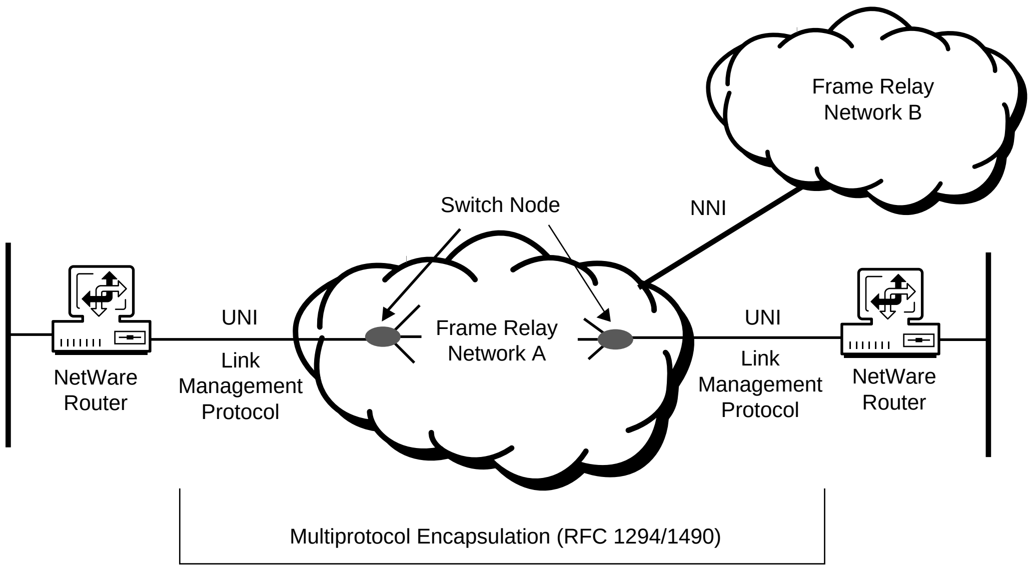
A frame relay network has the following characteristics:

- Transports frames transparently. The network modifies only the DLCI, congestion bits, and FCS.
- Detects transmission, format, and operational errors.
- Preserves the order of the frame transfer on individual PVCs.
- Does not acknowledge or retransmit frames.

With NetWare Link/Frame Relay, you can have a logical end-to-end link (a virtual private line) between communication end points. Although NetWare Link/Frame Relay appears as a dedicated private network to the user, the use of virtual circuits and high-speed internode trunking make the NetWare Link/Frame Relay service more cost-effective than a dedicated line service, with similar performance. NetWare Link/Frame Relay is intended primarily for high-speed, bursty data communications applications, such as LAN interconnections.

The UNI and NNI standards define the interoperability between end points on the LAN and the end points of the frame relay network, and between frame relay networks. This is shown in Figure 5.

Figure 5 Interoperability Standards



UNI describes how a router connects and accesses frame relay network services.

NNI describes how frame relay networks interconnect. With NNI, users subscribing to different frame relay network providers can communicate. Note that the standards for NNI have been defined only recently, and few network providers and equipment manufacturers currently support NNI.

Needed NetWare Link/Frame Relay Parameters

To set up and use NetWare Link/Frame Relay, you must determine the following network service parameters at subscription time. These parameters are statically configured before link activation and are in effect on a per-virtual-circuit basis.

- **DLCIs** —The PVC numbers that you need for data transfer. (One DLCI denotes one end of a virtual circuit; it takes two DLCIs to form one end-to-end virtual circuit.) The DLCI is also known as the virtual circuit number.
- **Bc** —The Committed Burst size, or the maximum number of data bits that a network agrees to transfer under normal conditions over a measured time interval.
- **Be** —The Excess Burst size, or the maximum number of uncommitted data bits that the network attempts to deliver over a measured time interval.
- **CIR** —The Committed Information Rate, or the user information rate, in bits per second, at which the network agrees to transfer data on a particular virtual circuit under typical operating conditions.
- **AR** —The Physical Access Rate of the user channel in bits per second. The offered load to the frame relay network is bounded by this parameter.
- *T* —A measurement interval, or the time interval over which rates and burst sizes are measured.

When a client workstation needs access to a remote node, the NetWare Link/Frame Relay router sends the frame to the local frame relay network switch, which sends it through the network to the remote end node.

The CIR protocol is used to enforce minimum committed bandwidth access. If a user exceeds the specified CIR limit, there is a risk of dropped packets; however, users working within their set CIR are usually guaranteed delivery by the service provider.

The frame relay network switch monitors the access rate and size of data frames transferred through the mesh network. The data throughput CIR is guaranteed by the network, but allows for excess bursts (Be) of data not to exceed the access rate (AR) of the connection. The committed burst size (Bc) sets the maximum amount of data that the network agrees to transfer in a specified time period.

Bursting above the set CIR is allowed only if the connection is configured for it and the actual bandwidth is available on an end-to-end basis. This means that the entrance edge node into the frame relay network, the transit nodes within the network, and the exiting edge node of the network must be available.

Management Control

For a frame relay link from a router to a frame relay network, and within the frame relay network itself, there are three types of management control: local management, frame relay network management, and network congestion control management.

For more information, refer to:

- Local Management
- Frame Relay Network Management
- Network Congestion Control Management

Local Management

Local management of NetWare Link/Frame Relay is accomplished by using a Link Management protocol—either the LMI or the Annex D protocol—to exchange status information between the router and the frame relay network. The LMI protocol also defines a number of optional features to simplify implementation or enhance operation. The LMI protocol learns about all devices that are accessible on the frame relay network, and exchanges *keep-alive* packets that are sent at a specified time interval. The keep-alive packet is a continuous link confidence test at the access interface, based on sequence numbers or counters that are exchanged between the frame relay network and the router.

LMI and Annex D promote a frame relay UNI implementation that addresses signaling and other network management functions.

LMI Operation

LMI, based on ISDN Digital Signaling System 1 (DSS1), is widely implemented on most frame relay equipment and provides the following support:

- Notification of the addition, deletion, and presence of a PVC

- Notification of the availability of a configured PVC
- Verification of link integrity using keep-alive sequence number exchanges

Annex D Operation

Annex D provides for the following in-channel signaling procedures:

- Notification of the addition and deletion of a PVC
- Notification of the availability of a configured PVC
- Verification of link integrity using keep-alive sequence number exchanges

Frame Relay Network Management

To support SNMP, frame relay network management is implemented within the network by the frame relay MIB. Managed objects are organized into the following three tables:

- Frame Relay Data Link Connection Management Interface

  Contains data-link connection management interface parameters for a frame relay interface attachment.

- Frame Relay Circuit

  Contains information about a virtual circuit. The virtual circuit is identified by an interface index and the corresponding DLCI. Virtual circuits associated with the same frame relay interface attachment are contained in one table.

- Frame Relay Error

  Contains information about errors that occurred on a frame relay interface binding.

Network Congestion Control Management

A frame relay network supports congestion control procedures to prevent performance degradation and to maintain an acceptable quality of service. Congestion control includes congestion avoidance and recovery procedures. To determine vendor-specific congestion control features, refer to your frame relay carrier or switch vendor.

Network Congestion Avoidance

Congestion avoidance procedures are initiated before the network approaches a moderate congestion state. These procedures prevent severe congestion from occurring so that initiation of congestion recovery procedures is not necessary.

To avoid congestion, explicit congestion notifications are sent to source and destination machines.

To throttle down a destination-controlled transmitter, an FECN indication can be set in frames sent in the forward direction (congested node to destination node).

To throttle down a source-controlled transmitter, a BECN indication can be set in frames sent in the backward direction (congested node to source node).

Alternatively, a Consolidated Link Layer Management (CLLM) message can be sent in the backward direction.

Network Congestion Recovery

Congestion recovery procedures are usually initiated when the network begins to drop frames because of severe congestion.

To recover from severe congestion, networks can discard DE-set frames and frames in excess of the CIR agreed upon at subscription time. Networks can also discard non-DE-set frames, clear existing calls, reject new calls, and negotiate CIRs downward, as necessary.

2 Planning

The NetWare Link/Frame Relay software is a streamlined, connection-oriented *frame-mode* data service based on frame-switching/relaying technology—the process of quickly transporting High-level Data Link Control (HDLC) frames through a network.

NetWare Link/Frame Relay is based on frame relay, a WAN telecommunications protocol standard specified by the ITU-T and American National Standards Institute (ANSI). Frame relay was originally specified by ITU-T as an Integrated Services Digital Network (ISDN) frame-mode service.

NetWare Link/Frame Relay supports AppleTalk, TCP/IP, IPX, and the source route bridge software of the Novell Internet Access Server 4.1.

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

Configuration Decisions

How you configure NetWare Link/Frame Relay beyond the most basic configuration depends on the following decisions:

- Interface speed required. The interface speed should support the type of applications that will be communicating with NetWare Link/Frame Relay.
- Physical interface required.
- Number of partner routers that will be connected by frame relay.

Setting Up and Using NetWare Link/Frame Relay

When you set up and use NetWare Link/Frame Relay, the following network service information is determined at subscription time, are statically configured before link activation, and are in effect on a per-virtual-circuit basis:

- Data-Link Connection Identifiers (DLCIs)—The PVC numbers that you need for data transfer. (One DLCI denotes one end of a virtual circuit; it takes two DLCIs to form one end-to-end virtual circuit.) The DLCI is also known as the *virtual circuit number*.
- Bc—The committed burst size, or the maximum number of data bits that a network agrees to transfer under normal conditions over a measured time interval.
- Be—The excess burst size, or the maximum number of uncommitted data bits that the network attempts to deliver over a measured time interval.
- CIR—The committed information rate, or the user information rate, in bits per second, at which the network agrees to transfer data on a particular virtual circuit under typical operating conditions.
- AR—The physical access rate of the user channel, in bits per second. The offered load to the frame relay network is bounded by this parameter.
- T—A measurement interval, or the time interval over which rates and burst sizes are measured.

For more information about NetWare Link/Frame Relay, refer to "Understanding."

Frame Relay Networks

Private line networks permanently allocate dedicated transmission resources between communications end points, regardless of traffic conditions. The frame relay network uses statistical multiplexing; therefore, transmission resources are not allocated until active communications exist. Network resources are shared dynamically among participating end points.

Frame relay networks provide the best features of time division multiplexing (TDM) high-speed, low-delay circuit switching and the statistical multiplexing and port sharing of X.25 packet-switching technologies. This guarantees bandwidth according to the set committed information rate (CIR) and allows bandwidth-on-demand bursts.

The frame relay network consists of frame relay switches, which usually are owned and administered by the carriers. The access connection to the frame relay network is typically provided by a Local Exchange Carrier (LEC); it can also be bundled into the frame relay provider's service. A network provider can be an LEC; a metropolitan frame relay service; an interexchange carrier (IXC); or an interstate, national, or global frame relay service.

NetWare Link/Frame Relay encapsulates data frames and routes them through the frame relay network based on the Data-Link Connection Identifier (DLCI), which identifies the local permanent virtual circuit (PVC) end point of the router. DLCIs are defined through the configuration process or learned through the NetWare Link/Frame Relay link management protocol.

A frame relay network has the following characteristics:

- Transports frames transparently. The network modifies only the DLCI, congestion bits, and frame check sequence (FCS).
- Detects transmission, format, and operational errors.
- Preserves the order of the frame transfer on individual PVCs.
- Does not acknowledge or retransmit frames.

Using NetWare Link/Frame Relay, you can have a logical end-to-end link (a virtual private line) between communications end points. Although NetWare Link/Frame Relay appears as a dedicated private network to the user, the virtual circuits and high-speed internode trunking make it a more cost-effective service than a dedicated line service, with similar performance. It is intended primarily for high-speed, bursty data communications applications, such as WAN interconnections.

NetWare Link/Frame Relay Parameters

NetWare Link/Frame Relay network service parameters, which are determined at subscription time, are in effect on a per-virtual-circuit basis. To set up and use NetWare Link/Frame Relay, the following parameters must be configured before frame relay link activation:

- DLCIs are the PVC numbers that you need for data transfer (one DLCI denotes one end of a virtual circuit). Two DLCIs, one at each end of the connection, are required to form one end-to-end virtual circuit. The DLCI is also known as the virtual circuit number.

- Committed burst size (Bc) is the maximum number of data bits that a network agrees to transfer under normal conditions over a measured time interval.
- Excess burst size (Be) is the maximum number of uncommitted data bits that the network attempts to deliver over a measured time interval.
- Committed information rate (CIR) is the user information rate, in bits per second, at which the network agrees to transfer data on a particular virtual circuit under typical operating conditions.
- The physical access rateaccess rate (AR) of the user channel is the throughput rate, in bits per second, that limits the load offered to the frame relay network.
- The measurement interval (T) is the time over which rates and burst sizes are measured.

When a client workstation needs access to a remote node, the NetWare Link/Frame Relay router sends the frame to the local frame relay network switch, which then sends the frame through the network to the remote end node.

Minimum committed bandwidth access is enforced using the CIR protocol feature. If a user exceeds the specified CIR limit, there is a risk of dropped packets; however, users working within their set CIR are usually guaranteed delivery by the service provider.

The frame relay network switch monitors the access rate and size of data frames transferred through the mesh network. The data throughput CIR is guaranteed by the network, but allows for excess bursts (Be) of data not to exceed the access rate (AR) of the connection. The committed burst size (Bc) sets the maximum amount of data that the network agrees to transfer in a specified time period.

Bursting above the set CIR is allowed, however, only if the connection is configured for it and the actual bandwidth is available on an end-to-end basis. This means that the entrance edge node into the frame relay network, the transit nodes within the network, and the exiting edge node from the network must be available before excess bursting can occur.

Diagramming Your Frame Relay Network

To ensure that all the desired connections to the frame relay network are properly diagrammed, complete the following steps:

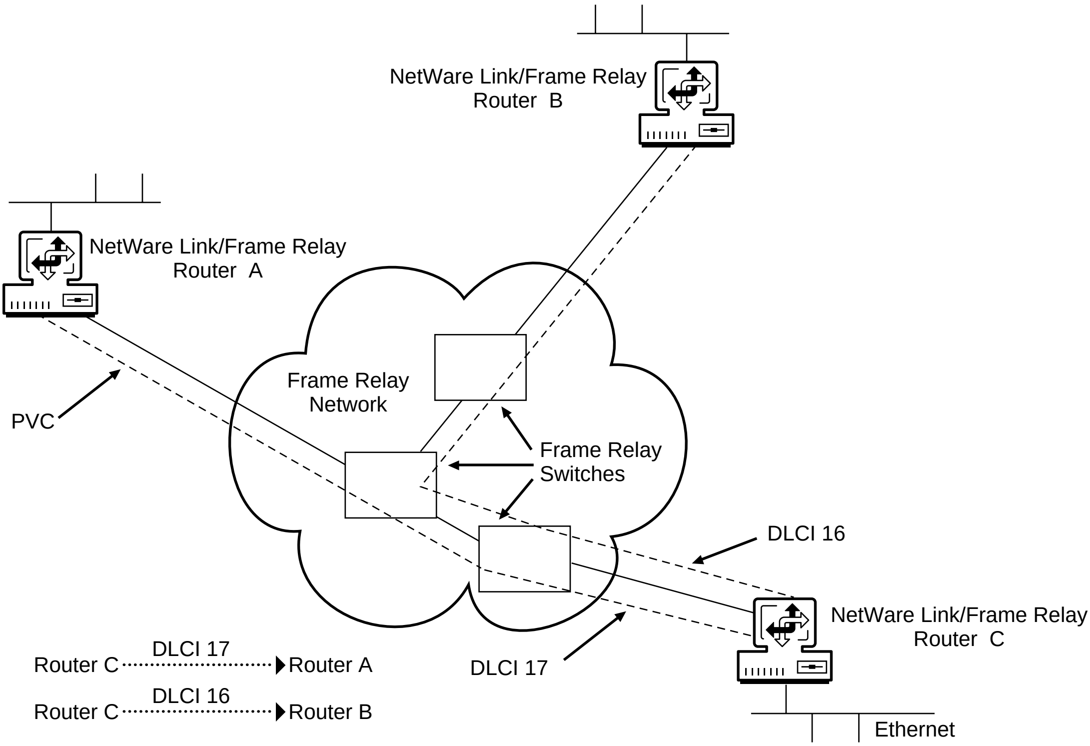
1. Diagram the existing frame relay network showing all Novell Internet Access Server 4.1 routing access points.

   Figure 6 shows a simple example of a planning diagram.

2. Draw each connection from the local NetWare router to its corresponding partner.

   Indicate the DLCI number assigned by the network for each connection (PVC).

Figure 6 Frame Relay Planning Diagram



Planning Your Frame Relay Network

To ensure that all aspects of your connections to the frame relay network are covered, complete the following steps:

1. For each location where a router attaches to the frame relay network, specify the following parameters:

- Interface speed required (for example, 256 Kbps or 1.544 Mbps)

  The interface speed should support the type of applications that will be communicating using NetWare Link/Frame Relay software.

  For example, if you have an application that must communicate with three remote sites using a minimum of 32 Kbps sustained bandwidth, the physical interface must be able to support at least 3 x 32 Kbps, or 96 Kbps.

  You should also consider traffic pattern characteristics (bursty or sustained) when specifying interface speed.

- Physical interface required (for example, V.35 or RS-232)
- Number of partner routers that will be connected using frame relay

2. Contact your frame relay network service provider and request the specific parameter values you require.

   These values should correspond to those defined in Step 1.

   The frame relay network service provider will set up your service and assign DLCI numbers to each PVC.

3. Using the information from Step 1 and Step 2, fill in the NetWare Link/Frame Relay worksheet.

   Figure 7 shows a template of the NetWare Link/Frame Relay configuration worksheet.

Figure 7 NetWare Link/Frame Relay Worksheet

NetWare Link/Frame Relay Worksheet Local Router ID:

Complete a copy of this worksheet for each NetWare router.

Network Access

Physical Type (circle one): **V35** | RS-232 | RS-422 | RS-423 X.21

Interface Speed (circle one): **External** | Internal = ______________________

Encoding (circle one): NRZ | **NRZ**

Connections

Destination (Partner)	DLCI Number

The following fields are included in the NetWare Link/Frame Relay configuration worksheet:

- NetWare Link/Frame Relay Local Router ID (at top of page)—Symbolic name assigned by the system administrator to identify a particular NetWare Link/Frame Relay router. The ID is arbitrary. It provides a way to track or reference a particular NetWare Link/Frame Relay router.
- Physical Type —Physical connection type to the frame relay switch that the NetWare Link/Frame Relay router is to be connected to.
- Interface Speed —External or internal. Internal speeds vary with the driver used.
- Encoding Option —Corresponds to the encoding set on the physical line that the NetWare Link/Frame Relay router is attached to. It can be *NRZI* (nonreturn to zero inverted) or *NRZ* (nonreturn to zero).
- Destination (Partner) —Destination name at the remote end of a PVC that connects communications partners.
- DLCI Number —Data Link Connection Identifier number assigned by the frame relay network service provider for each PVC.

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 for configuration information.

3 Setting Up

This section describes how to configure the NetWare® Link/Frame Relay™ software:

Configuring a Frame Relay Network Interface

After you have configured a NetWare Link/Frame Relay WAN interface board, as described in Setting Up in the *Boards* documentation, you need to configure a frame relay network interface.

How to Configure a Frame Relay Network Interface

Before you begin, make sure you have planned your frame relay network. Refer to Planning for frame relay checkpoints and planning information.

To configure network interface parameters for NetWare Link/Frame Relay, 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 Frame Relay , then press Enter.

   The Frame Relay Network Interface Configuration menu is displayed. The Interface Name field is a read-only field. It displays the name defined in the Configured Boards screen.

4. 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 the pop-up menu.

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

5 In the Physical Type field, accept V.35 by pressing the Down-arrow key to skip to the next field, or press Enter to select a new value from the pop-up menu.

The possible physical interface types are RS-232, RS-422, V.35, or X.21. Select the one you are using.

6 In the Interface Speed field, accept External, or press Enter to select a new value from the pop-up menu.

Internal speeds vary with the driver selected.

7 In the Data Encoding field, accept NRZ, or press Enter to select NRZI from the pop-up menu.

8 Select Expert Configuration, then press Enter.

The Frame Relay Expert Configuration menu is displayed.

The default values for the frame relay expert parameters should be adequate for most applications. You should accept these values.

9 Enter a valid value in the User Data Size field, then press Enter.

This value specifies the largest amount of data, in bytes, that this interface supports. This is the maximum size of user data frame that can be received on this link. The range of values is 1 to 4,520 bytes; the default value is 4,202 bytes.

This size should be smaller than the frame size that the network can accommodate. The data size you specify here should not be larger than the Maximum Physical Packet Receive Size value in the STARTUP.NCF file. Make sure that both sides of the link have the same configured Maximum Physical Packet Receive Size value in their respective STARTUP.NCF files.

WARNING: If you choose to increase the user data size, you must also use the INSTALL utility to edit the STARTUP.NCF file and change the Packet Receive Size to a value greater than the value of the User Data Size.

When communicating between a Novell Internet Access Server 4.1 system and a NetWare MultiProtocol Router™ 2.11 system (without the 81466.ETF patch), you must set the NetWare Link/Frame Relay User Data Size to a value 1 byte larger than that of NetWare MultiProtocol Router 2.11.

When communicating between a Novell Internet Access Server 4.1 system and a NetWare MultiProtocol Router 2.11 system with the 81466.ETF patch (the RFC 1490 upgrade), you must set the NetWare Link/Frame Relay User Data Size to the same value on both sides. In all cases, the NetWare Link/Frame Relay User Data Size value must be less than or equal to the Physical Packet Size value (the system ECB size).

10 Enter a valid value in the Send Queue Limit field, then press Enter.

This value specifies the maximum number of outbound data packets that can be queued to this port for transmission. When the queue limit is exceeded, the most recently queued outbound packets are dropped.

The range of values is 0 through 512 packets; the default value is 100 packets (0 = disable, allowing unlimited queue depth).

11 Highlight the Parameter Group field, then press Enter. The available options are displayed in a pop-up menu.

This value specifies the type of link management used. LMI and Annex D both provide the same types of management, but with different parameter settings. The only difference is that Annex D enables an unrequested status from the network.

The Point-to-Point Test allows you to test two routers or servers using frame relay in a point-to-point test procedure. The default option is Annex D Parameters.

12 Press Enter to view or change the Parameter Group Configuration parameters.

This menu shows the configurable parameters of the specific parameter group you selected (LMI or Annex D).

The LMI or Annex D parameters have defaults that should be adequate for most applications. You should accept these values.

12a Enter a valid value in the Full Status Enquiry Counter field, then press Enter.

This value specifies the number of status inquiries that are exchanged before a full status inquiry of the network is issued.

The network responds with a full status message, and the router updates its network informational status.

The range of values is 1 through 255 inquiries. The default value is 6.

12b Enter a valid value in the Error Threshold Counter field, then press Enter.

This value specifies the maximum number of error events detected within the most recent monitored events (specified by the Monitored

Event Counter parameter). An alarm is generated if this counter is exceeded.

This counter must be less than or equal to the Monitored Event Counter value.

The range of values is 1 through 10. The default values are 2 events for LMI and 3 events for Annex D.

12c Enter a valid value in the Monitored Event Counter field, then press Enter.

This value specifies the number of most recent consecutive exchanges to be monitored by the router.

This counter must be greater than or equal to the Error Threshold Counter value.

The range of values is 1 through 10 events. The default is 4.

12d Enter a valid value in the Status Polling Timer field, then press Enter.

This value specifies the number of seconds between consecutive status inquiries initiated by the router to the network. At the specified time interval, the router requests a sequence number exchange status. An error is detected if the router does not receive a status message response within the specified polling time.

The range of values is 5 through 30 seconds. The default values are 10 seconds for LMI and 15 seconds for Annex D.

13 Press Esc , select Yes when prompted to save your changes, then press Enter.

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

The Frame Relay Enterprise Specific Traps Configuration menu is displayed.

14a In the Interface Status Change Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes frame relay to generate Simple Network Management Protocol (SNMP) traps when a frame relay interface link status is changed (up or down).

14b In the DLCI Status Change Trap field, accept the default value, Disabled , or press Enter to select Enabled from the pop-up list.

Enabling this parameter causes frame relay to generate SNMP traps when a DLCI status is changed (active, inactive, or valid).

14c 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 Hardware Specific Module™ (WHSM) software to generate SNMP traps while the Physical layer's send or receive utilization exceeds the Bandwidth Upper Threshold value, and to continue to generate SNMP traps until the Physical layer's send or receive utilization falls below the Bandwidth Lower Threshold value.

14d 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.

14e In the Bandwidth Upper Threshold field, set the value to any number less than 100 and 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.

15 Press Esc as many times as necessary to return to the Internetworking Configuration menu.

Configuring the WAN Call Directory

The WAN Call Directory is a list of the 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 the parameters that NetWare Link/Frame Relay applies when it is establishing and maintaining calls to the destination.

Only permanent call configurations are supported in the current frame relay implementation. 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.

How to Configure WAN Call Destinations

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

NOTE: This procedure is optimal for TCP/IP and source route bridge only. You only need to define WAN call destinations for TCP/IP if you are using a numbered link and the remote router does not support inverse ARP. You do not need to define WAN call destinations for the Internetwork Packet Exchange™ (IPX™) protocol or AppleTalk protocol.

To configure WAN call destinations for frame relay 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 37 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. Frame relay is not available if you have not yet configured a frame relay interface.

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

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

   NOTE: You must install a WAN board and configure a NetWare Link/Frame Relay interface, as described in the previous section.

4. Select Frame Relay as the wide area medium, then press Enter.

   The Frame Relay Call Destination Configuration menu is displayed.

   The Call Destination Name field is a read-only field. It displays the name you entered in the Configured WAN Call Destinations screen.

5. Select Interface Name , then press Enter.

   The Select Interface screen displays a list of the configured frame relay interfaces. Using this menu, select the name of the interface through which this WAN call destination can be accessed.

6. Select a configured frame relay interface, then press Enter.

7. Circuit Type is selected; just press the Down-arrow key.

   Only permanent virtual circuits are used in the current implementation of frame relay.

8. In the DLCI Number field, type the circuit number and press Enter.

   This field specifies the DLCI number to be used for calls to this destination.

9. 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.

10. To configure another WAN call destination, repeat Step 2 through Step 9.

11. Press Esc to return to the Internetworking Configuration menu.

4 Managing

This section describes the utilities used to monitor NetWare® Link/Frame Relay WAN connections.

Using the FRCON Utility

The Frame Relay Console (FRCON) is an SNMP console-based utility that provides interface statistics, virtual circuit statistics, and the SNMP trap log. You can enable or disable the following enterprise specific SNMP traps: physical bandwidth threshold trap, interface status change trap, and DLCI status trap. You can also configure the upper and lower threshold values for the bandwidth threshold traps.

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

Select View Status for NIAS > Protocols and Routing > Frame Relay

Using the FRTRACE Utility

The Frame Relay Trace utility (FRTRACE) can be used locally at the router or server console, or remotely from a workstation that is running RCONSOLE. FRTRACE offers the following features:

- Real-time protocol trace facility
- Capture to RAM (for high-speed, high-utilization link traffic) or to disk (for moderate traffic)
- Real-time capture trace playback from RAM or disk
- Network interface level statistics (with throughput calculations)

- Virtual circuit level statistics
- Support for all links and protocols
- Network interface summary information
- Raw-mode display option
- Autodecode, which enables the automatic detection and decode of either LMI, Annex A, or Annex D protocols, in addition to manual decode selection
- Upper-level protocol encapsulation decode option, per RFC 1490
- Decode and display traffic in one of three modes (hex, ASCII, or EBCDIC)
- DLCI filtering, which enables you to configure a list of DLCIs whose traffic will be displayed in the data capture and helps you to focus on only the traffic that you want to examine
- Print utility that reads an FRTRACE capture file, converts the file contents from hex to ASCII, decodes the file contents for the link management protocol and RFC 1490 (if specified), and writes the contents to an output file that can be printed or viewed with an ASCII editor or browser

  The command for this DOS executable file has the following format: **FRDISP <*saved_file*> <*output_file*> /d**, with the /d option causing a decode for the link management protocol and RFC 1490.

Viewing Frame Relay Configuration Information

To see how frame relay is configured, load FRCON and select the following options:

- SNMP for direct access to local nodes's frame relay information and TCP/IP access to select nodes of frame relay information.
- Frame Relay Interface for all frame relay network interfaces, including unique identification, interface name, state, and maximum virtual circuits.
- Frame relay Virtual Circuits for all virtual circuits reported by the target host.
- Display Traps for a list displaying the local SNMP trap log reporting significant TCP/IP events.

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/Frame Relay™ 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 59 will help you isolate and resolve the problem. If a problem with a specific symptom occurs, refer to "Common Problems."

Troubleshooting Tools

The following utilities can be used to troubleshoot NetWare Link/Frame Relay:

- Frame Relay Trace
- Frame Relay Console
- MONITOR
- Tests

Frame Relay Trace

The Frame Relay Trace utility (FRTRACE) can be used locally at the router or server console, or remotely from a workstation that is running RCONSOLE. FRTRACE offers the following features:

- Real-time protocol trace facility
- Capture to RAM (for high-speed, high-utilization link traffic) or to disk (for moderate traffic)
- Real-time capture trace playback from RAM or disk
- Network interface level statistics (with throughput calculations)
- Virtual circuit level statistics
- Support for all links and protocols
- Network interface summary information
- Raw-mode display option
- Autodecode, which allows the automatic detection and decode of either LMI or Annex D protocols, in addition to manual decode selection
- Upper-level protocol encapsulation decode option, in accordance with RFC 1490
- Decode and display traffic in one of three modes (hexadecimal, ASCII, or EBCDIC)
- DLCI filtering, which enables you to configure a list of DLCIs whose traffic will be displayed in the data capture and helps you to focus on only the traffic that you want to examine
- Print utility that reads an FRTRACE capture file, converts the file contents from hexadecimal to ASCII, decodes the file contents for the link management protocol and RFC 1490 (if specified), and writes the contents to an output file that can be printed or viewed with an ASCII editor or browser

  The command for this DOS executable file has the following format: **FRDISP** <*saved_file*> <*output_file*> **/d**, with the **/d** option causing a decode for the link management protocol and RFC 1490

Frame Relay Console

Frame Relay Console (FRCON), an SNMP console-based utility, provides interface statistics, virtual circuit statistics, and the SNMP trap log. You can enable or disable the following enterprise-specific SNMP traps: physical bandwidth threshold trap, interface status change trap, and DLCI status trap. In addition, you can configure the upper and lower threshold values for the bandwidth threshold trap in NIASCFG.

MONITOR

MONITOR displays various system statistics, including the LAN/WAN Driver Information option, that allows you to view generic and custom WAN driver statistics. These statistics enable you to determine whether the driver is sending and receiving frames and whether errors are detected (CRC errors, no ECB, receive overflow, packet too big, and others). Other relevant statistics include the following:

- Adapter Queue Drop—Number of transmit packets dropped because of send queue overflow.
- Adapter Not Ready Packet Drop—Number of transmit packets dropped because of an adapter not ready condition (network interface board problem).
- Adapter Peak Queue Depth—Maximum queue depth recorded during peak traffic (an indicator for peak traffic characteristics).

MONITOR also shows the data terminal equipment (DTE) and data circuit-terminating equipment (DCE) circuit signals (DTR, DSR, DCD, RTS, and CTS) that indicate whether the required interface signals are present and whether the DTE-DCE handshake has been completed successfully. If a driver provides transition counters (increments for each signal transition) for DTE and DCE signals, these counters can be useful indicators for link disconnects caused by router power cycles, DSU/CSU power cycles, and so on. CRC errors and aborts are good indicators for line noise/interference-related problems. The MSMTxFreeCount statistic indicates whether a network interface board is accepting frames (if the MSMTxFreeCount statistic is zero, the board is no longer accepting frames for transmission). DMA errors and receiver restarts are indicators for potential network interface board-level (firmware and hardware) errors.

Tests

This section describes various methods you can use to test NetWare Link/Frame Relay.

Equipment Hookup

Figure 8 and Figure 9 show how the equipment to be tested is connected.

Figure 8 Customer-to-Network Hookup

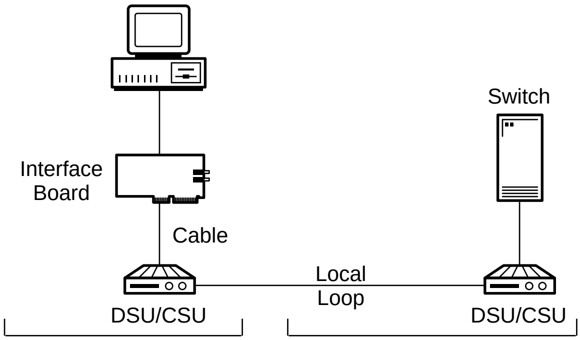
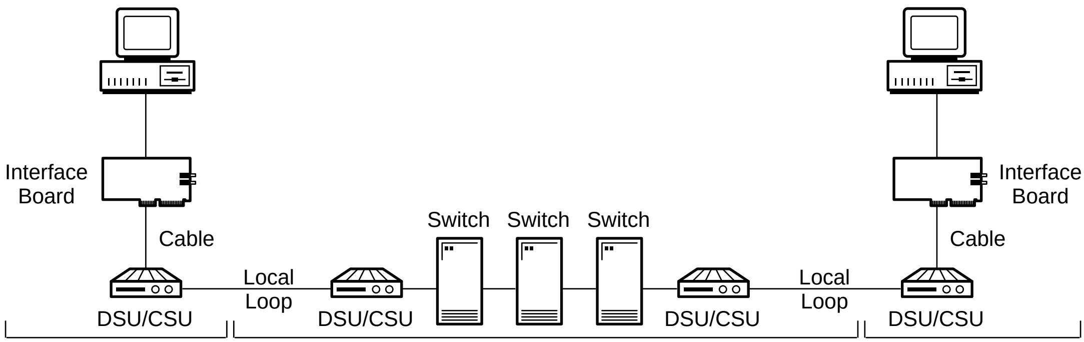


Figure 9 End-to-End Hookup



Dual-Port Loopback Test

This test involves connecting two ports of a router through a modem eliminator or a pair of DSU/CSUs. To start this test, select the Point-to-Point Test option in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > a specific frame relay interface > Expert Configuration > Parameter Group).

Alternatively, two ports can be connected through a special crossover cable (sometimes called a *null modem cable*). In addition to selecting the Point-to-

Point Test option in NIASCFG, one port must provide a clock signal to drive the other port, which is configured in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > select an interface > Interface Speed). Only one port speed must be specified; the other port must remain externally clocked.

Because the two connected ports form a loop, the network protocol can issue error messages. Also, in this case, PING does not allow you to verify connectivity across the loop. However, this test does allow you to verify whether a router can transmit and receive packets properly.

Single-Port Loopback Test

You can also use the DSU/CSU built-in loopback feature to perform a single-port loopback test at either the local (customer) DSU/CSU or remote (network) DSU/CSU.

Because no remote router is present, network protocol connections (IP, AppleTalk, source route bridge, and Internetwork Packet Exchange™ [IPX™] connections) are not established. However, this test allows you to verify whether a router can transmit and receive packets properly.

Back-to-Back Test

This test involves connecting two Novell® routing interfaces through a modem eliminator or a pair of DSU/CSUs. To start this test, select the Point-to-Point Test option in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > a specific frame relay interface > Expert Configuration > Parameter Group).

Alternatively, two routers can be connected through a null modem cable. In addition to selecting the Point-to-Point Test option in NIASCFG, one port must provide a clock signal to drive the other port, which is configured in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > select a specific frame relay interface > Select Interface Speed). Only one port speed must be specified; the other port must remain externally clocked.

An incorrectly made crossover cable can cause problems that are difficult to isolate; therefore, we recommend using a modem eliminator.

This test can check router-to-router connectivity and is preferred over the loopback test.

Test Matrix

In Table 5 , an X indicates which tests can be used to test the components shown in Figure 8 and Figure 9.

Table 5 Test Matrix

Components	Dual-Port Loopback Test	Dual-Port Back-to-Back Test	Single-Port Local DSU/ CSU Loopback Test	Single-Port Remote DSU/CSU Loopback Test	PING Test	Network Interface Board Self-Diagnostics
Local Components						
Network protocols	X	X	X	X	X	
Frame relay	X	X	X	X	X	
WAN driver	X	X	X	X	X	
Board/cable	X	X	X	X	X	X
DSU/CSU			X	X	X	
Local loop				X	X	
DSU/CSU				X	X	
Switch					X	
Remote Components						
Trunk					X	
Switch					X	
DSU/CSU					X	
Local loop					X	
DSU/CSU					X	
Board/cable					X	
WAN driver					X	
Network protocols					X	

Test Tools Matrix

In Table 6 , an X indicates which tools can be used to test the different hardware and software components.

Table 6 Test Tools Matrix

Tools	Network Protocols	Frame Relay	WAN Driver	Network Interface Board and Cable	DSU/CSU
Call Manager	X				
Network Protocol Consoles	X				
Frame Relay Console		X	X		
Frame Relay Trace		X	X		
PING	X				
MONITOR			X	X	X
SNMP Log	X	X	X		
ManageWise software	X	X	X		
Console Log	X	X	X		

Configuration Tips

This section lists recommendations for configuring NetWare Link/Frame Relay.

- 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.

- When routing AppleTalk or IPX over frame relay, do not specify a WAN call destination under Bindings. All AppleTalk, IPX, and IP WAN connections over frame relay are incoming calls that are originated by the frame relay switch. These incoming calls connect automatically and require no manual intervention. You cannot initiate an outgoing call for AppleTalk, IPX, or IP over frame relay.
- Make sure User Data Size is set to the same value on both sides of the link.
- If a frame relay PVC does not come up, verify that the link management protocol (Local Management Interface [LMI] or Annex D) set in the WAN interface configuration is the same as the protocol used by the frame relay switch, or verify that the switch is configured for autodetect.
- Either the LMI or ANNEX-D polling timer should always be set to a value less than the network timer value set for the switch.
- 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.
- You do not need to configure WAN call destinations when routing IPX, AppleTalk, and (in most situations) IP. However, you must configure a WAN call destination in the following circumstances:
    - You are routing IP and the router at the other end of the connection does not support Inverse ARP (for example, when connecting to Cisco Systems* and IBM 6611 routers).
    - You are binding the source route bridge software to the frame relay interface.
- 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 used.
- Verify that the following configuration parameter settings match the settings used by the frame relay switch and your ISP:
    - User data size should be equal to or less than the size used by the frame relay switch. Also, ensure that the user data size is equal to or less than the physical receive packet size.
    - Line management protocol (ANNEX-D, LMI) should match the protocol used by your ISP.

- Data encoding of NRZ or NRZI should be set to match your ISP
- Status polling timer value should be equal to or slightly less than the maximum value the switch supports. To change this value, load NIASCFG and select Configure NIAS > Protocols and Routing > Network Interfaces > select a specific frame relay interface > Expert Configuration > Parameter Group Configuration > Status Polling Timer option).

Troubleshooting Checkpoints

To isolate and resolve problems with NetWare Link/Frame Relay, complete the following steps:

1. Conduct a back-to-back test to make sure that the router hardware (PC, network interface board, cable, and so on) and software (driver, protocols, and so on) are functional. For information, refer to Back-to-Back Testing in the *Overview* documentation.

2. Attach one of the fully tested routers to the local DSU/CSU (or modem) and perform a DSU/CSU (or modem) local loopback test.

   Use MONITOR to check whether the router can send and receive frames through the local DSU/CSU loopback. If the loopback test is unsuccessful, troubleshoot the DSU/CSU (or modem).

3. Verify that the routing configuration (including frame relay) and DSU/CSU (or modem) match the requirements of the carrier and remote router (LMI/ANNEX-D Status Exchange counters, timers, NRZ/NRZI, SF/ESF, B8ZS, network protocol options, and so on).

4. After you have attached the DSU/CSU and router to the network (switch) and restarted the router, use CALLMGR to check the protocol connection status.

   Wait at least one minute to allow NetWare Link/Frame Relay to learn DLCI configuration information from the attached switch through status exchanges. If connections are not established, continue with Step 5. Otherwise, go to Step 11.

5. Check DTE/DCE handshake signals using MONITOR.

   If the DTE/DCE signals are present and valid, use MONITOR to check the transmit and receive clocks and compare their speed with the expected (subscribed) port speed. Contact your ISP if the speeds are inconsistent. If the speeds match, check your DSU/CSU (or modem) configuration. If the DSU/CSU is configured properly and is functional, contact your ISP to troubleshoot the local loop (possibly through a remote DSU/CSU loopback test).

6. Use MONITOR to make sure that frames can be transmitted and received successfully.

7. Use FRTRACE to make sure NetWare Link/Frame Relay can exchange link management (LMI or ANNEX-D) frames successfully with the attached network switch.

   Contact your ISP to resolve any link management status exchange errors.

8. Verify the configured DLCIs and their associated status using the (frame relay) Virtual Circuit option of FRCON or the Full Status Response decode option of FRTRACE.

   Contact your ISP if these DLCIs are inconsistent with the services to which you subscribed.

9. Check the protocol connection status using CALLMGR.

   If connections are not established, check the network protocol (IPX, IP, AppleTalk, and source route bridge) configuration on local and remote routers to ensure compatibility and interoperability. Repeat this step until all connections are established.

10. Check the console messages or CONLOG in SYS: etc\console.log for error messages. To determine the action required for each error message, refer to Novell Internet Access Server 4.1 Messages.

11. Check router/server connectivity using the DISPLAY SERVER console command, the protocol console's routing/forwarding tables, or the individual protocol's PING or Echo utility.

    If expected routers are missing, check the network protocol configuration on local and remote routers to ensure compatibility and interoperability. Repeat this step, if required.

Common Problems

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

- The NetWare Link/Frame Relay connection will not come up.

  Cause 1 —Misconfiguration of protocol parameters.

  - Verify that there are no incompatible frame relay parameter settings (timers, counters, frame size, and so on) between the router and the attached network.
  - Verify that there are no incompatible router-to-router parameter settings (network and routing protocol options and so on) among peer routers.

  Cause 2 —The router on the other end of the PVC is inactive.

  - Typically, the frame relay switch will not report that the DLCI is active until both end's link management protocols (LMI or Annex-D) are up and running; however, some ISPs can force the DLCI to become active, even though the router at the other end is not connected.
  - If the remote router is connected but the link will still not come up, then load NIASCFG to reduce the Status Poll Timer value by a few seconds (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > frame relay interface > Expert Configuration > Parameter Group Configuration).

  Cause 3 —Misconfiguration of hardware options.

  - Verify that there are no incompatible hardware options (loopback, ESF, B8ZS, and so on) between the customer DSU/CSU (or modem) and network DSU/CSU (or modem).
  - Verify that there are no incompatible hardware options (clock source, electrical interface, cable wiring, and so on) between the network interface board and the customer DSU/CSU (or modem).
  - Verify that there are no incompatible hardware options (NRZ, NRZI, and so on) between the network interface board and the attached switch port.
  - Verify that there are no conflicting interrupt levels or shared memory locations among multiple network interface boards residing in the same PC.

  Cause 4 —Hardware problems.

  Verify that there are no malfunctioning NICs, DSU/CSUs, and cables.

- There are problems with data corruption, parity errors, and server abends. Typically, the symptoms are intermittent.

  There is a network interface board or PC system timing incompatibility.

Use Novell-approved hardware.

- There are CRC errors, transmission aborts, and link restarts.

  There are problems with the line noise/interference or signal attenuation. When line quality becomes unacceptable because of excessive errors, NetWare Link/Frame Relay issues disconnects. NetWare Link/Frame Relay recovers automatically (reestablishes the link) when link quality becomes acceptable again.

  Contact your ISP.

- DLCI status is inactive.

  If the DLCI status is inactive, decrease the status polling time several seconds in NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > Expert Configuration > Parameter Group Configuration > Status Polling Timer option).

  In FRCON, select the Virtual Circuits option to check the DLCI status.

  If the status is active, load FRTRACE and select REAL-TIME MONITOR. See the Load FRTRACE menu item.

- LMI and ANNEX-D settings don't match.

  Load FRTRACE, select the Real-time Monitor option, and view sent and received data. If the message `unknown packets` appears, load NIASCFG to verify that the LMI and ANNEX-D settings on the local and remote routers match (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > Parameter Group). These parameters manage the data link connection.

  If only one IPX packet is sent and received each time the routing software attempts to establish a connection, decrease the user data size so that it is equal to or less than the size used by the frame relay switch. Also, ensure that the user data size is equal to or less than the physical receive packet size.

- Unknown packets appear in FRTRACE.

  If the message `unknown packets` appears in the FRTRACE file, load NIASCFG to verify that the LMI and ANNEX-D settings on the local and remote routers match (parameter path: Select Configure NIASCFG > Protocols and Routing > Network Interfaces > Parameter Group). These parameters manage the data link connection.

- IPX link connects and then immediately disconnects.

Load NIASCFG (parameter path: Select Configure NIAS > Protocols and Routing > Network Interfaces > frame relay network interface > Expert Configuration > User Data Size) to reduce the User Data Size parameter value. The User Data Size value should be less than or equal to the maximum limit supported by the frame relay switch and less than or equal to the Maximum Physical Receive Packet Size value on your router. Check with your frame relay provider for the frame relay switch value.

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