

Bay Networks

The Merged Company of SynOptics and Wellfleet

Customizing LLC Services

Part No. 110051 A

Customizing LLC Services

Router Software Version 8.10
Site Manager Software Version 2.10

Part No.110051 Rev. A
February 1995



Bay Networks

The Merged Company of SynOptics and Wellfleet

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About This Guide

If you are responsible for configuring and managing Wellfleet® routers, you need to read this guide.

This guide provides information on how to customize Wellfleet router software for LLC (8802/802.2 logical link control) services. You must add LLC services when you want Wellfleet routers in your network to support LAN Network Manager (LNM) servers, Data Link Switching (DLSw) services, and Advanced Peer-to-Peer networking (APPN).

Refer to this guide information about

- The LLC protocol and its client protocols (Chapter 1)
- LLC2 over frame relay (Chapter 2)
- Editing LLC parameters (Chapter 3)

For information and instructions about the following topics, refer to *Configuring Wellfleet Routers*.

- Initially configuring LLC services on the router
- Retrieving a configuration file
- Rebooting the router with a configuration file

Before You Begin

Before using this guide, you must complete the following procedures:

- ❑ Create and save a configuration file that contains at least one LLC interface.
- ❑ Retrieve the configuration file in local, remote, or dynamic mode.

Refer to *Configuring Wellfleet Routers* for instructions.

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| | |
|-------------------|-----------------|
| United States | 1-800-2LAN-WAN |
| Valbonne, France | (33) 92-966-968 |
| Sydney, Australia | (61) 2-903-5800 |
| Tokyo, Japan | (81) 3-328-0052 |

Conventions

| | |
|------------------------|---|
| angle brackets (< >) | Indicate that you choose the text to enter based on the description inside the brackets. Do not type the brackets when entering the command. Example: if command syntax is ping <ip_address>, you enter ping 192.32.10.12 |
| arrow character (→) | Separates menu and option names in instructions. Example: Protocols→AppleTalk identifies the AppleTalk option in the Protocols menu. |
| user entry text | Denotes text that you need to enter. Example: Start up the Windows environment by entering the following after the prompt: win |
| command text | Denotes command names in text. Example: Use the xmodem command. |
| <i>italic text</i> | Indicates variable values in command syntax descriptions, new terms, file and directory names, and book titles. |

| | |
|-----------------------|--|
| screen text | Indicates data that appears on the screen. Example: <code>Set Trap Monitor Filters</code> |
| quotation marks (“ ”) | Indicate the title of a chapter or section within a book. |
| vertical line () | Indicates that you enter only one of the parts of the command. The vertical line separates choices. Do not type the vertical line when entering the command. Example: If the command syntax is show at routes nets , you enter either show at routes or show at nets , but not both. |

Acronyms

| | |
|------|--|
| ANSI | American National Standards Institute |
| APPN | Advanced Peer-to-Peer Networking |
| DLCI | datalink connection identifier |
| DLSw | Data Link Switching |
| DSPU | downstream physical unit |
| FDDI | Fiber Distributed Data Interface |
| FEP | front-end processor |
| FR | frame relay |
| FRAD | frame relay access device |
| IEEE | Institute of Electrical and Electronic Engineers |
| ISO | International Organization for Standardization |
| LAN | local area network |
| LSB | least significant bit |
| LLC | Logical Link Control |
| LNM | LAN Network Manager |
| LSAP | link service access point |
| LSDU | link service data units |

| | |
|---------|-----------------------------------|
| MAC | media access control |
| MSB | most significant bit |
| NetBIOS | Network Basic Input-Output System |
| NCP | Network Communications Program |
| OSI | Open Systems Interconnection |
| PDU | protocol data unit |
| RFC | Request for Comment |
| SAP | service access point |
| SDLC | Synchronous Data Link Control |
| SNA | Systems Network Architecture |
| SR | source routing |
| SRB | source route bridging |
| WAN | wide area network |

Chapter 1

Logical Link Control Overview

This chapter provides an overview of Logical Link Control (LLC) in Wellfleet routers. It supplies information you need to edit LLC parameters, and it lists sources for further information.

LLC is a standard protocol within the CCITT 8802.2 and IEEE 802.x family of LAN standards. IBM® Systems Network Architecture (SNA) protocols require the services of LLC to support communication over local area networks (LANs). Network devices such as NetWare® and DECnet™ also use LLC services for end-to-end communication in a LAN environment.

Our implementation of the LLC protocol consists of LLC Class 1 (LLC1), a connectionless service, and LLC Class 2 (LLC2), a connection-oriented service.

Logical Link Control in a Wellfleet router supports

- Data Link Switching (DLSw) as defined in RFC 1434 and *Customizing DLSw Services*
- Advanced Peer-to-Peer Networking (APPN) as defined in *Customizing APPN Services*
- LAN management servers (LNM), as defined in *Customizing LNM Services*

LLC 8802/802.2 Standards

The LLC protocols comply with the CCITT 8802.2 standard, and operate within the upper sublayer of the datalink layer of the IEEE Project 802.x protocol stack.

Figure 1-1 compares the location of LLC in the 802.x protocol stack to its equivalent location in the ISO/OSI model.

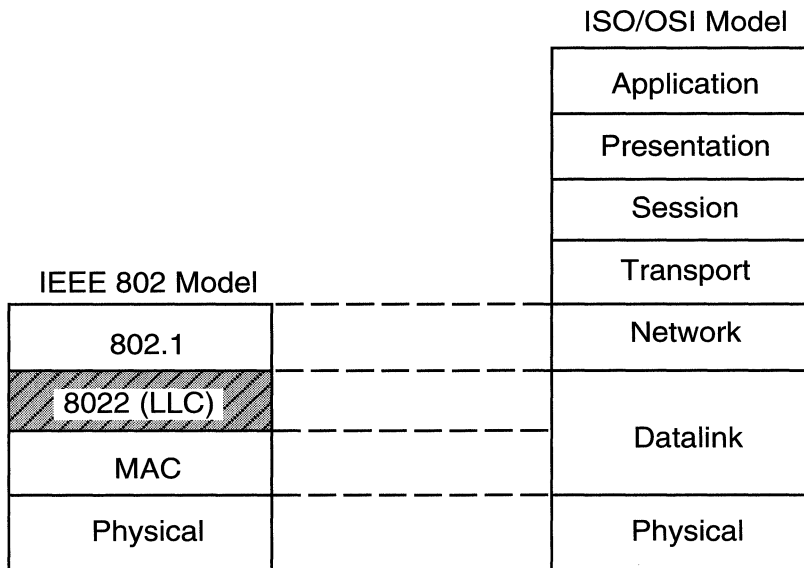


Figure 1-1. The LLC Sublayer in the IEEE 802.x and OSI Models

You can add an IEEE 802.2-compliant LLC interface to any physical circuit attached directly to an 8802.x/802.x LAN segment. Each interface provides services to higher-level clients (networking protocols and applications) and relies on services from the lower-level media access control (MAC) and physical layers operating within the router.

Certain protocols on a Wellfleet router automatically configure a supporting LLC1 (default) interface and, if needed, a configurable LLC2 interface on the same circuit.

For example, Wellfleet routers in your corporate network may need to support sessions between an LNM workstation (client) and multiple Token Ring LANs in that network. In this case, Site Manager enables you to add an LNM Servers subsystem to any Token Ring circuit on the router. The LNM Servers on a Token Ring circuit automatically configure an LLC1 and an LLC2 interface on the same physical circuit.

The Data Link Switching (DLSw) protocol also supports a default LLC configuration. You can customize the operation of any LLC2 interface automatically added to the router configuration to support another protocol such as DLSw.

LLC and SNA

The SNA protocols require a connection-oriented datalink layer that provides end-to-end sequencing and error control. Over wide area networks (WANs) the Synchronous Data Link Control (SDLC) protocol has traditionally provided this service. However, front-end processors (FEPs), controllers, and NetBIOS™ client/server stations in a LAN environment commonly use an LLC2 layer for this purpose. To support communication among these devices, you can add LLC2 interfaces to a router configuration.

SNA devices and NetBIOS PCs use LLC when they establish sessions through a LAN topology. SNA and NetBIOS need LLC2 connection-oriented circuits to provide higher-layer sequencing and error control in bridged LAN environments. LLC2 works much like SDLC in terms of packet sequencing and acknowledgment, but it does not impose unbalanced, primary/secondary relationships between communicating nodes: any LLC station can initiate a peer-to-peer conversation with any other LLC station.

LLC and Non-SNA Protocols

TCP/IP, NetWare, DECnet, and other internetworking protocols do not require an LLC connection-oriented datalink layer, the network and transport layers of those protocols provide these functions. These protocols can, however, use LLC1 services. You add LLC1 interfaces to a router configuration to support these higher-level protocols.

Supported Media

DLSw and APPN with LLC2 run over the following:

- ❑ Token Ring
- ❑ Ethernet
- ❑ Synchronous media
- ❑ FDDI

LLC2 runs over source route bridging (SRB) on all media. LLC2 also runs over the transparent bridge on Ethernet. Every interface to Ethernet, however, must have LLC2 and either the DLSw or APPN protocol enabled.

LLC supports routed native frame relay. It conforms to RFC 1490.

LNLM with LLC runs over Token Ring only.

LLC Service Classes

The 802.2/LLC recommendations support three *service classes*:

- ❑ Connectionless Unacknowledged (Class 1 or LLC1)
- ❑ Connection-Oriented (Class 2 or LLC2)
- ❑ Connectionless Acknowledged (Class 3 or LLC3)

Note: The Wellfleet implementation of LLC does not support LLC3. The following sections present information only about LLC1 and LLC2 services.

LLC1 (Connectionless Service)

LLC1 is a datagram service that allows you to send and receive LLC frames called link service data units (LSDUs) without requiring acknowledgment from the peer to assure delivery.

LLC1 supports all forms of communication (point-to-point, multipoint/multicast, and broadcast).

LLC1 is appropriate for protocols that provide addressing, routing, recovery and sequencing services at a higher layer.

LLC2 (Connection-Oriented Service)

LLC2 provides a point-to-point virtual circuit connection between link service access points (LSAPs). The LLC2 protocol

- ❑ Responds to a request from a higher-level protocol to open a connection through the datalink layer
- ❑ Notifies a higher-level protocol that a connection through the datalink layer has been established successfully
- ❑ Provide a means for a higher-level protocol to
 - Send or receive LSDUs over an established datalink-layer connection
 - Sequence LSDUs sent over a datalink-layer connection
 - Control the flow of LSDUs over a datalink-layer connection

The LLC2 service also

- ❑ Responds to a request from a higher-level protocol to reset a connection to its initially connected state

- Responds to a request from a higher-level protocol to close an established connection
- Notifies a higher-level protocol that a connection previously established has been closed successfully

Because the connection occurs in the datalink layer rather than in higher layers, LLC2 must also provide frame sequencing, flow control, and error recovery services for the datalink layer.

LLC Operation Types

LLC supports two *operation types*:

- Unnumbered, Unacknowledged (Type 1)
- Numbered, Acknowledged (Type 2)

LLC1 supports only Type 1 operations; LLC2 supports both Type 1 and Type 2 operations.

Type 1 Operations

Type 1 operations have the following characteristics:

- LLCs exchange protocol data units (PDUs) without establishing a datalink connection.
- The peer does not acknowledge the PDUs it receives.
- There are no mechanisms for PDU sequencing, flow control, or error recovery, because higher-level protocols supply these.

Type 2 Operations

Type 2 operations have the following characteristics:

- The LLC and its peer must establish a datalink-layer virtual circuit/connection prior to any exchange of data.

- ❑ The source and destination are peer LLCs in an asynchronous, balanced datalink connection.
- ❑ The source and destination LLCs control traffic by means of a numbering scheme for the sequential transfer of PDUs. The PDUs for each virtual circuit/connection have independent sequence-numbering schemes.
- ❑ The destination LLC acknowledges data PDUs that the source LLC sends by informing the source LLC of the sequence number it expects next.

LLC Functionality

The LLC sublayer can support multiple logical links concurrently. The LLC protocols generate and interpret command packets or frames called protocol data units (PDUs), which Tables 1-1 and 1-2 describe. The LLC sublayer

- ❑ Initiates and terminates control signal interchange with the XID, TEST, SABME, and DISC PDUs.
- ❑ Organizes data flow with the U, I, and UA PDUs. The level of organization differs between Type 1 and Type 2 operations.
- ❑ Interprets command PDUs it receives, and generates appropriate response PDUs, which differ between Type 1 and Type 2 operations and LLC1 and LLC2 service.
- ❑ Manages error control and recovery with the REJ, RR, RNR, and FRMR PDUs.

Table 1-1 lists Type 1 and Type 2 *command PDUs* and their counterpart *response PDUs*:

Table 1-1. LLC Command PDUs

| Operation Type | Command PDU | Response PDU |
|-----------------------|---|--------------------------------|
| Type 1 | Unnumbered Information (UI) | <i>No response</i> |
| | Exchange Identification (XID) | Exchange Identification (XID) |
| | Test (TEST) | Test (TEST) |
| Type 2 | Information (I) | Information (I) |
| | Receiver Ready (RR) | Receiver Ready (RR) |
| | Receiver Not Ready (RNR) | Receiver Not Ready (RNR) |
| | Reject (REJ) | Reject (REJ) |
| | Set Asynchronous Balanced Mode Extended (SABME) | Unnumbered Acknowledgment (UA) |
| | Disconnect (DISC) | Disconnected Mode (DM) |
| | <i>No command</i> | Frame Reject (FRMR) |

- Type 1 operations do not include definition of an Acknowledgment PDU.
- Type 2 operations do not include a command PDU counterpart for the FRMR response PDU.

Table 1-2 further defines the purpose of each command and response PDU:

Table 1-2. Command Names and Definitions

| Command/ Response | Definition |
|-------------------------------------|---|
| Unnumbered Information (UI) | Transports information to one or more LLCs. Since this is a Type 1 operation, there is no corresponding response/reply PDU. |
| Exchange Identification (XID) | <p>The XID command PDU conveys to the destination LLC:</p> <ul style="list-style-type: none"> □ The types of LLC services the source LLC supports □ The receive window size the source LLC supports per datalink connection (per virtual circuit) <p>The XID response PDU identifies the responding LLC and conveys to the source LLC:</p> <ul style="list-style-type: none"> □ The types of LLC services the destination LLC supports □ The receive window size the destination LLC supports per datalink connection (per virtual circuit) |
| Test (TEST) | <p>The TEST command PDU causes the destination LLC to respond with the TEST response PDU; it performs a loopback test of the LLC-to-LLC transmission paths.</p> <p>The TEST command PDU also initiates the establishment of an LLC1 logical link across a network to another LLC entity.</p> <p>The TEST response PDU confirms the establishment of an LLC1 link.</p> |
| Information (I) | <p>The I command PDU indicates to the destination LLC:</p> <ul style="list-style-type: none"> □ The sequence number for each I command PDU □ The I PDU sequence number the destination LLC expects next <p>The I command PDU also serves as an I response PDU by indicating to the destination LLC that the source LLC has received I PDUs up to a designated number from that destination LLC.</p> |
| Receiver Ready (RR) | The RR command PDU indicates that the source LLC is ready to receive an I PDU. The sending LLC then considers I PDUs sent prior to the RR condition as acknowledged. |

| | |
|---|--|
| Receiver Not Ready (RNR) | The RNR command PDU conveys notification to the destination LLC that the originating LLC is busy and temporarily unable to receive I PDUs. RNRs, combined with RRs, provide a mechanism for flow control between source and destination LLC interfaces. |
| Reject (REJ) | The REJ command PDU conveys a request to peer LLC to retransmit I PDUs, starting with the I PDU REJ command designates. |
| Set Asynchronous Balanced Mode Extended (SABME) | The SABME command PDU establishes an LLC2 connection to the destination LLC. The connection operates in asynchronous balanced mode. If the destination LLC receives from its network layer a DataLink Connect request, the destination LLC replies to the SABME PDU with a UA PDU. If the destination receives from its network layer a DataLink Disconnect request, it does not send a UA PDU. |
| Disconnect (DISC) | The DISC response PDU closes an open connection by initiating a SABME command. The DISC PDU informs the destination LLC that the source LLC is suspending the datalink connection, and the destination LLC should assume the Disconnected Mode. Prior to acting on the DISC command, the destination LLC must confirm the acceptance of the DISC command PDU by sending a UA response PDU. I PDUs sent previously but not acknowledged remain unacknowledged. |
| Unnumbered Acknowledgment (UA) | The UA response PDU acknowledges the receipt and acceptance of a SABME or DISC command PDU relating to a specific datalink connection to be opened or closed, as appropriate for the type of command PDU it has received. |
| Disconnected Mode (DM) | The DM response PDU indicates that the LLC sending the response is logically disconnected from the datalink connection. |
| Frame Reject (FRMR) | The FRMR command PDU reports to the sending LLC that an uncorrectable condition was detected in a received frame. The FRMR PDU includes an information field that indicates the reason for the PDU rejection. The LLC receiving the FRMR PDU <ul style="list-style-type: none"> <input type="checkbox"/> Initiates the appropriate mode setting <input type="checkbox"/> Initiates corrective action by re-initializing transmission in both directions on the datalink connection, using the SABME and DISC command PDUs, as appropriate |

LLC Protocol Data Unit Formats

The LLC protocol data unit (PDU) contains fields for addressing, control, and data, as shown in Figure 1-2. This section provides additional information on each field of the LLC PDU.

| | | | |
|--------|--------|--------------|------------------------------|
| DSAP | SSAP | CTRL | INFORMATION (DATA) |
| 8 Bits | 8 Bits | 8 or 16 Bits | Variable; 8 bits each packet |

Figure 1-2. LLC PDU Structure

If the PDU fails to conform to the model shown in Figure 1-2, that PDU is declared Invalid.

Address Fields

As shown in Figure 1-2, each LLC PDU contains two address fields:

- ❑ The destination service access point (DSAP)
- ❑ The source service access point (SSAP)

SAP Addressing Scheme

All of the 802.2/LLC protocols provide a SAP addressing scheme that lets multiple applications and protocol entities in a single machine share a MAC address. Popular network protocols such as NetWare, NetBIOS, and SNA all have published SAP addresses, but any application can use an SAP to send or receive data via the LLC sublayer. The LLC SAP function sorts frames coming up from the MAC layer and directs them to the appropriate application or protocol software entity. Figure 1-3 illustrates some SAPs published for NetBIOS and SNA.

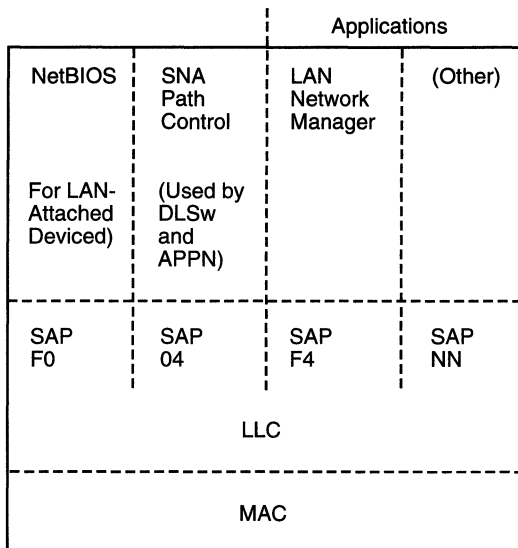


Figure 1-3. SAPs for LLC Clients

SAP addresses can be

- ❑ *Individual*—Designates a single SAP. The individual address is usable as both an SSAP and a DSAP. The individual SAP has an Address Designation bit value of 0.
- ❑ *Group*—Designates a group of DSAPs. The group DSAP has an Address Designation bit value of 1.
- ❑ *Global*—Designates a group consisting of all DSAPs that the underlying MAC SAP addresses actively service. The global DSAP has a value of all 1s.
- ❑ *Null*—Designates the SAP of the underlying MAC sublayer and does not identify any SAP to the network layer or any SAP to an associated layer management function. The Null address is usable as both an SSAP and a DSAP. The Null SAP has a value of all 0s.

Destination SAP (DSAP)

The DSAP Address field identifies one or more SAPs for which the LLC PDU is intended. The DSAP field contains 7 bits of actual address and 1 Address Designation bit to indicate an Individual (I) destination address or a Group (G) destination address, as shown in Figure 1-4.

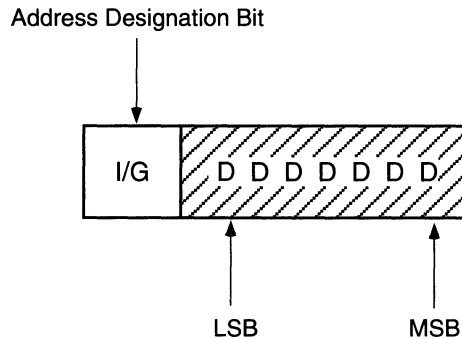


Figure 1-4. DSAP Address Field

- A value of 0 for the Address Designation bit indicates that the PDU is destined for an individual SAP.
- A value of 1 for the Address Designation bit indicates that the PDU is destined for a group-level SAP.

Source SAP (SSAP)

The SSAP Address field identifies the specific service access point that initiated the PDU. The SSAP field contains 7 bits of actual address and 1 Command/Response Identifier bit to indicate that the LLC PDU is a Command (C) PDU or a Response (R) PDU, as shown in Figure 1-5.

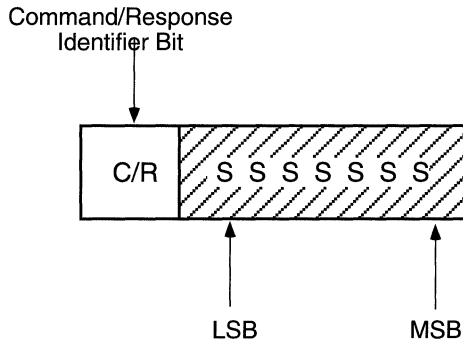


Figure 1-5. SSAP Address Field

- ❑ A value of 0 for the Command/Response Identifier bit indicates that the PDU is a Command PDU.
- ❑ A value of 1 for the Command/Response Identifier bit indicates that the PDU is a Response PDU.

Control Field

The Control field consists of one or two octets that designate command and response functions. It also contains sequence numbers when required.

The format of the Control field of the LLC PDU defines the Type of Operation (Type 1 versus Type 2):

- ❑ Information (an I format PDU)
- ❑ Supervisory (an S format PDU)
- ❑ Unnumbered (a U format PDU)

Figure 1-6 shows the three Control field formats.

| | Bit | | | | | | | | | |
|--|-----|------|---|---|-----|---|---|---|-----|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10-16 |
| I format PDU Information Transfer Commands/Responses | 0 | N(S) | | | | | | | P/F | N(R) |
| S format PDU Supervisory Commands/Responses | 1 | 0 | S | S | X | X | X | X | P/F | N(R) |
| U format PDU Unnumbered Commands/Responses | 1 | 1 | M | M | P/F | M | M | M | | |

- N(S) Transmitter send sequence number
(bit 2 = low-order bit)
- N(R) Transmitter receive sequence number
(bit 10 = low-order bit)
- S Supervisory function bit
- M Modifier function bit
- X Reserved and set to zero
- P/F Poll bit in command PDU transmissions
Final bit in response PDU transmissions

Figure 1-6. LLC PDU Control Field Format

Control Field Formats

Table 1-3 further defines the purpose of the three PDU types, where the specific format in the PDU Control field determines the type.

Table 1-3. PDU Format and Functional Purpose

| Format | Function |
|---------------------------------|---|
| Information Transfer Format (I) | The I format PDU performs a numbered information transfer in Type 2 operation. Except for the UI, TEST, FRMR, and XID command/response PDUs, the I format PDU is the only LLC PDU that can contain an Information field. (Refer to “Information Field” later in this chapter for more details.) |
| Supervisory Format (S) | The S format PDU performs datalink supervisory control functions in Type 2 operation, such as acknowledging I format PDUs, requesting retransmission of I format PDUs, and requesting a temporary suspension of transmission of I format PDUs. |
| Unnumbered Format (U) | The U format PDU is available for Type 1 or Type 2 operations, and provides additional datalink control functions and unsequenced information transfer. |

Table 1-4 further describes the purpose of parameter bits in the PDU Control field.

Table 1-4. Control Field Bits and Functional Purpose

| Bit | Purpose |
|----------------------------------|--|
| Send Sequence Number N(S) Bit | Only I PDUs contain N(S), which is the sequence number of the PDU being transmitted. |
| Receive Sequence Number N(R) Bit | Only I PDUs contain N(R), which is the sequence number of the PDU an LLC expects to receive next on the specified datalink connection. |
| Poll/Final (P/F) Bit | The P/F bit is used to solicit (poll) a response from the addressed LLC. The Final (F) bit is used to indicate the response PDU sent as a result of a soliciting (poll) command. |

Command-Response PDU Format Table

Table 1-5 contains the same information as Table 1-1, but adds a column to identify the format of the individual command/response PDUs.

Table 1-5. PDU Format Types

| Type of Operation | Command PDU | Response PDU | PDU Control-Field Format |
|-------------------|---|--------------------------------|--------------------------|
| Type 1 | Unnumbered Information (UI) | <i>No response</i> | U |
| | Exchange Identification (XID) | Exchange Identification (XID) | U |
| | Test (TEST) | Test (TEST) | U |
| Type 2 | Information (I) | Information (I) | I |
| | Receiver Ready (RR) | Receiver Ready (RR) | S |
| | Receiver Not Ready (RNR) | Receiver Not Ready (RNR) | S |
| | Reject (REJ) | Reject (REJ) | S |
| | Set Asynchronous Balanced Mode Extended (SABME) | Unnumbered Acknowledgment (UA) | U |
| | Disconnect (DISC) | Disconnected Mode (DM) | U |
| | <i>No command</i> | Frame Reject (FRMR) | U |

Information Field

The purpose of the Information field depends on the type of PDU in which it appears, as follows:

- ❑ The Information field of an I format PDU contains only user data.
- ❑ The Information field of a UI command/response PDU also contains only user data.
- ❑ The Information field of a TEST command/response PDU is optional and contains a test pattern used for LLC loopback testing.
- ❑ The Information field of an XID command/response PDU contains
 - An 8-bit XID format identifier field
 - A 16-bit parameter field that is encoded to identify the LLC services supported, plus the maximum receive window size
- ❑ The Information field of an FRMR PDU provides the reason for PDU rejection by an LLC. (The contents of the Information field of an FRMR PDU is beyond the scope of this publication. For more details on the FRMR PDU, refer to the *ISO 8802/IEEE Std 802.2 1989*.)

For More Information about Logical Link Control

The following publications provide technical details on 802.2/Logical Link Control, Token Ring LANs, DLSw, APPN, IBM LAN Network Manager, and LNM Servers:

Institute of Electrical and Electronics Engineers. *International Standard ISO 8802-2/ANSI/IEEE Std 802.2 1989. Information Processing Systems, Local Area Networks, Part 2: Logical Link Control*. Washington, D.C., 1989.

IBM Corporation, SC30-3374-02. *IBM Token Ring Network Architecture Reference*. 3rd ed. September 1989.

IBM Corporation, 31G6962. *IBM LAN Network Manager User's Guide*.

Perlman, Radia. *Interconnections: Bridges and Routers*. Reading, Massachusetts: Addison-Wesley Publishing Company, 1992.

Chapter 2

LLC2 Routed over Frame Relay

This chapter provides information about how LLC2 in a Wellfleet router supports frame relay with Data Link Switching (DLSw), and with Advanced Peer-to-Peer Networking (APPN), based on RFC 1490 and the IBM standard NCP 7.1 and later.

Note: Native SNA over frame relay is another way of describing frame relay with LLC2.

Compatibility with RFC 1490

RFC 1490 describes an encapsulation method for carrying internetworking traffic over a frame relay backbone. It covers both bridging and routing.

Our implementation of LLC goes beyond RFC 1490, which only lets you encapsulate SNA in frame relay. Our LLC complies with the Frame Relay Forum, "Protocol Encapsulation over Frame Relay Implementation Agreements," which defines how routed SNA traffic traverses a frame relay network and adds RFC 1490 support for frame relay to DLSw and APPN.

This feature allows native SNA traffic originating from SDLC, Token Ring, or Ethernet attached devices to communicate over public or private frame relay networks directly with IBM 3745 or 3746 communications controllers. It operates on all Wellfleet routers that include a frame relay interface. Devices can communicate with

intermediate routing nodes or in a single switch configuration similar to a stand-alone frame relay access device (FRAD).

Compatibility with IBM NCP 7.1

LLC2 routed over frame relay is fully compatible with IBM NCP 7.1 and later, and with existing or new IBM equipment. It has passed IBM interoperability testing. You can use it without upgrading your LAN-based downstream physical units (DSPUs) or network type, such as APPN or IP.

DSPUs attached to the router retain full visibility for IBM NetView[®] management. The router passes through all NetView commands for the DSPUs and any Alerts generated by the DSPUs.

You can configure a network without a router at the host (if the host is SNA only) and put the communications controller directly on the frame relay network with LLC2. Some terminals can also connect directly to the frame relay network without a router. Thus frame relay networks save the expense of leased lines. Additional savings accrue because one port on a communications controller can support hundreds of data link connection identifiers (DLCIs).

Bay Networks provides support for NCP 7.1 and higher with software only, eliminating the need for any new hardware or upgrades to existing SNA or router equipment, even if you have a 3745 communications controller.

Figure 2-1 illustrates the connection of an SNA mainframe through a frame relay network in a configuration with multiprotocol traffic to other locations. LLC can also route SDLC and Ethernet traffic, in addition to APPN, Token Ring and IP traffic.

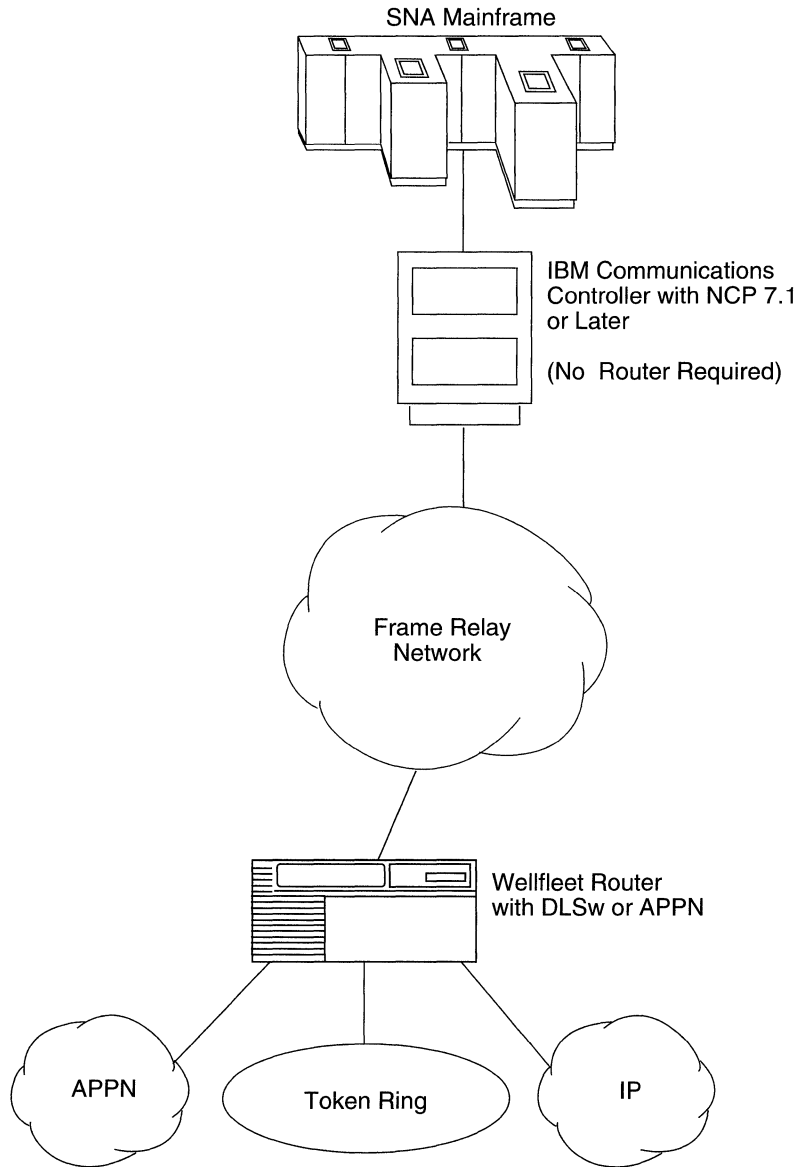


Figure 2-1. Sample Frame Relay Network Using LLC2

FRAD Functionality

Token Ring, Ethernet, and SDLC communicate with a router via FRADs, which convert SDLC to source route bridging over frame relay (also called native SNA over frame relay). The Wellfleet router with DLSw includes a FRAD capability, supporting Token Ring and Ethernet as well as SDLC. The router performs the following actions:

- ❑ Terminates the SDLC session or other session of the Data Link Control layer
- ❑ Strips the header off the SNA packet
- ❑ Runs over Transmission Control Protocol/Internet Protocol (TCP/IP)
- ❑ Establishes a TCP/IP session with the frame relay network
- ❑ Puts an LLC header on the SNA packet
- ❑ Sends packets into the frame relay network

When you use LLC over the source routing bridge, every interface must be configured with both source routing and either DLSw or APPN.

Mapping DLCIs to MAC Addresses

The frame relay network provides a number of permanent virtual circuits (PVCs) that form the basis for connections between stations attached to the same frame relay network. Each virtual circuit is uniquely identified at each frame relay interface by a DLCI.

The system administrator or frame relay provider assigns DLCIs. To communicate with the IBM host, you must associate the MAC address of your DSPU with that DLCI. You can accomplish this task in one of two ways:

- ❑ If you select a virtual mask, the Configuration Manager takes the DLCI address, such as 100 (decimal), and adds a unique mask before it to make a valid MAC address, for example, 400000FF0064. (Decimal 100 is 64 hex.)

- You may prefer to use the physical MAC address. In that case, be aware that if you change your hardware, you have to reconfigure this address.

Some boards require you to use the physical address. These are usually host (remote) boards.

SDLC single switched over LLC does not require address mapping. The SDLC configuration specifies a virtual MAC address to access the host. But you still have to define DLCIs.

Usually you configure only the MAC address of the remote host. (A host may be an IBM mainframe or another node running APPN Network Node software.) You must configure a local MAC address only if the router receives connection requests, which is only done with APPN. Usually only local (end-user) nodes can request a connection, so you configure only the remote host address.

Frame relay allows either group or direct (single) assignment of DLCIs. Group assignment allows many DLCIs per circuit; direct assignment allows only one.

Figure 2-2 illustrates address mapping. The remote hosts have each assigned a DLCI: 100 and 101 (hex numbers 64 and 65).

In the first diagram, the administrator at the workstation has configured remote or destination addresses that include both a host address and a DLCI, so no mapping is necessary at the router.

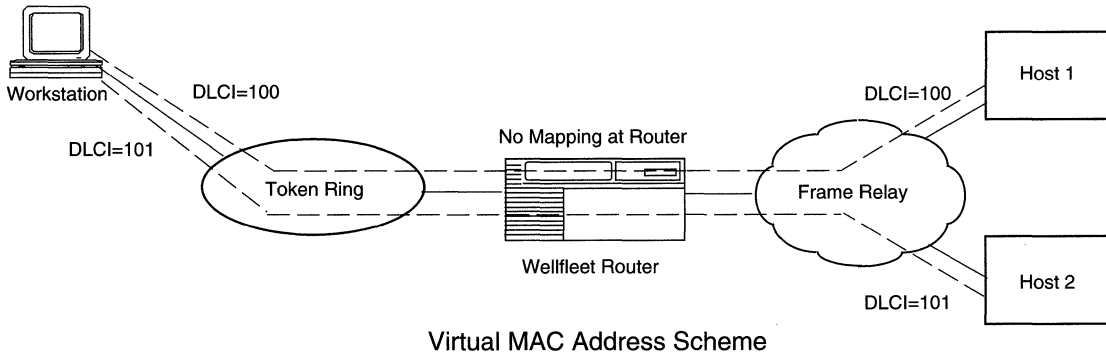
In the second diagram, the administrator at the workstation has configured remote addresses that do not include DLCIs, so the administrator at the router must set up a mapping table, assigning DLCI 100 to the Host 1 address, and DLCI 101 to the Host 2 address.

Mapping DLCIs to MAC Addresses

Configure at Workstation:

Remote Host 1: 400000FF0064 (64 Hex = 100 Decimal)

Remote Host 2: 400000FF0065 (65 Hex = 101 Decimal)



Configure at Workstation:

Remote Host 1: 400000000001

Remote Host 2: 400000000002

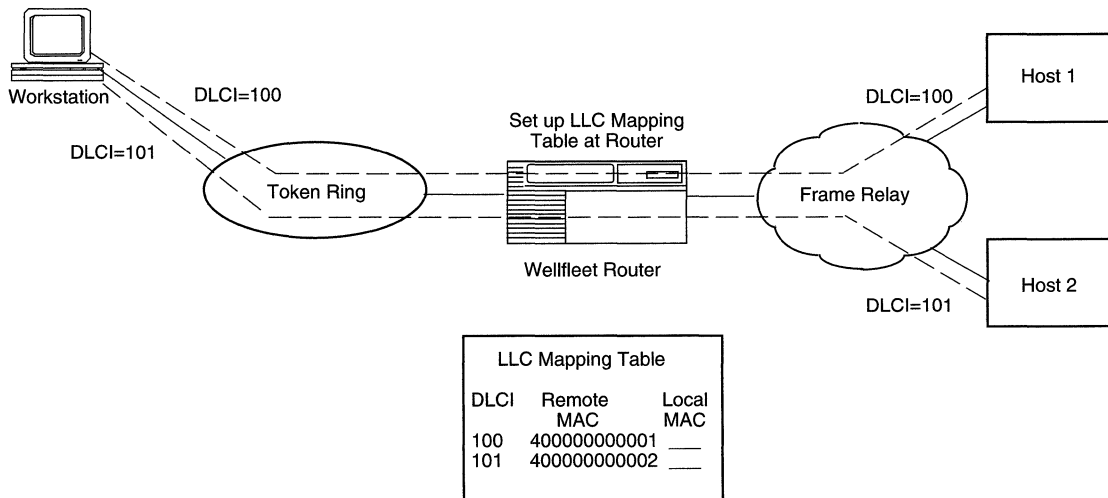


Figure 2-2. Address Mapping

LLC2 over Frame Relay: Routed versus Bridged

Figure 2-3 illustrates SNA over frame relay with source route bridging and SNA over frame relay in native mode, including routing through SDLC and Ethernet. The frame relay link can be part of an alternate routing to the Token Ring or other link. Dotted lines indicate the path of LLC, which is passed through bridging but terminated at the router for more flexible routing.

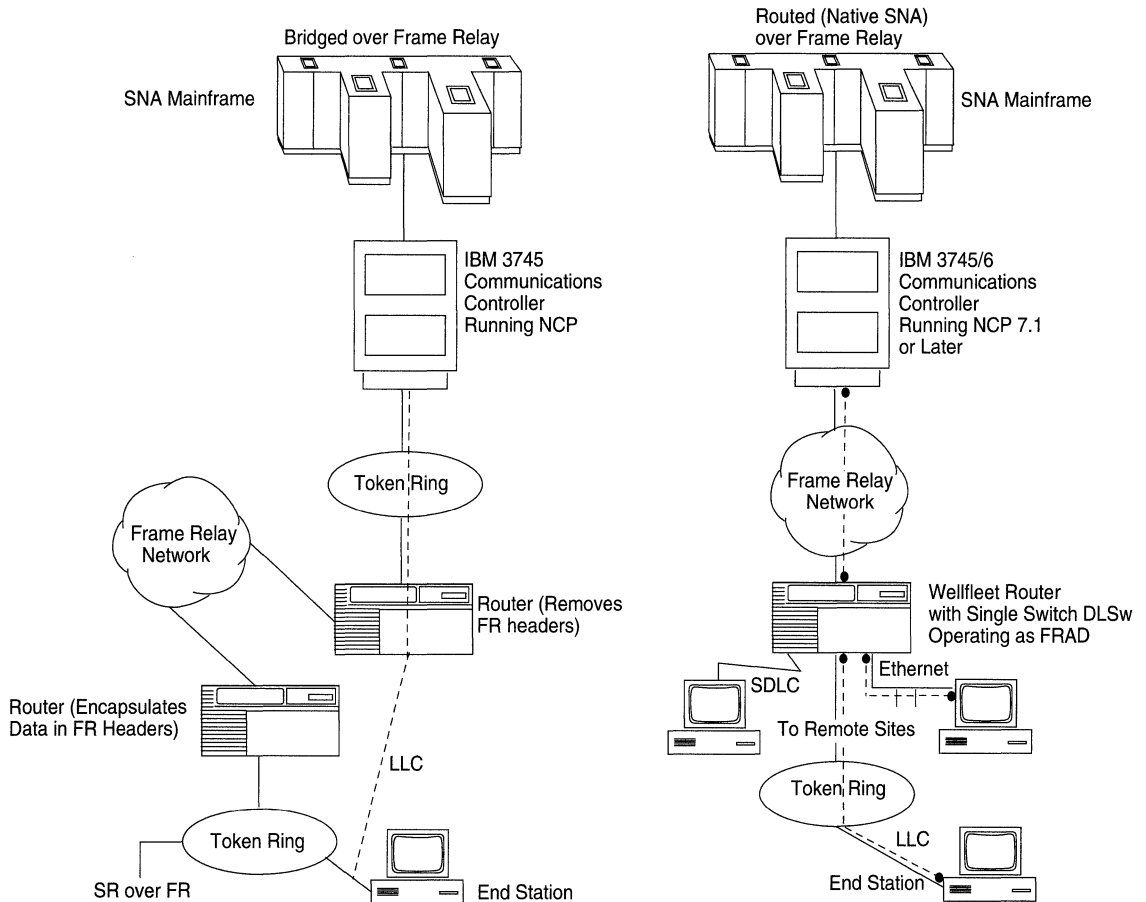


Figure 2-3. RFC 1490 Modes for SNA

For More Information about LLC2 over Frame Relay

The following publications provide technical detail on LLC2 over frame relay.

Bradley, Terry, Brown, Caralyn, and Malis, Andrew G. "Multiprotocol Interconnect over Frame Relay," RFC 1490, Wellfleet Communications and Ascom Timplex, Inc., July 1993.

Rao Cherukuri, ed. "Multiprotocol Encapsulation Implementation Agreement," FRF.3, IBM.

Chapter 3

Editing LLC Parameters

This chapter provides information on how you can edit, or customize, the parameters for the LLC interfaces that you configure on the router.

For each LLC parameter that you configure, this chapter gives the default setting, all valid setting options, the parameter function, instructions for setting the parameter, and the Management Information Base (MIB) object ID.

The Technician Interface allows you to modify parameters by issuing **set** and **commit** commands with the MIB object ID. This process is equivalent to modifying parameters using Site Manager. For more information about using the Technician Interface to access the MIB, refer to *Using Technician Interface Software*.

Note: You must have already configured at least one LLC interface on the router to edit LLC parameters. If you have *not* yet configured an LLC interface, or want to add additional LLC interfaces, see *Configuring Wellfleet Routers* for instructions.

- ❑ You can add only one LLC2 interface per physical circuit with native mode and source route bridging; with routed frame relay, you can add more, depending on your system's resources.

When you configure an LLC2 interface on an 802.x LAN physical (LAN attachment) circuit, you supply information required by the MAC and LLC sublayers.

Configuring LLC Parameters

To access and edit LLC parameters, begin from the Configuration Manager window, and select the Protocols→LLC2 path to the LLC2 options submenu (Figure 3-1).

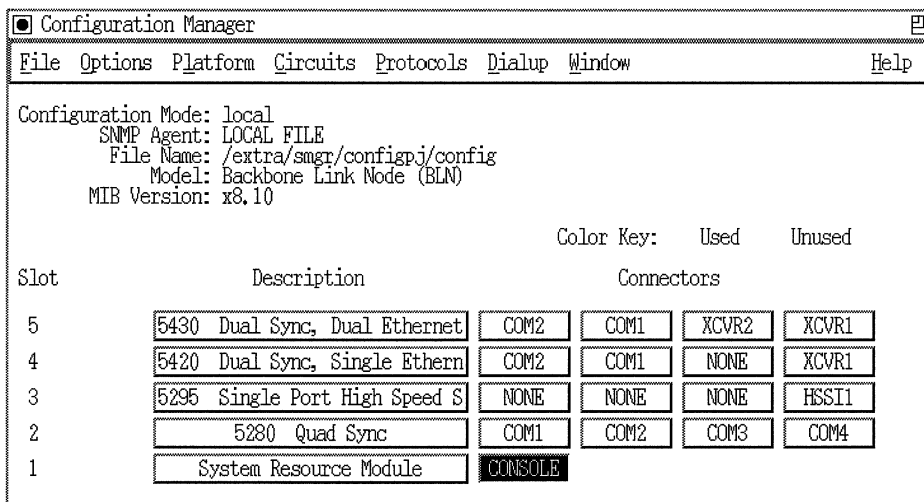


Figure 3-1. Configuration Manager Window

Alternatively, you can access LLC parameter windows by highlighting a circuit in the Configuration Manager window, and then selecting Edit Circuit to invoke the Circuit Definition window. This window is described in *Configuring Wellfleet Routers*. Use the LLC Circuit menu to access LLC parameters.

You can select either LLC1 Circuit or LLC2 Circuit from either menu. If you select LLC1 from the menu, the screen displays a list of interfaces that use LLC1 only (such as Source Routing Bridge). If you select LLC2, the screen displays a list of interfaces that require the services of LLC2 (such as DLSw and the LNM Servers).

Editing LLC2 Global Parameters

Only the Enable parameter is visible at the global (router) level for LLC. To change the setting of the Enable parameter, begin at the Configuration Manager window (Figure 3-1) and proceed as follows:

1. Select Protocols→LLC2→Edit Global.

The LLC2 Global Parameters window appears (Figure 3-2).

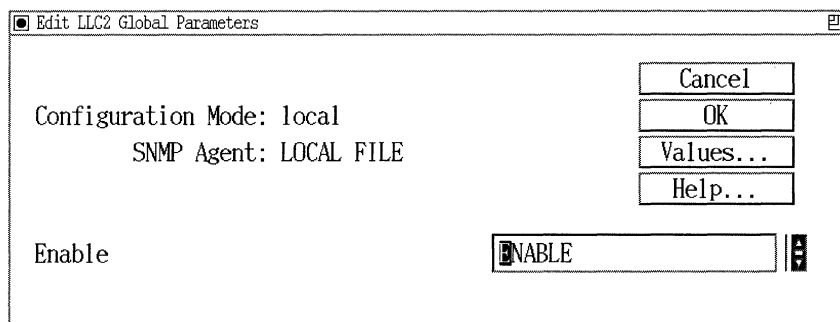


Figure 3-2. LLC2 Global Parameters Window

2. Change the Enable parameter to Disable if necessary. (Refer to the description of the Enable parameter, which follows this procedure.)
3. Click OK to save your change and exit the Global Parameters window.

| | |
|-------------------|--|
| Parameter: | Enable |
| Default: | Enable |
| Options: | Enable Disable |
| Function: | <p>Globally enables or disables the system software mechanisms that, in turn, allow (or do not allow) users to add an LLC2 interface to any 802.x LAN physical circuit. You can configure only one LLC2 interface per physical LAN circuit. Other significant actions the system software performs when you choose a setting for the LLC Enable parameter include</p> <p><i>Disable</i> – Forces every LLC2 interface on this node into the inoperative (down) state.</p> <p><i>Enable</i> – Reinitializes every LLC2 interface on this node, with each interface maintaining the most recent setting of its own interface Enable parameter. The actual operating state of each interface further depends on the current up/down state of the associated physical circuit.</p> |
| Instructions: | <p>Select Disable to force every LLC2 interface existing on this node into the inoperative (down) state.</p> <p>Select Enable only when an existing LLC2 interface is in the Disabled state.</p> |

Editing LLC2 Interface Parameters

Use the Configuration Manager to access and customize LLC2 interface parameters to optimize LLC operation for specific clients, such as DLSw and LAN Network Manager. These and other LLC2 clients may be configured on the same physical circuits and, therefore, share the same LLC interfaces. In such cases, you can determine a compromise profile of LLC2 parameter settings that satisfy the combined parameter value recommendations of the LLC2 clients.

To access and edit LLC2 interface parameters, begin at the Configuration Manager window and proceed as follows:

1. Select Protocols→LLC2→Interfaces to display the LLC2 Interface Configuration window (Figure 3-3).

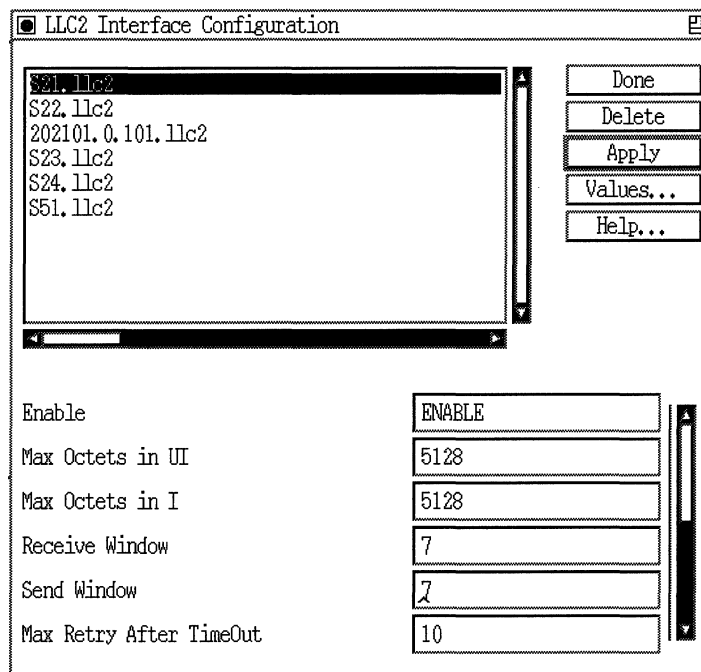


Figure 3-3. LLC2 Interface Configuration Window

Use the scroll bar on the lower right of your screen to view more parameters, including Frame Relay Virtual MAC Address Mask (Figure 3-4):

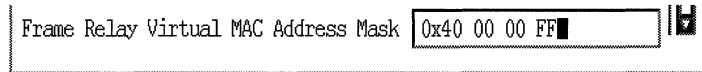


Figure 3-4. LLC2 Interface Configuration Window (Bottom)

Note: Alternatively, from the Circuit Definition window, select Group Protocols→Edit LLC2→Interface to display the Edit LLC2 Interface window. Both windows have the same parameters. The Edit LLC2 Interface window shows only the circuit you have highlighted from the Circuit Definition window.

The LLC2 Interface Configuration window contains the following information fields:

- The upper-left quarter contains a window that lists all LLC2 interfaces configured on physical circuits belonging to this node. This list does not appear in the Edit LLC2 Interface Parameters window.
 - The lower-left quarter lists parameters you can alter to suit your network configuration requirements.
 - The lower-right quarter shows the current interface parameter values.
2. Select or highlight the interface you want to customize. The values in effect for that interface appear (lower right) in the parameter value windows. (Click on Values to display the valid range of values for any parameter.)
 3. Edit those parameters you want to change, using the descriptions following this procedure as a guide.
 4. Click on Apply to save your changes.
 5. Click on Done to exit. You return to the original window.

LLC2 Interface Configuration Parameters

The LLC2 Interface Configuration window and Edit LLC2 Interface window include the following entries:

| | |
|-------------------|--|
| Parameter: | Enable |
| Default: | Enable |
| Options: | Enable Disable |
| Function: | Enables or disables the LLC2 interface added previously to this LAN physical circuit. |
| Instructions: | Select Enable if you disabled this LLC2 interface previously and now want to re-enable the interface on its associated LAN physical circuit. Select Disable if you want to disable this LLC2 interface on its associated LAN physical circuit. |
| MIB Object ID: | 1.3.6.1.4.1.18.3.5.1.6.2.1.2 |
| | |
| Parameter: | Max Octets in UI |
| Default: | 5128 (octets) |
| Range: | 1 to 5128 |
| Function: | Specifies, in octets, the maximum size of an Unnumbered Information (UI) PDU this LLC2 interface sends or receives. |
| Instructions: | Enter a valid value, from 1 octet (8 bits) to 5128 octets. Choose a value that is appropriate for the applications LLC2 supports. The LLC sublayer imposes no restrictions. However, all MAC sublayers must be capable of accommodating UI PDUs with Information fields up to 128 octets in length. |
| MIB Object ID: | 1.3.6.1.4.1.18.3.5.1.6.2.1.6 |

Parameter: Max Octets in I

Default: 5128 (octets)

Range: 1 to 5128

Function: Specifies, in octets, the size of an Information (I) PDU this LLC2 interface sends or receives.

Instructions: Enter any valid value, from 1 octet (8 bits) to 5128 octets. Choose a value that is appropriate for the applications LLC2 supports.

Refer to the various MAC descriptions to determine the precise value you should select for the given medium. All MACs must be capable of accommodating I format PDUs with Information fields up to 5128 octets in length.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.9

Parameter: Receive Window

Default: 7 (PDUs)

Range: 1 to 127

Function: Specifies a maximum number of unacknowledged Information PDUs that LLC can receive. LLC drops frames it receives outside this window and recovers them via timers.

Instructions: Enter any valid value from 1 to 127 LLC PDUs. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.22

Parameter: Send Window

Default: 7 (PDUs)

Range: 1 to 127

Function: Specifies a maximum number of Information PDUs that can be outstanding at any given time. The value serves as a default Send window size when no other size has been set by an XID information-exchange procedure.

Instructions: Enter any valid value from 1 to 127 LLC PDUs. Choose a value that is appropriate for the requirements of the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.23

Parameter: Max Retry After TimeOut

Default: 10 (number of retransmissions)

Range: 1 to 10

Function: Specifies the maximum number of times that a PDU can be sent following expiration of the Ack Timer for Xmit or the Reject timer.

Instructions: Enter a valid value, from 1 to 10 retransmissions. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.7

Parameter: Ack Timer for Xmt

Default: 1 (second)

Range: 1 to 15

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive

- An acknowledgment for one or more outstanding I-PDUs sent during the timer window
- A response PDU for an unnumbered command PDU sent during the timer window
- A response PDU with the F bit set

Instructions: Enter a valid value, from 1 to 15 seconds. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.13

Parameter: Reject Timer

Default: 1 (second)

Range: 1 to 30

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive a reply to a REJ PDU (Frame Reject response PDU).

If the Reject timer expires and no reply has been received for the REJ PDU sent by the local LLC, the local Reject timer restarts, and LLC retransmits the REJ PDU. (The total number of times that a specific REJ PDU can be retransmitted depends on the setting of the Max Retry After TimeOut parameter.)

Instructions: Enter any valid value, from 1 to 30 seconds. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.14

Parameter: Busy Timer

Default: 60 (seconds)

Range: 1 to 60

Function: Specifies the amount of time, in seconds, during which the local LLC waits for an indication from a remote LLC that it is ready to receive PDUs from the local LLC. (The busy condition at the remote LLC has been cleared.)

If the remote Busy timer expires and no indication has been received that the remote busy condition has been cleared, the remote Busy timer restarts and LLC again waits, either for the remote busy cleared indication or for expiration of the remote Busy timer interval.

Instructions: Enter any valid value, from 1 to 60 seconds. Choose a value that is appropriate for the applications LLC2 supports.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.15

Parameter: Inactivity Timer

Default: 30 (seconds)

Range: 1 to 30

Function: Specifies the amount of time, in seconds, during which the local LLC expects to receive a PDU soliciting the status of the remote.

If the Inactivity timer expires, the local LLC sends an S format PDU with the P bit set to solicit the status of the remote. It initiates the Ack timer to handle retries.

Instructions: Enter any valid value from 1 to 30 seconds.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.18

Parameter: Max Links

Default: 255 (logical connections)

Range: 4 to 5000

Function: Specifies the maximum number of logically independent, end-to-end connections the local LLC2 interface can allocate.

Instructions: Enter any valid number of end-to-end connections, from 4 to 5000. Choose a value that is appropriate for the aggregate performance requirements of all applications this LLC2 interface supports. Be aware that higher settings reduce the amount of available memory.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.20

Parameter: Frame Relay Virtual MAC Address Mask

Default: 0x 400000FF

Range: Octal string

Function: This mask specifies the upper 2 to 4 bytes of a virtual destination MAC address. The lower remaining bytes specify the DLCI to be used.

Instructions: Select a mask that is unique within your network. The mask should be the upper 2 to 4 bytes of a standard MSB Token Ring MAC address.

MIB Object ID: 1.3.6.1.4.1.18.3.5.1.6.2.1.26

| | |
|-------------------|---|
| Parameter: | Virtual Ring Number |
| Default: | None |
| Options: | 0x1 to 0xff |
| Function: | Indicates a ring number for LLC to use if you configure APPN with source route bridging. The ring number must be unique in the SRB network. |
| Instructions: | Select a hexadecimal number from 0x1 to 0xff that is unique in your SRB network. |
| MIB Object ID: | 1.3.6.1.4.1.18.3.5.1.6.2.1.25 |

Deleting an LLC2 Interface

To delete an LLC2 interface from its associated physical circuit:

1. From the LLC2 Interface Configuration window (see Figure 3-3), select the LLC2 interface you want to delete from the node configuration.
2. Click Delete.

The system software deletes the LLC2 entry you selected, and the entry disappears from the list of LLC2 interfaces in the window.

Editing LLC2 Inbound Traffic Filters

Inbound traffic filters operate and are configured in a standardized way on Wellfleet routers. Inbound traffic filters are in a category separate from route filters and outbound filters.

For descriptive and procedural information on inbound traffic filters for LLC and any other protocols that support this capability, refer to *Configuring Filter Options on Wellfleet Routers*.

Deleting LLC2 from the Node

You can delete all LLC2 interfaces from the node in two steps.

To delete LLC2, begin at the Configuration Manager window and complete the following steps:

1. Select Protocols→LLC2→Delete LLC2. A confirmation window appears.
2. Select OK. The Configuration Manager window appears. LLC2 interfaces are no longer configured on the router.

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