Configuring LLC2 and SDLC Parameters

The Logical Link Control, type 2 (LLC2) and Synchronous Data Link Control (SDLC) protocols provide data link-level support for higher-level network protocols and features such as SDLLC and remote source-route bridging (RSRB) with local acknowledgment. The features that are affected by LLC2 parameter settings are listed in the next section, "LLC2." The features that require SDLC configuration and use SDLC parameters are listed in the section "SDLC" later in this chapter.

LLC2 and SDLC package data in frames. LLC2 and SDLC stations require acknowledgments from receiving stations after a set amount of frames have been sent before sending further data. The tasks described in this chapter modify default settings regarding the control field of the data frames. By modifying the control field parameters, you can determine the amount of acknowledgments sent for frames received and the level of polling used to determine available stations. In this manner, you can set the amount of resources used for frame checking and optimize the network load.

SDLC is used as the primary Systems Network Architecture (SNA) link-layer protocol for wide-area network (WAN) links. SDLC defines two types of network nodes: primary and secondary. Primary nodes poll secondary nodes in a predetermined order. Secondaries then transmit if they have outgoing data. When configured as primary and secondary nodes, our routers are established as SDLC stations.

You do not need to configure LLC2 because it is already enabled on Token Ring interfaces. You can change the default settings of LLC2 parameters as needed. To support SDLC, you need to configure the router as a primary or secondary SDLC station. You also can change default settings on any of the SDLC parameters listed. Configuration examples for both LLC2 and SDLC are given at the end of the chapter.

For a complete description of the commands mentioned in this chapter, refer to the "LLC2 and SDLC Commands" chapter in the *Router Products Command Reference* publication. For historical background and a technical overview of LLC2 and SDLC, see the *Internetworking Technology Overview* publication.

LLC2

The following features use LLC services:

- Local acknowledgment for RSRB

  This feature is used in our implementation of RSRB as described in the chapter "Configuring Source-Route Bridging."

  Because local-area networks (LANs) are now connected through RSRB and wide-area network (WAN) backbones, the delays that occur are longer than LLC2 allows for bidirectional communication between hosts. Our local acknowledgment feature addresses the problem of delays, retransmissions, and loss of user sessions.

- IBM LAN Network Manager (LNM) support

  Routers using 4- or 16-Mbps Token Ring interfaces configured for SRB support LNM and provide all IBM Bridge Program functions. With LNM, a router appears as an IBM source-route bridge, and can manage or monitor any connected Token Ring interface.

  LNM support is described in the chapter "Configuring Source-Route Bridging."

- SDLLC media translation

  The SDLLC feature provides media translation between the serial lines running SDLC and Token Rings running LLC2. SDLLC consolidates the IBM SNA networks running SDLC into a LAN-based, multiprotocol, multimedia backbone network.

  SDLLC is described in the chapter "Configuring SDLLC."

- ISO Connection-Mode Network Services (CMNS)

  Our CMNS implementation runs X.25 packets over LLC2 so that X.25 can be extended to Ethernet, FDDI, and Token Ring media.

LLC2 Configuration Task List

Since LLC2 is already enabled on Token Rings, you do not need to enable it on the router. However, you can complete the tasks in the following sections to enhance LLC2 performance:

- Control Transmission of I-Frames
- Establish Polling Level
- Set Up XID Transmissions

To determine which LLC2 parameters need adjustment, you can perform the following task:

- Monitor LLC2 Stations

See the end of this chapter for an LLC2 configuration example

Control Transmission of I-Frames

You can control the number of information-frames (I-frames) and acknowledgments sent on the LLC2 network by completing the tasks described in THE following sectionS.

- Set the Maximum Number of I-Frames Received before Sending an Acknowledgment
- Set the Maximum Delay for Acknowledgments
- Set the Maximum Number of I-Frames Sent before Requiring Acknowledgment
- Set the Number of Retries Allowed
- Set the Time for Resending I-Frames
- Set the Time for Resending Rejected Frames

Set the Maximum Number of I-Frames Received before Sending an Acknowledgment

You can reduce overhead on the network by increasing the maximum number of frames the router can receive at once before it must send the sender an acknowledgment. To do so, perform the following task in interface configuration mode:

Task	Command
Set maximum number of I-frames the router can receive before it sends an acknowledgment.	**llc2 ack-max** *packet-count*

Set the Maximum Delay for Acknowledgments

You can ensure timely receipt of acknowledgments so that transmission of data is not delayed. Even if the maximum amount of frames has not been reached, you can set a timer forcing the router to send an acknowledgment and reset the maximum amount counter to 0.

To set the maximum delay time, perform the following task in interface configuration mode:

Task	Command
Set the I-frame acknowledgment time.	**llc2 ack-delay-time** *milliseconds*

Set the Maximum Number of I-Frames Sent before Requiring Acknowledgment

You can set the maximum number of I-frames that the router sends to an LLC2 station before the router requires an acknowledgment from the receiving end. A higher value reduces overhead on the network. Ensure that the receiving LLC2 station can handle the number of frames set by this value.

To set this value, perform the following task in interface configuration mode:

Task	Command
Set the maximum number of I-frames the router sends before it requires an acknowledgment.	**llc2 local-window** *packet-count*

Set the Number of Retries Allowed

You can set the number of times the router will resend a frame when the receiving station does not acknowledge the frame. Once this value is reached, the session is dropped. This value also is used to determine how often the router will retry polling a busy station. This task should be done in conjunction with the task for setting the time for resending I-frames (described next). Performing them together ensures that frame transmission is monitored at a reasonable level, while limiting the number of unsuccessful repeated tries.

To set the number of retries, perform the following task in interface configuration mode:

Task	Command
Establish number of times the router will resend unacknowledged frames or try polling a busy station.	**llc2 n2** *retry-count*

Set the Time for Resending I-Frames

You can set the amount of time the router will wait before resending unacknowledged I-frames. This interval is called the T1 time. Perform this task in conjunction with the tasks of setting the number of retries and setting the transit poll-frame timer. Performing these tasks in conjunction with each other provides a balance of network monitoring and performance.

To set the T1 time, perform the following task in interface configuration mode:

Task	Command
Control how long the router waits for an acknowledgment of transmitted I-frames.	**llc2 t1-time** *milliseconds*

Note Ensure that you allow enough time to account for the round trip between the router and its LLC2-speaking stations. Under heavy network loading conditions, resending I-frames every 3000 milliseconds is appropriate.

Set the Time for Resending Rejected Frames

You can set the amount of time that the router will wait for an expected frame before sending a reject command (REJ). Typically, when an LLC2 station sends an I-frame, a sequence number is included in the frame. The LLC2 station that receives these frames will expect to receive them in order. If it does not, it can reject a frame and indicate which frame it is expecting to receive instead. If the correct frame is not sent to the router before the reject timer expires, the router sends a REJ to the remote station and disconnects the LLC2 session.

To set the reject timer, perform the following task in interface configuration mode:

Task	Command
Set the time a router waits for a resend of a rejected frame before sending a reject command to the remote station.	**llc2 trej-time** *milliseconds*

Establish Polling Level

You can control the amount of polling that occurs on the LLC2 network by completing the tasks described in the following sections:

- Set the Polling Frequency
- Set the Polling Interval
- Set the Transmit-Poll-Frame Timer

Set the Polling Frequency

You can set the optimum interval of time after which the router sends Receiver Readys, or frames that tell other LLC2 stations that the router is available. These polls occur during periods of idle time on the network.

To set polling frequency, perform the following task in interface configuration mode:

Task	Command
Control the polling frequency during idle traffic.	**llc2 idle-time** *milliseconds*

Set the Polling Interval

The amount of time the router waits until repolling a busy station can also be set. Perform this task in conjunction with setting the number of retries. Typically, you do not need to perform this task unless an LLC2 station has unusually long busy periods before clearing the busy state. In this case, you should increase the value so that the station does not time out.

To set the polling interval, perform the following task in interface configuration mode:

Task	Command
Set the amount of time the router will wait before repolling a busy station.	**llc2 tbusy-time** *milliseconds*

Set the Transmit-Poll-Frame Timer

When sending a command that must receive a response, a poll bit is sent in the frame. Once the router sends the poll bit, it cannot send any other frame with the poll bit set until the receiver replies to that poll frame with a frame containing a final bit set. When the timer expires, the router assumes that it can send another frame with a poll bit.

Set the transmit-poll-frame timer to reduce problems with receiving stations that are faulty and cannot send the frame with the final bit set by performing the following task in interface configuration mode:

Task	Command
Set the amount of time the router waits for a final response to a poll frame before the resending it.	**llc2 tpf-time** *milliseconds*

This value should be larger than the T1 time. The T1 time determines how long the router waits for receipt of an acknowledgment before sending the next set of frames. See the section "Set the Time for Resending I-Frames" earlier in this chapter for more information.

Set Up XID Transmissions

You can control the number of frames used for identification on the LLC2 network by completing the tasks described in the following sections:

- Set the Frequency of XID Transmissions
- Set the Time for XID Retries

Set the Frequency of XID Transmissions

Exchange of identification (XID) frames identify LLC2 stations at a higher level than the MAC address and contain information about the configuration of the stations. You can set how often the router sends an XID frame by performing the following task in interface configuration mode:

Task	Command
Set the frequency of XID transmissions.	**llc2 xid-neg-val-time** *milliseconds*

⚠️ **Caution**   Do not change the value unless requested by your technical support representative.

Set the Time for XID Retries

You can set the amount of time the router waits for a reply to the XID frames it sends to remote stations. The value should be larger than the T1 time, which indicates how long the router waits for an acknowledgment before dropping the session.

To set the time for XID retries, perform the following task in interface configuration mode:

Task	Command
Set how long the router waits for a reply to the XID frames it sends to remote stations.	**llc2 xid-retry-time** *milliseconds*

Monitor LLC2 Stations

You can display the configuration of LLC2 stations to determine which LLC2 parameters need adjustment. Perform the following task in EXEC mode:

Task	Command
Display the configuration of LLC2 stations.	**show llc2**

SDLC

The SDLC tasks described in this section configure the router as an SDLC station. This is in contrast to a router configured for SDLC Transport, where the router is not an SDLC station, but passes SDLC frames between two SDLC stations across a mixed-media, multiprotocol environment.

The tasks described in this section support the following features:

- Frame Relay access support

  Our Frame Relay access support feature enables a router to function as a Frame Relay Access Device (FRAD) for SDLC, Token Ring, and Ethernet-attached devices over a Frame Relay Boundary Network Node (BNN) link.

  Frame Relay access support is described in the chapter "Configuring SNA Frame Relay Access Support."

- SDLLC media translation

  Our SDLLC feature provides media translation between the serial lines running SDLC and Token Rings running LLC2. SDLLC consolidates the IBM SNA networks running SDLC into a LAN-based, multiprotocol, multimedia backbone network.

  SDLLC is described in the chapter "Configuring SDLLC."

- SDLC local acknowledgment

  SDLC local acknowledgment is used with SDLC serial tunnel (STUN). The Transmission Control Protocol/Internet Protocol (TCP/IP) must be enabled. With local acknowledgment, STUN SDLC connections can be terminated locally at the router, eliminating the need for acknowledgments to be sent across a WAN.

  SDLC local acknowledgment is described in the chapter "Configuring STUN."

SDLC Configuration Task List

Perform the tasks in the following sections to enable the router as an SDLC station. The first task is required; you accomplish it with the appropriate set of commands for your network needs. The remaining tasks are optional; you can use them as necessary to enhance SDLC performance.

- Enable the Router as a Primary or Secondary SDLC Station
- Enable SDLC Two-Way Simultaneous Mode
- Determine Use of Frame Rejects
- Set SDLC Timer and Retry Counts
- Set SDLC Frame and Window Sizes
- Control the Buffer Size
- Control Polling of Secondary Stations
- Configure an SDLC Interface for Half-Duplex Mode
- Specify the XID Value
- Set the Largest SDLC I-Frame Size

To determine which SDLC parameters need adjustment, you can perform the following task:

- Monitor SDLC Stations

See the end of this chapter for SDLC configuration examples.

Enable the Router as a Primary or Secondary SDLC Station

SDLC defines two types of network nodes: primary and secondary. Primary nodes poll secondary nodes in a predetermined order. Secondaries then transmit if they have outgoing data. When configured as primary and secondary nodes, our routers are established as SDLC stations.

Depending on your particular network needs, perform the tasks in one of the following sections to enable the router as an SDLC station:

- Establish an SDLC Station for Frame Relay Access Support
- Establish an SDLC Station for SDLLC Media Translation

Establish an SDLC Station for Frame Relay Access Support

You can establish the router to be any of the following:

- A primary SDLC station
- A secondary SDLC station
- Either primary or secondary, depending on the role of the end stations or on XID negotiations
- A primary Node Type 2.1 (NT2.1) node

To establish routers as SDLC stations when you plan to configure Frame Relay access support, complete the following tasks in interface configuration mode:

Task	Command
Set the encapsulation type of the serial interface to SDLC.	**encapsulation sdlc**
Establish the role of the interface.	**sdlc role** {**none**	**primary**	**secondary**	**prim-xid-poll**}

If the interface does not play a role, the router can be either primary or secondary, depending on the end stations. The SDLC end station must be configured as negotiable or primary NT2.1. When the end stations are configured as physical unit (PU) type 2, you can set the role of the interface to primary or secondary. When the end station is configured as secondary NT2.1, you must set the role of the interface to poll the primary XID.

Note   Currently, Frame Relay access support does not support the secondary role.

Establish an SDLC Station for DLSw+ Support

To establish routers as SDLC stations when you plan to configure our DLSw+ feature, complete the following tasks in interface configuration mode:

Task	Command
Set the encapsulation type of the serial interface to SDLC.	**encapsulation sdlc**
Establish the role of the interface.	**sdlc role** {**none**	**primary**	**secondary**	**prim-xid-poll**}
Configure a MAC address for the serial interface.	**sdlc vmac** *mac-address*[1]

Task	Command
Specify the destination address with which an LLC session is established for the SDLC station.	**sdlc partner** *mac-address sdlc-address* [**inbound**]
Attach SDLC addresses to DLSw+	**sdlc dlsw** *sdlc-address...sdlc-address*

1. The last byte of the MAC address must be 00.

For additional DLSw+ configuration tasks, refer to the chapter "Configuring DLSw+".

Establish an SDLC Station for SDLLC Media Translation

To establish routers as SDLC stations when you plan to configure our SDLLC media translation feature, complete tasks in the order listed in the following table. One serial interface can have two or more secondary stations attached to it through a modem sharing device (MSD). Each secondary station address must be assigned to the primary station. You must perform the following tasks in interface configuration mode for the serial interface:

	Task	Command
Step 1	Establish a router as the primary SDLC station on the serial line.	**encapsulation sdlc-primary**
Step 2	Establish other routers as secondary SDLC stations.	**encapsulation sdlc-secondary**
Step 3	Assign secondary stations to a primary station.	**sdlc address** *hexbyte* [*echo*]

Use the **show interfaces** command to list the configuration of the SDLC serial lines. Use the **no sdlc address** command to remove a secondary address assignment. Addresses are hexadecimal (base 16).

Enable SDLC Two-Way Simultaneous Mode

SDLC two-way simultaneous mode allows a primary SDLC link station to achieve better utilization of a full-duplex serial line. With two-way simultaneous mode, the primary link station can send data to one secondary link station while there is a poll outstanding. Two-way simultaneous mode works on the SDLC primary side only. On a secondary link station, it responds to a poll from the primary station.

SDLC two-way simultaneous mode operates in either a multidrop link environment or point-to-point link environment.

In a multidrop link environment, a two-way simultaneous primary station is able to poll a secondary station and receive data from the station, and send data (I-frames) to other secondary stations.

In a point-to-point link environment, a two-way simultaneous primary station can send data (I-frames) to the secondary station although there is a poll outstanding, as long as the window limit is not reached.

To enable two-way simultaneous mode, perform either of the following tasks in interface configuration mode:

Task	Command
Enable the primary station to send data to and receive data from the polled secondary station.	**sdlc simultaneous full-datamode**
Prohibit the primary stations from sending data to the polled secondary station.	**sdlc simultaneous half-datamode**

Determine Use of Frame Rejects

You can specify that a secondary station does not send Frame Rejects (FRMRs), or reject commands indicating frame errors. If you do so, the router will drop an SDLC connection if it receives an error from the secondary station. To determine handling of FRMRs, perform the following task in interface configuration mode:

Task	Command
Specify that this secondary station does not support Frame Rejects (FRMRs).	**sdlc frmr-disable**

To specify that the secondary station does support FRMRs, use the **no sdlc frmr-disable** command.

Set SDLC Timer and Retry Counts

When an SDLC station sends a frame, it waits for an acknowledgment from the receiver saying that this frame has been received. You can modify the time the router allows for an acknowledgment before resending the frame. You can also determine the number of times that a router resends a frame before terminating the SDLC session. By controlling these values, you can reduce network overhead while continuing to check transmission of frames.

To set the SDLC timer and retry counts, perform one or both of the following tasks in interface configuration mode:

Task	Command
Control the amount of time the router waits for a reply.	**sdlc t1** *milliseconds*
Set the number of times a router will retry an operation that has timed out.	**sdlc n2** *retry-count*

Set SDLC Frame and Window Sizes

You can set the maximum size of an incoming frame and set the maximum number of I-frames (or window size) a router will receive before sending an acknowledgment to the sender. By using higher values, you can reduce network overhead.

To set SDLC frame and window sizes, perform any of the following tasks in interface configuration mode:

Task	Command
Set the maximum size of an incoming frame.	**sdlc n1** *bit-count*
Set the local window size of the router.	**sdlc k** *window-size*
Set how many times a primary station will poll a secondary station.	**sdlc poll-limit-value** *count*

Control the Buffer Size

You can control the router's buffer size. The buffer holds data that is pending transmission to a remote SDLC station. This task is particularly useful in the case of the SDLLC media translator, which allows an LLC2-speaking SNA station on a Token Ring to communicate with an SDLC-speaking SNA station on a serial link. The frame sizes and window sizes on Token Rings are often much larger than those acceptable for serial links, and serial links are often slower than Token Rings.

To control backlogs that can occur during periods of high data transfer from the Token Ring to the serial line, perform the following task in interface configuration mode on a per-address basis:

Task	Command
Set the maximum number of packets held in queue before transmitting.	**sdlc holdq** *address queue-size*

Control Polling of Secondary Stations

You can control the intervals at which the router polls secondary stations, the length of time a primary station can send data to a secondary station, and how often the router polls one secondary station before moving on to the next station.

Keep the following points in mind when performing these tasks:

- Secondary stations cannot transmit data until they are polled by a primary station. Increasing the poll-pause timer increases the response time of the secondary stations. Decreasing the timer can flood the serial link with unneeded polls and require secondary stations to spend wasted CPU time processing them.

- Increasing the value of the poll limit allows for smoother transactions between a primary station and a single secondary station but can delay polling of other secondary stations.

To control polling of secondary stations, perform one or more of the following tasks in interface configuration mode:

Task	Command
Set the length of time the router pauses between sending each poll frame to secondary stations on a single serial interface.	**sdlc poll-pause-timer** *milliseconds*
Set how many times a primary station will poll a secondary station.	**sdlc poll-limit-value** *count*

To retrieve default polling values for these operations, use the **no** forms of these commands.

Configure an SDLC Interface for Half-Duplex Mode

By default, SDLC interfaces operate in full-duplex mode. To configure an SDLC interface for half-duplex mode, perform the following task in interface configuration mode:

Task	Command
Configure an SDLC interface for half-duplex mode.	**sdlc hdx**

On an interface that is in half-duplex mode and that has been configured for DCE, you can adjust the delay between the detection of Request To Send (RTS) and the assertion of Clear To Send (CTS). To do so, perform the following task in interface configuration mode:

Task	Command
Delay the assertion of a CTS.	**sdlc cts-delay unit**

On an interface that is in half-duplex mode and that has been configured for DTE, you can adjust the time the interface waits for the DCE to assert CTS before dropping an RTS. To do so, perform the following task in interface configuration mode:

Task	Command
Adjust the amount of time before interface drops an RTS.	**sdlc rts-timeout unit**

Specify the XID Value

The exchange of identification (XID) value you define on the router must match that of the IDBLK and IDNUM system generation parameters defined in VTAM of the Token Ring host to which the SDLC device will be communicating. To specify the XID value on the router, perform the following task in interface configuration mode:

Task	Command
Specify the XID value to be associated with the SDLC station.	**sdlc xid** *address xid*

Set the Largest SDLC I-Frame Size

Generally, the router and the SDLC device with which it communicates should support the same maximum SDLC I-frame size. The larger this value, the better the line is utilized, thus increasing performance.

After the SDLC device has been configured to send the largest possible I-frame, you must configure the router to support the same maximum I-frame size. The default is 265 bytes. The maximum value the router can support must be less than the value of the LLC2 largest frame value defined when setting the largest LLC2 I-frame size.

To set the largest SDLC I-frame size, perform the following task in interface configuration mode:

Task	Command
Set the largest I-frame size that can be sent or received by the designated SDLC station.	**sdlc sdlc-largest-frame** *address size*

Monitor SDLC Stations

You can monitor the configuration of SDLC stations to determine which SDLC parameters need adjustment by performing the following task in EXEC mode:

Task	Command
Display SDLC station configuration information.	**show interfaces**

Configuration Examples

The following sections provide LLC2 and SDLC configuration examples:

- LLC2 Configuration Example
- SDLC Two-Way Simultaneous Mode Configuration Example
- SDLC Encapsulation for Frame Relay Access Support Configuration Examples
- SDLC Configuration for DLSw+ Example
- Half-Duplex Configuration Example

LLC2 Configuration Example

You can configure the number of LLC2 frames received before an acknowledgment. For this example, assume that at time 0, two I-frames are received. The maximum amount of three has not been reached, so no acknowledgment for these frames is sent. If a third frame, which would force the router to send an acknowledgment, is not received in 800 milliseconds, an acknowledgment will be sent anyway, because the delay timer alarm will have gone off.

```
interface tokenring 0
llc2 ack-max 3
llc2 ack-delay-time 800
```

At this point, because all frames are acknowledged, the counter for the maximum amount of I-frames will be reset to zero.

SDLC Two-Way Simultaneous Mode Configuration Example

The following configuration defines serial interface 0 as the primary SDLC station with two SDLC secondary stations, C1 and C2, attached to it through a modem sharing device. Two-way simultaneous mode is enabled.

```
interface serial 0
encapsulation sdlc-primary
sdlc address c1
sdlc address c2
sdlc simultaneous full-datamode
```

The network for this configuration is shown in Figure 25-1.

Figure 25-1   Two SDLC Secondary Stations Attached to a Single Serial Interface through an MSD
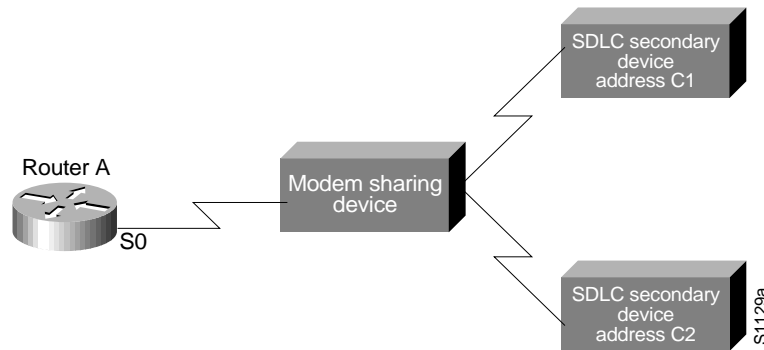
SDLC Encapsulation for Frame Relay Access Support Configuration Examples

The following examples describe possible SDLC encapsulation configurations if you plan to configure Frame Relay access support.

The following configuration is appropriate if the SDLC station is a negotiable or primary Node Type 2.1 station:

```
interface Serial 2/6
no ip address
encapsulation sdlc
clockrate 9600
fras map sdlc C1 serial 2/0 frame-relay 32 4 4
sdlc address C1
```

The following configuration is appropriate if the SDLC station is a secondary Node Type 2.1 station:

```
interface Serial2/6
no ip address
encapsulation sdlc
clockrate 9600
fras map sdlc C1 serial 2/0 frame-relay 32 4 4
sdlc role prim-xid-poll
sdlc address C1
```

The following configuration is appropriate if the SDLC station is a secondary PU2 station:

```
interface Serial2/6
no ip address
encapsulation sdlc
clockrate 9600
fras map sdlc C1 serial 2/0 frame-relay 32 4 4
sdlc role primary
sdlc address C1
sdlc xid C1 01700001
```

SDLC Configuration for DLSw+ Example

The following example describes an SDLC configuration if you plan to implement DLSw+ support. In this example, 4000.3745.001 is the MAC address of the host. The router serves as the primary station for the remote secondary stations, c1 and c2. Both c1 and c2 are reserved for DLSw+ and cannot be used by any other data link user.

```
interface serial 0
encapsulation sdlc
sdlc vmac 4000.3174.0000
sdlc address c1
sdlc xid c1 01712345
sdlc partner 4000.3745.0001 c1
sdlc address c2
sdlc xid c2 01767890
sdlc partner 4000.3745.0001 c2
sdlc dlsw c1 c2
sdlc role primary
```

Half-Duplex Configuration Example

In the following example, an SDLC interface has been configured for half-duplex mode:

```
encapsulation sdlc-primary
sdlc hdx
```