

Link-Layer Protocol Lab

High-Level Data Link Control (HDLC)

Introduction:

There are a number of similar standards for bit-oriented data link control protocol, namely HDLC (by ISO), ADCCP (by ANSI), LAPB (by CCITT), and SDLC (by IBM). High-Level Data Link Control (HDLC) has a wide variety of different options and modes of operation. It is designed for a variety of link types, including either multi-access or point-to-point links and three possible modes of operations, i.e. NRM, ARM, and ABM, one of which is selected when the link is initialized for use.

In this lab, we have two computers are connected by a point-to-point link using HDLC protocol. One is set to be DTE and the other is set to be DCE. The Asynchronous Balance Mode (ABM) mode is used in this experiment. The one with DTE is used to be the sender and the one with DCE is used as the receiver. Both half-duplex and full-duplex transmission mode can be used. The main purpose of this lab is for a student to be able to set up the link and observe frames being sent during different communications phases: link setup, data transfer, and link disconnection. Student should be able to distinguish the sender and the receiver of each frame and the data transfer sequence can be observed by using FELINE protocol analyzer which will capture all frames transmitted between those two stations.

Finally, student will conduct the experiment to compare the performance of the HDLC, a bit-oriented link layer protocol, with the Kermit, a character-oriented link layer protocol, using different window sizes. While performing, the steps of this lab, students should consider why the HDLC protocol behaves in the manner they observed and in the comparison to the other link layer protocol such as Kermit. In doing so, they will gain into the trade off that protocol designers and users must make when they design and use the communications protocols.

Equipment and Setup:

Only one HDLC setups will be available for students to use. Students may work in groups of no more than three persons. A sign-up sheet for the lab equipment will be posted outside the lab.

- Estimated Time: One Hour
- Table 1 is a list of the equipment required for this lab. The equipment should be pre-configured for you before coming to the lab. Consult with on-duty GSA if you have any difficulty identifying or operating the correct equipment

Qty	Equipment Description
3	NCR 386/sx Pc (or equivalent) as detailed below <ul style="list-style-type: none">• 1 PC serving as a HDLC sender.• 1 PC serving as a HDLC receiver.• 1 PC serving as the FELINE Protocol Analyzer.
2	S502E cards (supports hardware interrupts as well as operating in a passive polled mode.)
2	HDLC Support for MS-DOS
1	FELINE/ParaScope Pod (Parallel interface).
1	FELINE Protocol Analysis Software

Table 1: Hardware and Software required for the HDLC/Link-Layer lab.

Setting up HDLC, Feline, and the ParaScope Pod:

The outer PCs are configured with HDLC software to transfer files over the serial cable, and the center PC is configured with the FELINE software and the ParaScope Pod to monitor and examine the transfer. A null-modem serial cable is connected between the 25-pin RS-232 port on one of the HDLC PCs and one of the ParaScope Pod. A standard serial cable is then connected from the 25-pin RS-232 port on the ParaScope Pod and the 25-pin RS-232 port on the HDLC PC. The ribbon cable attached to the ParaScope pod is attached to the FELINE PC's parallel port. Check to make sure that the AC-adaptor is plugged into the ParaScope Pod and into the 110-volt AC outlet. Finally, check that the power switch on the ParaScope Pod is turned on.

Note:

- Please do not attach or detach any of the serial or parallel cables while the PCs are powered on. This can damage the serial port on the PC. There are already many PCs in the lab that will not work because of damage to the serial port. Turn the power off, or ask the GSA for assistance in moving any cabling.
- Before turning on the PC installed with FELINE, make sure that the ParaScope Pod is already powered on and do not turn off ParaScope Pod after you finish.

Lab Procedures:

Part I - Analyze HDLC Frames:

Overview:

In this part of the lab, you will learn how to configure and setup the connection between the DCE and DTE using the HDLC protocol and how to change the HDLC communications configuration. The information frame (I-frame) will be sent and captured in the FELINE buffer. You need to specify the contents in the HDLC I-frame. As a means of achieving uniformity we have the left PC labeled as the sender, the middle PC as FELINE, and the right PC as the receiver. The left and right PCs are transposable (through the DTE/DCE selection).

1. Setting the HDLC configurations

- At the sender/receiver PC:

```
C:\> cd HDLC
C:\HDLC> GO
```

At the HDLC main menu

Press <F4> **HDLC configuration**

Check that the parameters are as follows:

<u>HDLC Configuration</u>	
Baud rate (bps)[38400]	
T1 timer (seconds)	[3]
N2 counter	[10]
Maximum I-field length (octets)	[1027]
K (frame window)	[7]
ABM poll multiple	[O]
Automatic modem error fixing	[Y]

2. Start FELINE on the center PC for the monitoring purpose

- At the FELINE PC:

```
C:\> FELINE
```

FELINE automatically loads the configuration and program files, and then places itself in monitor mode to begin the traffic capture.

- Remove pre-loaded program out of FELINE memory.

Press <F10> to **Exit** monitor mode

Press <F1> to access the **Program**

Remove each program line using the <Delete> key and the <Down arrow> key.

Press <F10> to **Exit Program**

- Change the FELINE default setup for the HDLC transmission by loading the saved configuration files "HDLC" or using the normal setup.

Press <F10> to **Exit** monitor mode

Press <F9> for **Utility** setup

Press <F1> to access configuration **File**

Press <F2> to change Config file

Press <F2> to **Load** new configuration file

Enter config to be loaded: **HDLC**

On the screen it will show "File Loaded" means that the configuration file has been successfully loaded.

- Go back to the monitoring mode
 - Press <F10> **Exit** configuration file
 - Press <F10> **Exit** utility menu
 - Press <F10> **Exit** set-up
 - Press <F2> to enter line **Monitor** mode

Now the feline is poised to capture a transfer and we will next setup a connection between the sender and receiver.

3. Open a connection between sender and receiver

- At the sender/receiver PC:
 - Press <F5> Hip function calls
- Now you are in the Hip main menu
 - Select **Configure a link**

At the sender PC

Select "T" for DTE to place the station in the SENDER mode.

At the receiver PC

Select "C" for DCE to place the station in the RECEIVER mode.

Select **Open a link**

Select **Link setup**

Select **read link status**

- Note:
 - Read Link Status will indicate the connection mode used and the current status of the connection.
 - You may get a modem error message. Press <Enter> and repeat the above steps again.

4. Put the DCE in the ready state.

- At the receiver PC:
 - Place the receiver in a ready state to receive the transmitting frames.
 - Select <Esc> to go back to the Hip main menu

Select **Receive I-frames**

Select "S" for single I-frames reception

Select "A" for ASCII format

5. Send the information frame (I-frame)

- At the sender PC:

Select <Esc> to get back to the Hip main menu

Select **Send I-frames**

Type "S" for single I-frame

Type "Y" to set the P/F Bit

Enter data "**We are the People of the United States**"

- At the Feline terminal

Press <F2> to stop display and analyze the contents in the HDLC frame.

Note: In order to analyze the data captured at the FELINE, you should exit the monitor mode first and then get into the examine mode to see the contents of the frames.

Press <F10> to **Exit** the line monitor mode

Press <F10> to **Exit** the monitor mode

Press <F4> to enter the **Examine** mode

6. Answer the following questions:

5.1 What are the three possible modes in HDLC ? Which mode did we use in this lab?

Describe in detail.

5.2 Name and analyze the length (in the unit of bits) and content of each field in the transmitted INFO frame.

Part II - Analyze Transmission Sequence:

Overview:

In this part of the lab you will ask to capture the frame transfer sequences for two-way alternate (half-duplex) transmission between DTE and DCE during a data transfer and a disconnection phase. Also, you will learn how the P/F bit is useful in the data transmission and error recovery process.

1. Place the Feline in the Monitor mode and change the screen display to Level2

- At the Feline PC:

Press <F10> **Exit** the examine mode

Press <F2> to get into the **Monitor** mode

Press <F2> to get into the **Line Monitor** mode

Press <F2> to **Start** display
 Press <F1> to **Change Screen**
 Press <F5> **Level 2**

Note:

At the FELINE, under this condition (line monitor level 2), you will see the RR (Receiver Ready) frames are being sent back and forth between the sender and the receiver.

2. Disconnect the link from the DTE (sender)

- At the sender PC:
 Select **Link disconnect**

- At the FELINE:
 Press <F2> **Stop** Display
 Press <F10> **Exit** line monitor mode
 Press <F10> **Exit** monitor mode
 Press <F4> to enter the **Examine** mode

- **NOTE:**

When there is no data transmitted, the DTE and DCE will keep exchanging the RR (Receiver Ready) frames. So a buffer at the Feline PC may be filled up. It is advisable that you clear the buffer right before you do the link disconnect. This way the sequence of captured frames can be read easily. The Feline buffer can be cleared by

Press <F2> **Stop** Display
 Press <F2> **Start** Display

- After the link disconnect, there are different kinds of frames transmitted between DTE and DCE. Examine the sequence of frames captured and describe in each case the next 5 frames sent following the disconnect action in table 2.1.

ADD (address)	CODE (frame type)	PF (P/F bits)	FCS (frame check sequence)
	DISC/RD		

Table 2.1: The sequence of frames after the link disconnect

3. Setup a connection and transfer data

- Follow the connection setup procedure at both sender and receiver as states in **Part I (step 3)**.

- At the Feline PC:

Place the Feline in the mode that is ready to capture the traffic.

Press <F10> **Exit** the examine mode
 Press <F2> to get into the **Monitor** mode
 Press <F2> to get into the **Line Monitor** mode
 Press <F2> to **Start** display

- At the receiver PC:

Place the receiver PC in the ready state to receive the frame.

Select **I-frame throughput speed test**

Select **R** to Receive I-frames

Type **1027** for bytes, in information frame length

Type **10** for number of frames to be received

Press **Enter** to wait for transmitted frames.

- At the sender PC:

Start to transmit the information frame.

Select **I-frame throughput speed test**

Select **S** to Send I-frames

Select **Y** to set P/F bit

Type **1027** for bytes in information frame length

Type **10** for number of frames to be transmitted

Press **Enter** to start transmitting the frame.

- At the Feline PC:

Examine the captured frames at the Feline terminal.

Press **<F2> Stop Display**

Press **<F10> Exit line monitor mode**

Press **<F10> Exit monitor mode**

Press **<F4>** to enter the **Examine** mode

- After complete data transmission, note the sequence of frames and frame descriptions in table 2.2

Address (ADD)	Frame type (CODE)	Send Sequence Number (NS)	P/F bit (PF)	Receive sequence number (NR)

Table 2.2: Sequence of frames during the information transfer phase

- What is the function of P/F bits?

Part III - Performance Comparison:

Overview:

In the last part we will compare the performance of the bit-oriented and character-oriented data link layer protocol, HDLC and Kermit. In this case, we will measure the throughput or utilization of the HDLC as compared to the Kermit by changing the different window sizes.

1. Reconfigure the connection by setting the baud rate to 9,600 bps and the window size of 1 and then 7.

- At the Hip main menu at the Sender/Receiver PC:

Select **Flush data buffer**

Select **Read/Set configuration**

Using Page Up/Down

Set **Baud rate** (bps) **9,600**

Set **K (frame window)** **1 or 7**

Press "**S**" to reconfigure the HDLC configuration and return to the Hip main menu.

2. Start sending the I-frame by setting the frame length to 285 bytes and number of transmitted frame to 40 (1.4 Kbytes data transmission.)

- At the receiver PC:

Place the receiver PC in the ready state to receiver the frame.

Select **I-frame throughput speed test**

Select **R** to Receive I-frame.

Type **285** for bytes, in information frame length

Type **40** for number of frames to be received

Press **Enter** to wait for transmitted frames.

- At the sender PC:

Start to transmit the information frame.

Select **I-frame throughput speed test**

Select **S** to Send I-frames

Select **Y** to set P/F bit

Type **285** for bytes, in information frame length

Type **40** for number of frames to be transmitted

Press **Enter** to start transmitting the frames.

- After finish transmission, record the effective data rate at the receiver PC. Calculate the utilization of the link by

$$\text{Link Utilization} = \frac{\text{Effective Data Rate}}{\text{Operated Data Rate}}$$

Window Size	HDLC	Kermit
1		63.41
7		68.07

Table 3.1: The HDLC and Kermit Utilization in transferring fig 1.4 bytes data

- Table 3.1 shows the Kermit utilization in transferring 1.4-Kbyte ASCII file using the baud rate 9.600 kbps and maximum frame length of 285 bytes. Under the same transmission configuration, fill in table 3.1 for the HDLC utilization and answer the following questions.
 1. Explain why the utilization of the HDLC is better than the Kermit protocol.
 2. Explain why difference window size effects the link utilization of the Kermit protocol greater than the HDLC protocol.