Module 4

Standards

Lesson

10

Data Link Layer Continued .... HDLC

Version 1 ECE , IIT Kharagpur

LESSON OBJECTIVE

General

This lesson will focus upon the standard of the datalink layer in the seven layer OSI model.

Specific

On completion of this lesson, the learner shall be able to

1. Define the frame structure of HDLC
2. Understand the flow control and the error control mechanisms in HDLC.
3. Differentiate between various network configurations on the basis of the types of stations involved.

4.3.1 INTRODUCTION

HDLC stands for High-level Data Link Control, and was suggested by the ISO. SDLC (Synchronous Data Link Control) was being employed previously. Earlier protocols were byte oriented, i.e. a byte was used to indicate a function. IBM first suggested bit-oriented protocol where each bit can indicate a separate action; HDLC is a bit-oriented protocol.

4.3.2 FRAME STRUCTURE

HDLC uses synchronous transmission. All transmissions are in the form of frames, and a single frame format suffices for all types of data control exchanges. Figure …. depicts the structure of the HDLC frame. The flag address and control fields are known as header. The FCS and flag fields are referred to as trailer.

Field	**Flag**	**Address**	**Control**	**Information**	**FCS**	**Flag**
Bits	8	8/extendable	8/16	variable	16 / 32	8

Figure 4.3.1 HDLC frame structure

FLAG

It identifies the beginning and end of the frame. It is a unique bit sequence and was previously called Unique Word. The unique bit sequence is 8 bit

long here. A correlator is used at the receiver to identify the flag in order to obtain frame synchronization (the bit synchronization (clock synchronization) and the carrier synchronization (modulation synchronization) are done at the physical layer). In the HDLC the flag is the predetermined bit stream 01111110.

Now consider a case where the flag bit sequence occurs in the information as well. Then the correlator will give high output at wrong time. It can be prevented by

1. Detect the unique word a number of times before declaring synchronization.
2. If 6 consecutive ones come in the information then make the last bit zero, i.e. any sequence of 111111 will be changed as 111110. It is called bit stuffing, where the stuffed bit is removed at the receiver. It can also be used to detect errors (as whenever) 6 consecutive ones come in the information the receiver knows that there is an error.

ADDRESS

It is required in the conditions where multiple clients are connected to a host/server. Out of the 8 bits in the address field I bit is kept aside to indicate while 8 bit or 16 bit addressing format was used.

The transmitter datalink layer will not take network PDUs until the previous packet is transmitted successfully. Similarly the receiver datalink layer will not deliver a packet to the network layer until the frame is successfully received. For all these processing time is required at both the datalink layers. Only one frame is successfully taken at a time and delivered.

FLOW CONTROL

It is the mechanism by which a slow receiver prevents it from being swamped with transmission from a fast transmitter. The receiver indicates the transmitter through a separate channel. A better scheme will be acknowledgement, where a frame can be transmitted only after getting the acknowledgement to the previous frame. It gives the receiver the control of the transmission to some extent. Sending and receiving an acknowledgement is an agreed upon procedure and hence a protocol.

FCS

The Frame Checksum field is a minor variation on the well-known cyclic redundancy code, using CRC-CCITT as the generator polynomial. The variation is to allow lost flag bytes to be detected.

ERROR CONTROL

It has three major parts:

1. Error detection: to check the received frame being right or wrong as a whole.
2. Error correction: where has the error occurred and its kind? And then correction at the receiver. It is called Forward Error Correction.
3. Retransmission: here the receiver upon detecting an error simply tells the transmitter to retransmit a frame. Here a separate channel may be necessary for feedback. It is called Automatic Repeat Request (ARQ).

4.3.3 CONTROL FRAMES

There are basically three types of control frames. All of them have similar structures.

1. I-frames: information frames
2. S-frames: supervisory frames
3. U-frames: unnumbered frames

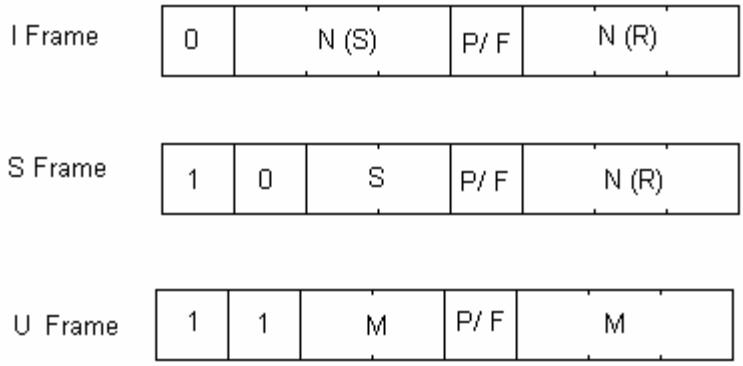

Figure 4.3.2 8 bit Control frames

The receiver must know which frames are in error. So some kind of frame numbering is required. *The numbering bits increases as the frames at the datalink layer are stored.* With three numbering bits, modulo 7 counting operation is performed, so the 8th frame is 000 again.

N(S): the transmit sequence number, can be of 3 or 7 bits

N(R): the receive sequence number

P/F: used in server-terminal kind of situation where a single central

station converses with several remote hosts. The P bit is by the server to indicate polling between the secondary stations. The F bit is used by a secondary station to indicate that the frame under consideration is the final/last frame to be transmitted by it.

S: supervision bits, 2 bits are used to indicate 4 supervisory functions

M: 5 bits used to indicate a maximum of 32 unnumbered operations

Control field length is informed to the receiver through the unnumbered frame.

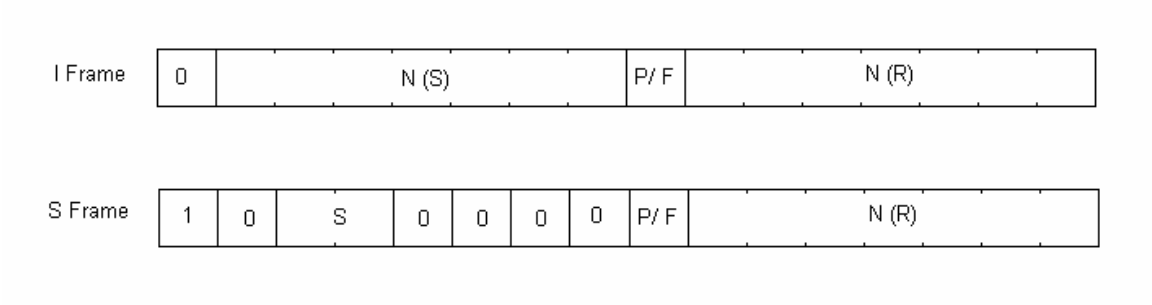

Figure 4.3.3 16 bit control frames

SUPERVISORY FUNCTIONS:

1. RR (00): Receive Ready, used to indicate that the receiver is ready to receive the next frame expected
2. REJ (01): REJect, used to indicate that some transmission error has been detected and asks the transmitter to retransmit all the frames after the one indicated in N(S) including it.
3. RNR (10): Receive Not Ready, tells the sender to stop transmission, may be temporarily
4. SR (11): Selective Reject, tells the transmitter to retransmit only the frame indicated by the N(S) field.

MODES OF OPERATION

1. NRM: Normal Response Mode
2. ARM: Asynchronous Response Mode
3. ABM: Asynchronous Balanced Mode

TYPE OF STATIONS

1. Primary: can issue commands and thus can control the link
2. Secondary: no control and can not initiate any communication

3. Combined: can work as both primary and secondary

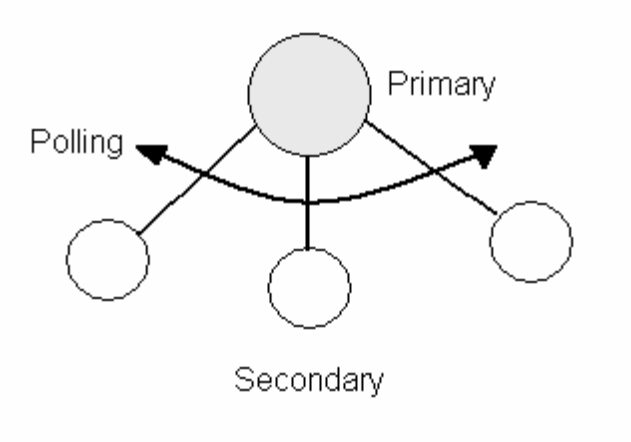

Figure 4.3.4 Types of stations

NETWORK CONFIGUARTION

1. Unbalanced
2. Symmetrical
3. Balanced

In communication between a primary station and one or more secondary stations, response can be sought from the secondary nodes by polling. The link joining the two nodes may be either half-duplex or full-duplex. The operation mode is NRM while the configuration is unbalanced.

In communication between two combined stations, both of the stations can act as primary or secondary stations. Mode of operation is ABM, while the configuration is symmetrical. Operation is asynchronous since sending or receiving frames is not done synchronously. WAN, Internet uses this mode of operation.

Asynchronous Response Mode is a very rarely used mode of operation. It used in case of emergency when even the secondary station can initiate communication without getting command from the primary station, but after that the control is again with the primary.

Objective Questions

10.01 N(S) can be _____or _____bits long.

10.02 All the frames sent by the terminal except the final one have their P/F bit set to _____.

10.03 The various kind of supervisory frames are distinguished by the _____ field.

Subjective Questions

10.11 Explain the HDLC frame structure.

10.12 What is bit-stuffing? What is its purpose?

10.13 What are the different control frame formats in HDLC?

10.14 What is the function of the P/F bit in the HDLC control frame?

10.15 What are the different modes of operation and the different types of stations in HDLC standard?

Level 2 Questions

10.21