Module
4
Standards

Lesson
9
Data link Layer

LESSON OBJECTIVE

General

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

4.2.1 INTRODUCTION

The datalink layer has a number of specific functions to carry out. These functions include providing a well-defined interface to the network layer, framing, dealing with transmission errors and regulating the flow of frames. To see the need of datalink control, we list some of the requirements and objectives for effective data communication between two directly connected transmitting-receiving stations.

- Frame synchronization: this is needed to mark the beginning and end of each frame.
- Flow control: the sending stations must not swamp the receiver with frames
- Error control: bit errors introduced by the transmission medium should be corrected.
- Addressing: on a multi point line, the identity of the two stations must be specified by their addresses.
- Link management: procedures are required for the initiation maintenance and termination of a sustained data exchange.

4.2.2 FLOW CONTROL

Flow control is a technique for assuring that the transmitting entity does not overwhelm the receiving entity with data. The receiving entity typically allocates a data buffer of some maximum length for a transfer. In the absence of flow control, the receiver buffer may get filled up and overflow while it is processing the previously received data. The following model shown in fig 1, is used to examine mechanisms of flow control in the absence of errors.

Stop and Wait Protocol

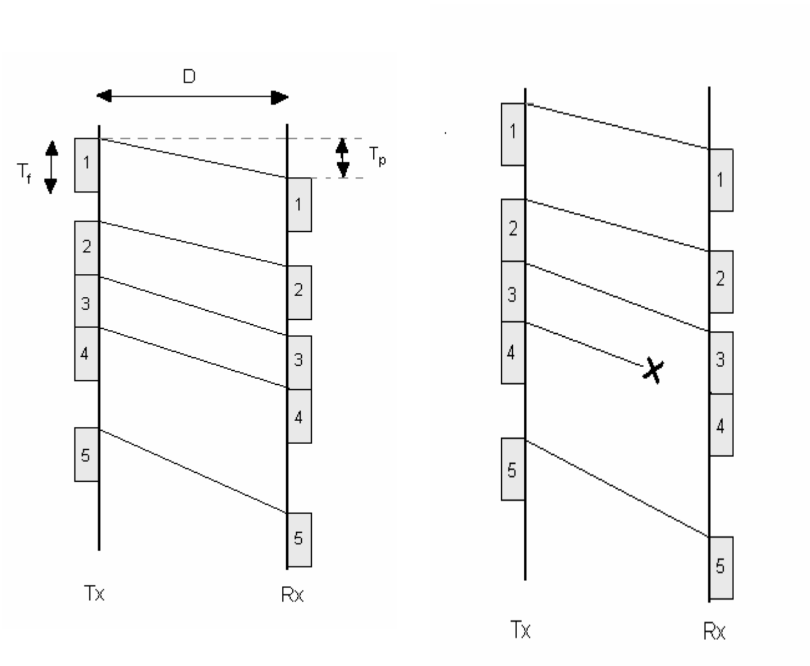

Figure 1 Flow control

T_f is the frame time and depends on data rate and the length of frame, L. T_p, the propagation time, depends on the velocity through medium and distance between the source and destination.

So total time required for the last bit of the frame to reach its destination is $T_f + T_p$

If $T_f > T_p$ then by the time the first bit reaches the receiver the last bit has yet not come out of the transmitter. So the entire time axis between the source and destination is occupied by the frame.

Otherwise, if $T_f < T_p$ then the frame occupies a small portion of the physical path. Here line capacity is free for most of the time and hence line utilization efficiency is very low.

Performance depends on the value of the time-out. Both transmitter and the receiver need to have a timer.

Numbering of the frames is essential so that the receiver knows which frame it receives, whether it is an old frame retransmitted or a fresh frame.

Some kind of acknowledgement is required to let the transmitter know whether the receiver has received a previously transmitted properly. The ACK can be represented in two ways:

The receiver might send ACK0 to indicate successful reception of frame 0.

The receiver may send ACK1 to request transmission of frame 1, which implicitly specifies that it has received frame 0 successfully.

The transmitter must wait for the ACK from the receiver. Only a single bit with modulo-2 counting is used to number frames. ACK1 signifies reception of frame 0 (1^{st} frame) and ACK0 then indicates reception frame 1 (2^{nd} frame). ACK1 again signifies reception of frame 1 request for transmission of frame 0 (3^{rd} frame). The whole process is called Stop-&-Wait. It is the most inefficient of all techniques, with efficiency specified by

$U=T_f/(T_f+2T_p)$

Continuous Protocol

Transmitter continuously sends frames without waiting for the ACK from the receiver. When the receiver detects an error or does not receive a frame it sends a NAK (negative acknowledgement) for the frame. When the transmitter receives the NAK it retransmits that particular frame or all frames after that frame. So it requires storage of a certain number of previously transmitted frames. So some sort of window is used to transmit and store frames. Window size mat be either of 8, 16 or 32. The transmitter sends 8 frames, and then waits. The receiver receives 8 frames and sends ACK or NAK accordingly. When ACK for all the 8 frames are received the transmitter removes those frames from storage and stores and sends next 8 frames.

The efficiency increases with window size but the storage requirement also increases. N(S) is used to indicate the number of bits to represent the window size. For window size of 8, N(S) is 3. With 7 bit N(S) window size is 128.

Stop-&-Wait is special case of continuous protocol with window size of 1.

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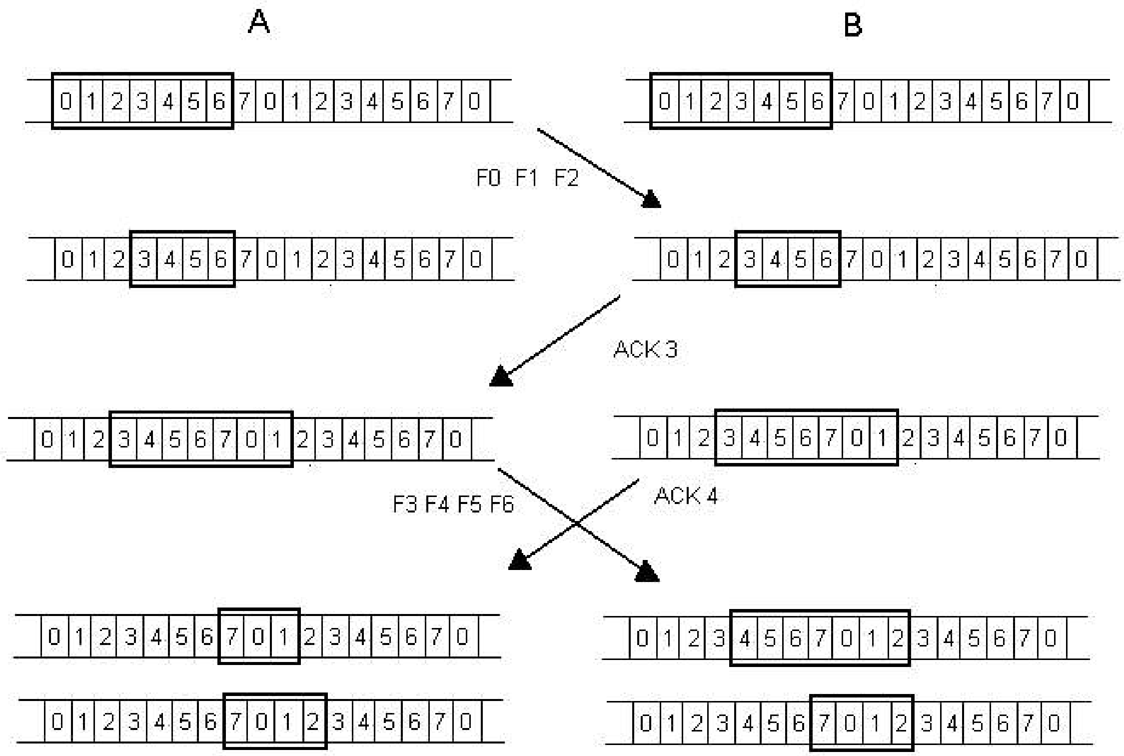


4.2.3 ERROR CONTROL

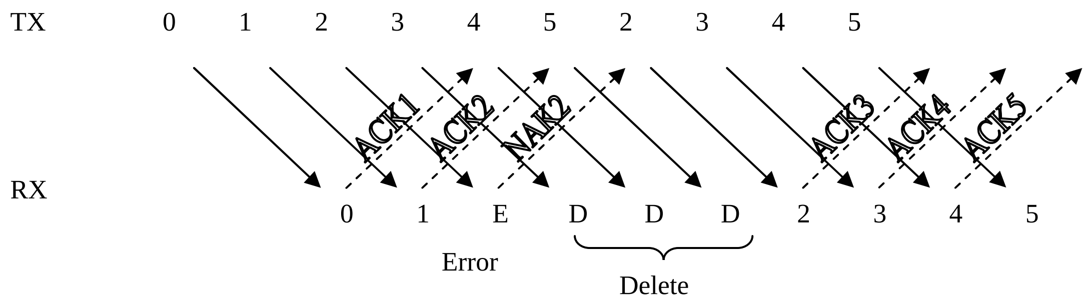
Error control refers to the mechanisms to detect and correct errors that occur in the transmission of frames. The most common techniques for error correction are based on some or all of the following principles.

- Error detection
- Positive acknowledgement
- Retransmission after time-out
- Negative acknowledgement and retransmission

Collectively these mechanisms are all referred to as Automatic Repeat Request (ARQ)

ARQ Protocols

GO-BACK-N



Transmitter goes back N times, i.e. receives N packets, as soon as it gets the NAK. The receiver discards the frames subsequent to the erroneous frame until the frame under consideration is received properly. Here the responsibility of retransmission is solely on the transmitter and hence need to have a large buffer space.

SELECTIVE REJECT

Here the processing responsibility is shared by the receiver as well, so the processing burden at the transmitter is less. The receiver, upon a receiving a frame with error, tells the transmitter to retransmit that particular frame only. When it gets the frame correctly it inserts it into its correct position at the receive frame sequence.

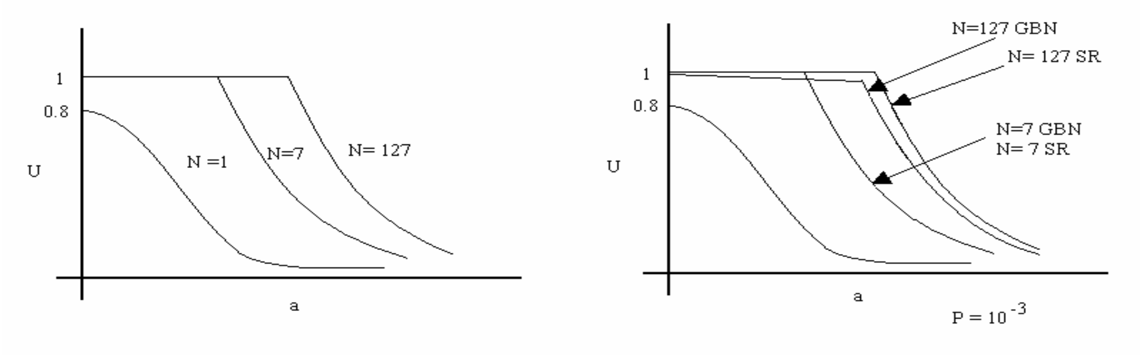
Performance of these three techniques:

Parameter a is defined as, $a=T_{prop}/T_{frame}$

Now for Stop-&-Wait efficiency is defined as

Efficiency U = 1 for $N > 2a+1$

$N/(2a+1)$ for $N < 2a+1$



For large distances a is large so U is very low in that case for Stop-&-Wait method. For smaller distance, though, the efficiency is acceptable.

Efficiency increases as window size is increased. So it is really a choice between the buffer requirement at the stations and efficiency. The SR method provides more efficiency than the GBN method.

Role of N(R)

At the beginning of transmission N(R) is zero. The ACK can be piggybacked on the frame from receiver to the transmitter or separate ACK frame may be sent.

N(R) specifies the transmitter about the frame the receiver is expecting. For initial frame it is 000 as no frame has been received.

If the receiver does not have I-frames to send then it sends ACK by using the S-frame, which also has the provision for N(R).

I-frames can be used for both ACK and NAK.

HDLC is inherently slow as processing and storage at each node is required. The speed that can be supported is up to 64kbps.

Previously telephone lines were being used for data communication which led to high noise and worse quality of transmission. Then the co-axial cable came which somewhat increased the quality. Later on satellite communication really led to vast improvement in quality of data transmission and also facilitated very long distance communication. Using OFC superior transmission quality has been achieved and hence some of the previous protocol function may become redundant.

Objective Questions

9.01

Subjective Questions

9.11 Explain Sliding Window protocol.

9.12 Explain Flow control techniques.

9.13 Explain the Error control techniques.

Level 2 Questions

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