UNIT 3 MEDIUM ACCESS CONTROL AND DATA LINK LAYER

3.0 INTRODUCTION

This unit introduces the design of Data Link Layer and its Medium Access Control Sublayer. This includes various protocols for achieving reliable, efficient communication. It also covers the study of nature of errors, causes and how they can be detected and corrected.

The MAC sublayer contains protocols which determines who goes next on a multi-access channel.

3.1 OBJECTIVES

After completion of this unit you will be able to:

- understand various error handling methods;
- understand various flow control methods, and
- MAC sublayer protocols like CSMA/CD, Polling, Token Passing.

3.2 DATA LINK LAYER

To exchange digital information between devices A and B, we require an interconnecting transmission medium to carry the electrical signals; a standard interface and the physical layer to convert bits into electrical signals and vice-versa.

This has certain limitations:

- If the electrical signal gets impaired due to the encountered interference with other signals or electromagnetic waves from external sources, errors may be introduced in the data bits.
- Errors can also be introduced if the receiving device is not ready for the incoming signal, hence resulting in the loss of some information.

The data link layer constitutes the second layer of the hierarchical OSI Model. The Data Link layer together with physical layer provide a data link connection for

reliable transfer of data bits over an imperfect physical connection, between two adjacent nodes.
It accomplishes this task by having the sender break the input data into data frames, transmit the frames sequentially and process the acknowledgement frames sent back by the receiver. The data link layer to creates and recognises frame boundaries.

Another issue that arises in data link layer is how to keep a fast transmitter from overflowing a slow receiver in data.

The data link layer incorporates certain processes, which carry out error control, flow control and the associated link management functions. The data block along with the control bits is called a frame.

Data link layer is divided up into two sublayers:

Logical link control (LLC) concerned with providing a reliable communication part between two devices. It is also involved with flow control and sequencing. The LLC is non-architecture-specific and is the same for all IEEE defined LANs.

Medium Access Control (MAC) focuses on methods of sharing a single transmission medium.

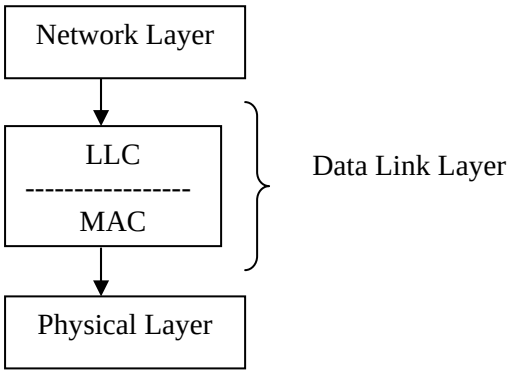

Figure 1: Network Layer

3.2.1 Services Provided by Data Link Layer (logical link control)

- **Framing:** Some control bits are added to the data packets from network layer to mark the start and end of a frame. This is done using character count, special character or bit patterns.
- **Flow Control:** Flow control deals with how to keep the fast sender from overflowing a slow receiver by buffering and acknowledgement procedures.
- **Error detection and correction codes:** Various methods used for error-detection and corrections are – Parity bit, cyclic redundancy check, checksum, Hamming code, etc.

3.2.2 Retransmission Strategies

In this section we will discuss several retransmission strategies, which are also considered as a flow control and error control mechanism.

Stop and Wait

The sender allows one message to be transmitted, checked for errors and an appropriate ACK (Positive Acknowledgement) or NAK (Negative

Acknowledgement) returned to the sending station. No other data messages can be transmitted until the receiving station sends back a reply, thus the name STOP and WAIT is derived from the originating station sending a message, stopping further transmission and waiting for a reply.

Its major drawback is the idle line time that results when the stations are in the waiting period. If the ACK is lost then the sending station retransmits the same message to the receiver side. The redundant transmission could possibly create a duplicate frame. A typical approach to solve this problem is the provision for a sequence number in the header of the message. The receiver can then check for the sequence number to determine if the message is a duplicate. The Stop and Wait mechanism requires a very small sequence Number, since only one message is outstanding at any time. The sending and receiving station only use a one bit alternating sequence of 0 and 1 to maintain the relationship of the transmitted message and its ACK/NAK status.

Sliding Window

Here data and control frames flow from sender to receiver in a more continuous manner and several frames can be outstanding at any one time.

The transmitting station maintains a sending window that maintains the number of frames it is permitted to send to the receiving station and the receiving station also maintains a receiving window that performs complementary functions. The two sides use the window to coordinate the flow of frames between each other. The window wrap around is used to reuse the same set of numbers for different frames. There are sliding window techniques :

(1) Go Back N
(2) Selective Repeat

The following two diagrams (*Figure 1 and Figure 2*) explain the functioning of Go Back N and Selective Repeat respectively.

Go Back N

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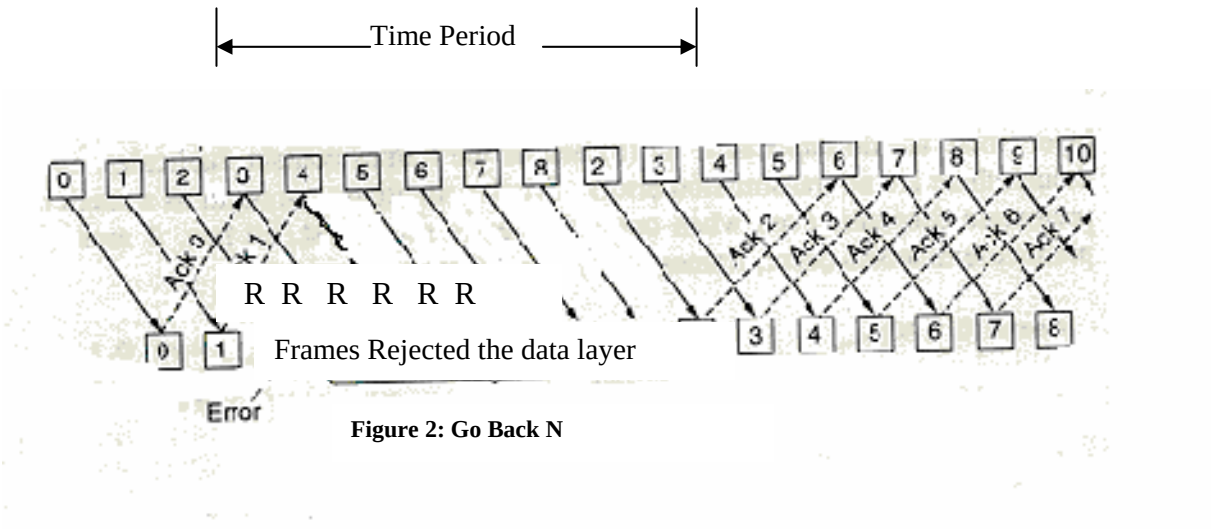

Figure 2: Go Back N

This is a sliding window technique. It allows data and control messages to be transmitted continuously without waiting for its acknowledgement from the receiver. In the event of error detection at the receiving side, the erroneous message is retransmitted, as well as all other frames that were transmitted after the erroneous message.

Selective Repeat

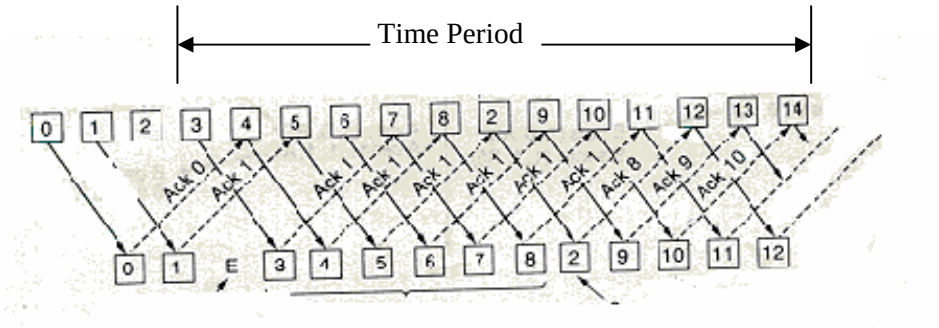

Figure 3: Selective Repeat

Error Buffered by receiver Packets 2-8 passed to upper layer

This method provides for a more refined approach. In contrast to the Go back N, the only messages retransmitted are those for which negative acknowledgement is received.

Studies reveal that the selective repeat mechanism produces greater throughput than the Go Back N. Selective Repeat mechanism requires additional logic to maintain the sequence of the recent message and merge it into the proper place as the queue at the receiver end.

3.3 MEDIUM ACCESS CONTROL (MAC) SUBLAYER

In any broadcast network, key issue is how to determine who gets to use the channel when there is competition for it. The protocols used to determine who goes next on a multi-access channel belong to a sub-layer of a Data Ling Layer called MAC sublayer.

3.3.1 Contention Based Media Access Protocols

Contention is what happens at a staff meeting when several people start to talk at the same time. In contention protocol no one controls usage of the communication channel.

All workstations on a contention network share a common transmission channel. Messages are broadcast on that channel and may be overheard by all attached workstations. A workstation responds only to message with its address. Message intended for other nodes are ignored.

Message to be transmitted are converted to packets and are sent when ready, without verifying the availability of the channel. When transmission of a station overlaps with that of another, collision occurs. Colliding packets with their messages are destroyed.

3.3.2 Polling based MAC Protocols

Polling involves the channel control of all workstations in a network. The primary workstation which acts like a teacher going down the rows of the class room asking each student for homework. When one student has answered, the next is given a chance to respond.

A polling network contains two classes of workstations, the primary workstation and the multiple secondary workstations connected to it. A buffer that can temporarily store messages is associated with each secondary workstation. When a workstation

has information to transmit, the data is passed to the buffer. The frames are held until the central controller polls the workstation.

Following are two possibilities for the path of a message from some to destination workstation:

- All messages may be required to pass to the central workstation, which route them to their destination.
- Messages may be sent directly.

Polling technique can be said to maintain a tight control over the network resources than do contention based protocols.

Token Passing

The network continuously circulates a special bit pattern known as a token among all the nodes in the network.

Each token contains network information, comprising of a header, a data field and a trailer. Any node willing to send a frame has to grab a token first. After a node has captured a token it transmit its frame. The frame is relayed by all intermediate nodes still it reaches destination, when it is copied. Now let us talk about some standards.

3.3.3 IEEE Standard 802.3 and Ethernet

It uses CSMA/CD mechanism expand (carrier Seen Multiple Access/Collision Detect). When a station wants to transmit, it listens to the cable. If the cable is busy, the station waits until it goes idle, otherwise it transmits immediately. If two or more stations simultaneously begin transmitting on an idle cable they will collide. All colliding stations then terminate their transmissions, wait a random time and repeat the whole process all over again.

3.3.4 IEEE Standard 802.4 Token Bus

Token bus combines features of Ethernet and token ring (discussed in the next section). It combines the physical configuration of Ethernet (bus topology) and collision free (predictable delay) feature of token ring. Token bus is a physical bus that operates as logical ring using tokens.

It is a linear cable onto which the stations are attached. When the logical ring is initialised, the highest numbered station may send the first frame after it is done, it passes permission to its immediate neighbour by sending the neighbour a special control frame called a token.

The token propagates around the logical ring with only the token holder being permitted to transmit frames. Since only one station at a time holds the token, collisions do not occur.

3.3.5 IEEE Standard 802.5 Token Ring

In a token ring, the token circulates around the ring whenever all stations are idle. When a station wants to transmit a frame, it is required to seize the token and remove it from the ring before transmitting. This action is done by inverting a single bit in the 3-byte token which instantly changes it into the first 3 bytes of a normal data frame. Because there is only one token, only one station can transmit at a given instant, thus solving the channel access problem.

☞ Check Your Progress

1) How is Selective Repeat better than Go Back N?

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2) What are the four LAN architectures?

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3.4 SUMMARY

In this unit, an introduction to issues of DLL and various methods for allocation of a common channel to the competing users were discussed. LANs are dominated by three types of architecture: Ethernet, Token bus, Token Ring . Each of them has its own advantages and disadvantages. Depending upon the requirements, the choice is made.

3.5 SOLUTIONS/ANSWERS

1) Selective repeat is a more refined approach. It gives higher throughout, maintains proper sequence of the messages and transmits only those messages for which negative acknowledgement have been received.

2) The LAN architectures are namely:

(i) Ethernet
(ii) Token Bus
(iii) Token Ring

These architectures are defined by IEEE standards.