MODULE-3: Data Link Layer

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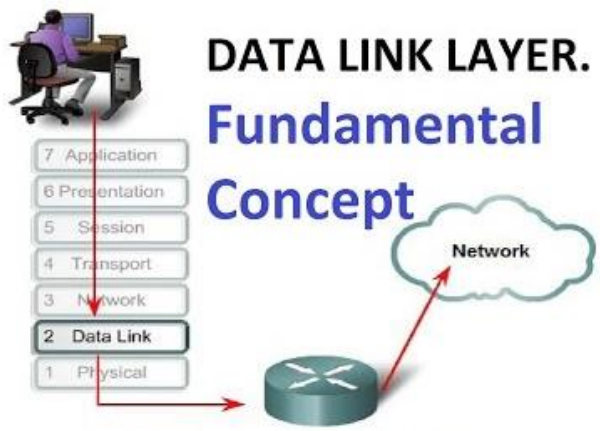

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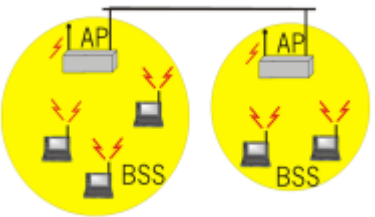
Module 3 Data Link Layer

Medium Access Control sublayer
Channel Allocation problem, Multiple access Protocol(Aloha, Carrier Sense Multiple Access (CSMA/CD)

Channel Allocation problem

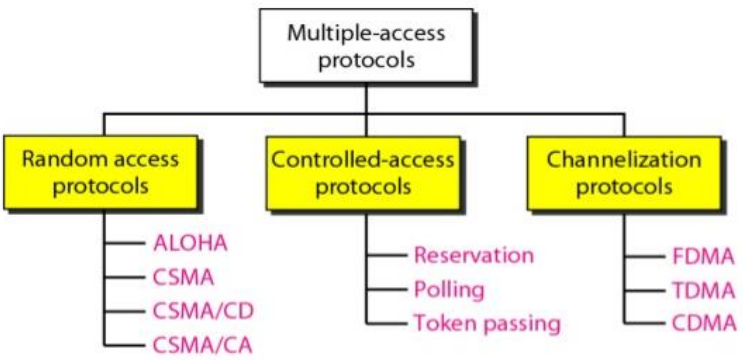
In a single channel broadcast network, when multiple stations try to send messages simultaneously, who has the right to use the channel?

A common sense:
When we take about MAC, we are faced with a broadcast network.

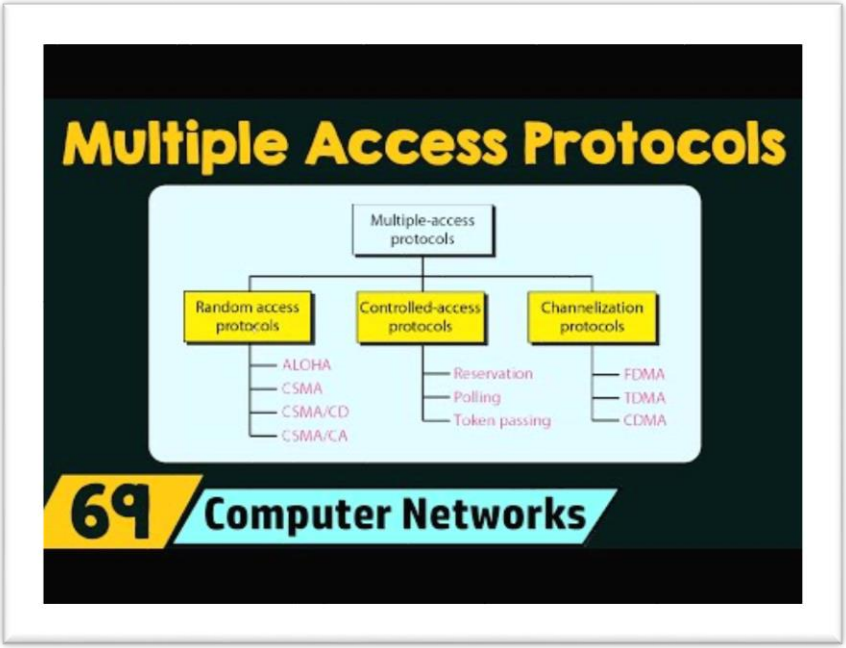


Multiple access Protocol

If there is a dedicated link between the sender and the receiver then data link control layer is sufficient, however if there is no dedicated link present then multiple stations can access the channel simultaneously. Hence multiple access protocols are required to decrease collision and avoid crosstalk.



Video
Multiple Access Protocols



Random Access Protocol:

In this, all stations have same superiority that is no station has more priority than another station. Any station can send data depending on medium's state(idle or busy). It has two features:

1. There is no fixed time for sending data
2. There is no fixed sequence of stations sending data

ALOHA

The core idea is extremely simple:

- Anyone may transmit whenever they want. (Continuous time model.)
- Detect if the transmission is successful. (So we need some way for Collision Detection (CD)).
- After a collision, wait a random amount of time and transmit the same frame again. This technique is known as backoff.

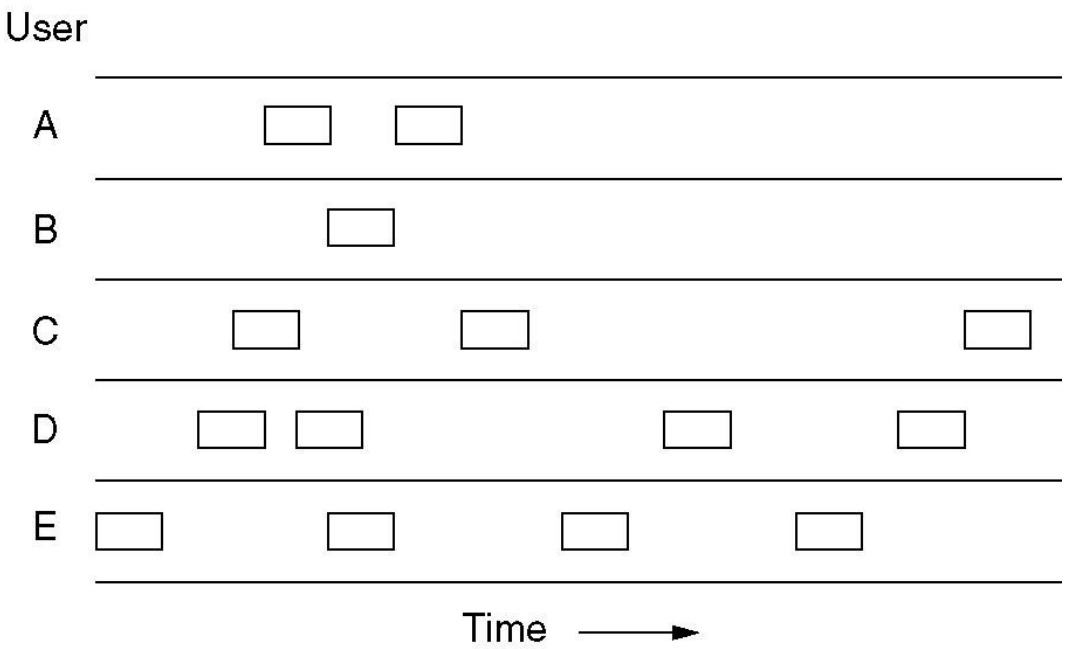
Pure ALOHA

When a station sends data it waits for an acknowledgement. If the acknowledgement doesn't come within the allotted time then the station waits for a random amount of time called back-off time (Tb) and re-sends the data. Since different stations wait for different amount of time, the probability of further collision decreases.

Vulnerable Time = 2* Frame transmission time

Throughput = G exp{-2*G}

Maximum throughput = 0.184 for G=0.5



In pure ALOHA, frames are transmitted at completely arbitrary times.

Slotted ALOHA

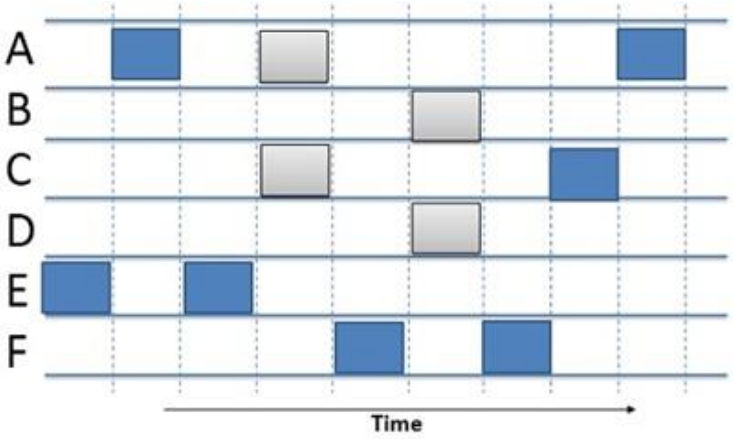
It is similar to pure aloha, except that we divide time into slots and sending of data is allowed only at the beginning of these slots. If a station misses out the allowed time, it must wait for the next slot. This reduces the probability of collision.

Vulnerable Time = Frame transmission time

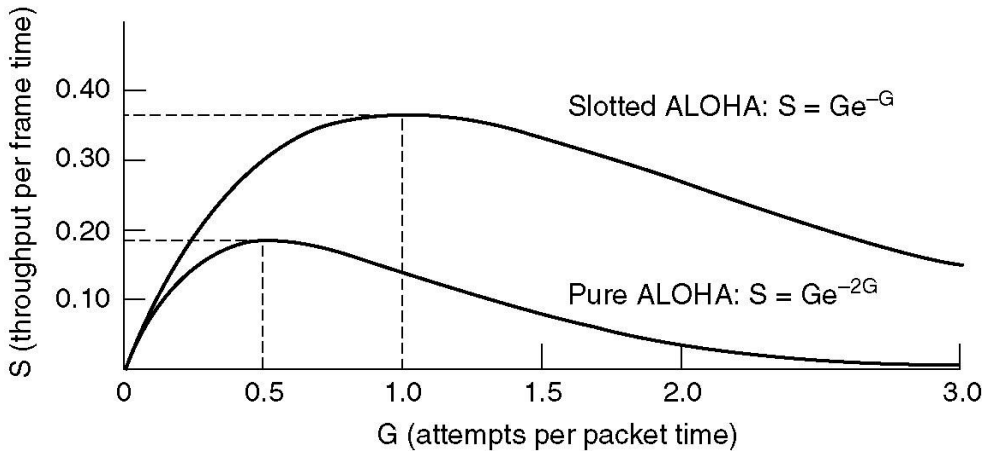
Throughput = G exp{-*G}

Maximum throughput = 0.368 for G=1

While there is a new frame A to send to -
1. Send frame A at a slot boundary and wait for ACK
2. If after some time ACK is received, successful transmission of frame. 3. If there is a collision, the node detects the collision before the end of the slot.
4. Wait a random amount of time and go to 1
End



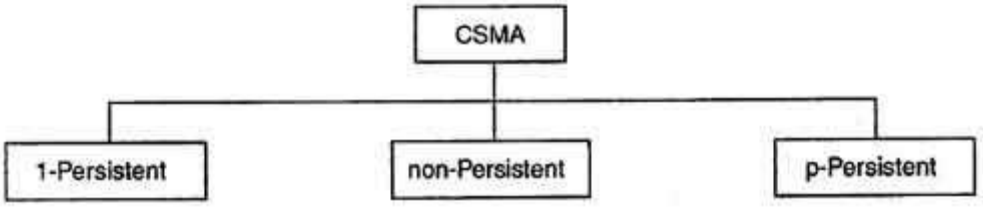
Throughput versus offered traffic for ALOHA systems.



CSMA (Carrier Sense Multiple Access)

Carrier Sense Multiple Access ensures fewer collisions as the station is required to first sense the medium (for idle or busy) before transmitting data. If it is idle then it sends data, otherwise it waits till the channel becomes idle. However there is still chance of collision in CSMA due to propagation delay.

There Are Three Different Type of CSMA Protocols



1-persistent CSMA

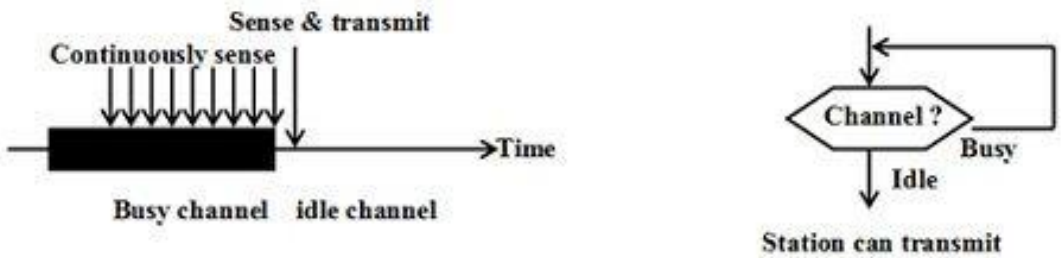
• In this method, station that wants to transmit data continuously senses the channel to check whether the channel is idle or busy.

• If the channel is busy, the station waits until it becomes idle.

• When the station detects an idle-channel, it immediately transmits the frame with probability 1. Hence it is called I-persistent CSMA.

• This method has the highest chance of collision because two or more stations may find channel to be idle at the same time and transmit their frames.

• When the collision occurs, the stations wait a random amount of time and start allover again.



1-persistent CSMA

Non-persistent CSMA

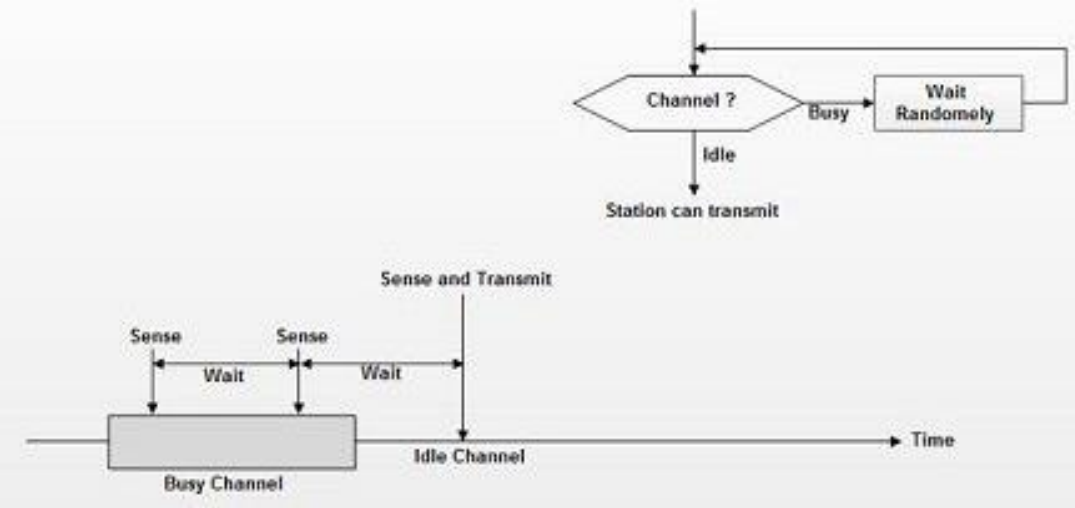
• In this scheme, if a station wants to transmit a frame and it finds that the channel is busy (some other station is transmitting) then it will wait for fixed interval of time.
• After this time, it again checks the status of the channel and if the channel is free it will transmit.

• A station that has a frame to send senses the channel.

• If the channel is idle, it sends immediately.

• If the channel is busy, it waits a random amount of time and then senses the channel again.

• In non-persistent CSMA the station does not continuously sense the channel for the purpose of capturing it when it detects the end of previous transmission.



P-persistent CSMA

• This method is used when channel has time slots such that the time slot duration is equal to or greater than the maximum propagation delay time.

• Whenever a station becomes ready to send, it senses the channel.

• If channel is busy, station waits until next slot.

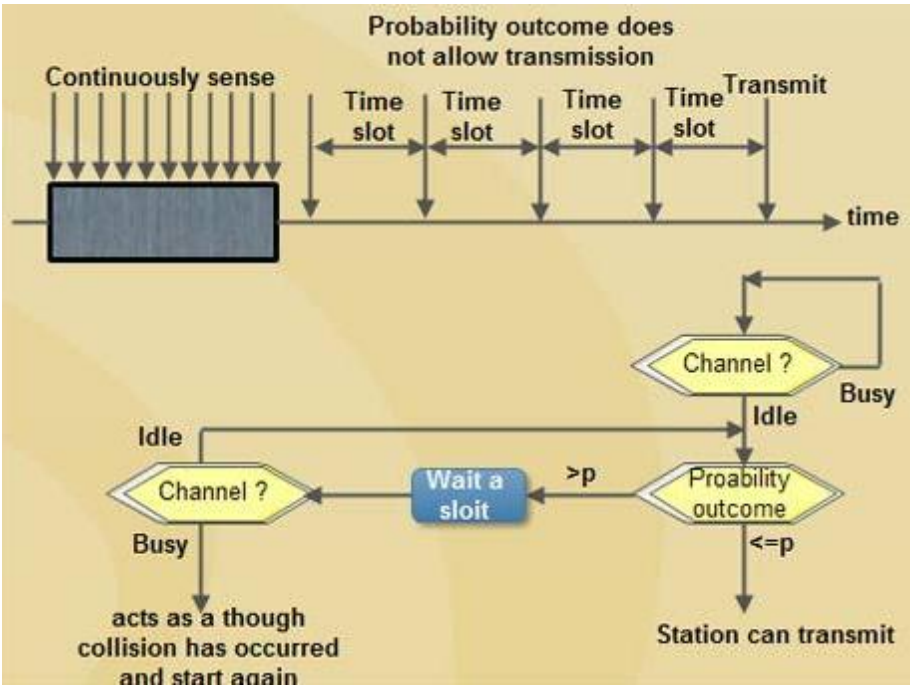
• If channel is idle, it transmits with a probability p.

• With the probability q=l-p, the station then waits for the beginning of the next time slot.

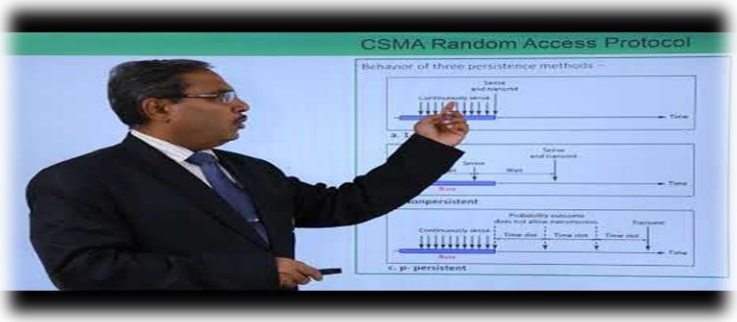
• If the next slot is also idle, it either transmits or waits again with probabilities p and q.

• This process is repeated till either frame has been transmitted or another station has begun transmitting.

• In case of the transmission by another station, the station acts as though a collision has occurred and it waits a random amount of time and starts again.



Video CSMA Random Access Protocol



CSMA/CD

Carrier sense multiple access with collision detection. Stations can terminate transmission of data if collision is detected.

For more details refer – Efficiency of CSMA/CD

CSMA/CA

Carrier sense multiple access with collision avoidance. The process of collisions detection involves sender receiving acknowledgement signals. If there is just one signal (its own) then the data is successfully sent but if there are two signals (its own and the one with which it has collided) then it means a collision has occurred. To distinguish between these two cases, collision must have a lot of impact on received signal. However it is not so in wired networks.

VIDEO

CSMA/CD and CSMA/CA Explained

Controlled Access Protocol:

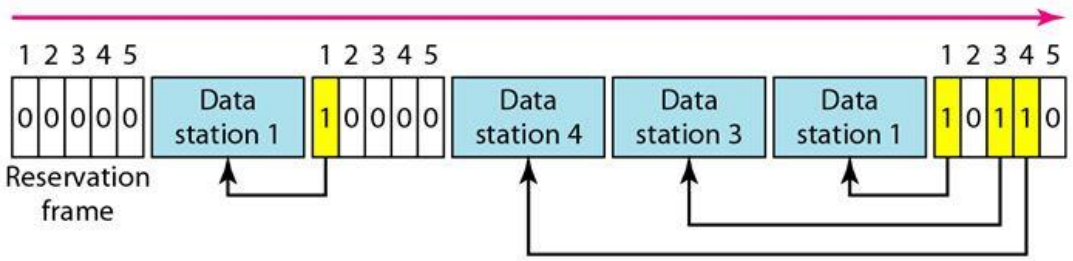
In this, the data is sent by that station which is approved by all other stations.

For further details refer – Controlled Access Protocols

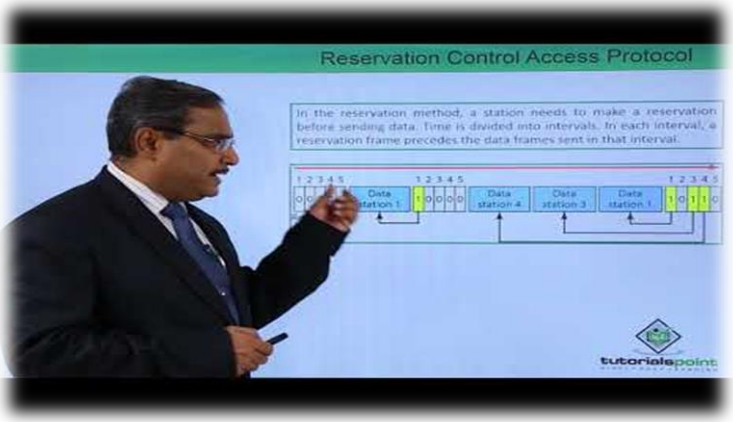
1. Reservation:

In the reservation method, a station needs to make a reservation before sending data. Time is divided into intervals. In each interval, a reservation frame precedes the data frames sent in that interval.

The following figure shows a situation with five stations and a five-minislot reservation frame. In the first interval, only stations 1, 3, and 4 have made reservations. In the second interval, only station 1 has made a reservation.



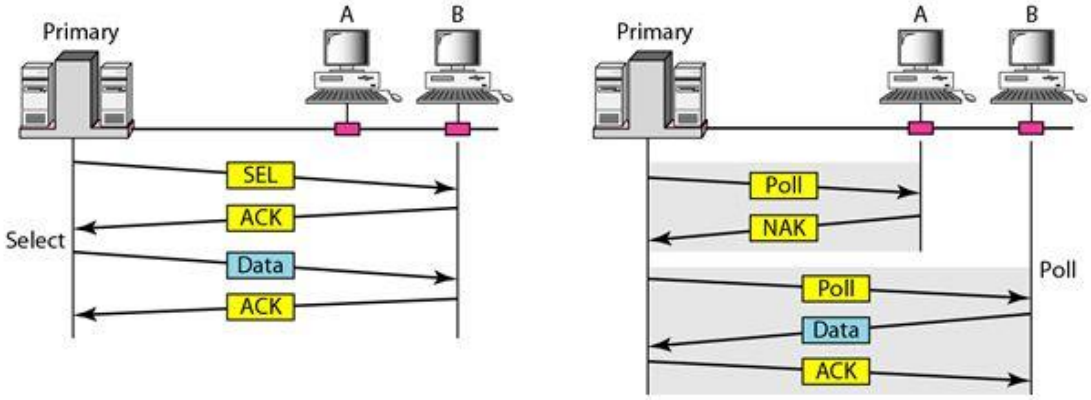
Video:
Reservation Control Access Protocol



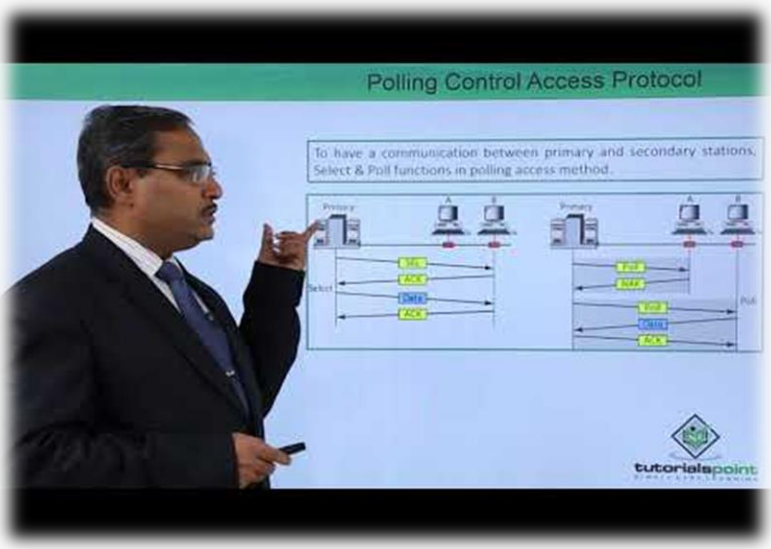
2. Polling:

Polling works with topologies in which one device is designated as a primary station and the other devices are secondary stations. All data exchanges must be made through the primary device even when the ultimate destination is a secondary device.

The primary device controls the link; the secondary devices follow its instructions. It is up to the primary device to determine which device is allowed to use the channel at a given time. The primary device, therefore, is always the initiator of a session. Consider the following figure.

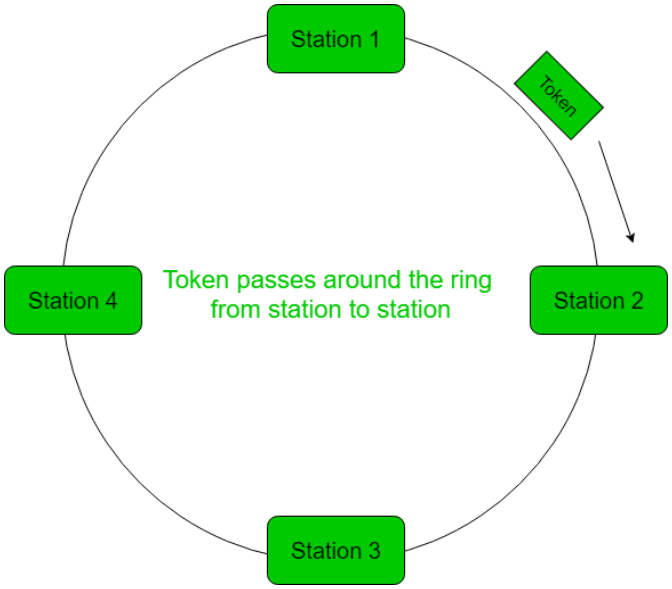


Video: Polling



3. Token Passing:

In this method, a special packet called a token circulates through the ring. The possession of the token gives the station the right to access the channel and send its data. When a station has some data to send, it waits until it receives the token from its predecessor. It then holds the token and sends its data. When the station has no more data to send, it releases the token, passing it to the next logical station in the ring. The station cannot send data until it receives the token again in the next round.



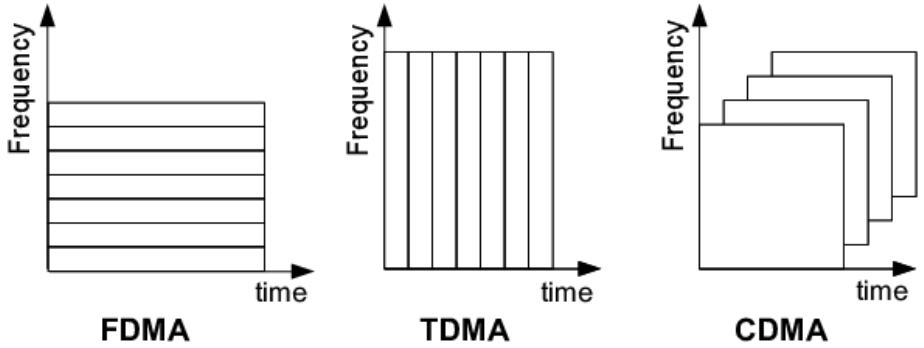
Channelization:
In this, the available bandwidth of the link is shared in time, frequency and code to multiple stations to access channel simultaneously.

Frequency Division Multiple Access (FDMA) – The available bandwidth is divided into equal bands so that each station can be allocated its own band.

Time Division Multiple Access (TDMA) – In this, the bandwidth is shared between multiple stations. To avoid collision time is divided into slots and stations are allotted these slots to transmit data.

Code Division Multiple Access (CDMA) – One channel carries all transmissions simultaneously. There is neither division of bandwidth nor division of time. For example, if there are many people in a room all speaking at the same time, then also perfect reception of data is possible if

only two person speak the same language. Similarly data from different stations can be transmitted simultaneously in different code languages.



Video

MULTIPLE ACCESS - FDMA/TDMA/CDMA

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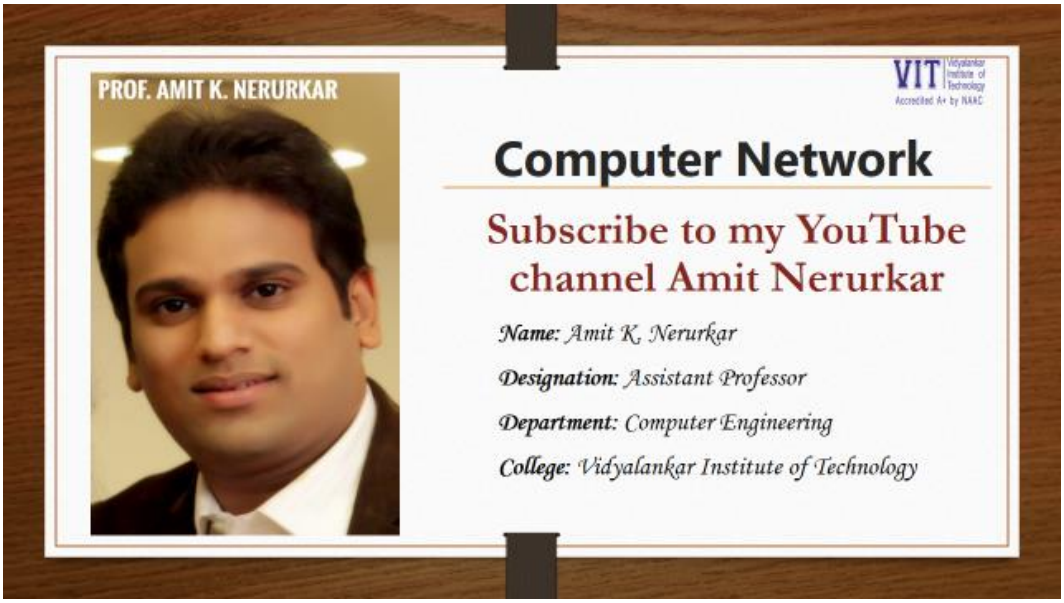

Subjects Taught by Amit K. Nerurkar

1. C programming
2. Data Structure
3. Computer Network
4. Network Security
5. Artificial Intelligence
6. Soft Computing
7. Distributed Systems
8. Internet of Things
9. Linux Administration
10. Database Management System