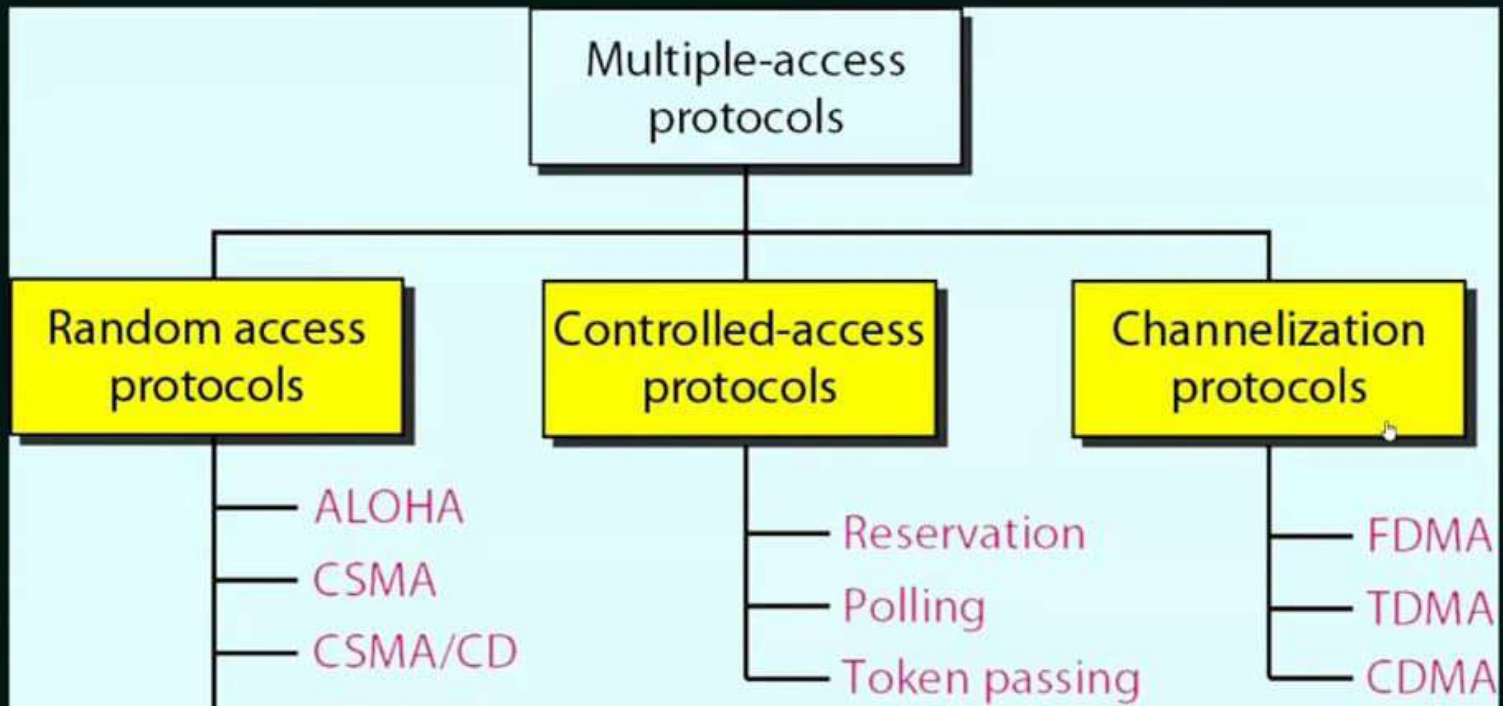
Why Multiple Access Protocols?

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.

Multiple Access Protocols



Random Access Protocols

- ★ 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).
- ★ In a Random access method, each station has the right to the medium without being controlled by any other station.
- ★ If more than one station tries to send, there is an access conflict (COLLISION) and the frames will be either destroyed or modified.

Random Access Protocols

To avoid access conflict, each station follows a procedure.

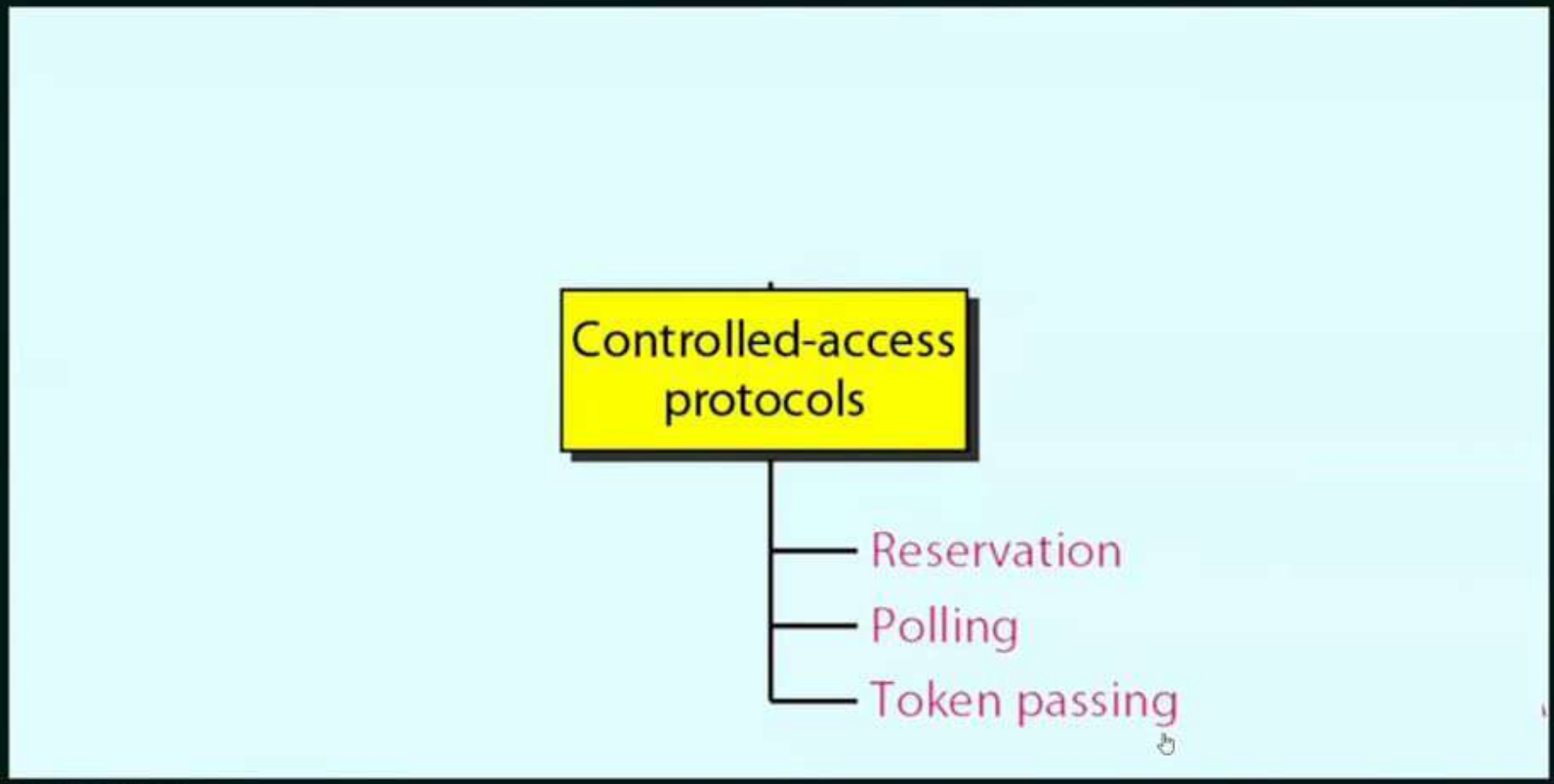
- ★ When can the station access the medium ?
- ★ What can the station do if the medium is busy ?
- ★ How can the station determine the success or failure of the transmission ?
- ★ What can the station do if there is an access conflict ?

Random Access Protocols

Controlled Access Protocols

- ★ In controlled access, the stations consult one another to find which station has the right to send.
- ★ A station cannot send unless it has been authorized by other stations.

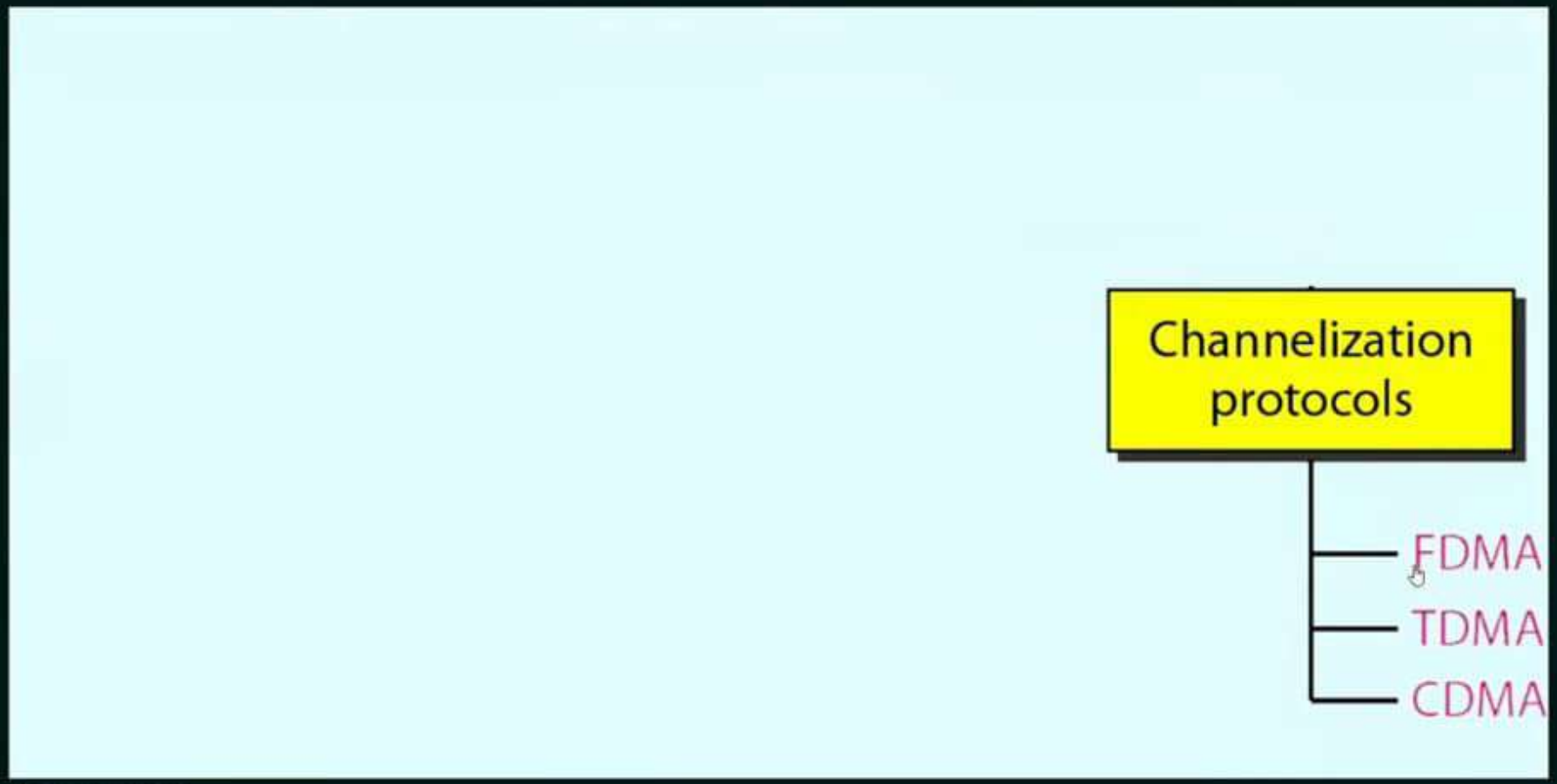
Controlled Access Protocols



Channelization Protocols

Channelization is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, between different stations.

Channelization Protocols



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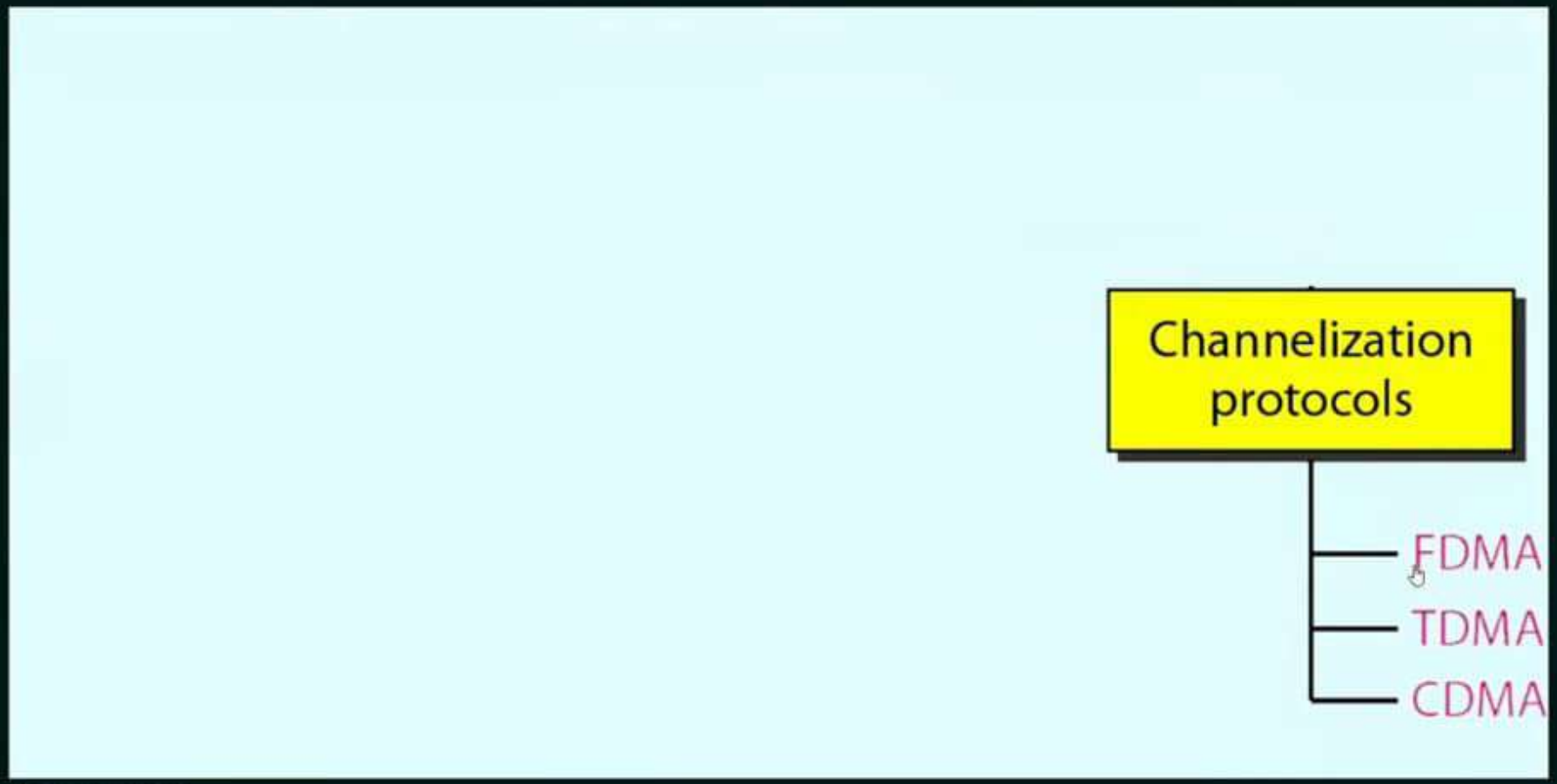
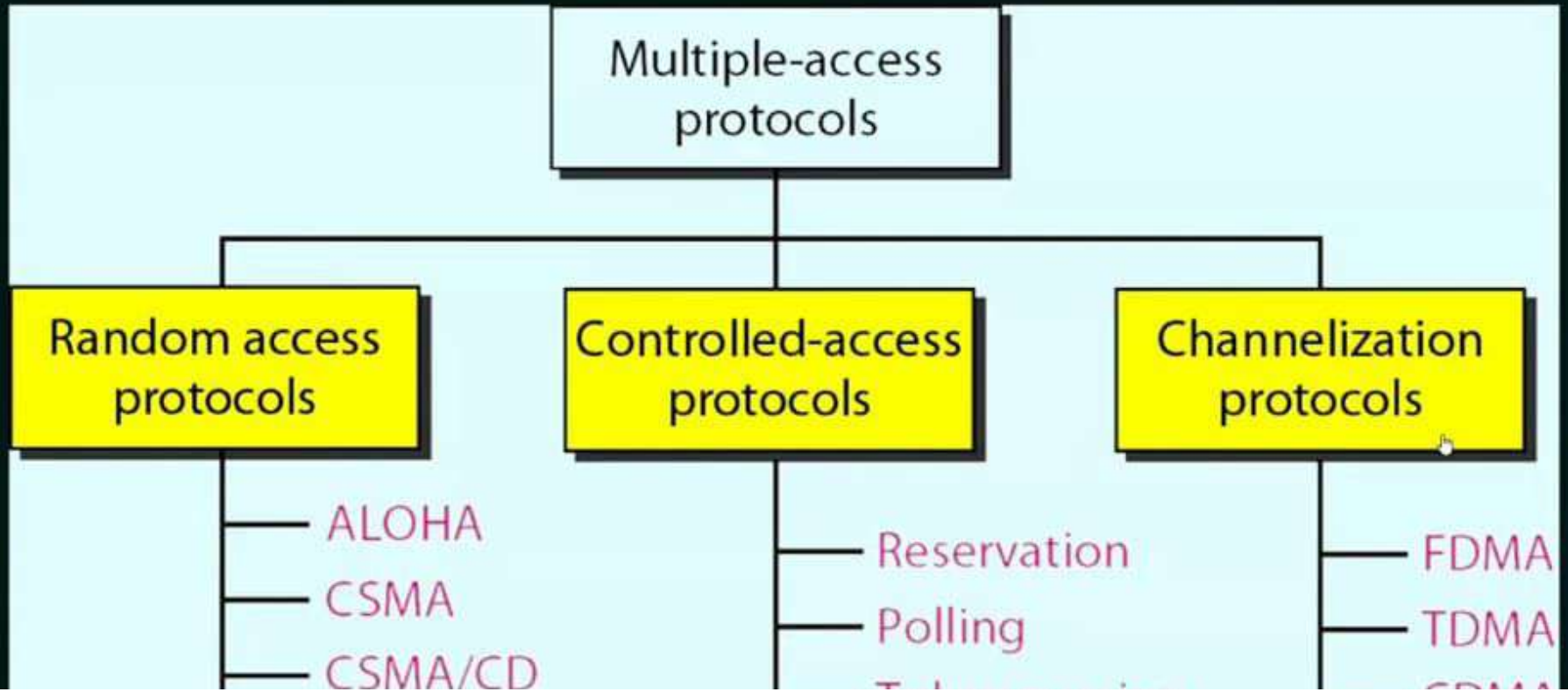
Channelization Protocols



Multiple Access Protocols



ALOHA

- ★ Aloha is a random access protocol.
- ★ It was actually designed for WLAN but it is also applicable for shared medium.
- ★ In this, multiple stations can transmit data at the same time and can hence lead to collision and data being garbled.

Collision

ALOHA

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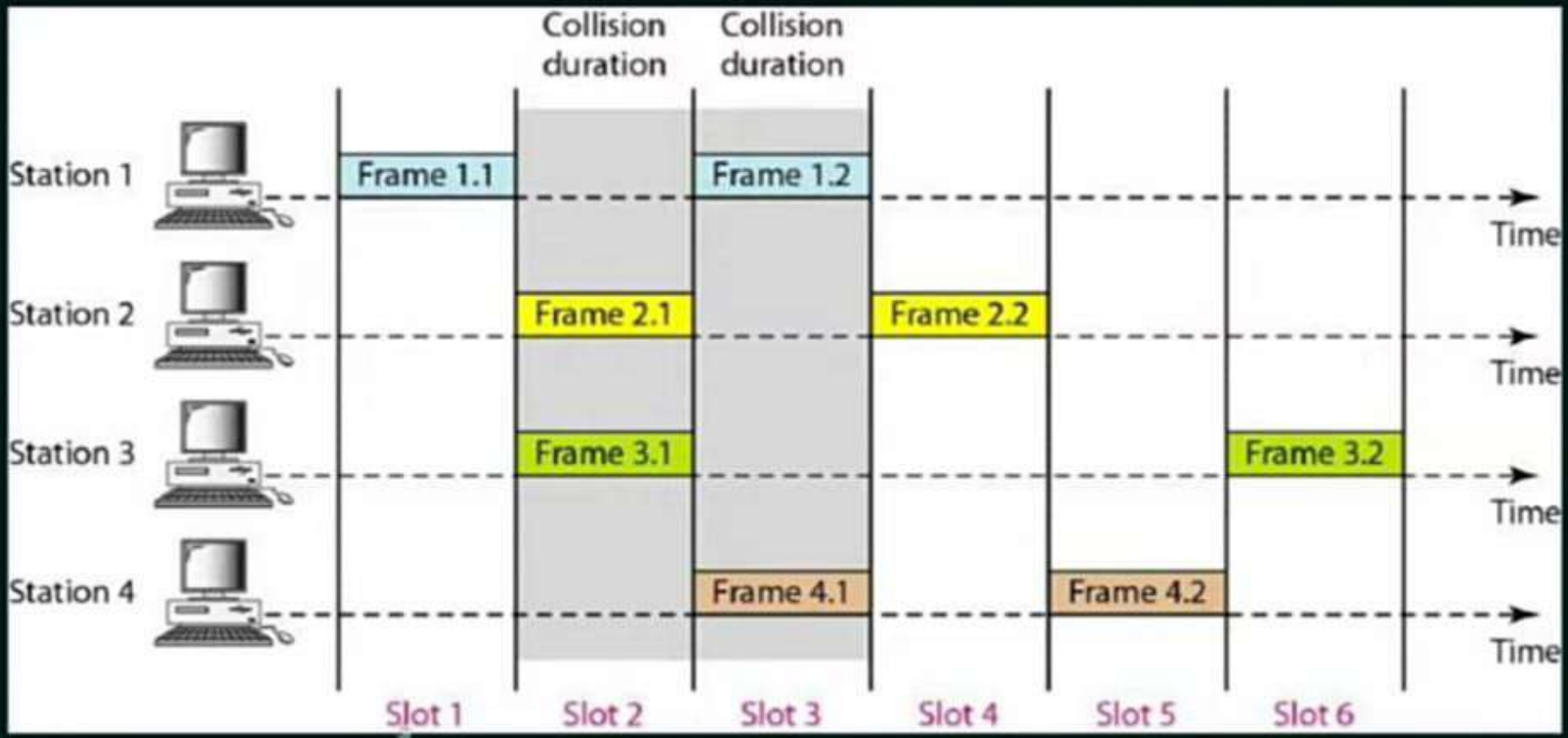
Types:

- ★ Pure Aloha
- ★ Slotted Aloha

Slotted ALOHA



Pure aloha vs Slotted aloha

Pure Aloha	Slotted Aloha
Any station can transmit the data at any time.	Any station can transmit the data at the beginning of any time slot.
The time is continuous and not globally synchronized.	The time is discrete and globally synchronized.
Vulnerable time in which collision may occur $= 2 \times T_{Fr}$	Vulnerable time in which collision may occur $= T_{Fr}$
Probability of successful transmission of data packet= $G \times e^{-2G}$	Probability of successful transmission of data packet= $G \times e^{-G}$
Maximum efficiency = 18.4% (Occurs at G = 1/2)	Maximum efficiency = 36.8% (Occurs at G = 1)
Main advantage: Simplicity in implementation.	Main advantage: It reduces the number of collisions to half and doubles the efficiency of pure aloha.

CSMA PROTOCOL

- ★ Carrier Sense Protocol.
- ★ To minimize the chance of collision and, therefore, increase the performance, the CSMA method was developed.
- ★ Principle of CSMA: "sense before transmit" or "listen before talk."
- ★ Carrier busy = Transmission is taking place.
- ★ Carrier idle = No transmission currently taking place.
- ★ The possibility of collision still exists because of propagation delay; a station may sense the medium and find it idle, only because the first bit sent by another station has not yet been received.

CSMA PROTOCOL

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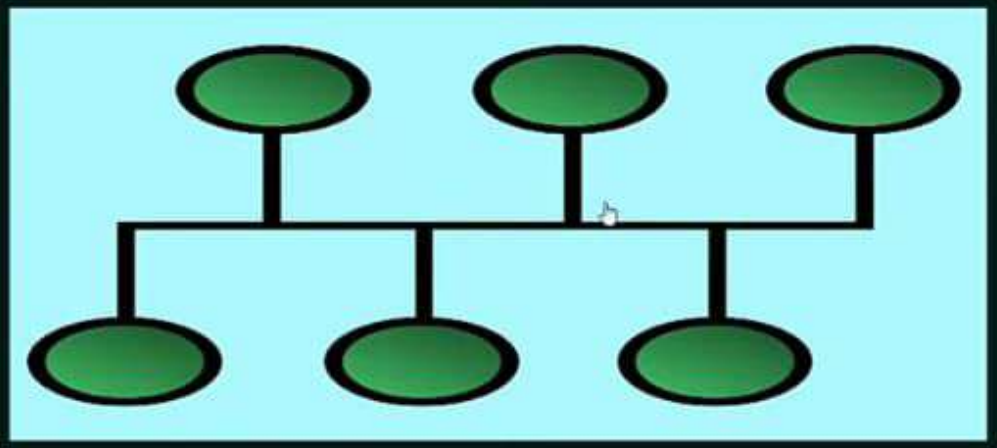


Types of CSMA

1. 1-Persistent CSMA
2. P-Persistent CSMA
3. Non-Persistent CSMA
4. O-Persistent CSMA

CSMA/CD (CSMA with Collision Detection)

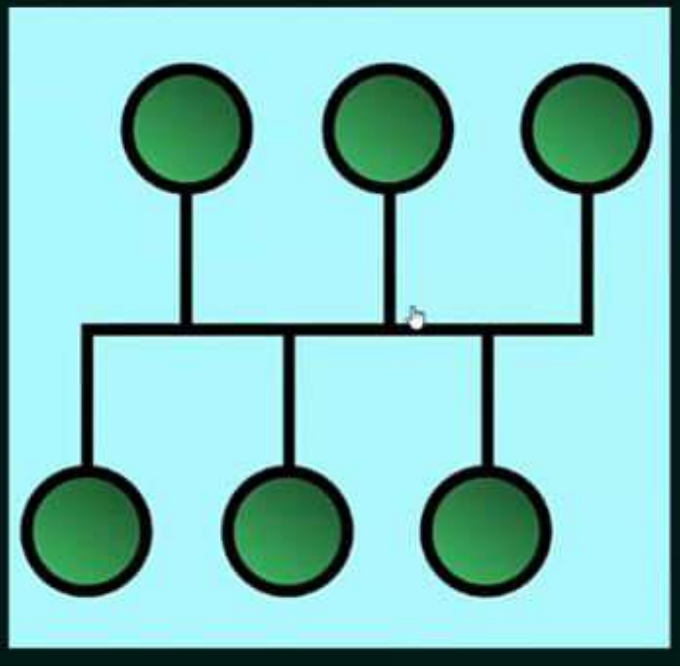
CSMA/CA (CSMA with Collision Avoidance)

1-Persistent CSMA

- ★ Before sending the data, the station first listens to the channel to see if anyone else is transmitting the data at that moment.
- ★ If the channel is idle, the station transmits a frame.
- ★ If busy, then it senses the transmission medium continuously until it becomes idle.
- ★ Since the station transmits the frame with the probability of 1 when the carrier or channel is idle, this scheme of CSMA is called as 1-Persistent CSMA.
- ★ The propagation delay has an important effect on the performance of the protocol.

1-Persistent CSMA

★ The longer the propagation delay, the more important this effect becomes, and the worse the performance of the protocol.



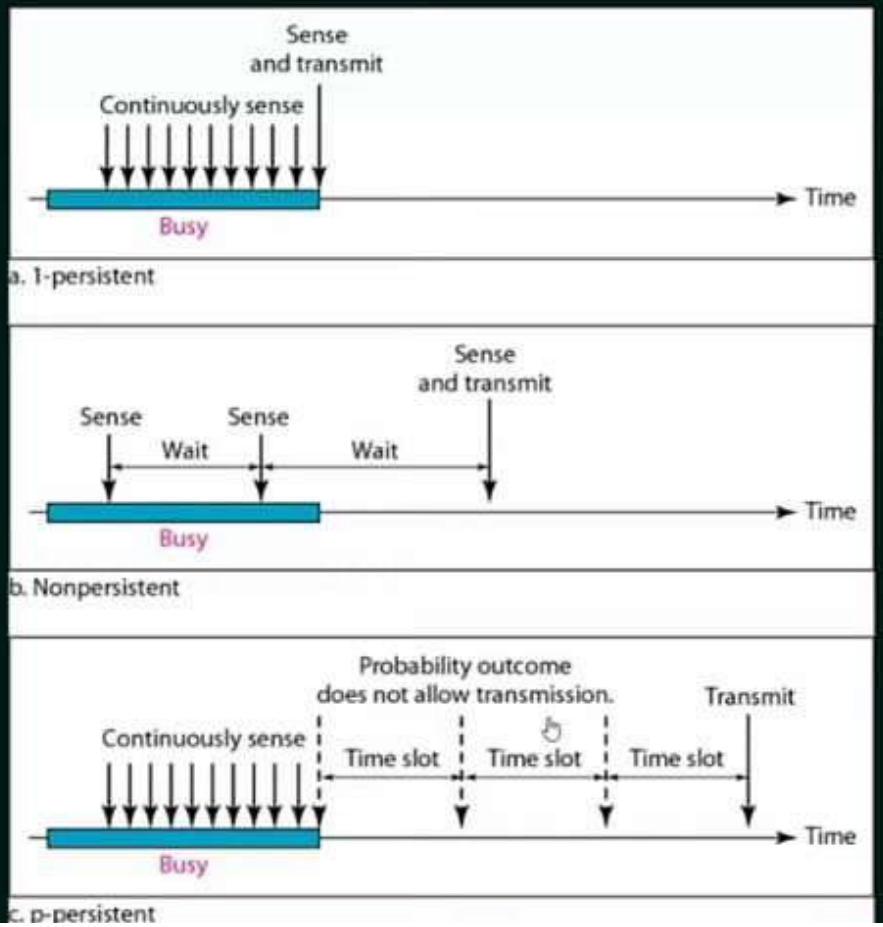
Non-Persistent CSMA

- ★ Before sending, a station senses the channel. If no one else is sending, the station begins doing so itself.
- ★ However, if the channel is already in use, the station does not continually sense it for the purpose of seizing it immediately upon detecting the end of the previous transmission.
- ★ Instead, it waits a random period of time and then repeats the algorithm. Consequently, this algorithm leads to better channel utilization but longer delays than 1-persistent CSMA.

P-Persistent CSMA

- ★ It applies to slotted channels.
- ★ When a station becomes ready to send, it senses the channel.
- ★ If it is idle, it transmits with a probability P.
- ★ With a probability Q=1-P, it defers until the next slot.
- ★ If that slot is also idle, it either transmits or defers again, with probabilities P and Q.
- ★ This process is repeated until either the frame has been transmitted or another station has begun transmitting.
- ★ In the latter case, the unlucky station acts as if there had been a collision (i.e., it waits a random time and starts again).
- ★ If the station initially senses the channel busy, it waits until the next slot and applies the above algorithm.

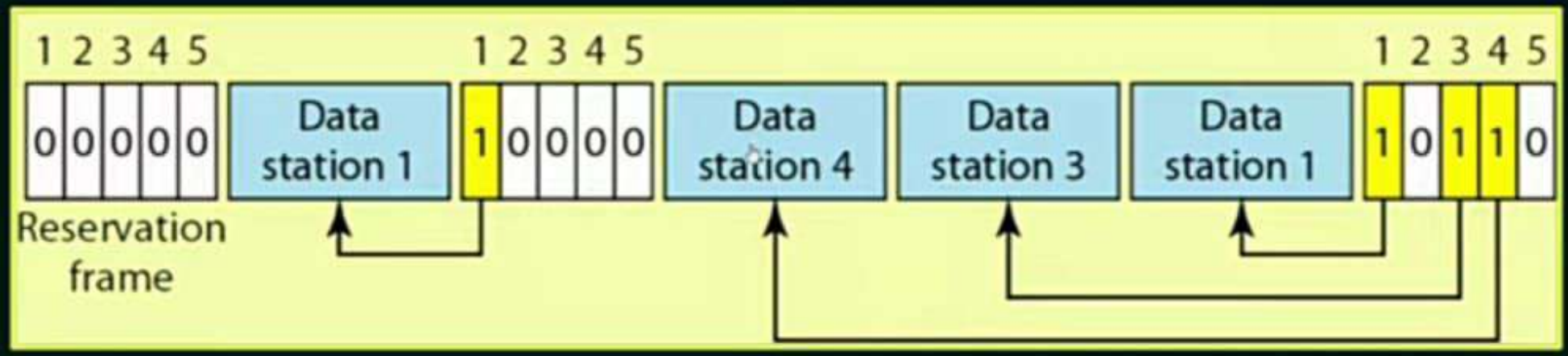
Behaviour of three persistent methods



Reservation

- ★ A station need to make a reservation before sending data.
- ★ In each interval, a reservation frame precedes the data frames sent in that interval.
- ★ If there are N stations in the system, there are exactly N reservation minislots in the reservation frame.
- ★ Each minislot belongs to a station.
- ★ When a station needs to send a data frame, it makes a reservation in its own minislot.
- ★ The stations that have made reservations can send their data frames after the reservation frame.

Reservation



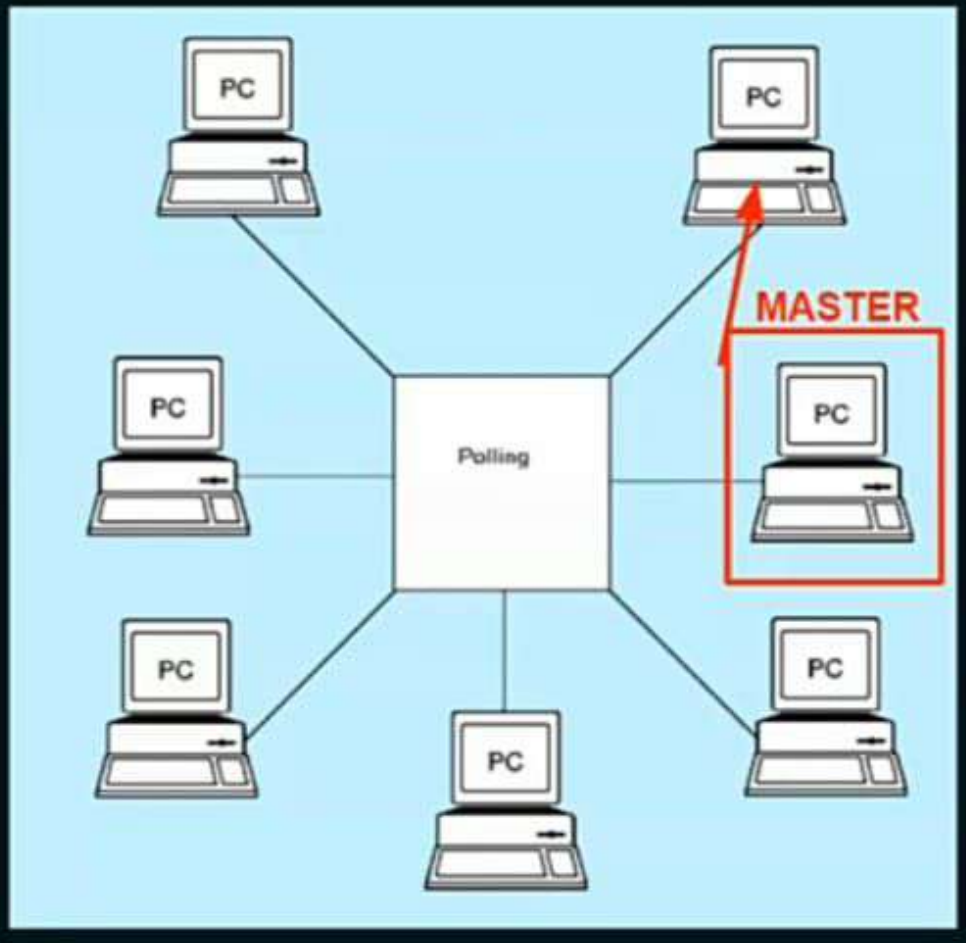
POLLING

- ★ The polling protocol requires one of the nodes to be designated as a Master node (Primary station).
- ★ The master node polls each of the nodes in a round-robin fashion.
- ★ In particular, the master node first sends a message to node 1, saying that it (node 1) can transmit up to some maximum number of frames.
- ★ After node 1 transmits some frames, the master node tells node 2 it (node 2) can transmit up to the maximum number of frames.
- ★ The master node can determine when a node has finished sending its frames by observing the lack of a signal on the channel.

POLLING

- ★ The procedure continues in this manner, with the master node polling each of the nodes in a cyclic manner.
- ★ The polling protocol eliminates the collision.
- ★ This allows polling to achieve a much higher efficiency.
- ★ The first drawback is that the protocol introduces a polling delay—the amount of time required to notify a node that it can transmit.
- ★ The second drawback, which is potentially more serious, is that if the master node fails, the entire channel becomes inoperative.

POLLING



Polling – Functions

- ★ Poll function : If the primary wants to receive data, it asks the secondaries if they have anything to send.
- ★ Select function : If the primary wants to send data, it tells the secondary to get ready to receive.

Token passing

- ★ A station is authorized to send data when it receives a special frame called a token.
- ★ Here there is no master node.
- ★ A small, special-purpose frame known as a token is exchanged among the nodes in some fixed order.
- ★ When a node receives a token, it holds onto the token only if it has some frames to transmit; otherwise, it immediately forwards the token to the next node.

Token passing

- ★ If a node does have frames to transmit when it receives the token, it sends up to a maximum number of frames and then forwards the token to the next node.
- ★ Token passing is decentralized and highly efficient. But it has problems as well.
- ★ For example, the failure of one node can crash the entire channel. Or if a node accidentally neglects to release the token, then some recovery procedure must be invoked to get the token back in circulation.

Token Passing

CHANNELIZATION

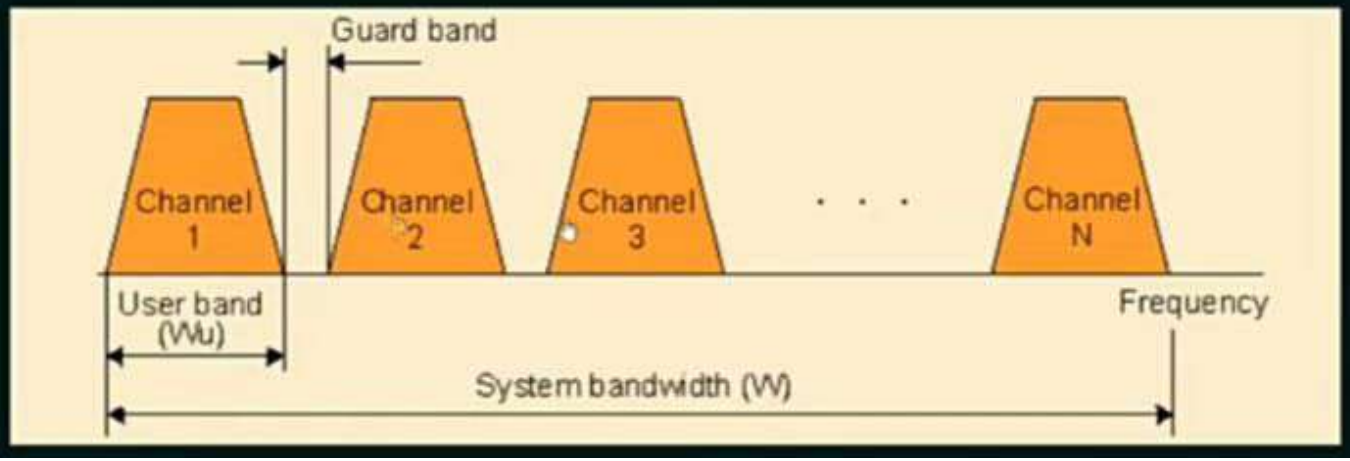
★ Channelization is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, between different stations.

VARIOUS MULTIPLE ACCESS METHODS

- ★ Frequency Division Multiple Access (FDMA)
- ★ Time Division Multiple Access (TDMA)
- ★ Code Division Multiple Access (CDMA)

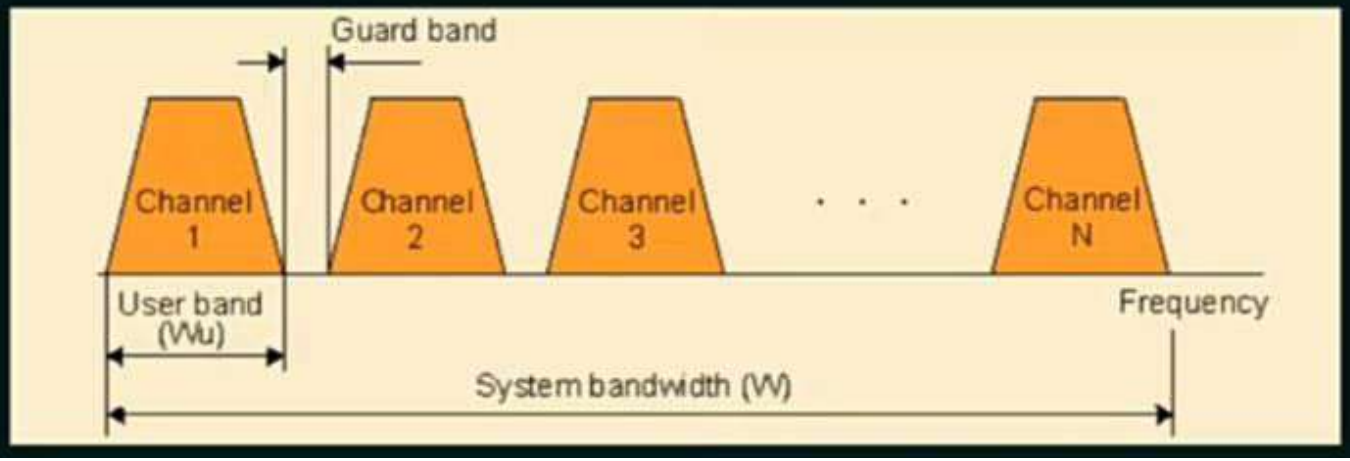
FDMA

★ In FDMA, the available bandwidth of the common channel is divided into bands that are separated by guard bands.

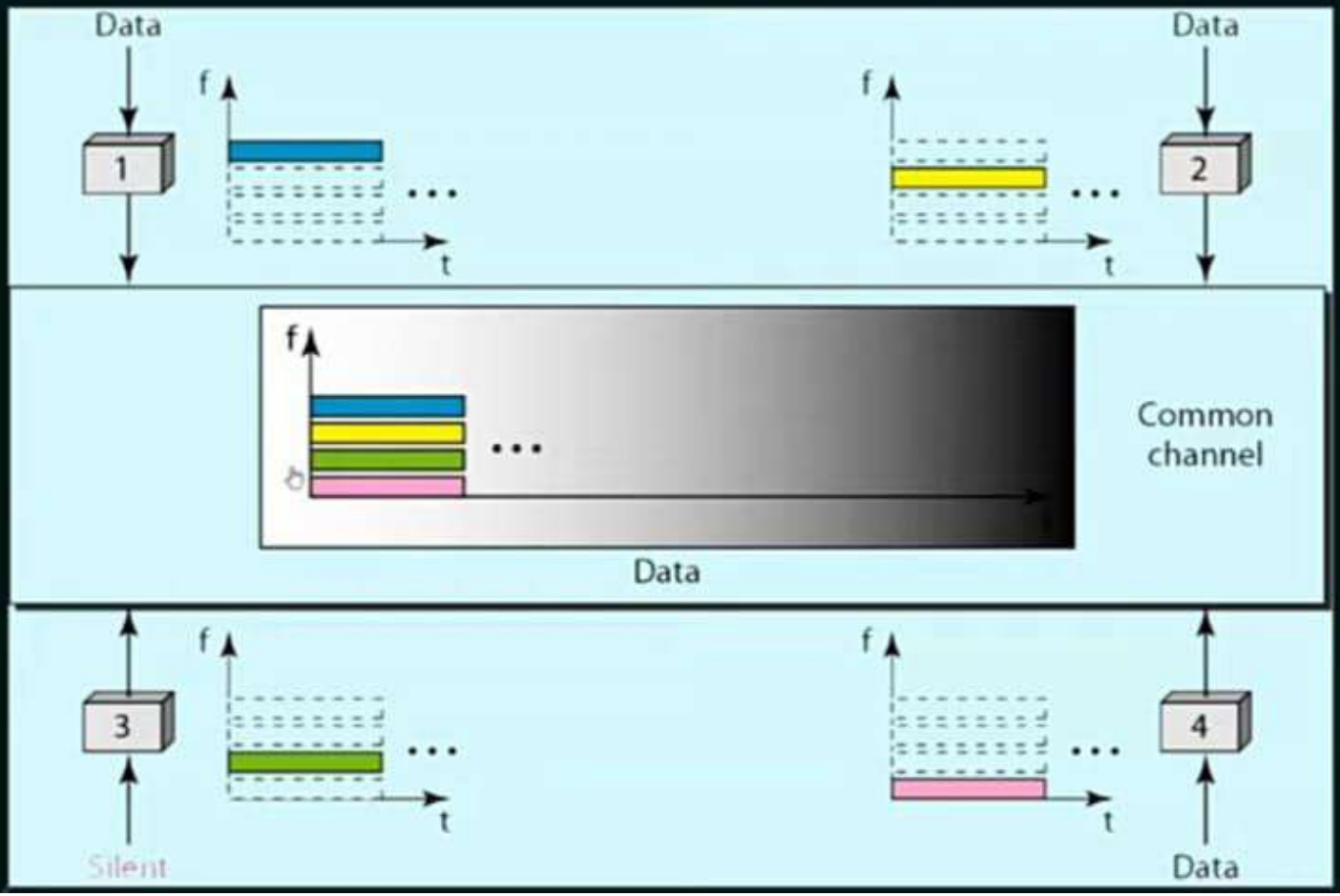


FDMA

- ★ In FDMA, the available bandwidth of the common channel is divided into bands that are separated by guard bands.
- ★ The available bandwidth is shared by all stations.
- ★ The FDMA is a data link layer protocol that uses FDM at the physical layer.



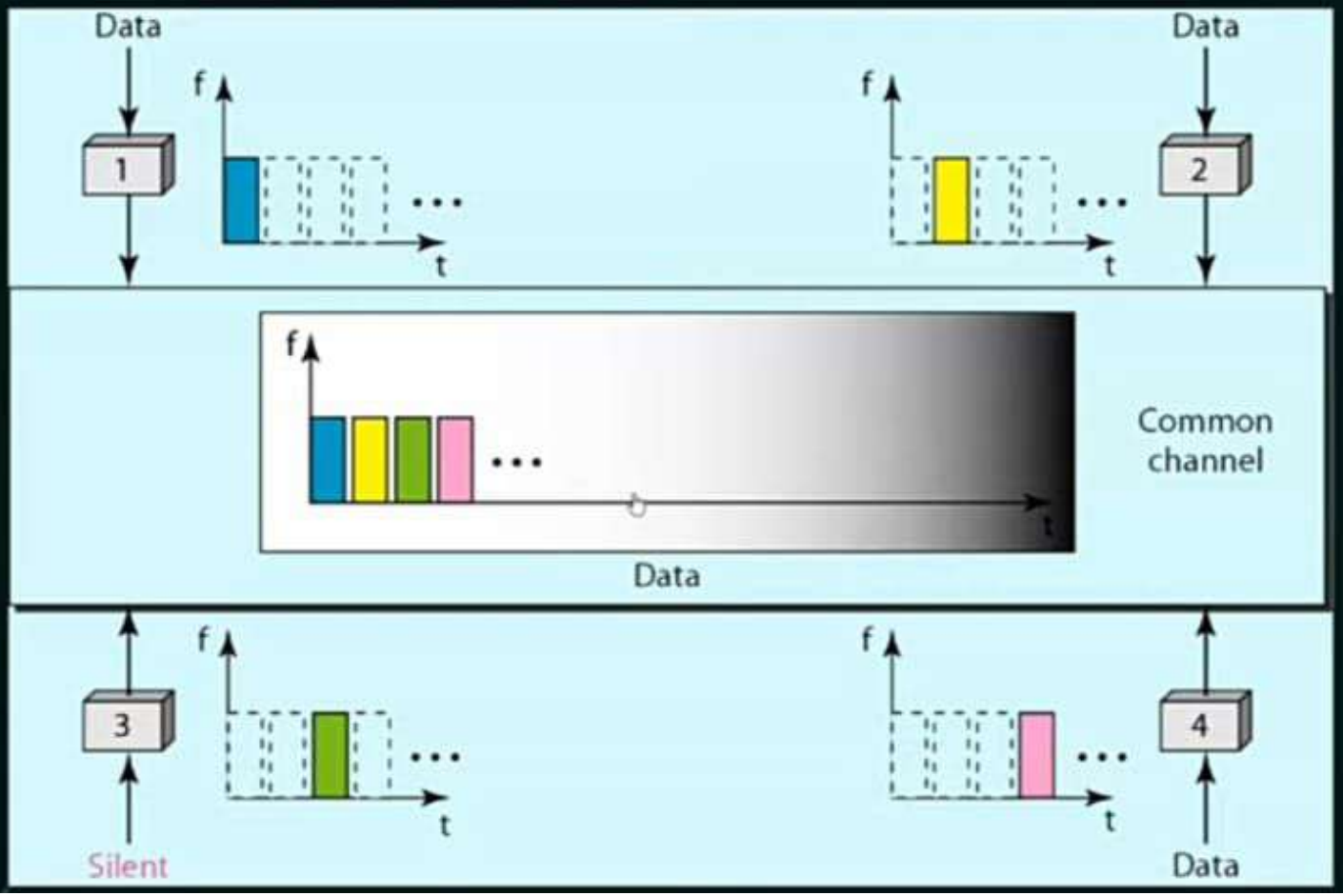
FDMA



TDMA

- ★ In TDMA, the bandwidth is just one channel that is time shared between different stations.
- ★ The entire bandwidth is just one channel.
- ★ Stations share the capacity of the channel in time.

TDMA



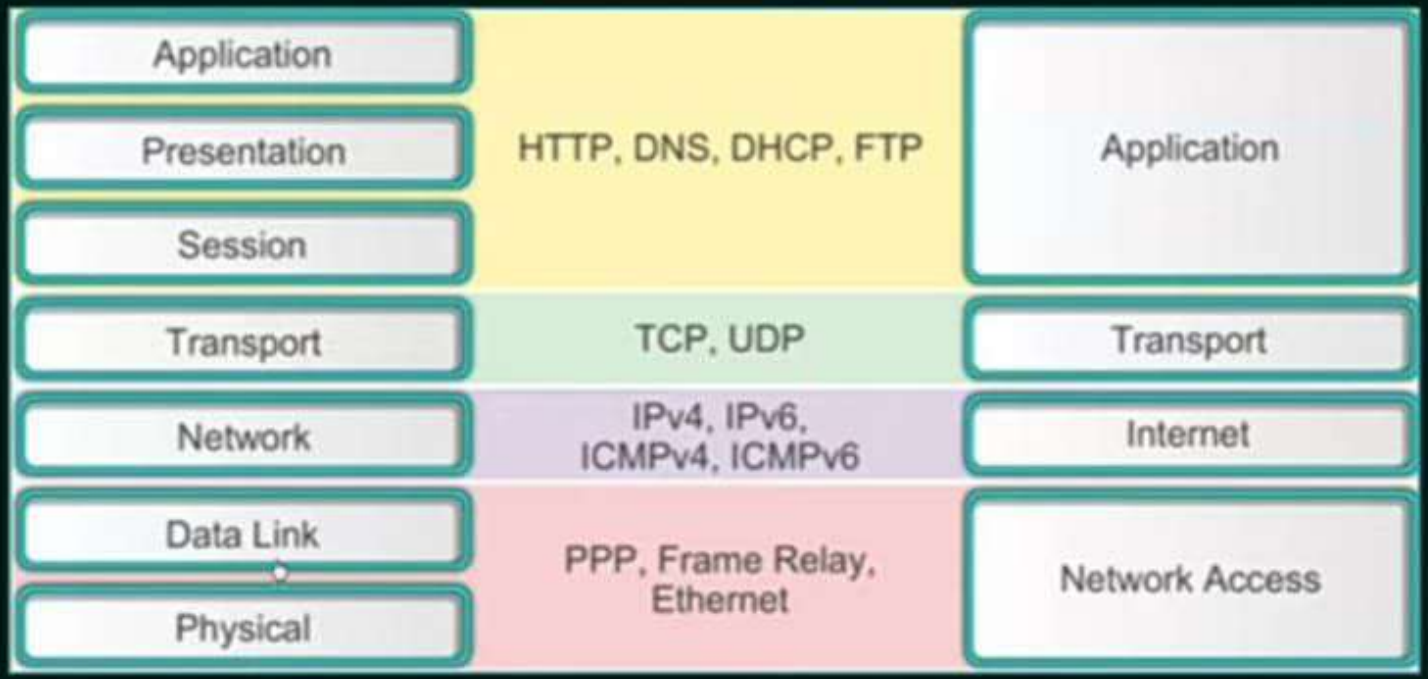
CDMA

- ★ In CDMA, one channel carries all transmissions simultaneously.
- ★ CDMA differs from FDMA because only one channel occupies the entire bandwidth of the link.
- ★ It differs from TDMA because all stations can send data simultaneously; there is no time sharing.

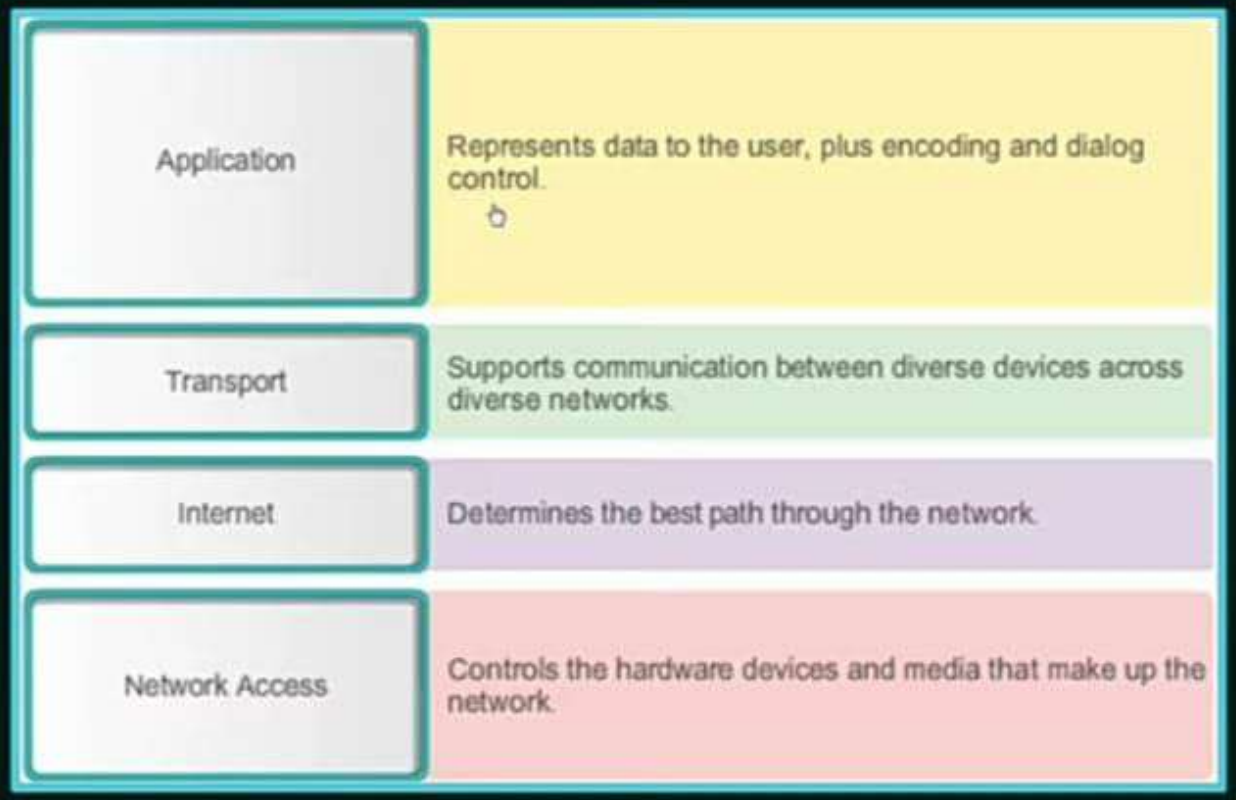
CDMA


d_1
d_2
1
2
$d_1 \cdot c_1$
$d_2 \cdot c_2$
$d_1 \cdot c_1 + d_2 \cdot c_2 + d_3 \cdot c_3 + d_4 \cdot c_4$
Data
Common channel
$d_3 \cdot c_3$
$d_4 \cdot c_4$
3
4
d_3
d_4

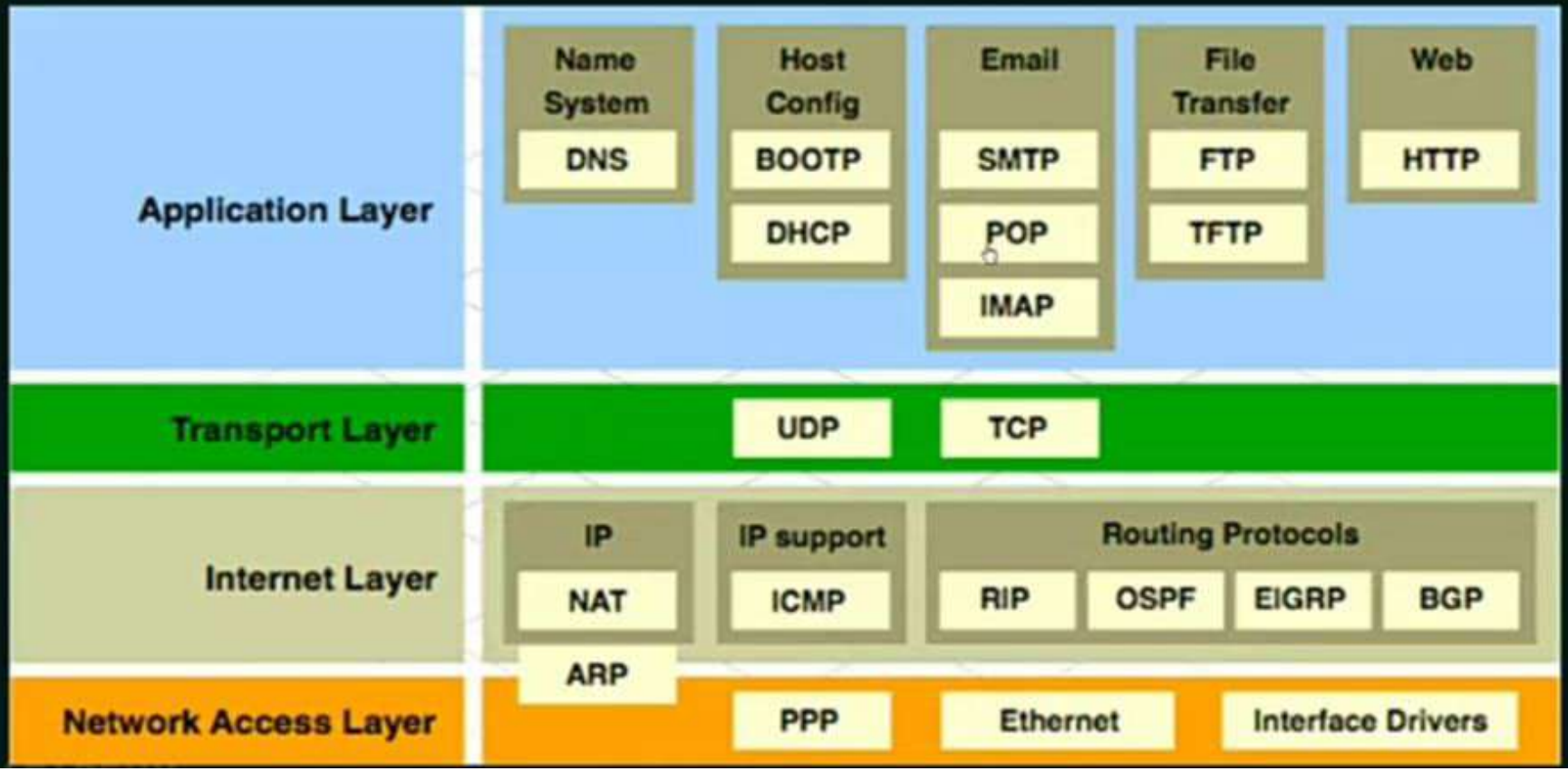
OSI Reference model Vs TCP/IP model



THE TCP/IP MODEL



THE TCP/IP PROTOCOL SUITE

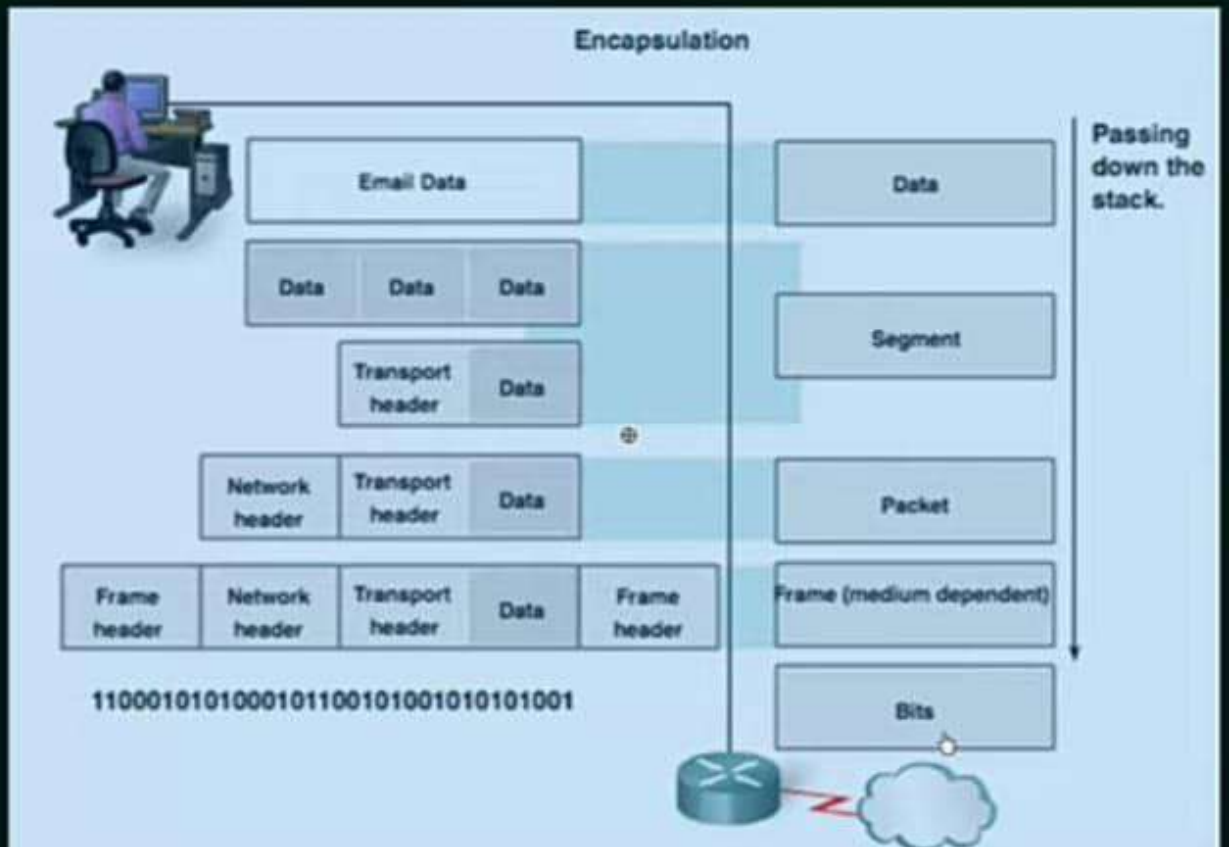


Protocol Data Unit (PDU)

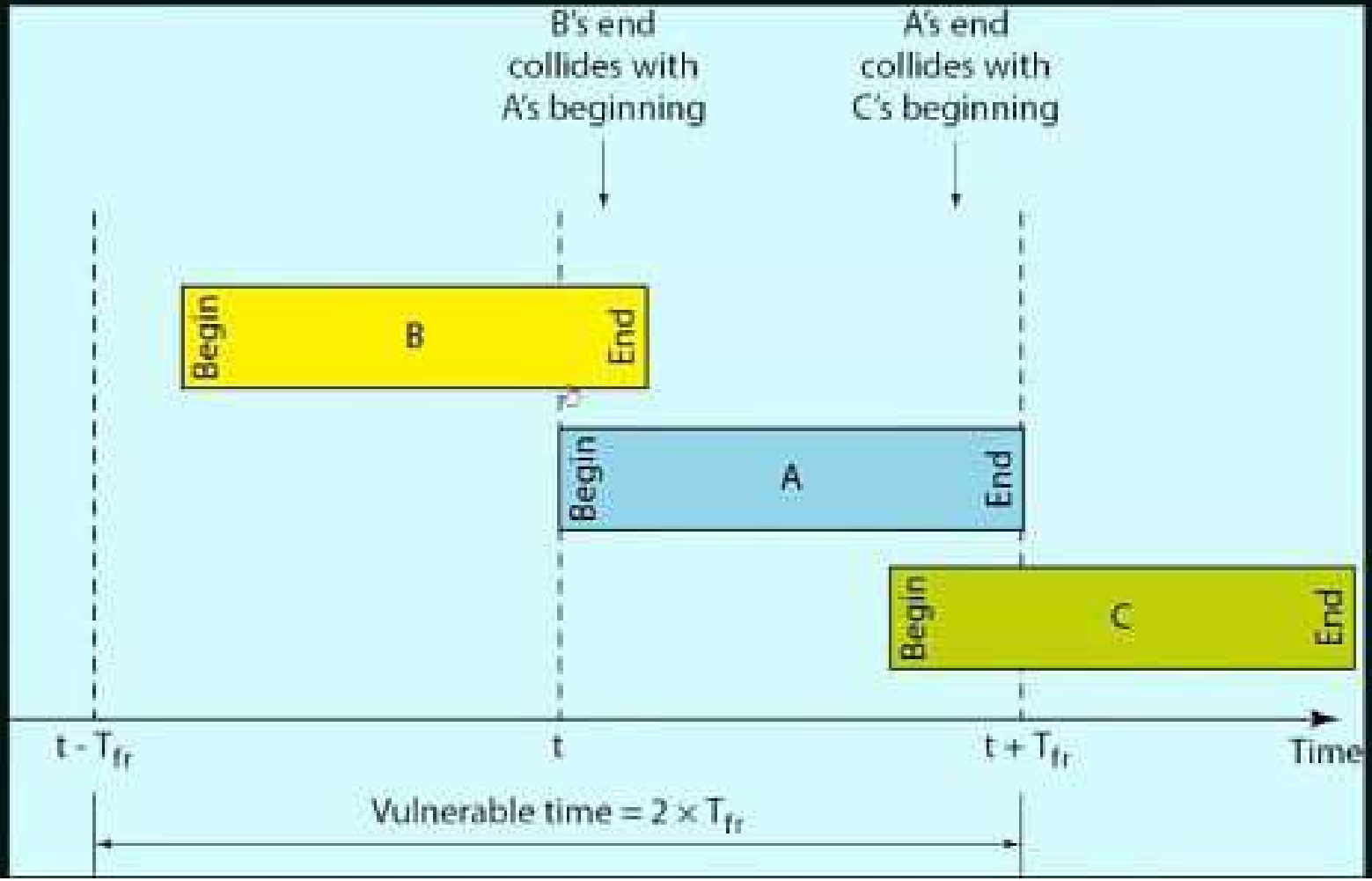
Protocol Data Units (PDUs) are named according to the protocols of the TCP/IP suite: data, segment, packet, frame, and bits.

Application Layer – Data
Transport Layer – Segment
Network Layer – Packet
Data Link Layer – Frame
Physical Layer– Bits

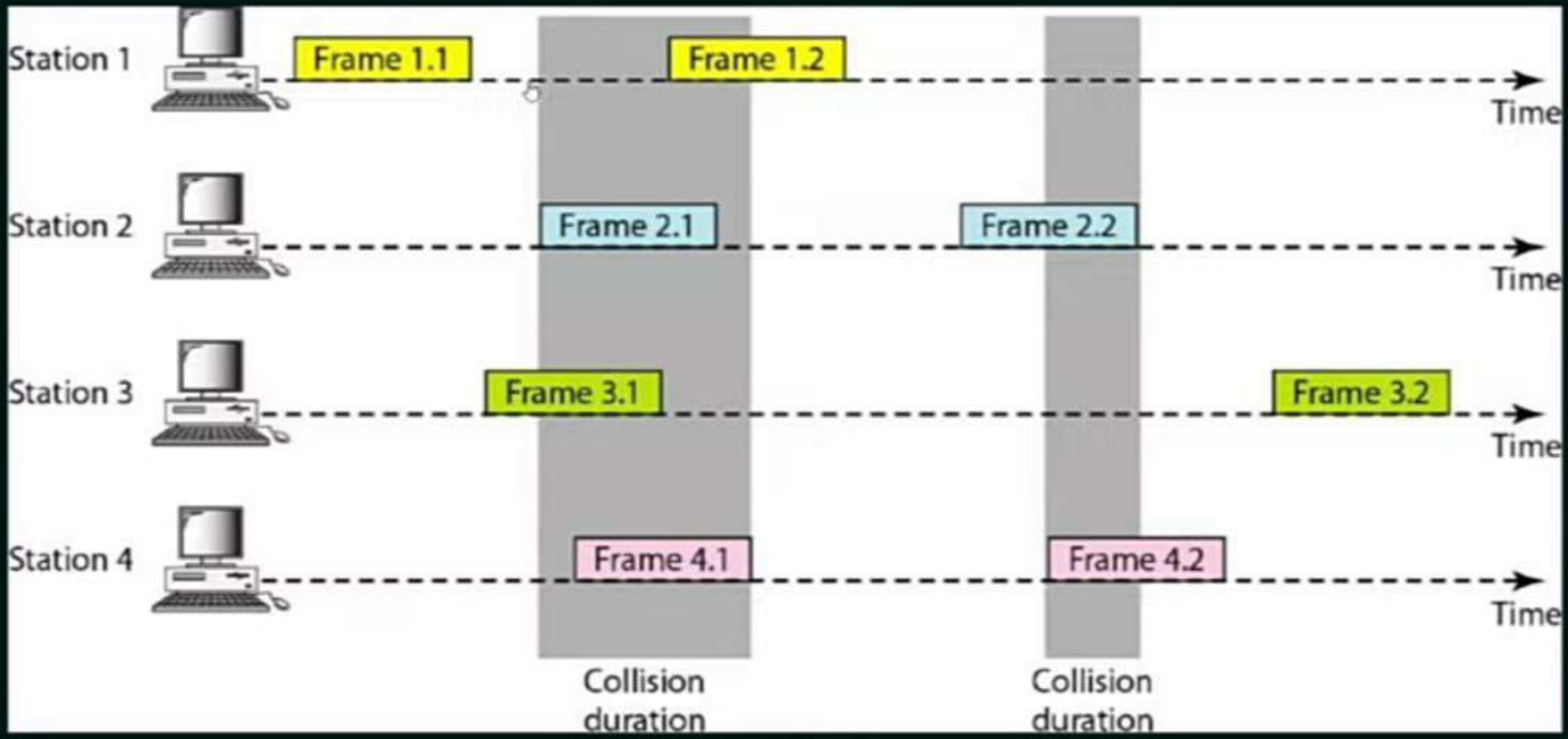
Protocol Data Unit (PDU)



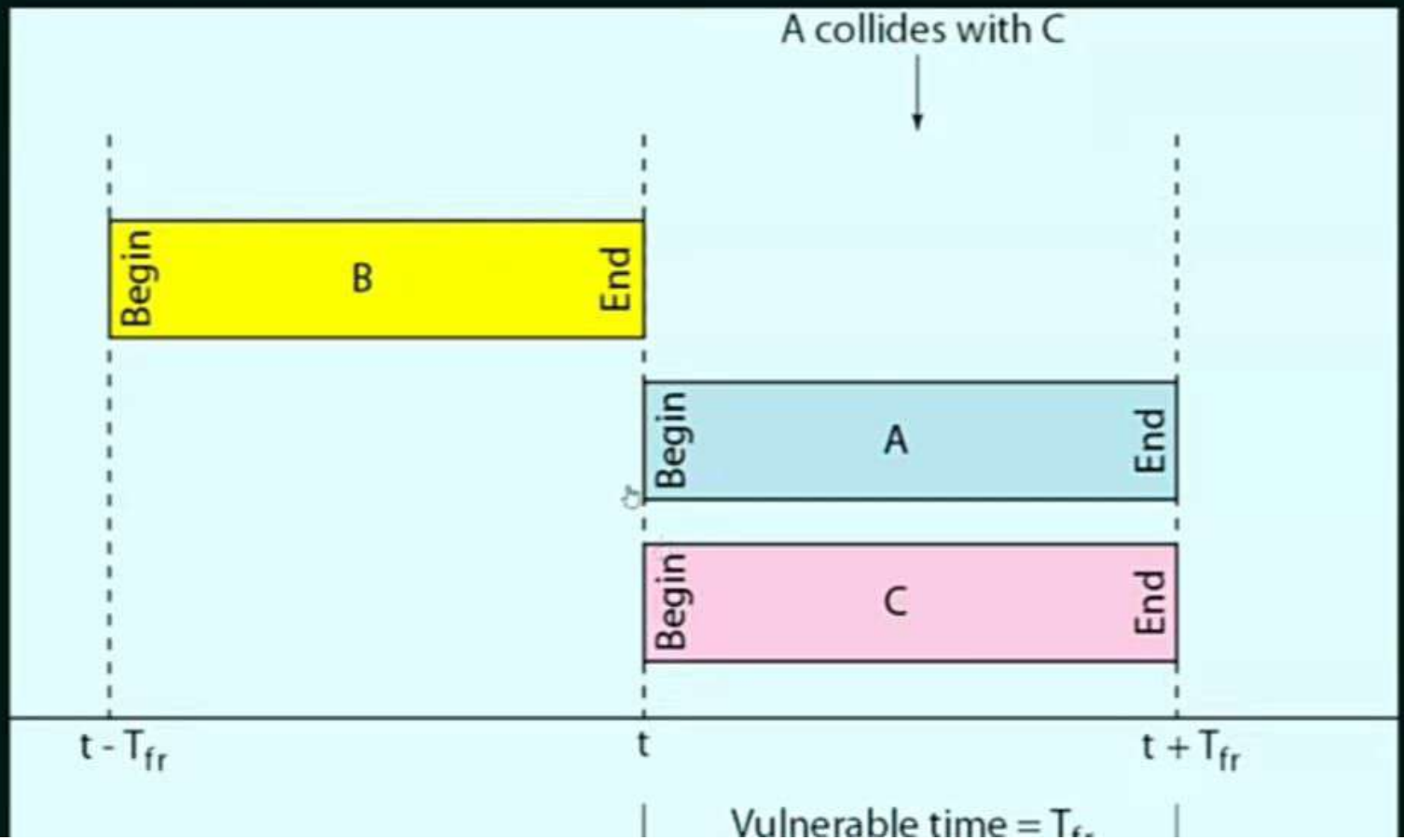
Pure aloha


B's end
collides with
A's beginning
A's end
collides with
C's beginning
Begin
B
End
Begin
A
End
Begin
C
End
t - Tfr
t
t + Tfr
Time
Vulnerable time = 2 × Tfr

Pure aloha


Station 1
Frame 1.1
Frame 1.2
Time
Station 2
Frame 2.1
Frame 2.2
Time
Station 3
Frame 3.1
Frame 3.2
Time
Station 4
Frame 4.1
Frame 4.2
Time
Collision duration
Collision duration

Slotted aloha



Slotted aloha