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Multiple Access Protocols

By

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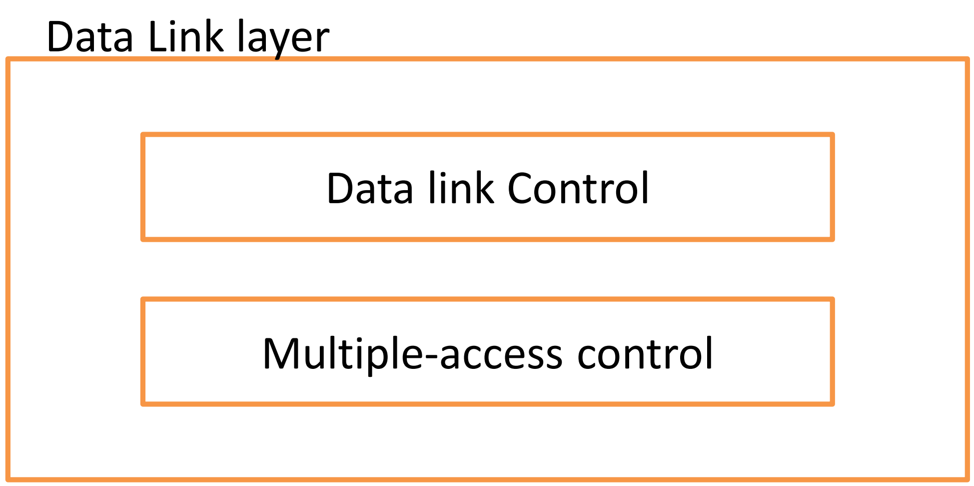
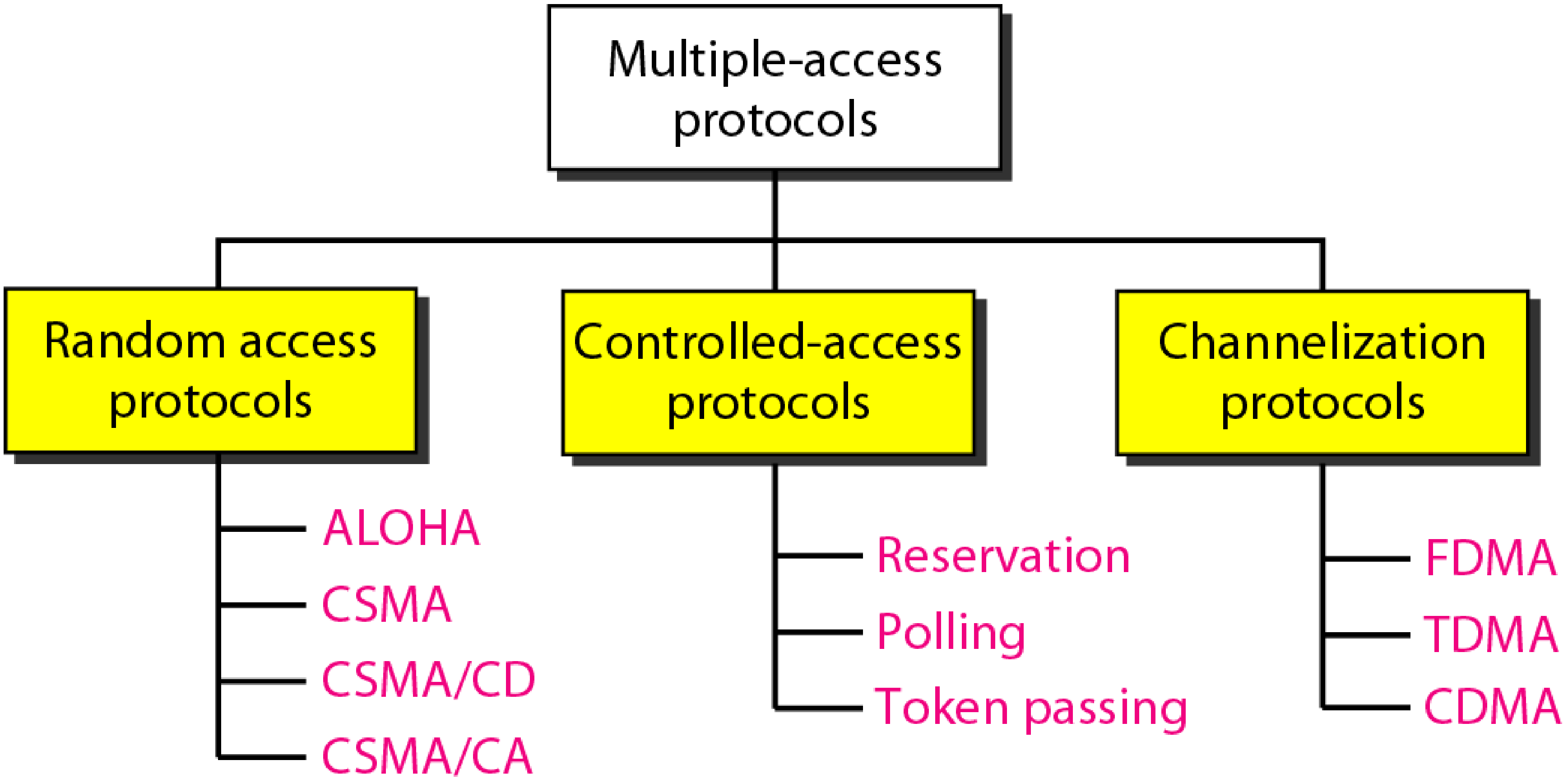
Multiple Access

- Data link layer is considered as two sublayers.
- The upper sublayer is responsible for data link control.
- The lower sublayer is responsible for resolving access to the shared media.



Taxonomy of multiple-access protocols



Random Access Method

In random access or contention methods, no station is superior to another station and none is assigned the control over another. No station permits, or does not permit, another station to send. At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send.

Collision: If more than one station tries to send, there is as access conflict. This is called collision and the frames either be destroyed or modified.

Random Access Method (Contd.)

- In random access, there is no schedule time for a station to transmit. Transmission is random among the stations.
- No rules specify which station should send next.

In this chapter we will discuss the following topics in detail.

1. ALOHA
2. Carrier Sense Multiple Access
3. Carrier Sense Multiple Access with Collision Detection
4. Carrier Sense Multiple Access with Collision Avoidance

ALOHA

- It is the earliest random access method
- Two types of ALOHA
  - i) Pure ALOHA
  - Ii) Slotted ALOHA
- The original ALOHA protocol is called **pure ALOHA**
- **This is very simple and the idea is that each station sends a frame whenever it has a frame to send.**
- Since only one channel to share, there is the possibility of **collision** between frames from different stations
- The Figure next shows the working procedure of it and the collision between frames

PURE ALOHA (CONTD.)

- It is relies on acknowledgement from the receiver.
- If the Ack does not arrive after a time-out period, the station assumes the frame has been destroyed, and resends the frame.

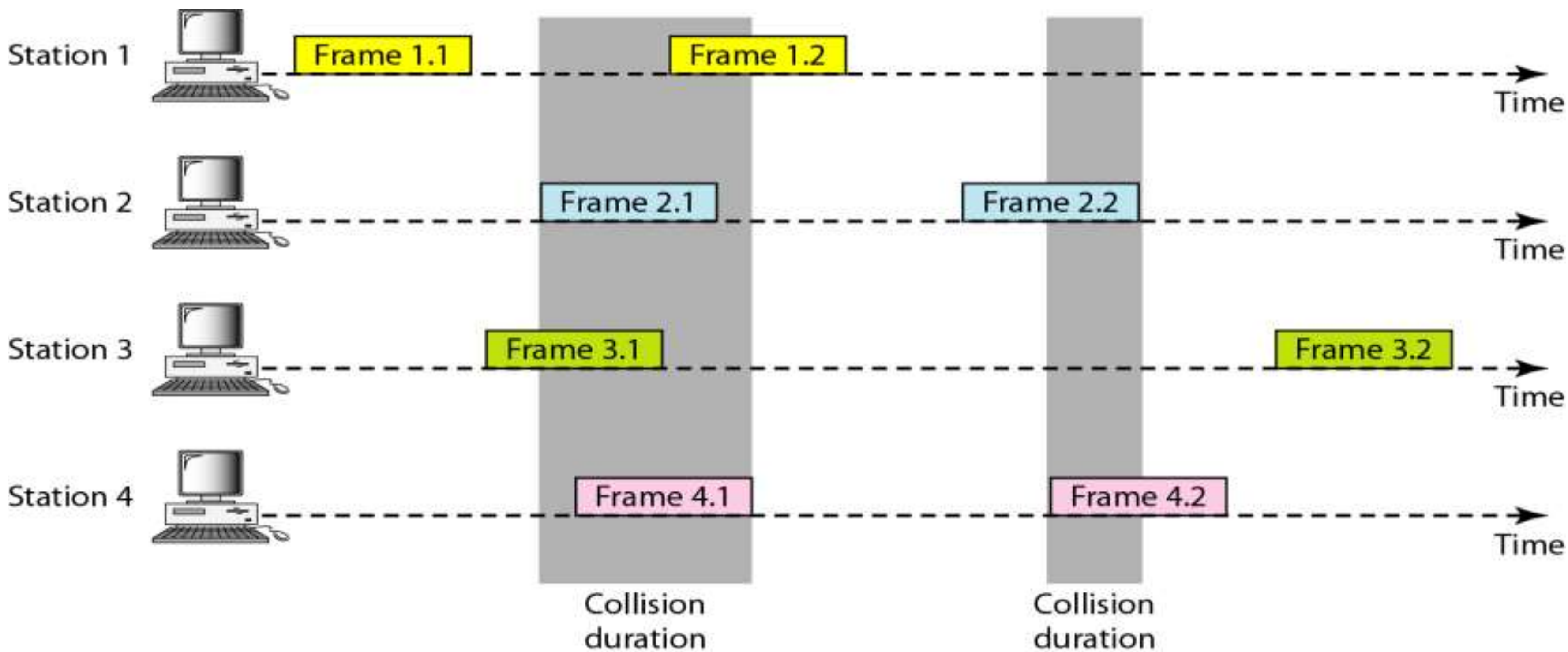


Figure 1: Frames in a pure ALOHA network

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Vulnerable Time: It is the time in which there is a possibility of collision.
Pure ALOHA vulnerable time = 2 x T_{fr}

Figure below shows the explanation of finding vulnerable time.

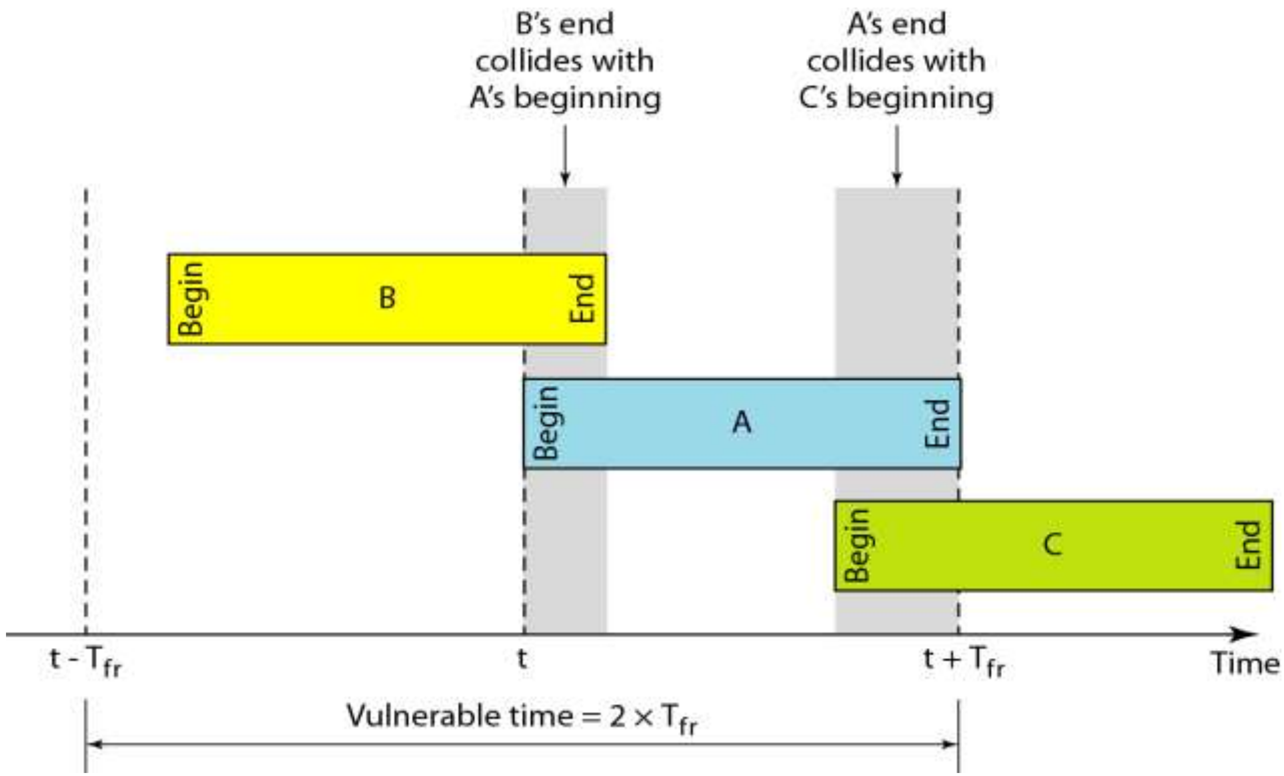


Figure 2: Vulnerable time for pure ALOHA protocol

Contd.

Therefore, the throughput for pure ALOHA is given as:

$$S = G \times e^{-2G} .$$

And the maximum throughput is

$S_{max} = 0.184$ when G= (1/2).

Example 1

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second b. 500 frames per second

c. 250 frames per second.

Solution

The frame transmission time is 200/200 kbps or 1 ms.

a. If the system creates 1000 frames per second, this is 1 frame per millisecond. The load is 1. In this case $S = G\times e^{-2G}$ or $S = 0.135$ (13.5 percent). This means that the throughput is $1000 \times 0.135 = 135$ frames. Only 135 frames out of 1000 will probably survive.

b. If the system creates 500 frames per second, this is (1/2) frame per millisecond. The load is (1/2). In this case $S = G \times e^{-2G}$ or $S = 0.184$ (18.4 percent). This means that the throughput is $500 \times 0.184 = 92$ and that only 92 frames out of 500 will probably survive.

c. If the system creates 250 frames per second, this is (1/4) frame per millisecond. The load is (1/4). In this case $S = G \times e^{-2G}$ or $S = 0.152$ (15.2 percent). This means that the throughput is $250 \times 0.152 = 38$. Only 38 frames out of 250 will probably survive.

Slotted ALOHA

- In slotted ALOHA, time is divided onto slots of T_{fr} s and force the station to send only beginning of the time slot.
- As station is allowed to send only at beginning of the time, if a station misses this moment, it must wait until the beginning of the next time slot.
- This reduce the collision of frames than pure ALOHA.

Contd.

•There is still the possibility of collision if two stations try to send the beginning of the same time slot

• Vulnerable time is now reduced to one-half

•Vulnerable time= T_{fr}

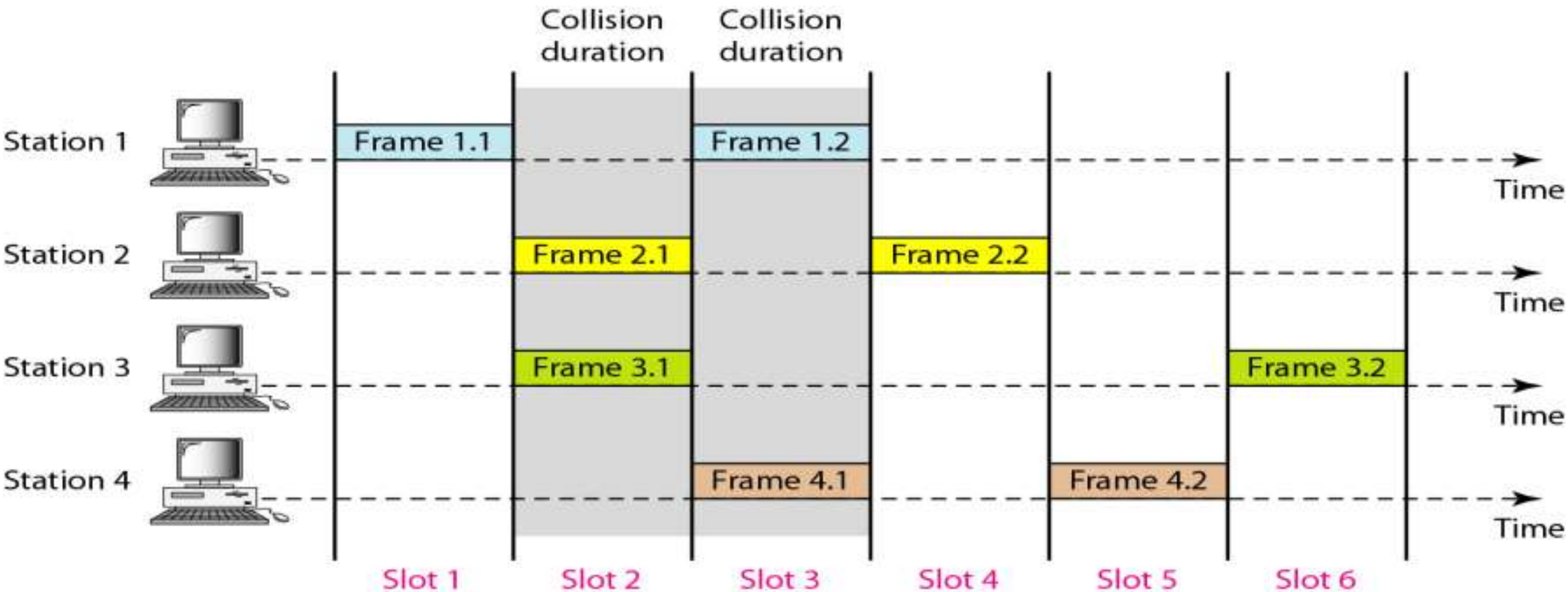
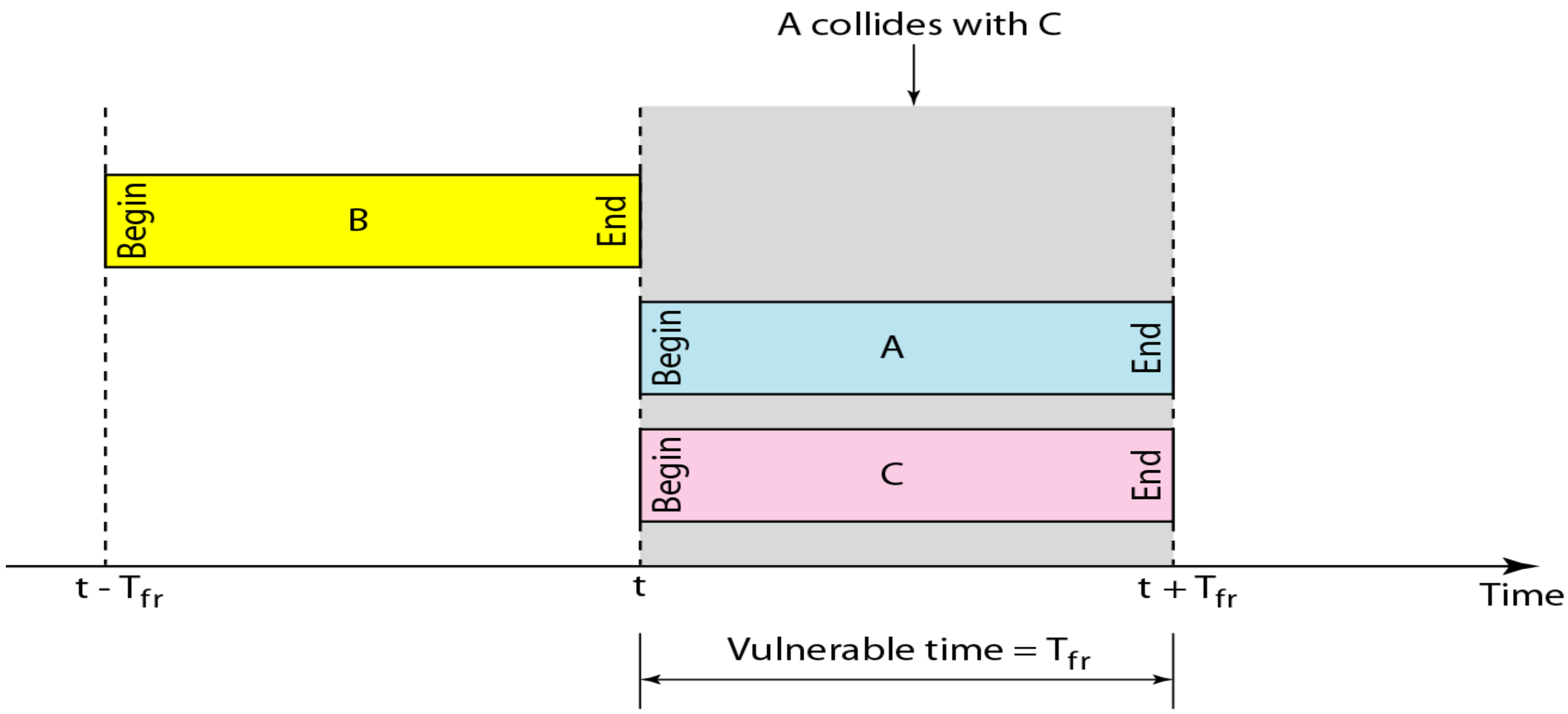


Figure 3: Frames in a slotted ALOHA network

Vulnerable time for slotted ALOHA protocol

Figure 4 shows the calculation of vulnerable time for slotted ALOHA.



The throughput for slotted ALOHA is $S = G \times e^{-G}$.

The maximum throughput $S_{max} = 0.368$ when G = 1.

Example 2 (Assignment-1)

A slotted ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second b. 500 frames per second

c. 250 frames per second.

Carrier Sense Multiple Access(CSMA)

- To minimize the chance of collision and increase the performance, the CSMA method was developed
- CSMA requires that each station first listen to the medium (before trying to use it), before sending the frames.
- CSMA can reduce the possibility of collision, but it cannot remove it

CSMA

CSMA/CD

CSMA/CA

Space/time model of the collision in CSMA

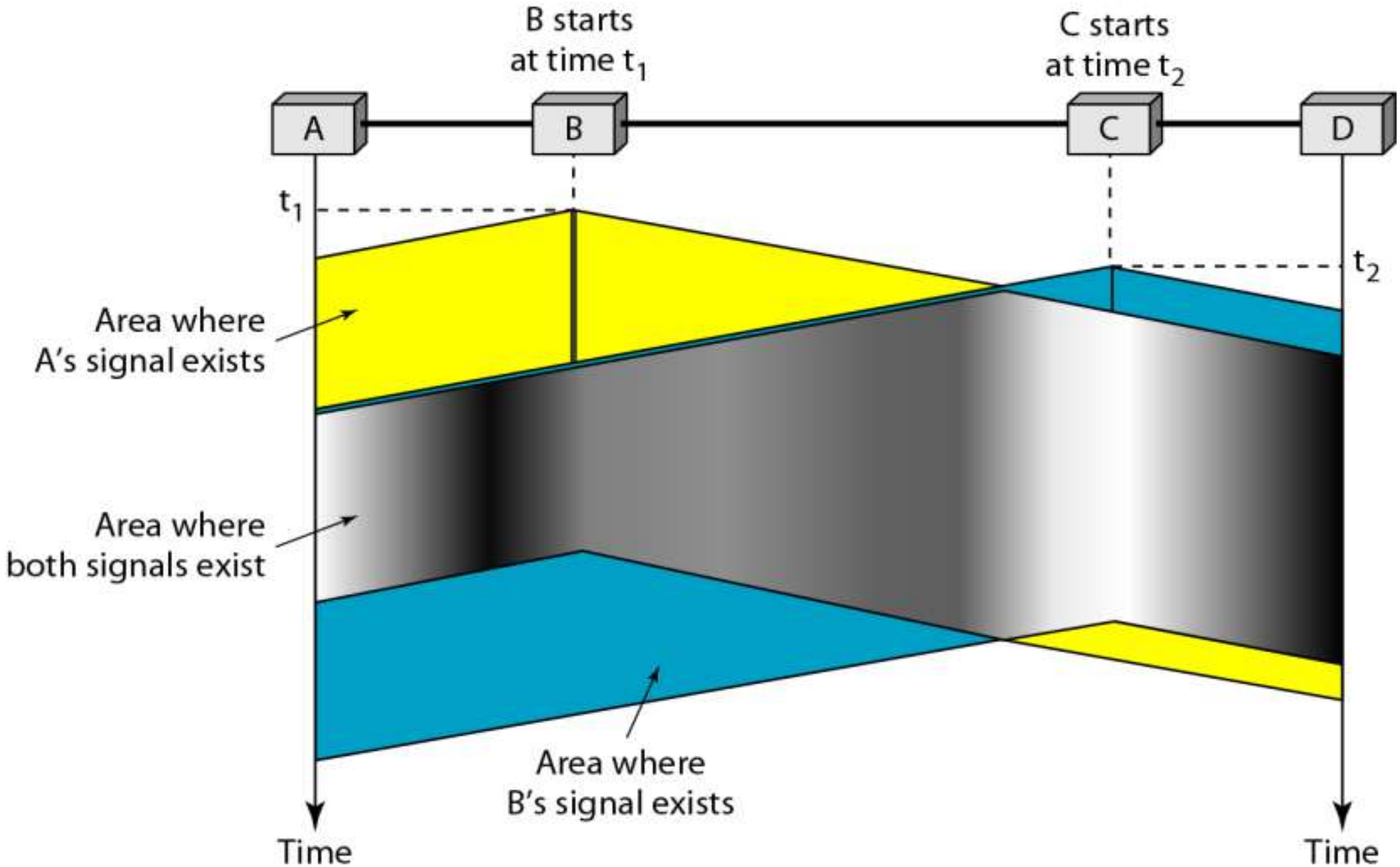


Figure 5: Collision in CSMA

Vulnerable time in CSMA

The vulnerable time for CSMA is the **propagation time T_p**

Where, *propagation time* is the time needed for a signal to propagate from one end of the medium to the other.

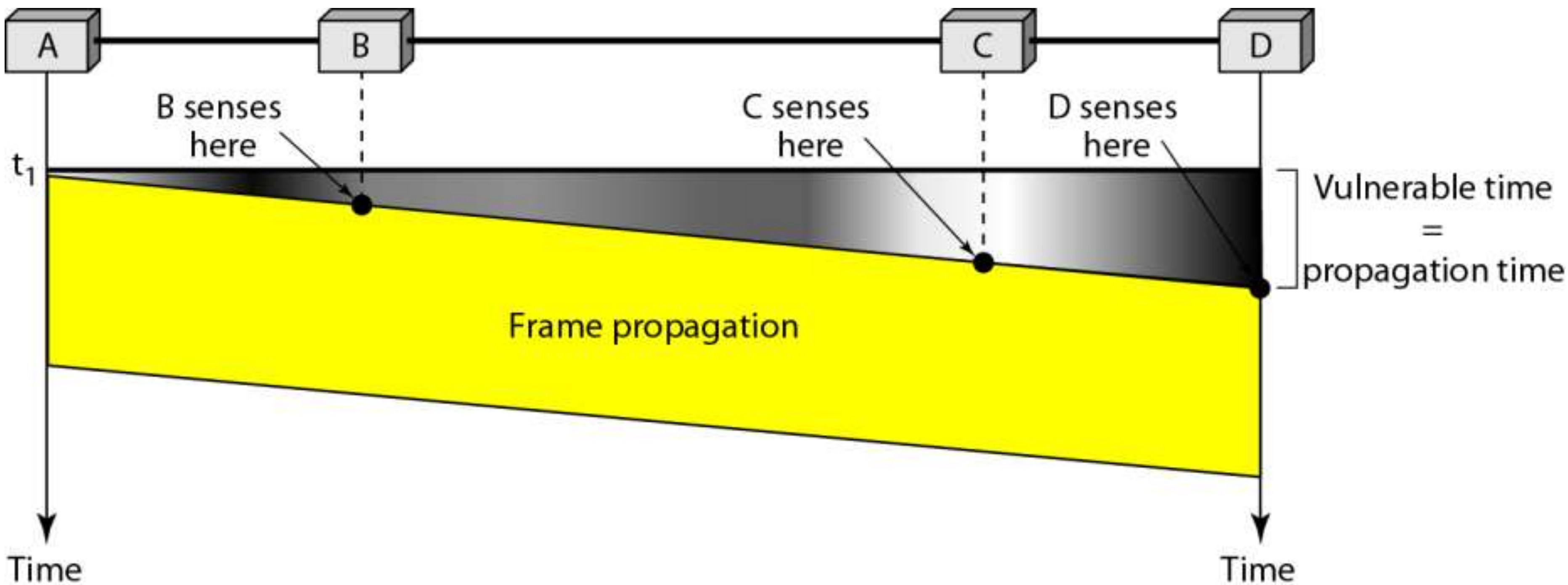


Figure 6: Vulnerable time in CSMA

Persistence Methods

- 1-persistent- here, after the station finds the line idle, it sends the frame immediately with probability 1. highest chance of collision.
- Nonpersistent- senses the line first. If the line is idle, it sends immediately. If not, it waits a random amount of time and then senses the line again.
- P-persistent- with probability p, the station sends its frame. With probability q = 1-p, the station waits for the beginning of the next time slot and checks the line again.

CSMA/CD

•In this method, a station monitors the medium after sends a frame to see if the transmission was successful. If there is a collision, the frame is resent again.

•Below figure, station A and C are involved in the collision. It is clear from the figure that A transmits for the duration t_4-t_1, whereas C transmits for the duration t_3-t_2.

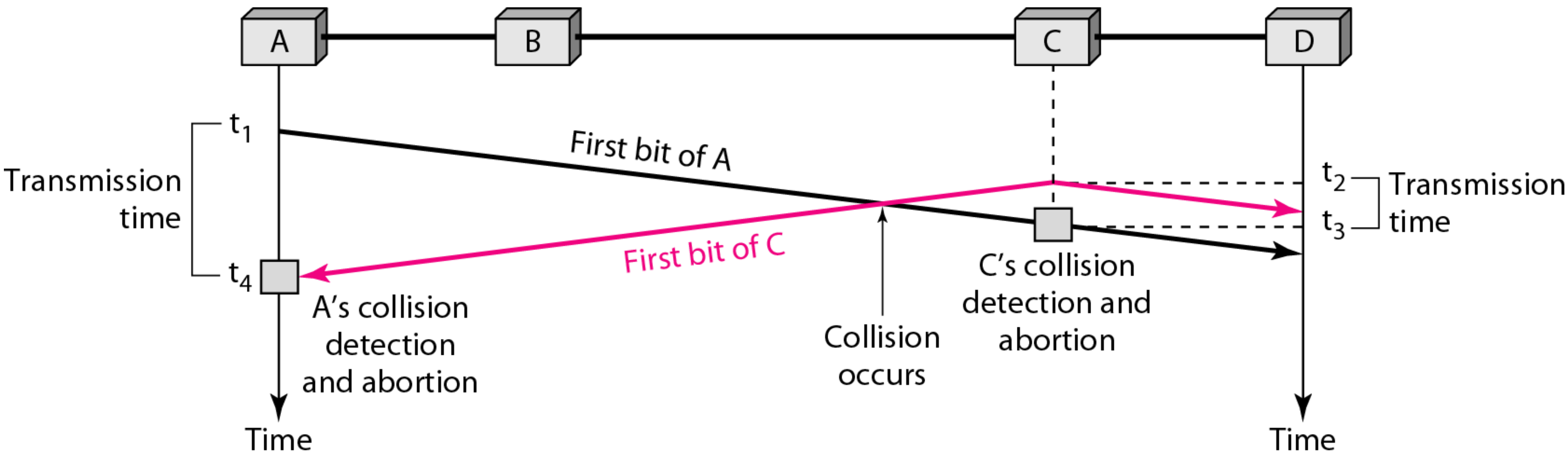


Figure 7: Collision of the first bit in CSMA/CD

Collision and abortion in CSMA/CD

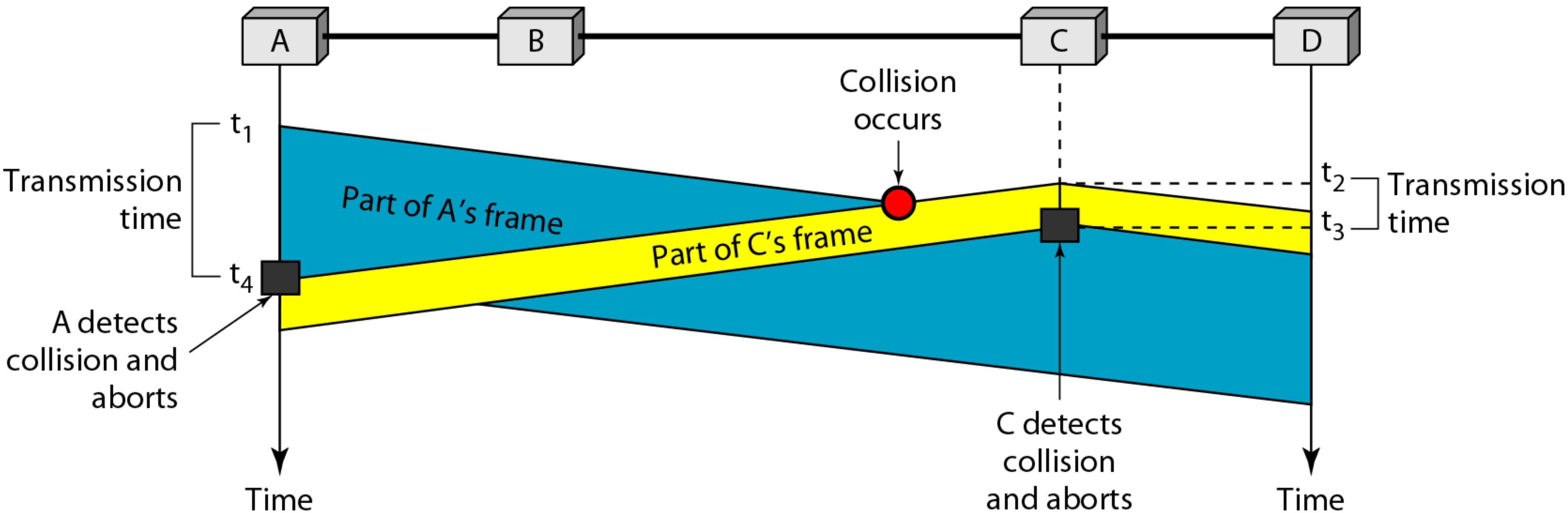


Figure 8: Collision and abortion in CSMA/CD

Contd.

A station that has a frame to send or is sending a frame needs to monitor the energy Level to determine if the channel is idle, busy, or in collision mode.

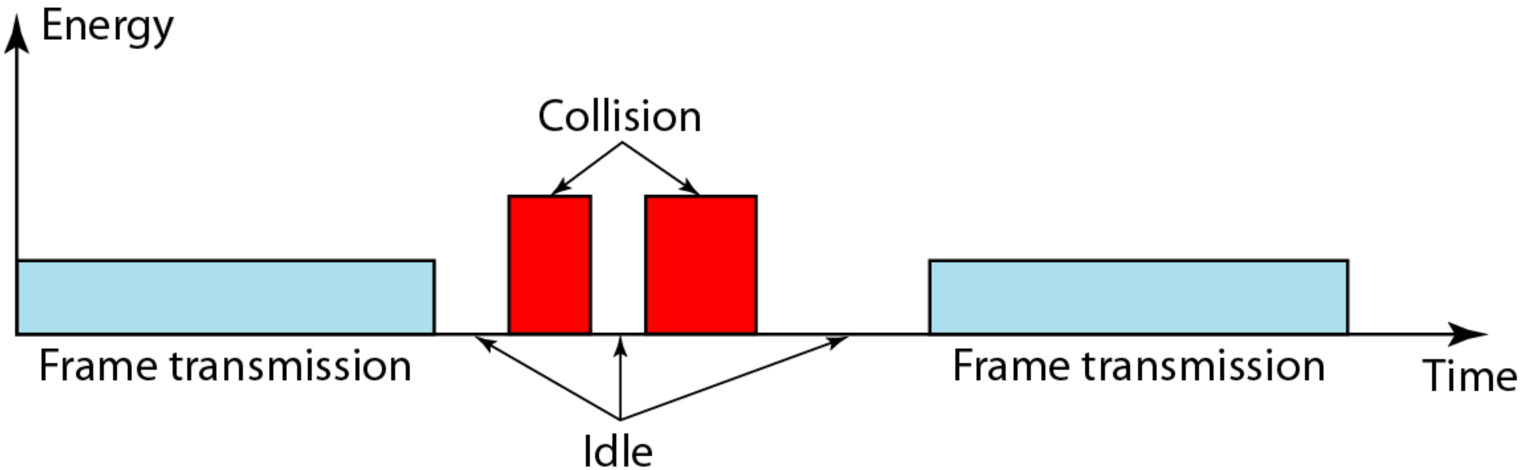
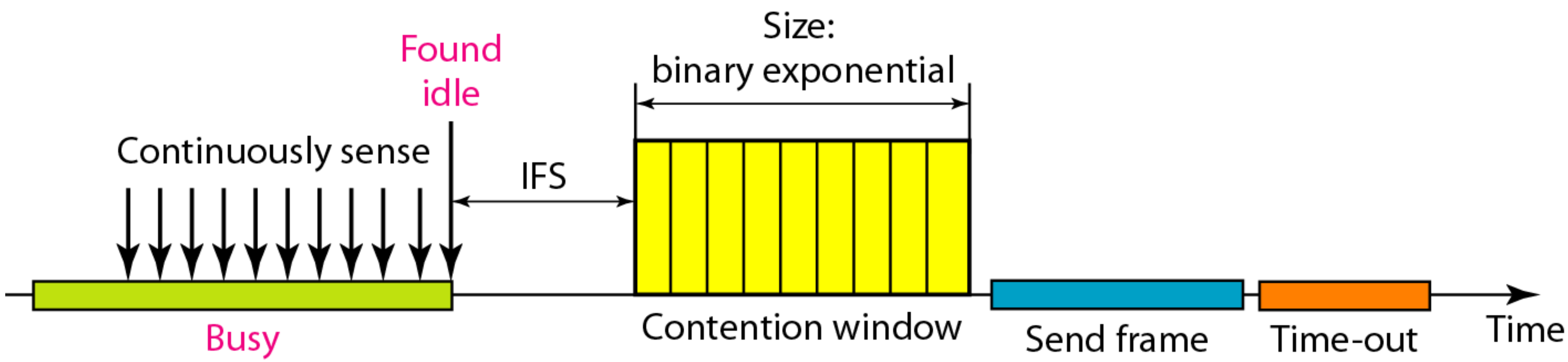


Figure 9: Energy level during transmission, idleness, or collision

CSMA/CA

For wireless network, CSMA/CA was invented.

Three strategies are used namely- interframe space, contention window, and acknowledge



In CSMA/CA, if the station finds the channel busy, it does not restart the timer of the contention window; it stops the timer and restarts it when the channel becomes idle.

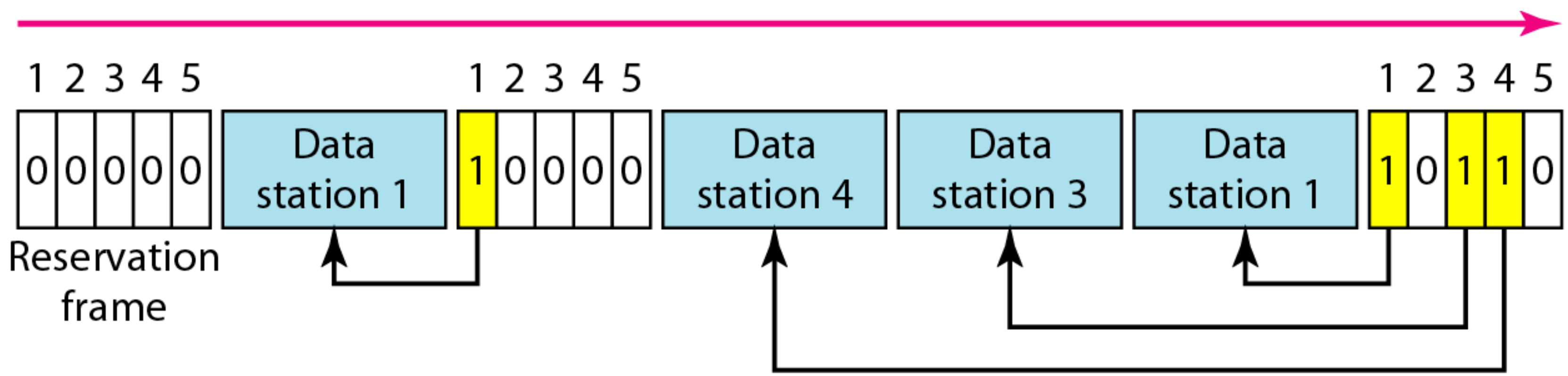
CONTROLLED ACCESS

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. We discuss three popular controlled-access methods.

1. Reservation
2. Polling
3. Token Passing

Reservation access method

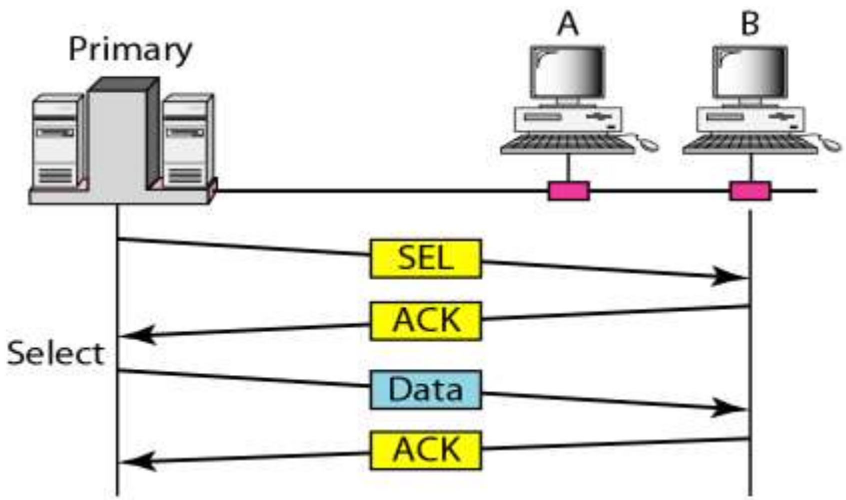
•In the reservation method, a station needs to make a reservation before sending data.
•Time is divided into intervals.
•In each interval, a reservation frame precedes the data frames sent in that interval.

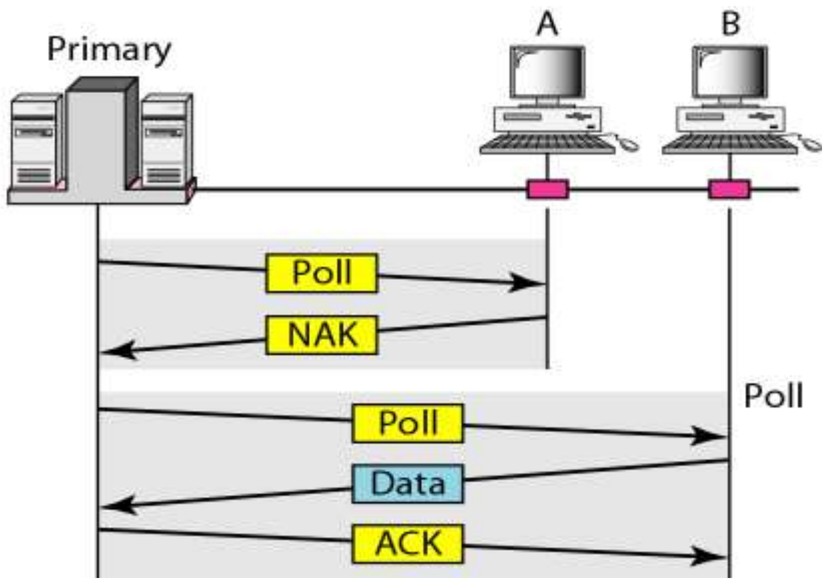


Select and poll functions in polling access method

Polling methods one device is designated as a primary station and the other devices are secondary stations.
Data exchanges made through the primary device even when the destination is a secondary Device.

1. **Select** function is used whenever the primary device has something to send.
2. **Poll** function is used by the primary device to solicit transmissions from the secondary device.

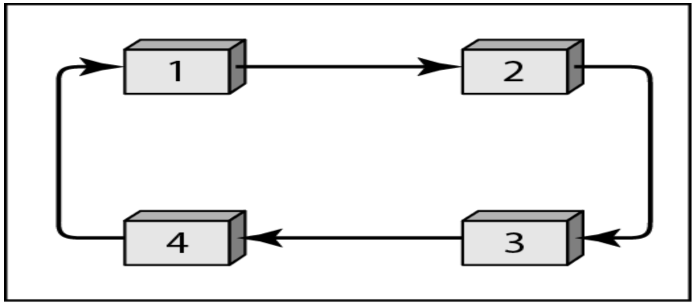




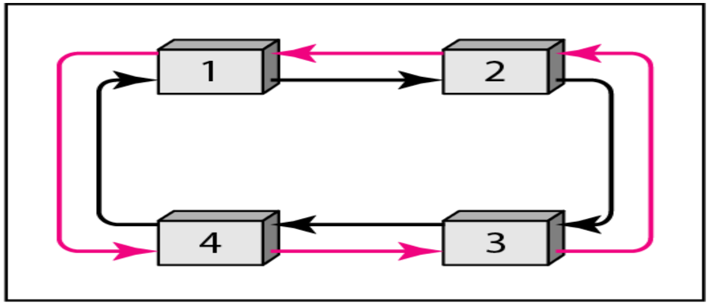
Logical ring and physical topology in token-passing access method

In token-passing method, the stations are organized in a logical ring.
For each station, there is a *predecessor* and *successor.*

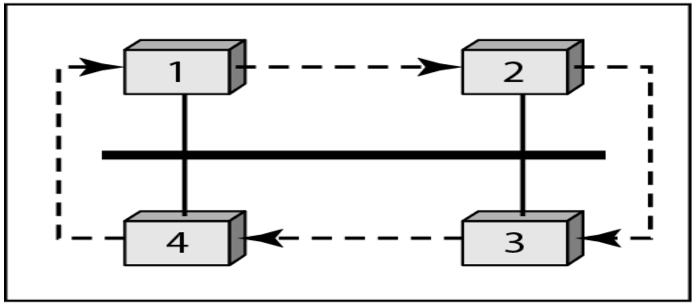
Token- It is a special packet circulates through ring.



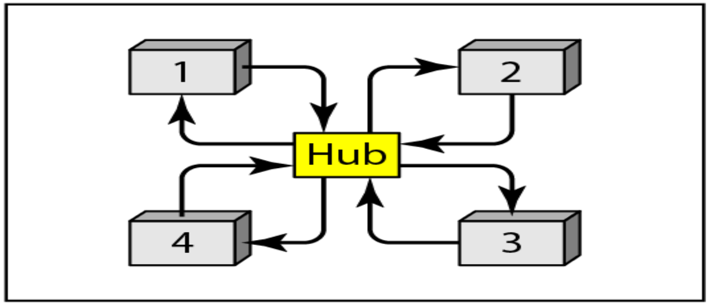
a. Physical ring



b. Dual ring



c. Bus ring



d. Star ring

Contd.

- physical ring- when a station sends the token to its successor
- Dual ring- it uses a second ring which operates in the reverse direction compared with the main ring
- Bus ring-it is also called token bus. The stations are connected to a single cable called a bus.
- Star ring- there is a hub and acts as the connector. The wiring inside the hub makes the ring.

Reference Book: Data Communications and Networking (4th Edition) by B A Forouzan

For any queries/doubts

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