Media Access Control (MAC)
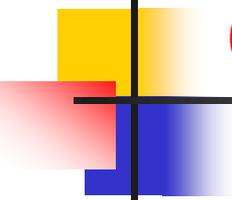
Chapter 5: Outline

12.1 RANDOM ACCESS

12.2 CONTROLLED ACCESS

12.3 CHANNELIZATION

Multiple-access protocols

> *When more than two nodes send at the same time , the transmitted frames collide.*

> *All collide frames are lost and the bandwidth of the broadcast channel will be wasted.*

> *We need multiple –access protocol to coordinate access to **multipoint or broadcast link** (Nodes or stations are connected to or use a common link)*

> *Multiple access protocols are needed in wire and wireless LANs and satellite networks*

10.

Figure 12.1: Taxonomy of multiple-access protocols
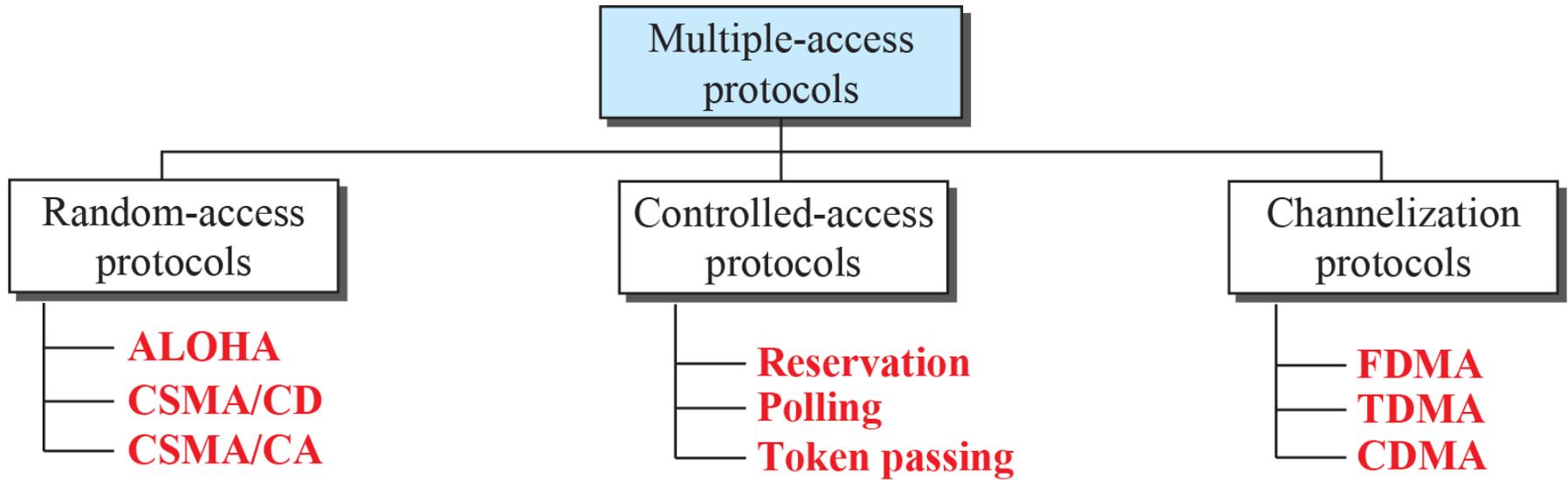
12-1   RANDOM   ACCESS

In random-access or contention no station is superior to another station and
none is assigned control over another. 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. This decision depends on the state of the medium (idle or busy).
Collision: *an access conflict occurs when more than one station tries to send, as a result the frame will be either destroyed or modified.*

12.12.1 ALOHA

ALOHA, the earliest random access method, was developed at the University of Hawaii in early 1970. It was designed for a radio (wireless) LAN, but it can be used on any shared medium. It is obvious that there are potential collisions in this arrangement. The medium is shared between the stations. When a station sends data, another station may attempt to do so at the same time. The data from the two stations collide and become garbled.
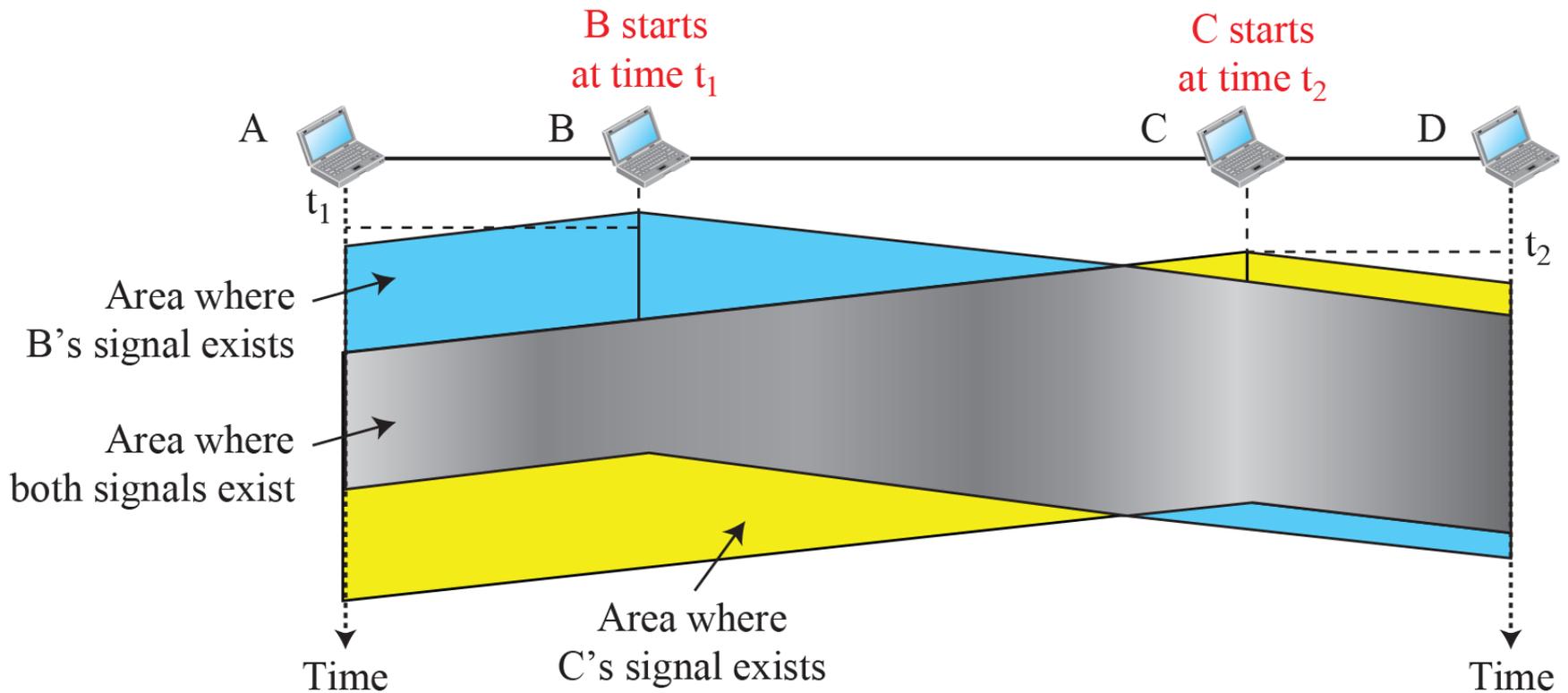
Figure 12.2: Frames in a pure ALOHA network
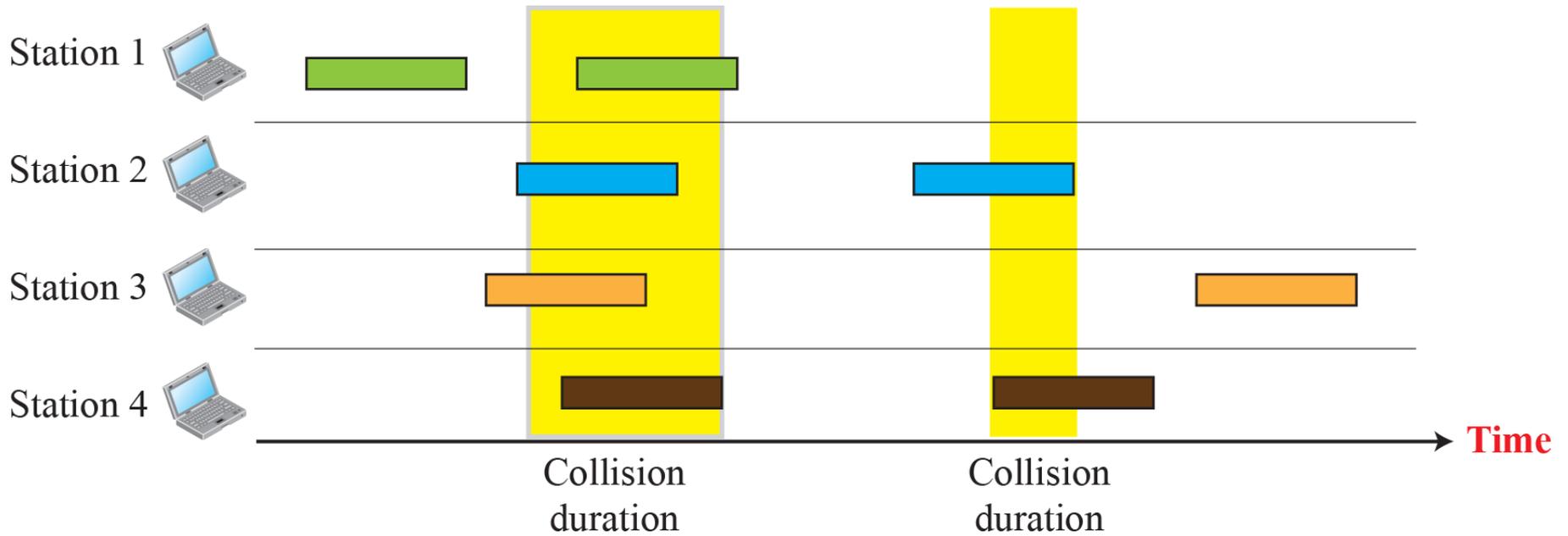
12.12.2 CSMA

To minimize the chance of collision and, therefore, increase the performance, the CSMA method was developed. The chance of collision can be reduced if a station senses the medium before trying to use it. Carrier sense multiple access (CSMA) requires that each station first listen to the medium (or check the state of the medium) before sending. In other words, CSMA is based on the principle "sense before transmit" or "listen before talk."

Figure 12.7: ***Space/time model of a collision in CSMA***

B starts
at time t_1

C starts
at time t_2

A   B   C   D

t_1

t_2

Area where
B's signal exists

Area where
both signals exist

Area where
C's signal exists

Time

Time

12.12.3 CSMA/CD

The CSMA method does not specify the procedure following a collision. Carrier sense multiple access with collision detection (CSMA/CD) augments the algorithm to handle the collision.

In this method, a station monitors the medium after it sends a frame to see if the transmission was successful. If so, the station is finished. If, however, there is a collision, the frame is sent again.

Figure 12.11: *Collision of the first bits in CSMA/CD*
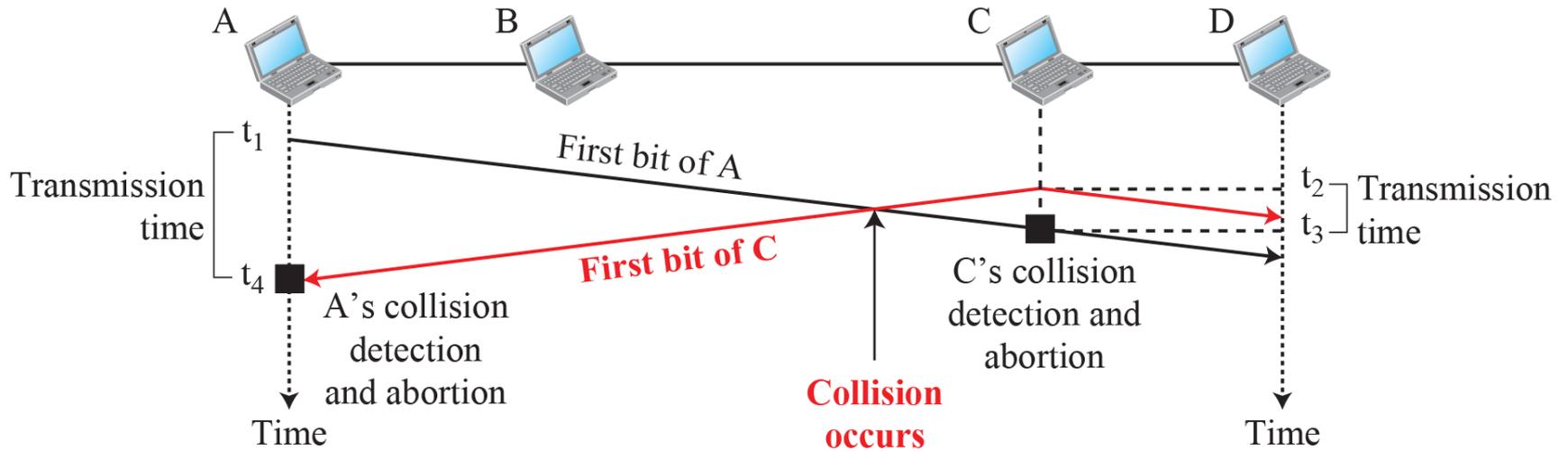
How the station detects a collision?
- *Detecting voltage level on the line*
- *Detecting energy level .*

Energy in channel can have three values: zero, normal, and abnormal.
- *at zero level, the channel is idle*
- *At the normal level, a station has successfully captured the channel and is sending its frame.*
- *At the abnormal level, there is a collision and the level of the energy twice the normal level.*
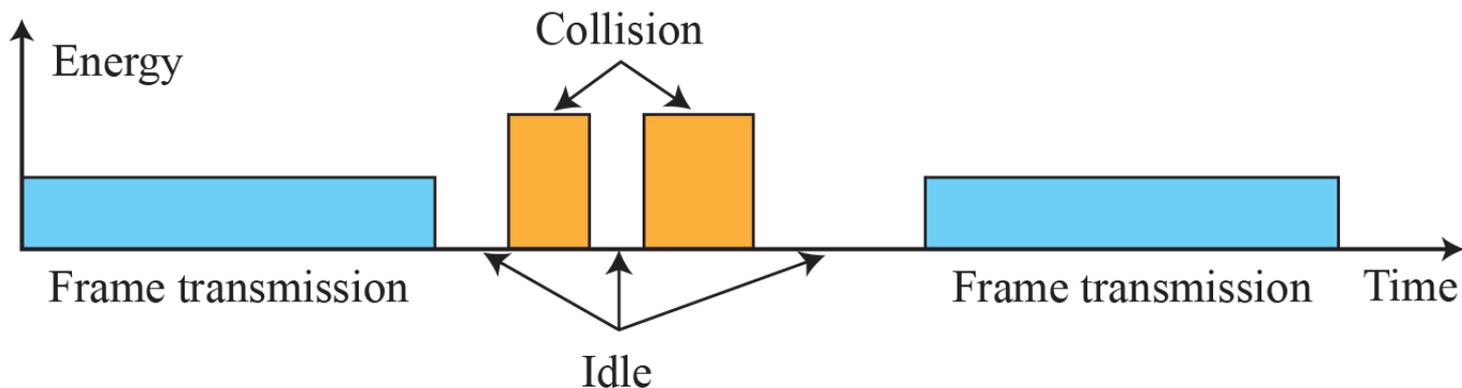
12-2   CONTROLLED ACCESS

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 controlled-access methods.

12.2.1 Reservation

In the reservation method, a station needs to make a reservation before sending data.

Time is divided into intervals

- ✓ A reservation frame proceeds each time interval
- ✓ Number of stations and number of mini-slots in the reservation frame are equal
- ✓ Each time slot belongs to a particular station
- ✓ If there are N stations in the system, there are exactly N reservation mini-slots in the reservation frame


Direction of packet movement
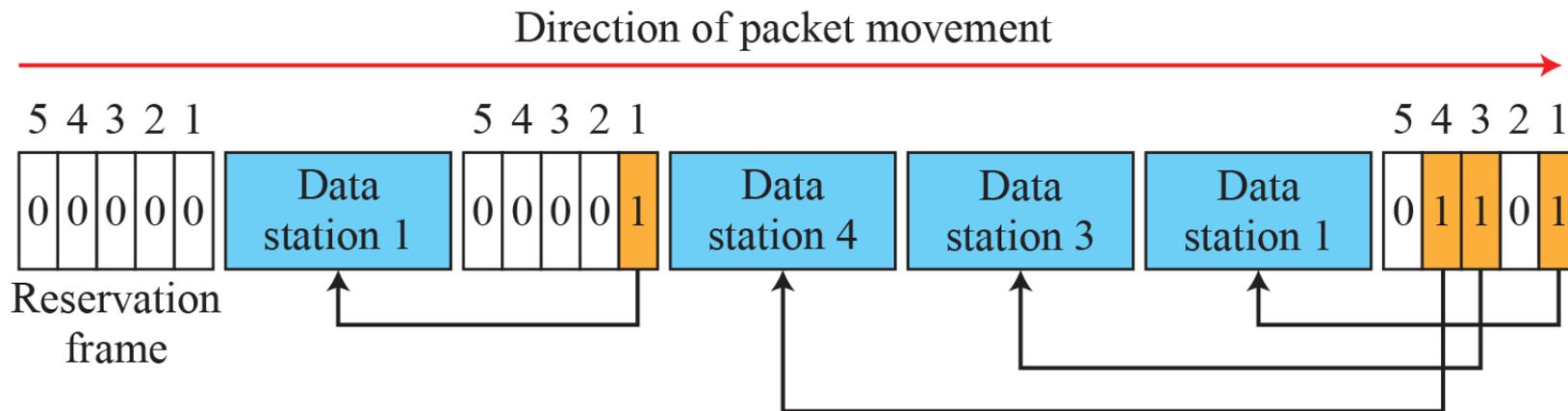
12.2.2 Polling

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.

Two functions: polls and select
Poll: If the primary wants to receive data, it asks the secondary if they have anything to send.
Select: if the primary wants to send data, it tells the secondary to get ready to receive data
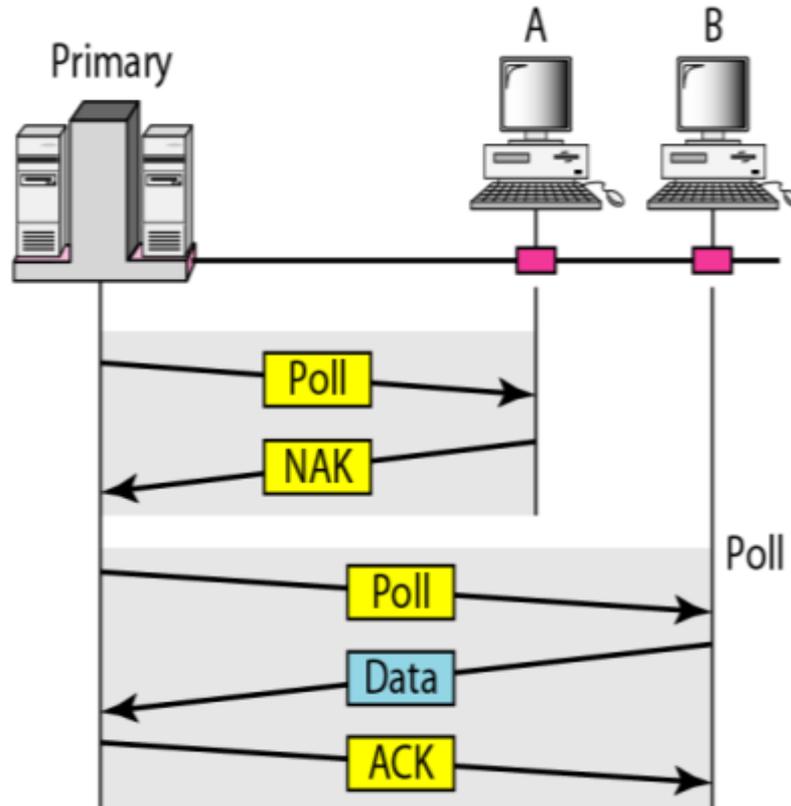
Polling access method
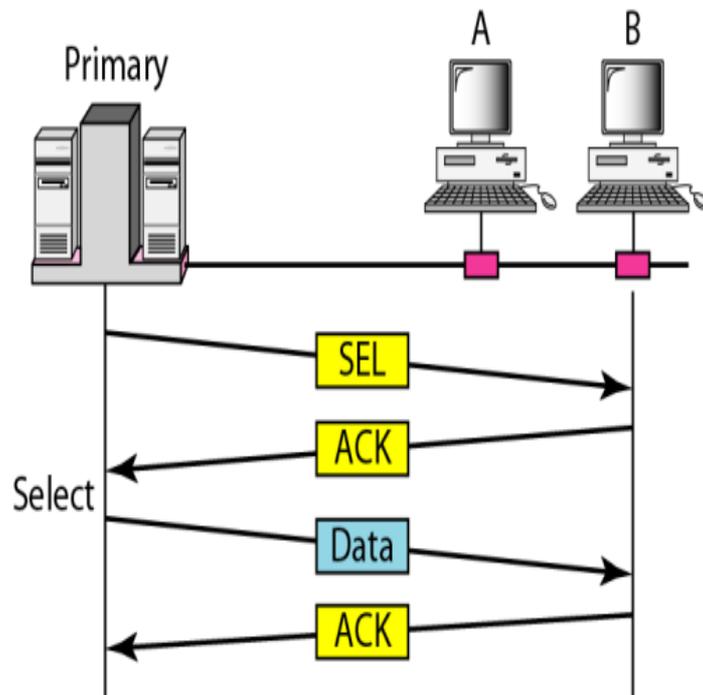
The select function is used when the primary has frames to send.

- **The primary creates and transmits a select (SEL) frame.**
- **SEL alerts the secondary to the upcoming transmission**
- **The primary waits for ACK to send the data**

10.

Polling access method

When the primary is ready to receive data, it must ask (Poll) each device in turn if it has anything to send.

- **When the first secondary is approached, it responds either with a NAK frame if it has nothing to send or with data if it does.**
- **If the response is NAK, the primary polls the next secondary.**
- **If it receives data, it sends ACK frame.**

10.

12.2.3 Token Passing

In the token-passing method, the stations in a network are organized in a logical ring. In other words, for each station, there is a predecessor and a successor.

- *The predecessor is the station which is logically before the station in the ring;*
- *the successor is the station which is after the station in the ring.*

Token Passing method

Station is authorized to send data when it receives a special frame called a token

- Stations are arranged around a ring.
- When no data are being sent, a token circulates the ring.
- If a station needs to send data, it waits for the token.
- The station captures the token and sends one or more frames (as long as it has frames to send or the allocated time has not expired), and finally it releases the token to be used by next station (successor).
- The maximum time any station can hold the token is limited.
- Since there is only one token, only one station transmits at a time, and collisions never occur.
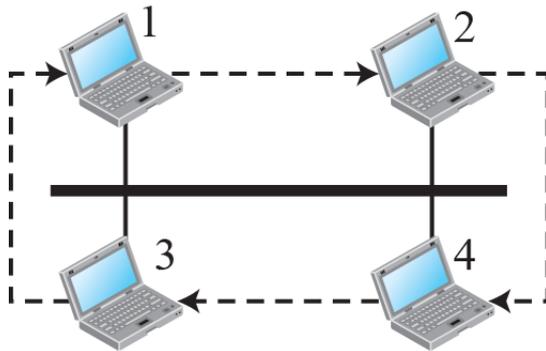
10.

Figure 12.20: Logical ring and physical topology in token-passing access method
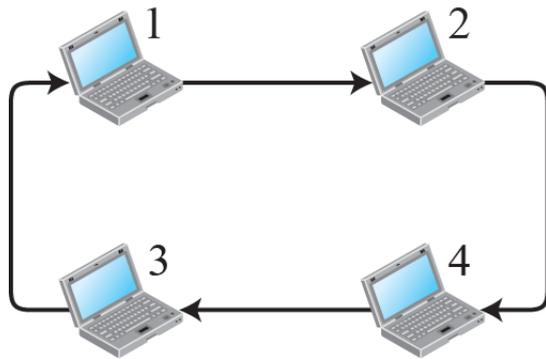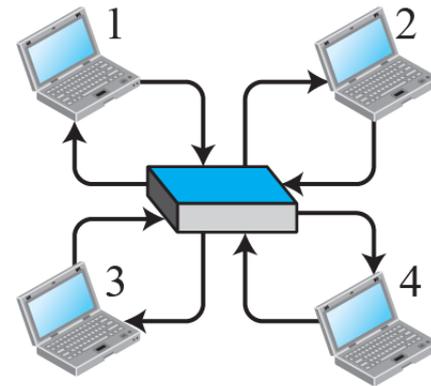

a. Physical ring
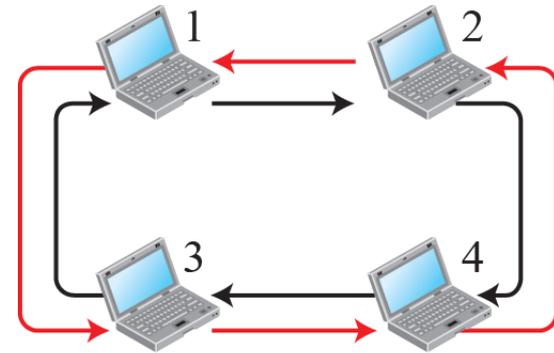
b. Dual ring

c. Bus ring

d. Star ring

12-3 CHANNELIZATION

Channelization **(or channel partition, as it is sometimes called) is a multiple-access**
method in which the available bandwidth of a link is shared in time, frequency, or through code, among different stations.

channelization protocols:

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