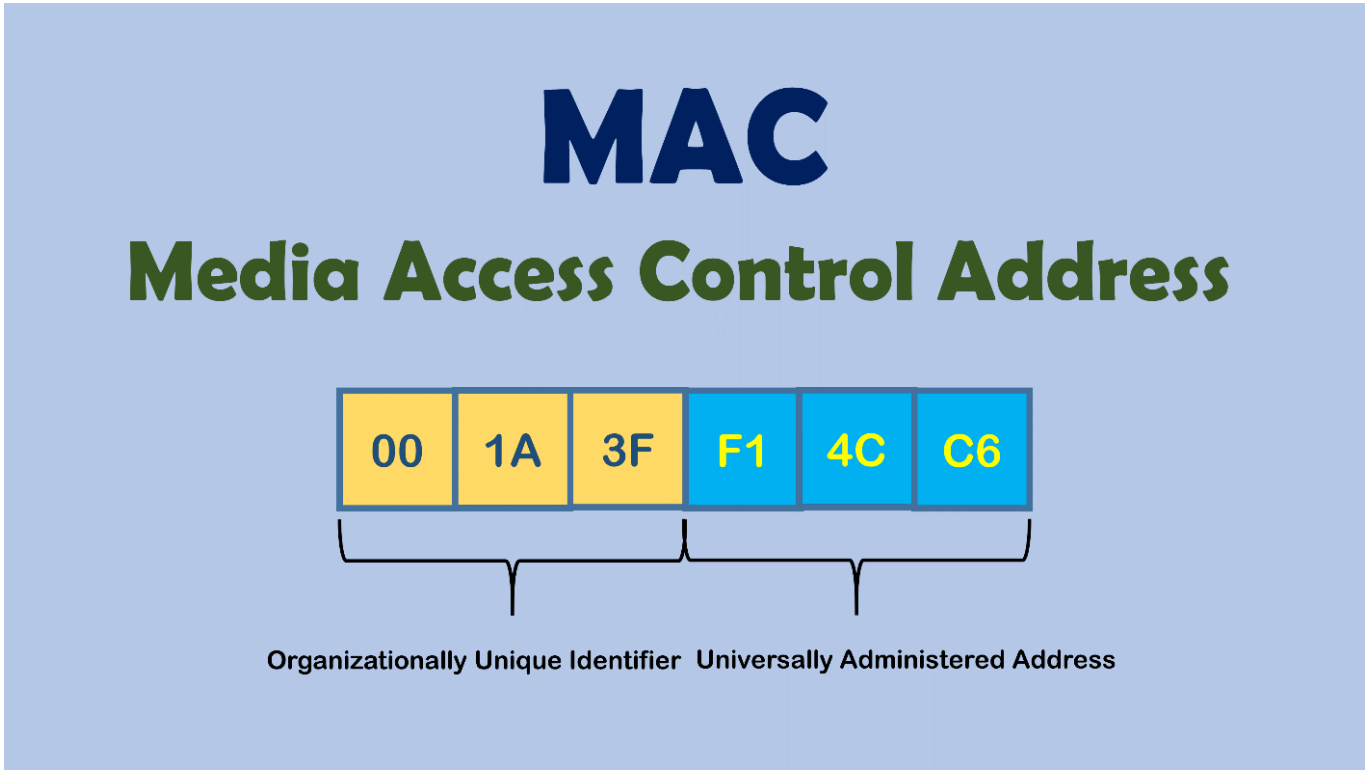
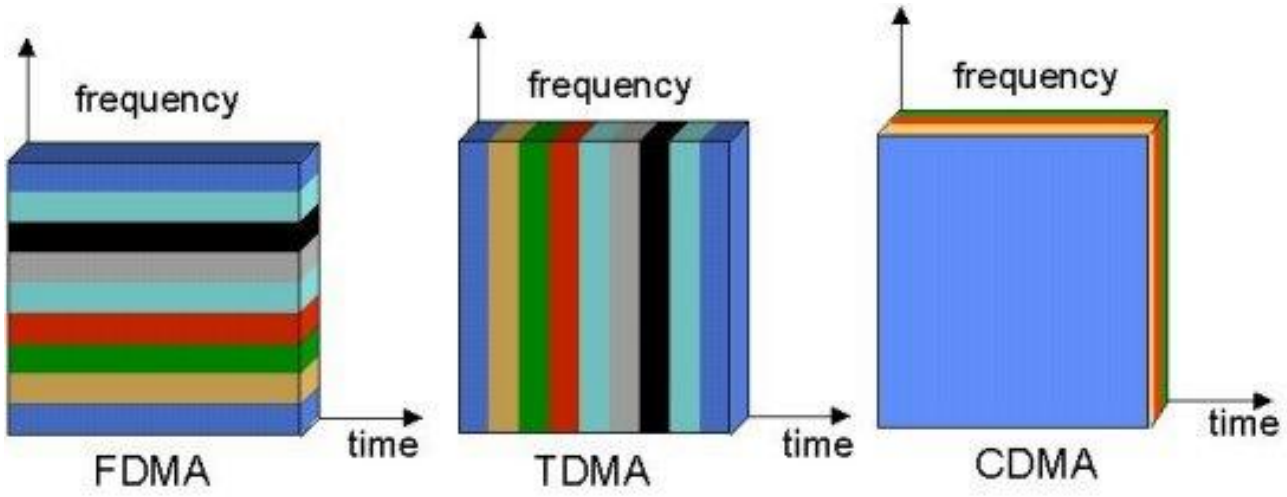
Chapter 12

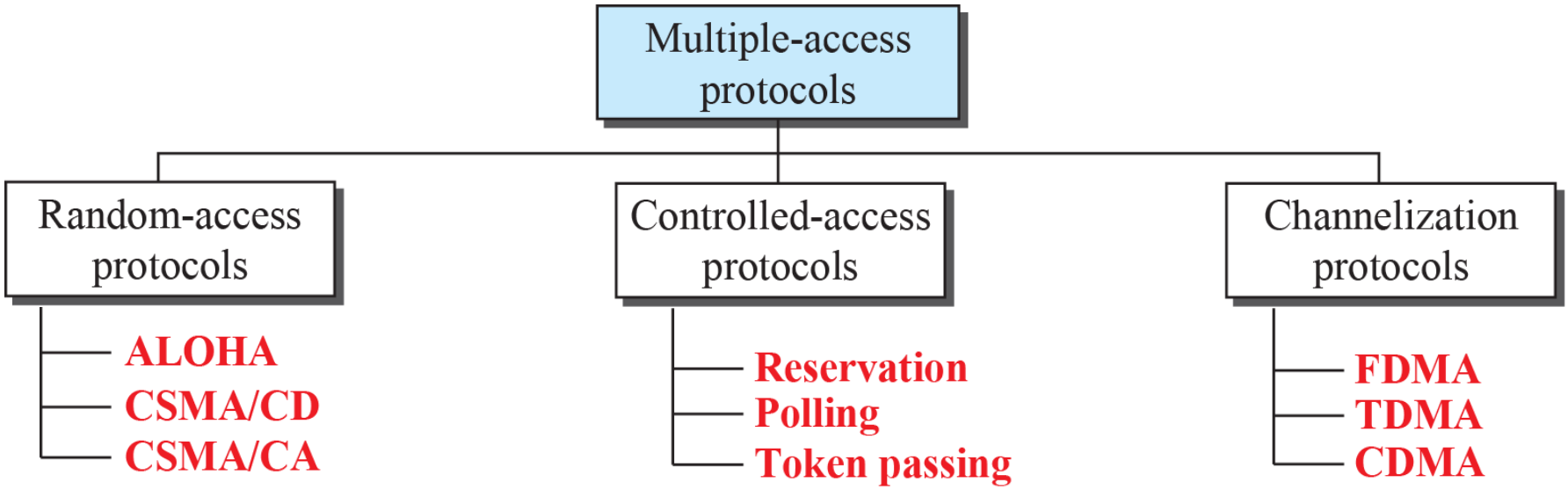
Media Access Control(MAC)



Objective

- ALOHA, CSMA, CSMA/CD, and CSMA/CA.
- Reservation, polling, and token-passing.
- FDMA, TDMA, and CDMA.





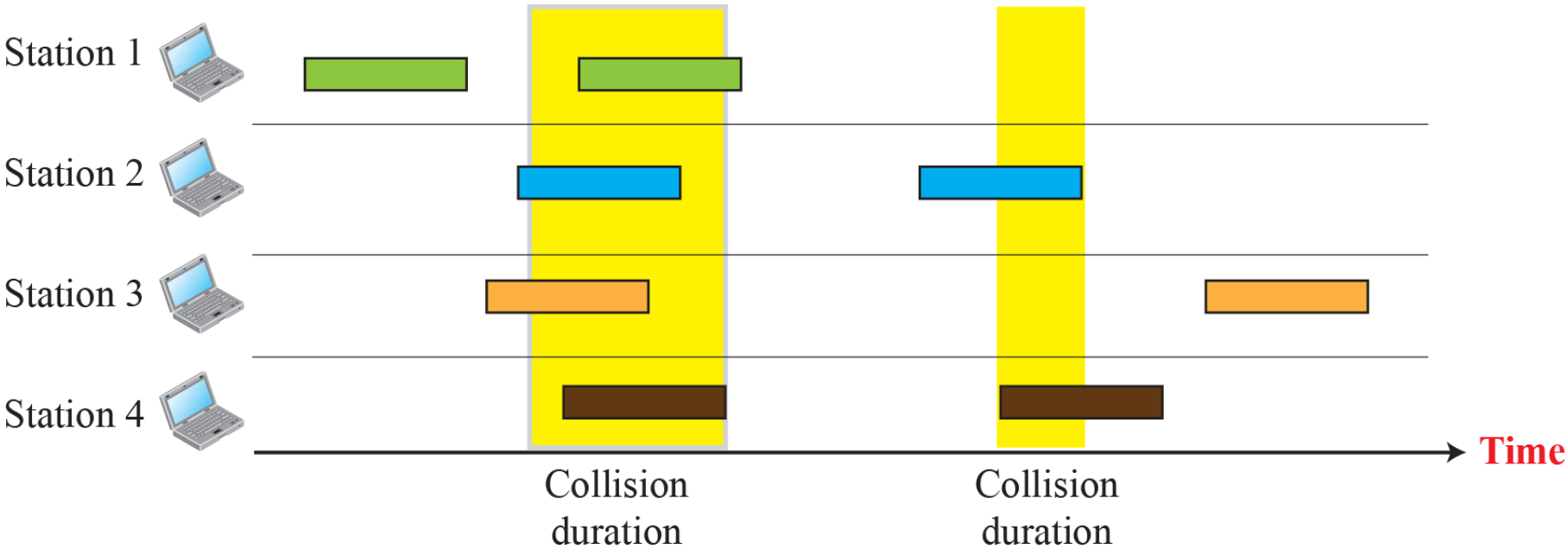
Taxonomy of multiple-access protocols

Random Access

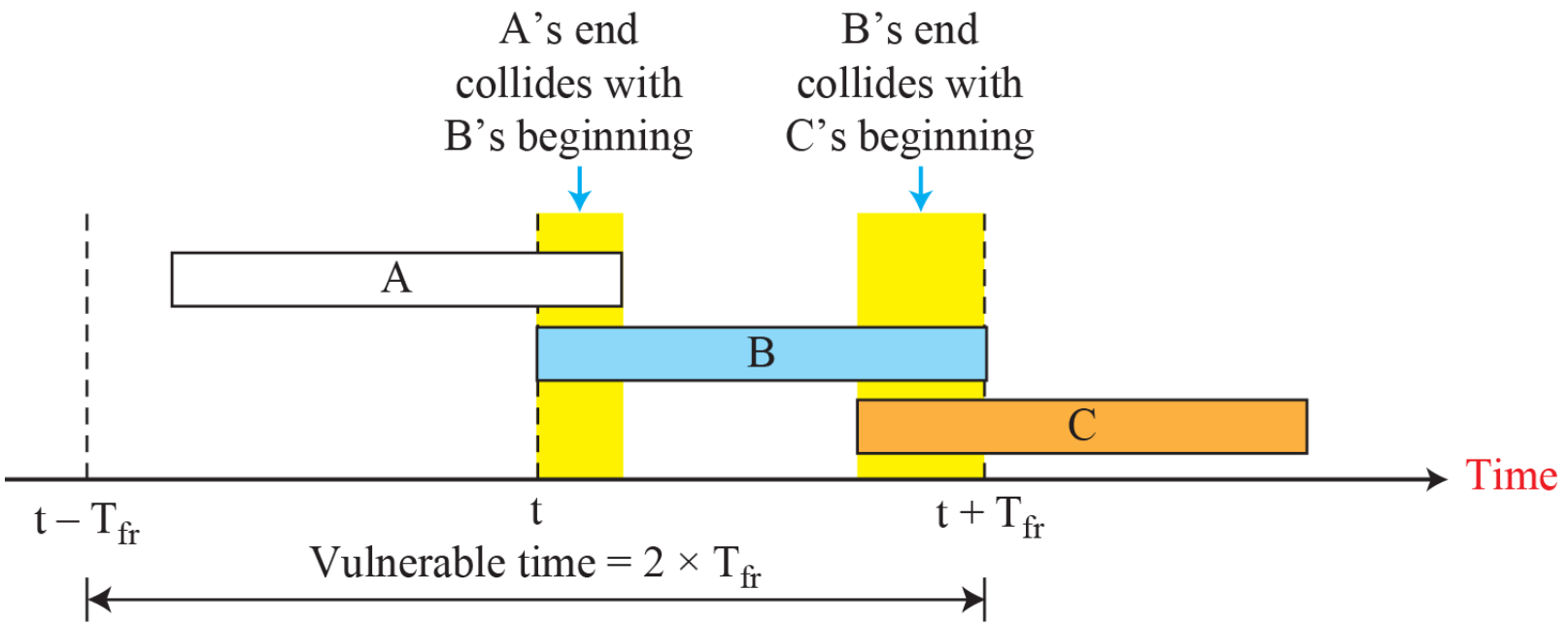
- In random-access or contention, no station is superior to another station and none is assigned control over another.
- At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send.
- This decision depends on the state of the medium (idle or busy).

ALOHA

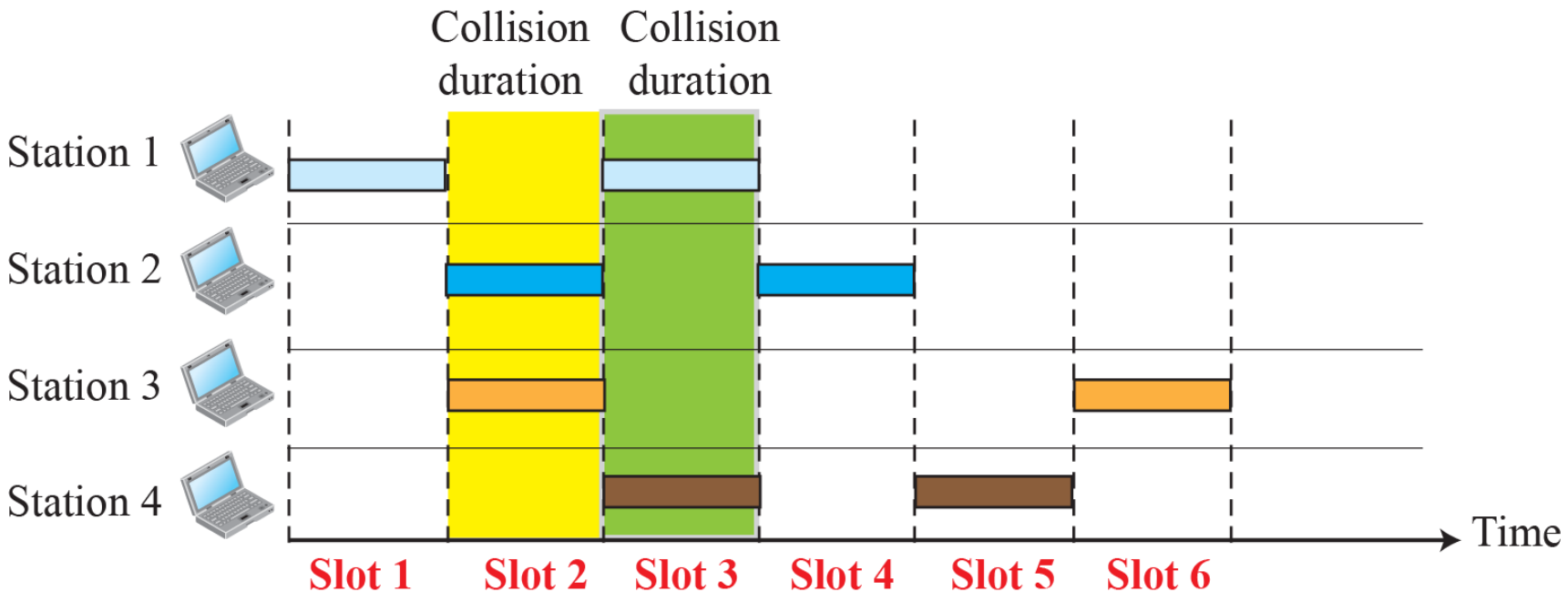
- ALOHA, the earliest random access method, was developed at the Univ. of Hawaii in early 1970.
- It was designed for a radio (wireless) LAN, but it can be used on any shared medium. It is obvious that there are potential collisions in this arrangement.
- The medium is shared between the stations. When 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.



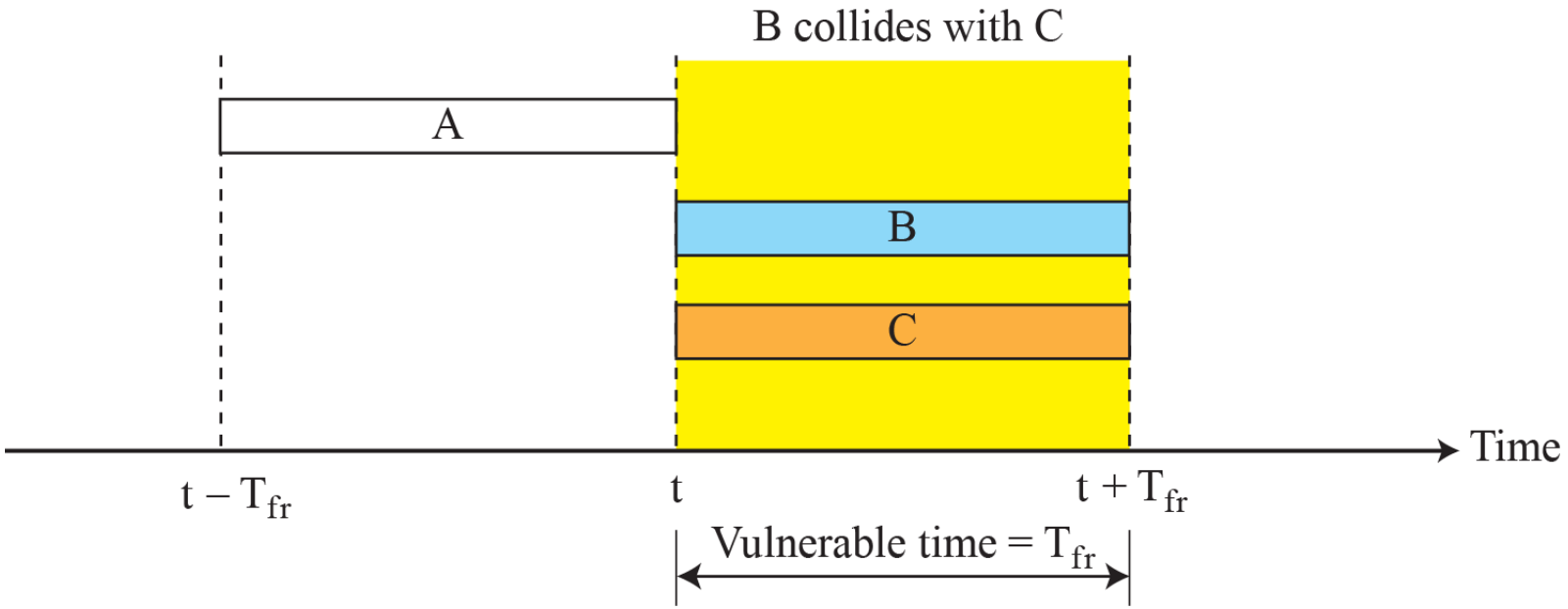
Frames in a pure ALOHA network



Vulnerable time for pure ALOHA protocol



Frames in a slotted ALOHA network



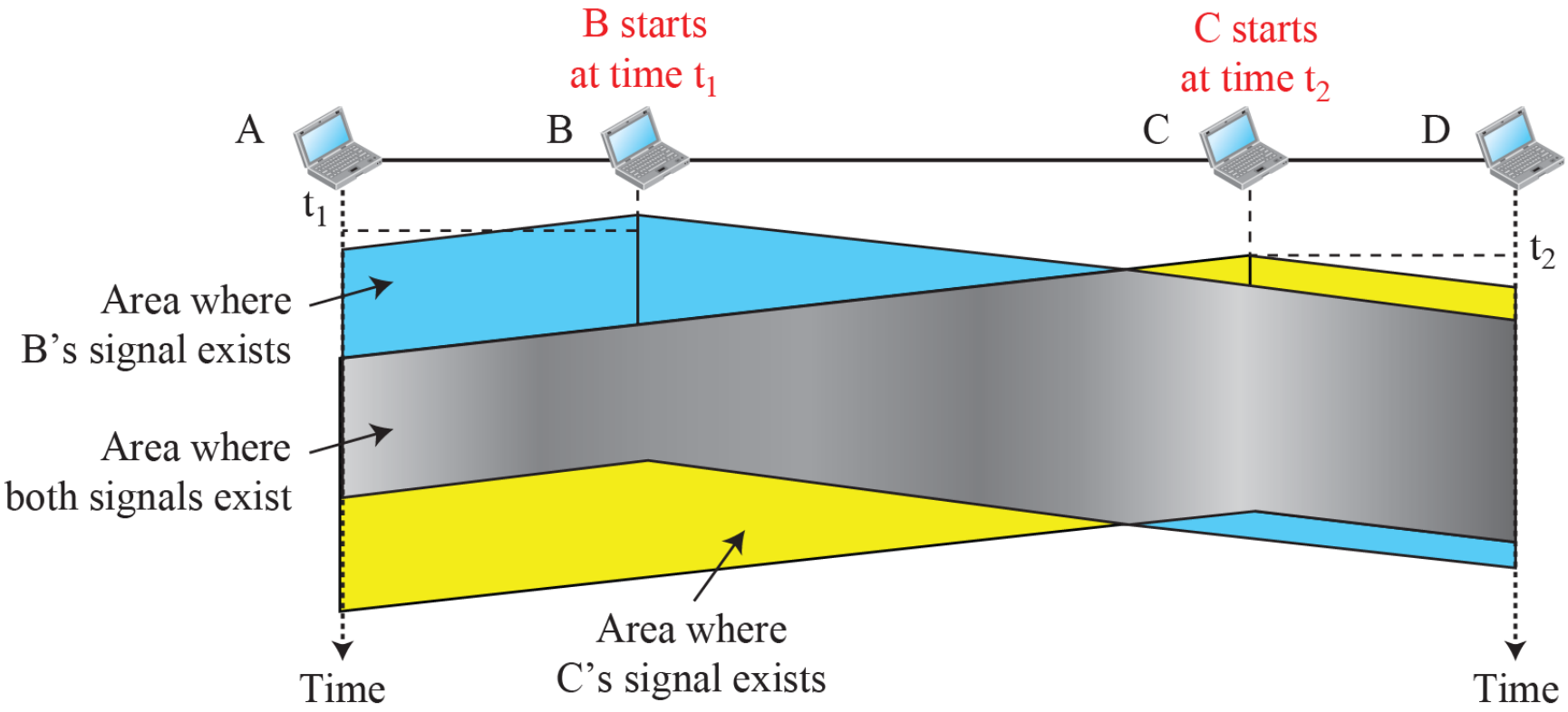
Vulnerable time for slotted ALOHA protocol

CSMA

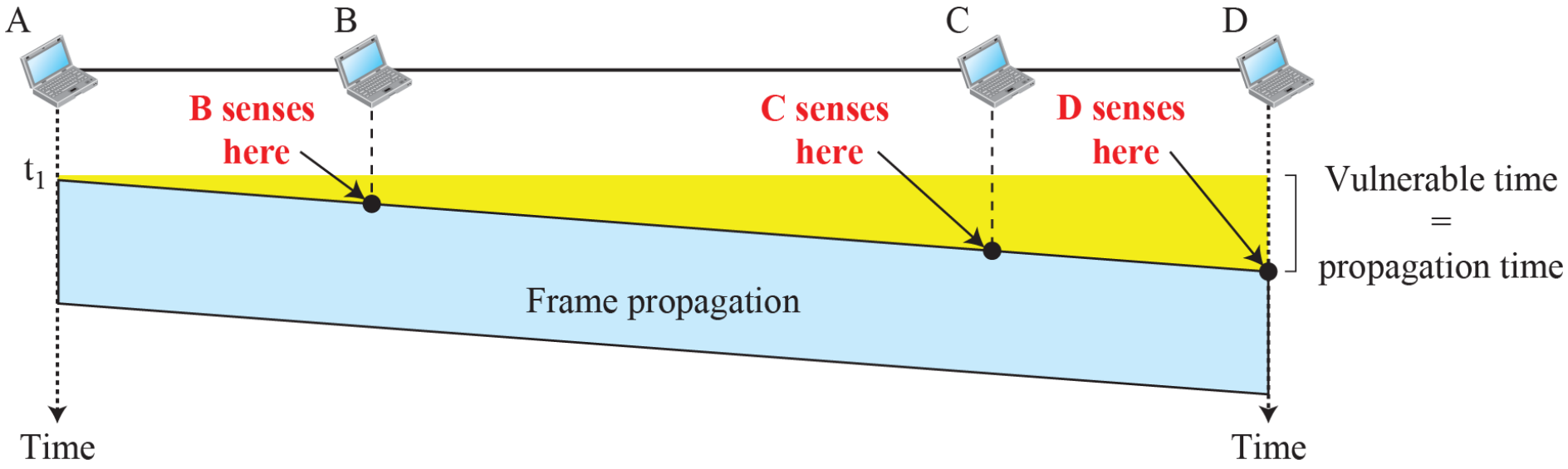
- To minimize the chance of collision and increase the performance, the CSMA method was developed. The chance of collision can be reduced if a station senses the medium before trying to use it.

- **Carrier sense multiple access (CSMA)** requires that each station first listen to the medium before sending.

- In other words, CSMA is based on the principle "sense before transmit" or "listen before talk."



Space/time model of a collision in CSMA



Vulnerable time in CSMA

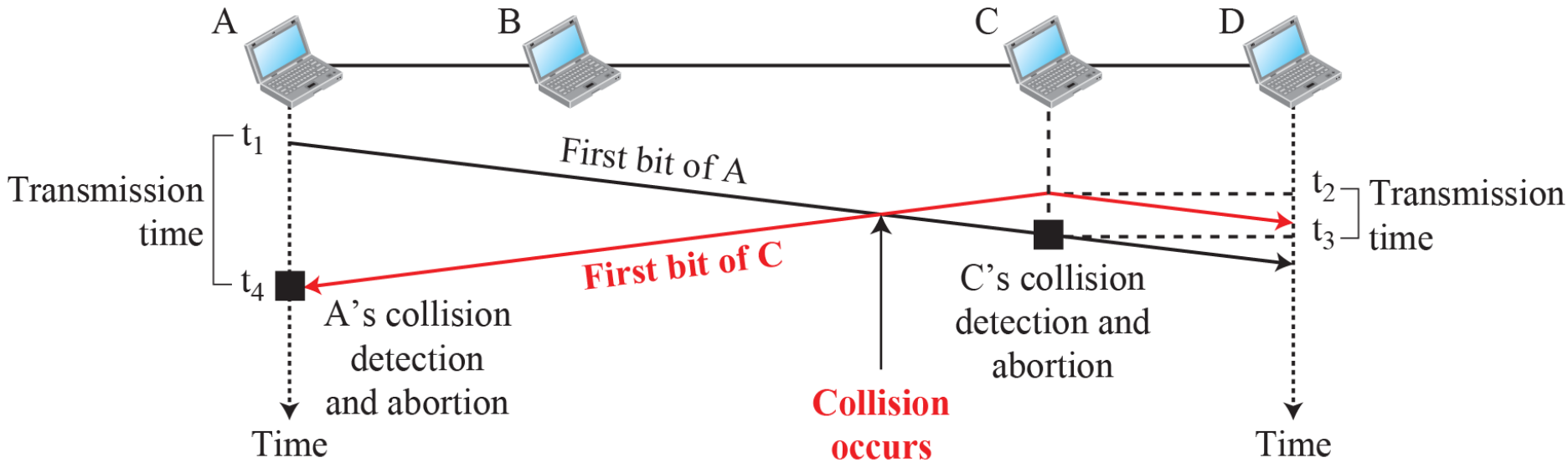
Access modes

- Variations of CSMA use different algorithms to determine when to initiate transmission onto the shared medium.
- 1-persistent, non-persistent, *p*-persistent methods
- They senses the transmission medium for idle or busy. If busy, then the protocol senses the transmission medium continuously until it becomes idle, If idle, then 1) it transmits immediately, 2) If busy, it waits for a random period of time, 3) If idle, it transmits with probability *p*.

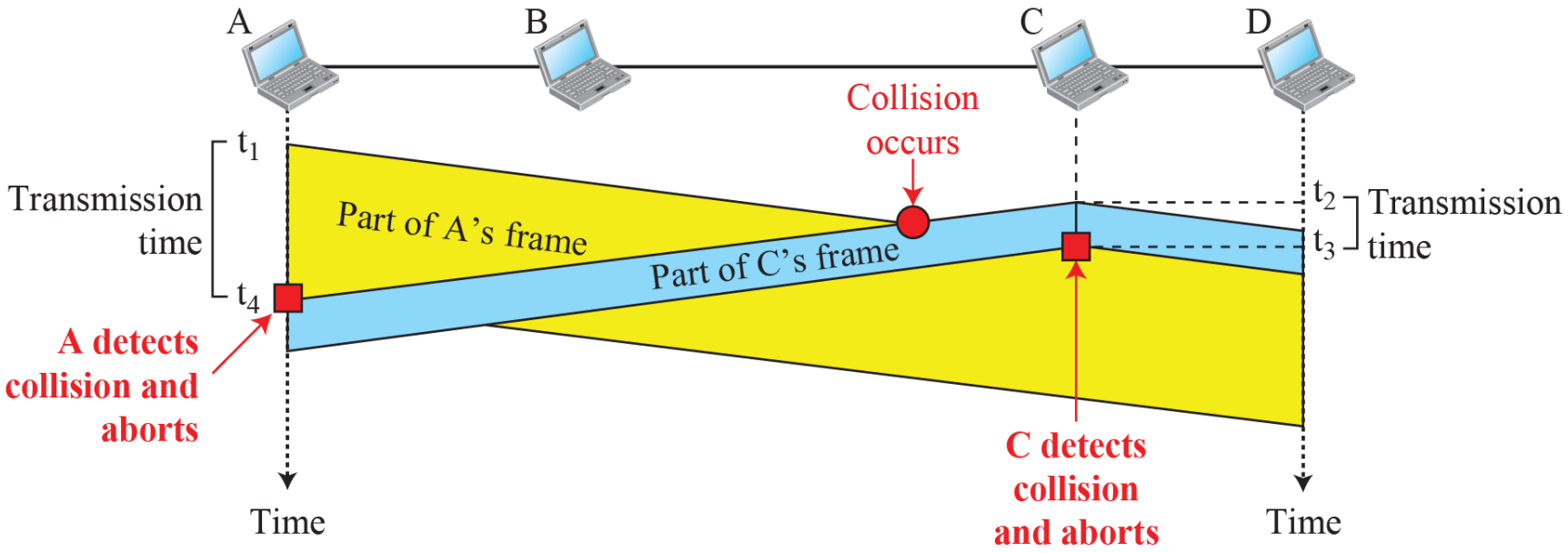
CSMA/CD

- 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.



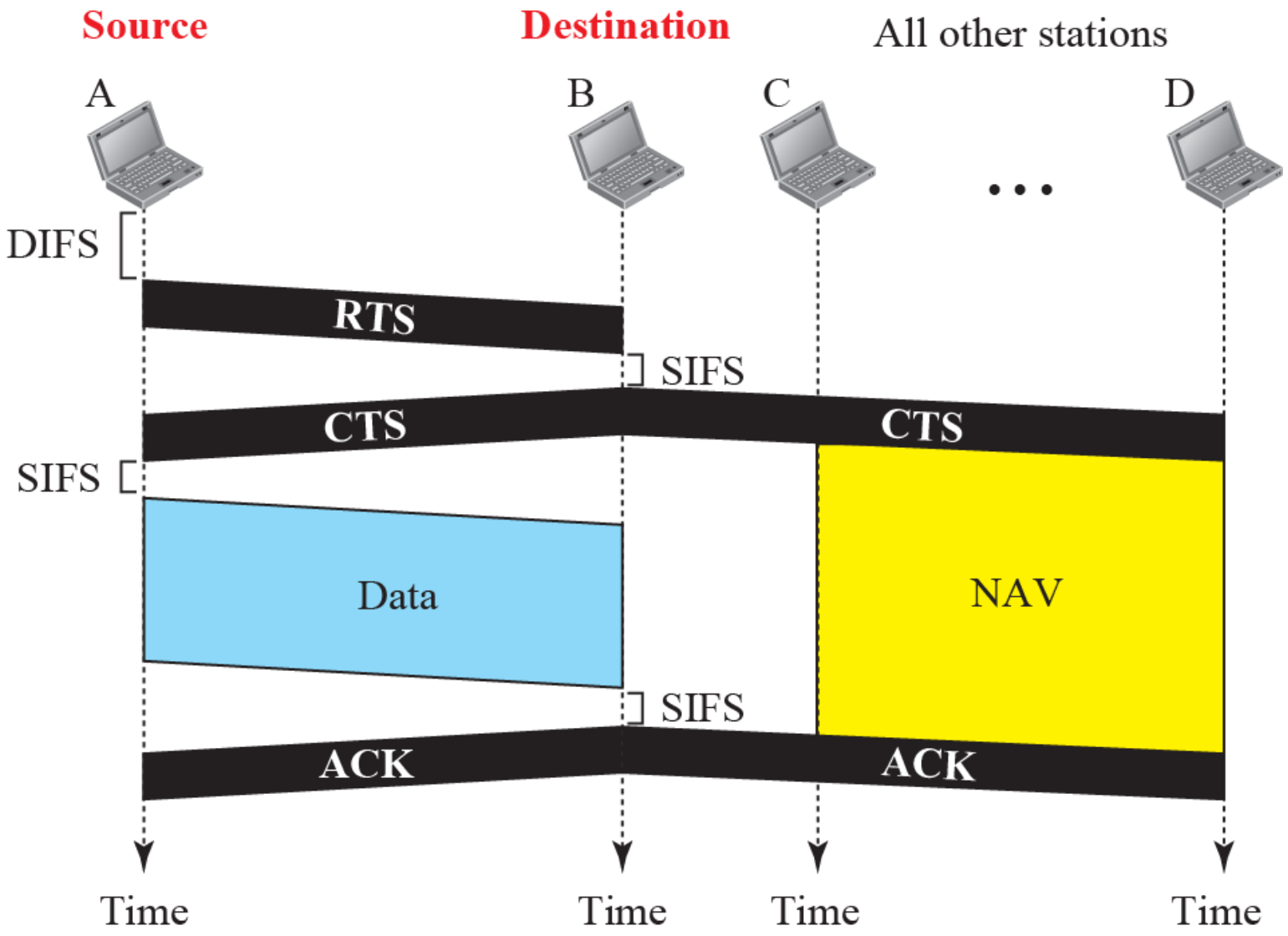
Collision of the first bits in CSMA/CD



Collision and abortion in CSMA/CD

CSMA/CA

- Carrier sense multiple access with collision avoidance (CSMA/CA) was invented for wireless networks.
- Collisions are avoided through the use of CSMA/CA's three strategies: the interframe space, the contention window, and acknowledgments.
- We discuss RTS and CTS frames later.



CMACA and NAV

Controlled Access

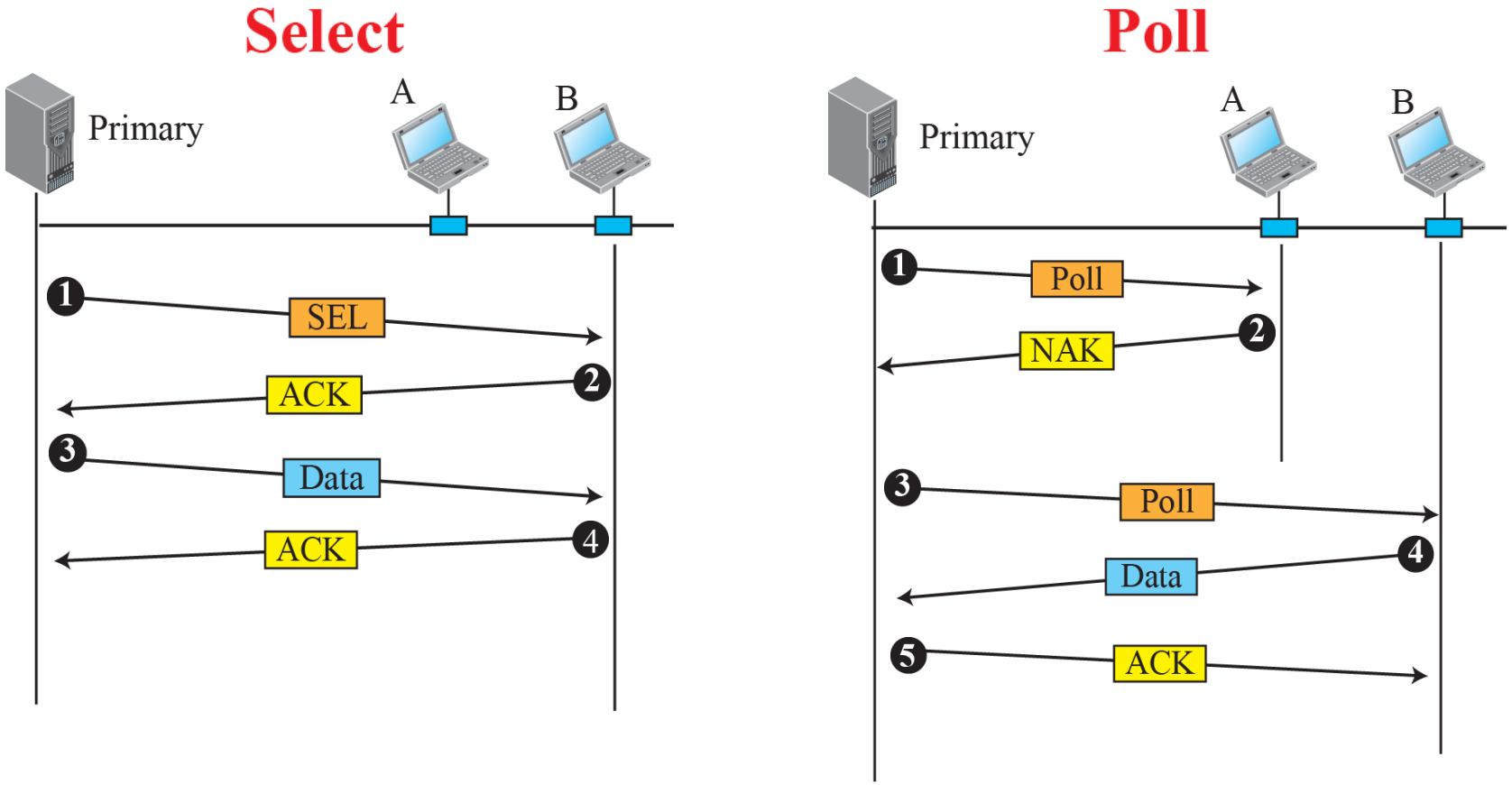
- In controlled access, the stations consult one another to find which station has the right to send. A station cannot send unless it has been authorized by other stations. We discuss three controlled-access methods.

- 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.

Polling

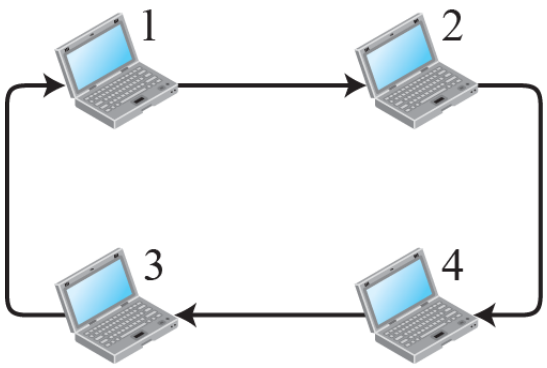
- Polling works with topologies in which one device is designated as a primary station and the other devices are secondary stations.
- All data exchanges must be made through the primary device even when the ultimate destination is a secondary device.
- The primary device controls the link; the secondary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



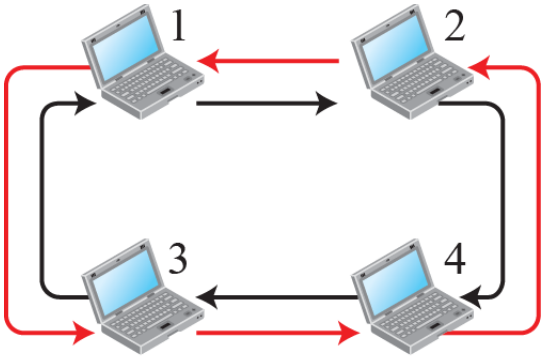
Select and poll functions in polling-access method

Token Passing

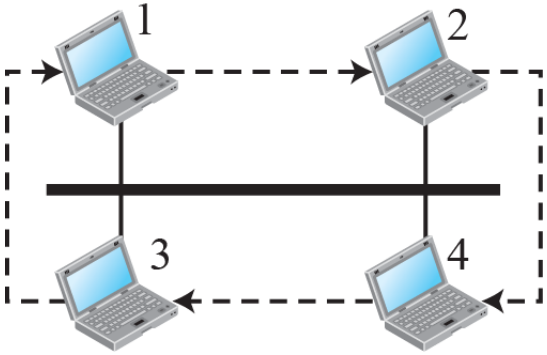
- In the token-passing method, the stations in a network are organized in a logical ring.
- In other words, for each station, there is a predecessor and a successor.
- The predecessor is the station which is logically before the station in the ring; the successor is the station which is after the station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



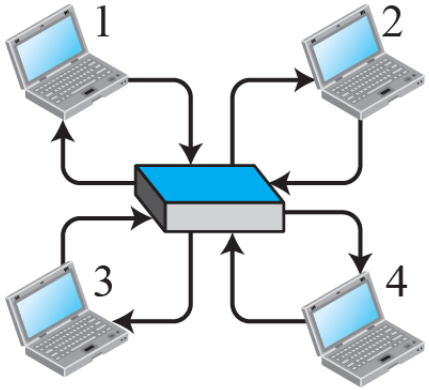
a. Physical ring



b. Dual ring



c. Bus ring



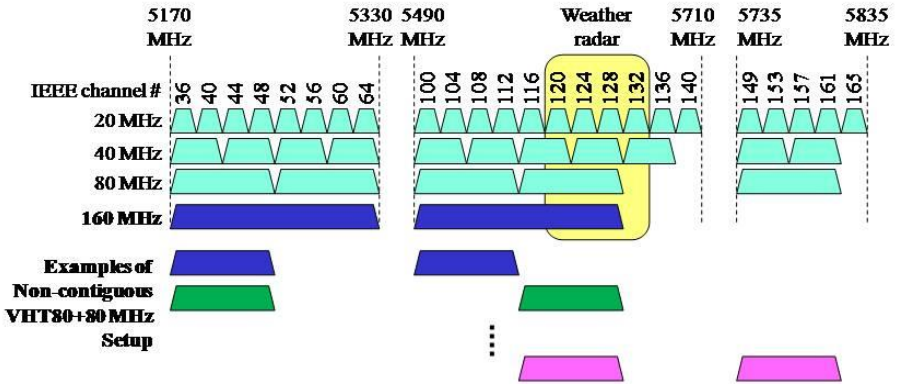
d. Star ring

Logical ring and physical topology in token-passing access method

Channelization

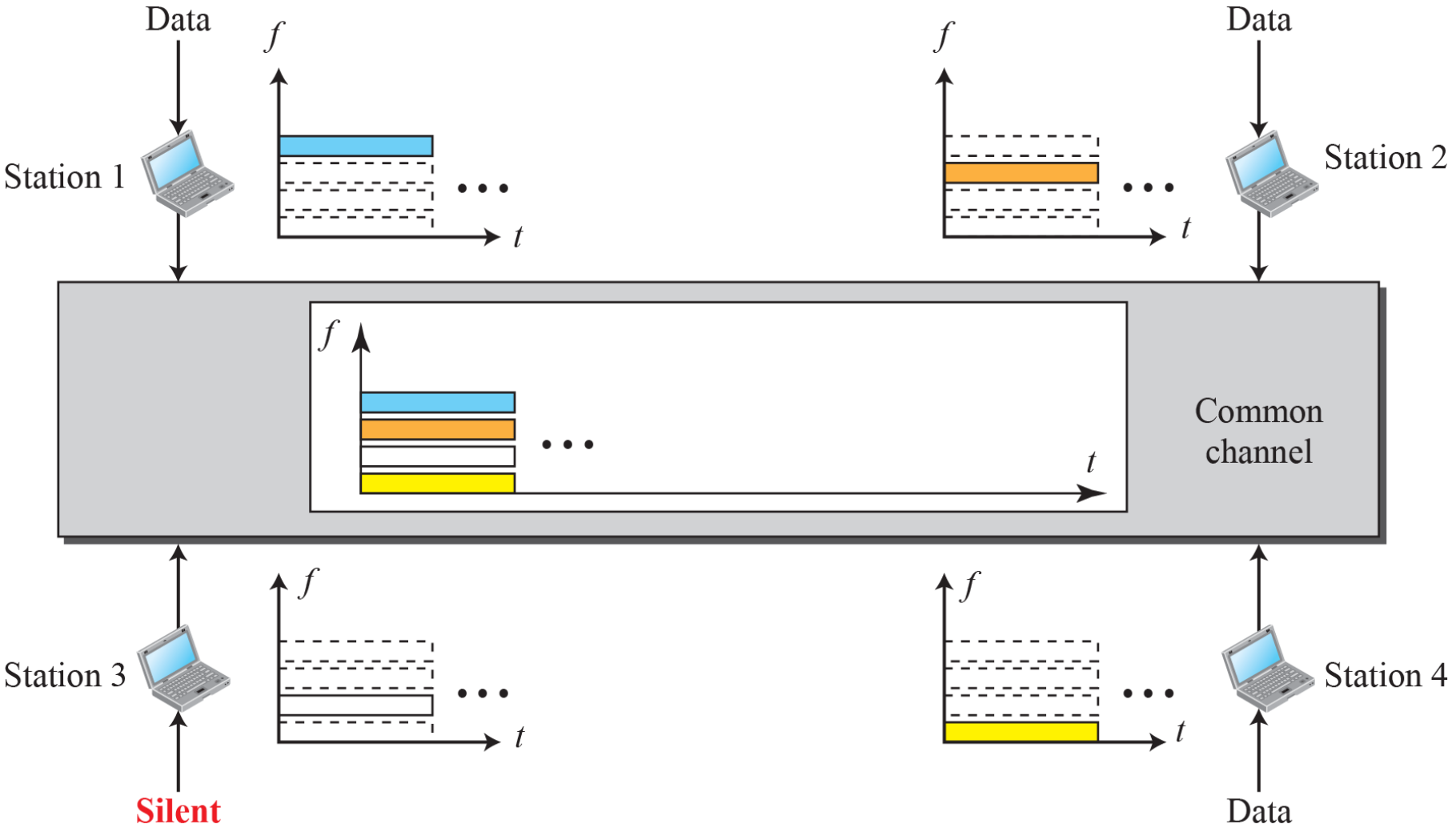
- Channelization (or channel partition, as it is sometimes called) is a multiple-access method in which the available bandwidth of a link is shared in time, frequency, or through code, among different stations.

- In this section, we discuss three protocols: **FDMA, TDMA, and CDMA.**



FDMA

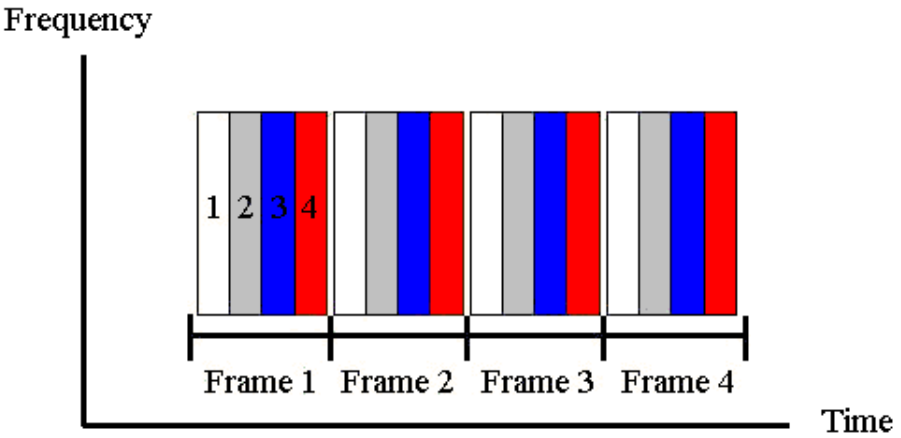
- In frequency-division multiple access (FDMA), the available bandwidth is divided into frequency bands. Each station is allocated a band to send its data.
- In other words, each band is reserved for a specific station, and it belongs to the station all the time.
- Each station also uses a bandpass filter to confine the transmitter frequencies.

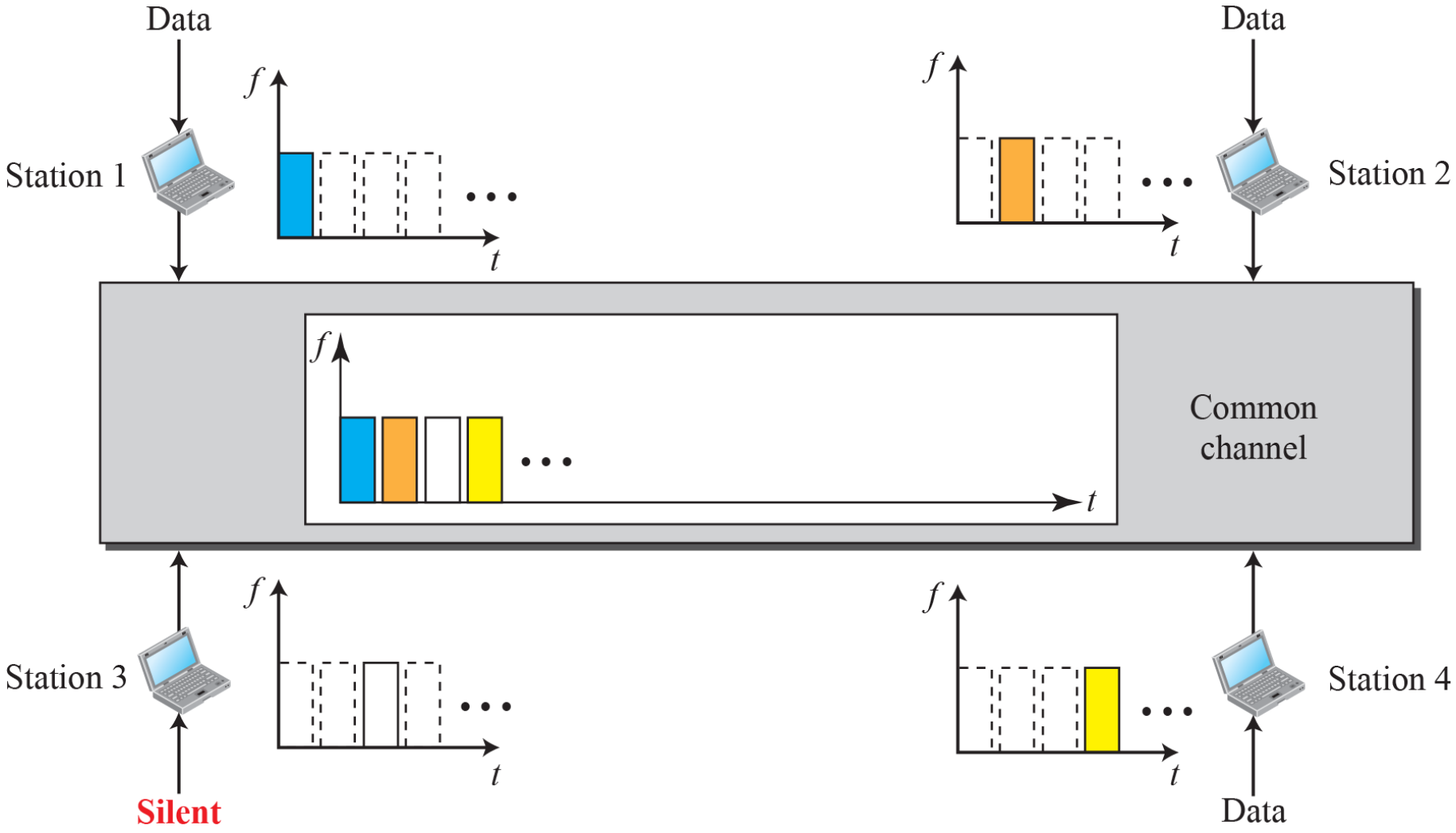


Frequency-division multiple access (FDMA)

TDMA

- In time-division multiple access (TDMA), the stations share the bandwidth of the channel in time.
- Each station is allocated a time slot during which it can send data.
- Each station transmits its data in its assigned time slot.

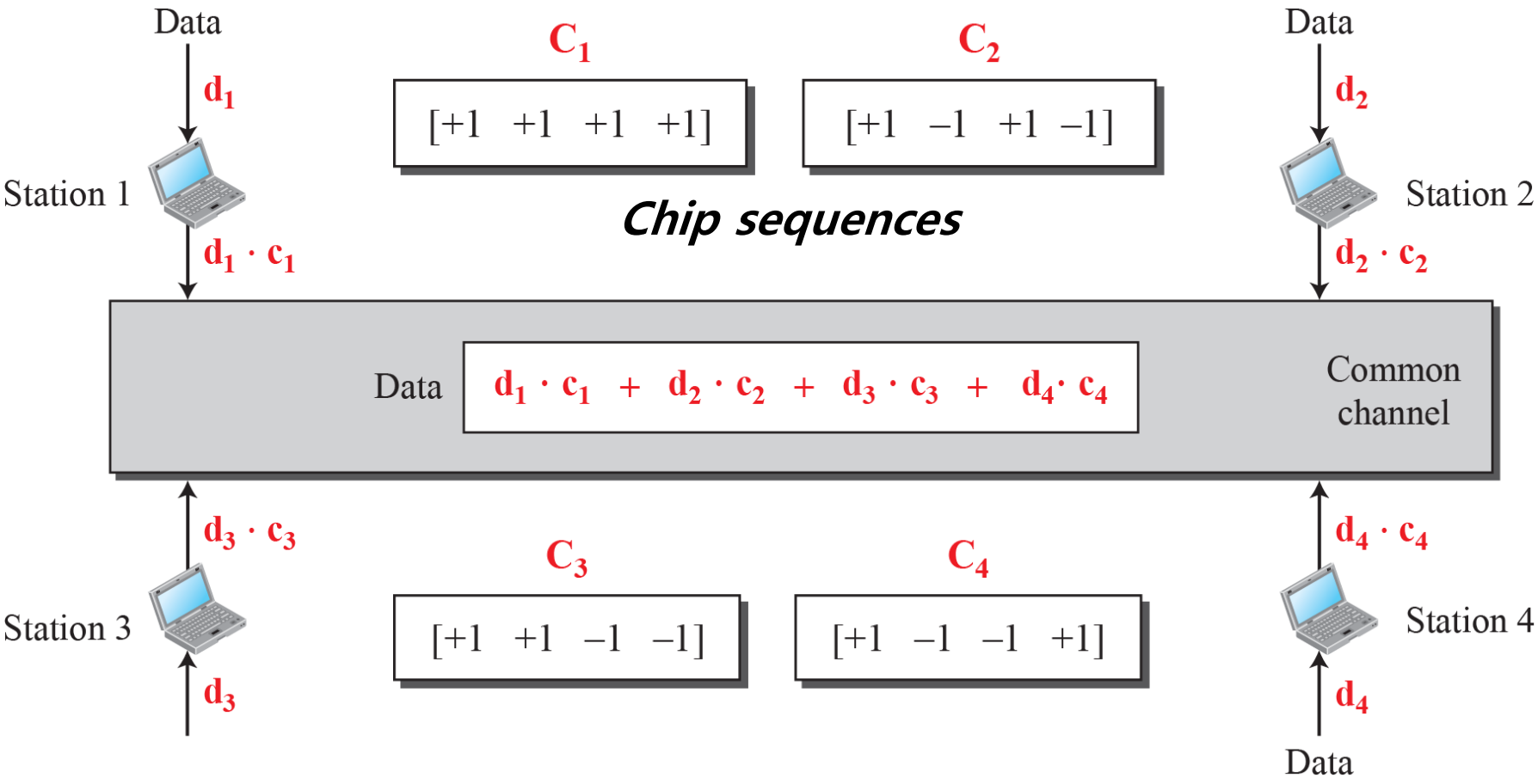




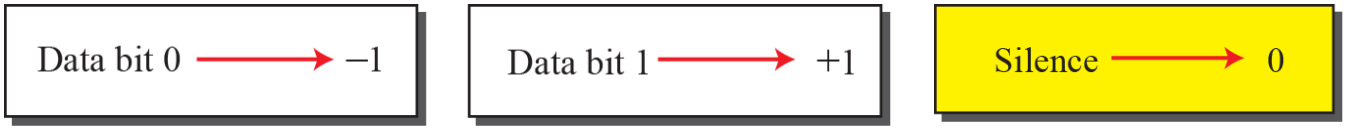
Time-division multiple access (TDMA)

CDMA

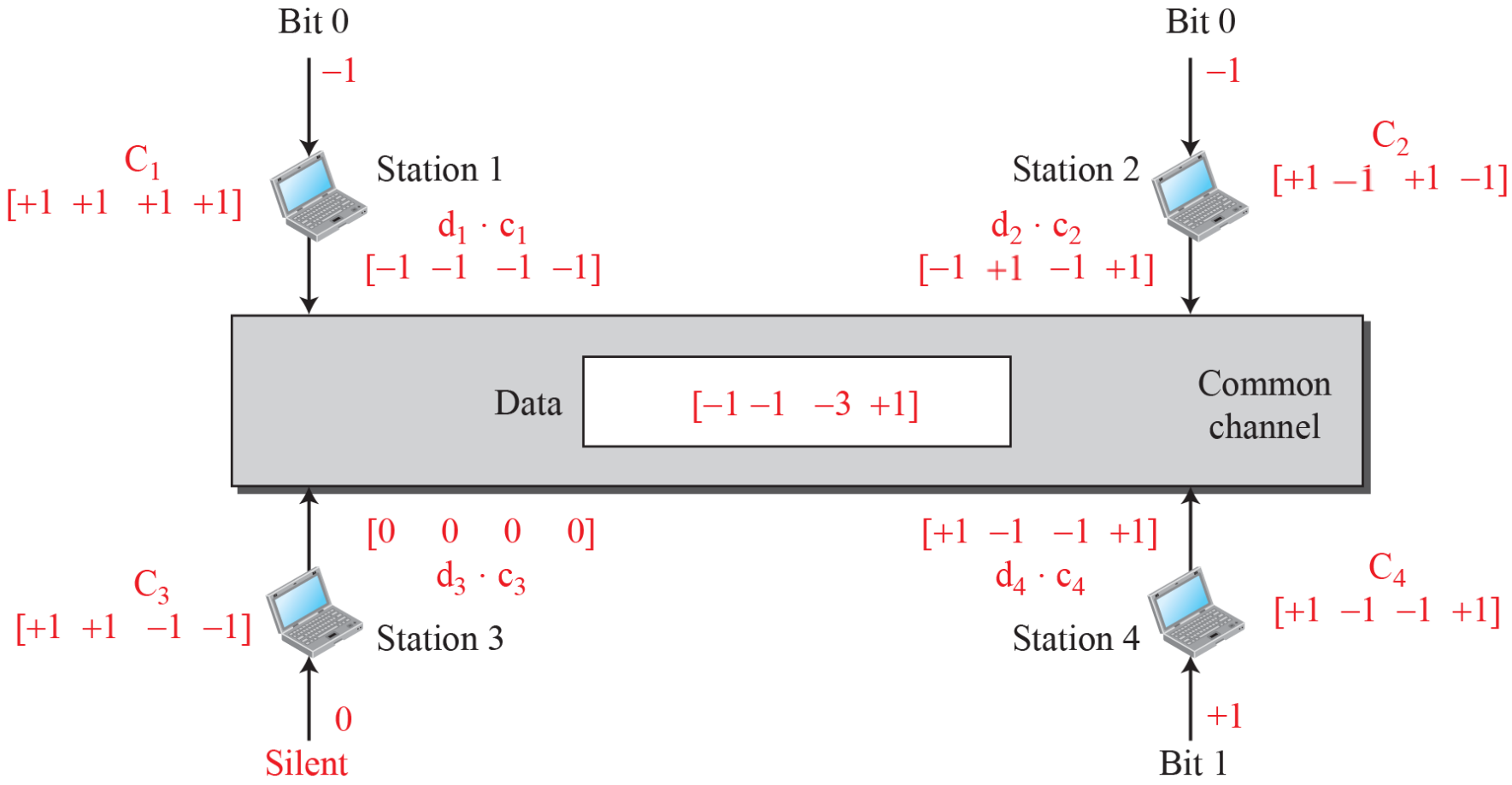
- Code-division multiple access (CDMA) was conceived several decades ago. Recent advances in electronic technology have finally made its implementation possible.
- CDMA differs from FDMA in that only one channel occupies the entire bandwidth of the link.
- It differs from TDMA in that all stations can send data simultaneously; there is no timesharing.



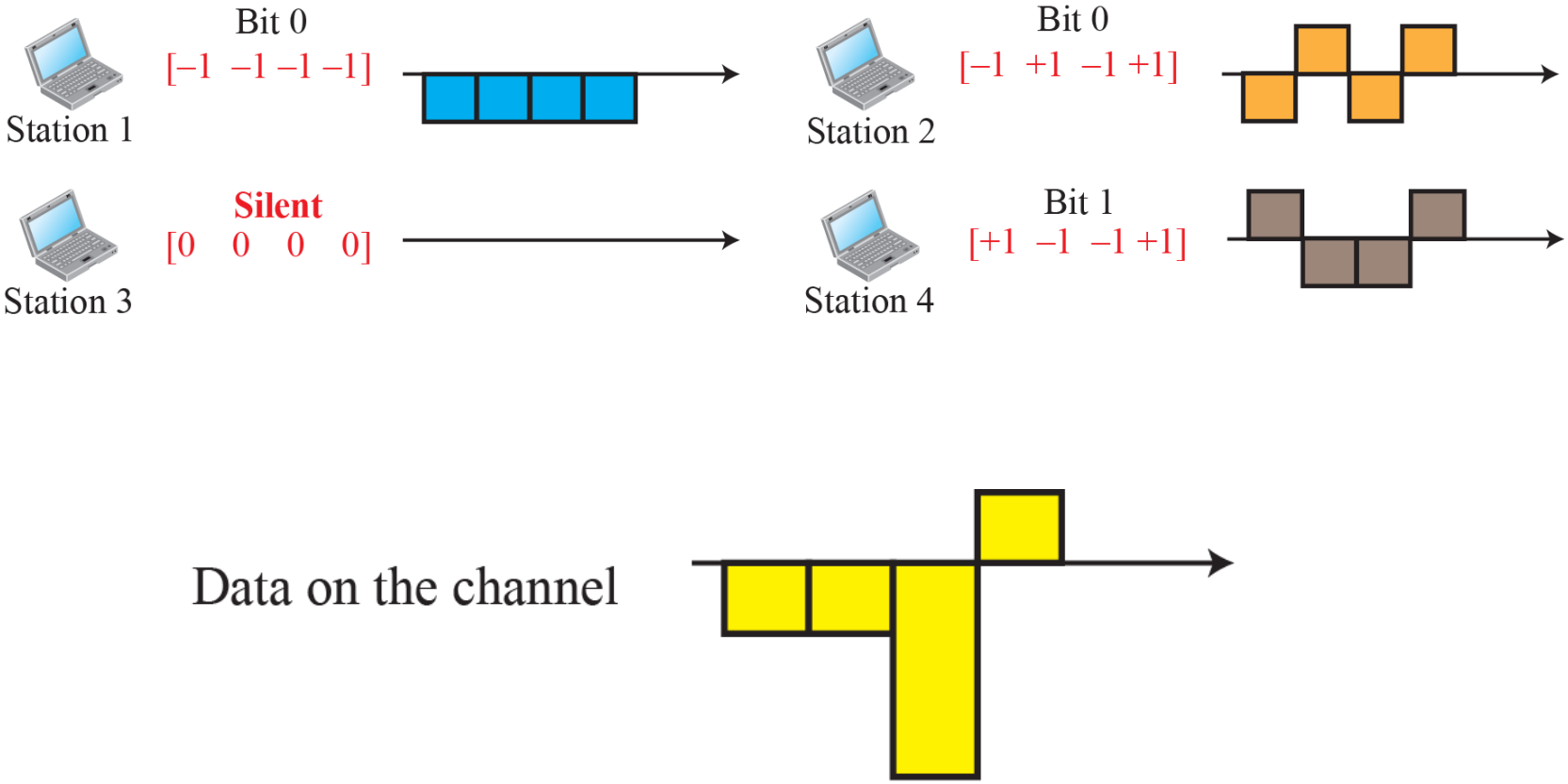
Simple idea of communication with code



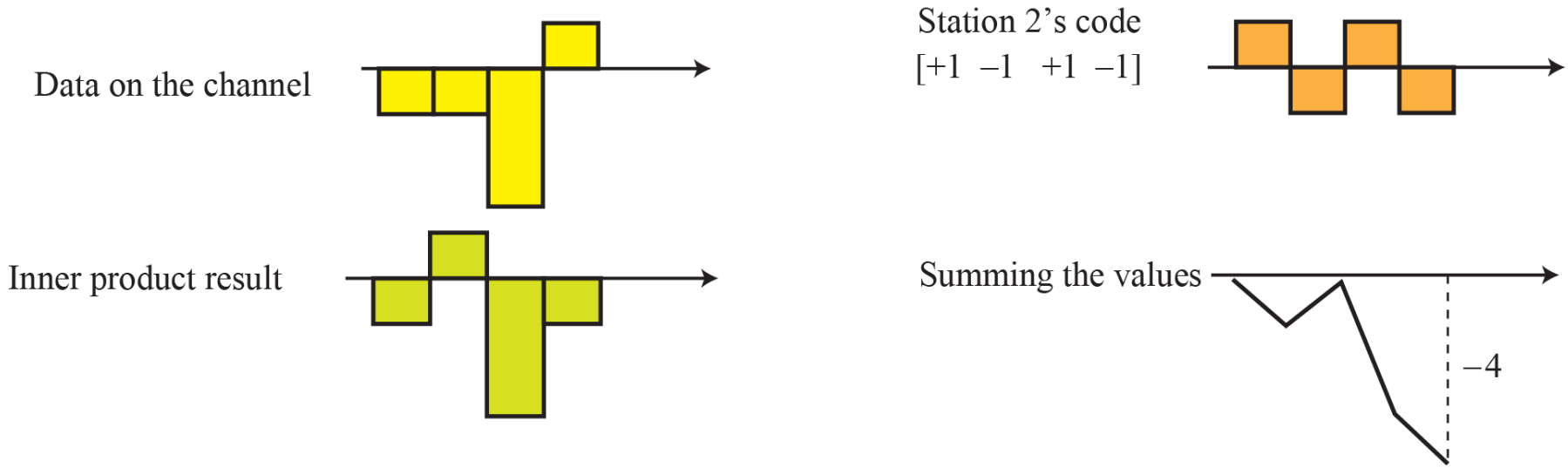
Data representation in CDMA



Sharing channel in CDMA



Digital signal created by four stations in CDMA



Decoding of the composite signal for one in CDMA