Unit 2.2

The Medium Access Control Sublayer

Figure 12.1 ***Data link layer divided into two functionality-oriented sublayers***

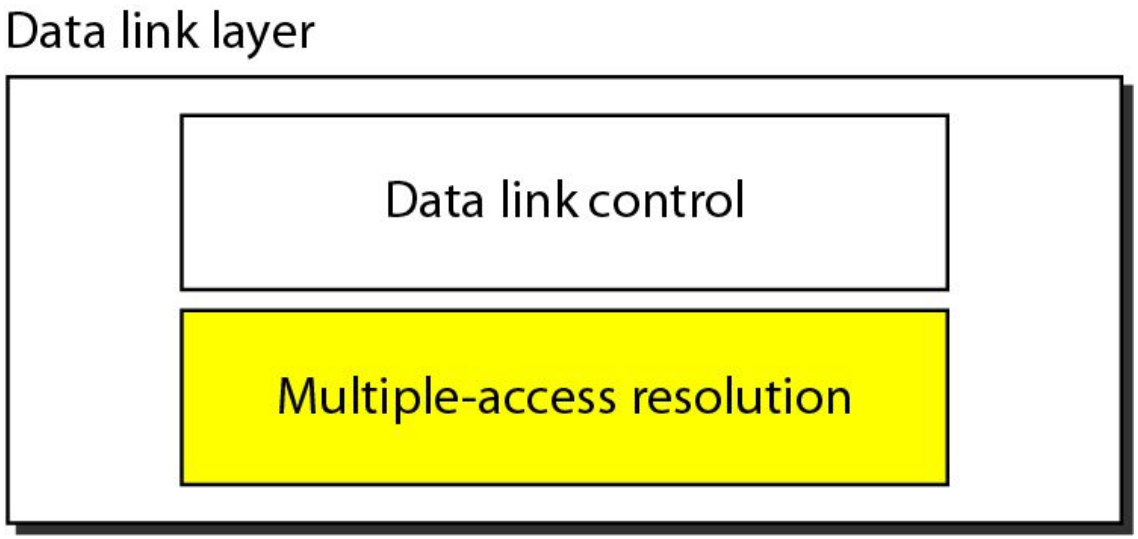
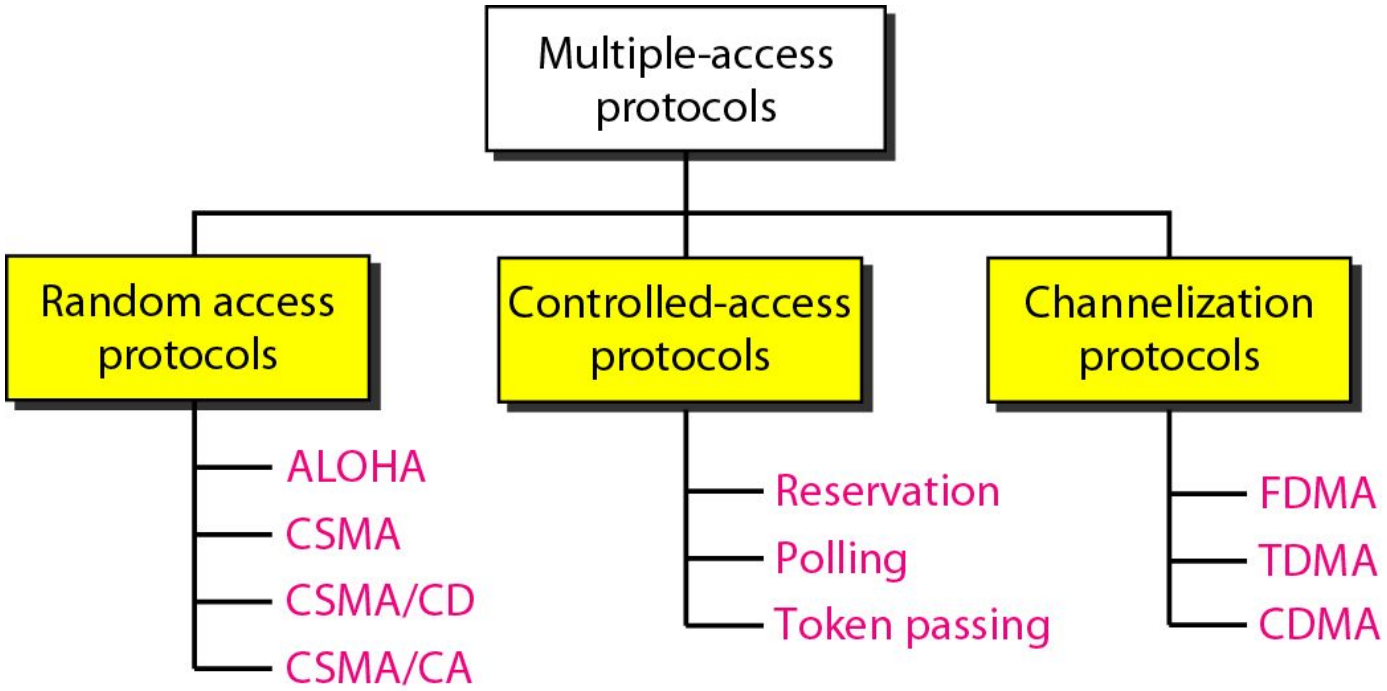


Figure 12.2 *Taxonomy of multiple-access protocols discussed in this chapter*



12-1 RANDOM ACCESS

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.

Topics discussed in this section:

ALOHA
Carrier Sense Multiple Access
Carrier Sense Multiple Access with Collision Detection
Carrier Sense Multiple Access with Collision Avoidance

Pure ALOHA

- The original ALOHA protocol is called pure ALOHA
- The idea is that each station sends a frame whenever it has a frame to send
- However, since there is only one channel to share, there is the possibility of collision between frames from different stations

Figure 12.3 *Frames in a pure ALOHA network*

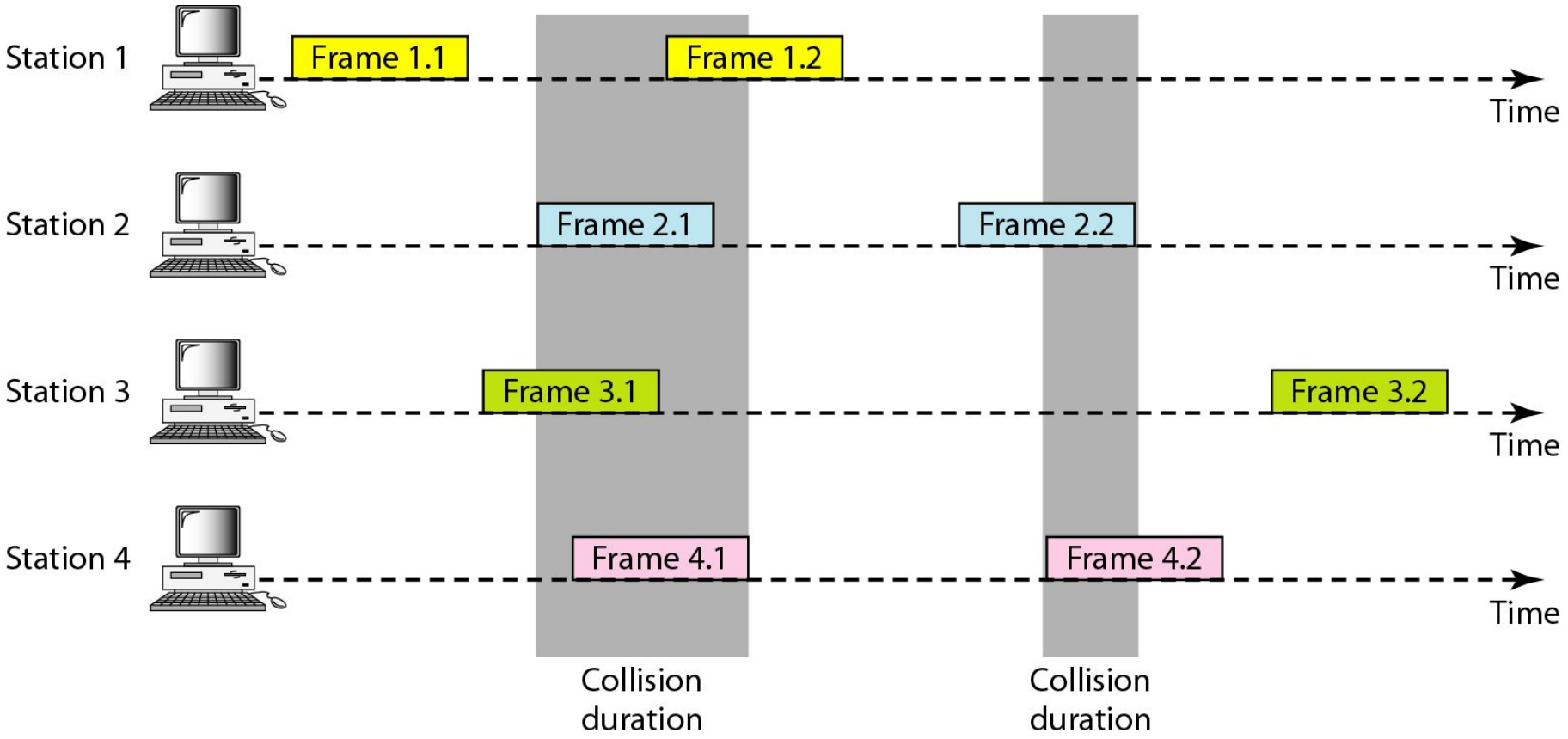


Figure 12.4 *Procedure for pure ALOHA protocol*

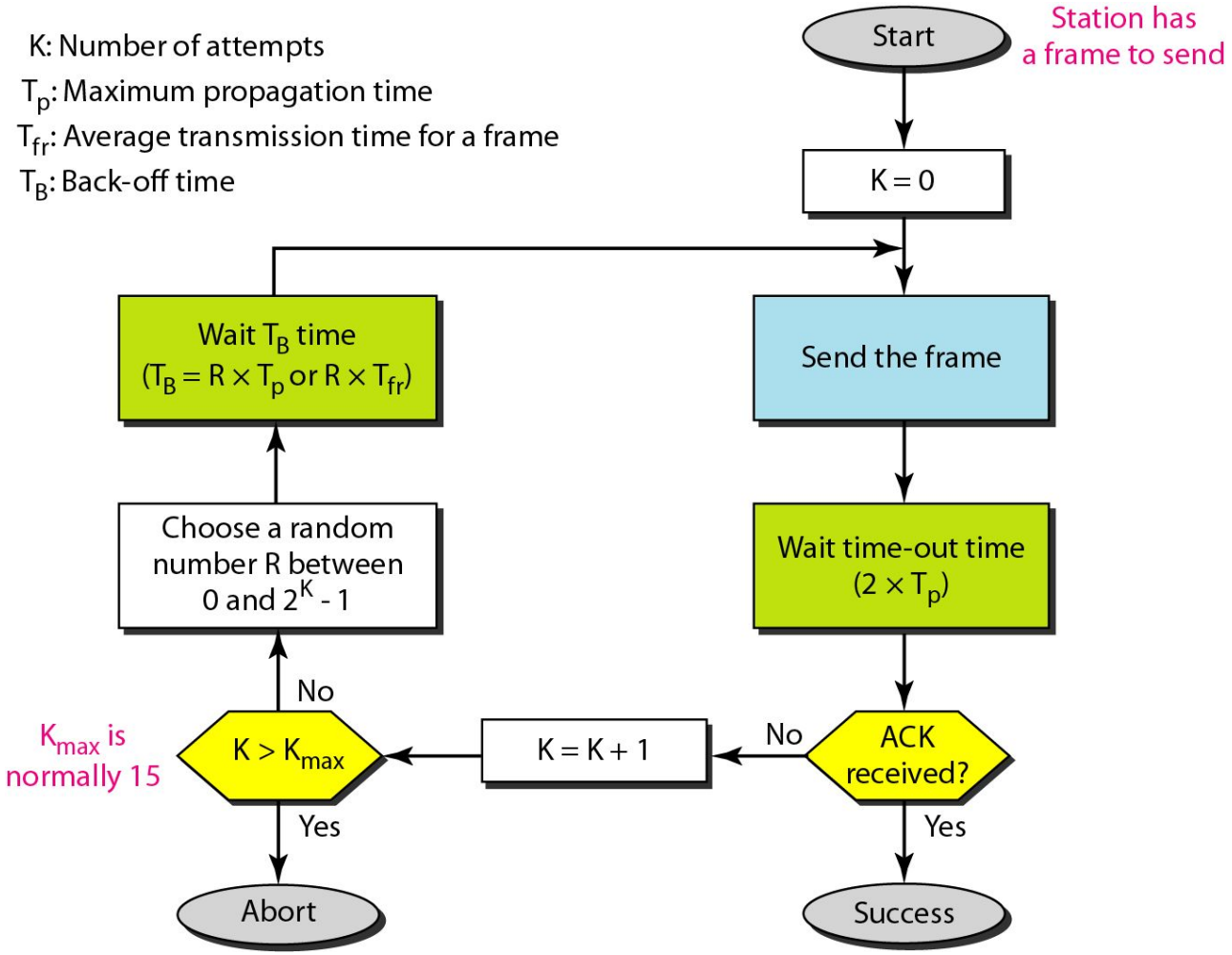
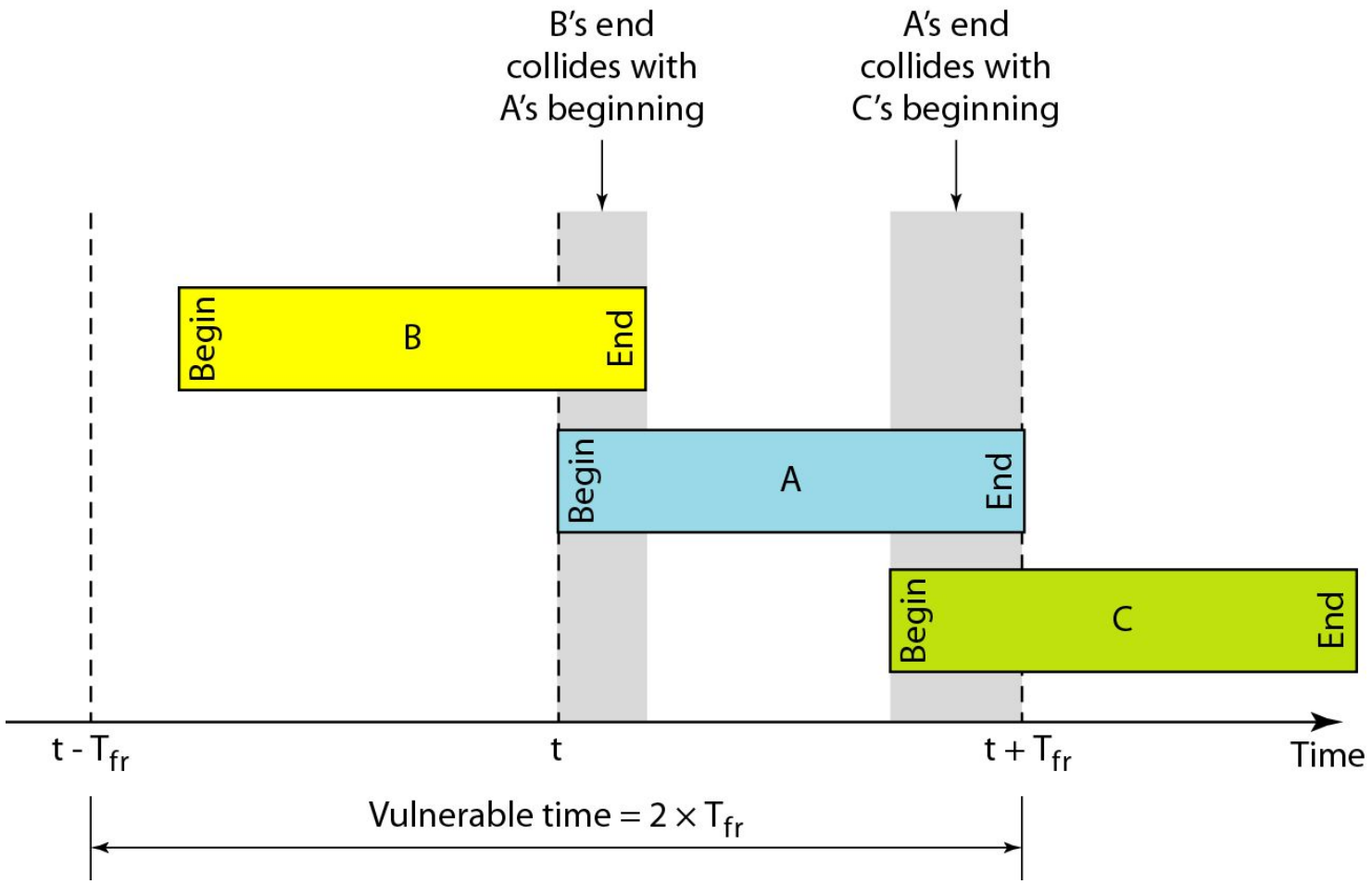


Figure 12.5 *Vulnerable time for pure ALOHA protocol*



Slotted ALOHA

- Pure ALOHA has a vulnerable time of 2 x Tfr. This is so because there is no rule that defines when the station can send

- Slotted ALOHA was invented to improve the efficiency of pure ALOHA

- In slotted ALOHA we divide the time into slots of Tfr and force the station to send only at the beginning of the time slot

Cont…

- A station is allowed to send only at the beginning of the synchronized time slot, if a station misses this moment, it must wait until the beginning of the next time slot.
- Of course, there is still the possibility of collision if two stations try to send at the beginning of the same time slot
- However, the vulnerable time is reduced

Figure 12.6 *Frames in a Slotted ALOHA network*

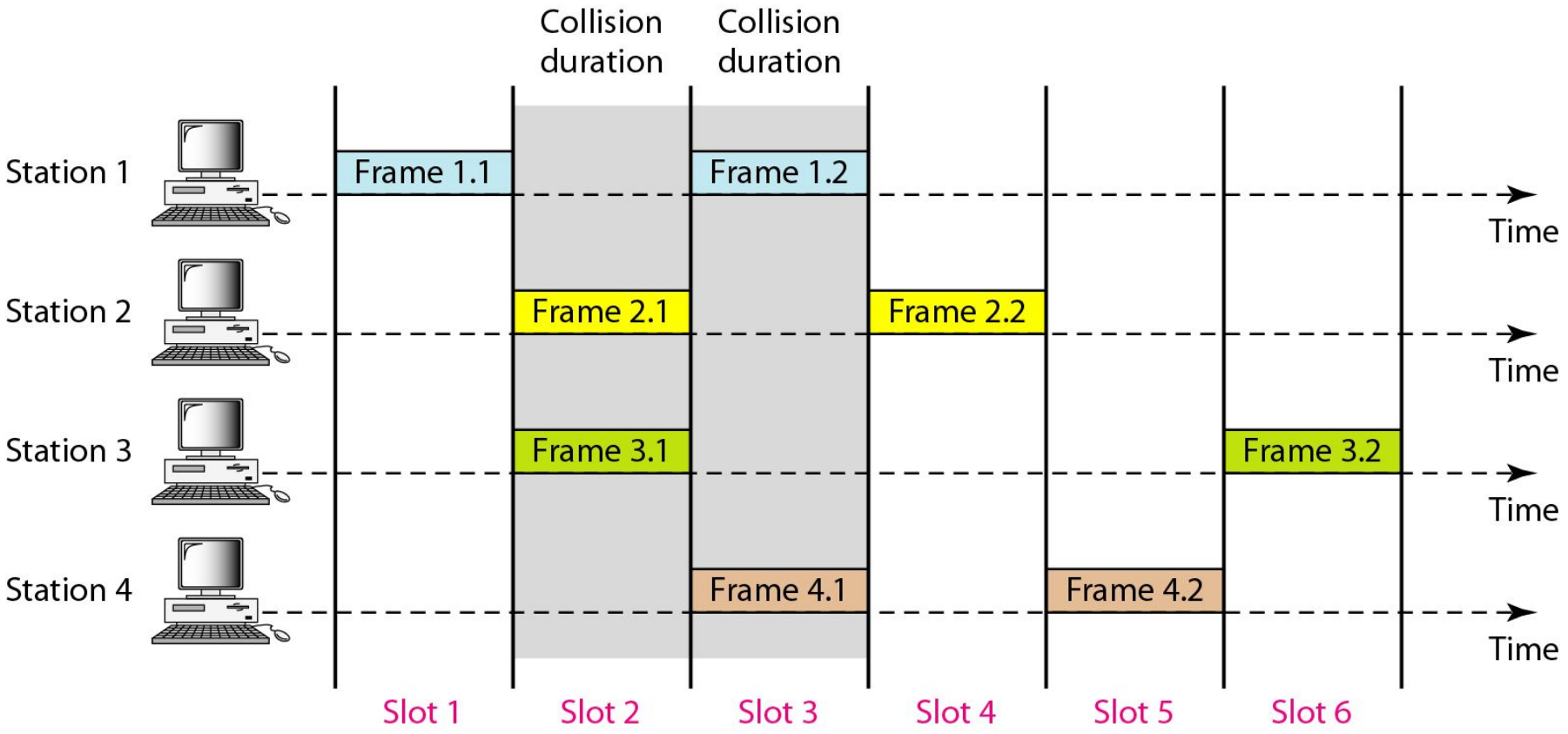
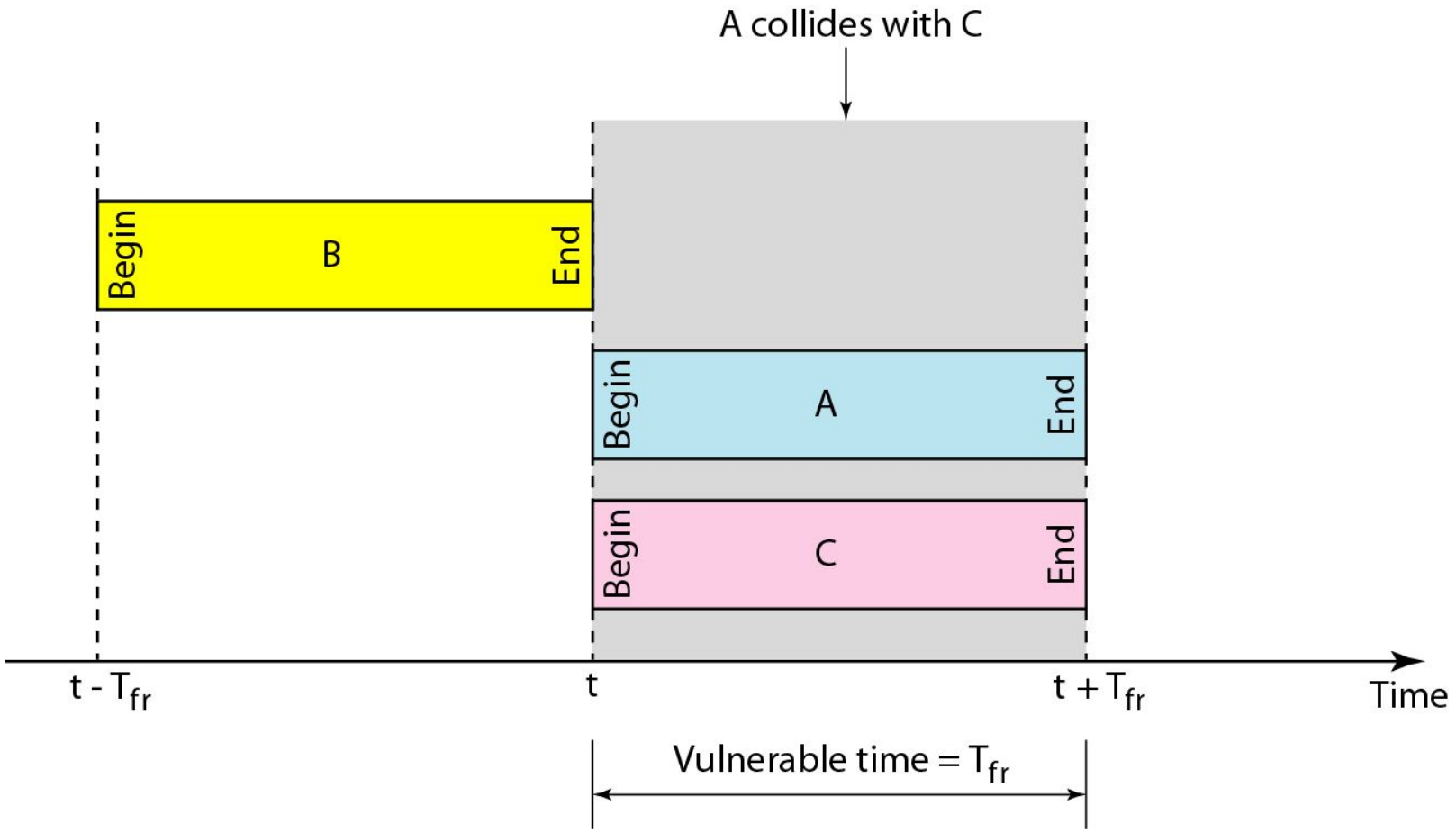


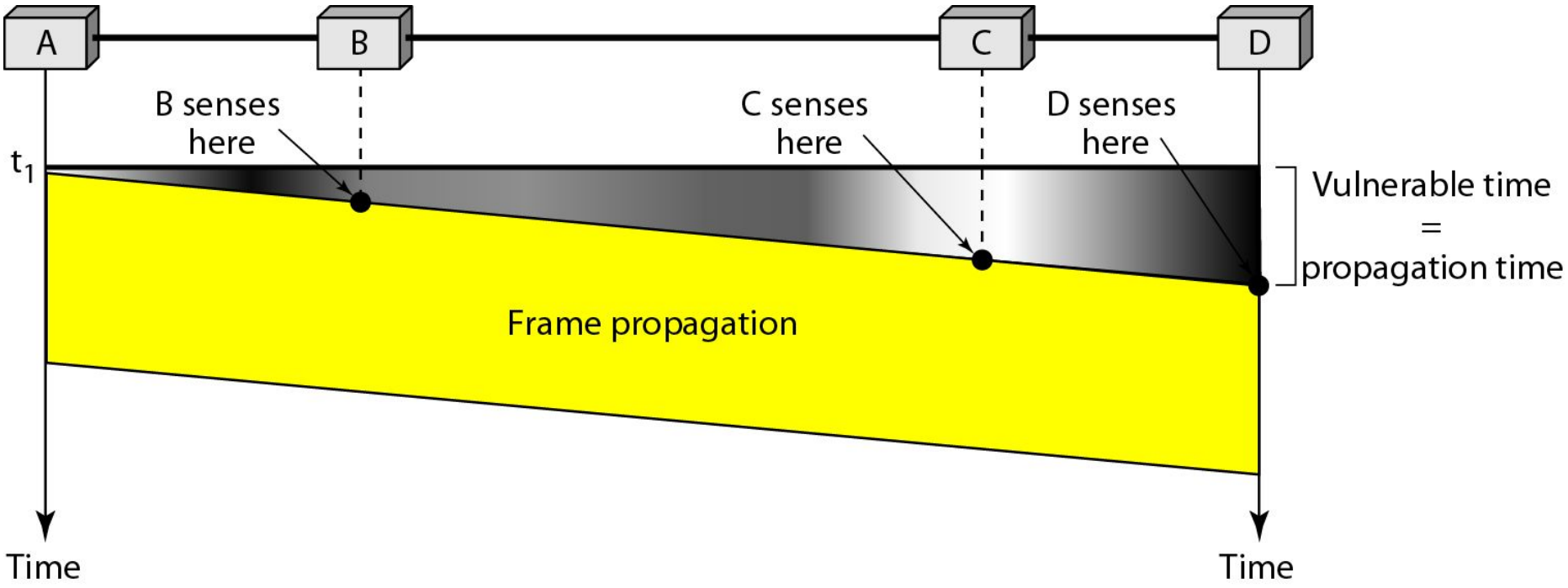
Figure 12.7 *Vulnerable time for slotted ALOHA protocol*



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 (or check the state of the medium) before sending
- In other words, CSMA is based on the principle "listen before talk
- CSMA can reduce the possibility of collision, but it cannot eliminate it

Figure 12.9 *Vulnerable time in CSMA*



Persistence Method

- What should a station do if the channel is busy? What should a station do if the channel is idle? Three methods have been devised to answer these questions:
  - The I-persistent method
  - The non-persistent method
  - The p-persistent method

Figure 12.11 *Flow diagram for three persistence methods*

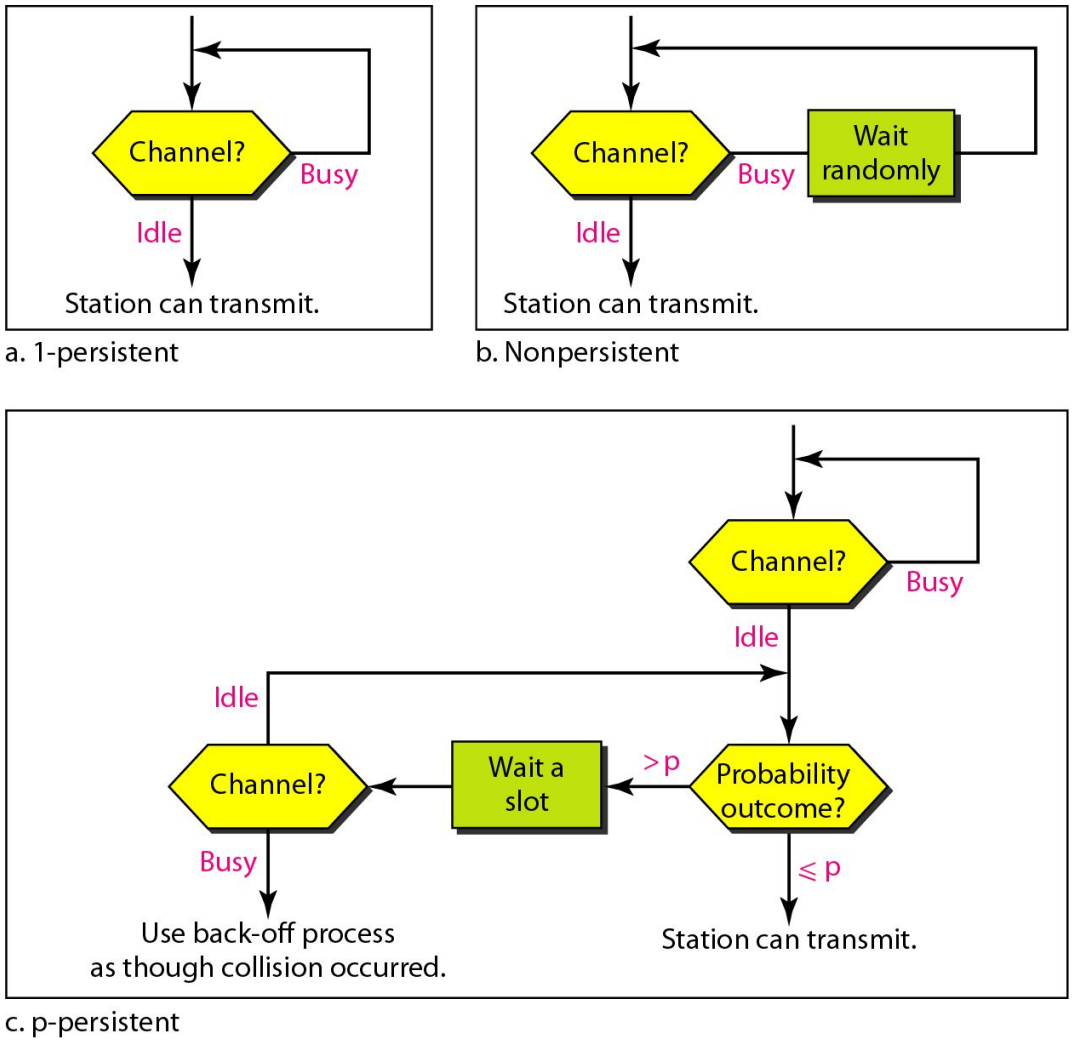
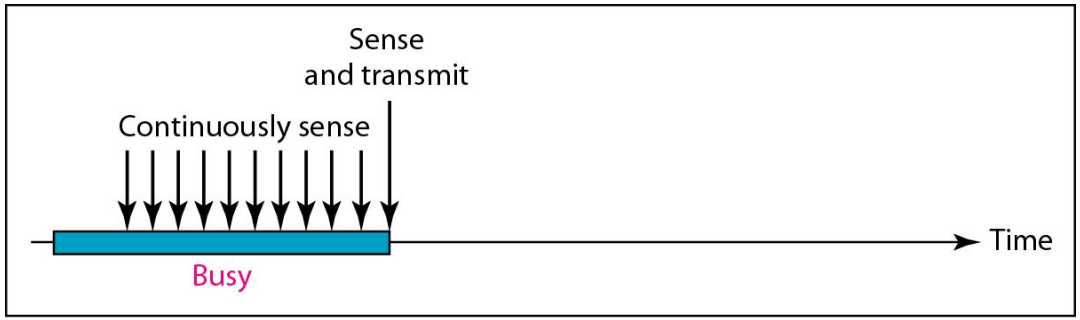
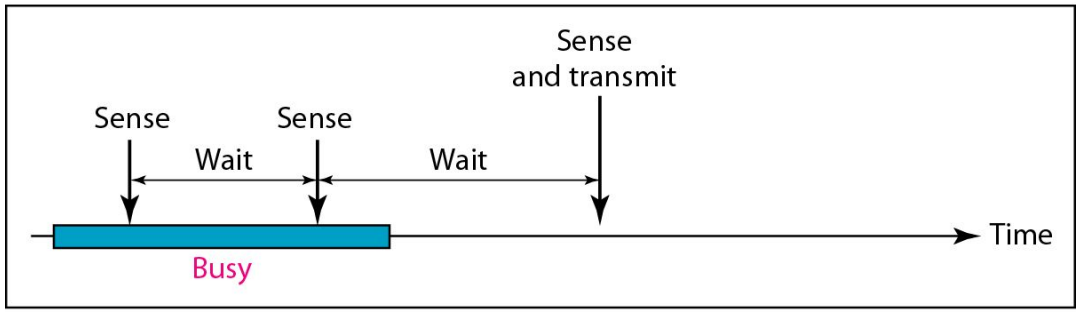


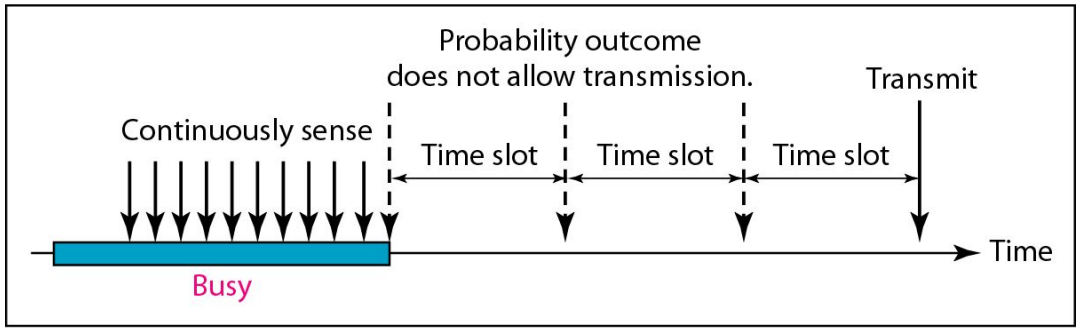
Figure 12.10 *Behavior of three persistence methods*



a. 1-persistent



b. Nonpersistent

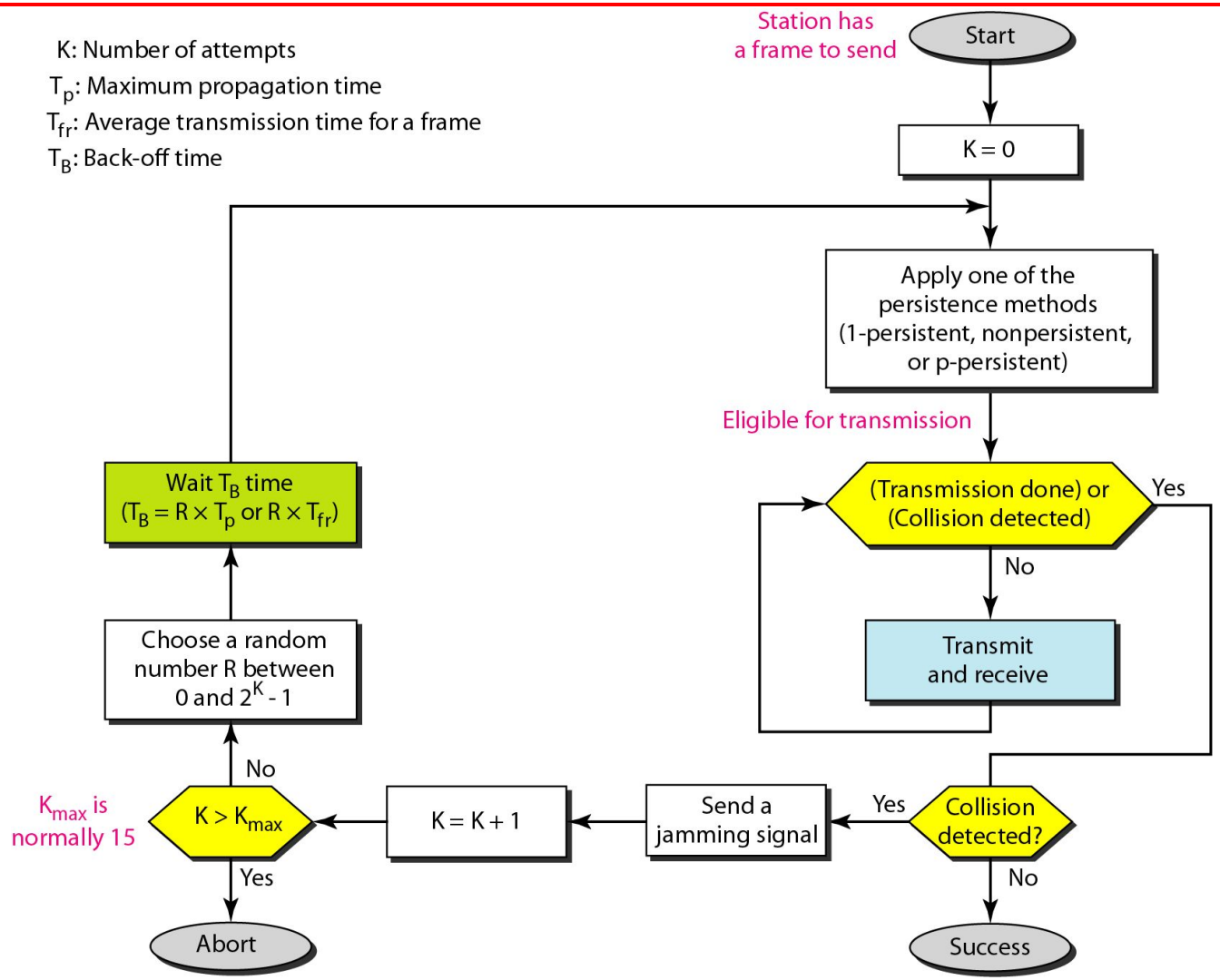


c. p-persistent

CSMA/CD

- 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 there is a collision, the frame is sent again

Figure 12.14 *Flow diagram for the CSMA/CD*



CSMA/CA

- The basic idea behind CSMA/CD is that a station needs to be able to receive while transmitting to detect a collision
- When there is no collision, the station receives one signal: its own signal. When there is a collision, the station receives two signals: its own signal and the signal transmitted by a second station
- In wired network it is easy to detect collision due to significant energy, while in wireless the case is difficult
- In wireless channel collision needs to be avoided rather than detection

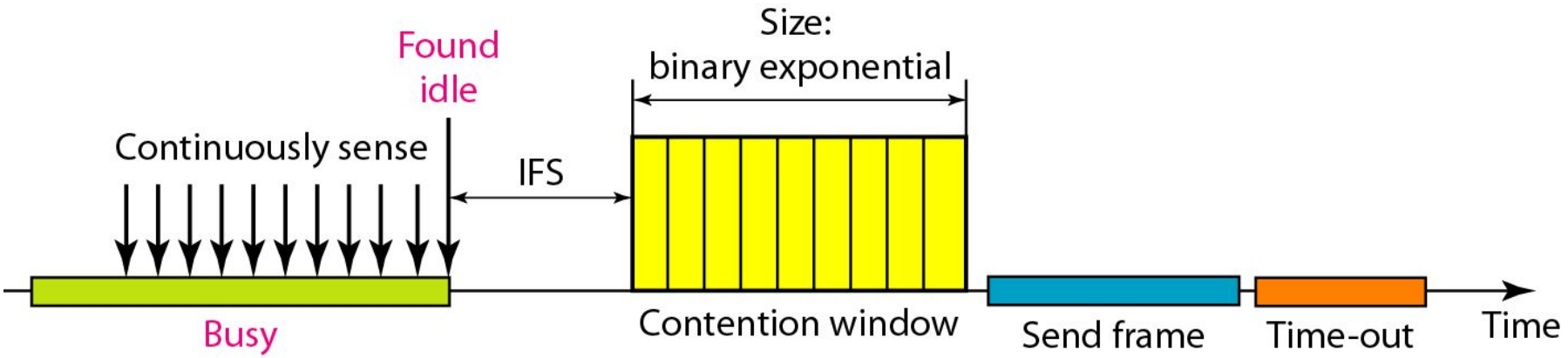
Cont…

- Collisions are avoided through the use of CSMA/CA's three strategies
  - The InterFrame Space
  - The contention window
  - Acknowledgments

Cont…

- Interframe Space (IFS)
  - When an idle channel is found, the station does not send immediately. It waits for a period of time called the interframe space or IFS
- The contention window
  - The contention window is an amount of time divided into slots. A station that is ready to send chooses a random number of slots as its wait time
- Acknowledgments
  - The positive acknowledgment and the time-out timer can help guarantee that the receiver has received the frame.

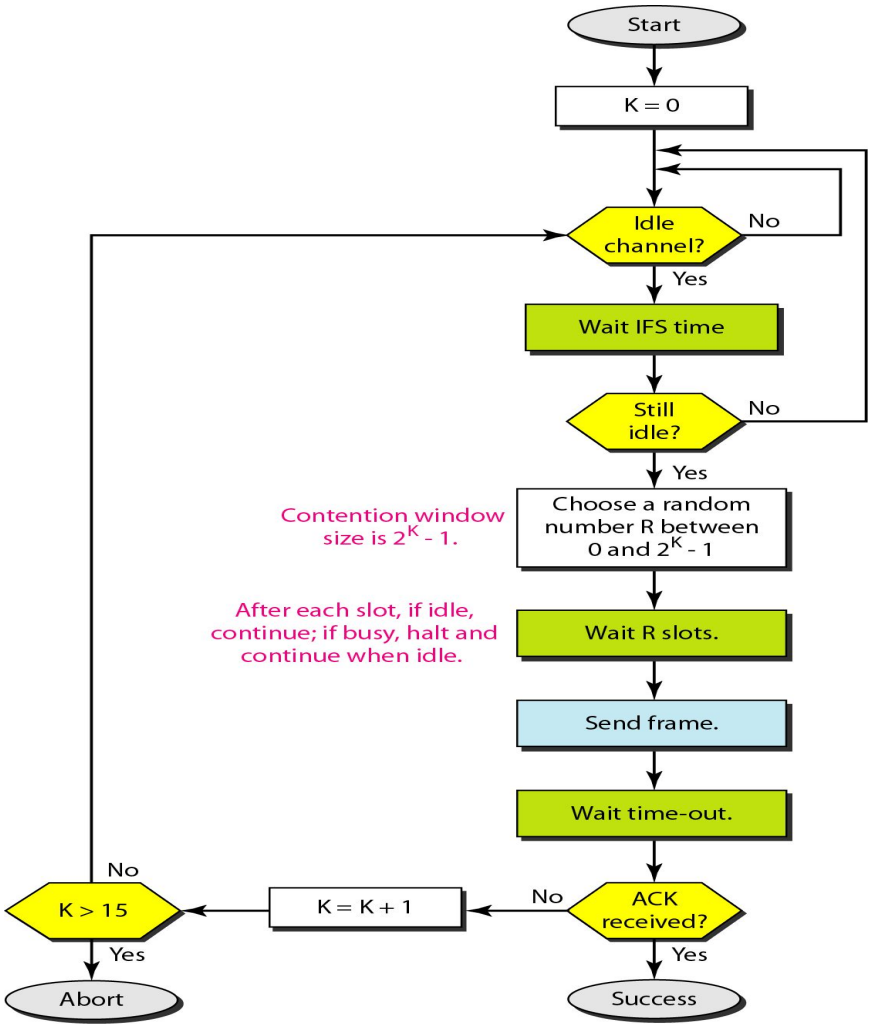
Figure 12.16 *Timing in CSMA/CA*



Note

In CSMA/CA, the IFS can also be used to define the priority of a station or a frame.

Figure 12.17 *Flow diagram for CSMA/CA*



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 popular controlled-access methods.

Topics discussed in this section:

Reservation
Polling
Token Passing

Figure 12.18 *Reservation access method*

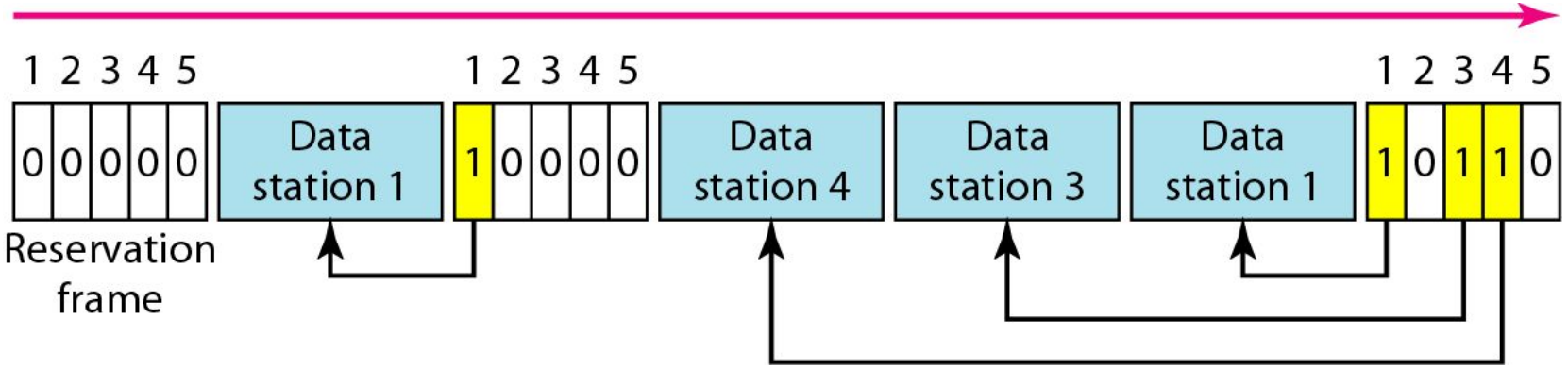


Figure 12.19 *Select and poll functions in polling access method*

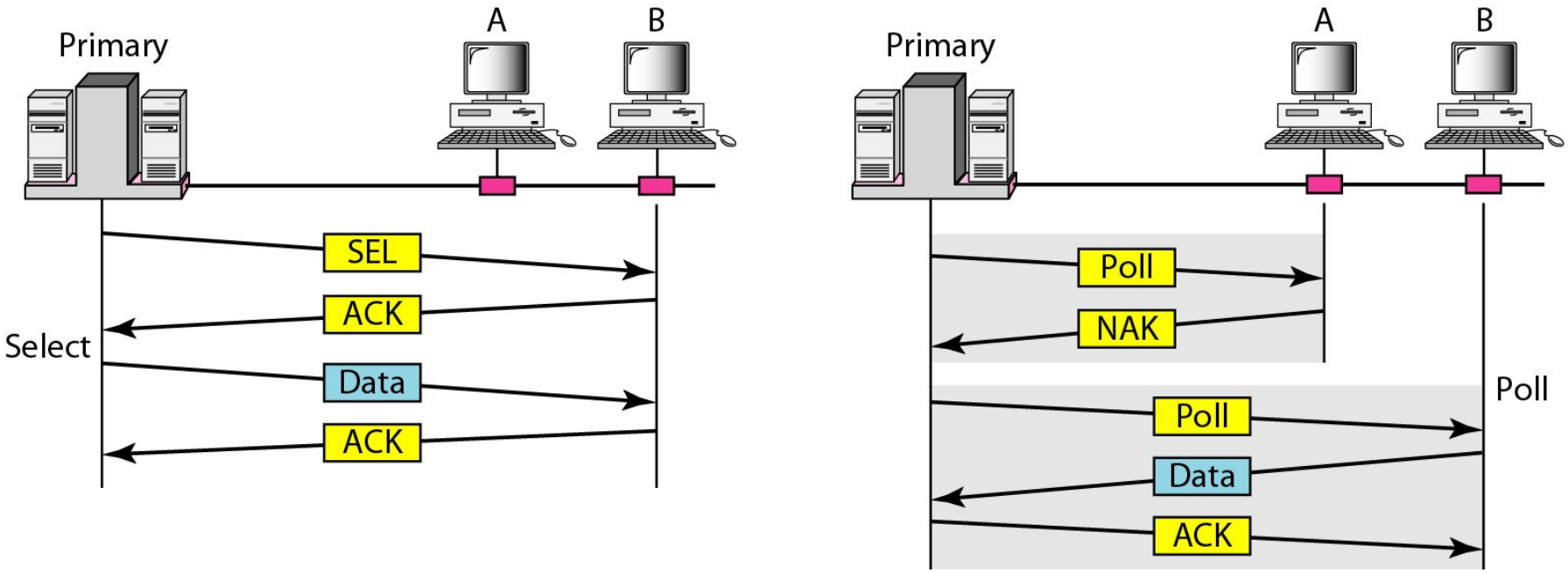
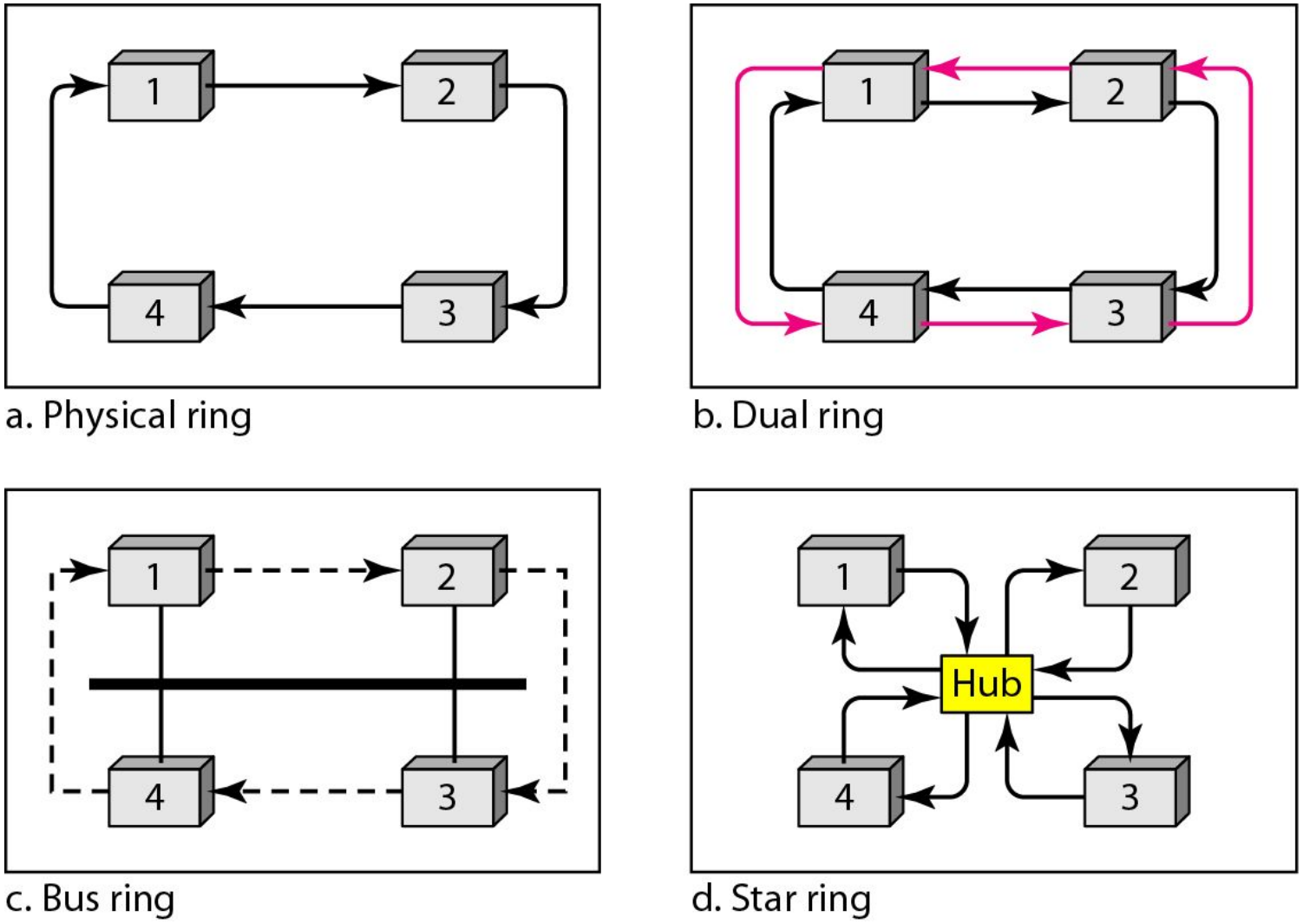


Figure 12.20 *Logical ring and physical topology in token-passing access method*



12-3 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. In this section, we discuss three channelization protocols.*

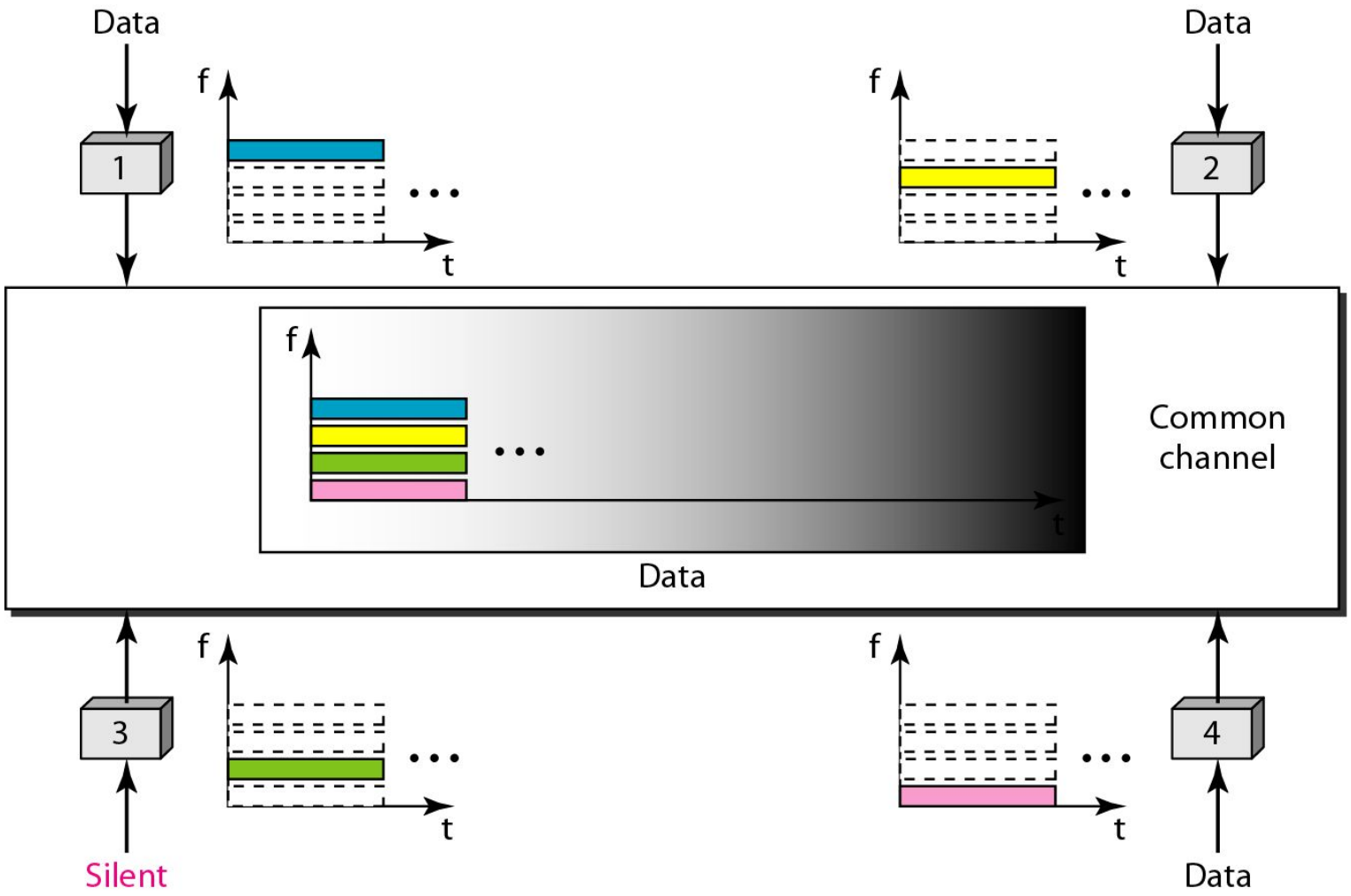
Topics discussed in this section:

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

Note

We see the application of all these methods in Chapter 16 when we discuss cellular phone systems.

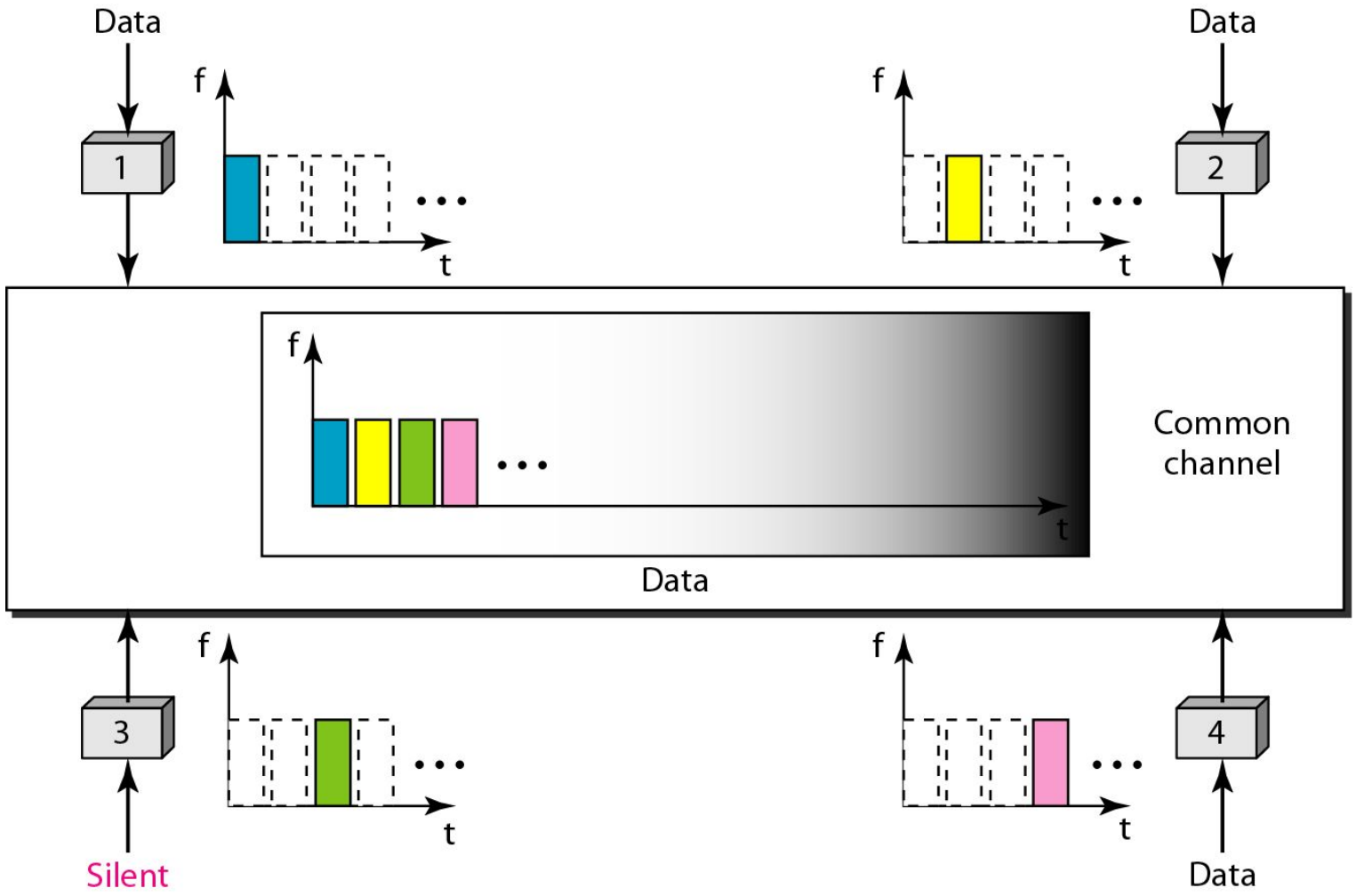
Figure 12.21 *Frequency-division multiple access (FDMA)*



Note

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

Figure 12.22 *Time-division multiple access (TDMA)*



Note

In TDMA, the bandwidth is just one channel that is timeshared between different stations.

Note

In CDMA, one channel carries all transmissions simultaneously.

Figure 12.23 *Simple idea of communication with code*

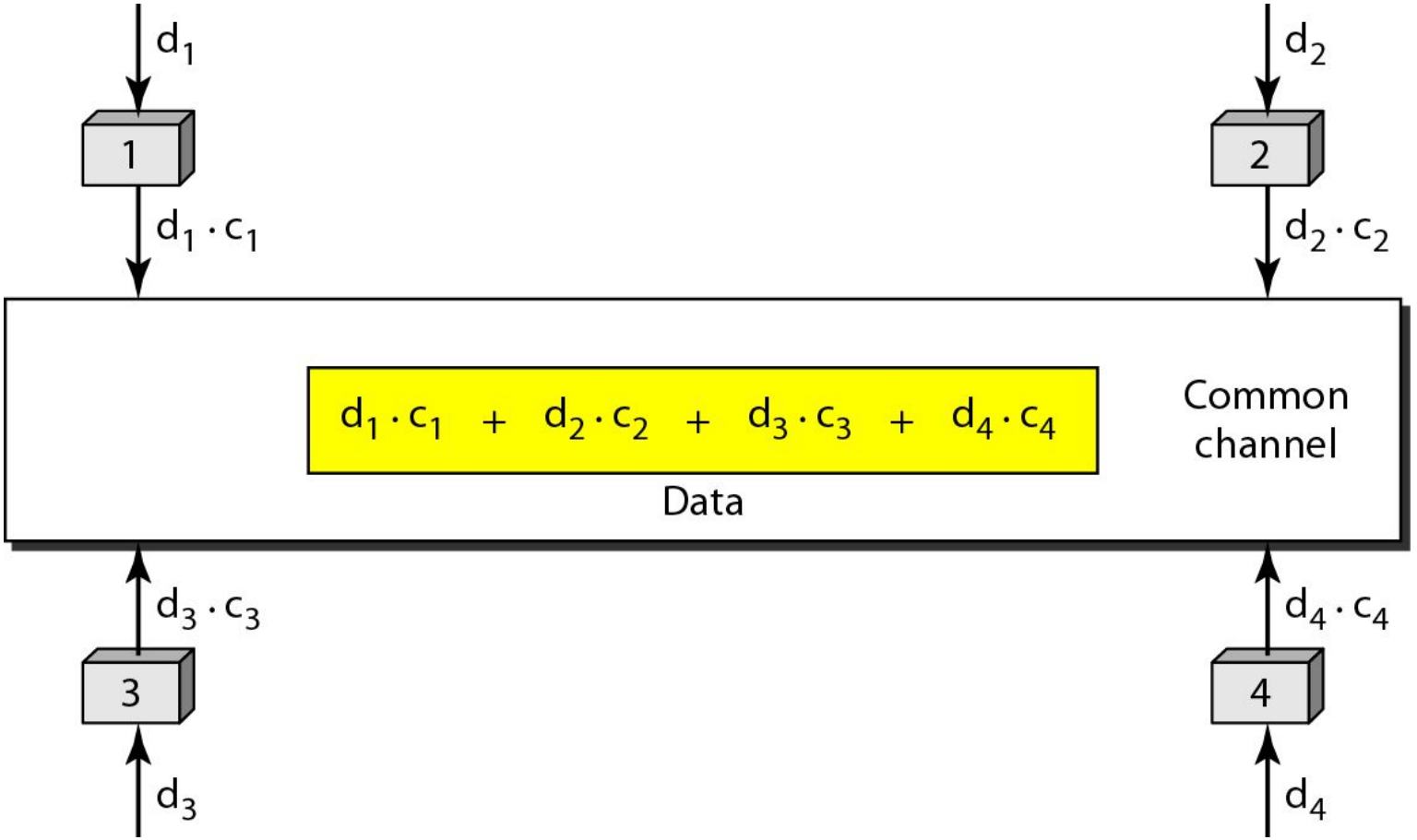


Figure 12.24 *Chip sequences*

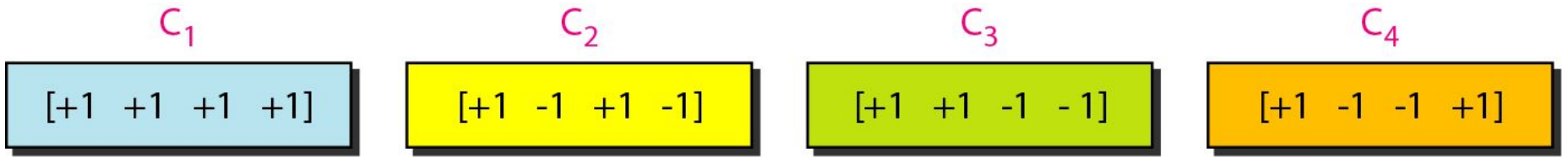


Figure 12.25 *Data representation in CDMA*

Figure 12.26 *Sharing channel in CDMA*