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

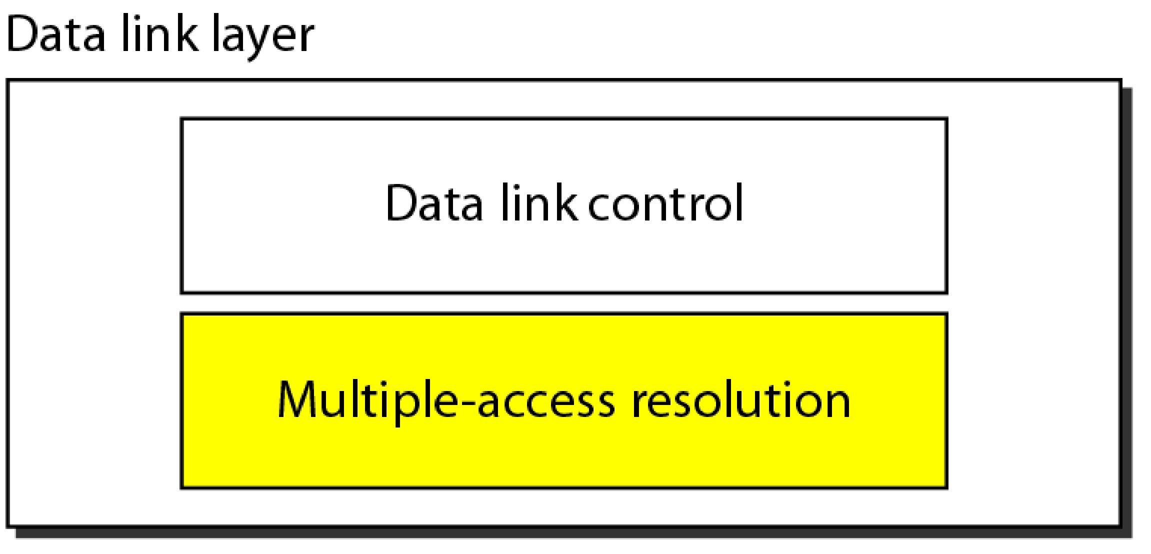
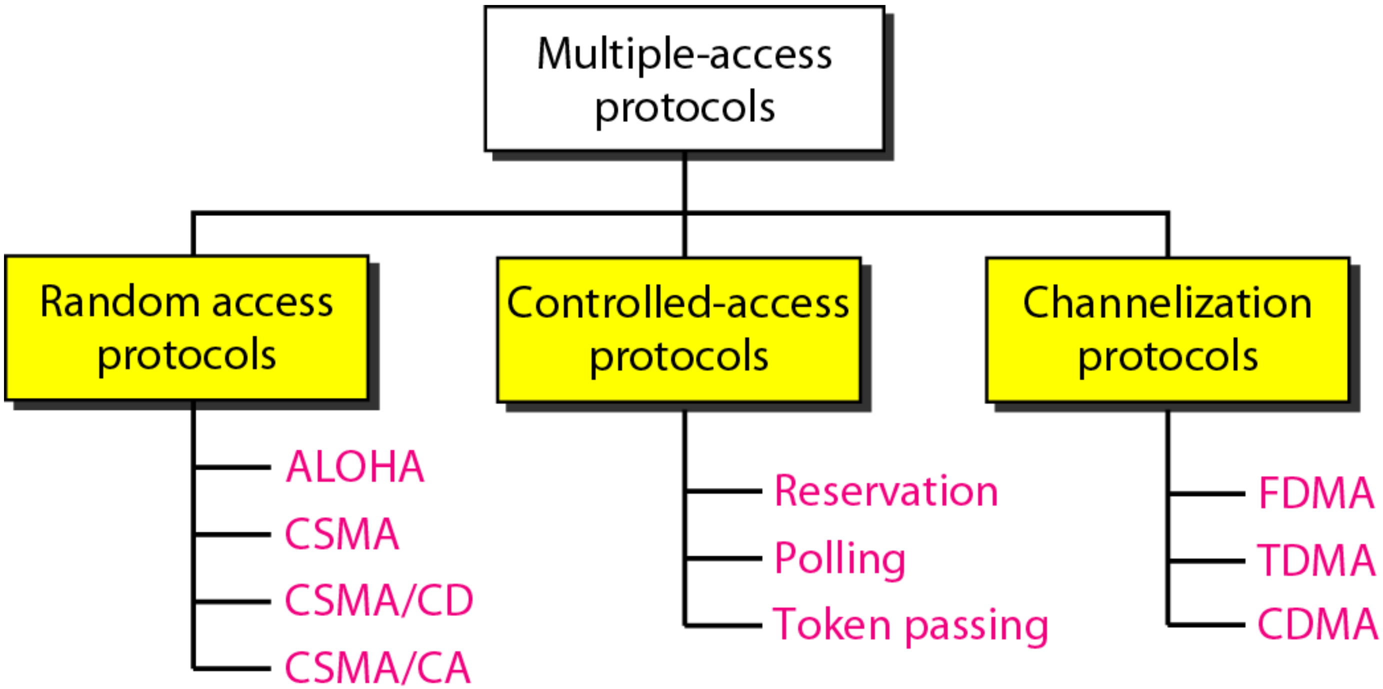


Figure 12.2 *Taxonomy of multiple-access protocols discussed in this chapter*



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

Figure 12.3 *Frames in a pure ALOHA network*

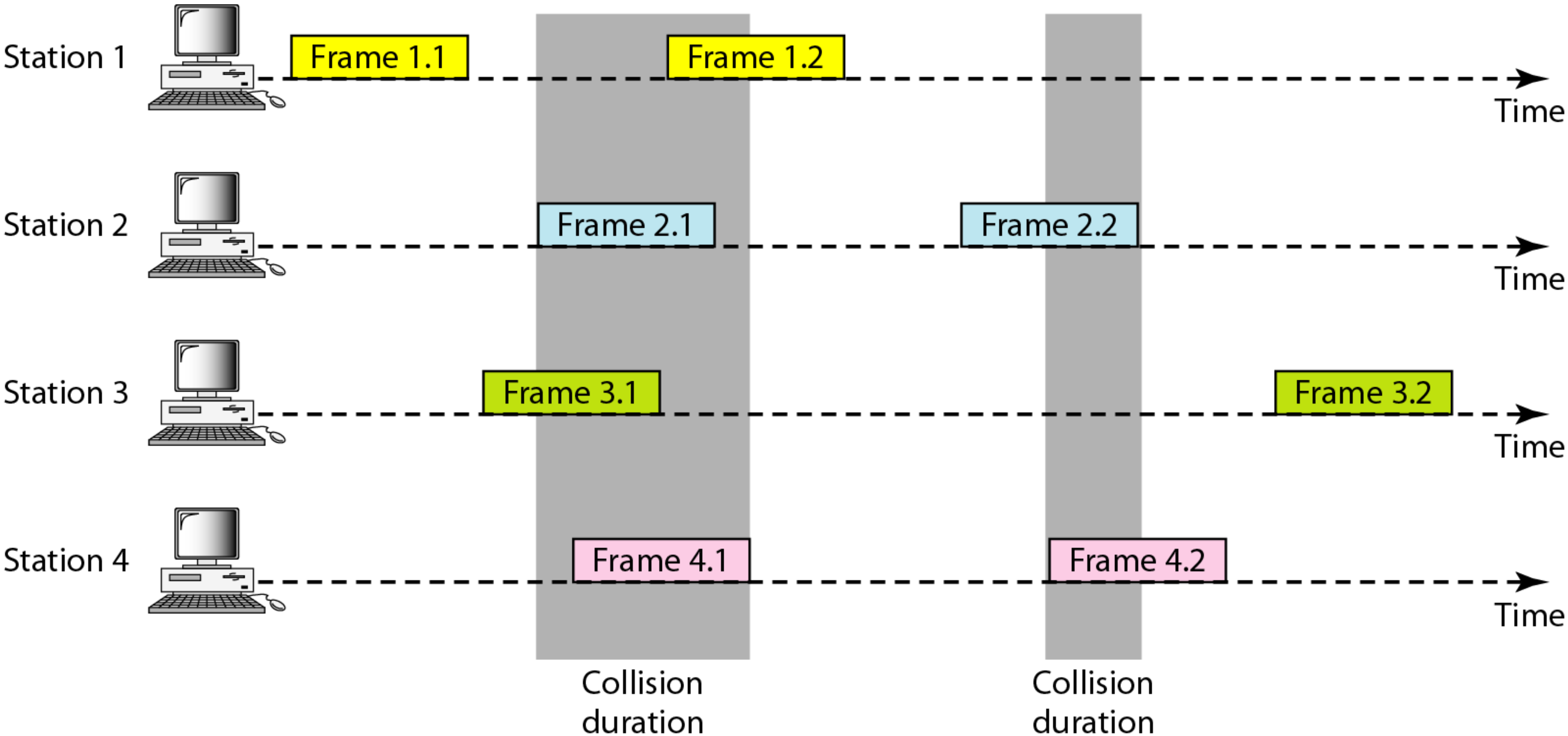


Figure 12.4 *Procedure for pure ALOHA protocol*

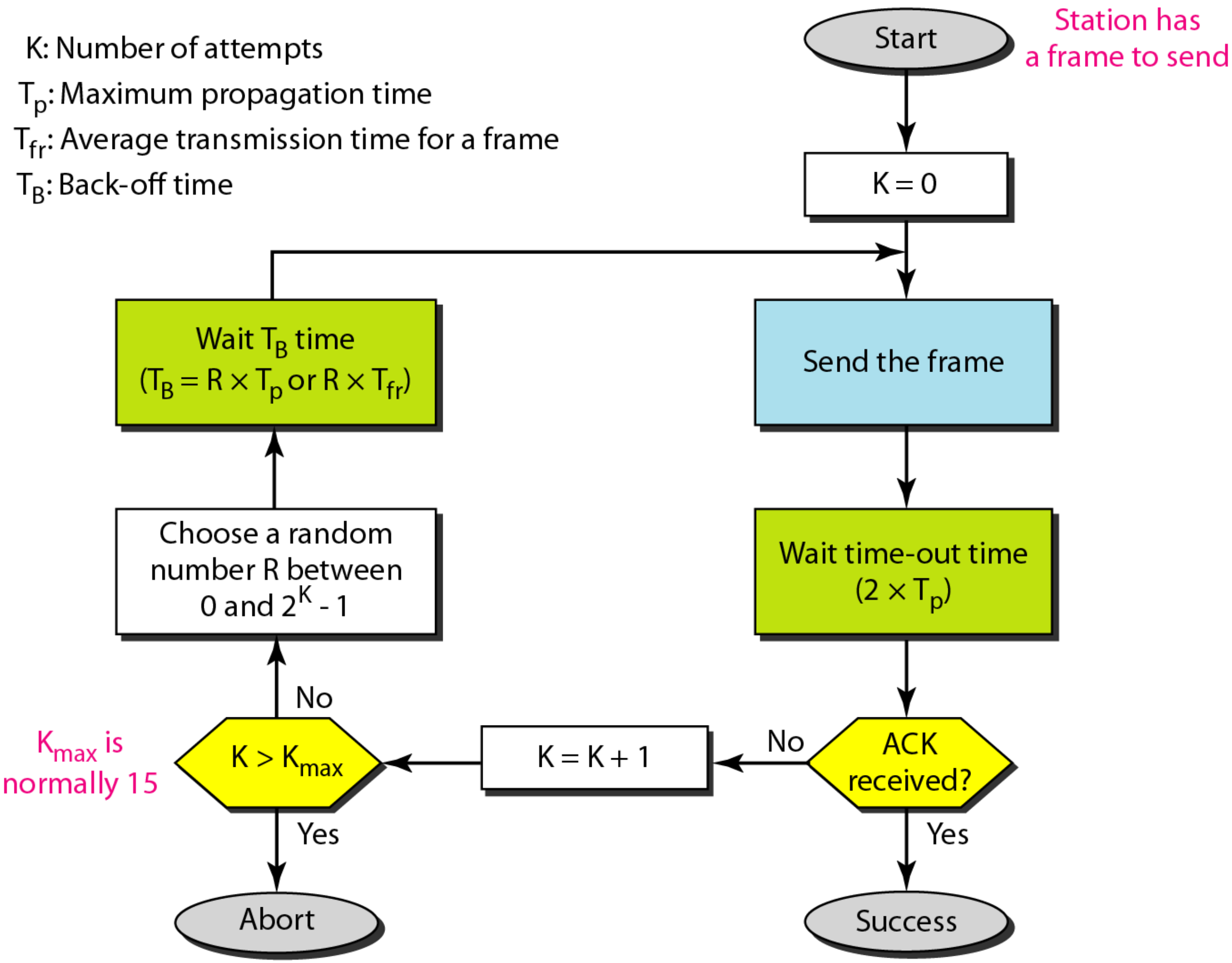
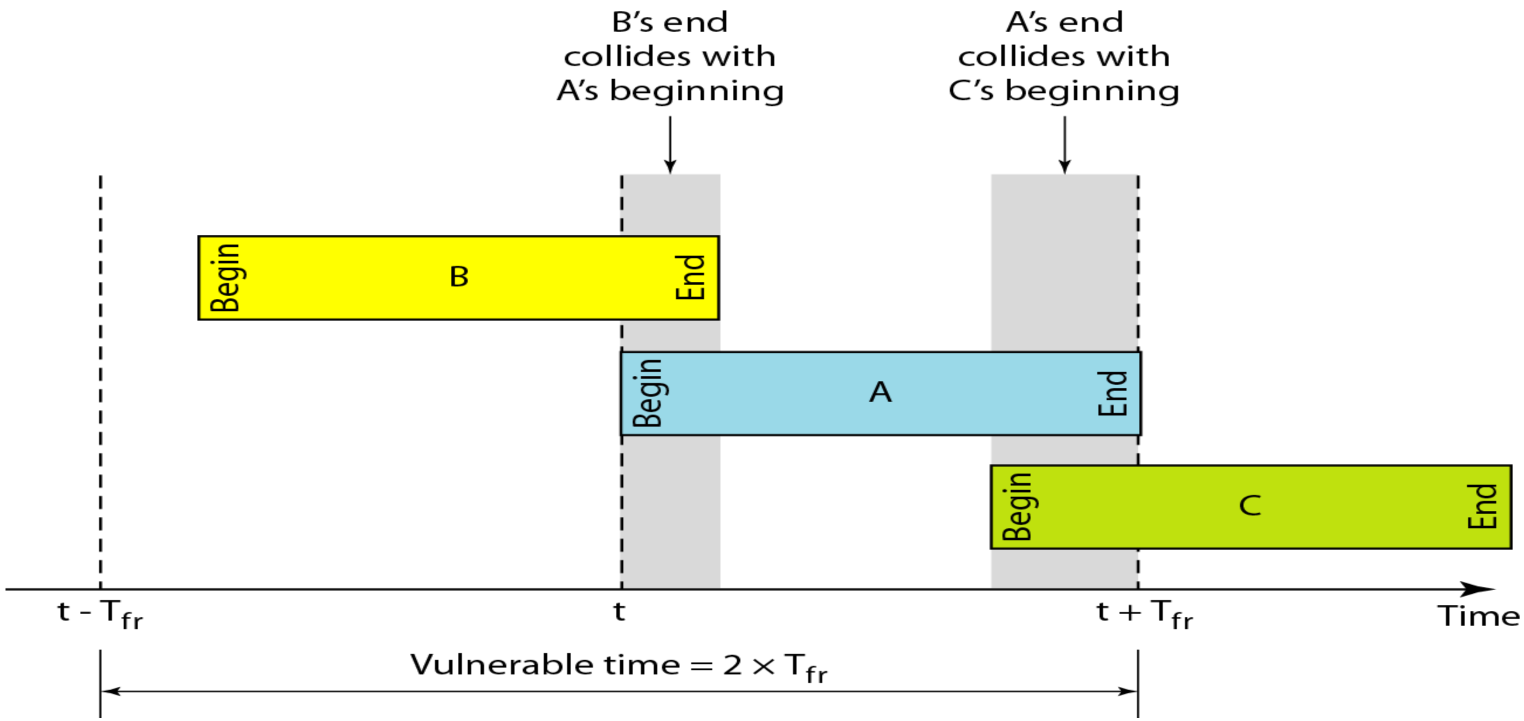


Figure 12.5 *Vulnerable time for pure ALOHA protocol*



The throughput for pure ALOHA is $S = G \times e^{-2G}$.

The maximum throughput

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

Figure 12.6 ***Frames in a slotted ALOHA network***

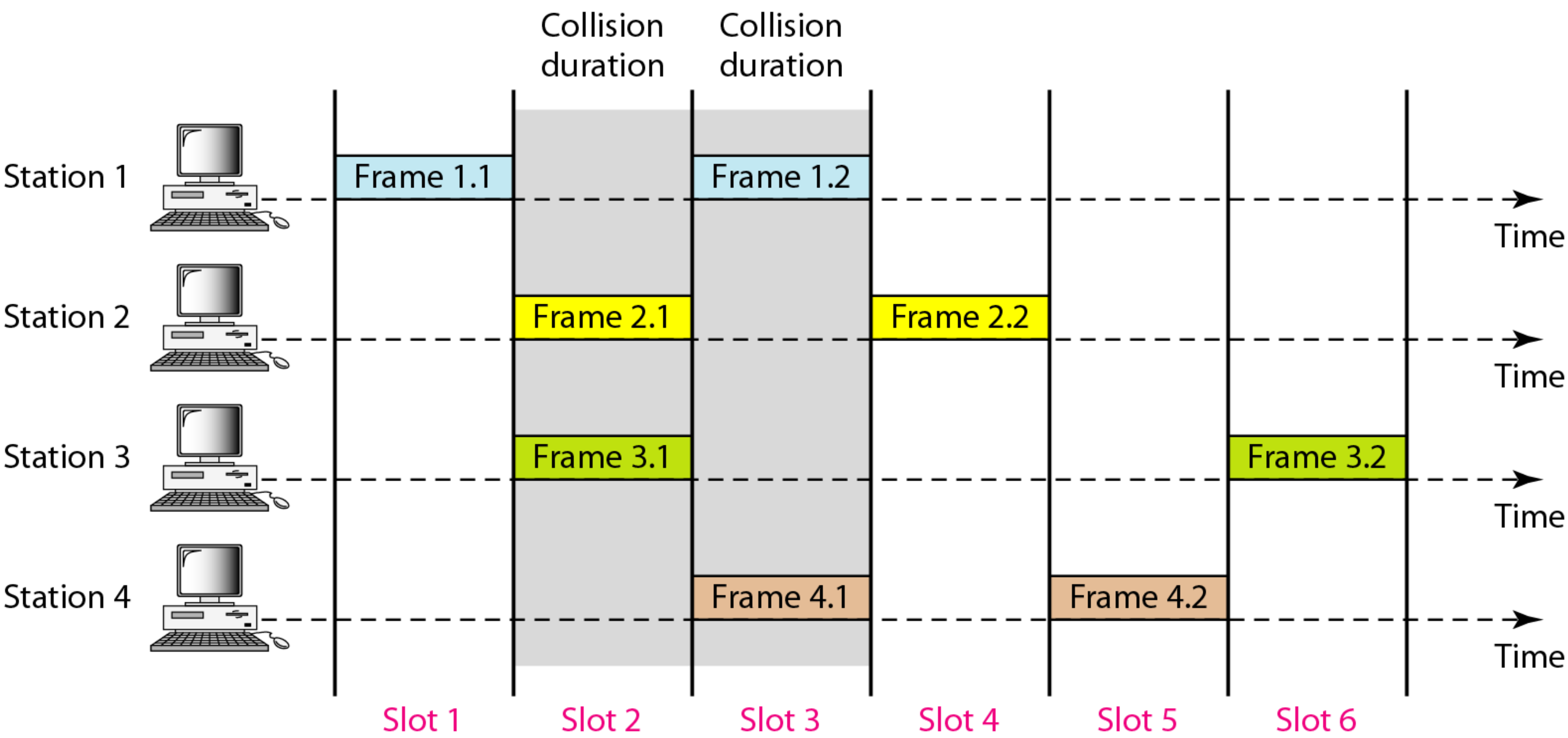
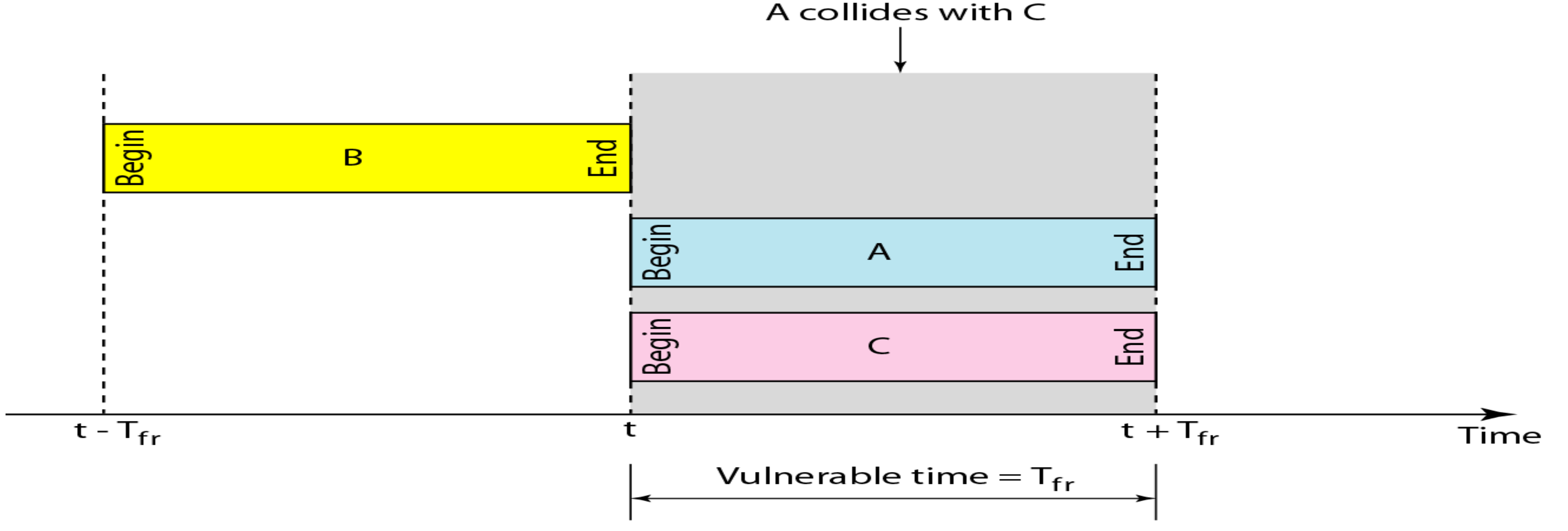


Figure 12.7 *Vulnerable time for slotted ALOHA protocol*



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

The maximum throughput

$S_{max} = 0.368$ when G = 1.

Figure 12.8 *Space/time model of the collision in CSMA*

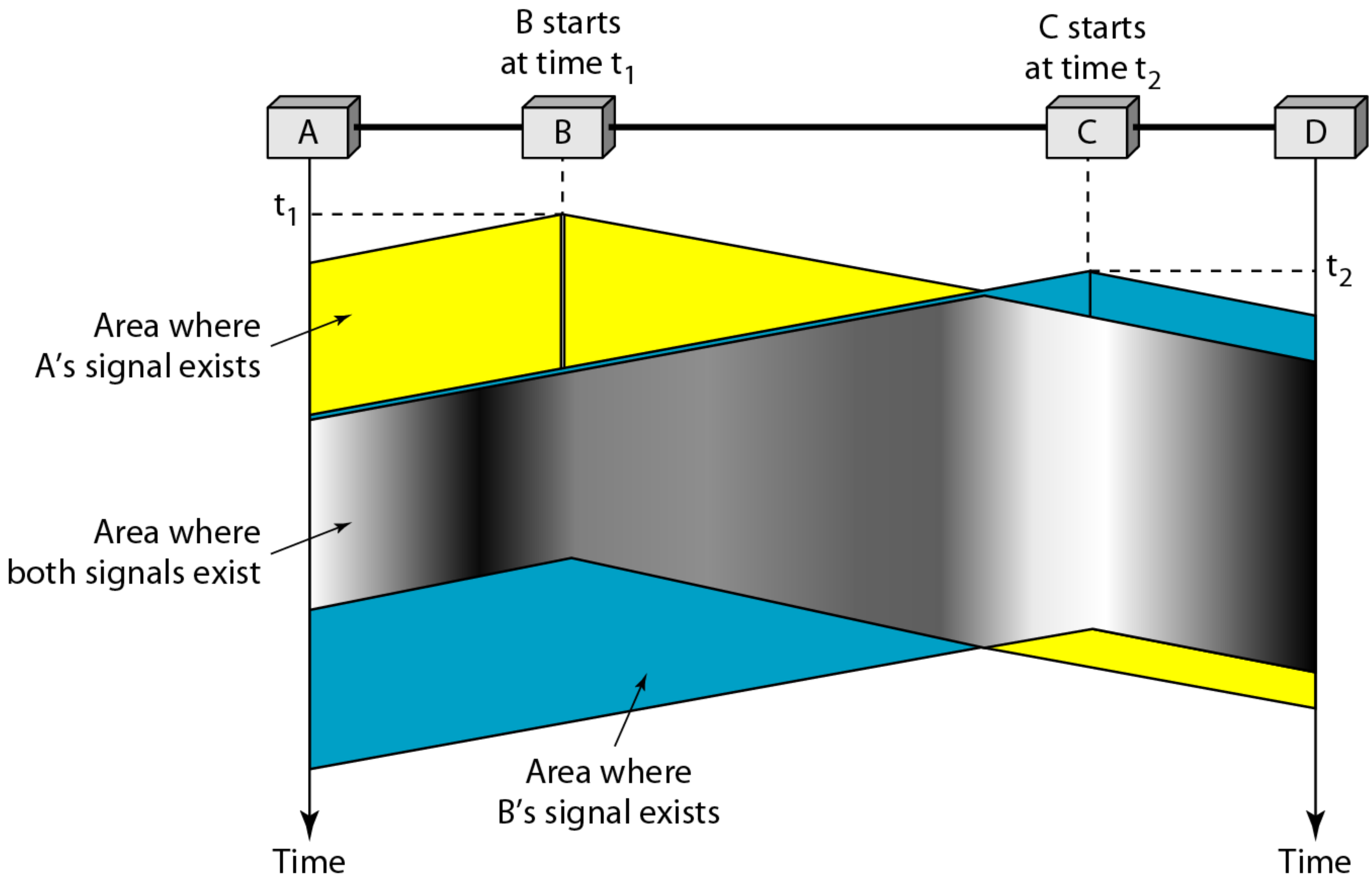


Figure 12.9 *Vulnerable time in CSMA*

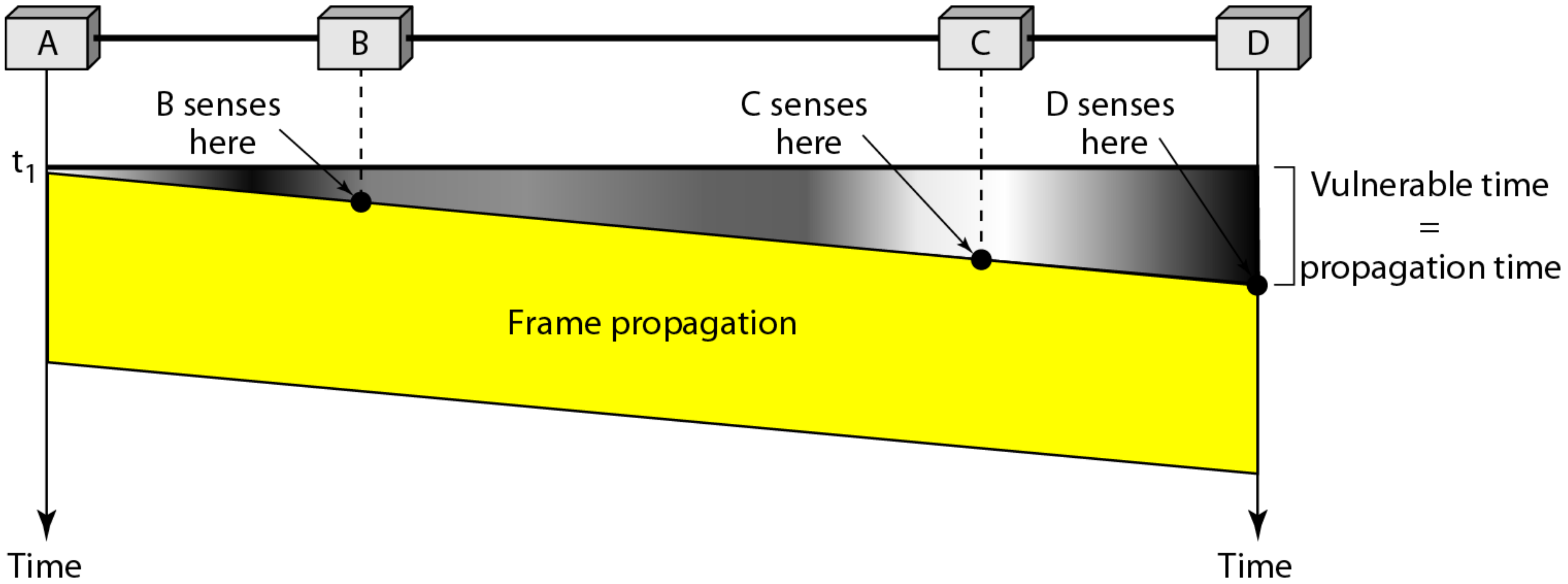
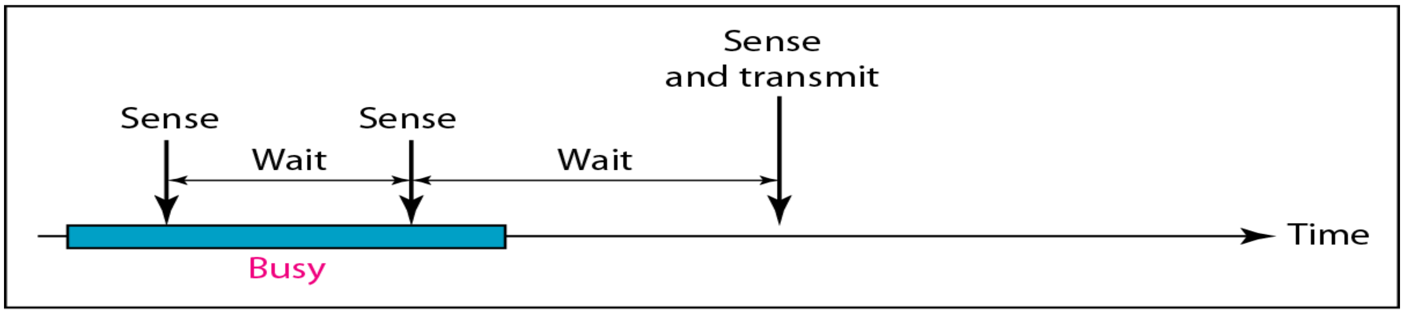
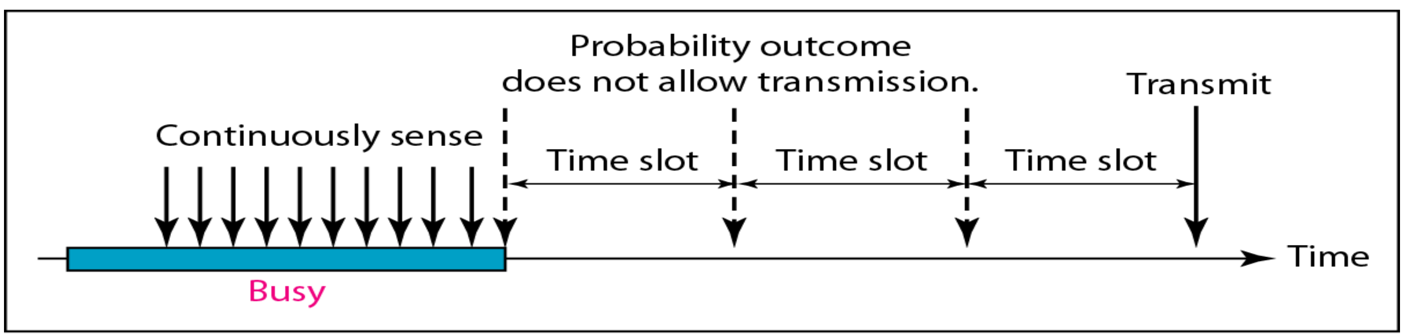


Figure 12.10 ***Behavior of three persistence methods***

a. 1-persistent



b. Nonpersistent



c. p-persistent

Figure 12.11 *Flow diagram for three persistence methods*

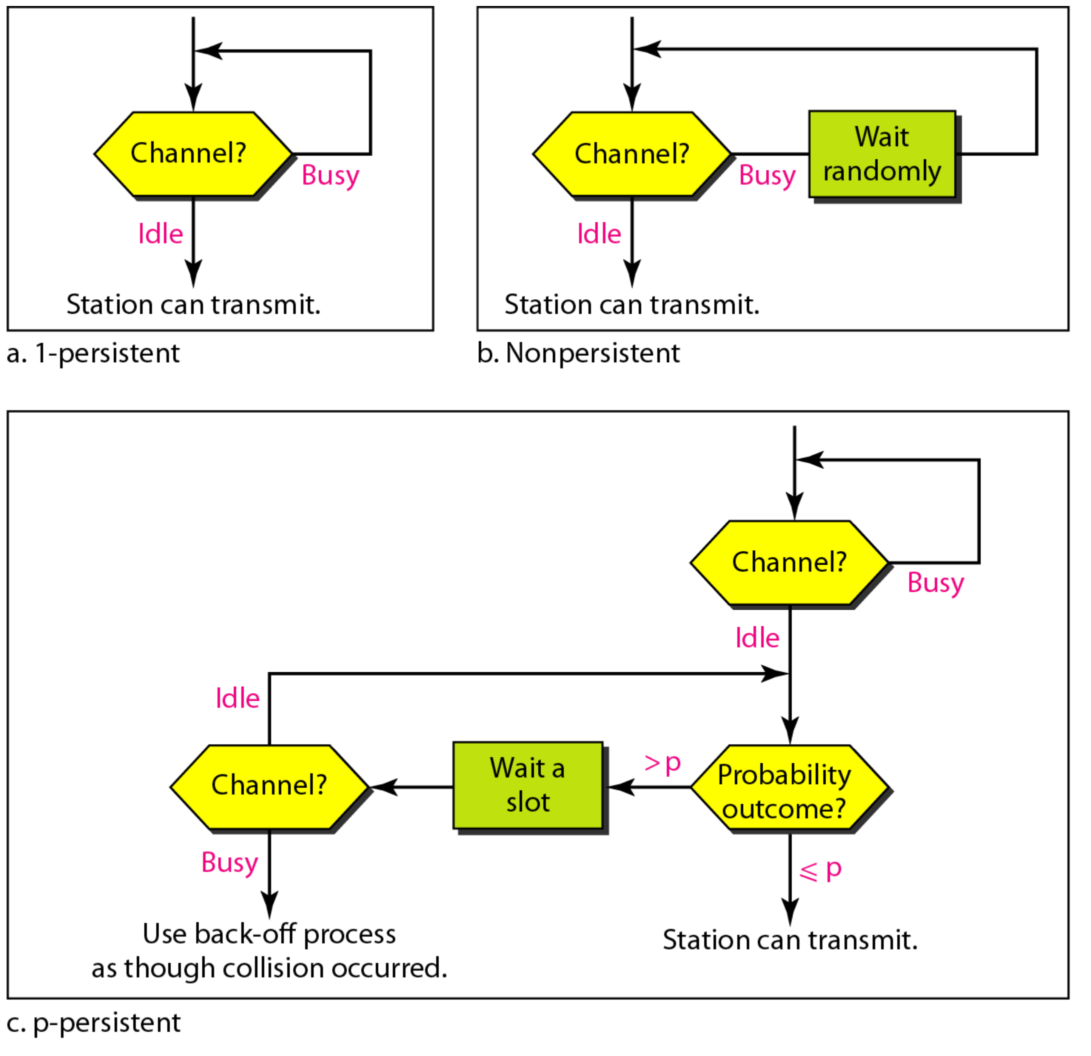


Figure 12.13 ***Collision and abortion in CSMA/CD***

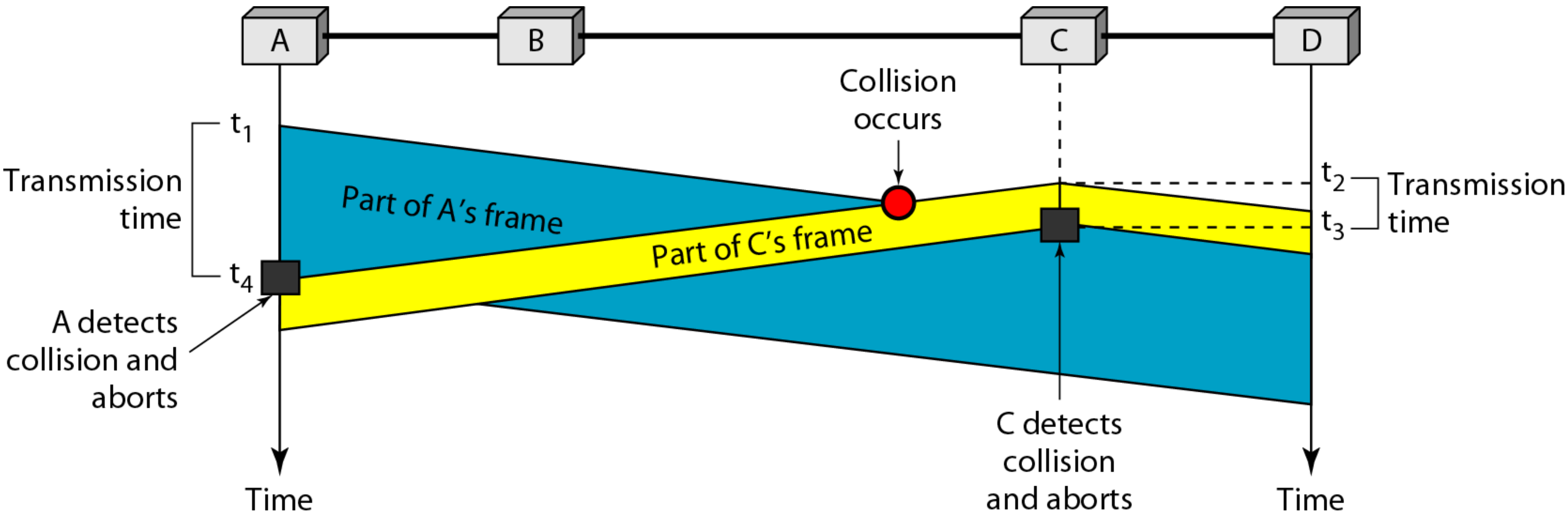


Figure 12.14 *Flow diagram for the CSMA/CD*

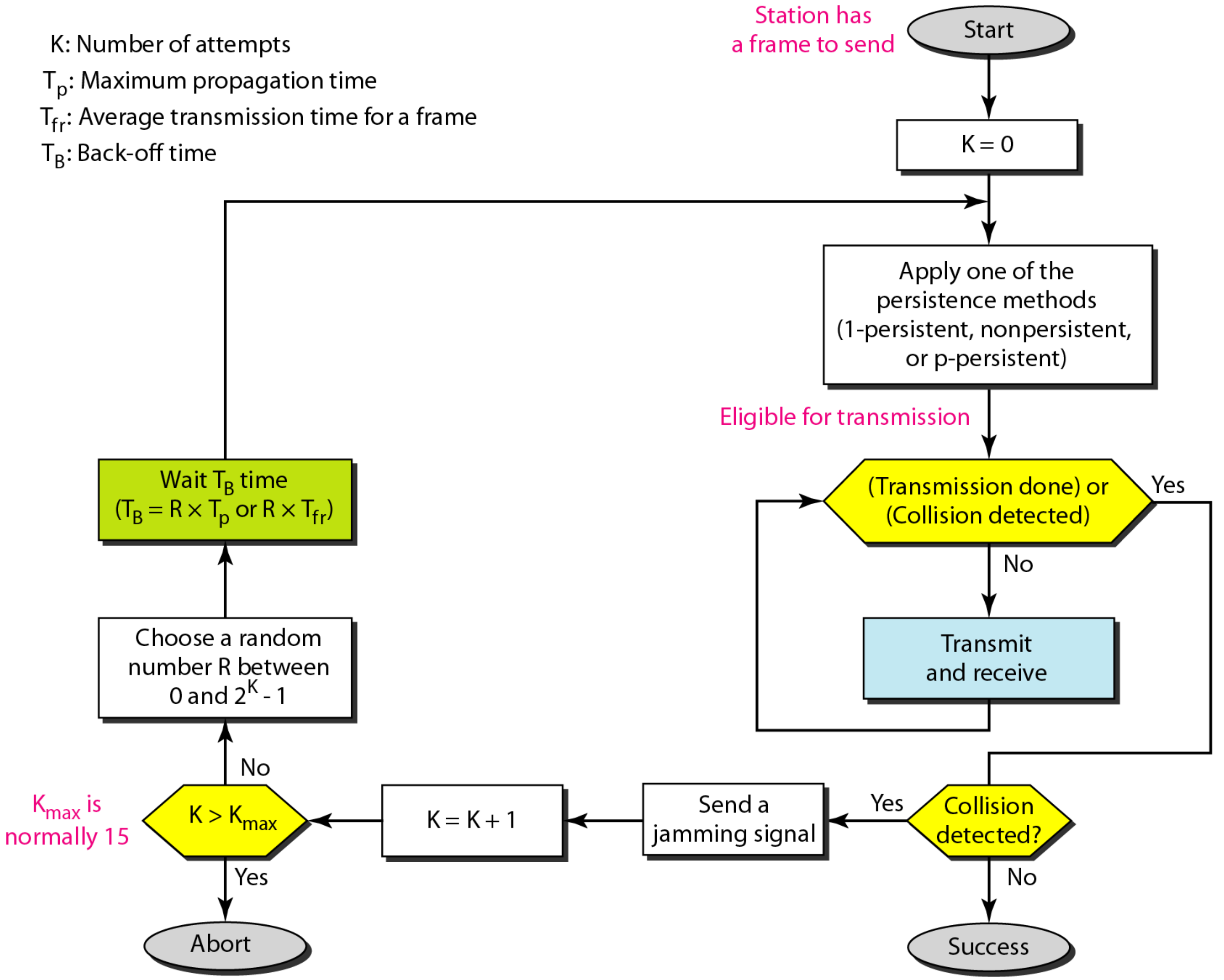
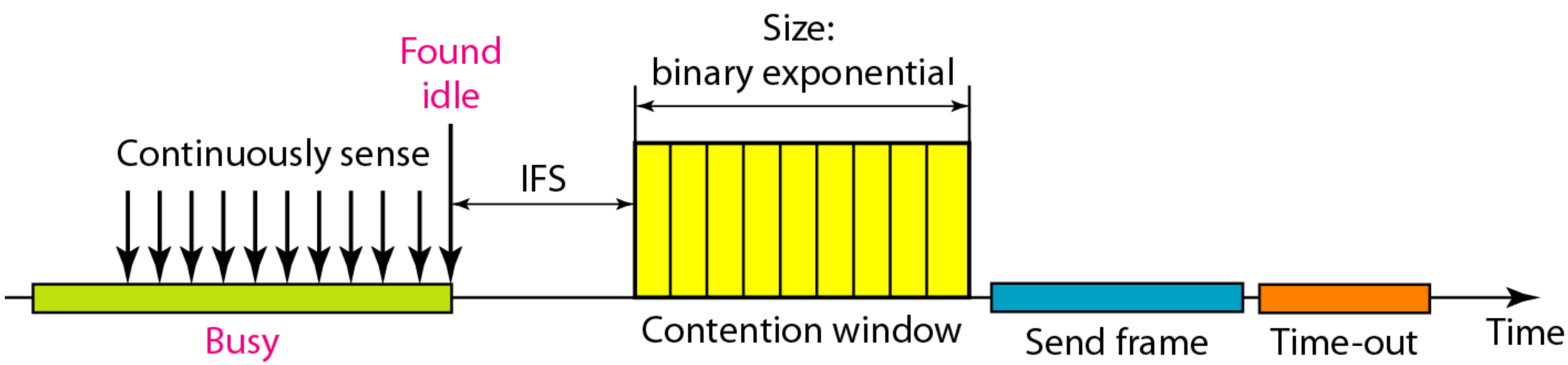


Figure 12.16 ***Timing in CSMA/CA***



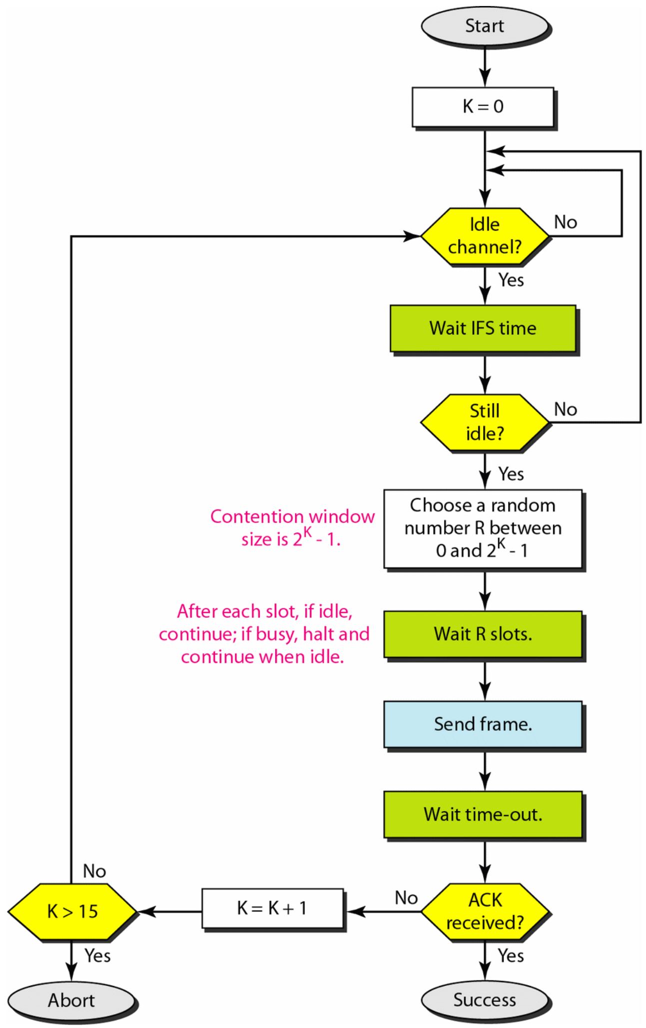
Note

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

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.

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*

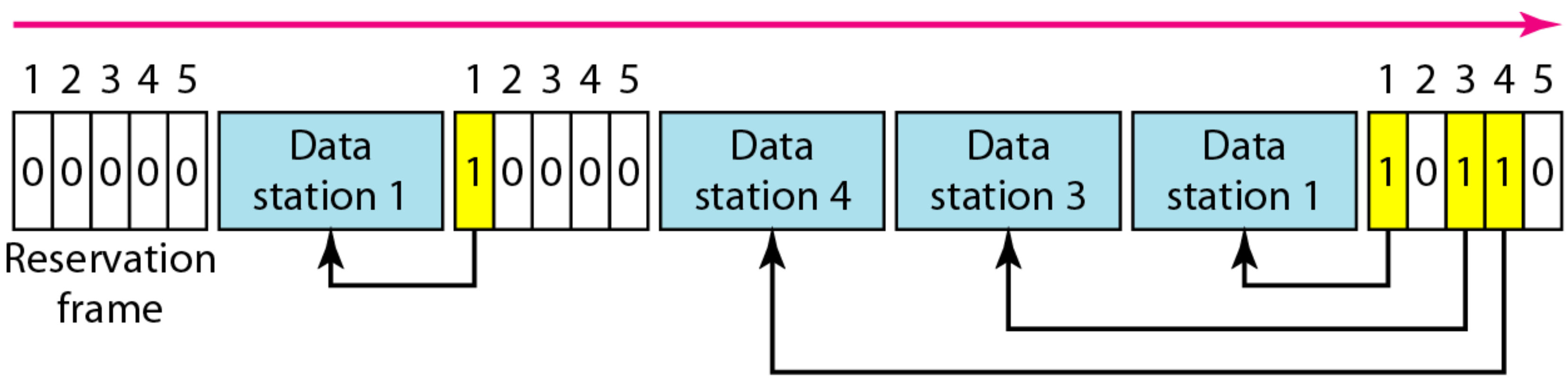


Figure 12.19 *Select and poll functions in polling access method*

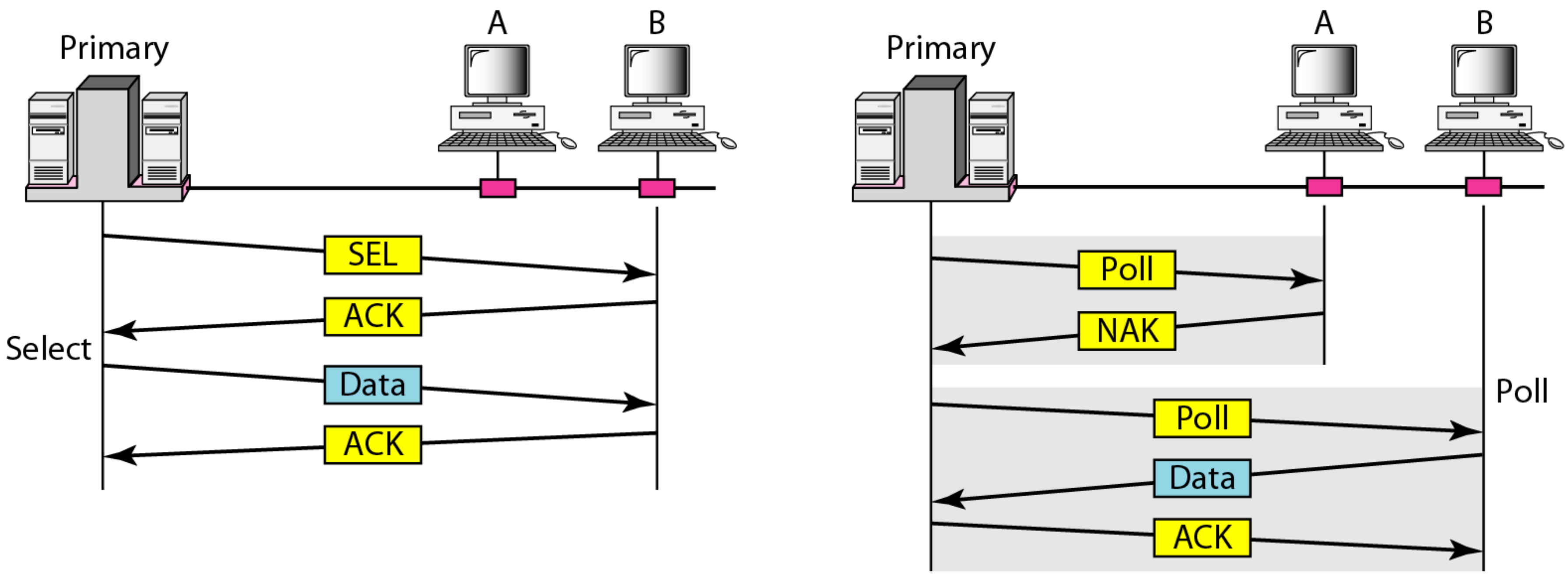
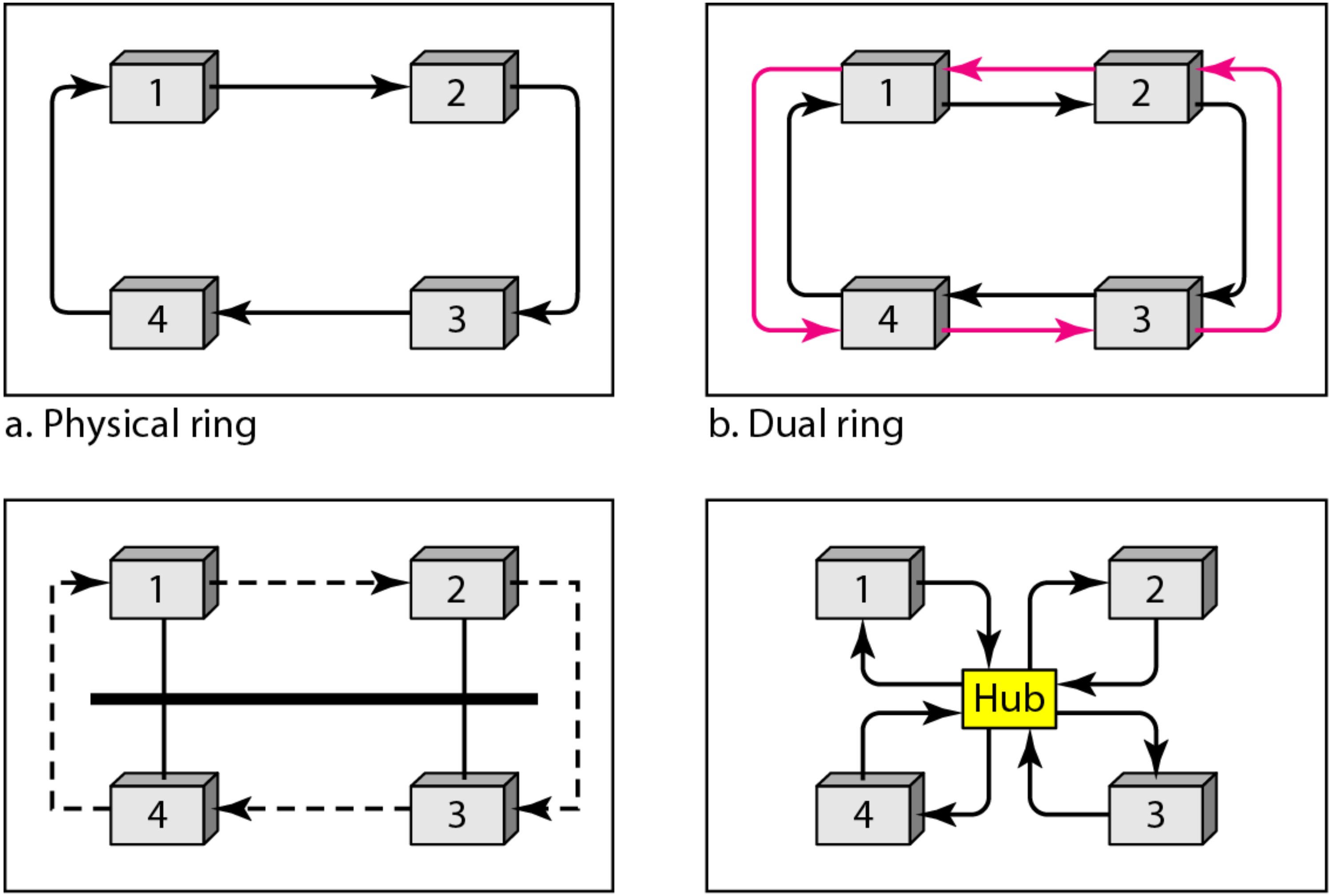


Figure 12.20 *Logical ring and physical topology in token-passing access method*



a. Physical ring

b. Dual ring

c. Bus ring

d. Star ring

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.*

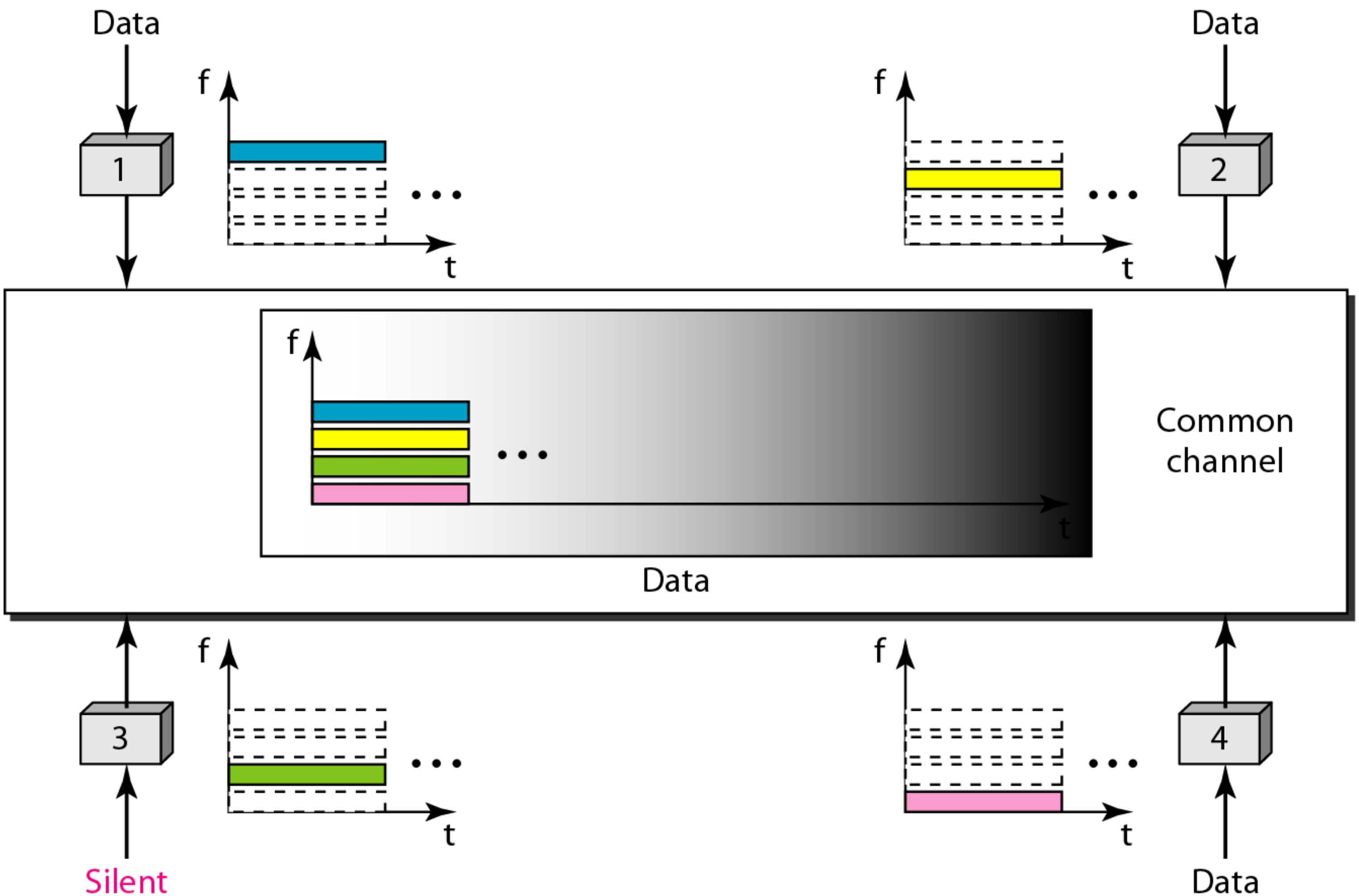
Topics discussed in this section:

Frequency-Division Multiple Access (FDMA)

Time-Division Multiple Access (TDMA)

Code-Division Multiple Access (CDMA)

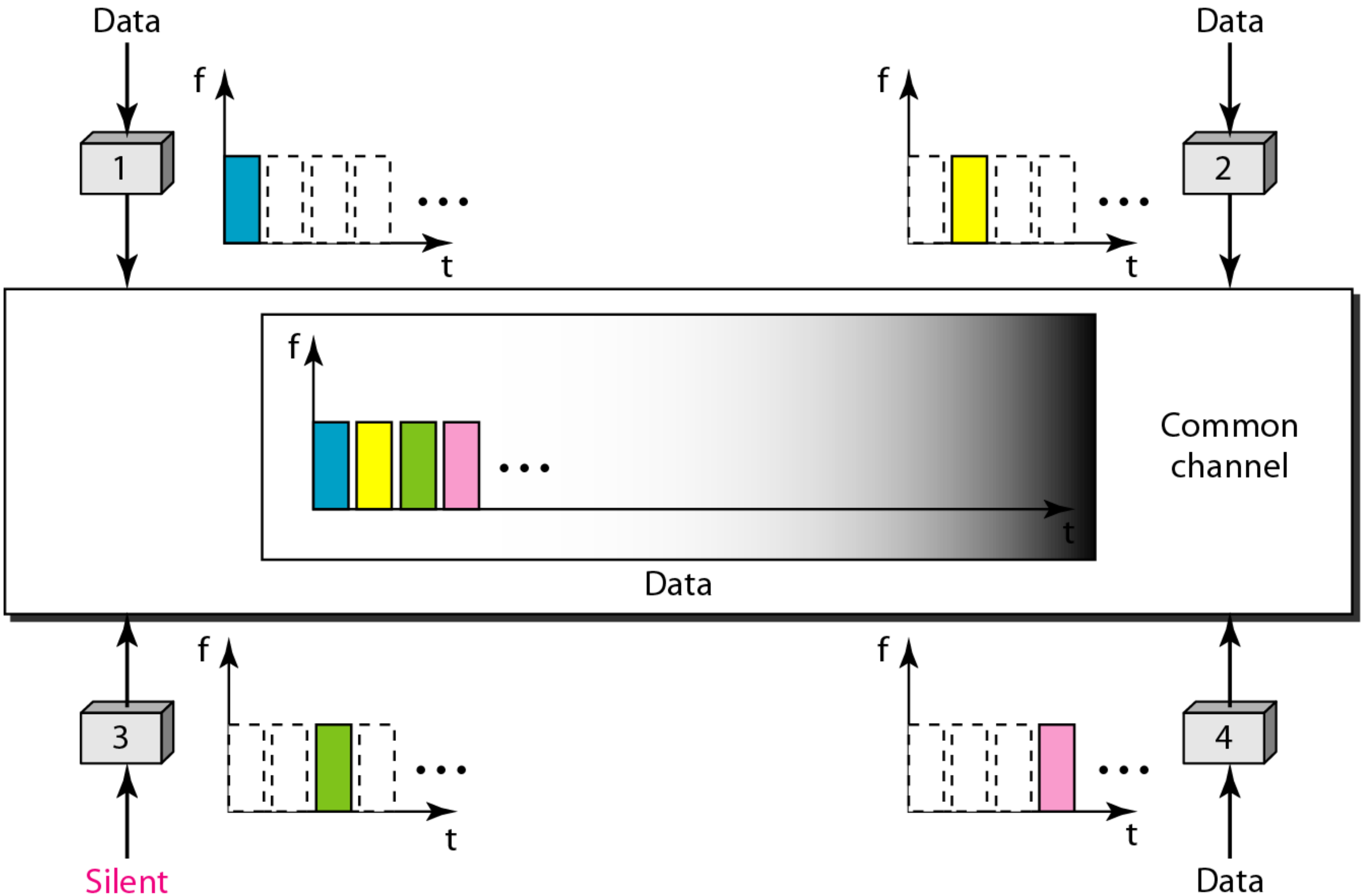
Figure 12.21 *Frequency-division multiple access (FDMA)*



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.

Figure 12.23 *Simple idea of communication with code*

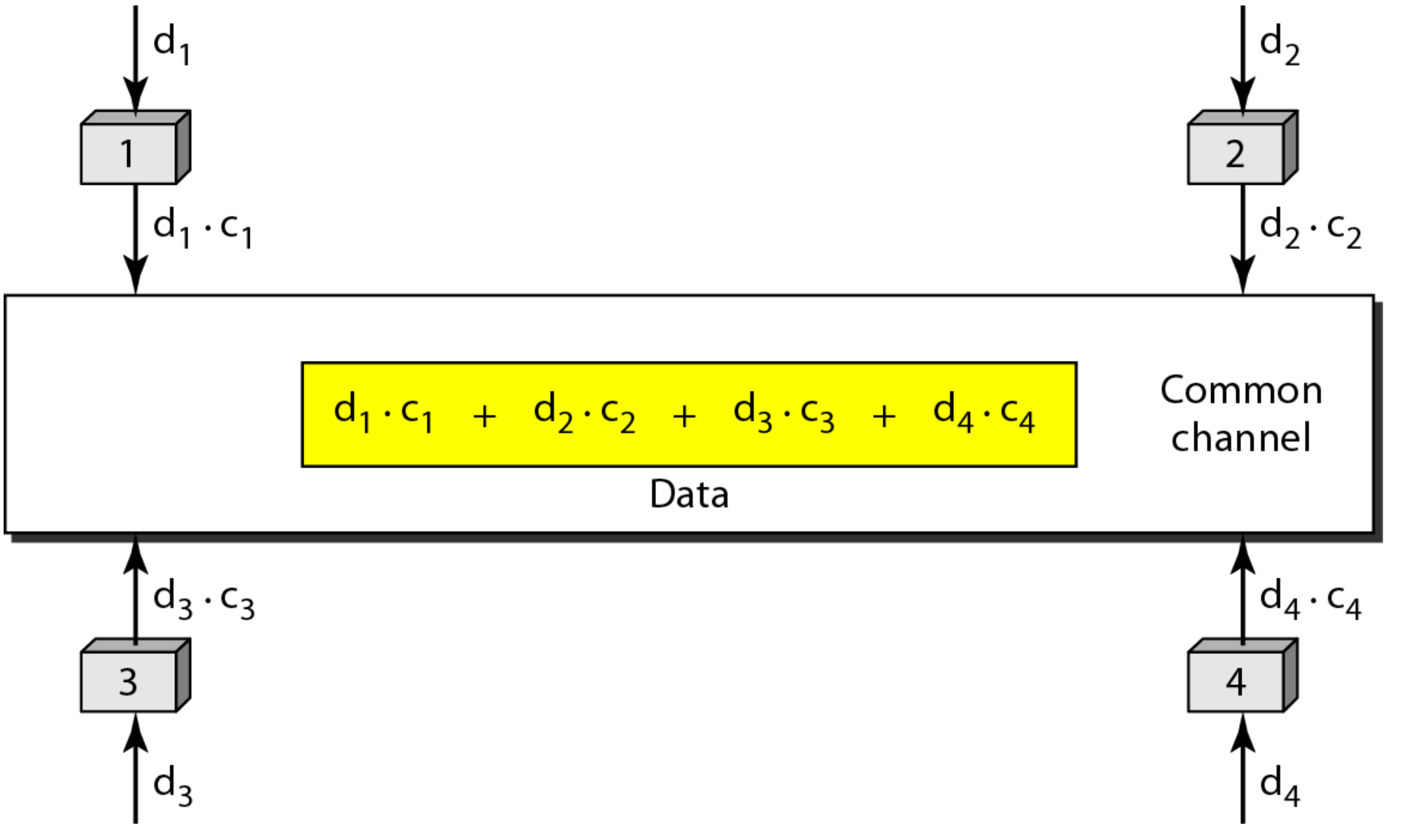


Figure 12.24 *Chip sequences*

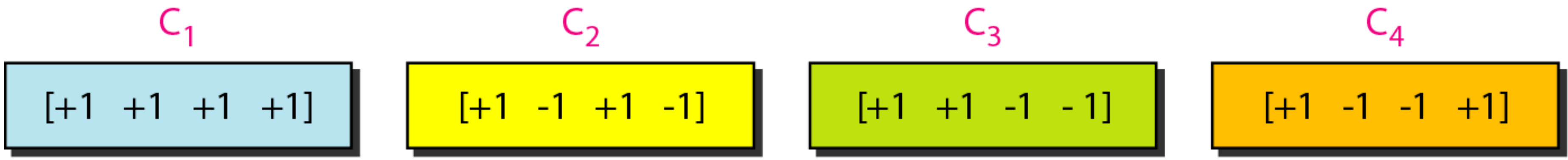


Figure 12.25 *Data representation in CDMA*

Figure 12.26 *Sharing channel in CDMA*

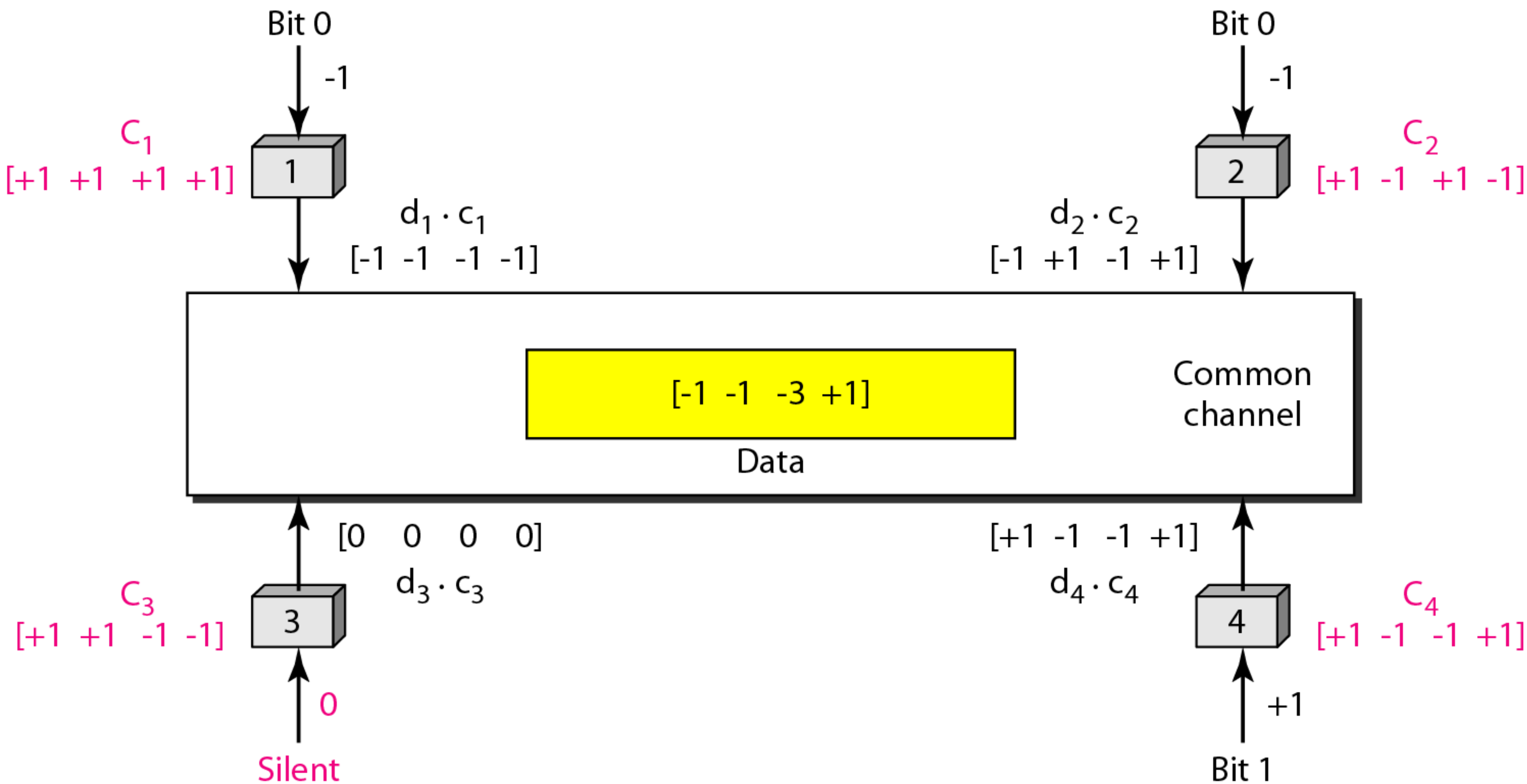


Figure 12.27 *Digital signal created by four stations in CDMA*

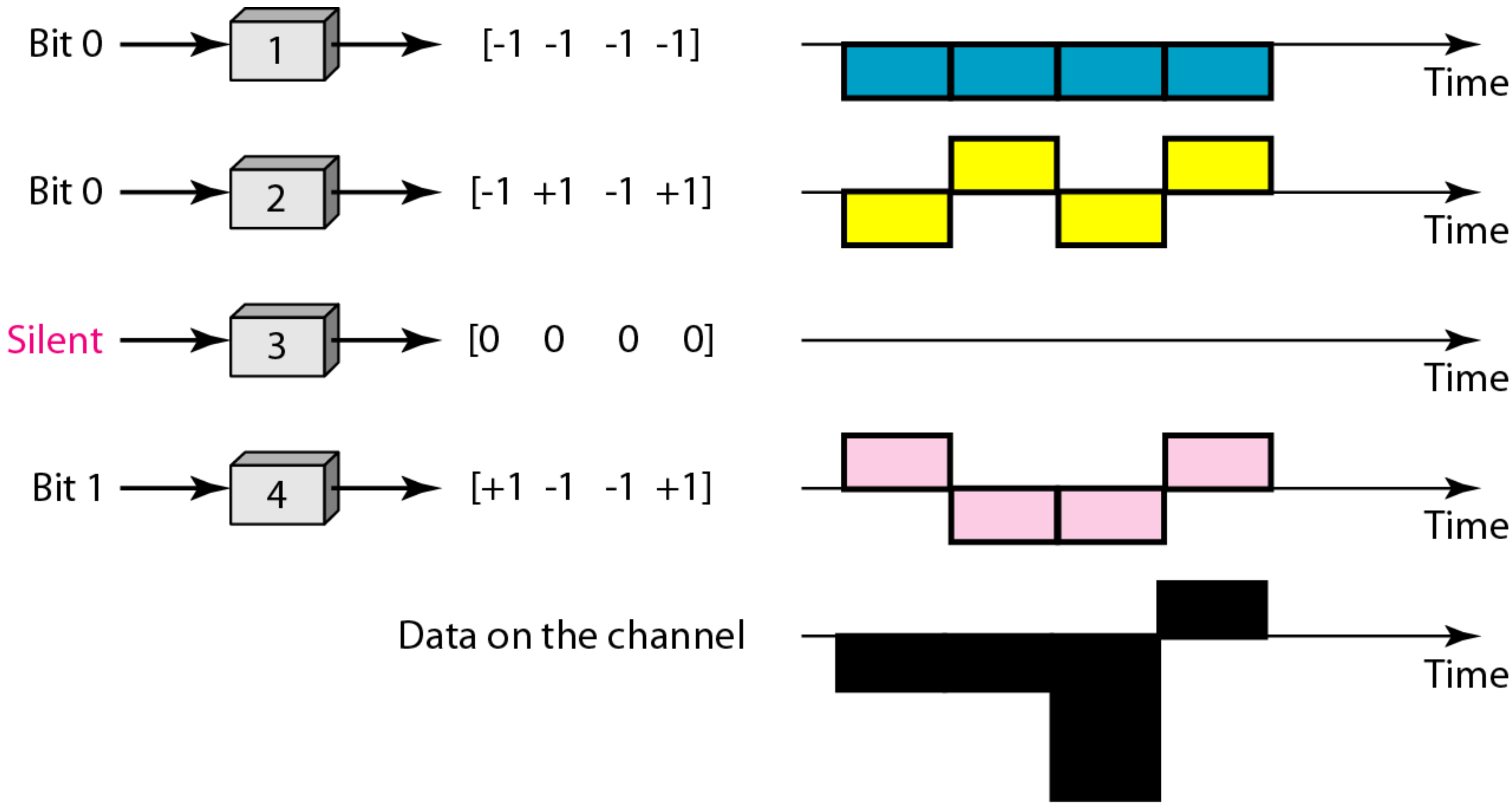


Figure 12.28 ***Decoding of the composite signal for one in CDMA***

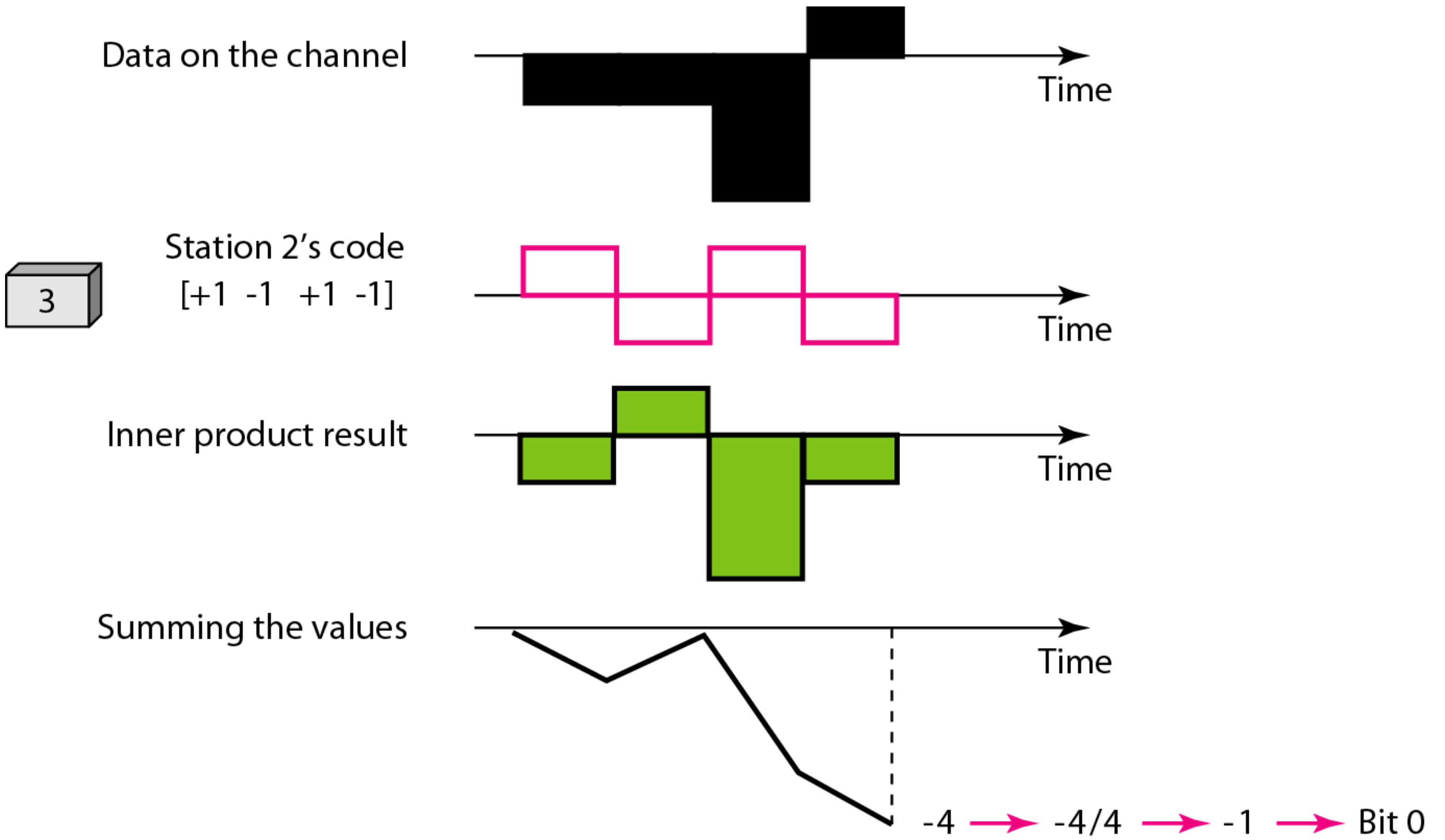


Figure 12.29 ***General rule and examples of creating Walsh tables***

$$W_1 = \begin{bmatrix} +1 \end{bmatrix} \qquad W_{2N} = \begin{bmatrix} W_N & W_N \\ W_N & \overline{W_N} \end{bmatrix}$$

a. Two basic rules

$$W_1 = \begin{bmatrix} +1 \end{bmatrix}$$

$$W_2 = \begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix} \qquad W_4 = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \end{bmatrix}$$

b. Generation of W_1, W_2, and W_4

Note

The number of sequences in a Walsh table needs to be $N = 2^m$.