Chapter 12

Multiple Access

Link Layer and LANs

- Link layer services:
  - Error detection
    - errors caused by signal attenuation, noise.
    - receiver detects presence of errors ➡ signals sender for retransmission or drops frame
  - Error correction
    - receiver identifies *and corrects* bit error(s) without resorting to retransmission
  - Flow control
    - pacing between adjacent sending and receiving nodes
  - Framing - link layer addressing
  - Sharing a **broadcast/multipoint** link : **Multiple access**

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

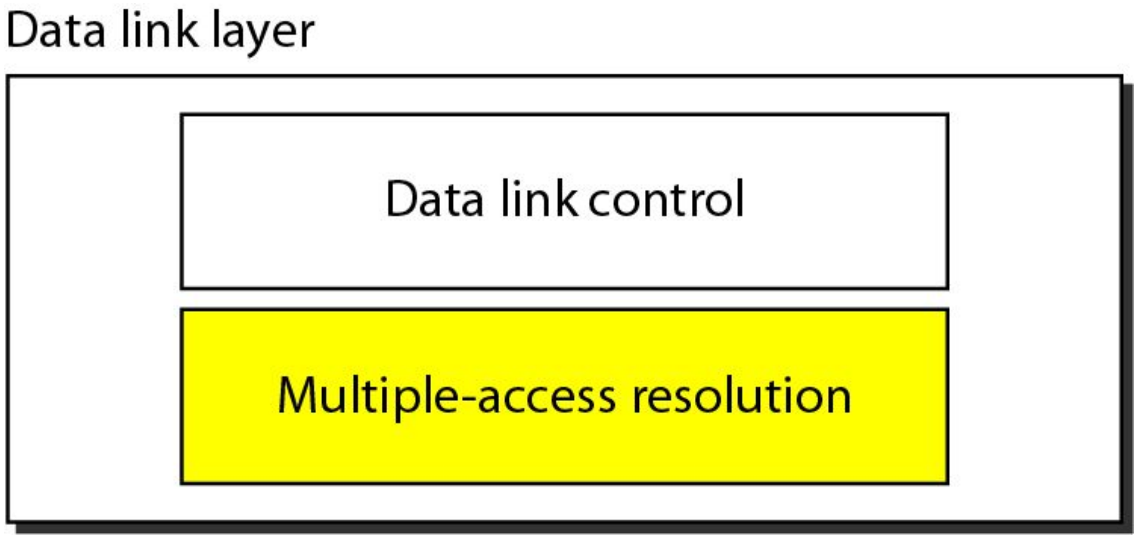
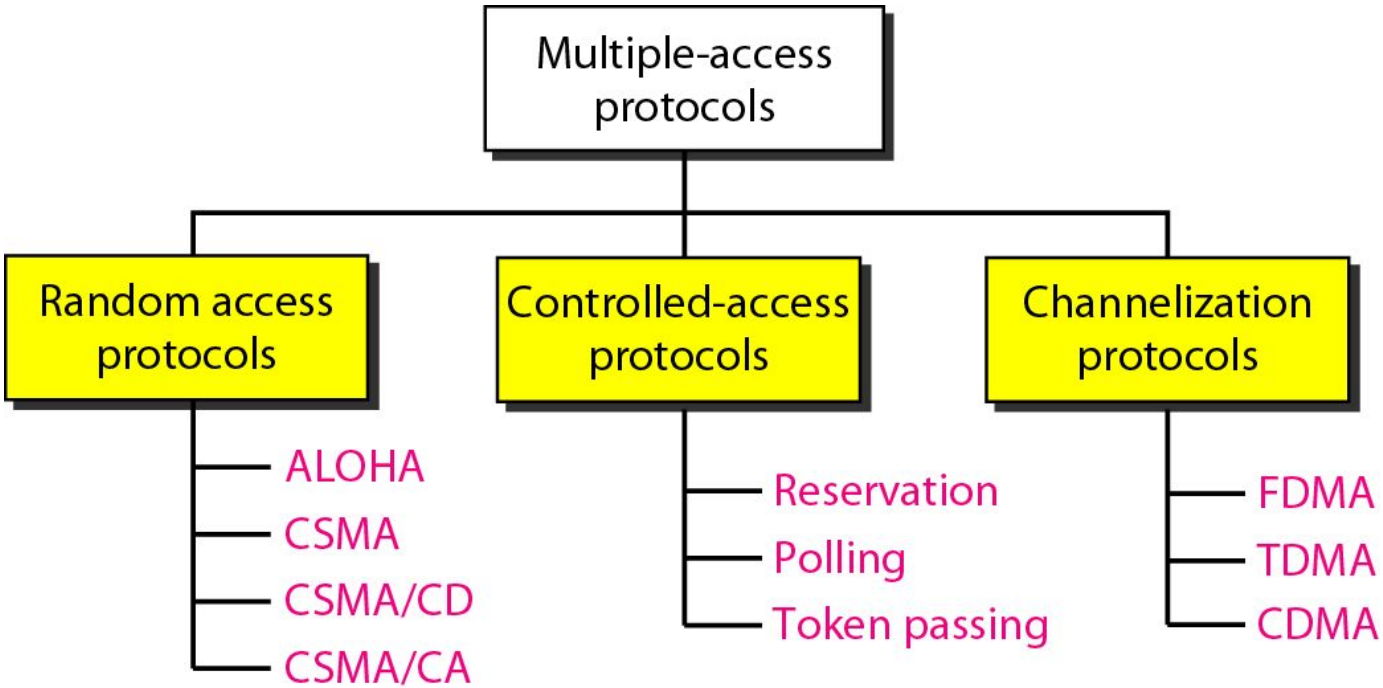


Figure 12.2 *Taxonomy of multiple-access protocols discussed in this chapter*



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

12-1-1 ALOHA

- The earliest random access method
- Was developed at the **University of Hawaii**
- Has two variants:
  - **Pure ALOHA**
  - **Slotted ALOHA**

PURE ALOHA

- The original ALOHA protocol
- Each station sends a frame whenever it has a frame to send
- 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*

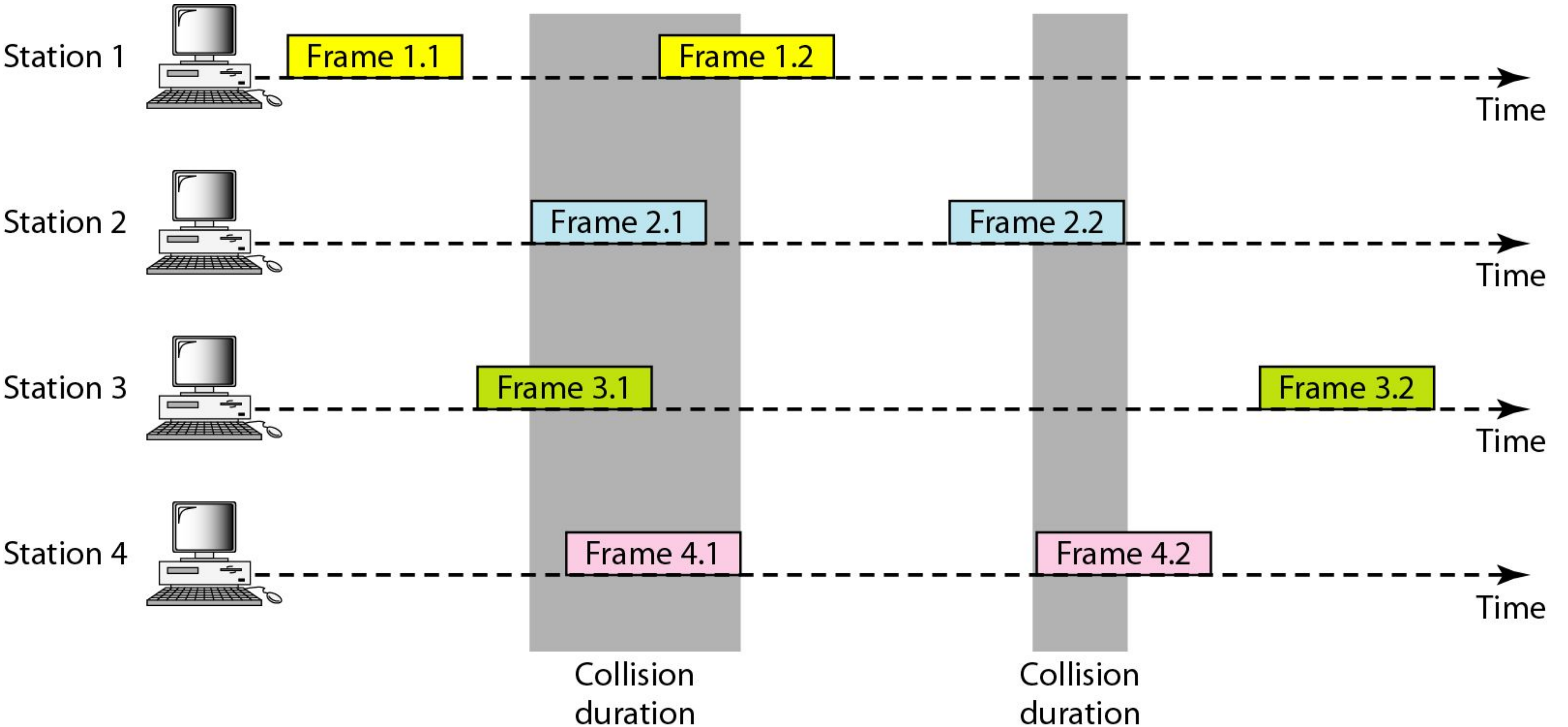
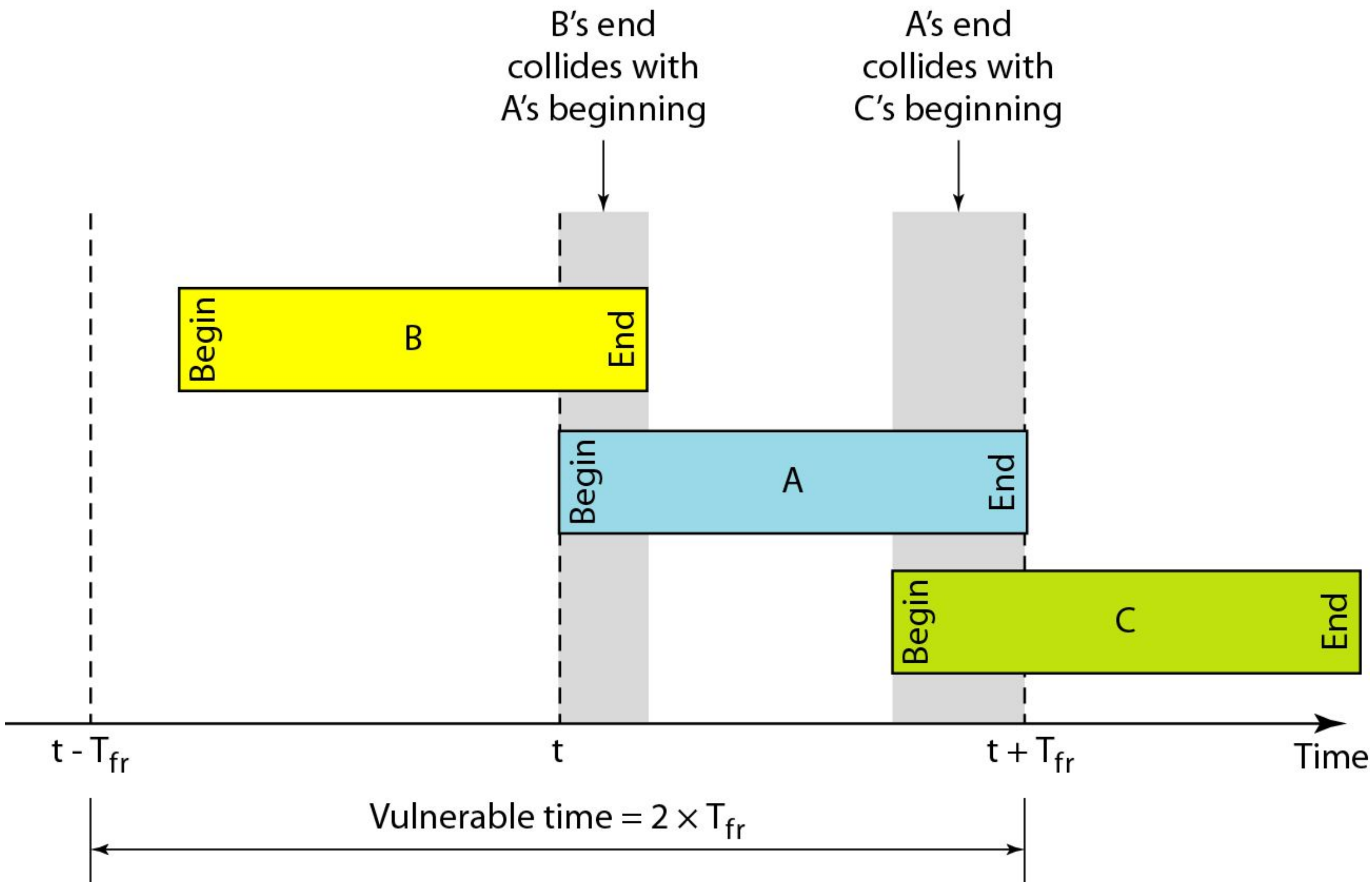


Figure 12.5 *Vulnerable time for pure ALOHA protocol*



SLOTTED ALOHA

- In slotted ALOHA the time is divided into slots of $\boldsymbol{T_{fr}}$ seconds
- Stations can send frames **only at the beginning of the time slot**
- Improves the efficiency of pure ALOHA

Figure 12.6 *Frames in a slotted ALOHA network*

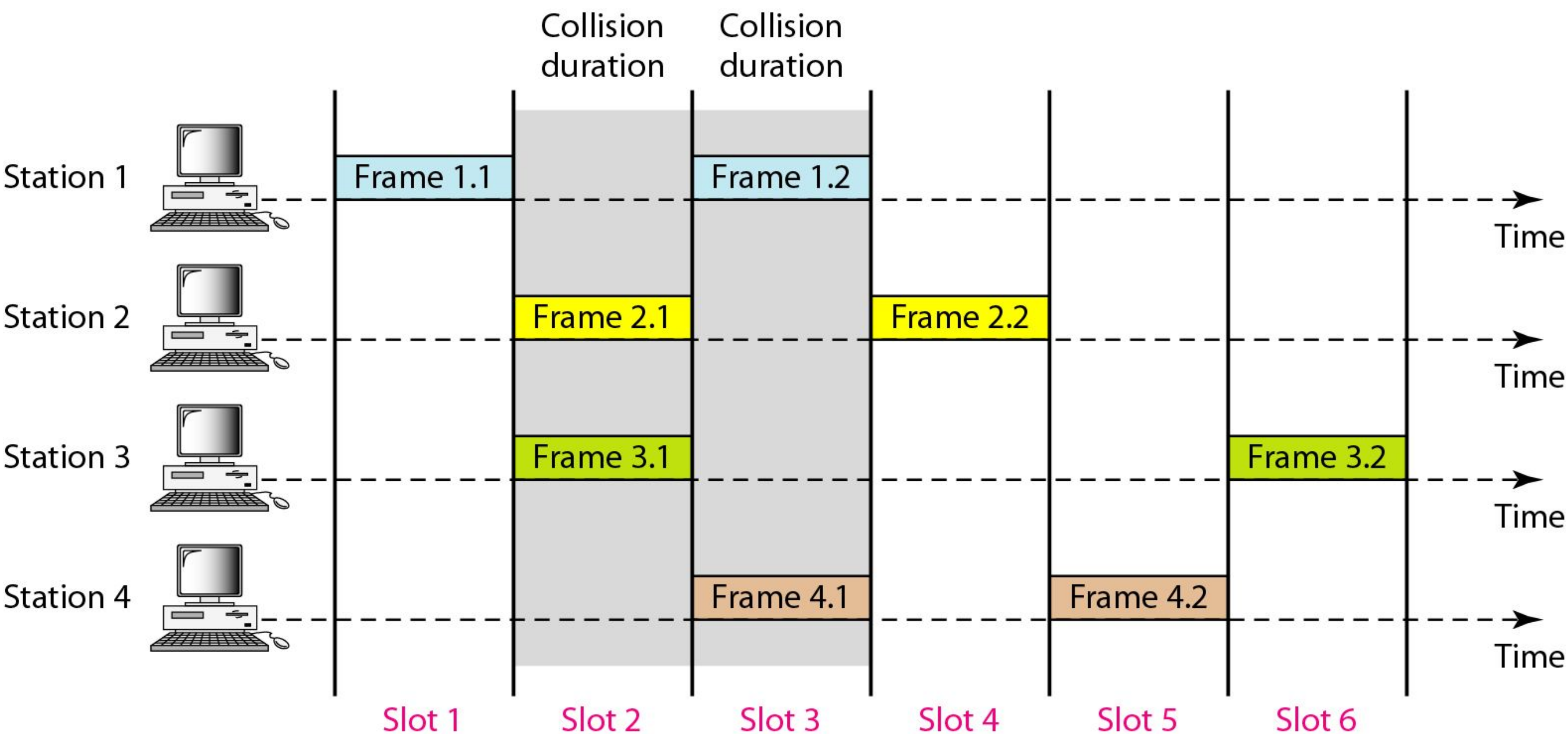
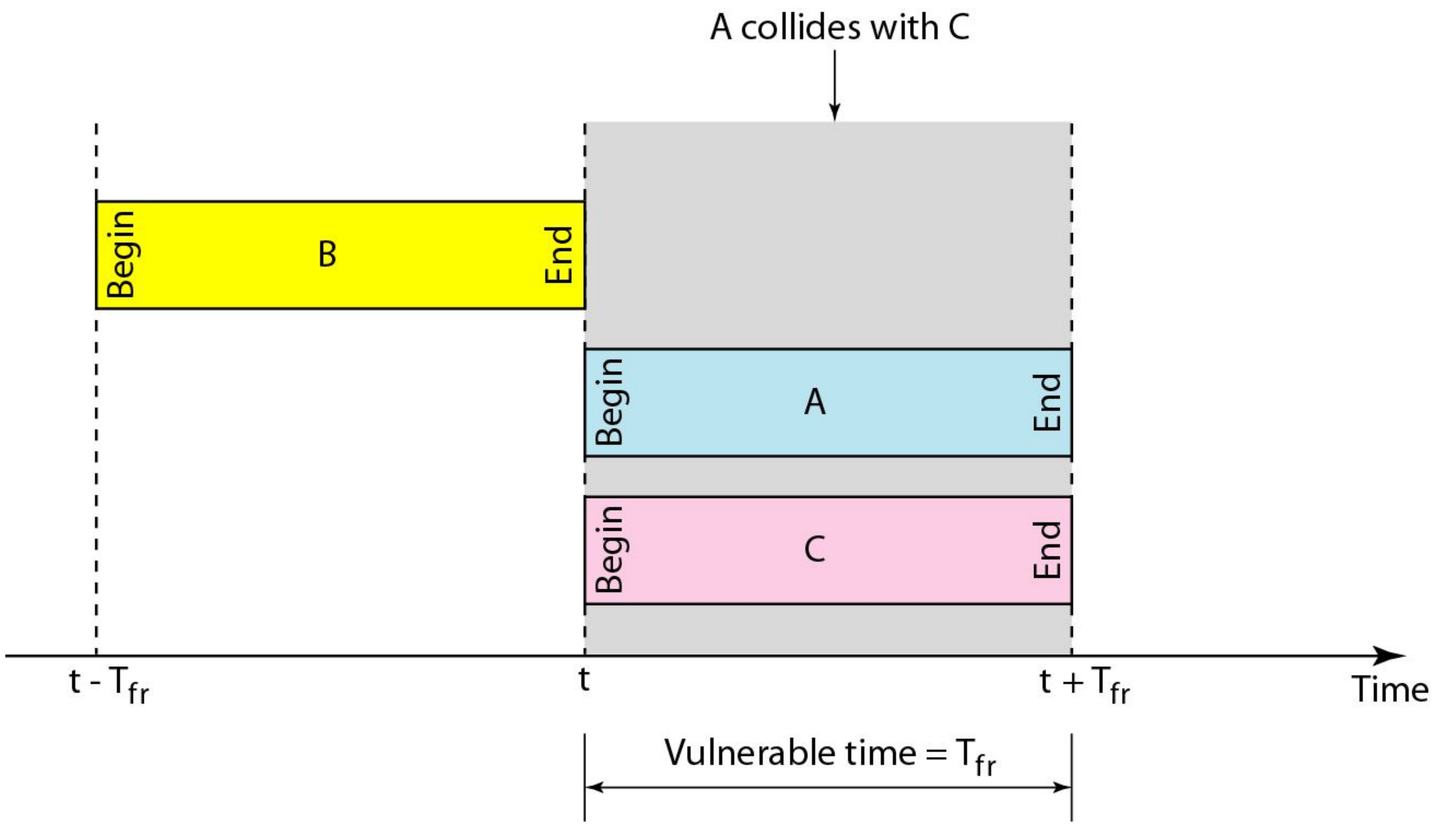


Figure 12.7 *Vulnerable time for slotted ALOHA protocol*



12-1-2 CSMA

- **Carrier Sense Multiple Access**
- Senses the medium before sending frame
- Reduce the possibility of collision, but it cannot eliminate it due to **propagation delay**

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

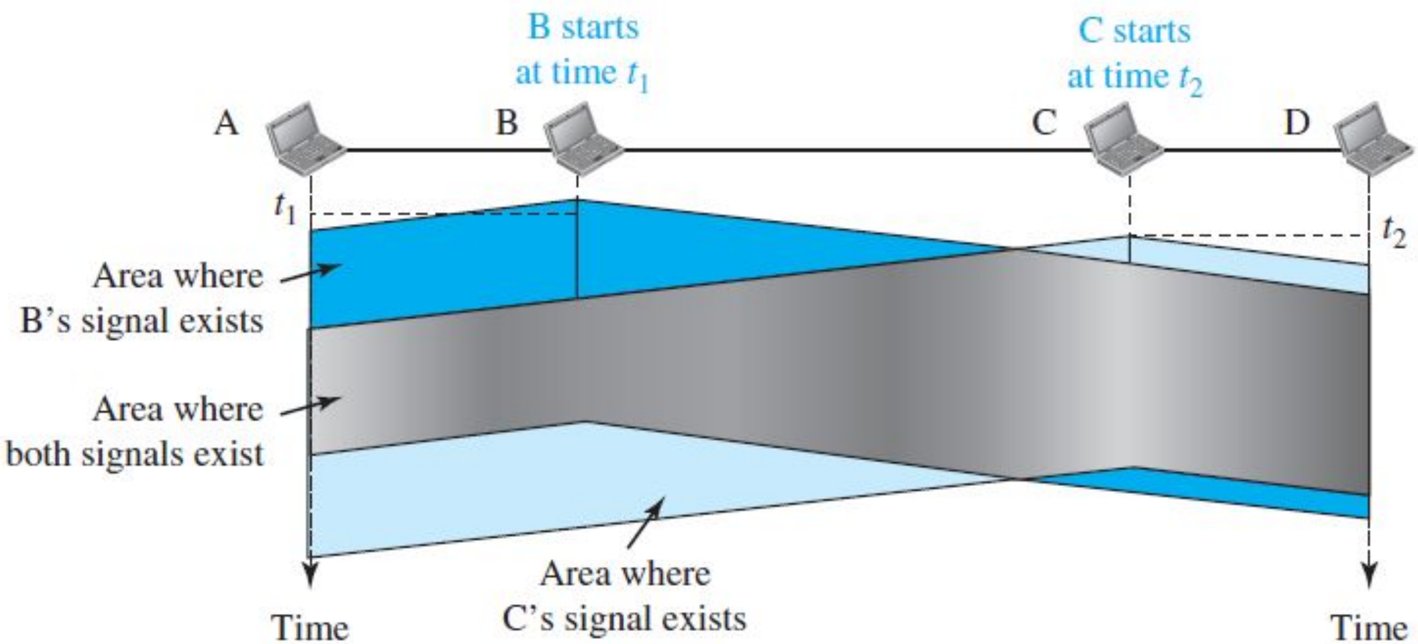


Figure 12.9 *Vulnerable time in CSMA*

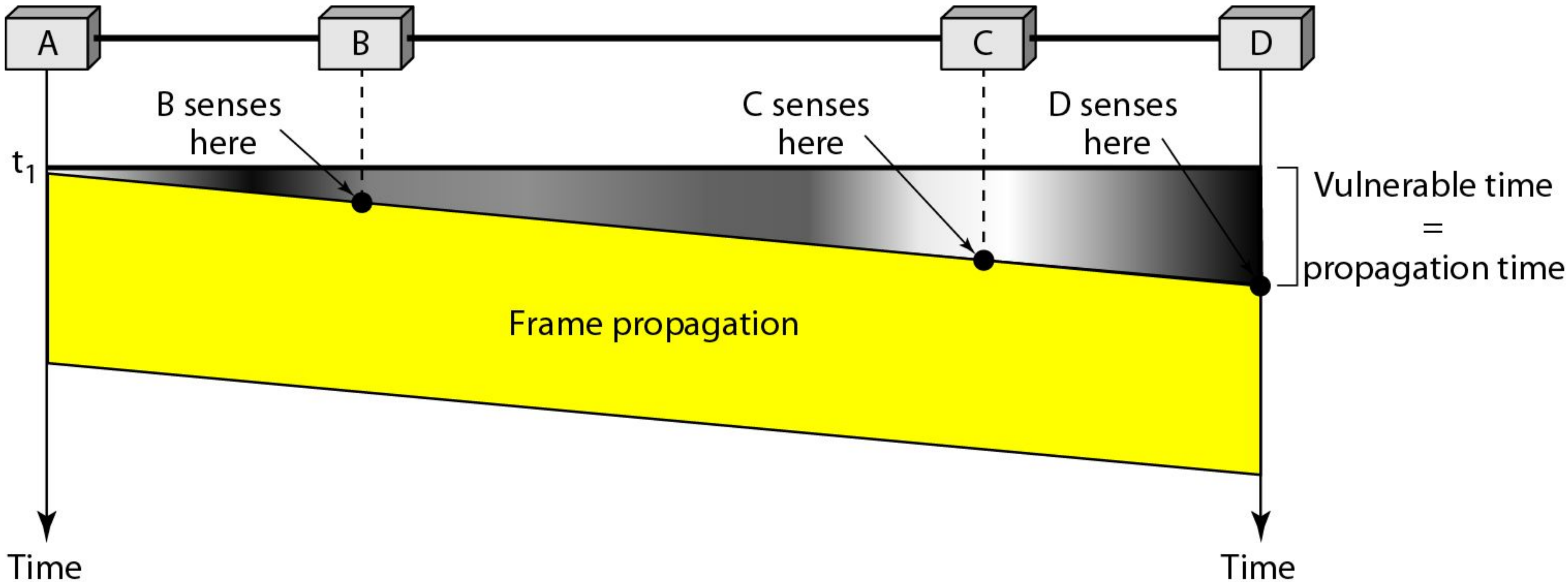
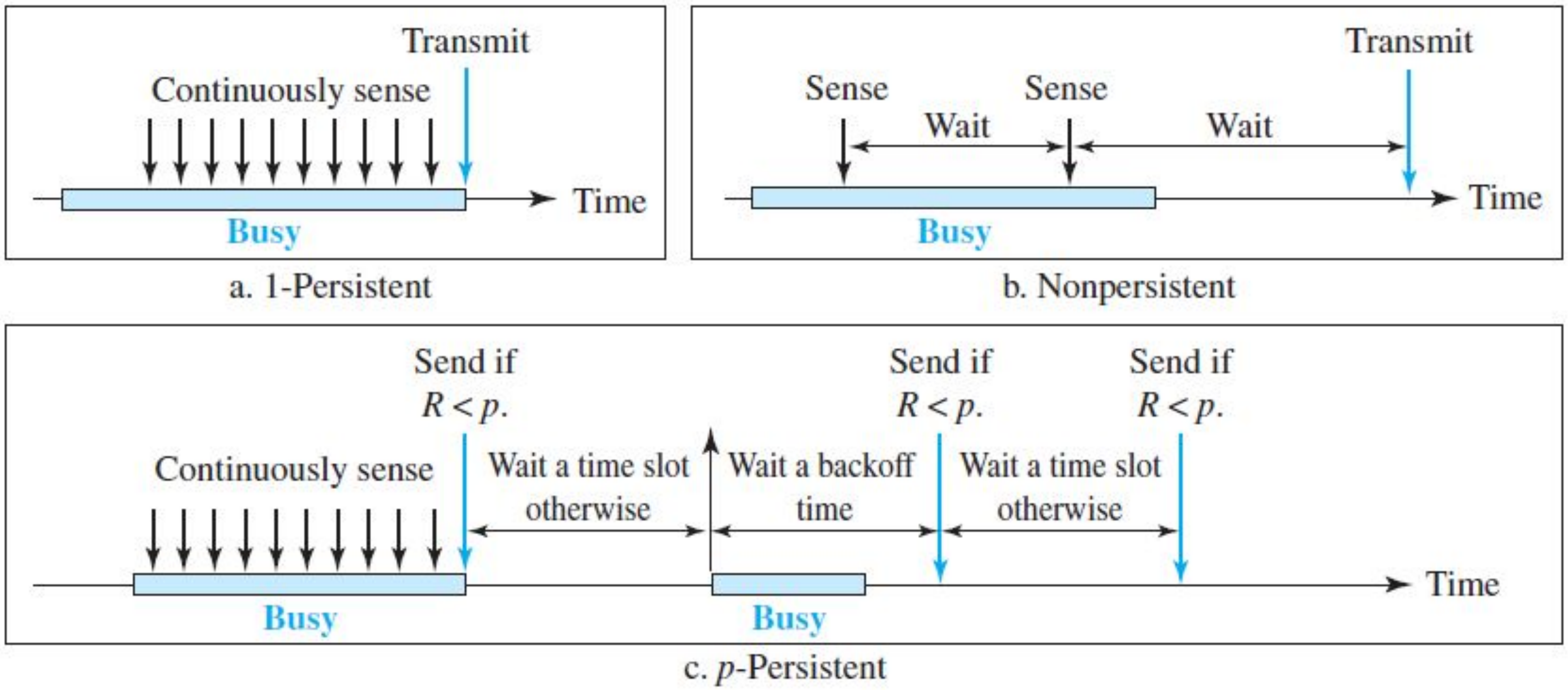


Figure 12.10 *Behavior of three persistence methods of CSMA*



12-1-3 CSMA/CD

- **Carrier Sense Multiple Access with Collision Detection**
- The CSMA method does not specify the procedure following a collision
- CSMA/CD augments the algorithm to handle the collision
- The medium is monitored continuously by each station
- If there is a collision,
  - **Immediately aborts transmission**
  - **The frame is sent again**

Figure 12.12 *Collision of the first bit in CSMA/CD*

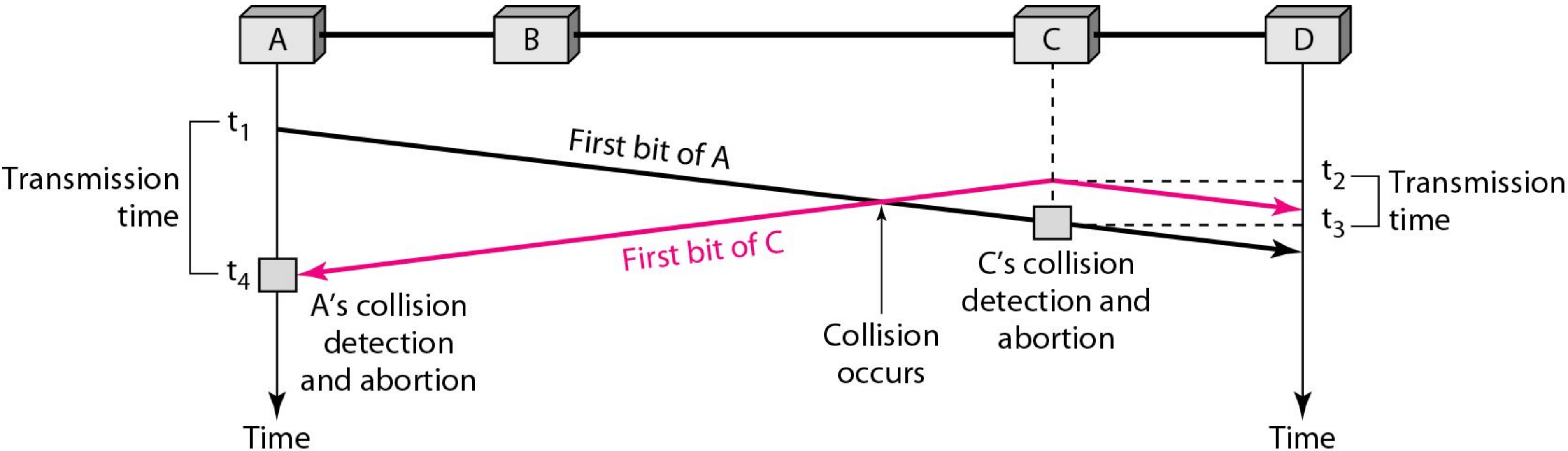
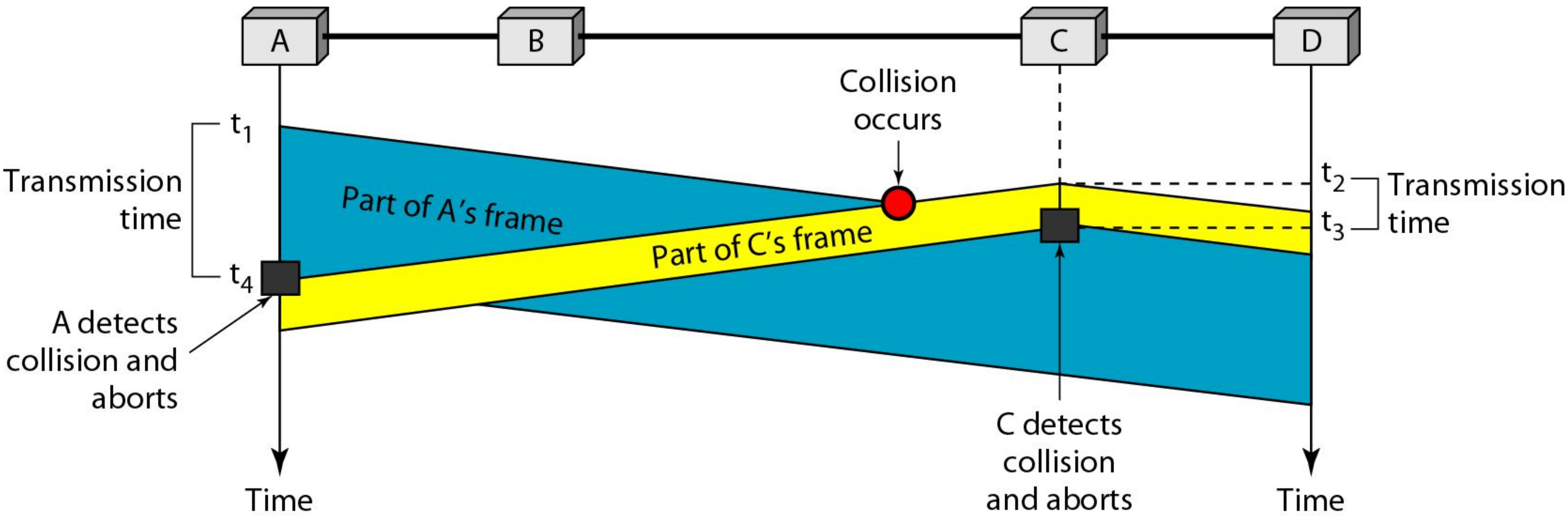


Figure 12.13 *Collision and abortion in CSMA/CD*



Minimum Frame Size

The frame transmission time T_{fr} must be at least two times the maximum propagation time T_p

Example 12.5

A network using CSMA/CD has a bandwidth of 10 Mbps. If the maximum propagation time (including the delays in the devices and ignoring the time needed to send a jamming signal, as we see later) is 25.6 μs, what is the minimum size of the frame?

Solution

The frame transmission time is $T_{fr} = 2 \times T_p = 51.2$ μs. This means, in the worst case, a station needs to transmit for a period of 51.2 μs to detect the collision. The minimum size of the frame is 10 Mbps × 51.2 μs = 512 bits or 64 bytes. This is actually the minimum size of the frame for Standard Ethernet.

Figure 12.14 *Flow diagram for the CSMA/CD*

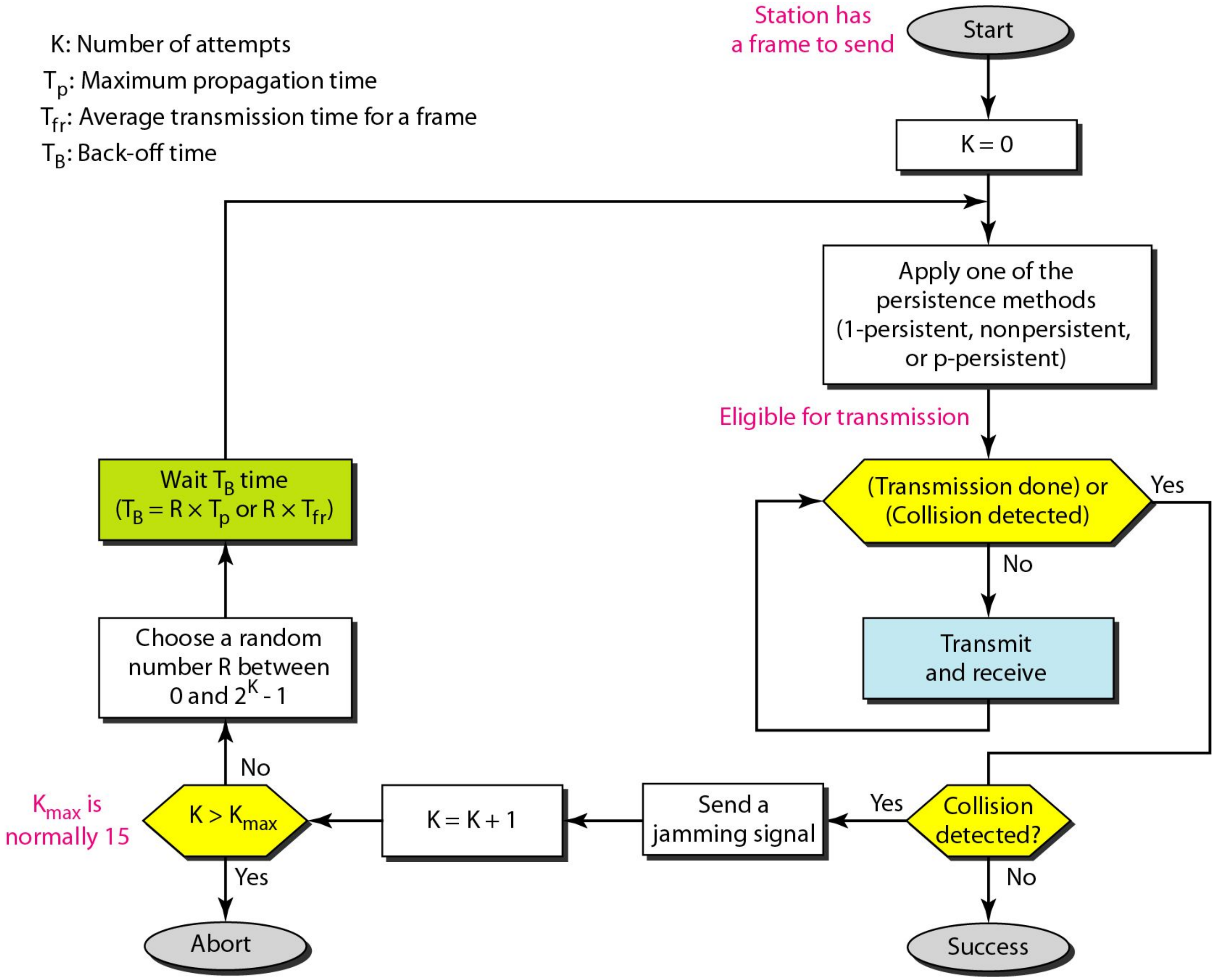
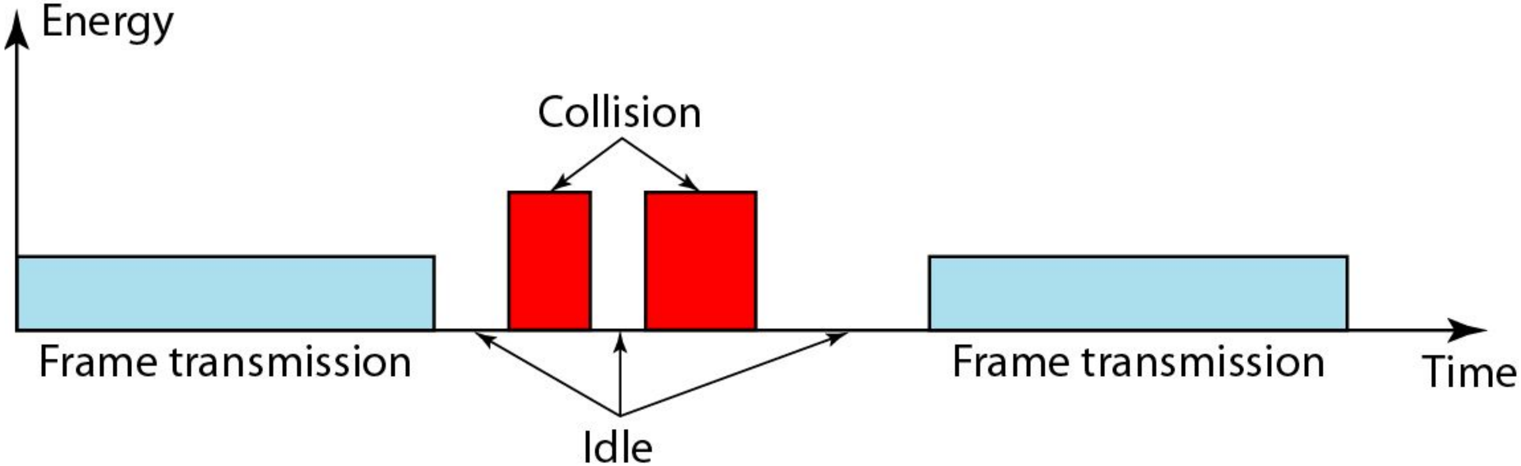


Figure 12.15 *Energy level during transmission, idleness, or collision*



THE END!