Local Area Network:

Protocols for Multiple Access Control

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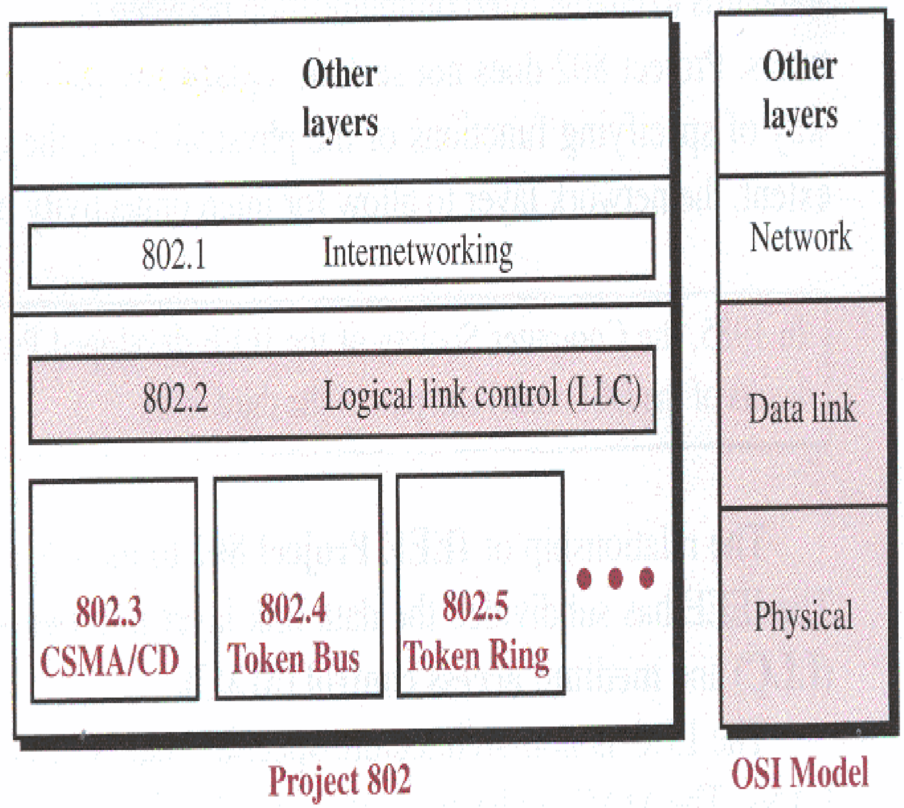
Introduction

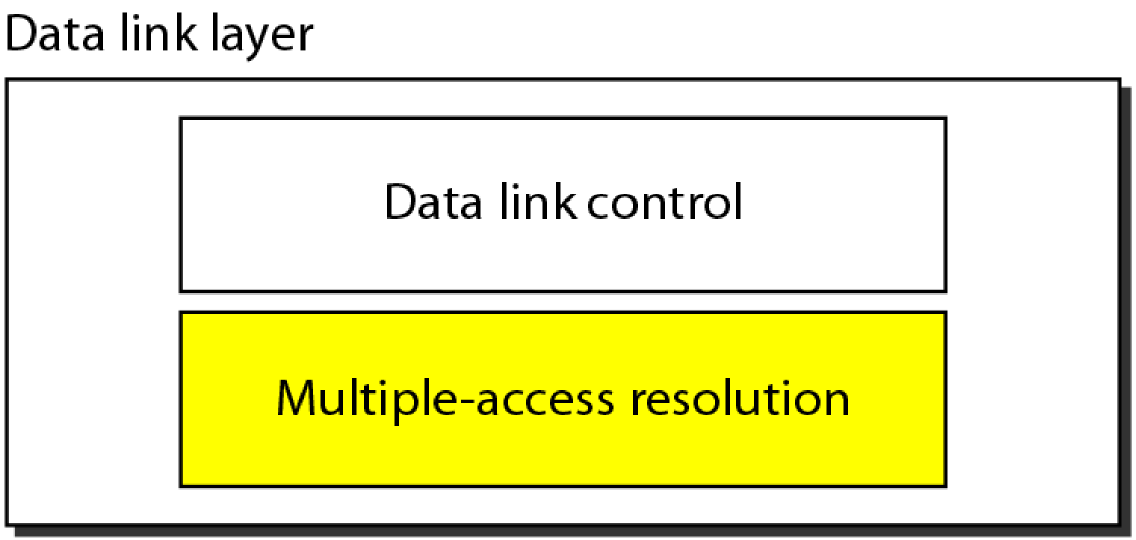
- Data links in networks can be of two types:
  - Dedicated *point to point*
  - Shared/ Multiple Access
- So, Data Link Layer is divided into two layers:
  - LLC: Logical Link Control
  - MAC: Multiple Access Control

IEEE Standards

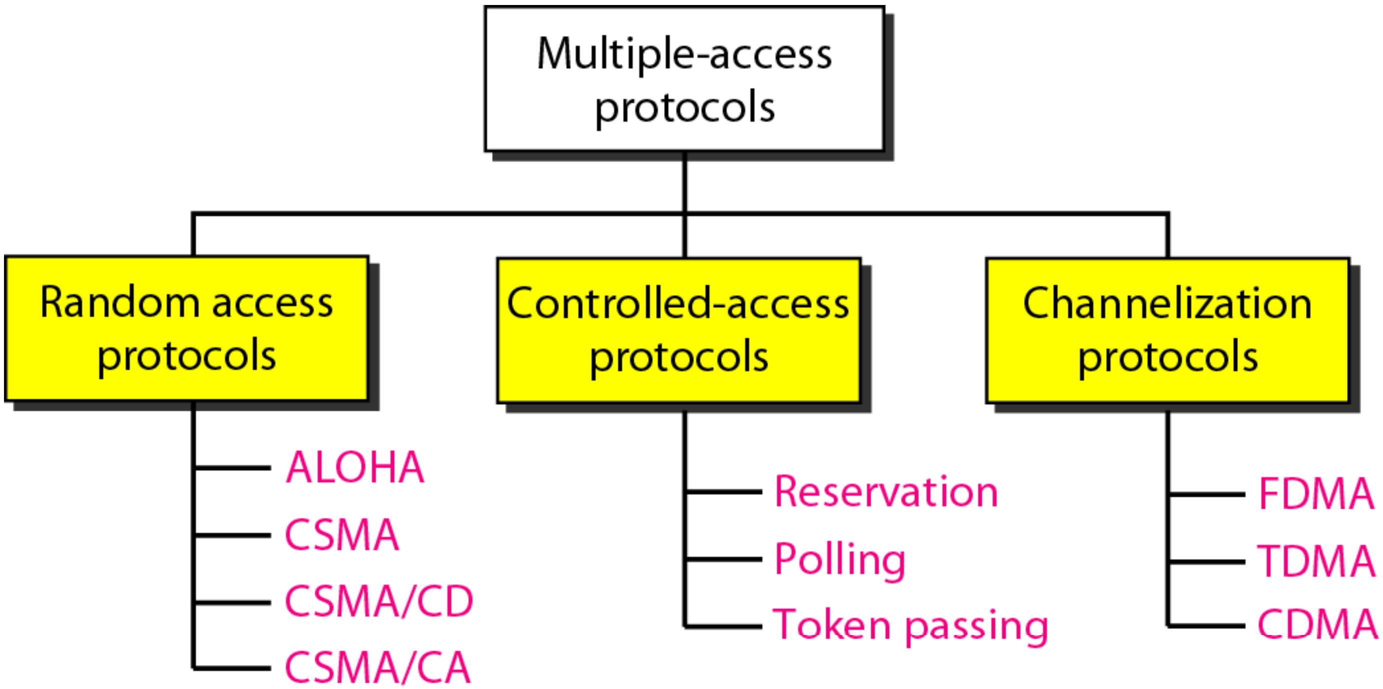
Figure 12.2 *Project 802*



Data link layer divided into two functionality-oriented sub layers



Taxonomy of multiple-access protocols discussed in this chapter

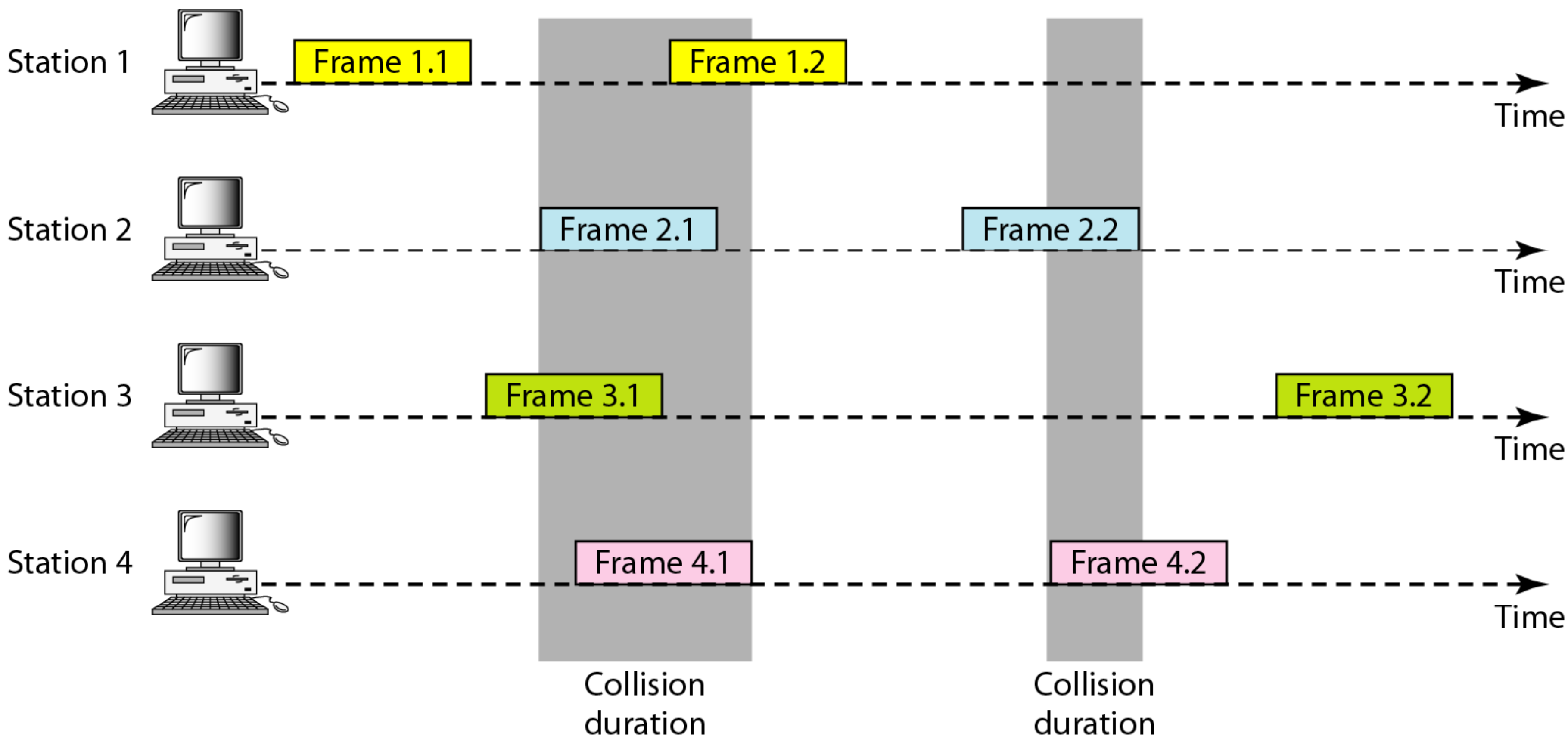


RANDOM ACCESS

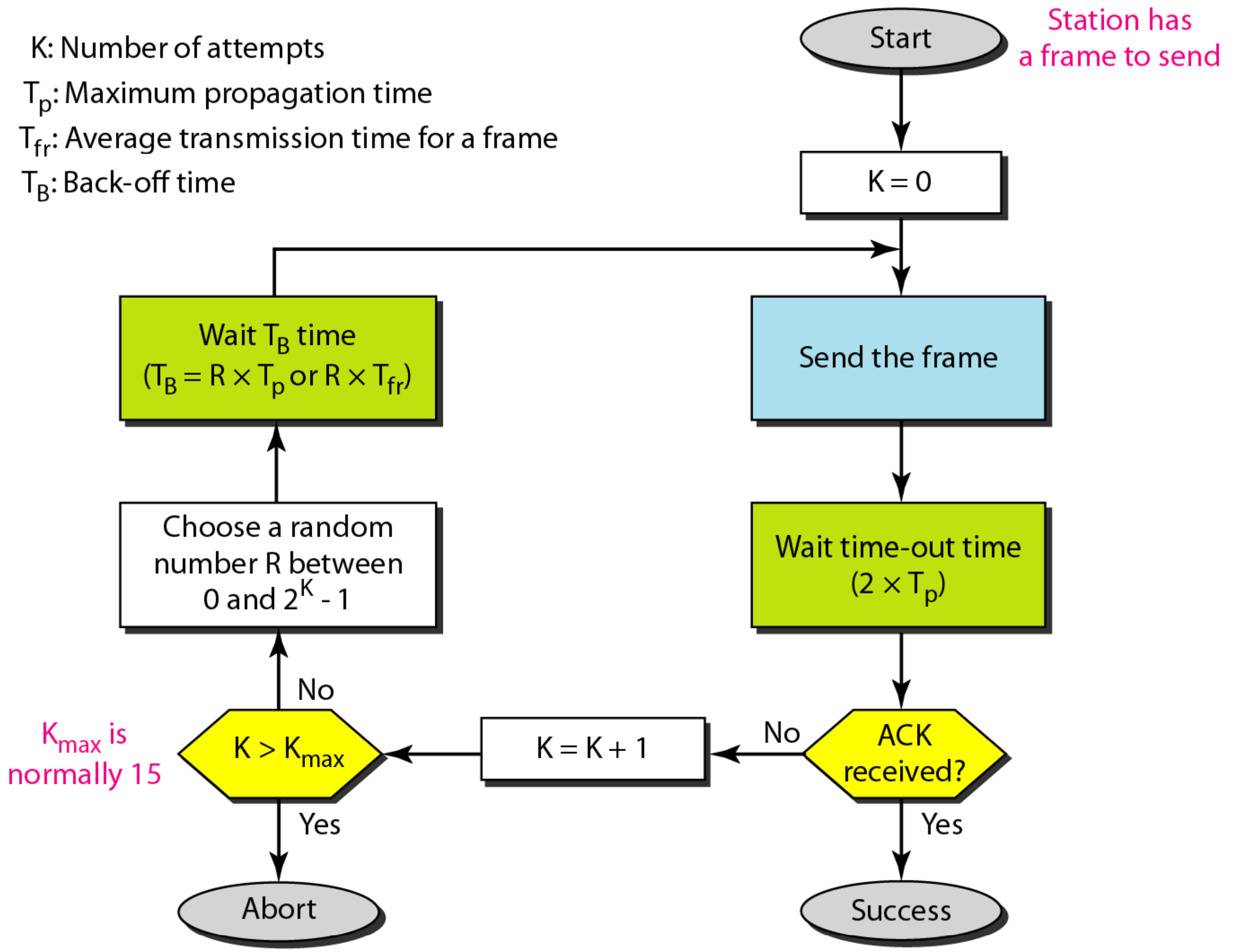
In random access or contention methods, no station is superior to another station and none is assigned the control over another. No station permits, or does not permit, another station to send. At each instance, a station that has data to send uses a procedure defined by the protocol to make a decision on whether or not to send. Different random access methods are:

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

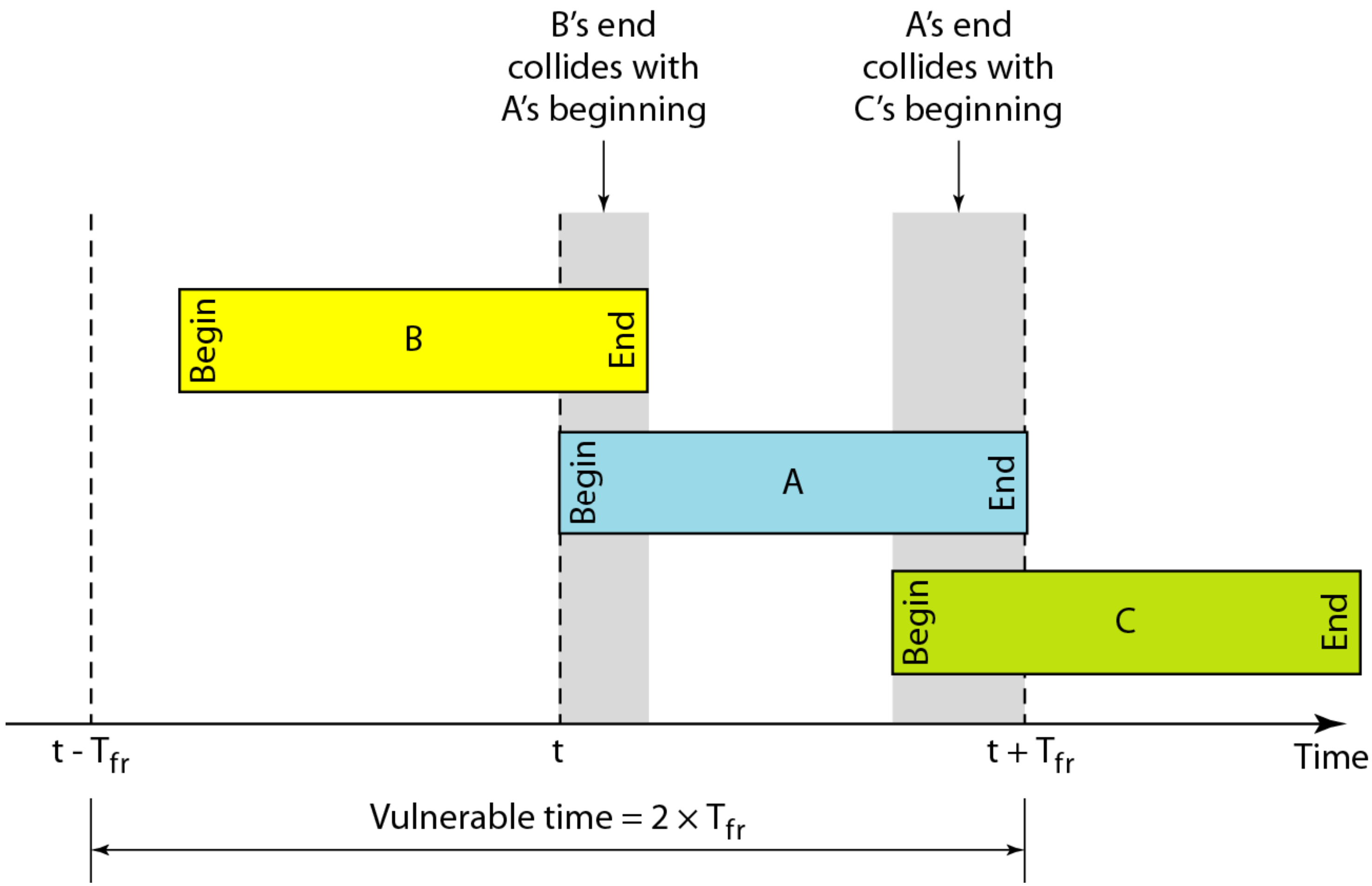
Frames in a pure ALOHA network



Procedure for pure ALOHA protocol



Vulnerable time for pure ALOHA protocol



Example

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the requirement to make this frame collision-free?

Solution

Average frame transmission time T_{fr} is 200 bits/200 kbps or 1 ms. The vulnerable time is 2×1 ms = 2 ms. This means no station should send later than 1 ms before this station starts transmission and no station should start sending during the one 1-ms period that this station is sending.

Note

The throughput for pure ALOHA is

$$S = G \times e^{-2G}$$

G=Average number of frames generated by the system during one frame transmission time

The maximum throughput

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

Example

A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces

a. 1000 frames per second *b. 500 frames per second*

c. 250 frames per second.

Solution

The frame transmission time is 200/200 kbps or 1 ms.

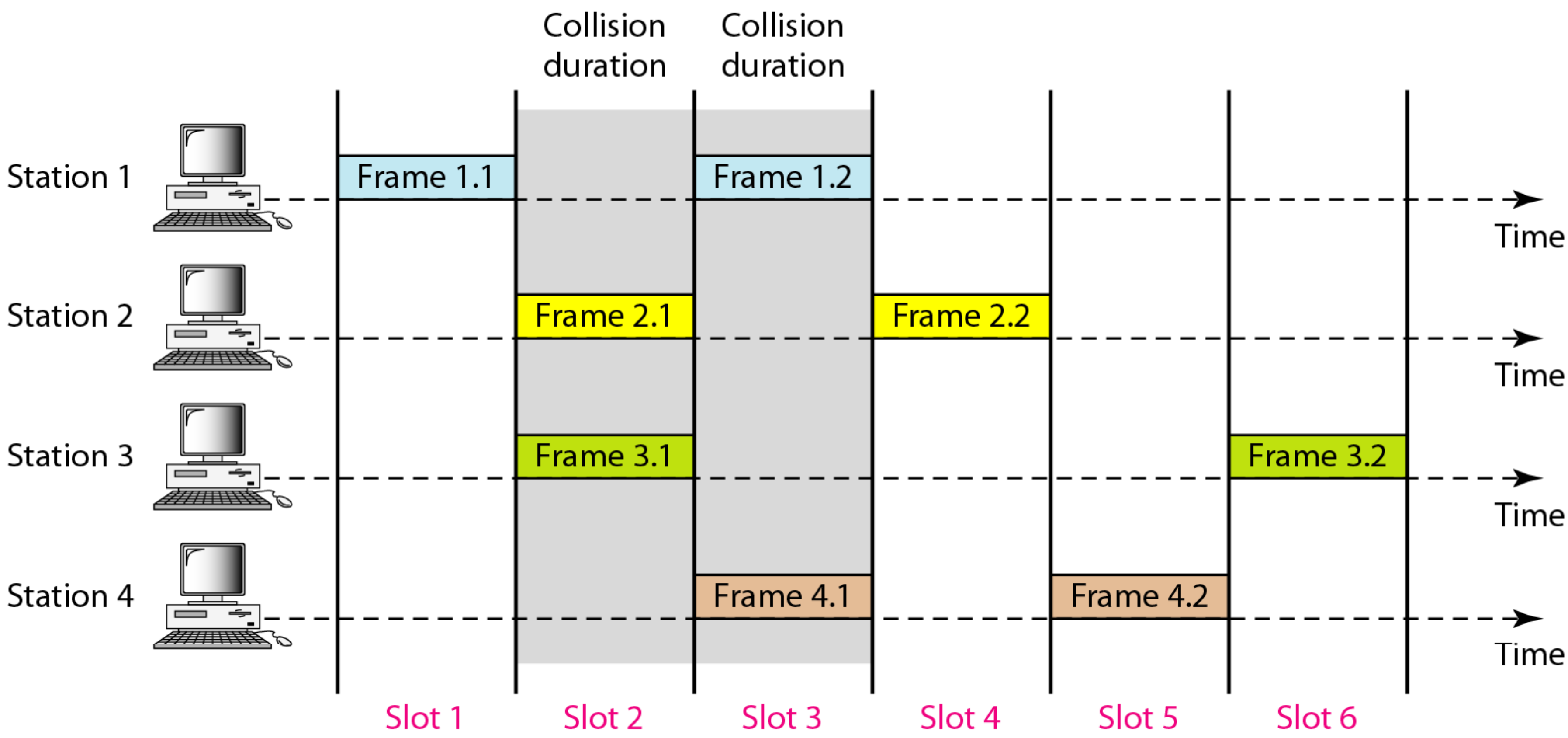
a. If the system creates 1000 frames per second, this is 1 frame per millisecond. The load is 1. In this case $S = G \times e^{-2G}$ or $S = 0.135$ (13.5 percent). This means that the throughput is $1000 \times 0.135 = 135$ frames. Only 135 frames out of 1000 will probably survive.

Example (continued)

b. *If the system creates 500 frames per second, this is (1/2) frame per millisecond. The load is (1/2). In this case* $S = G \times e^{-2G}$ *or* $S = 0.184$ *(18.4 percent). This means that the throughput is* $500 \times 0.184 = 92$ *and that only 92 frames out of 500 will probably survive. Note that this is the maximum throughput case, percentagewise.*

c. *If the system creates 250 frames per second, this is (1/4) frame per millisecond. The load is (1/4). In this case* $S = G \times e^{-2G}$ *or* $S = 0.152$ *(15.2 percent). This means that the throughput is* $250 \times 0.152 = 38$*. Only 38 frames out of 250 will probably survive.*

Frames in a slotted ALOHA network

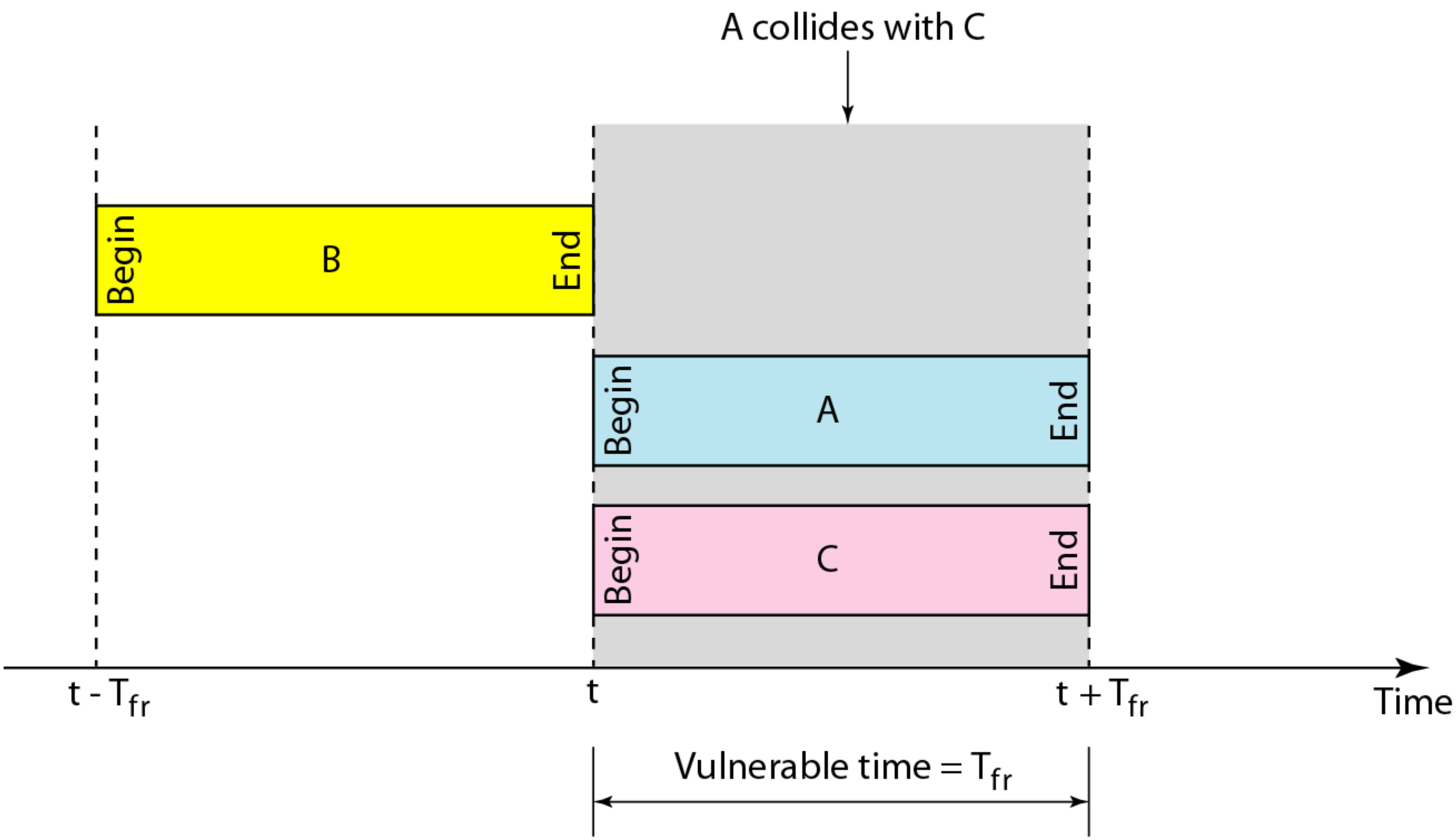


Note

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

The maximum throughput $S_{max} = 0.368$ when G = 1.

Vulnerable time for slotted ALOHA protocol



Example

A slotted ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces
a. 1000 frames per second b. 500 frames per second
c. 250 frames per second.

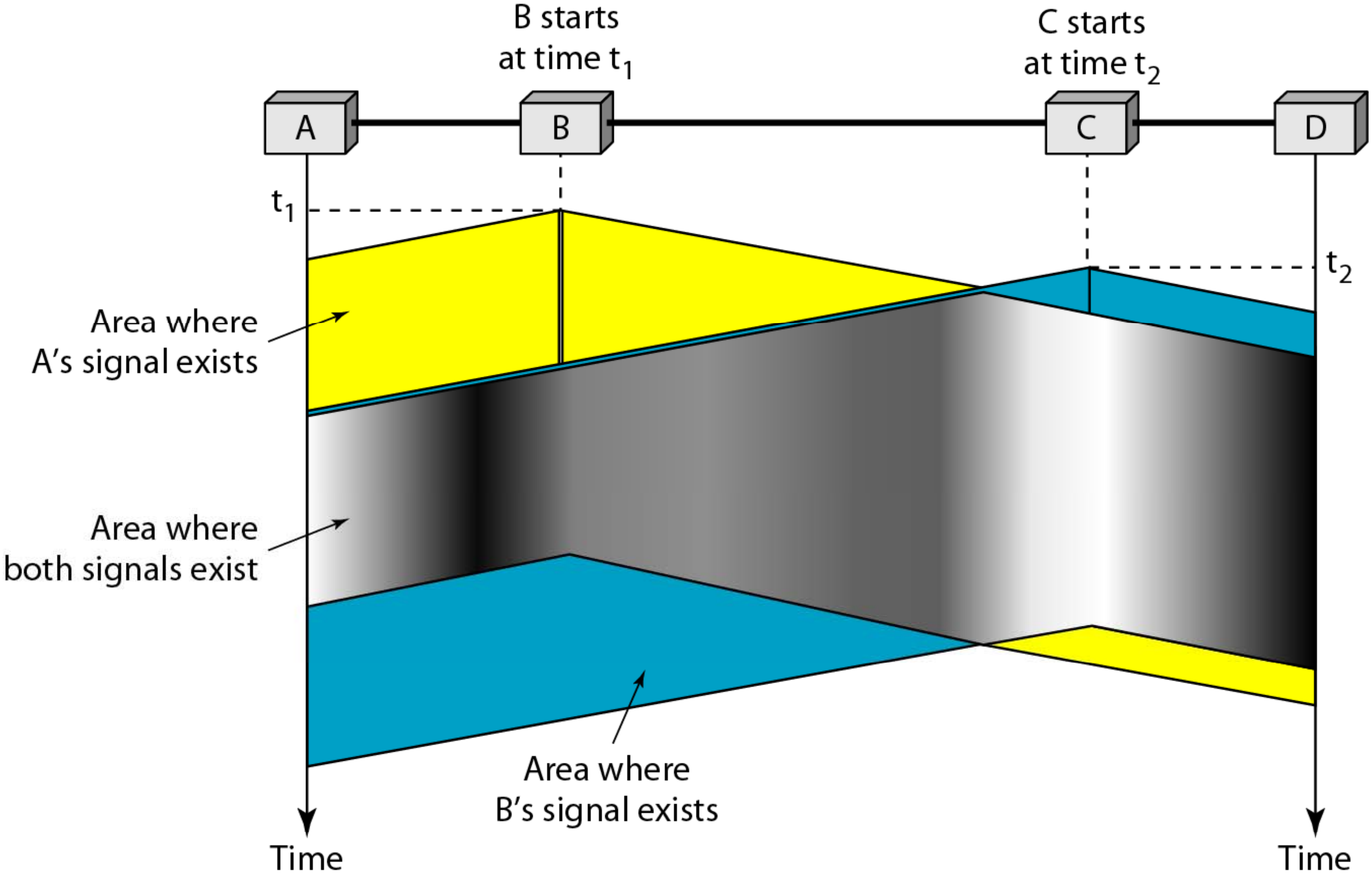
Solution
The frame transmission time is 200/200 kbps or 1 ms.
a. If the system creates 1000 frames per second, this is 1 frame per millisecond. The load is 1. In this case $S = G \times e^{-G}$ or $S = 0.368$ (36.8 percent). This means that the throughput is $1000 \times 0.0368 = 368$ frames. Only 386 frames out of 1000 will probably survive.

Example (continued)

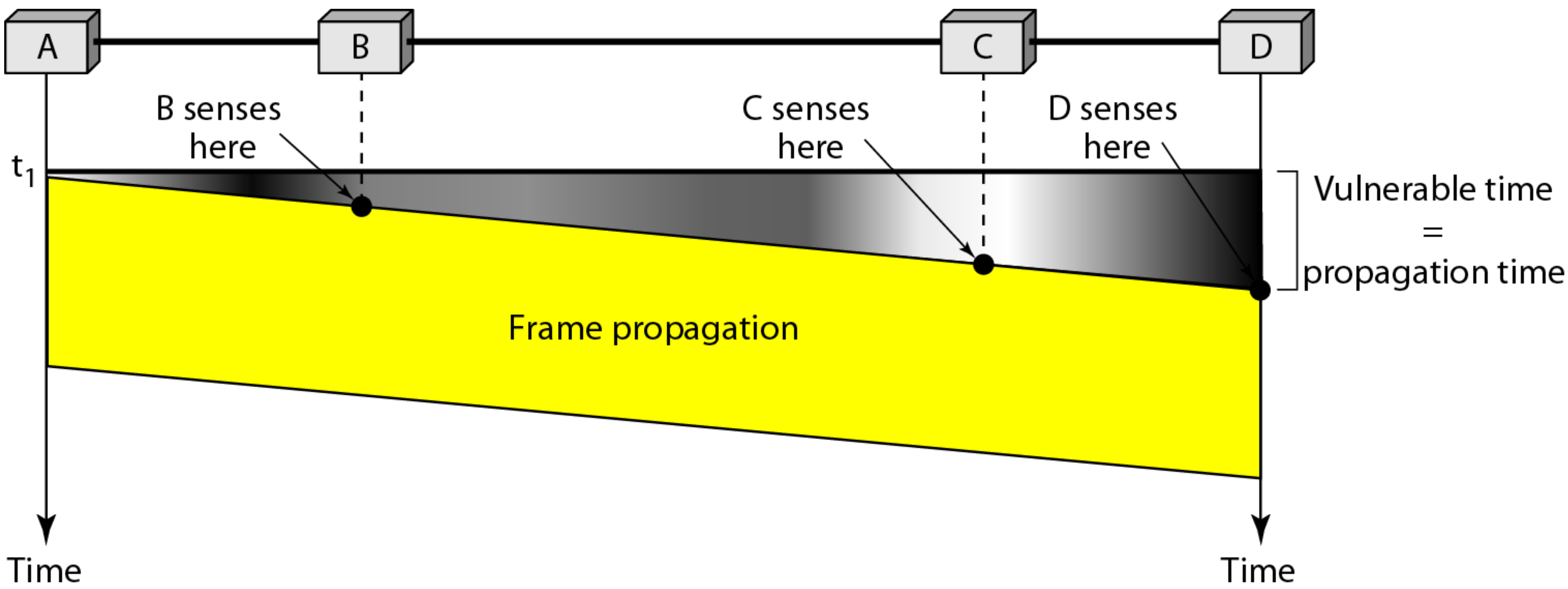
b. ***If the system creates 500 frames per second, this is (1/2) frame per millisecond. The load is (1/2). In this case $S = G \times e^{-G}$ or $S = 0.303$ (30.3 percent). This means that the throughput is $500 \times 0.0303 = 151$. Only 151 frames out of 500 will probably survive.***

c. ***If the system creates 250 frames per second, this is (1/4) frame per millisecond. The load is (1/4). In this case $S = G \times e^{-G}$ or $S = 0.195$ (19.5 percent). This means that the throughput is $250 \times 0.195 = 49$. Only 49 frames out of 250 will probably survive.***

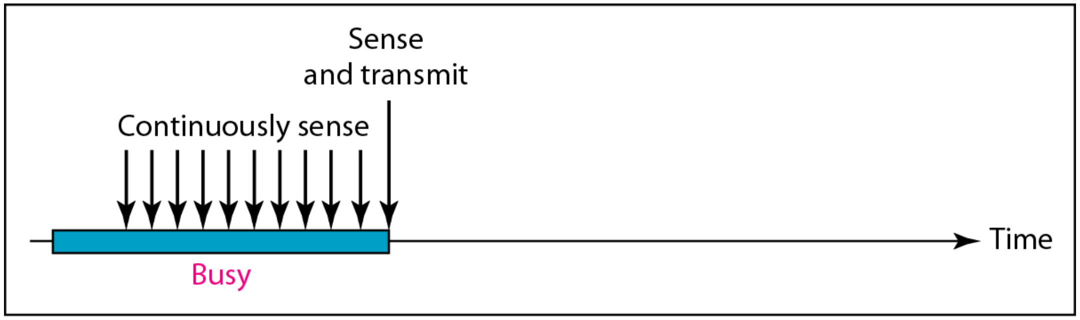
Space/time model of the collision in CSMA



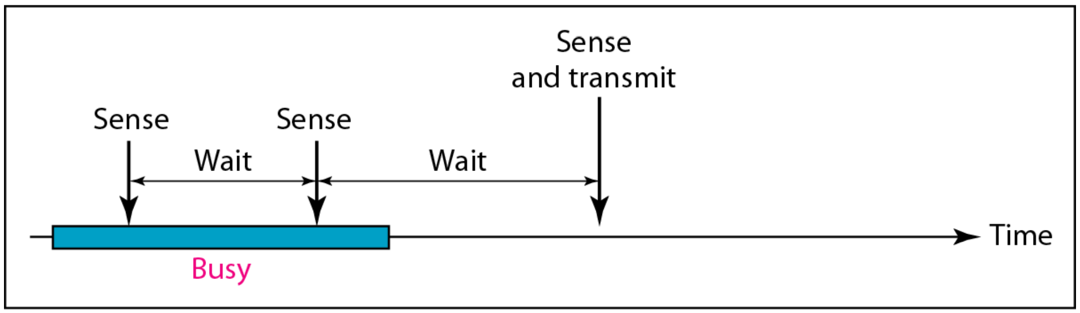
Vulnerable time in CSMA



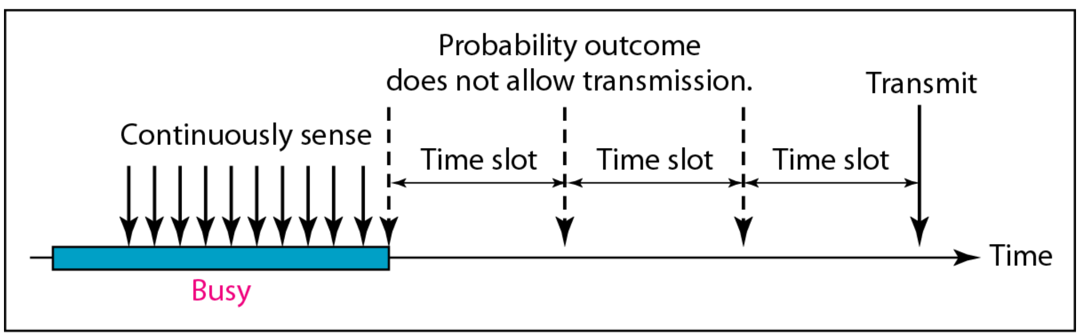
Behavior of three persistence methods



a. 1-persistent

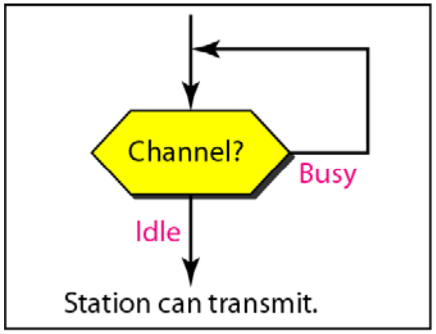


b. Nonpersistent

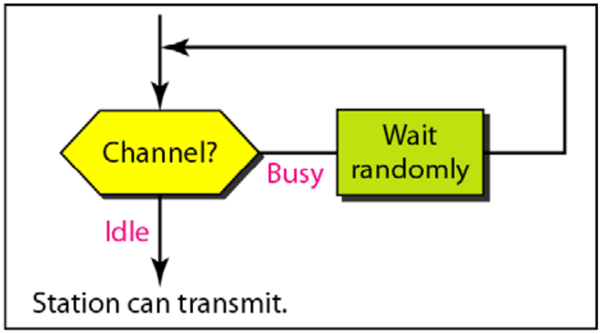


c. p-persistent

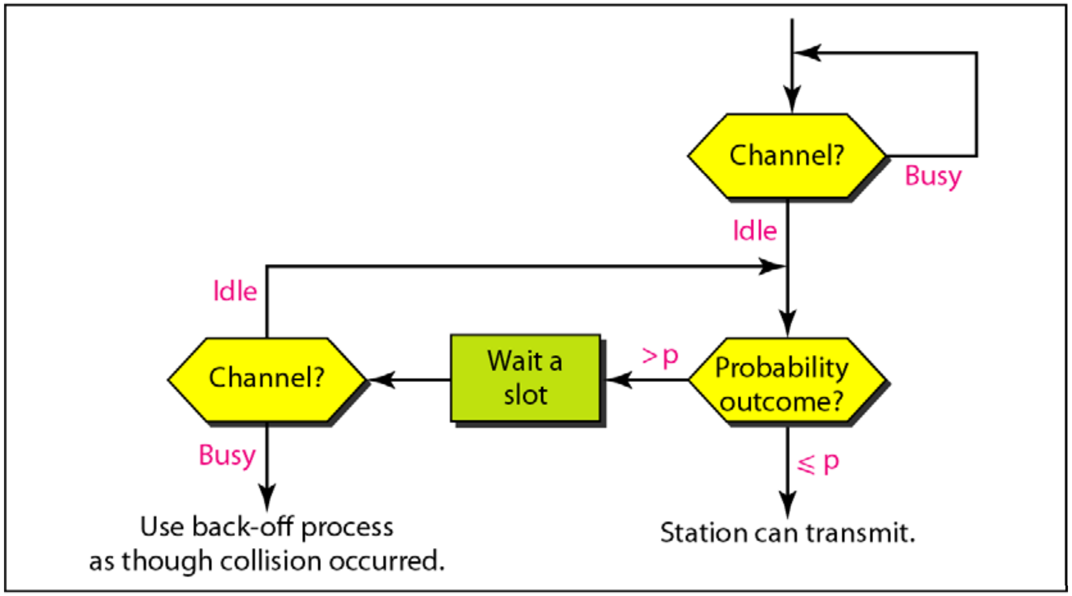
Flow diagram for three persistence methods



a. 1-persistent



b. Nonpersistent



c. p-persistent

Application

- Multiple Access Protocols are used in case of shared media/ shared channels
- These protocols are applicable in wireless communications

Scope of Research

- Protocol Support for 3G and 4G networks
- MAC algorithms for mobile networks
- MAC algorithms for wireless networks

Assignment 17

- Why performance of slotted Aloha is better than Pure Aloha?

Thank You