Rajiv Gandhi Proudyogiki Vishwavidyalaya, BhopalNew Scheme of Examinationas per ACTE Flexible Curricula VI Semester Bachelor of Technology (B.Tech.) Computer Science and Engineering
CS602 Computer Networks

Topic Covered
Distributed Random Access Schemes/Contention Schemes: for Data Services (ALOHA and Slotted-ALOHA), for Local-Area Networks (CSMA, CSMA/CD, CSMA/CA),

1. Distributed Random Access Schemes

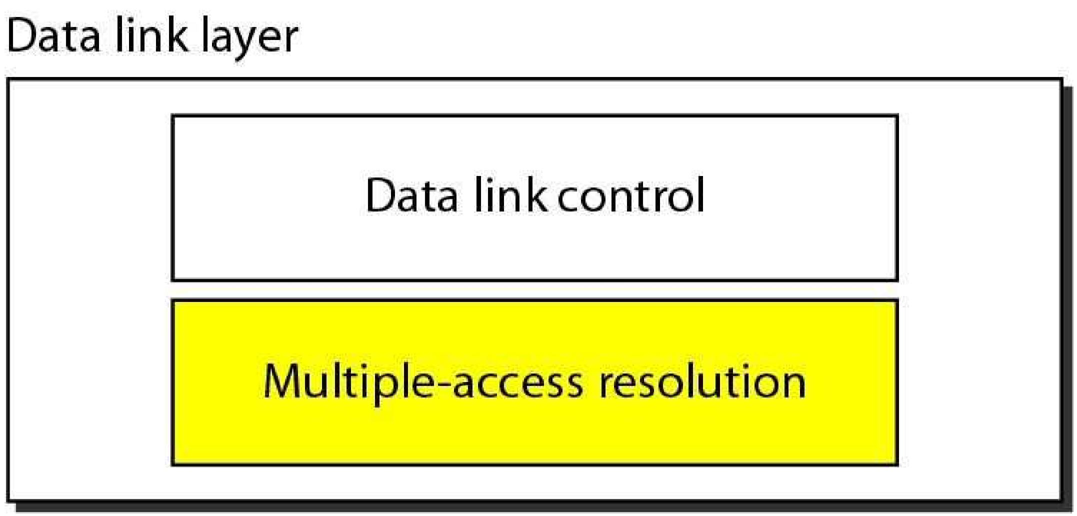

Figure 1.1 ***Data link layer divided into two functionality-oriented sub layers***

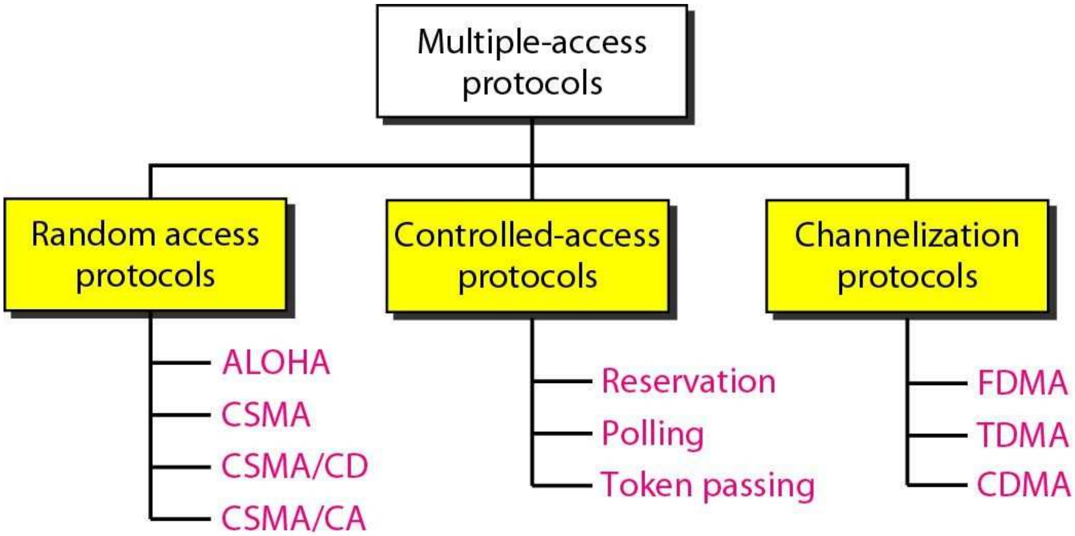

Figure 1.2 ***Taxonomy of multiple-access protocols***

1.1 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.

These are the following protocols:

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

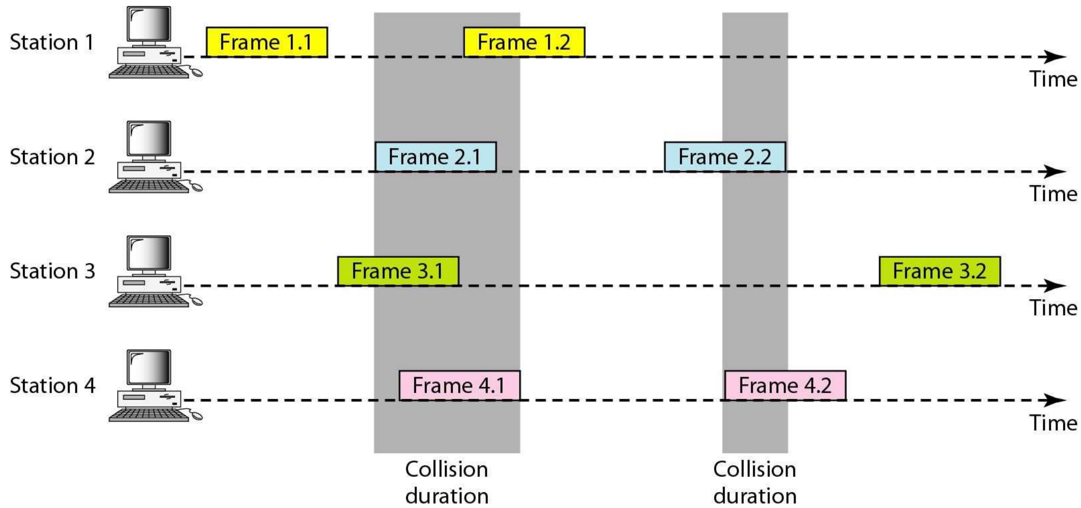

Figure 1.3 ***Frames in a pure ALOHA network***

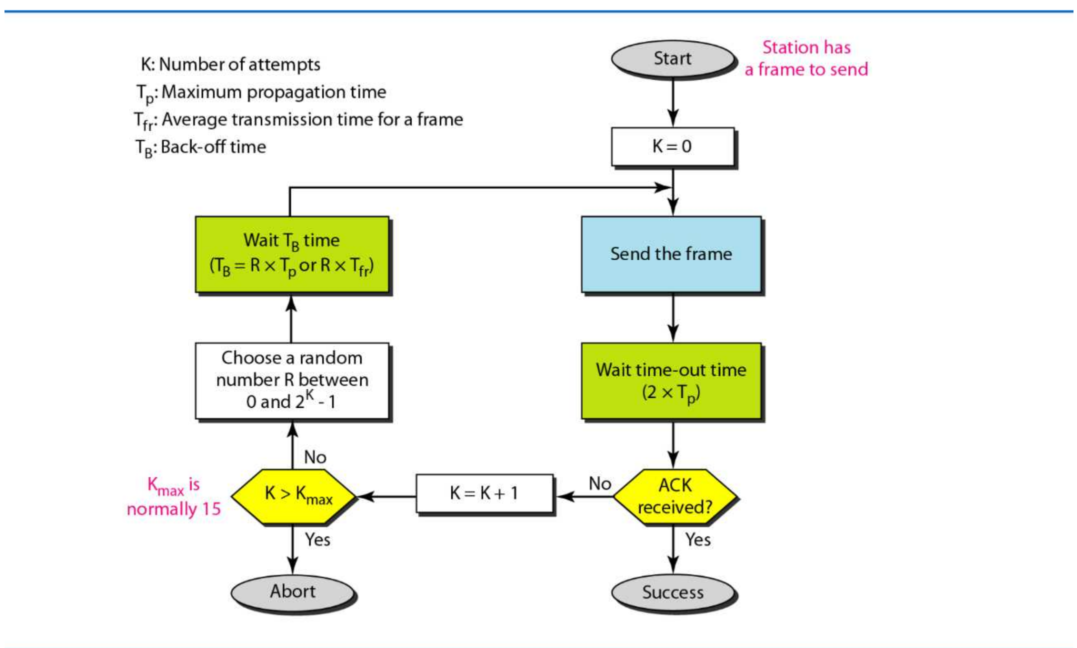

Figure 1.4 ***Procedure for pure ALOHA protocol***

Example 1.1

The stations on a wireless ALOHA network are a maximum of 600 km apart. If we assume that signals propagate at 3 × 108 m/s, we findTp = (600 × 105) / (3 × 108) = 2 ms.

Now we can find the value of TB for different values of K.

a. For K = 1, the range is {0, 1}. The station needs to| generate a random number with a value of 0 or 1. This means that TB is either 0 ms (0 × 2) or 2 ms (1 × 2), based on the outcome of the random variable.
b. For K = 2, the range is {0, 1, 2, 3}. This means that TB can be 0, 2, 4, or 6 ms, based on the outcome of the random variable.
c. For K = 3, the range is {0, 1, 2, 3, 4, 5, 6, 7}. This means that TB can be 0, 2, 4, ….14 ms, based on the outcome of the random variable.
d. We need to mention that if K > 10, it is normally set to 10.

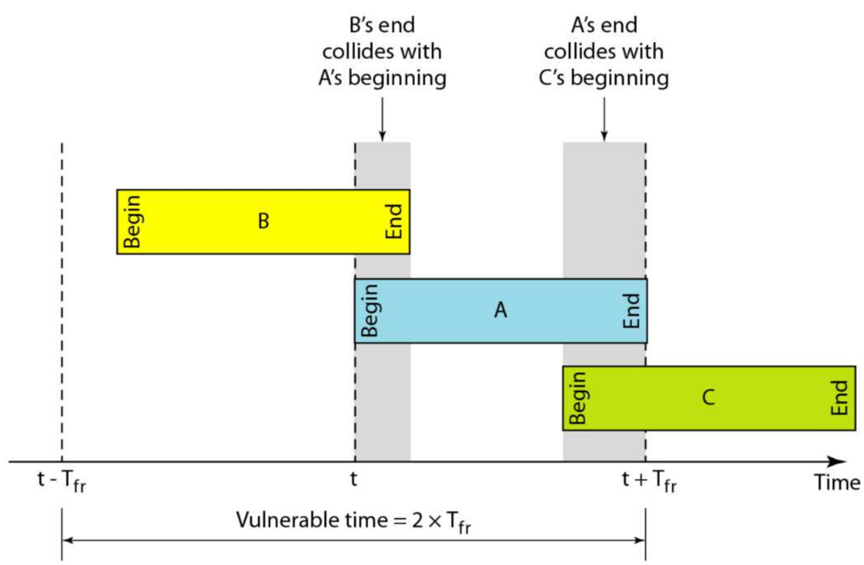

Figure 1.5 ***Vulnerable time for pure ALOHA protocol***

Example 1.2

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

The maximum throughput $S_{max} = 0.184$ when G= (1/2)

Example 1.3

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 × 0.135 = 135 frames. Only 135 frames out of 1000 will probably survive.
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 × 0.184 = 92 and that only 92 frames out of

500 will probably survive. Notethat 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 × e −2G or S = 0.152 (15.2 percent). This means that the throughput is 250 × 0.152 = 38. Only 38frames out of 250 will probably survive.

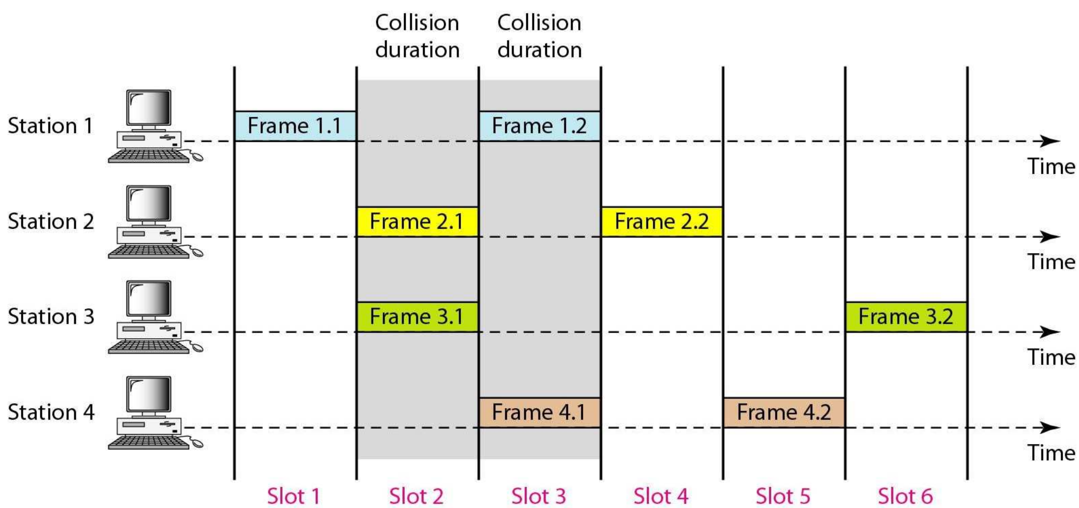

Figure 1.6 ***Frames in a slotted ALOHA network***

Note:

- The throughput for slotted ALOHA is S = G × e−G
- The maximum throughput Smax = 0.368 when G = 1

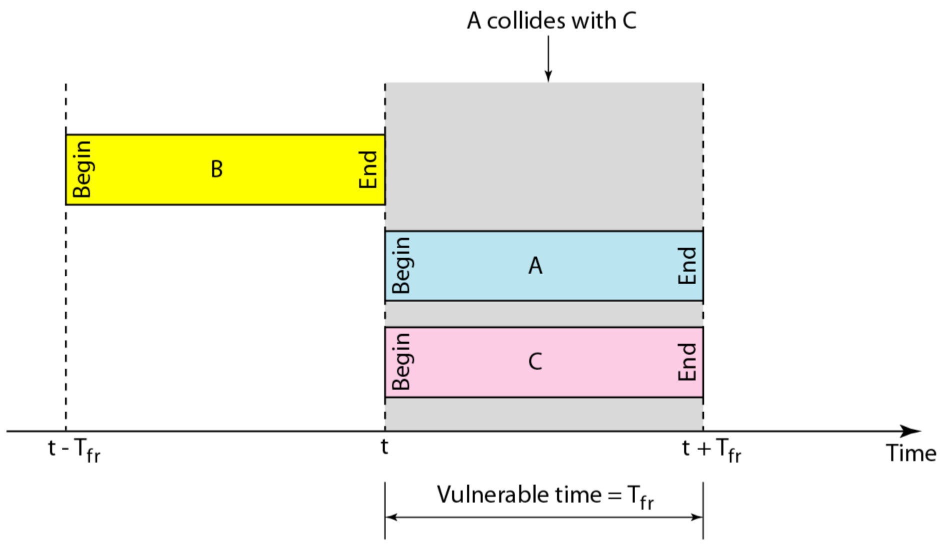

Figure 1.7 ***Vulnerable time for slotted ALOHA protocol***

Example 1.4

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× e−G or S = 0.368 (36.8 percent). This means that thethroughput is 1000 × 0.0368 = 368 frames.Only 386 frames out of 1000 will probably survive.
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 × e−G or S = 0.303 (30.3 percent). This

means that the throughput is 500 × 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 × 0.195 = 49. Only 49frames out of 250 will probably survive.

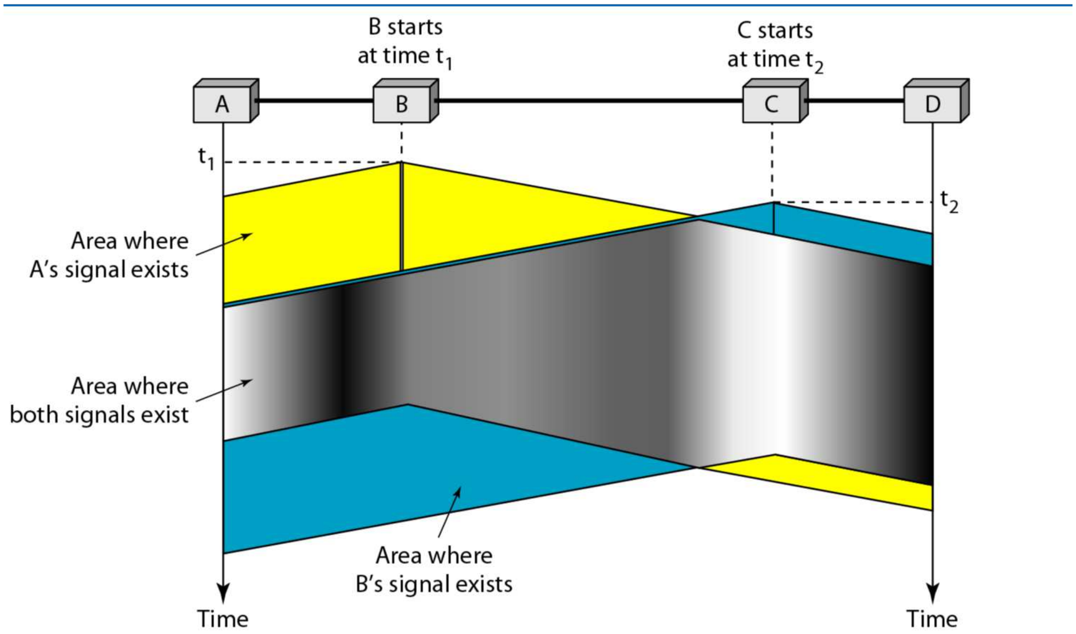

Figure 1.8 ***Space/time model of the collision in CSMA***

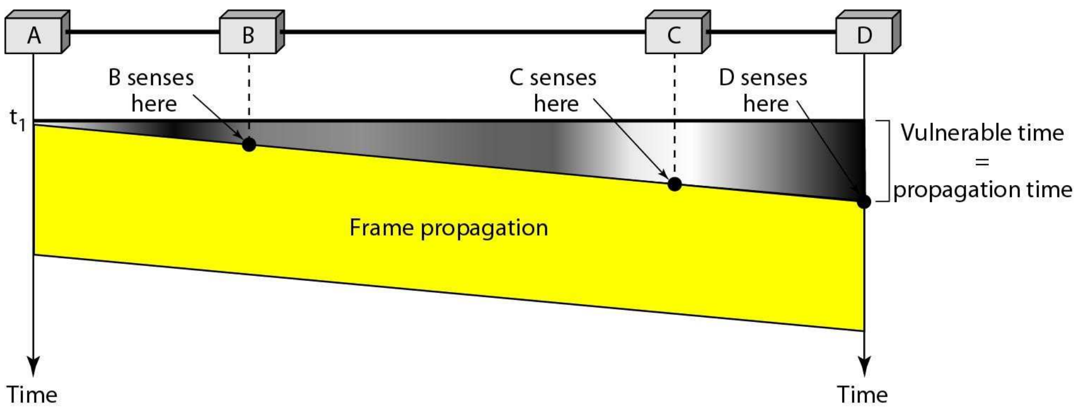

Figure 1.9 ***Vulnerable time in CSMA***

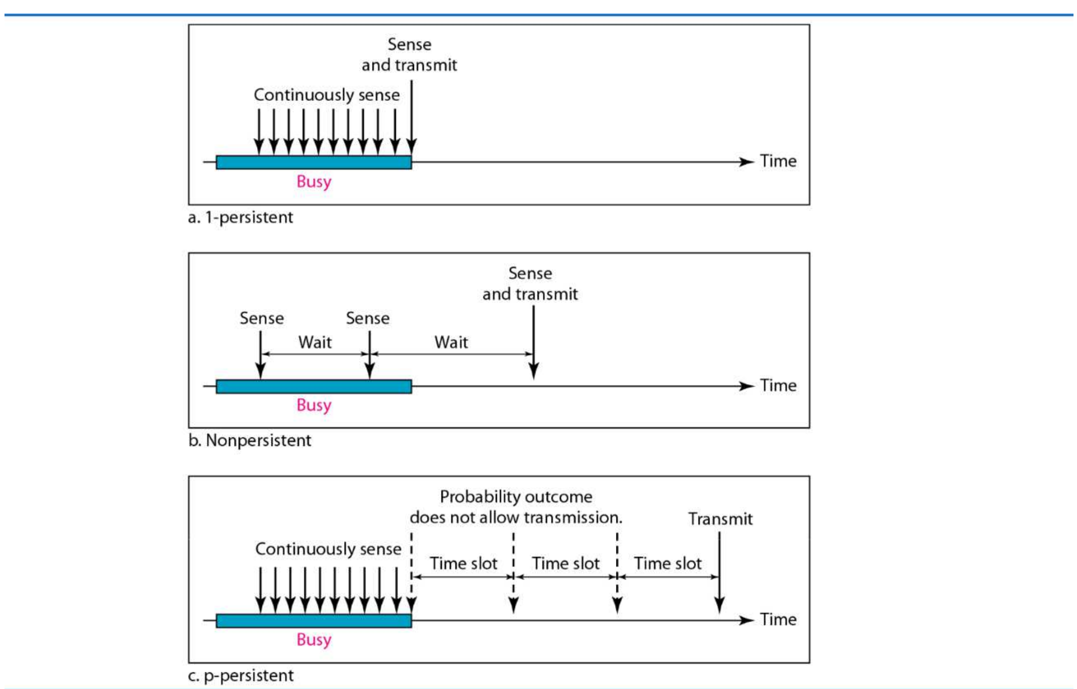

Figure 1.10 ***Behavior of three persistence methods***

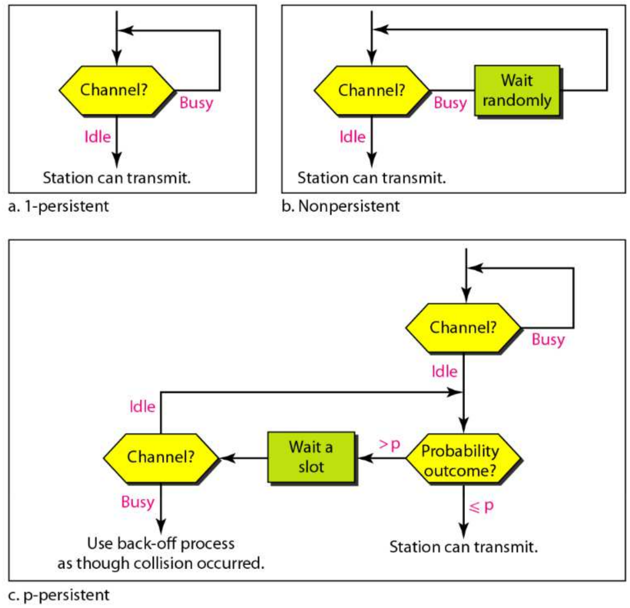

Figure 1.11 ***Flow diagram for three persistence methods***

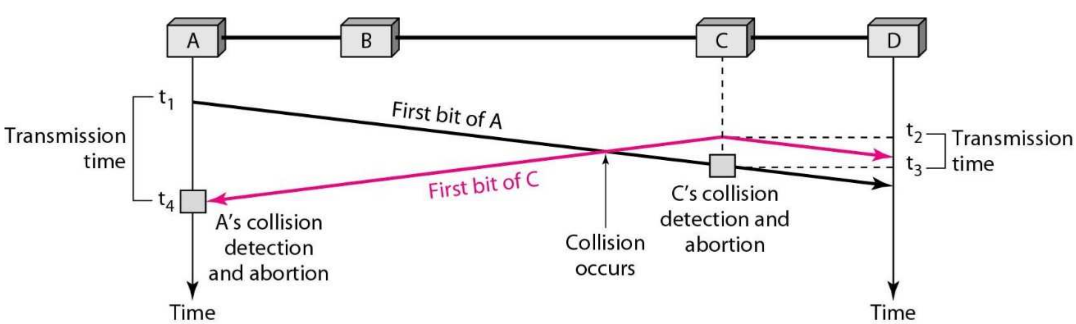

Figure 1.12 ***Collision of the first bit in CSMA/CD***

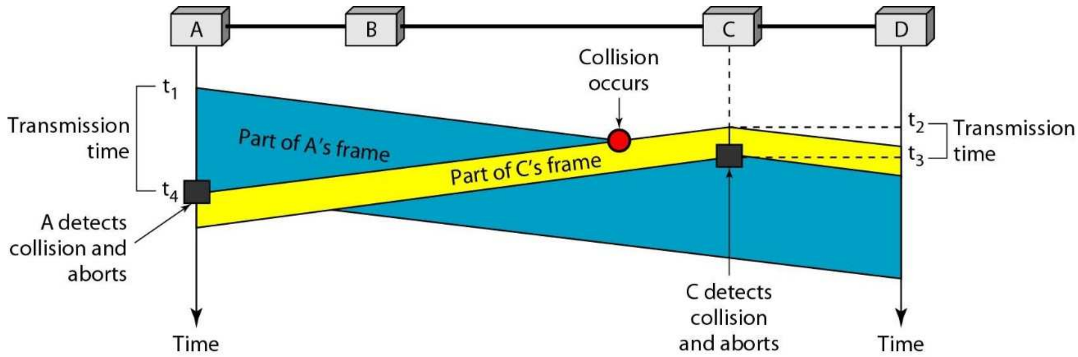

Figure 1.13 ***Collision and abortion in CSMA/CD***

Example 1.5

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 ajamming signal, as we see later) is 25.6 μs, what is the s, what is the minimum size of the frame?

Solution

The frame transmission time is Tfr = 2 × Tp = 51.2 μs, what is the s. This means, in the worst case, a station needs to transmit for a period of 51.2 μs, what is the s to detect the collision. The minimum size of the frame is 10 Mbps × 51.2 μs, what is the s = 512 bits or 64 bytes. This is actually the minimum size of the frame for Standard Ethernet**.**

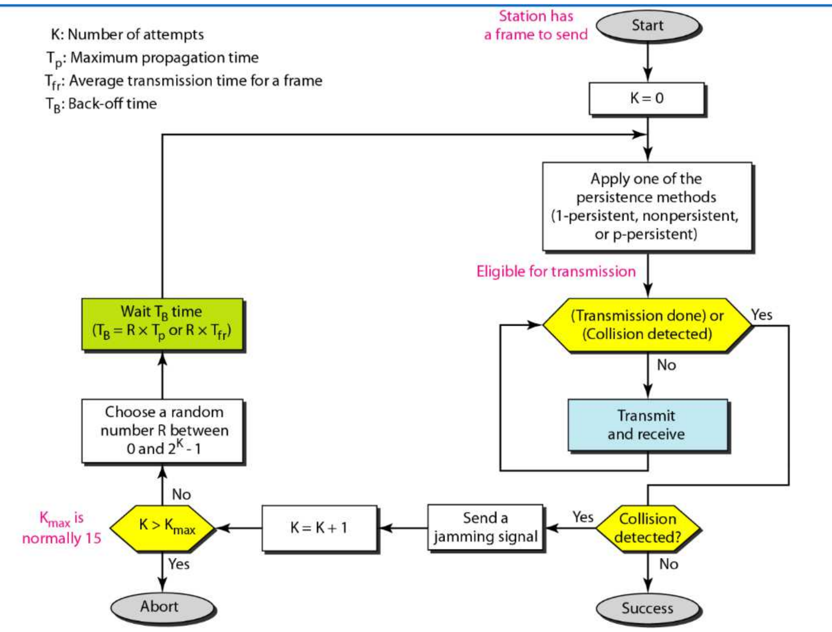

Figure 1.14 ***Flow diagram for the CSMA/CD***

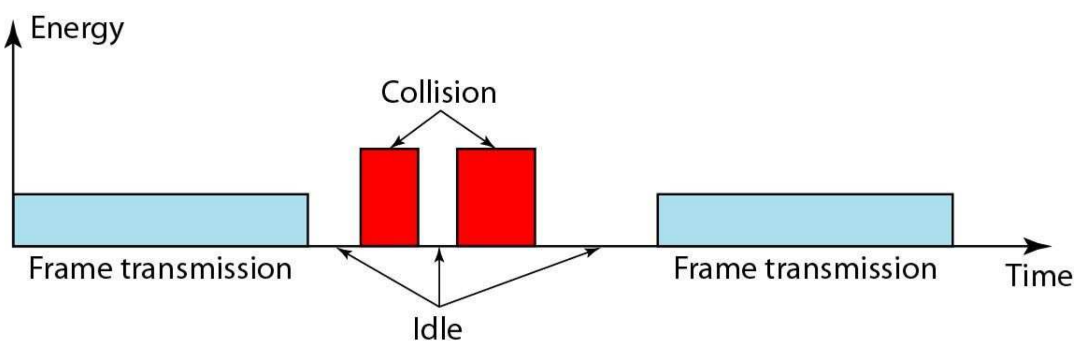

Figure 1.15 ***Energy level during transmission, idleness, or collision***

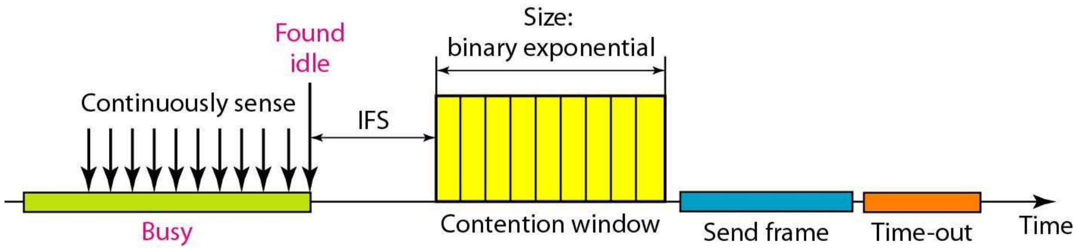

Figure 1.16 ***Timing in CSMA/CA***

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.

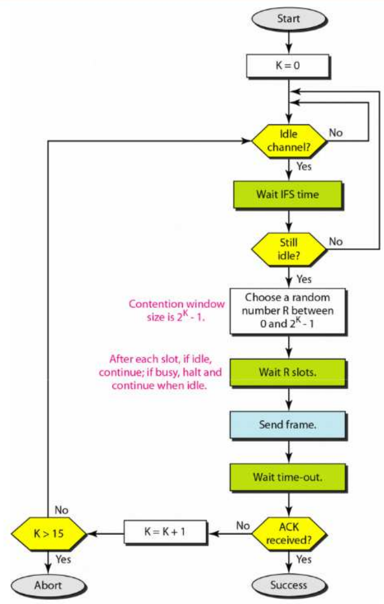

Figure 1.17 ***Flow diagram for CSMA/CA***

Assignment Questions

1. Draw Taxonomy of multiple-access protocols.
2. Make a comparison between pure ALOHA, slotted ALOHA and CSMA/CD?
3. We have come across three generations of Carrier Sense Multiple Access protocols -- the original CSMA, CSMA/CD, and CSMA/CA. Based on your knowledge to these variants of CSMA MAC protocols, address the following questions.
   a. How does CSMA/CD work in principle?
   b. Can frames collide in CSMA and how? What is the problem in CSMA that CSMA/CD is trying to resolve?
   c. How does CSMA/CA work in principle?
   d. How can collisions be detected? What is the problem in CSMA/CD that CSMA/CA is trying to resolve?

Bibliography

- http://citengg.blogspot.com/p/behrouz-forouzancomputer-networks4th.html
- Behrouz A. Forouzan,"Computer Networks",4th edition, McGraw-Hill