Computer Network

Lecture-23

Dharmendra Kumar (Associate Professor)
Department of Computer Science and Engineering
United College of Engineering and Research,
Prayagraj

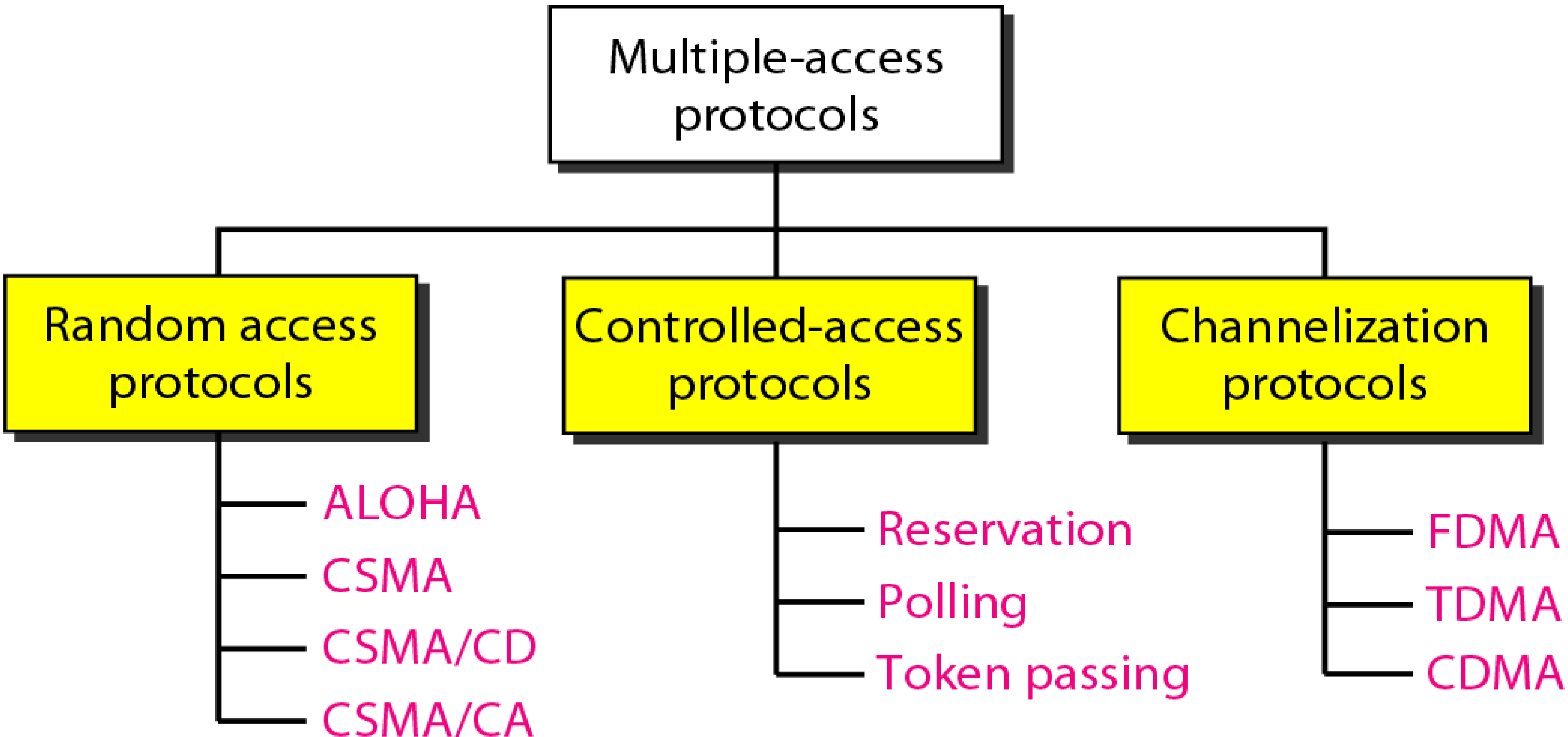
Media Access Control

Media Access Control

- Data link layer is considered as two sub-layers.
- The upper sub-layer is responsible for data link control. The upper sub-layer that is responsible for flow and error control is called the logical link control (LLC) layer.
- The lower sub-layer is responsible for resolving access to the shared media. The lower sub-layer that is mostly responsible for multiple access resolution is called the media access control (MAC) layer.

Media Access Control

When nodes or stations are connected and use a common link, called a multipoint or broadcast link, we need a multiple-access protocol to coordinate access to the link.



Random Access Protocol

- 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. This decision depends on the state of the medium (idle or busy).
- If more than one station tries to send, there is an access conflict (collision) and the frames will be either destroyed or modified.

Random Access Protocol

To avoid access conflict or to resolve it when it happens, each station follows a procedure that answers the following questions:

- When can the station access the medium?
- What can the station do if the medium is busy?
- How can the station determine the success or failure of the transmission?
- What can the station do if there is an access conflict?

Random Access Protocol

ALOHA Protocol

ALOHA was the earliest random access method. There are two types of ALOHA.

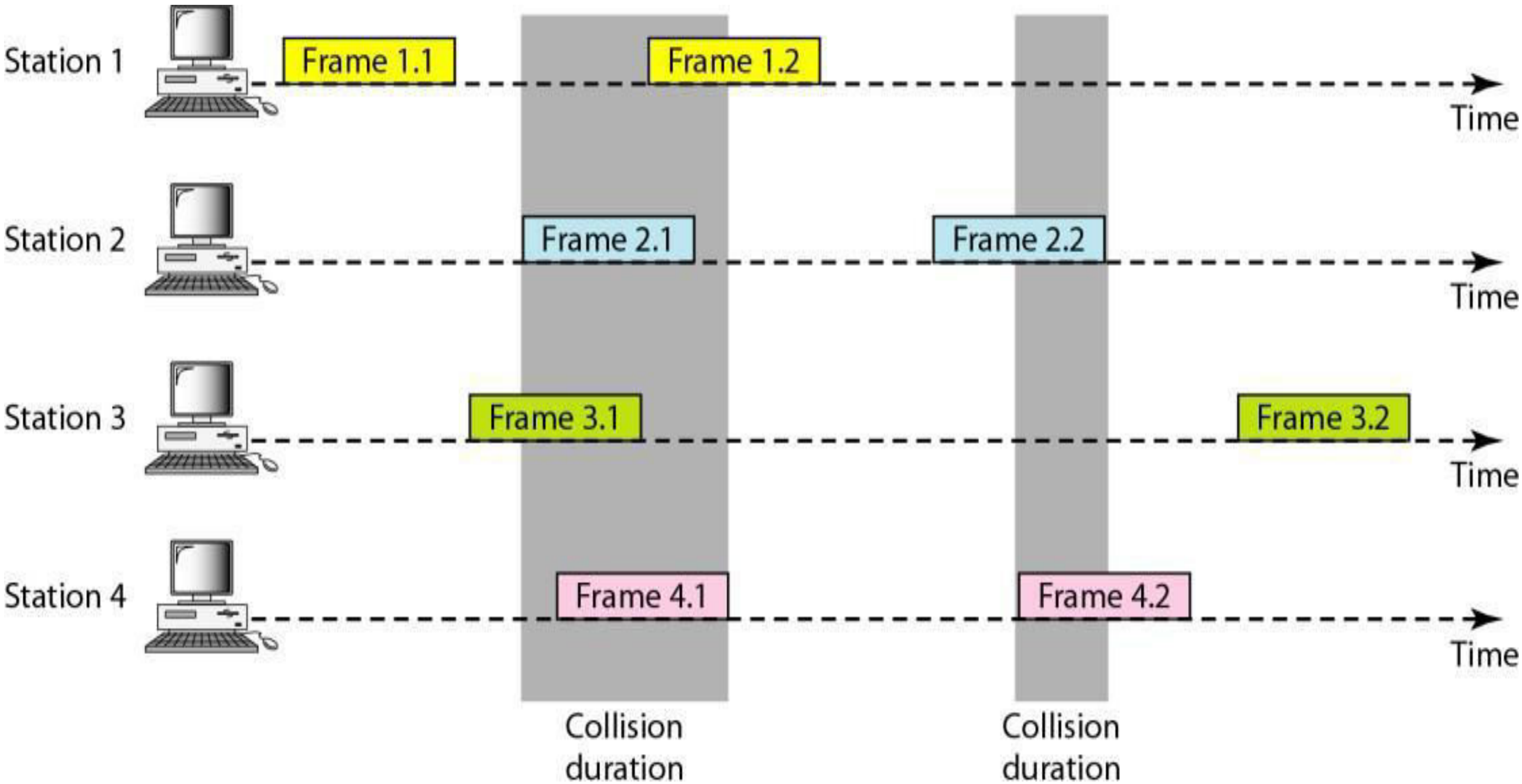
1. Pure ALOHA
2. Slotted ALOHA

Pure ALOHA

- The original ALOHA protocol is called pure ALOHA. This is a simple protocol.
- Full form of ALOHA is **Additive Links On-line Hawaii Area.**
- In this 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.

Pure ALOHA

Following figure shows an example of frame collisions in pure ALOHA.



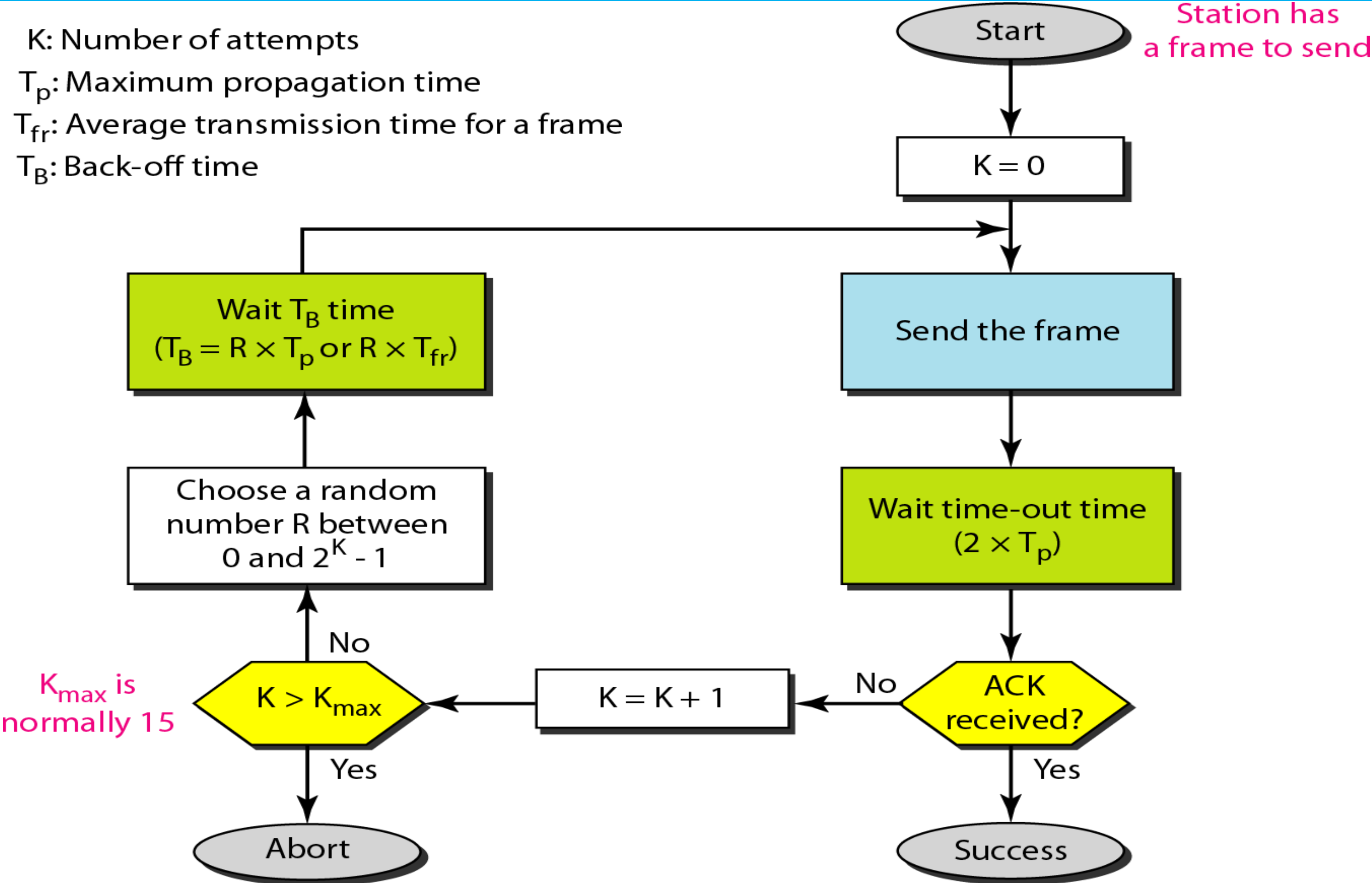
Pure ALOHA

- There are four stations that contend with one another for access to the shared channel.
- The figure shows that each station sends two frames; there are a total of eight frames on the shared medium. Some of these frames collide because multiple frames are in contention for the shared channel.
- Figure shows only two frames survive: frame 1.1 from station 1 and frame 3.2 from station 3.

Pure ALOHA

- The pure ALOHA protocol relies on acknowledgments from the receiver. When a station sends a frame, it expects the receiver to send an acknowledgment. If the acknowledgment does not arrive after a time-out period, the station assumes that the frame (or the acknowledgment) has been destroyed and resends the frame.
- A collision involves two or more stations. If all these stations try to resend their frames after the time-out, the frames will collide again. Pure ALOHA dictates that when the time-out period passes, each station waits a random amount of time before resending its frame. The randomness will help avoid more collisions. We call this time the back-off time T_B.
- After a maximum number of retransmission attempts Kmax' a station must give up and try later.

Pure ALOHA



K: Number of attempts
T_p: Maximum propagation time
T_{fr}: Average transmission time for a frame
T_B: Back-off time
Start
Station has a frame to send
K = 0
Send the frame
Wait time-out time ($2 \times T_p$)
ACK received?
No
Yes
Success
K = K + 1
$K > K_{max}$
K_{max} is normally 15
No
Yes
Abort
Choose a random number R between 0 and $2^K - 1$
Wait T_B time ($T_B = R \times T_p$ or $R \times T_{fr}$)

Pure ALOHA

- The time-out period is equal to the maximum possible round-trip propagation delay i.e.

  $t_{out} = 2T_p$

  Where T_p is the propagation time between two most widely separated stations.
- The back-off time T_B is random value that normally depends on K, where K is the number of attempted unsuccessful transmissions.
- T_B is calculated by **binary exponential back-off** algorithm.

According to this algorithm, for each retransmission, a multiplier in the range 0 to $2^K - 1$ is randomly chosen and multiplied by T_p (maximum propagation time) or T_{fr} (the average time required to send out a frame) to find T_B.

- In this procedure, the range of the random numbers increases after each collision.
- The value of K_{max} is usually chosen as 15.

Pure ALOHA

Example: The stations on a wireless ALOHA network are a maximum of 600 km apart. Signals propagate with speed at 3×10^8 m/s. Find the value of T_B for different value of K.

Solution:

$$T_p = (600 \times 10^3) / (3 \times 10^8) = 2 \text{ ms.}$$

Now we can find the value of T_B 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 T_B is either 0x2 = 0ms or 1x2 = 2ms, based on the outcome of the random variable.

(b) For K =2, the range is {0, 1, 2, 3}. This means that T_B can be 0, 2, 4, or 6 ms, based on the outcome of the random variable.

(c) For K =3, the range is to {0,1,2,3,4,5,6,7}. This means that T_B can be 0, 2, 4, ... , 14 ms, based on the outcome of the random variable.

Pure ALOHA

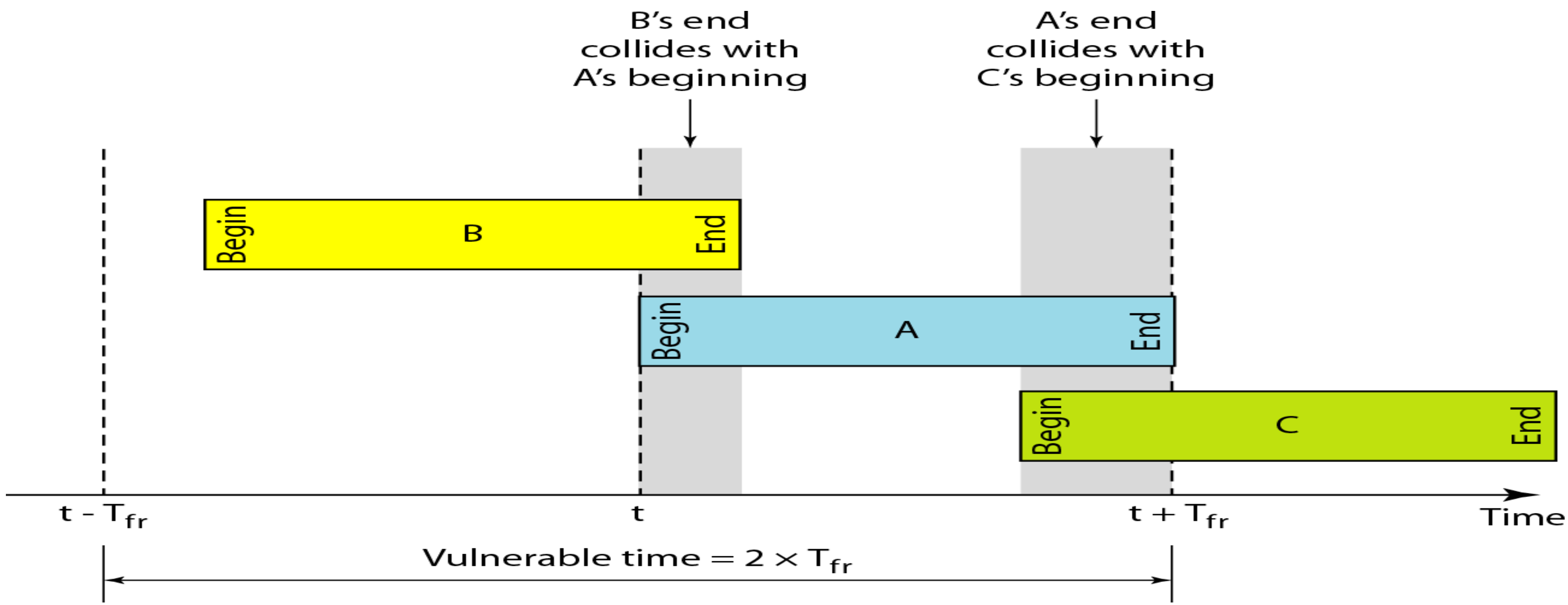
Vulnerable time

Vulnerable time is the length of time, in which there is a possibility of collision.

We assume that the stations send fixed-length frames with each frame taking T_{fr} second to send.

This figure shows the vulnerable time for station A.

Pure ALOHA vulnerable time = 2 x T_{fr}



Pure ALOHA

Throughput

Let G is the average number of frames generated by the system during one frame transmission time.

Average number of successful transmissions for pure ALOHA i.e. throughput, $\mathbf{S = G \times e^{-2G}}$.

The maximum throughput

$\mathbf{S_{max} = 0.184, \quad for\ G = 1/2}$.

Pure ALOHA

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?

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

Pure ALOHA

Solution:

Average frame transmission time T_{fr} = 200 bits/200 kbps

= 1 ms.

Therefore, the vulnerable time = 2 x T_{fr} = 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 1ms period that this station is sending.

Pure ALOHA

Solution:

Here, $T_{fr} = 200/(200*10^{-3}) = 1$ ms

(a) Throughput $S = G * e^{-2G}$

Here, G is the average number of frames generated in frame transmission time.

$G = 1000/1000 = 1$ frame

$S = 1*e^{-2*1} = e^{-2} = 0.135$ (13.5 percent)

This means that the throughput is 1000 X 0.135 =135 frames. Only 135 frames out of 1000 will probably survive.