COMPUTER NETWORK (BCA301)

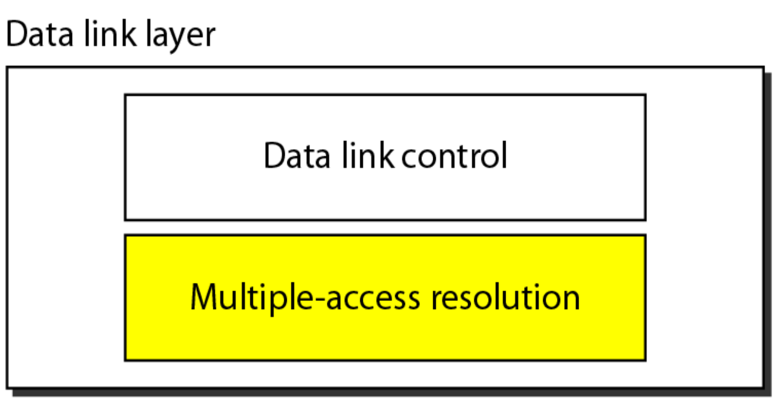
DEPARTMENT OF COMPUTER SCIENCE

PROGRAMME: BCA

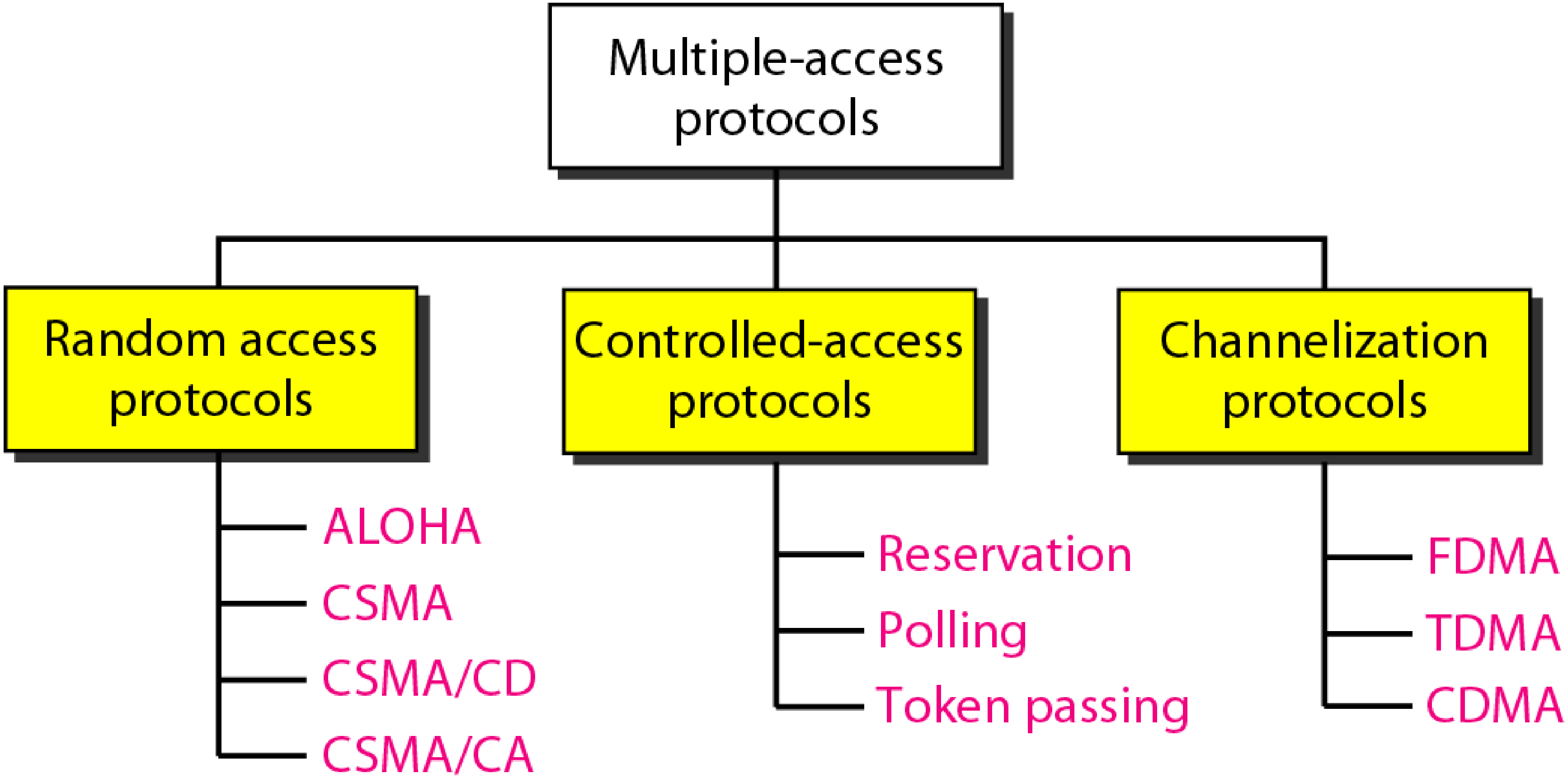
CENTRAL UNIVERSITY OF ORISSA
KORAPUT

Multiple Access

- We can consider the data link layer as two sub-layers.
- The upper sub-layer is responsible for data link control, and the lower sub-layer is responsible for resolving access to the shared media.
- If the channel is dedicated, we do not need the lower sub-layer.
- The upper sub-layer that is responsible for flow and error control is called the logical link control (LLC) layer.
- The lower sub-layer that is mostly responsible for multiple access resolution is called the media access control (MAC) layer.



Taxonomy of Multiple-Access Protocols



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.
- Each station can transmit when it desires on the condition that it follows the predefined procedure, including the testing of the state of the medium.
- **Why Random Access?**
- First, there is no scheduled time for a station to transmit. Transmission is random among the stations.
- Second, no rules specify which station should send next.
- In a random access method, each station has the right to the medium without being controlled by any other station.
- However, if more than one station tries to send, there is an access conflict-collision-and the frames will be either destroyed or modified.

ALOHA

- ALOHA, the earliest random access method, was developed at the University of Hawaii in early 1970.
- It was designed for a radio (wireless) LAN, but it can be used on any shared medium.
- The medium is shared between the stations.
- When a station sends data, another station may attempt to do so at the same time.
- The data from the two stations collide and become garbled.

PURE ALOHA

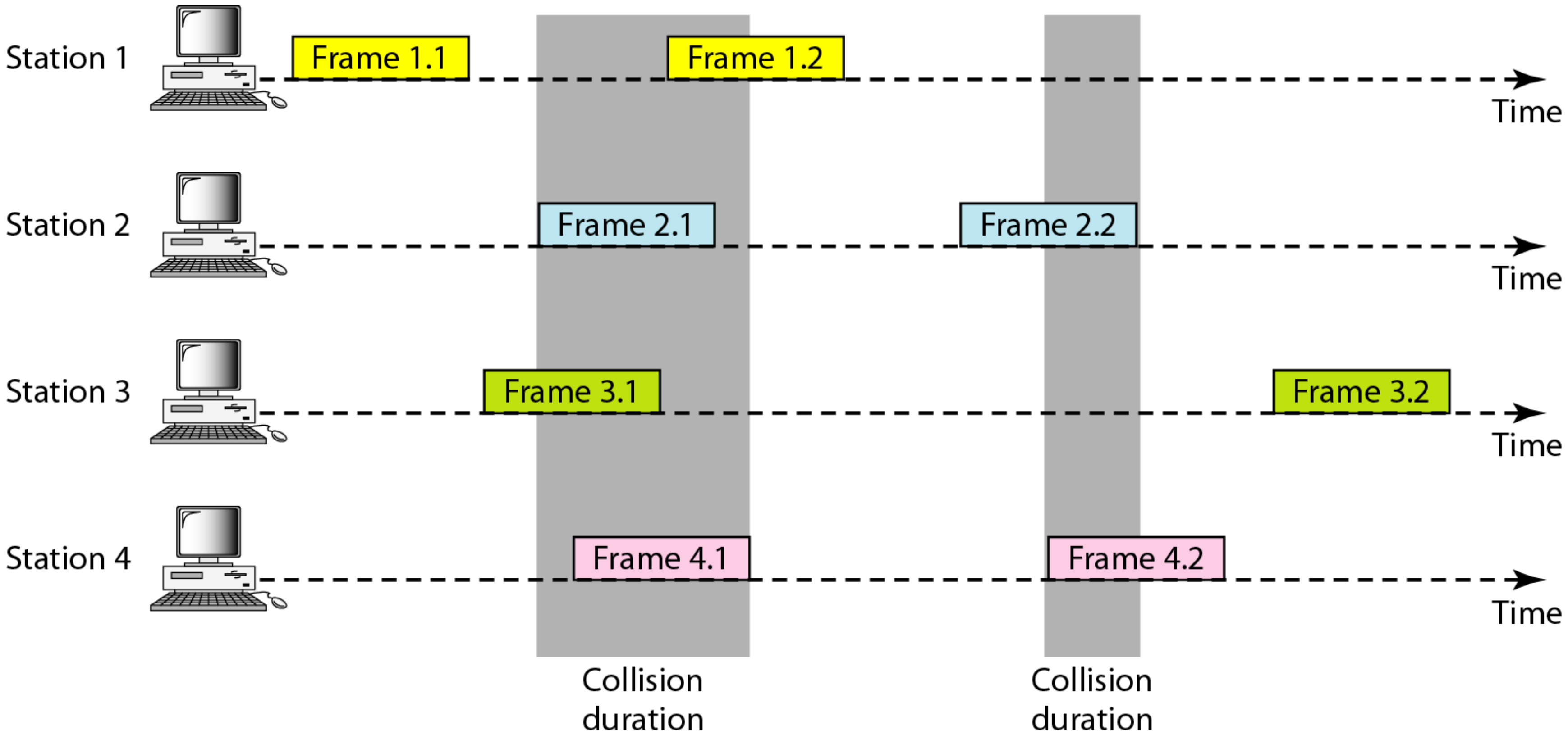
- The original ALOHA protocol is called pure ALOHA.
- This is a simple, but elegant protocol.
- The idea is that each station sends a frame whenever it has a frame to send.
- However, since there is only one channel to share, there is the possibility of collision between frames from different stations.
- 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.

Back-off Time TB

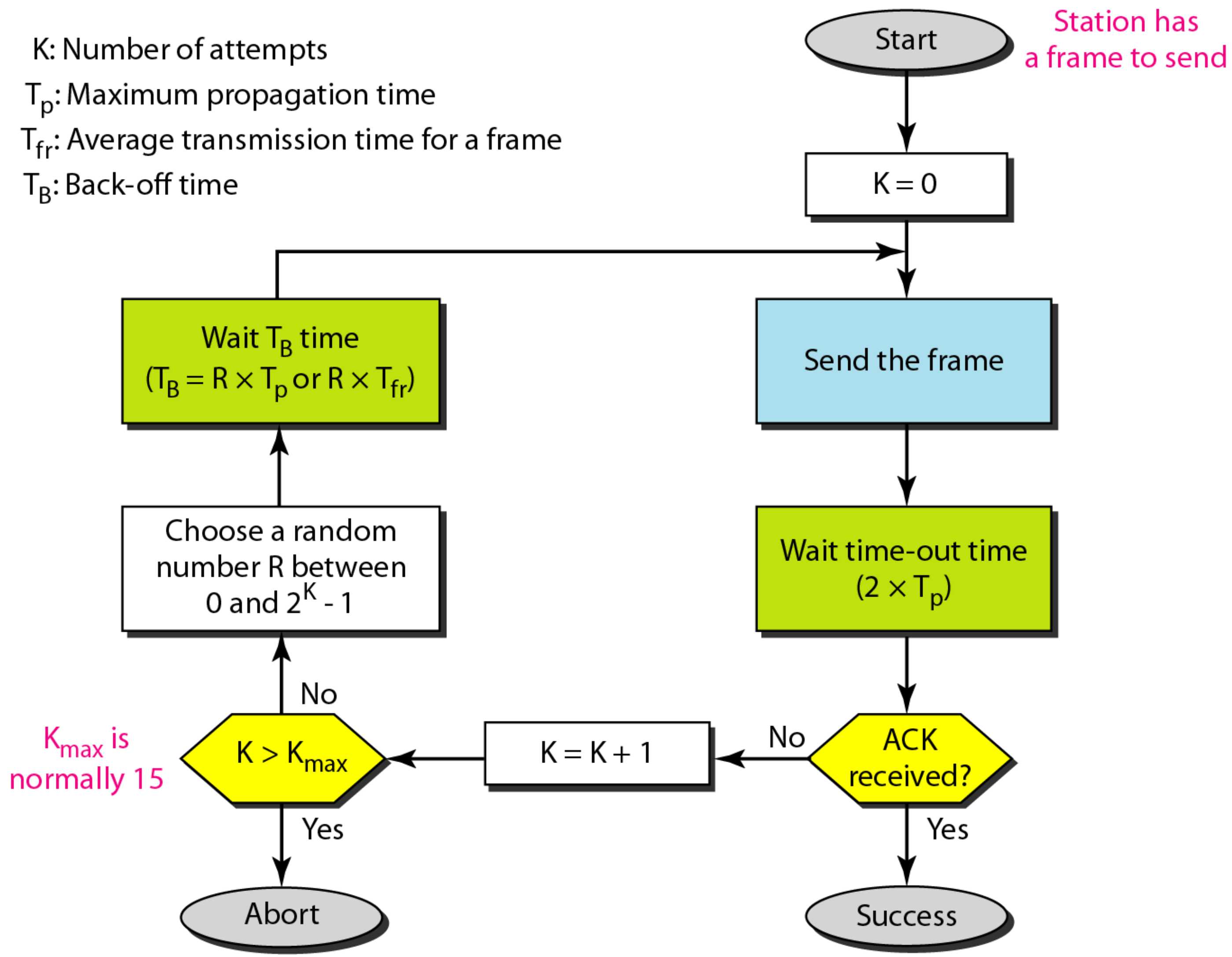
- **First Method:** A collision involves two or more stations.
- If all these stations try to resend their frames after the time-out, the frames will collide again.
- Pure ALOHA dictates that when the time-out period passes, each station waits a random amount of time before resending its frame.
- The randomness will help avoid more collisions.
- **Second Method :** After a maximum number of retransmission attempts K max' a station must give up and try later.

- The time-out period is equal to the maximum possible round-trip propagation delay, which is twice the amount of time required to send a frame between the two most widely separated stations (2 x Tp)‘.
- The back-off time TB is a random value that normally depends on K (the number of attempted unsuccessful transmissions).
- Pure ALOHA has a vulnerable time of 2 x Tfr .
- This is so because there is no rule that defines when the station can send.
- A station may send soon after another station has started or soon before another station has finished.

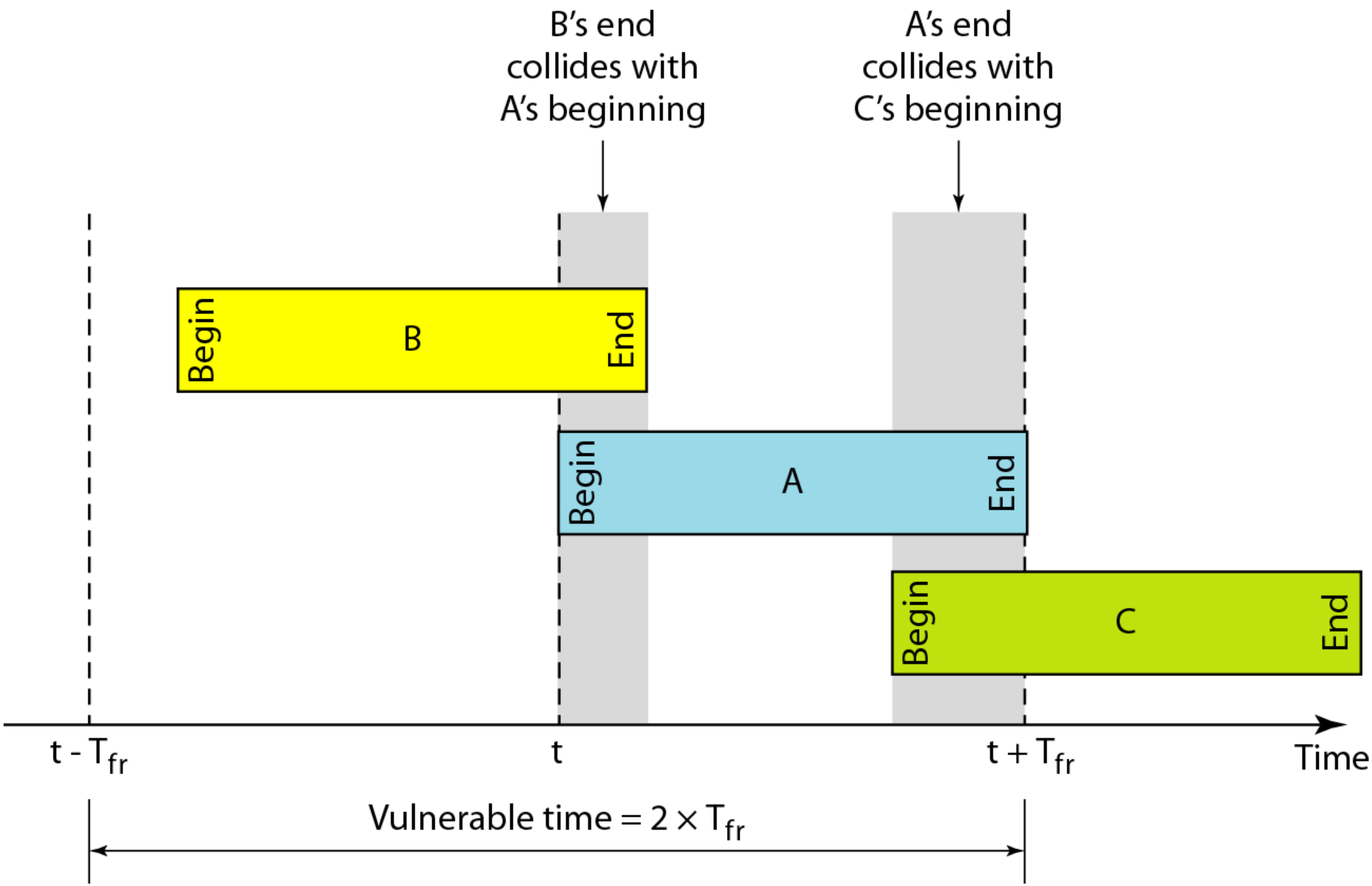
Frames in a pure ALOHA network



Procedure For Pure ALOHA Protocol



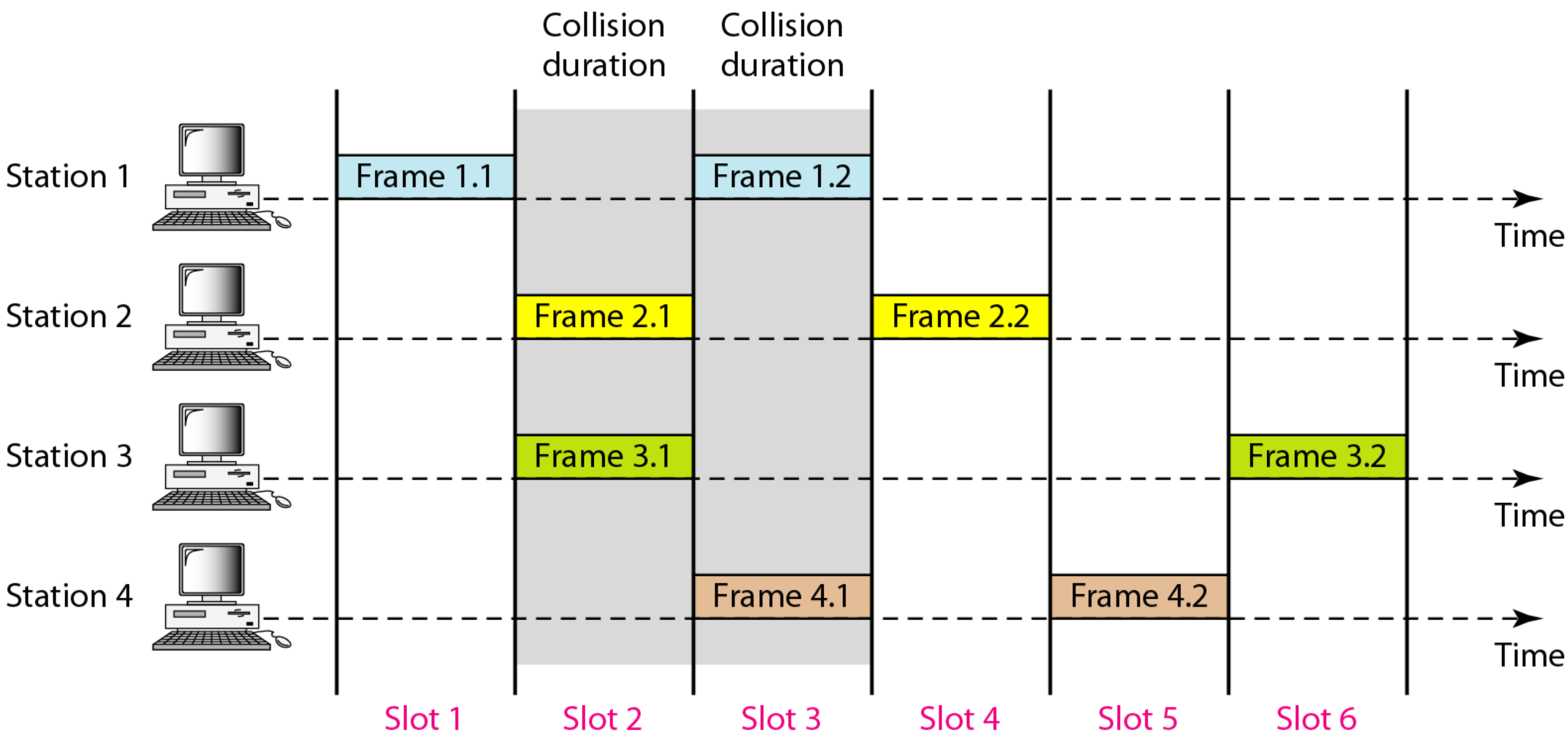
Vulnerable Time For Pure ALOHA Protocol



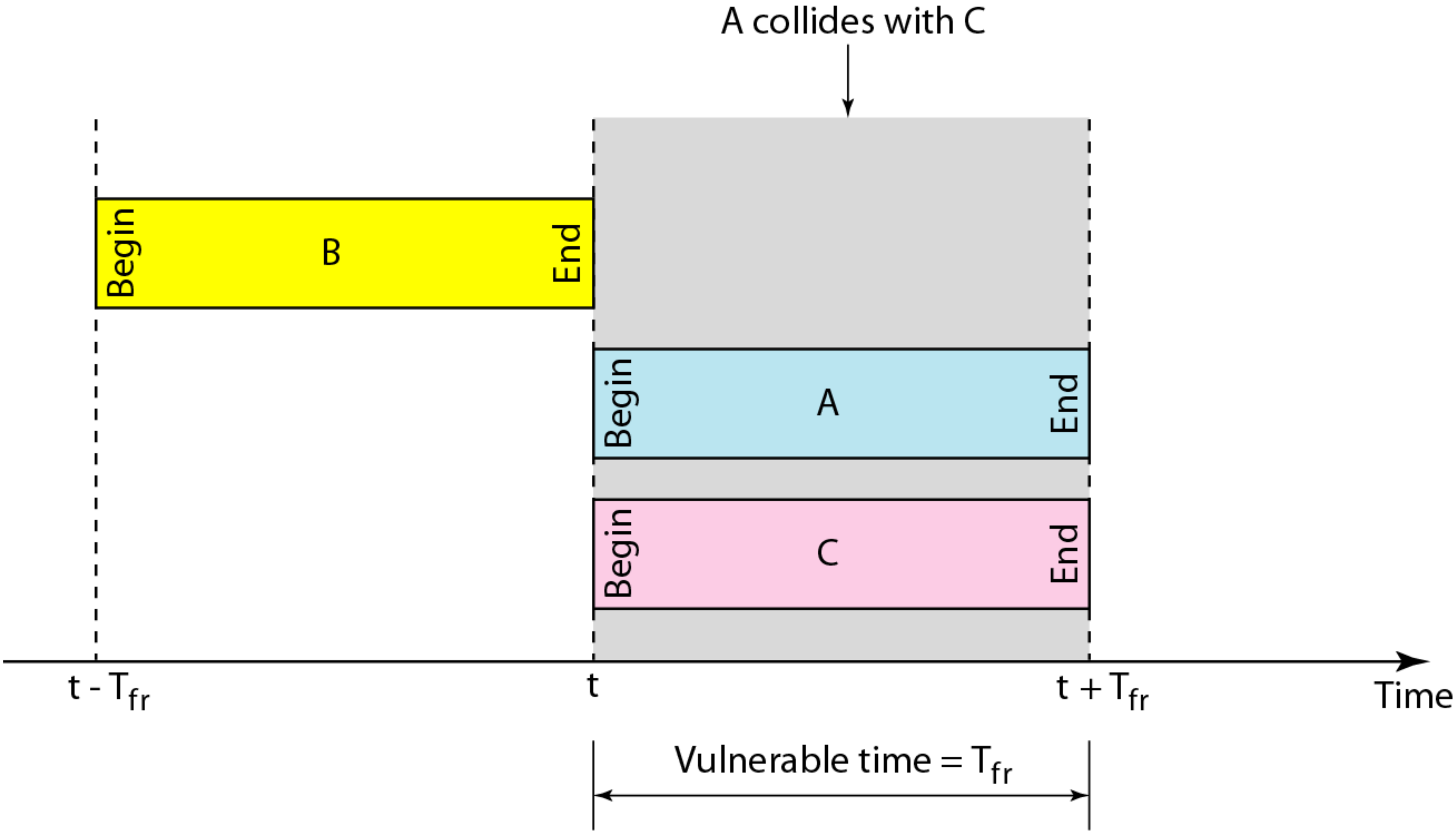
SLOTTED ALOHA

- In slotted ALOHA we divide the time into slots of Tfr s and force the station to send only at the beginning of the time slot.
- Because a station is allowed to send only at the beginning of the synchronized time slot, if a station misses this moment, it must wait until the beginning of the next time slot.
- Of course, there is still the possibility of collision if two stations try to send at the beginning of the same time slot.
- However, the vulnerable time is now reduced to one-half, equal to Tfr

Frames in A Slotted ALOHA Network



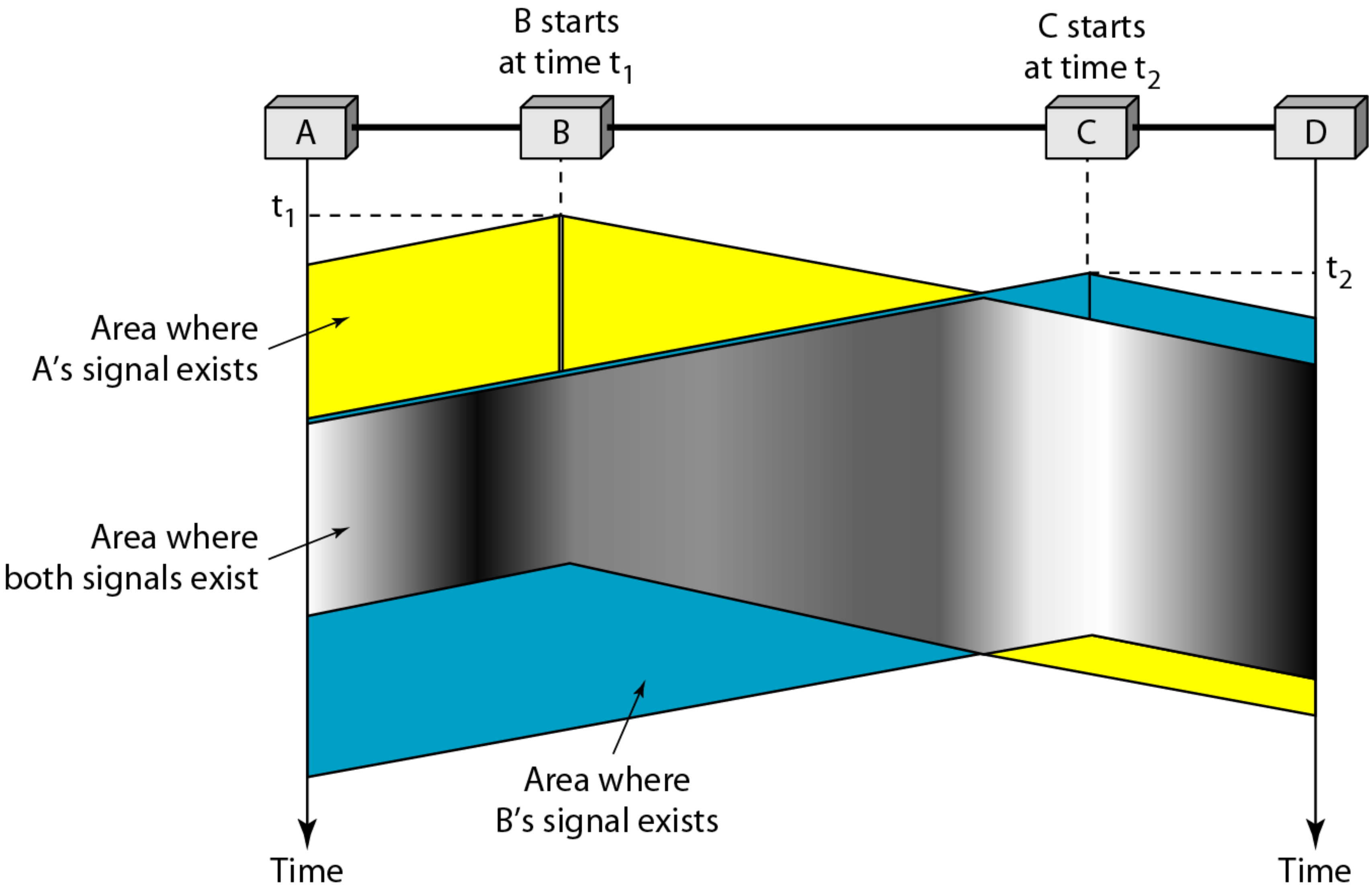
Vulnerable Time For Slotted ALOHA Protocol



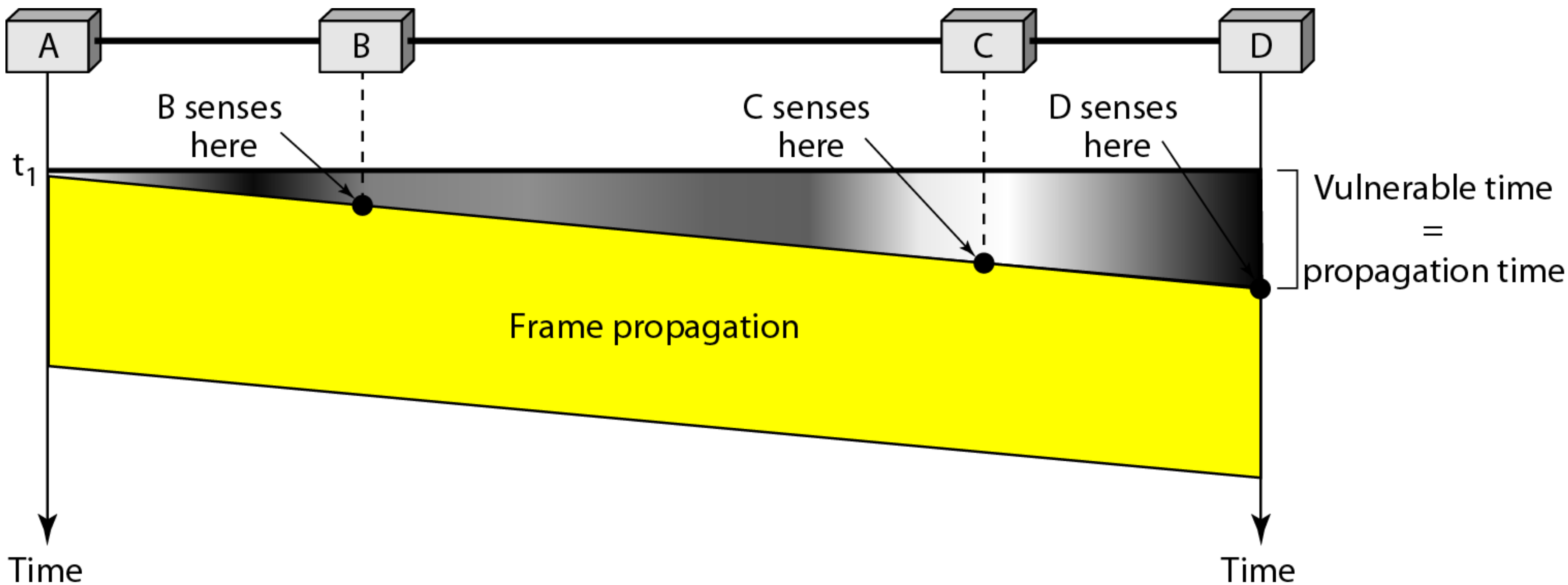
CARRIER SENSE MULTIPLE ACCESS (CSMA)

- To minimize the chance of collision and, therefore, increase the performance, the CSMA method was developed.
- It requires that each station first listen to the medium (or check the state of the medium) before sending.
- In other words, CSMA is based on the principle "sense before transmit" or "listen before talk."
- It can reduce the possibility of collision, but it cannot eliminate it.
- The possibility of collision still exists because of propagation delay i.e a station may sense the medium and find it idle, only because the first bit sent by another station has not yet been received.

SPACE/TIME MODEL OF THE COLLISION IN CSMA



VULNERABLE TIME IN CSMA



VULNERABLE TIME

- The vulnerable time for CSMA is the propagation time *Tp* .
- This is the time needed for a signal to propagate from one end of the medium to the other. When a station sends a frame, and any other station tries to send a frame during this time, a collision will result.
- But if the first bit of the frame reaches the end of the medium, every station will already have heard the bit and will refrain from sending.
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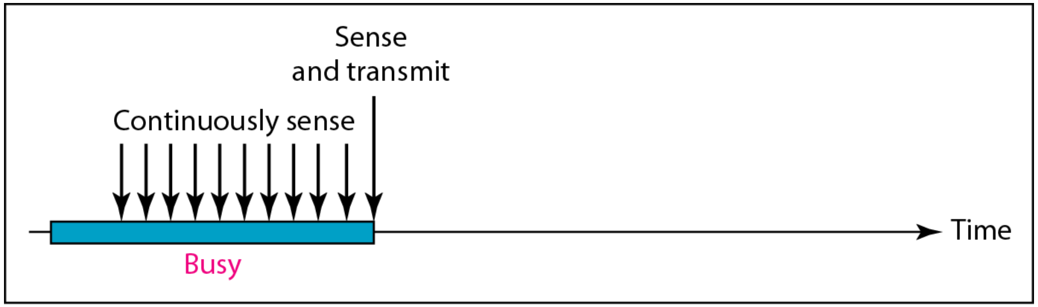
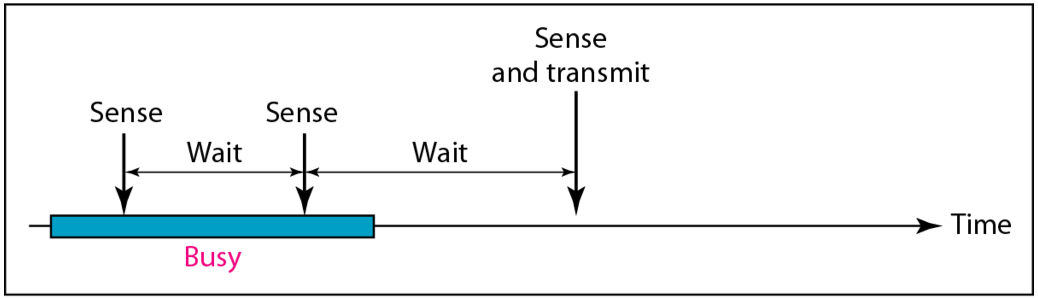
PERSISTENT METHOD

- What should a station do if the channel is busy?
- What should a station do if the channel is idle?
- Three methods have been devised to answer these questions:
- the I-persistent method,
- the non-persistent method, and
- the p-persistent method.

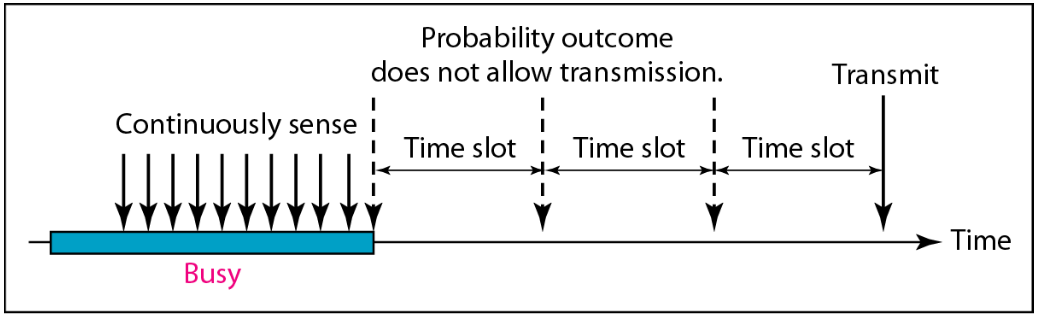
Behavior of three persistence methods



a. 1-persistent



b. Nonpersistent



c. p-persistent

I-PERSISTENT METHOD

- This is simple and straightforward.
- In this method, after the station finds the line idle, it sends its frame immediately (with probability I).
- This method has the highest chance of collision because two or more stations may find the line idle and send their frames immediately.
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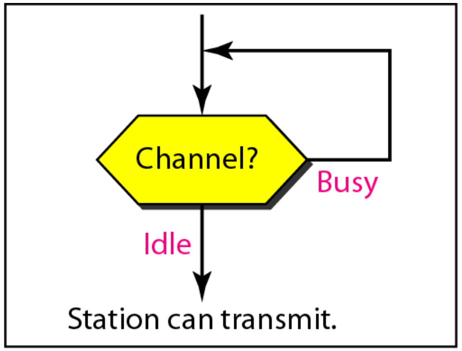
NON-PERSISTENT METHOD

- A station that has a frame to send senses the line. If the line is idle, it sends immediately.
- If the line is not idle, it waits a random amount of time and then senses the line again.
- Advantage: This approach reduces the chance of collision because it is unlikely that two or more stations will wait the same amount of time and retry to send simultaneously.
- Disadvantage: This method reduces the efficiency of the network because the medium remains idle when there may be stations with frames to send.

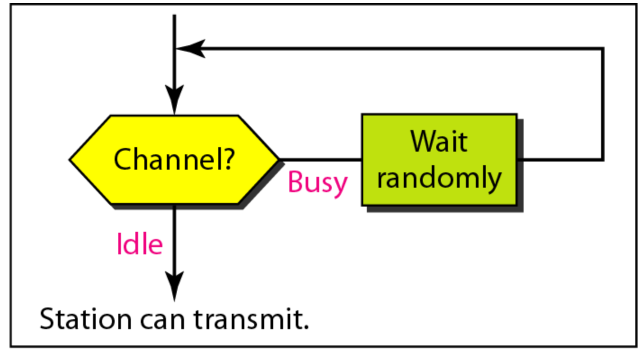
P-PERSISTENT METHOD

- The p-persistent method is used if the channel has time slots with a slot duration equal to or greater than the maximum propagation time.
- The p-persistent approach combines the advantages of the other two strategies. It reduces the chance of collision and improves efficiency.
- In this method, after the station finds the line idle it follows these
- **steps: 1** With probability p, the station sends its frame.
- **2.** With probability q = 1 - p, the station waits for the beginning of the next time slot and checks the line again.
- **a.** If the line is idle, it goes to step 1.
- **b.** If the line is busy, it acts as though a collision has occurred and uses the back-off procedure.
- The CSMA method does not specify the procedure following a collision.

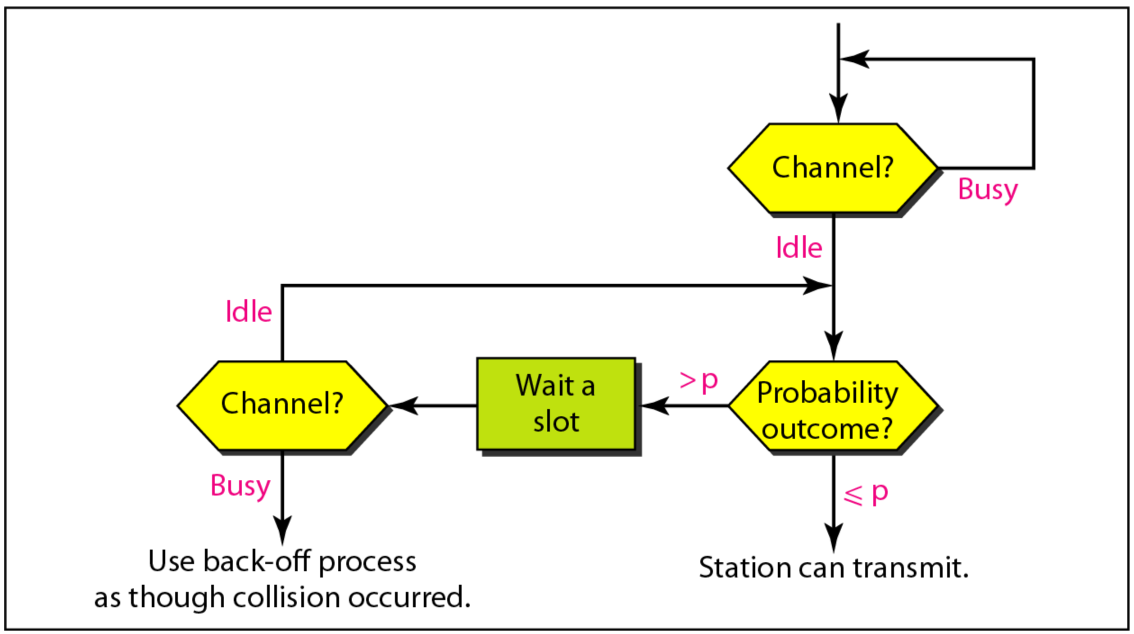
FLOW DIAGRAM FOR THREE PERSISTENCE METHODS



a. 1-persistent



b. Nonpersistent



c. p-persistent

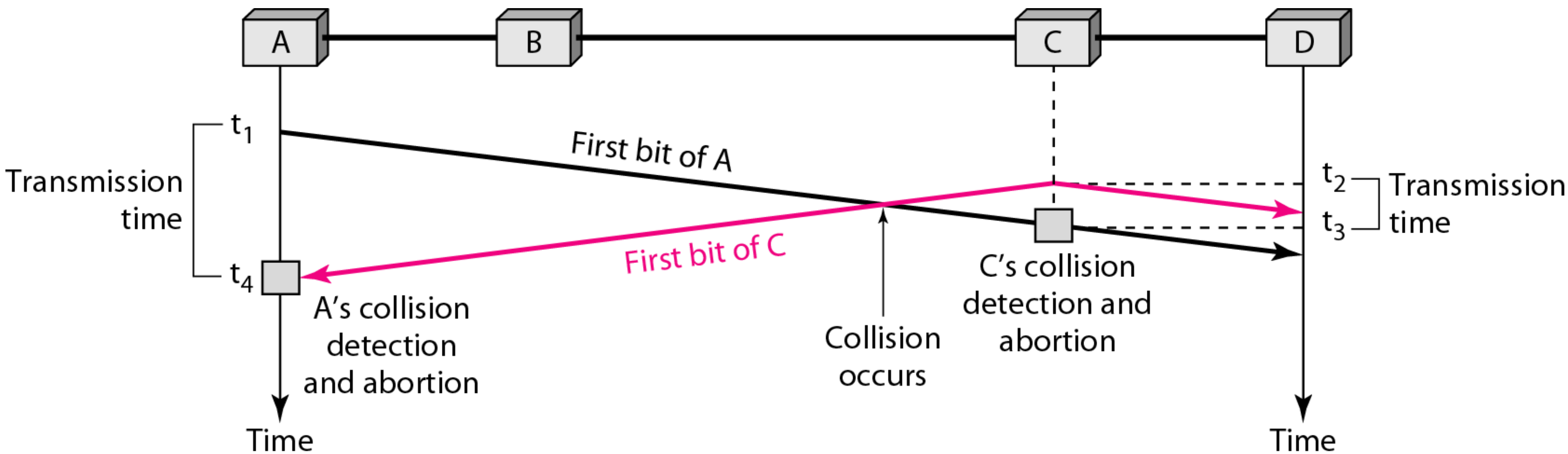
Carrier Sense Multiple Access with Collision Detection (CSMA/CD)

- **Limitations of CSMA:** The CSMA method does not specify the procedure following a collision.
- The CSMA/CD augments the algorithm to handle the collision.
- In this method, a station monitors the medium after it sends a frame to see if the transmission was successful.
- If so, the station is finished. If, however, there is a collision, the frame is sent again.

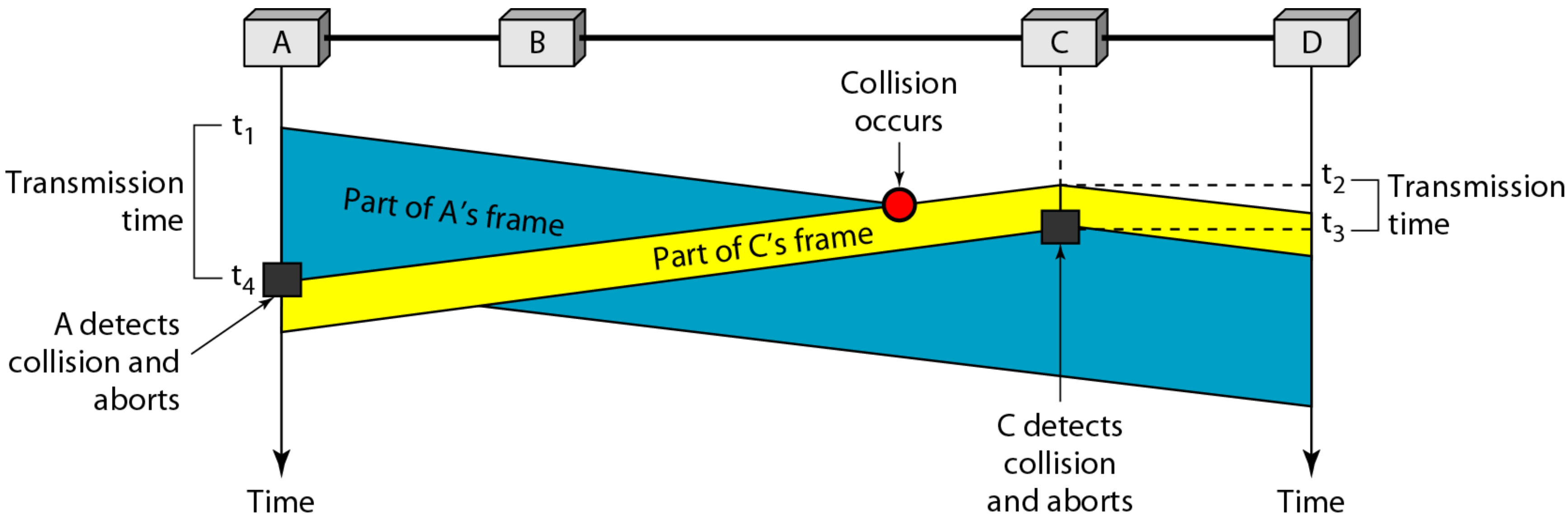
Difference between ALOHA and CSMA/CD:

- The first difference is the addition of the persistence process.
- The second difference is the frame transmission. In ALOHA, we first transmit the entire frame and then wait for an acknowledgment. In *CSMA/CD*, transmission and collision detection is a continuous process. We do not send the entire frame and then look for a collision. The station transmits and receives continuously and simultaneously (using two different ports).
- The third difference is the sending of a short jamming signal that enforces the collision in case other stations have not yet sensed the collision.
- Advantage: The throughput of CSMA/CD is greater than that of pure or slotted ALOHA.

COLLISION OF THE FIRST BIT IN CSMA/CD



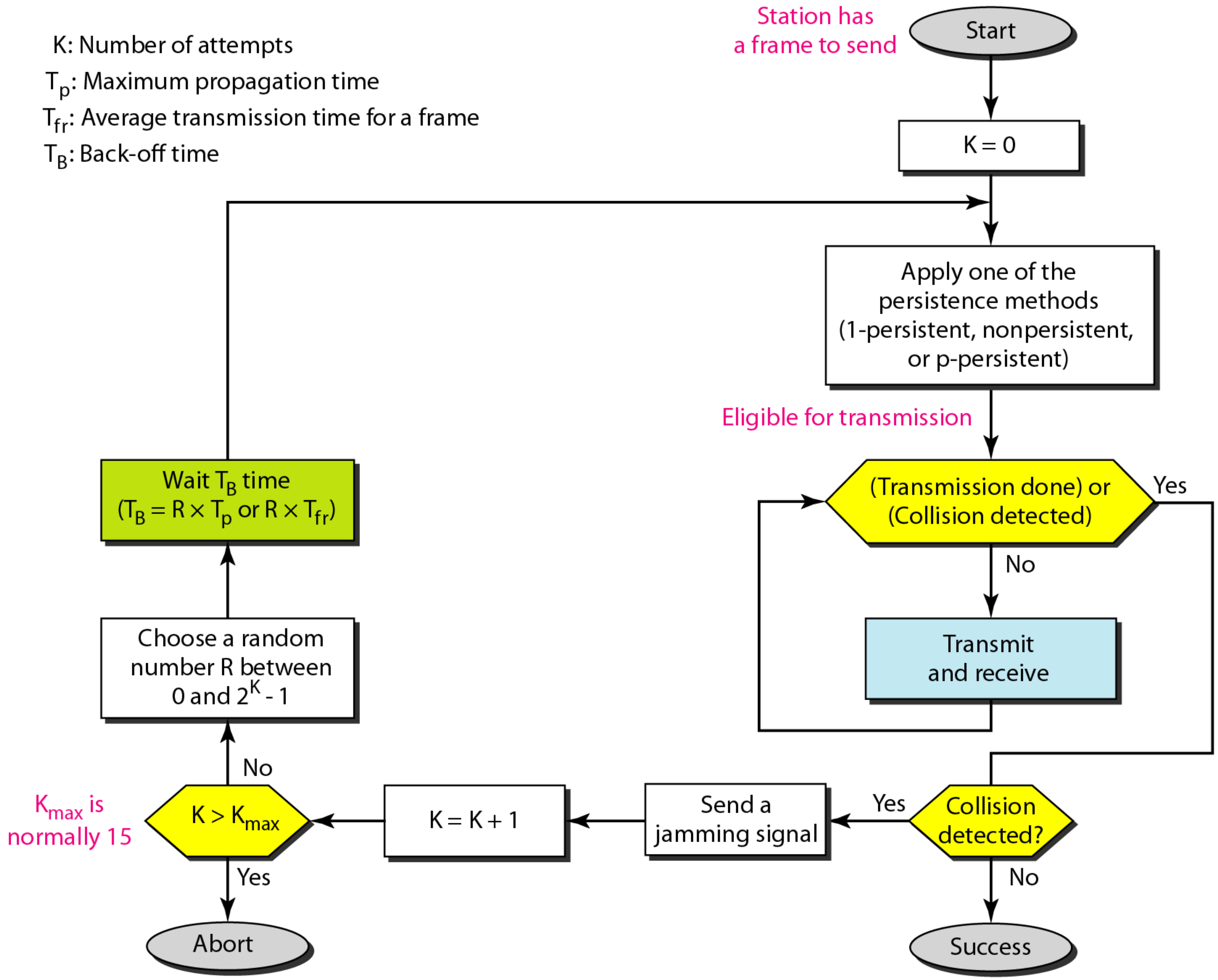
COLLISION AND ABORTION IN CSMA/CD



Minimum Frame Size

- For CSMA/CD to work, we need a restriction on the frame size.
- For the protocol to work, the length of any frame divided by the bit rate in this protocol must be more than either of these durations.
- Before sending the last bit of the frame, the sending station must detect a collision, if any, and abort the transmission.
- This is so because the station, once the entire frame is sent, does not keep a copy of the frame and does not monitor the line for collision detection.
- Therefore, the frame transmission time T_{fr} must be at least two times the maximum propagation time T_p.
- To understand the reason, let us think about the worst-case scenario.
- If the two stations involved in a collision are the maximum distance apart, the signal from the first takes time T_p to reach the second, and the effect of the collision takes another time T_p to reach the first.
- So the requirement is that the first station must still be transmitting after $2T_p$.

FLOW DIAGRAM FOR THE CSMA/CD



Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)

- It was invented for Wireless network.
- The basic idea behind *CSMA/CD* is that a station needs to be able to receive while transmitting to detect a collision.
- When there is no collision, the station receives one signal: its own signal.
- When there is a collision, the station receives two signals: its own signal and the signal transmitted by a second station.
- The signal from the second station needs to add a significant amount of energy to the one created by the first station.
- Collisions are avoided through the use of CSMA/CA's three strategies: the inter-frame space, the contention window, and acknowledgments.

INTERFRAME SPACE (IFS)

- First, collisions are avoided by deferring transmission even if the channel is found idle.
- When an idle channel is found, the station does not send immediately.
- It waits for a period of time called the inter-frame space or IFS.
- Even though the channel may appear idle when it is sensed, a distant station may have already started transmitting.
- The distant station's signal has not yet reached this station. The IFS time allows the front of the transmitted signal by the distant station to reach this station.
- If after the IFS time the channel is still idle, the station can send, but it still needs to wait a time equal to the contention time.
- The IFS can also be used to define the priority of a station or a frame.

CONTENTION WINDOW

- The contention window is an amount of time divided into slots.
- A station that is ready to send chooses a random number of slots as its wait time.
- The number of slots in the window changes according to the binary exponential back-off strategy.
- This means that it is set to one slot the first time and then doubles each time the station cannot detect an idle channel after the IFS time.
- This is very similar to the p-persistent method except that a random outcome defines the number of slots taken by the waiting station.
- The station needs to sense the channel after each time slot.
- 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.
- It gives priority to the station with the longest waiting time.

Timing in CSMA/CA

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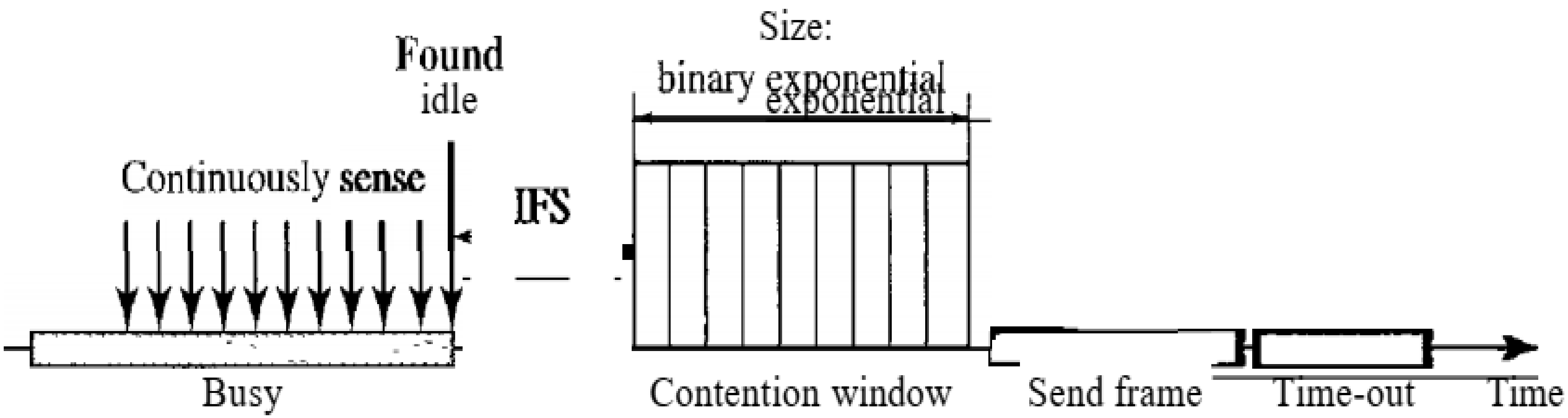
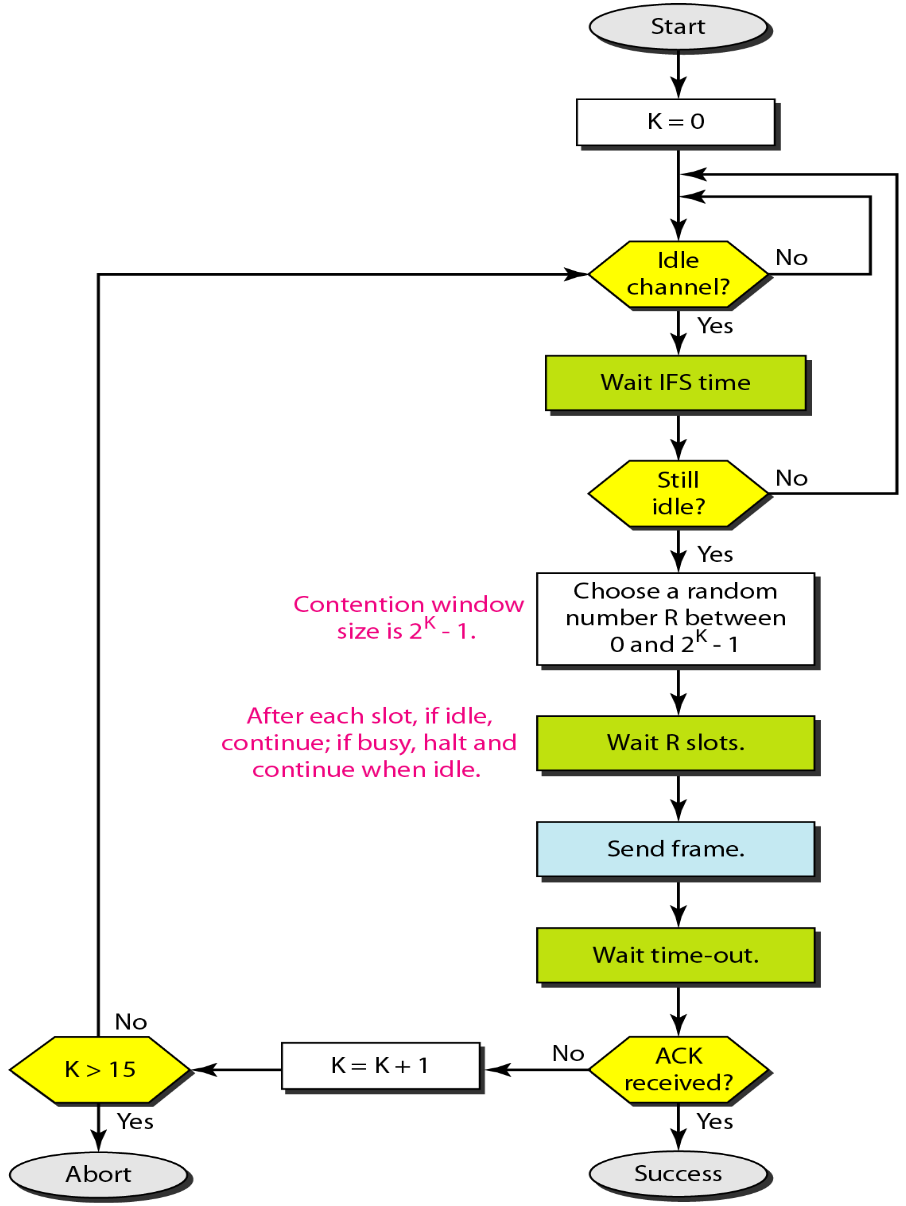


ACKNOWLEDGMENT

- There still may be a collision resulting in destroyed data and the data may be corrupted during the transmission.
- The positive acknowledgment and the time-out timer can help guarantee that the receiver has received the frame.

FLOW DIAGRAM FOR CSMA/CA



REFRENCES

- “ DATA COMMUNICATIONS AND NETWORKING ”, Behrouz A. Forouzan And Sophia Chung Fegan , Fourth Edition , McGraw-Hill