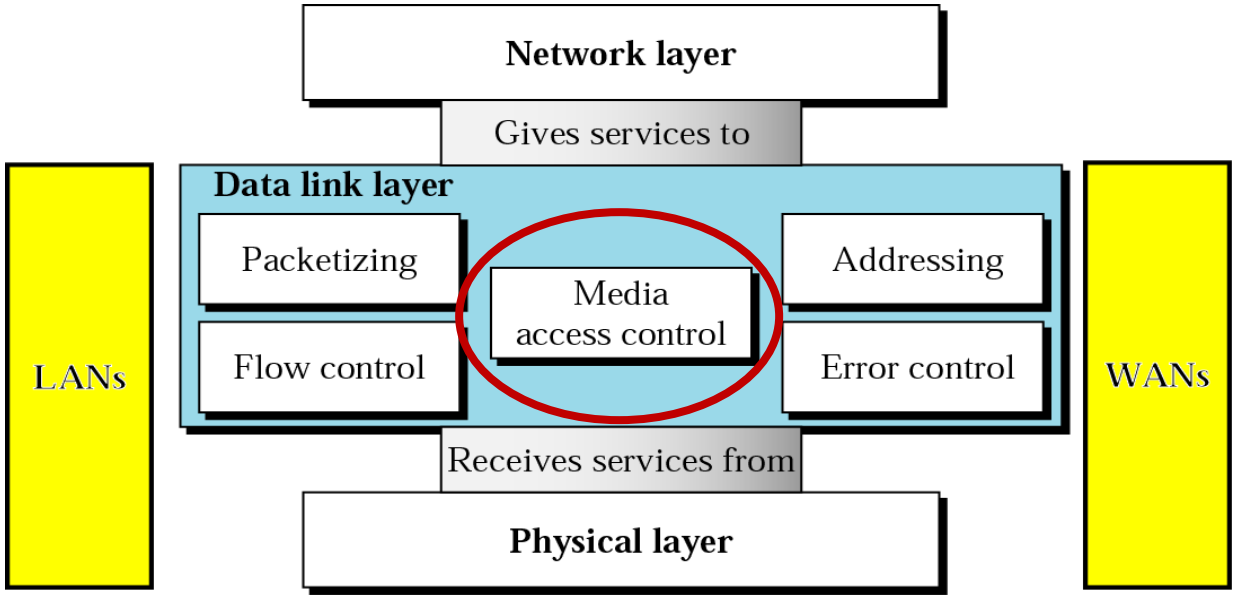
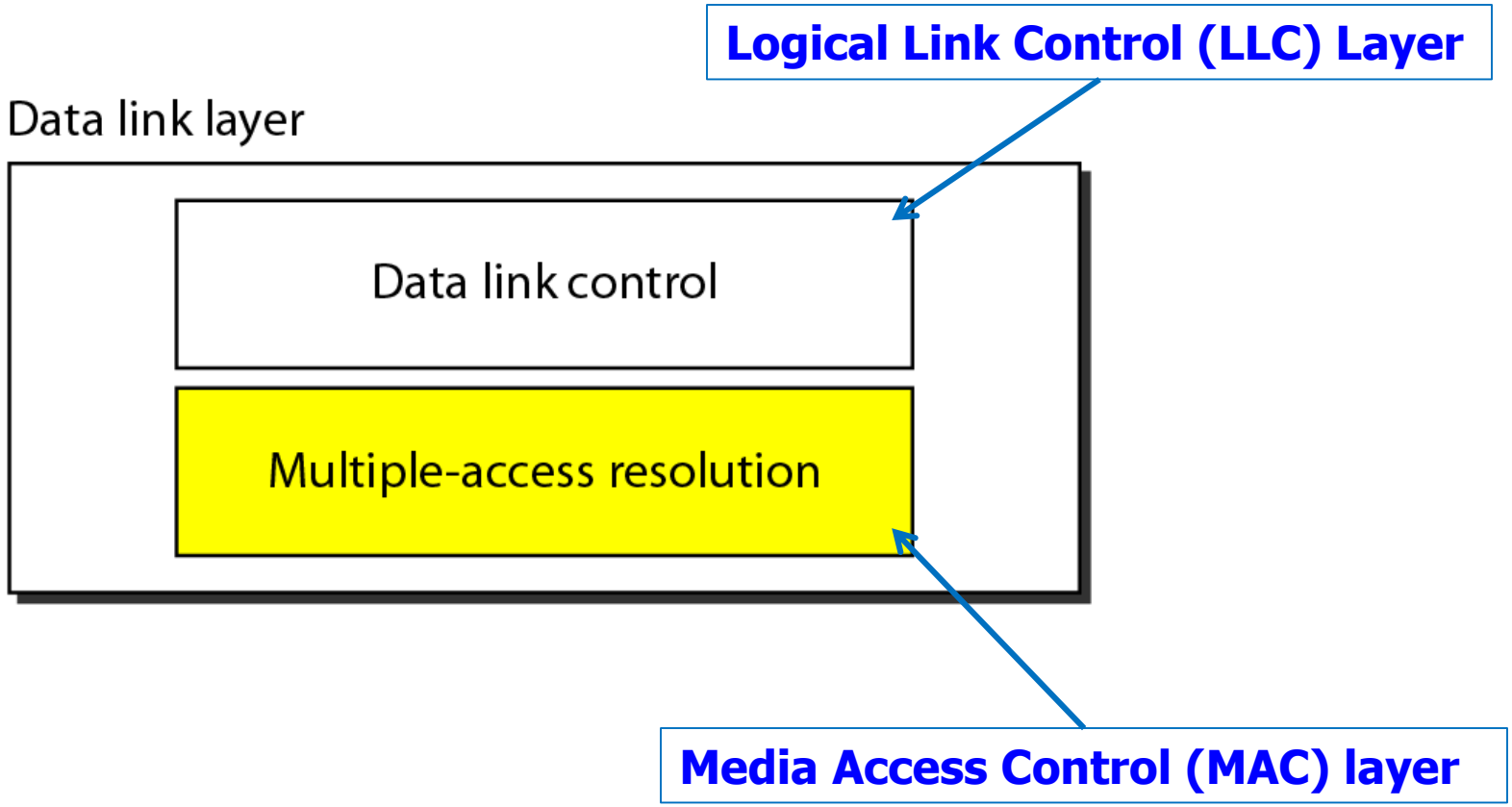
Ch-12: Multiple Access



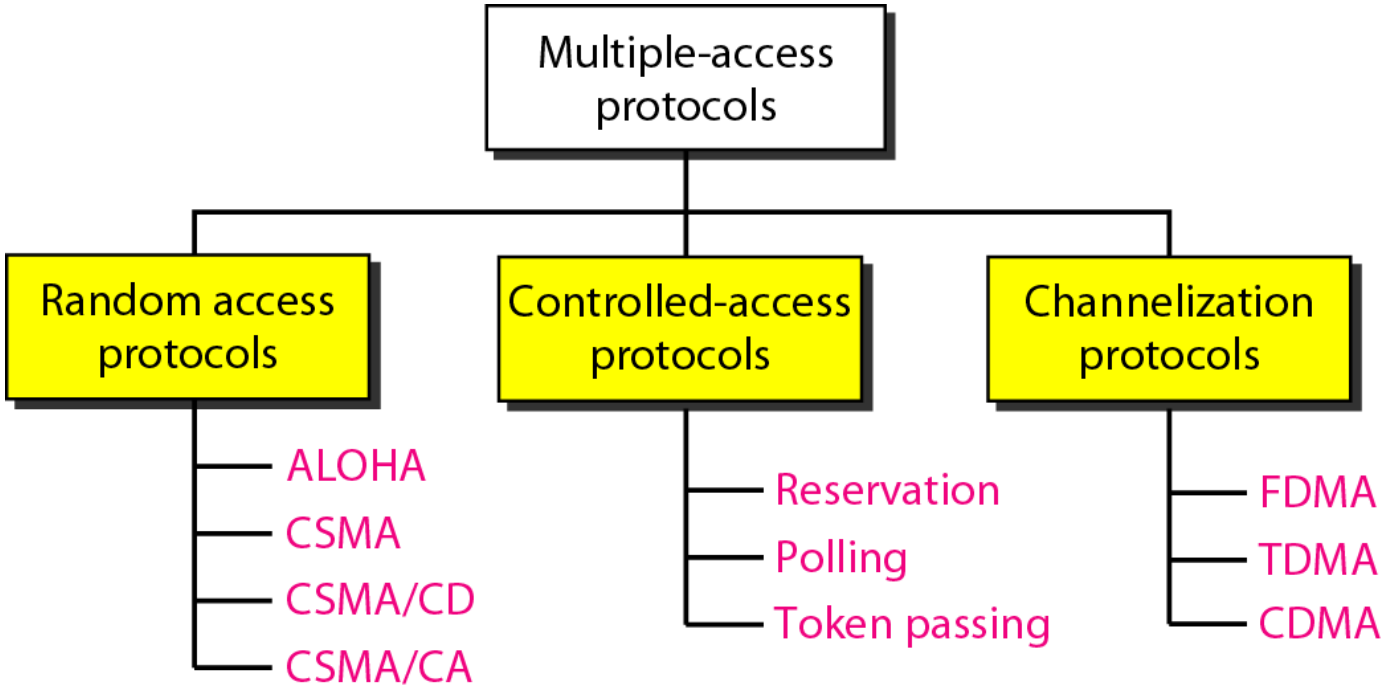
Outlines

- Multiple access mechanisms
  - Random access
  - Controlled access
  - Channelization

Sublayers of Data Link Layer



Multiple Access Mechanisms



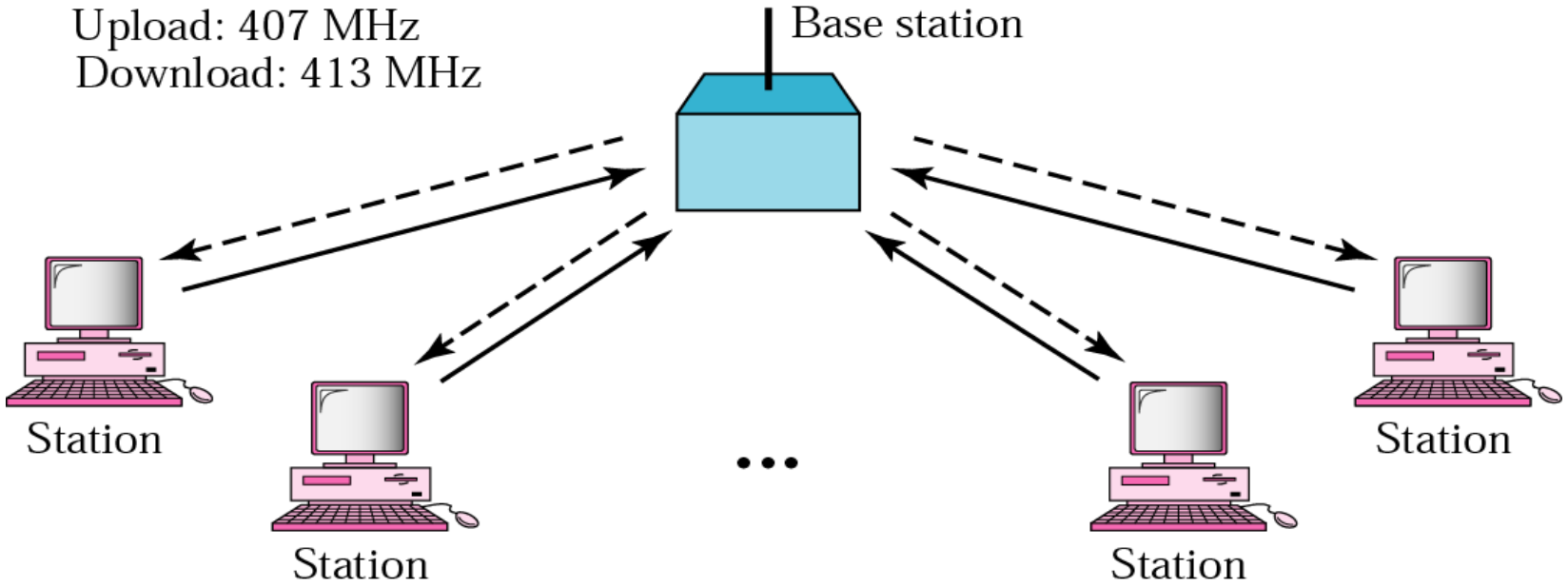
Random Access

Random Access

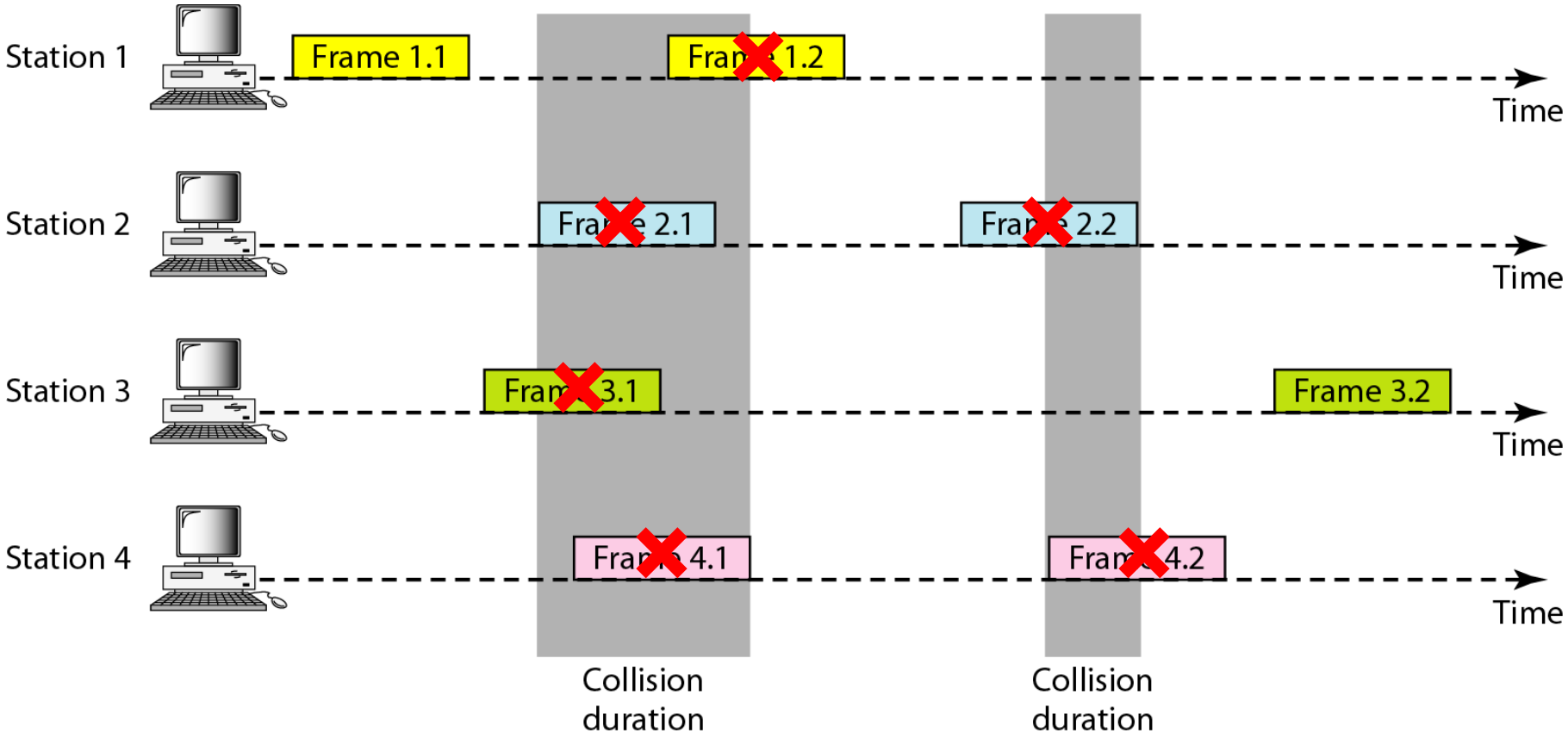
- Also called contention-based access
- No station is assigned to control another

ALOHA Network

- It was designed for a radio (wireless) LAN, but it can be used on any shared medium.
- There are potential collisions in this arrangement. The medium is shared between the stations.



Frames in Pure ALOHA



- Is there is a collision (even if one bit), the both frames will be destroyed
- Only two frames survive: frame 1.1 from station 1 and frame 3.2 from station 3

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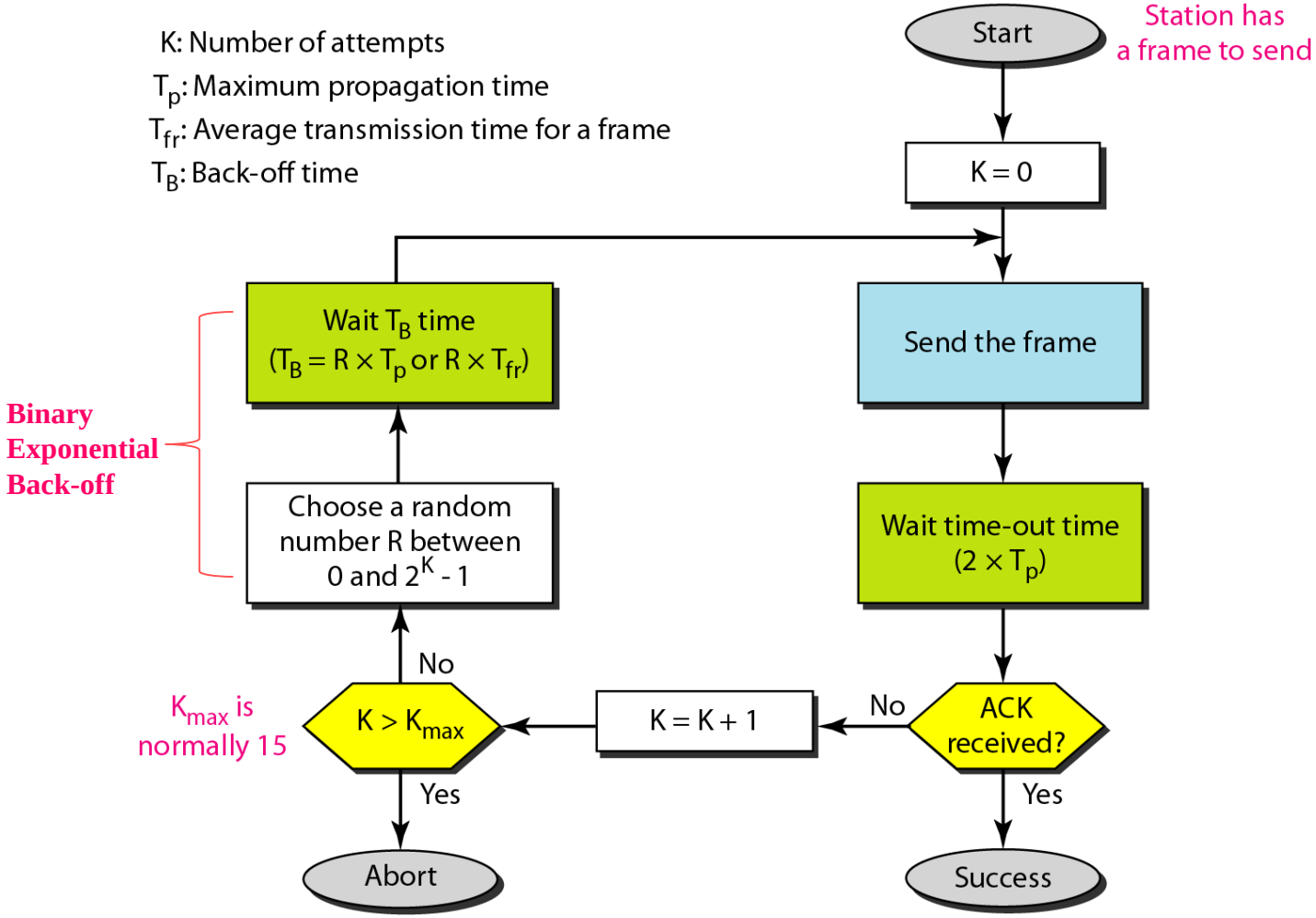
ALOHA Protocol



T_B : random amount of time before resending

Example

- Calculate possible values of T_B when stations on an ALOHA network are a maximum of 600 km apart (assume that signals propagate at 3×10^8 m/s).
- Ans:

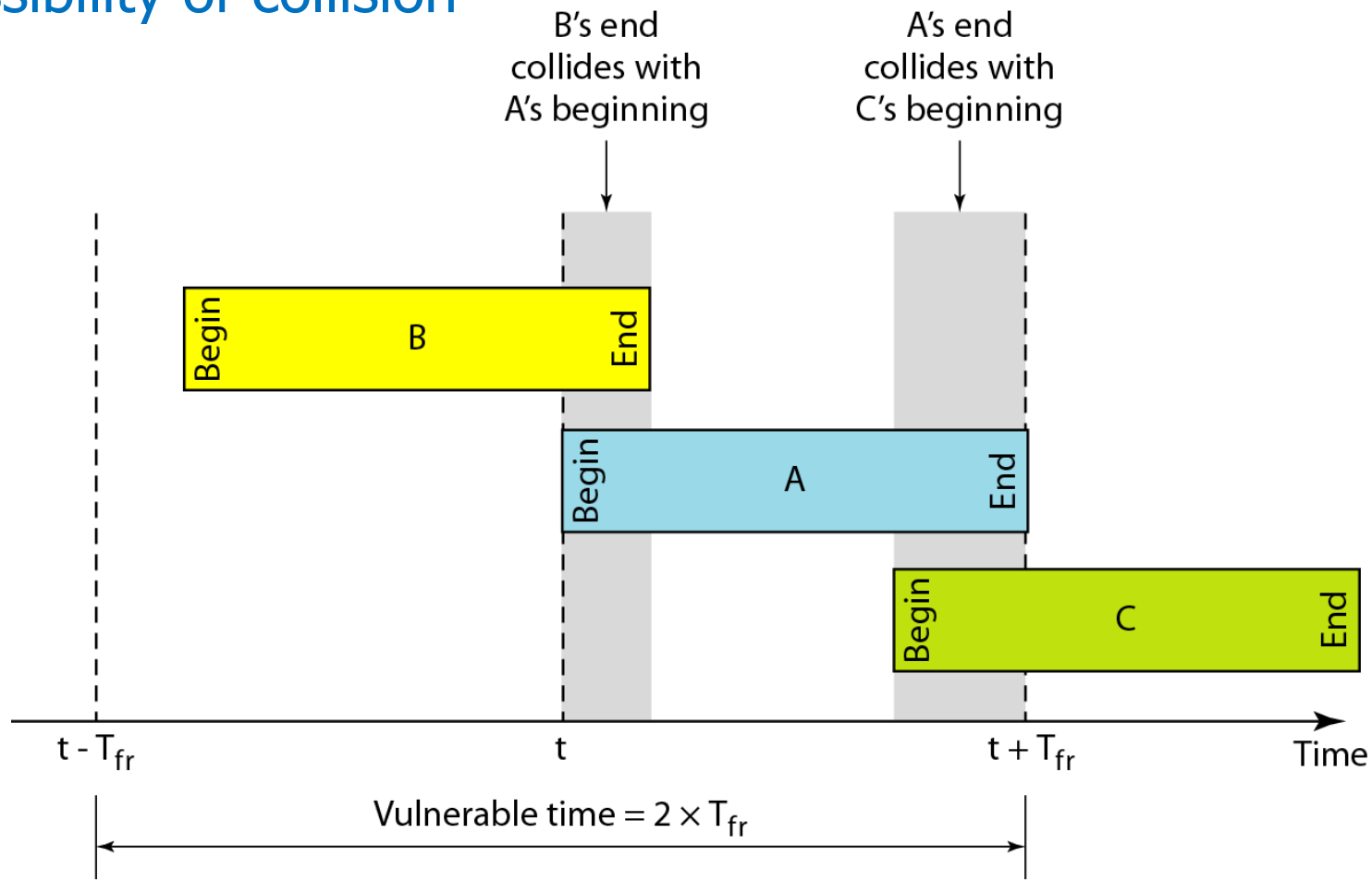
$$T_p = (600 \times 10^3) / (3 \times 10^8) = 2 \text{ ms}$$

While R is a multiplier in the range 0 to $2^K - 1$

- When K=1, T_B =R × $T_p \in$ {0ms,2ms}
- When K=2, $T_B \in$ {0ms,2ms,4ms,6ms}
- :

ALOHA: Vulnerable Time

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



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ALOHA: Throughput

- The throughput for pure ALOHA is

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

  - Where S is the average number of successful transmissions
  - G is the average number of frames generated during frame transmission time

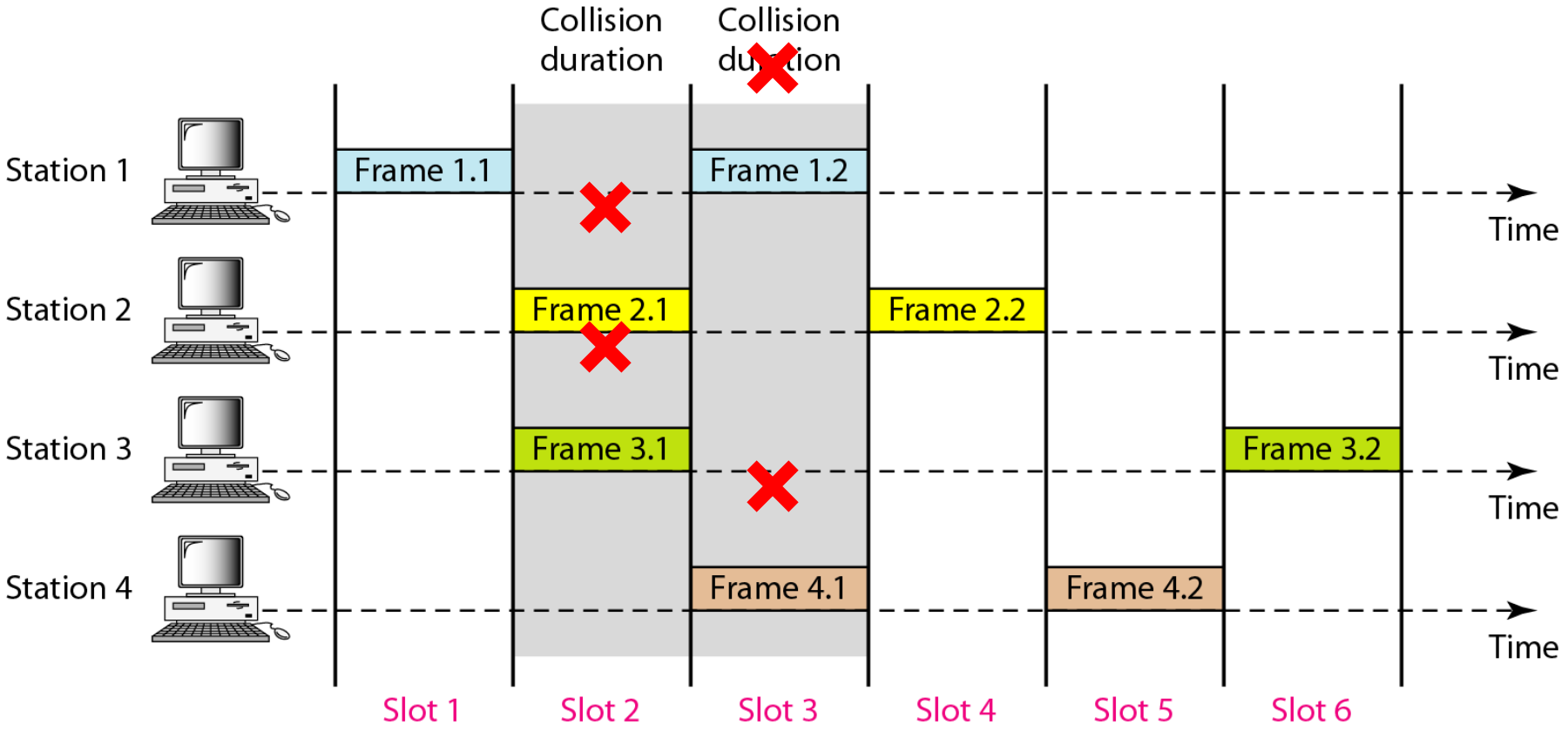
- The maximum throughput
  - S_{max} = 0.184 when G= ½
  - In other words, if one-half a frame is generated during one frame transmission time, then 18.4% of these frames reach their destination successfully.

Example

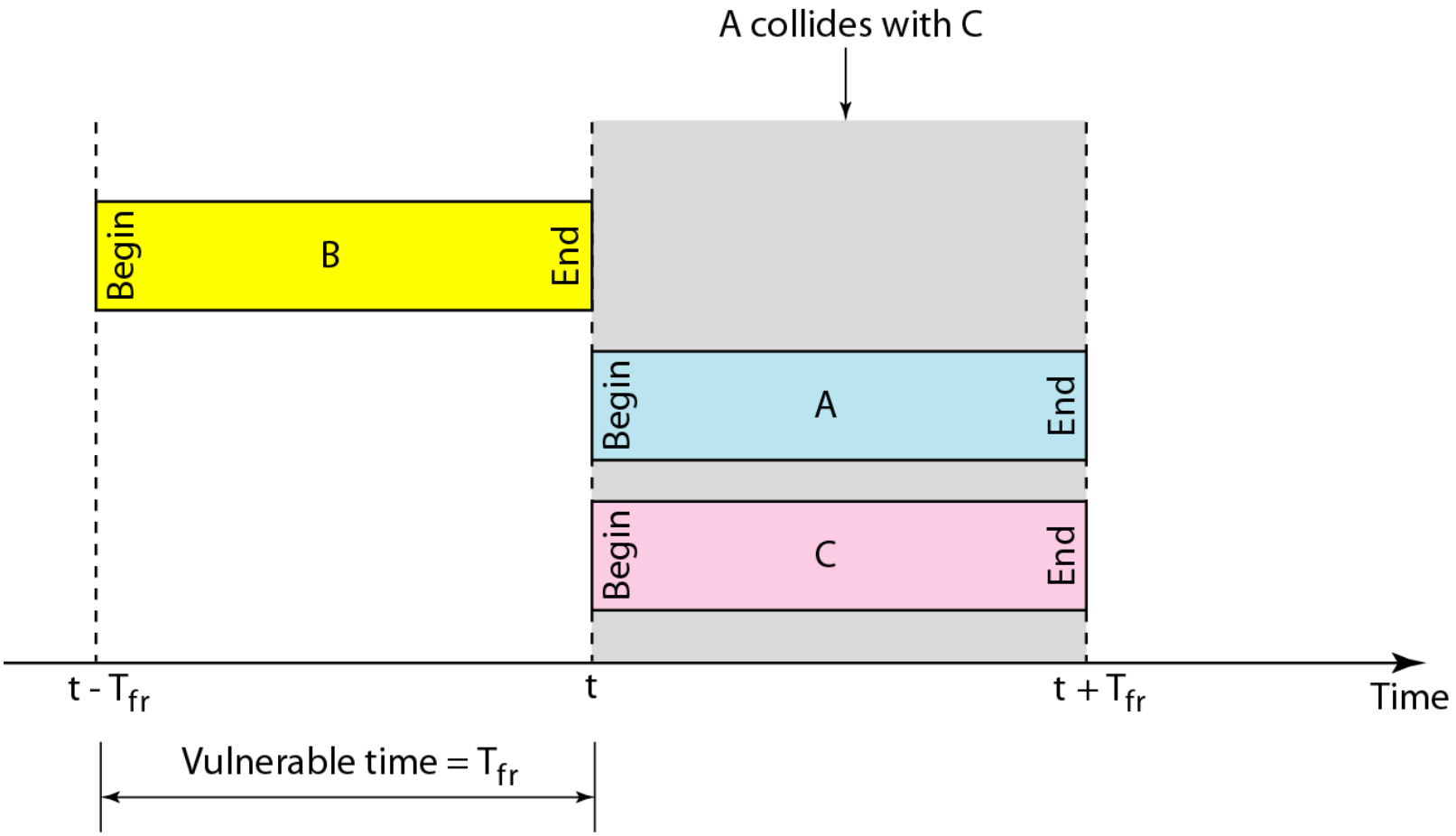
- A pure ALOHA network transmits 200-bit frames on a shared channel of 200 kbps. What is the throughput if the system (all stations together) produces
  - 1000 frames per second
  - 500 frames per second
  - 250 frames per second

Slotted ALOHA

Divides time into slots of T_{fr} s and force the station to send only at the beginning of the time slot.



Slotted ALOHA: Vulnerable Time



Slotted ALOHA: Throughput

- The throughput for Slotted ALOHA is

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

Where G is the average number of frames generated during frame transmission time

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

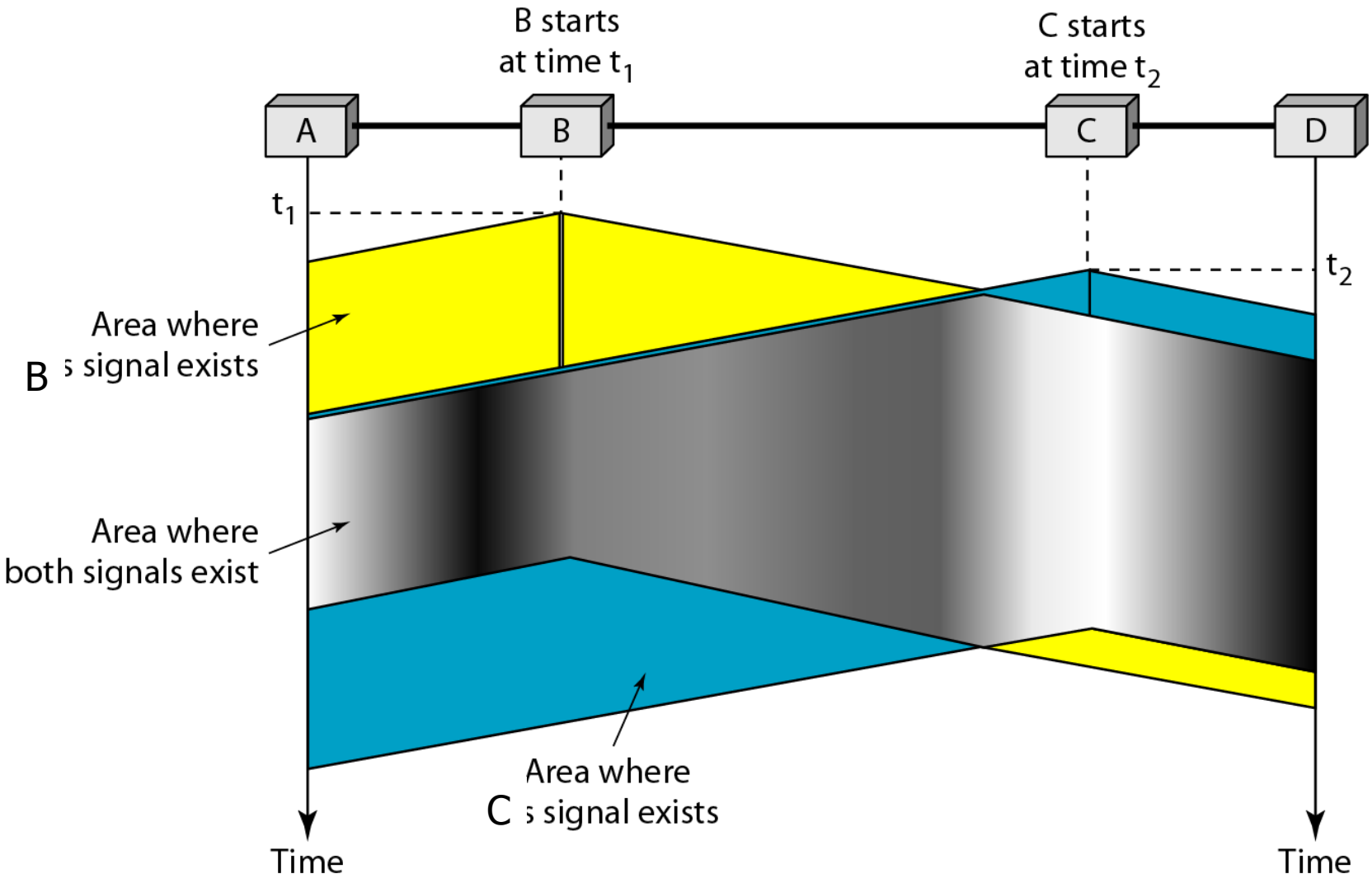
Example

- 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
  - 1000 frames per second
  - 500 frames per second
  - 250 frames per second

CSMA

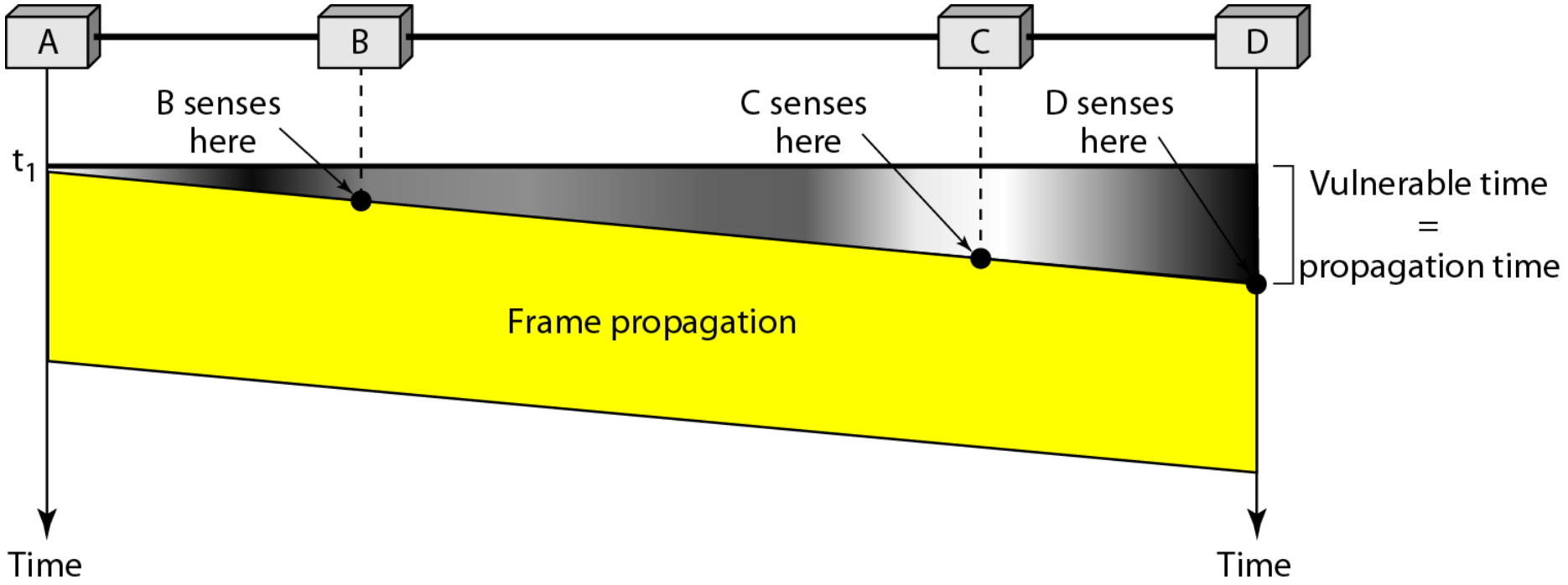
- **C**arrier **S**ense **M**ultiple **A**ccess
  - "Listen before talk"
  - "sense before transmit"
- Reduce the possibility of collision, therefore, increase the performance
  - But cannot completely eliminate it
  - The possibility of collision still exists because of propagation delay

Collision in CSMA



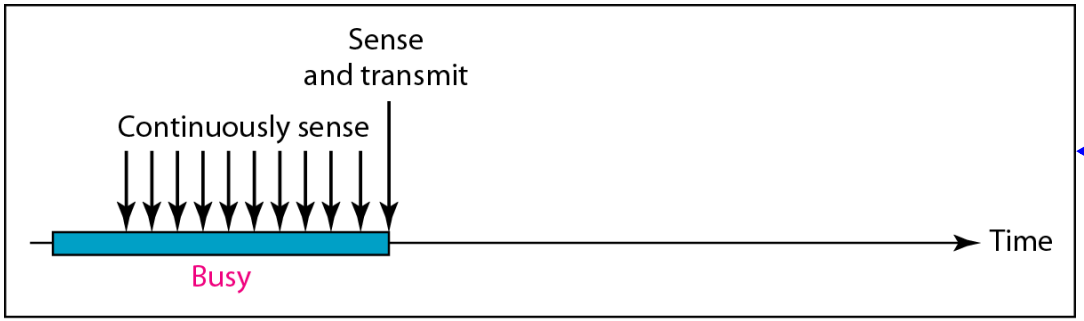
CSMA: Vulnerable Time

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



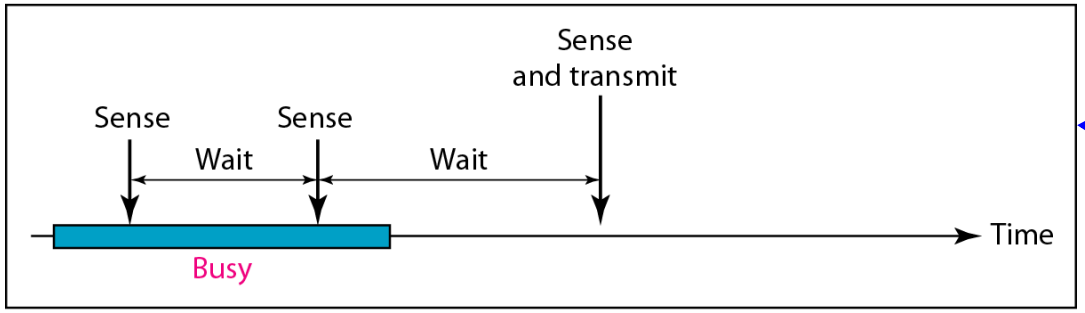
Persistence Methods

- What a station does when channel is idle or busy?



a. 1-persistent

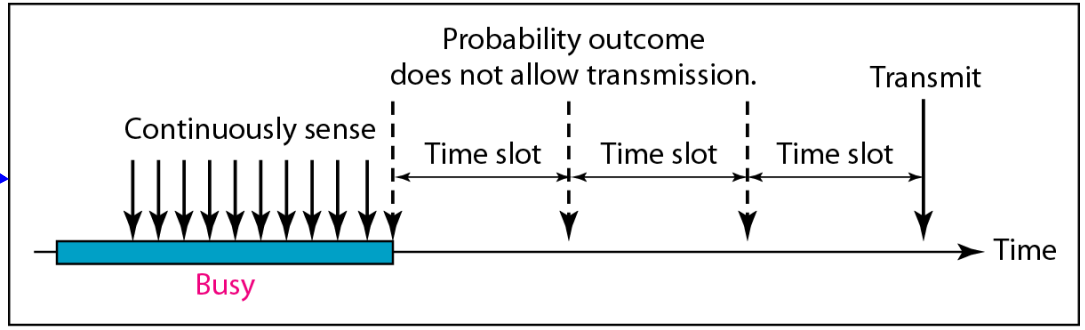
Highest chance of collision



b. Nonpersistent

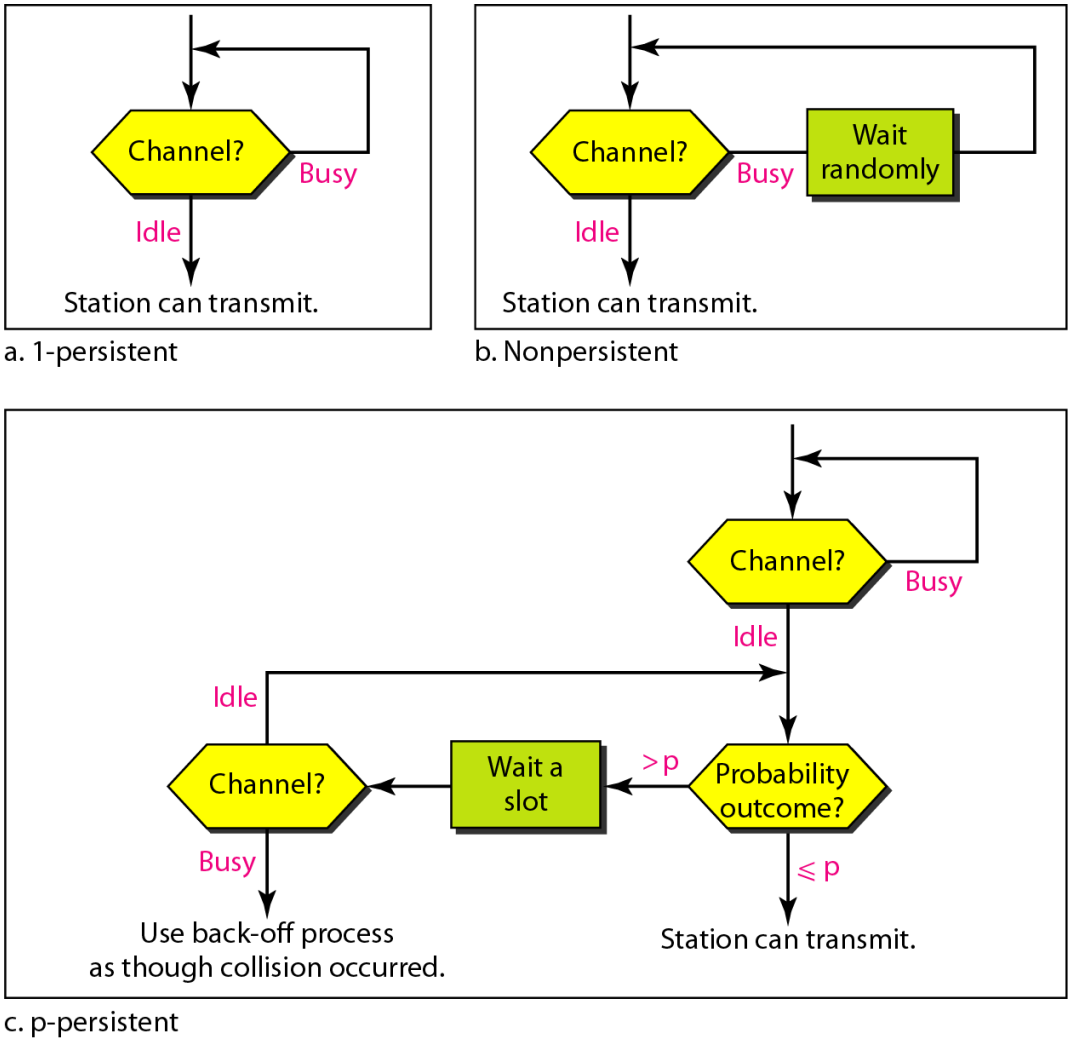
Reduces the efficiency

Combines the advantages of the others



c. p-persistent

Persistence Methods



a. 1-persistent

b. Nonpersistent

c. p-persistent

CSMA/CD

- **C**arrier **S**ense **M**ultiple **A**ccess with **C**ollision **D**etection
- Station monitors channel while sending a frame, If there is a collision, the frame is sent again.

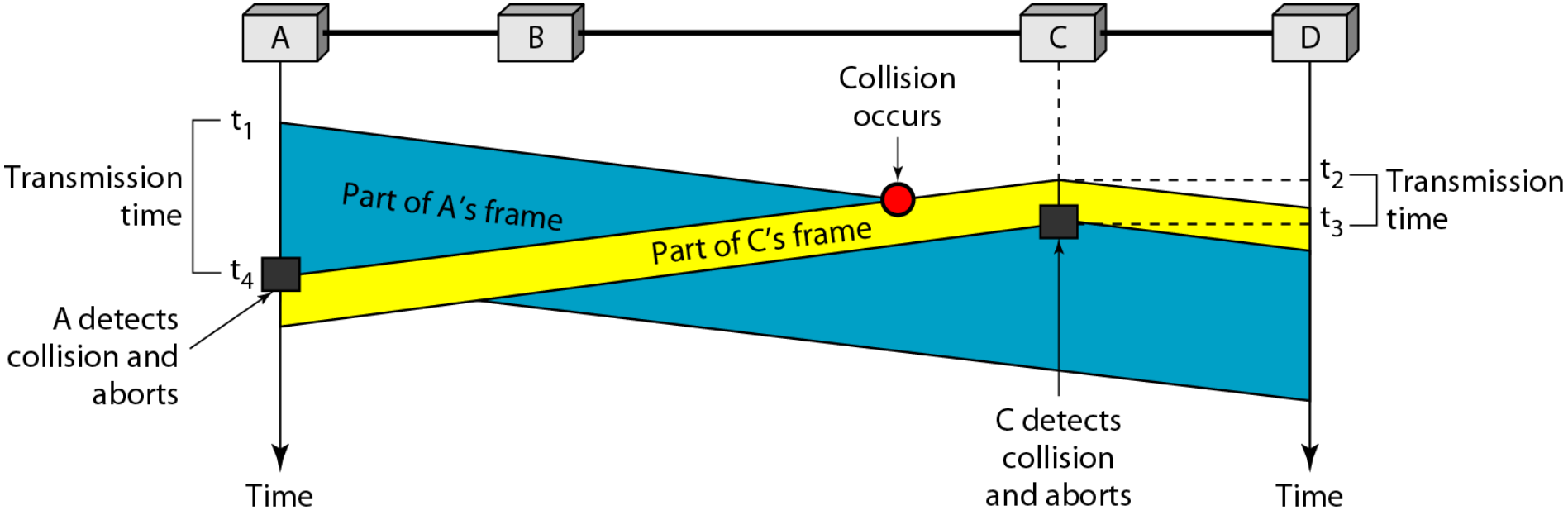
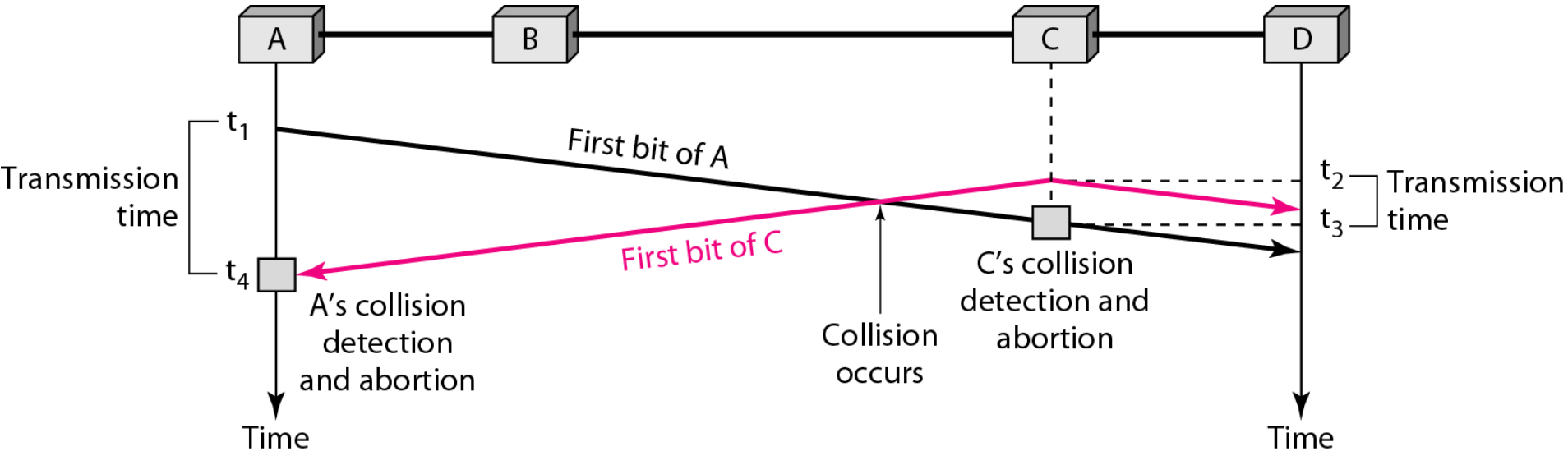
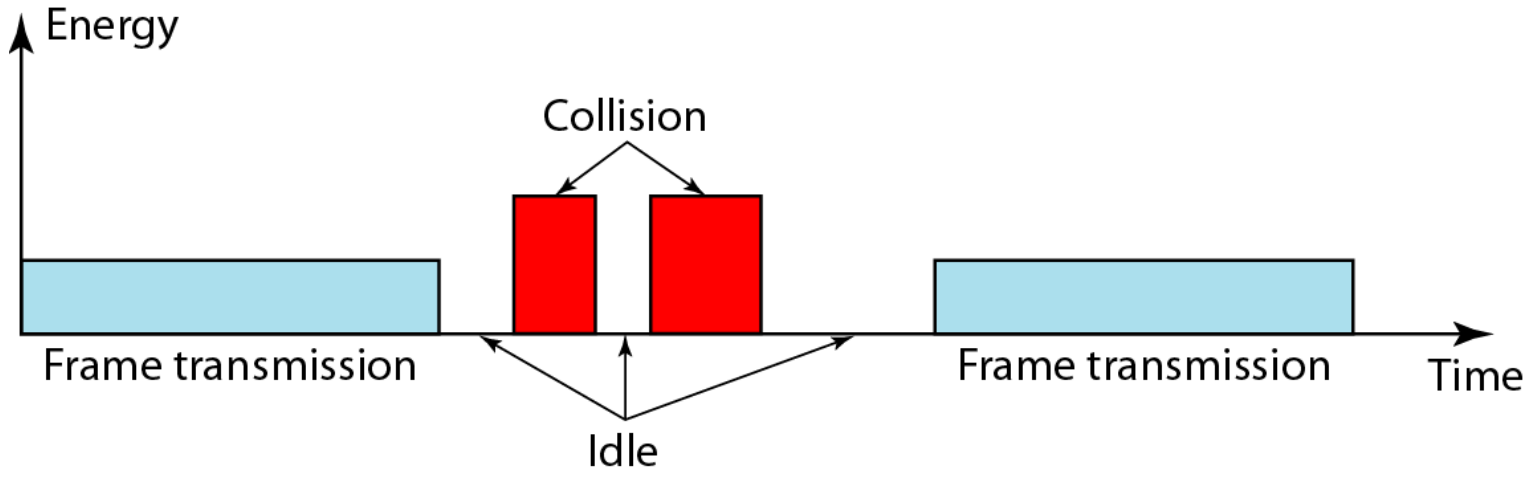


Figure 12.12 *Collision of the first bit in CSMA/CD*



Energy Levels

A station needs to monitor the energy level to determine if the channel is idle, busy, or in collision mode.

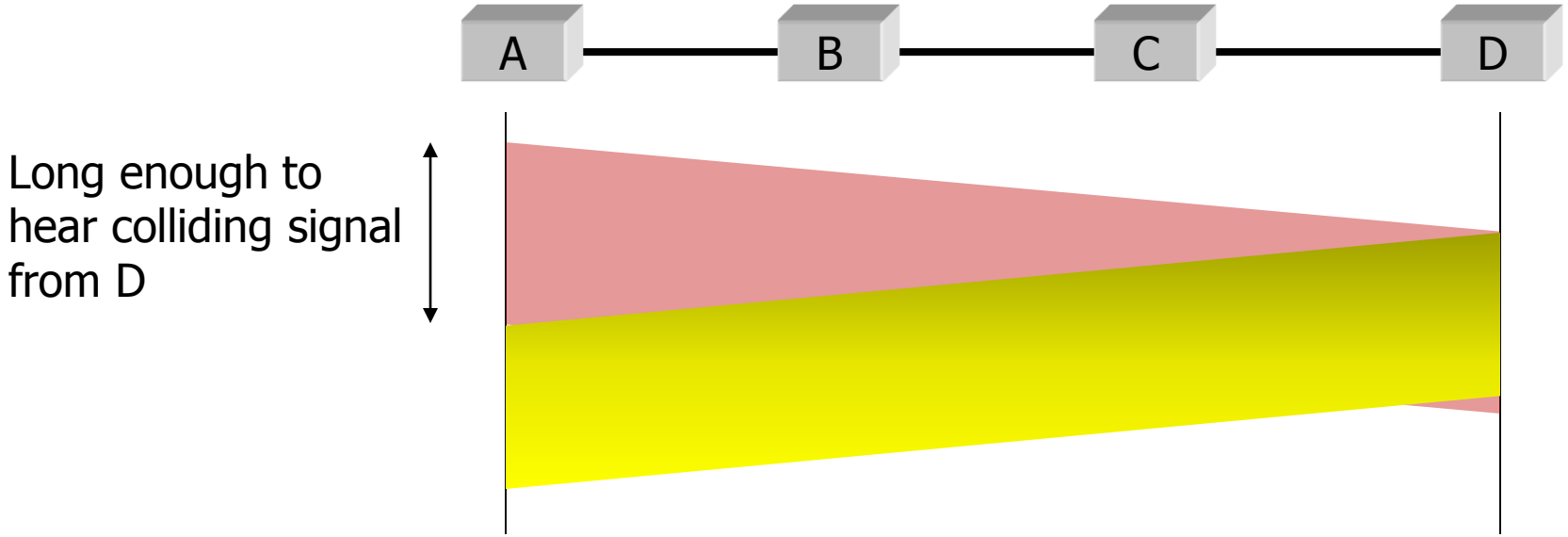


CSMA/CD: Minimum Frame Size

- Before sending the last bit of the frame, the sending station must detect a collision,
- because the station, once the entire frame is sent, 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* $2T_p$ *(*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.)*

CSMA/CD: Minimum Frame Size

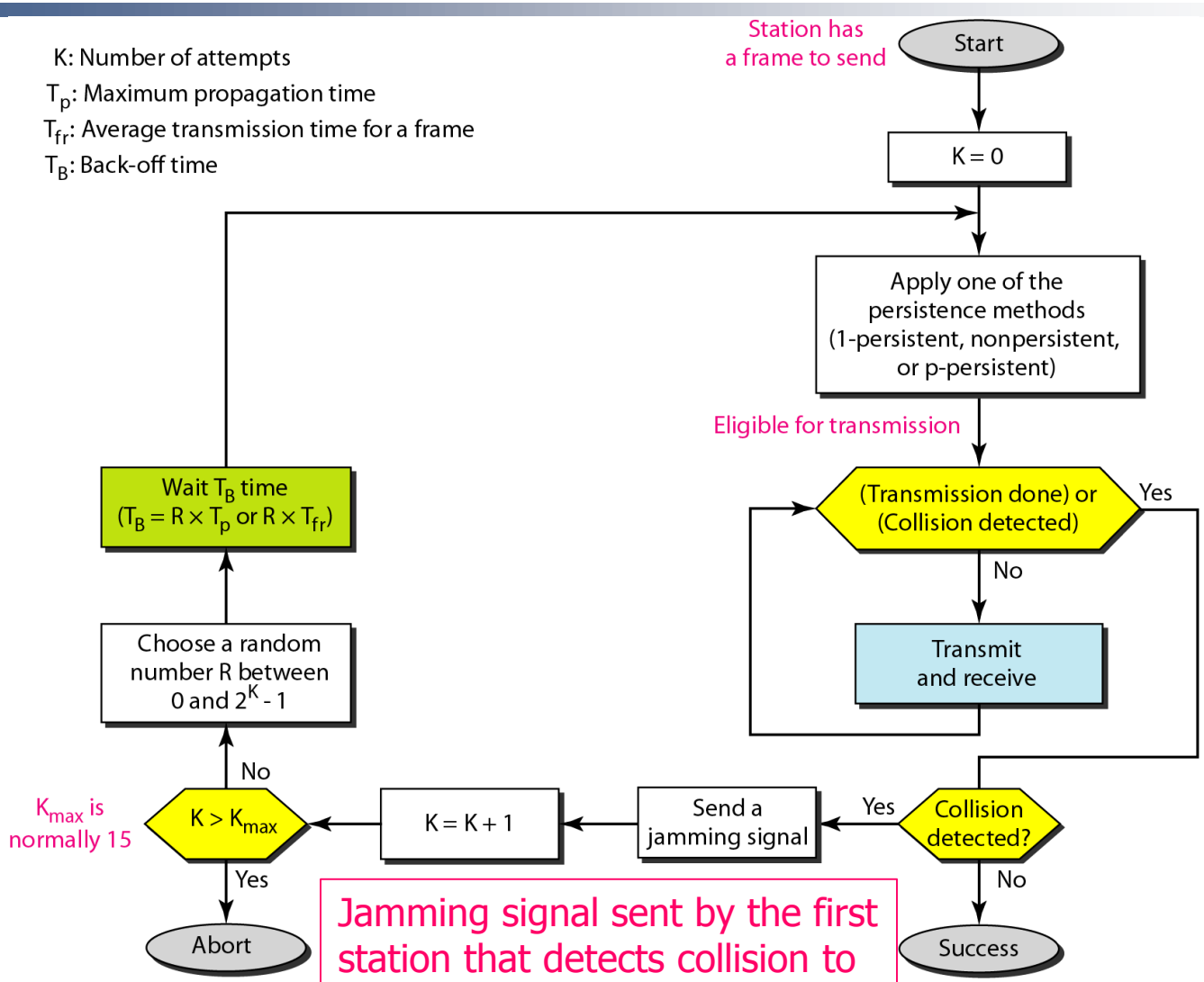
- Each frame must be large enough for a sender to detect a collision
- Worst case scenario:
  - "A" is transmitting
  - "D" starts transmitting just before A's signal arrives



Example

- A CSMA/CD network has a bandwidth of 10 Mbps. If the maximum propagation time is 25.6 μs, what is the minimum size of the frame?
- Ans:
  - The frame transmission time is T_{fr} = *2 x Tp =51.2 μs.*
  - The minimum size of the frame is = 10 Mbps x 51.2 μs =512 bits or 64 bytes.
  - Which is the minimum size of the frame for Standard Ethernet,

CSMA/CD: Flow Diagram

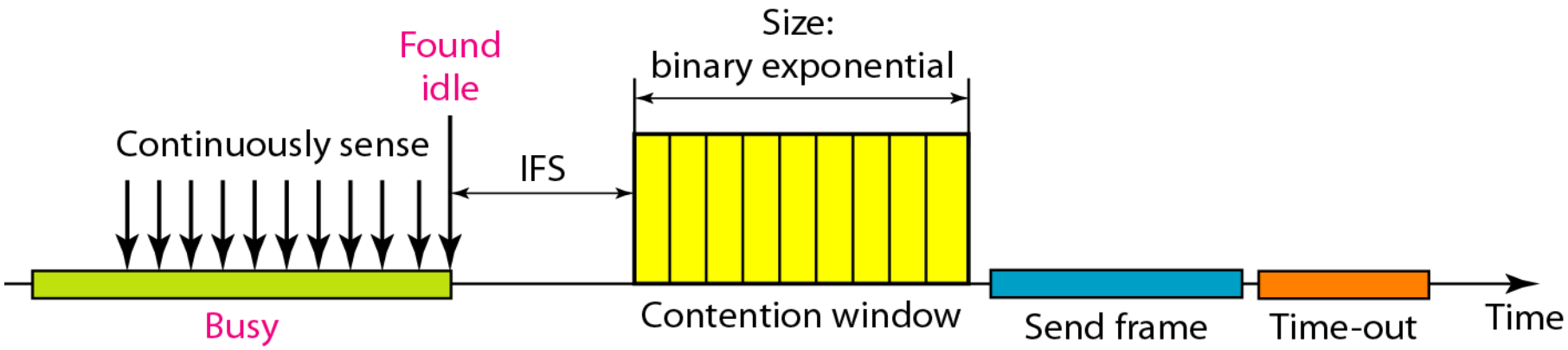


CSMA/CA

- **C**arrier **S**ense **M**ultiple **A**ccess with **C**ollision **A**voidance
- In a wireless network, much of the sent energy is lost in transmission. The received signal has very little energy.
- Therefore, a collision may add only 10 percent additional energy. This is not useful for effective collision detection.
- Thus, we need to avoid collisions on wireless networks because they cannot be detected

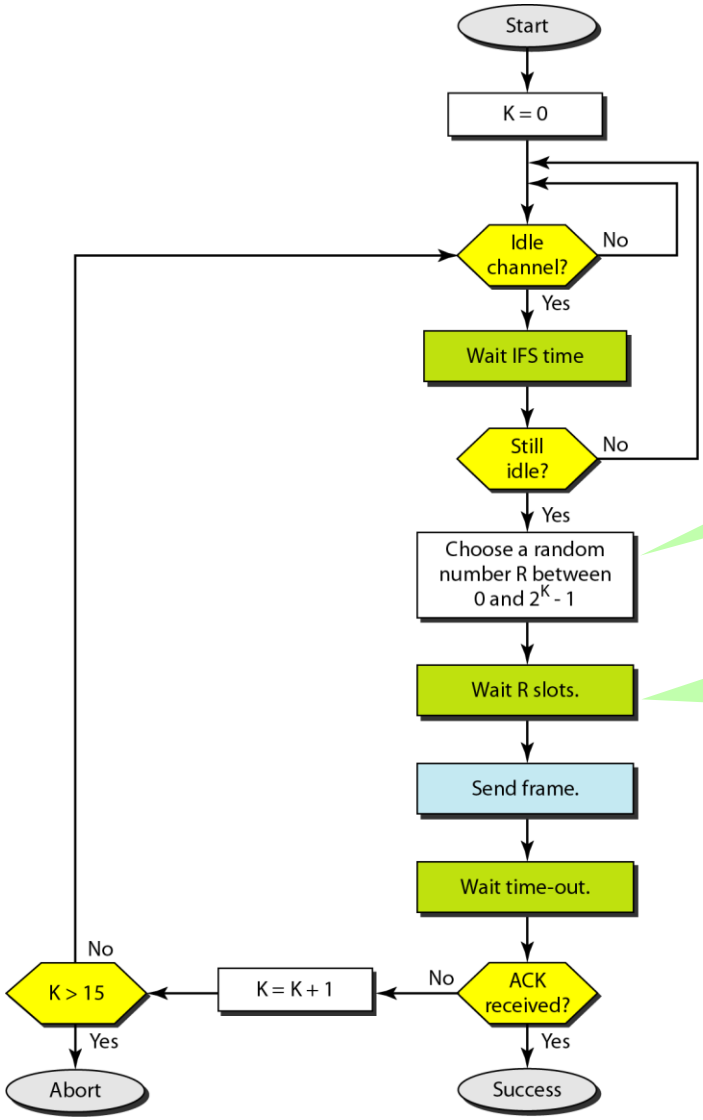
CSMA/CA

- Collisions are avoided through the use of three strategies: the interframe space, the contention window, and Acknowledgments.



IFS – Interframe Space

CSMA/CA: Flow Diagram



contention window size is 2^K-1

After each slot:
- If idle, continue counting
- If busy, stop counting

تم بحمد الله