Mobile Computing
Lecture 6
Medium Access Control

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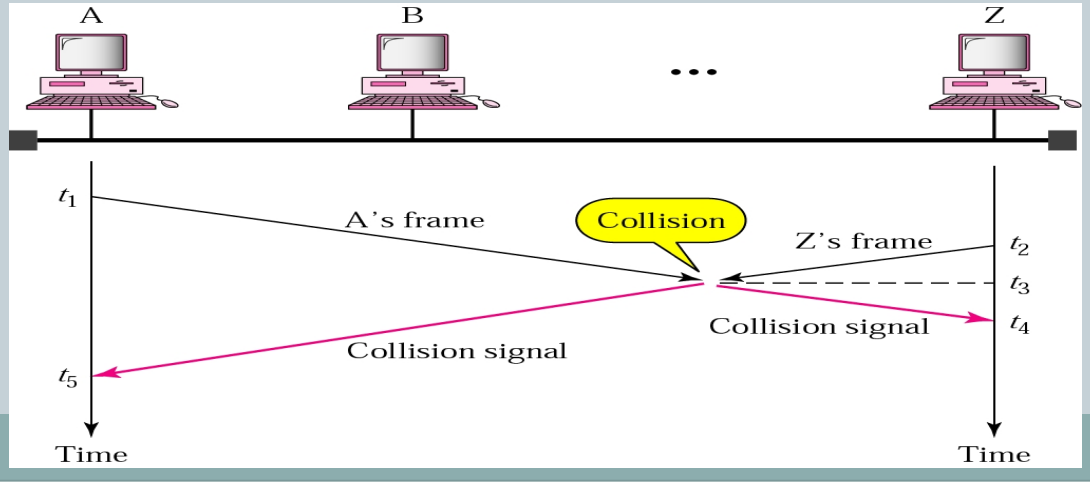
Random Access – Carrier Sense Multiple Access (CSMA)

- To improve performance, avoid transmissions that are certain to cause collisions
- Based on the fact that in LAN propagation time is **very small**
- If a frame was sent by a station, All stations knows immediately so they can **wait before start sending**
  - A station with frames to be sent, should **sense the medium** for the presence of another transmission (carrier) before it starts its own transmission
- This can **reduce** the possibility of collision but it cannot eliminate it.
  - Collision can only happen when more than one station begin transmitting within a short time (the **propagation time** period)



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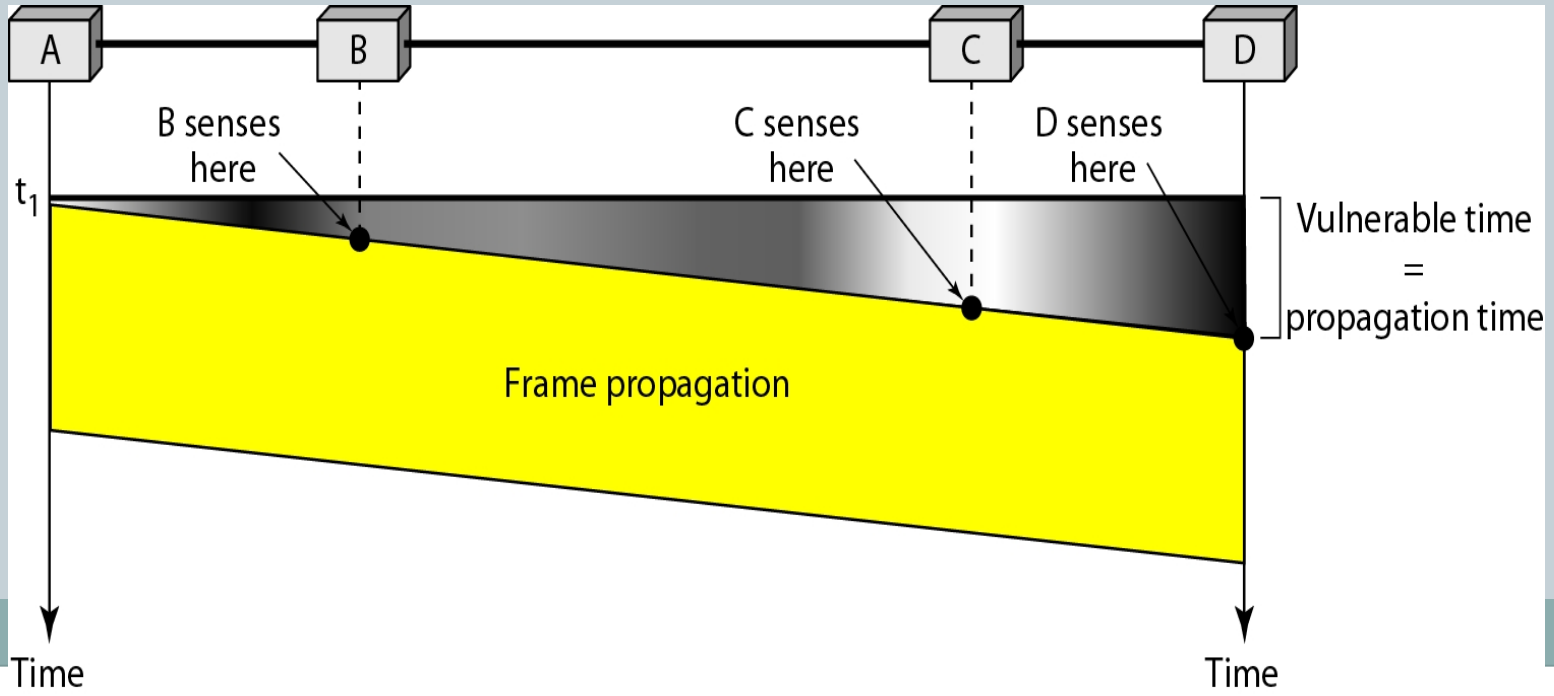
- Vulnerable time for CSMA is the **maximum propagation time**
- The longer the propagation delay, the worse the performance of the protocol because of the above case.



Types of CSMA Protocols

Different CSMA protocols that determine:

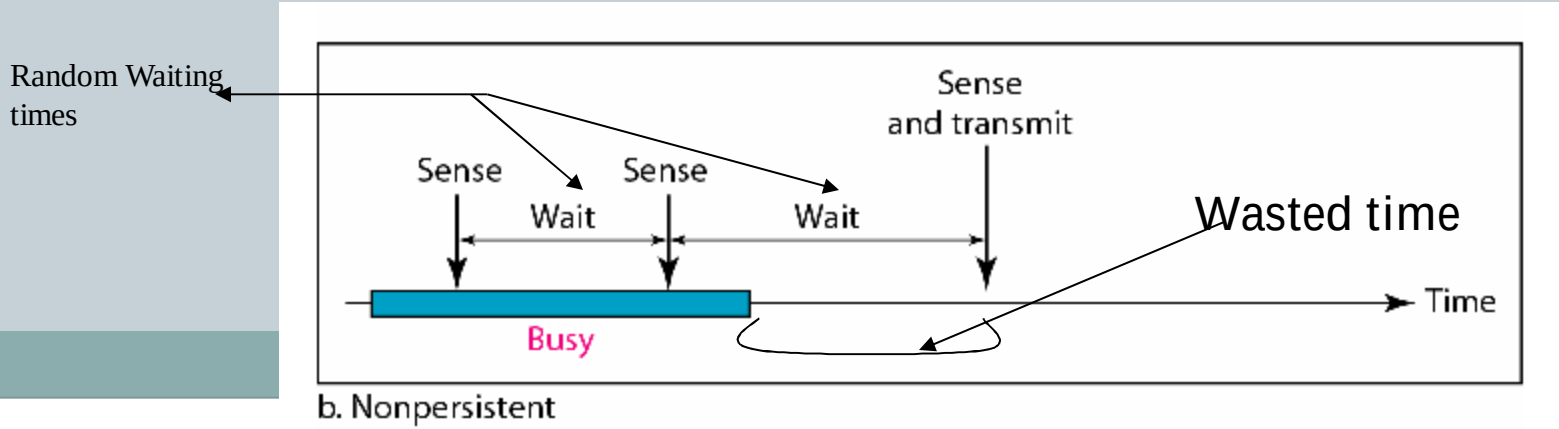
What a station should do when the medium is **idle**?

What a station should do when the medium is **busy**?

1. Non-Persistent CSMA
2. 1-Persistent CSMA
3. p-Persistent CSMA

Nonpersistent CSMA

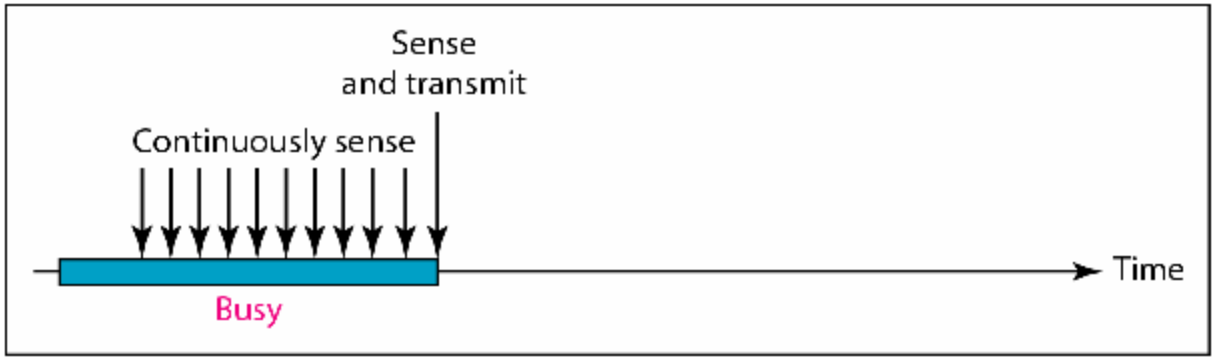
- A station with frames to be sent, should sense the medium
  1. If medium is idle, **transmit**; otherwise, go to 2
  2. If medium is busy, (backoff) wait a *random* amount of time and repeat 1
- Non-persistent Stations are **deferential (respect others)**
- Performance:
  - Random delays reduces probability of collisions because two stations with data to be transmitted will wait for different amount of times.
  - Bandwidth is **wasted** if waiting time (backoff) is large because medium will remain idle following end of transmission even if one or more stations have frames to send



b. Nonpersistent

1-persistent CSMA

- To avoid idle channel time, 1-persistent protocol used
- Station wishing to transmit listens to the medium:
  - If medium idle, **transmit** immediately;
  - If medium busy, **continuously listen** until medium becomes idle; then transmit immediately with probability 1
- Performance
  - 1-persistent stations are **selfish**
  - If two or more stations becomes ready at the same time, **collision guaranted**



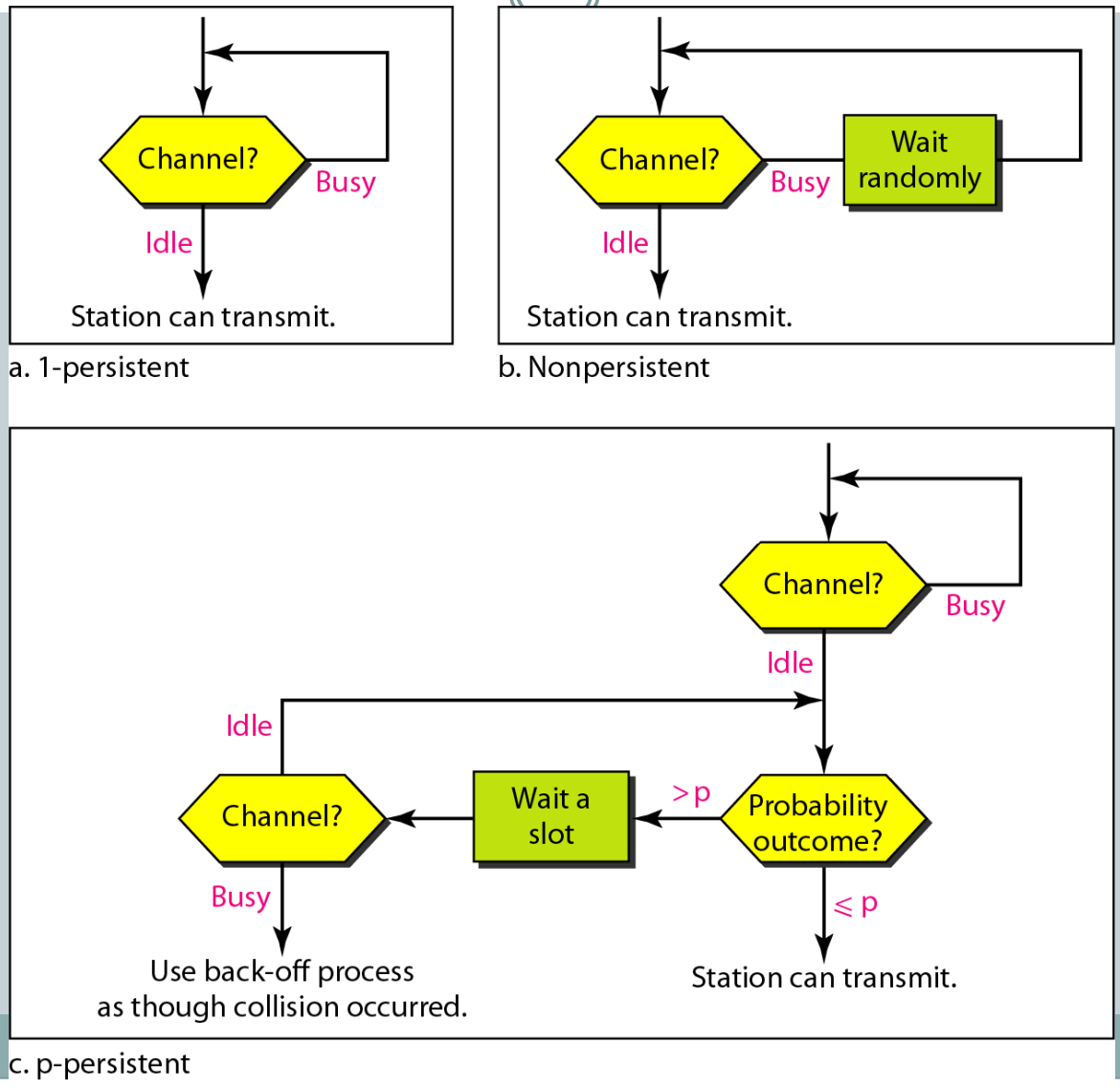
a. 1-persistent

P-persistent CSMA

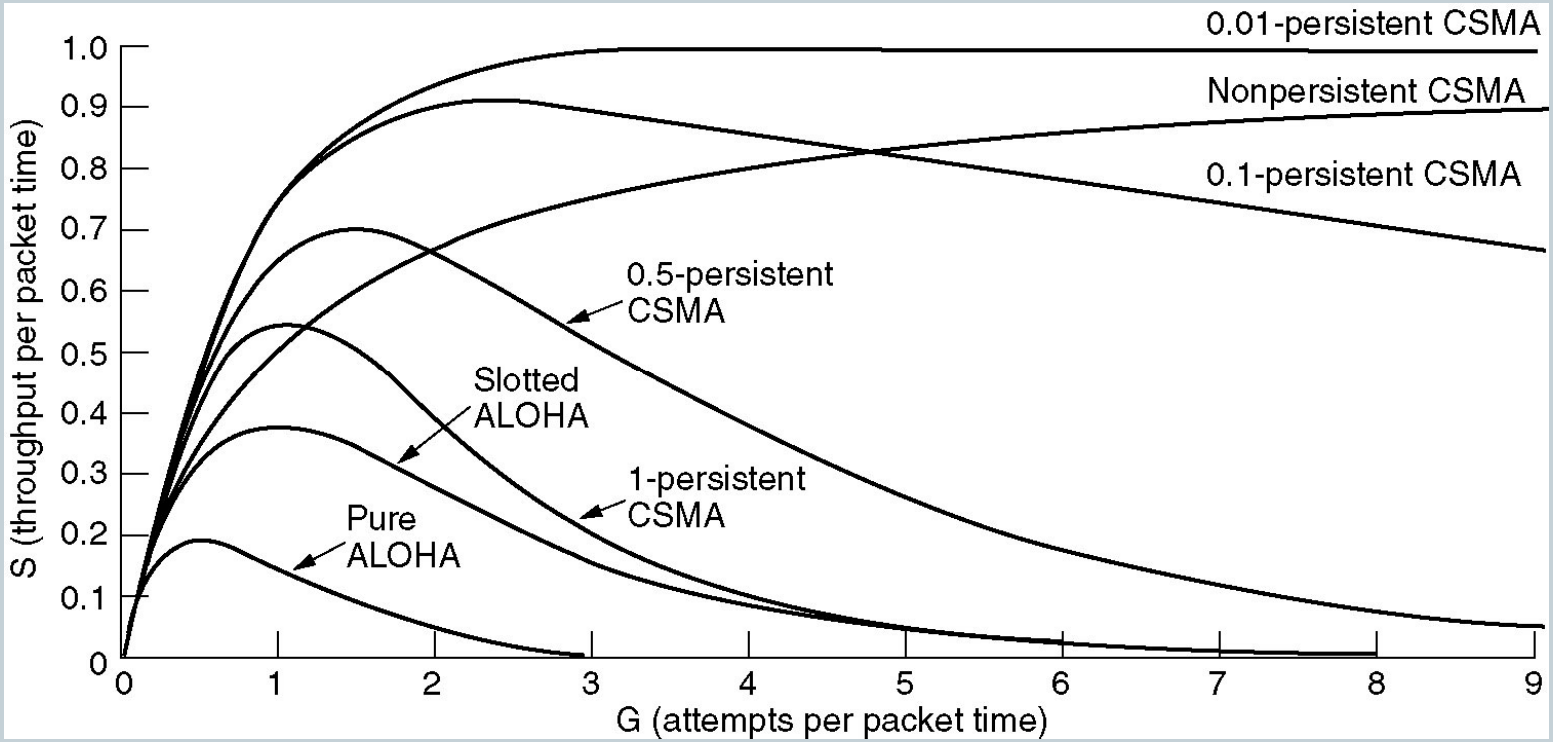
- Time is divided to slots where each Time unit (slot) typically equals **maximum propagation delay**
- Station wishing to transmit listens to the medium:

1. If medium idle,
   - transmit with probability (**p**), OR
   - wait **one time unit (slot)** with probability (**1 – p**), then repeat 1.
2. If medium busy, **continuously listen until idle** and repeat step **1**
3. Performance
   - Reduces the possibility of collisions like **nonpersistent**
   - Reduces channel idle time like **1-persistent**

Flow diagram for three persistence methods



Persistent and Nonpersistent CSMA



Comparison of the channel utilization versus load for various random access protocols.

CSMA/CD (Collision Detection)

- CSMA (all previous methods) has an inefficiency:
  - If a collision has occurred, the channel is unstable until colliding packets have been fully transmitted
- CSMA/CD (Carrier Sense Multiple Access with Collision Detection) overcomes this as follows:
  - While transmitting, the sender is listening to medium for collisions.
  - Sender stops transmission if collision has occurred reducing channel wastage.
- CSMA/CD is Widely used for bus topology LANs (IEEE 802.3, Ethernet).

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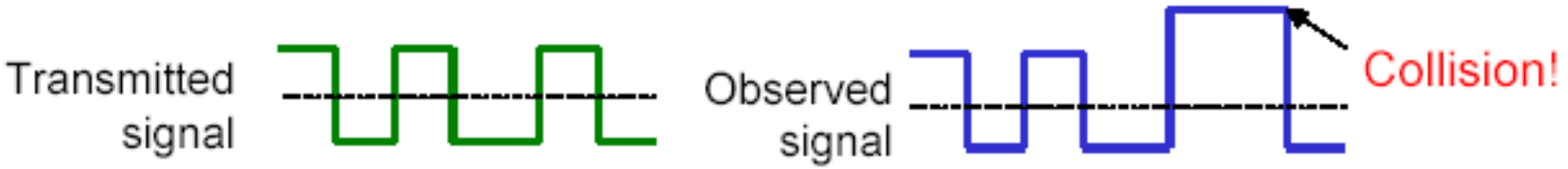
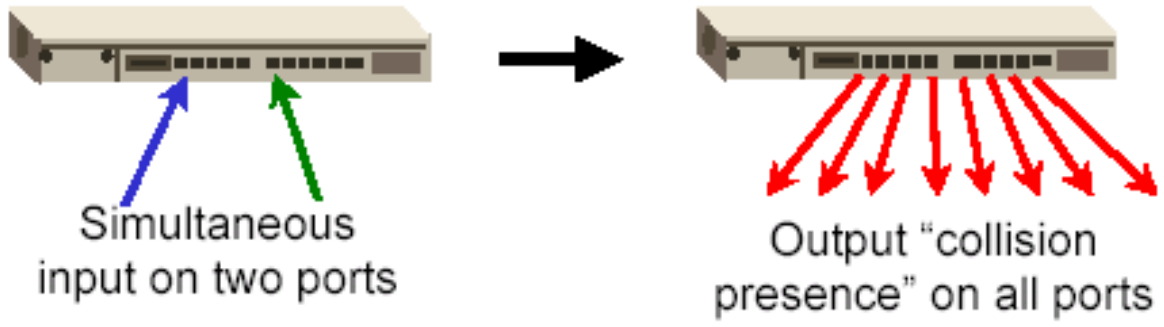
How does a node detect a collision?

Transceiver: **A node monitors the media while transmitting. If the observed power is more than transmitted power + attenuated reflection of its own signal, it indicates a collision.**



Hub: **if input occurs simultaneously on two ports, it indicates a collision. Hub sends a collision presence signal on all ports.**



CSMA/CD Protocol

- Use one of the CSMA persistence algorithm (non-persistent, 1-persistent, p-persistent) for transmission
- If a collision is detected by a station during its transmission then it should do the following:
  - Abort transmission and
  - Transmit a jam signal (48 bit) to notify other stations of collision so that they will discard the transmitted frame also to make sure that the collision signal will stay until detected by the furthest station
  - After sending the jam signal, backoff (wait) for a random amount of time
  - Transmit the frame again

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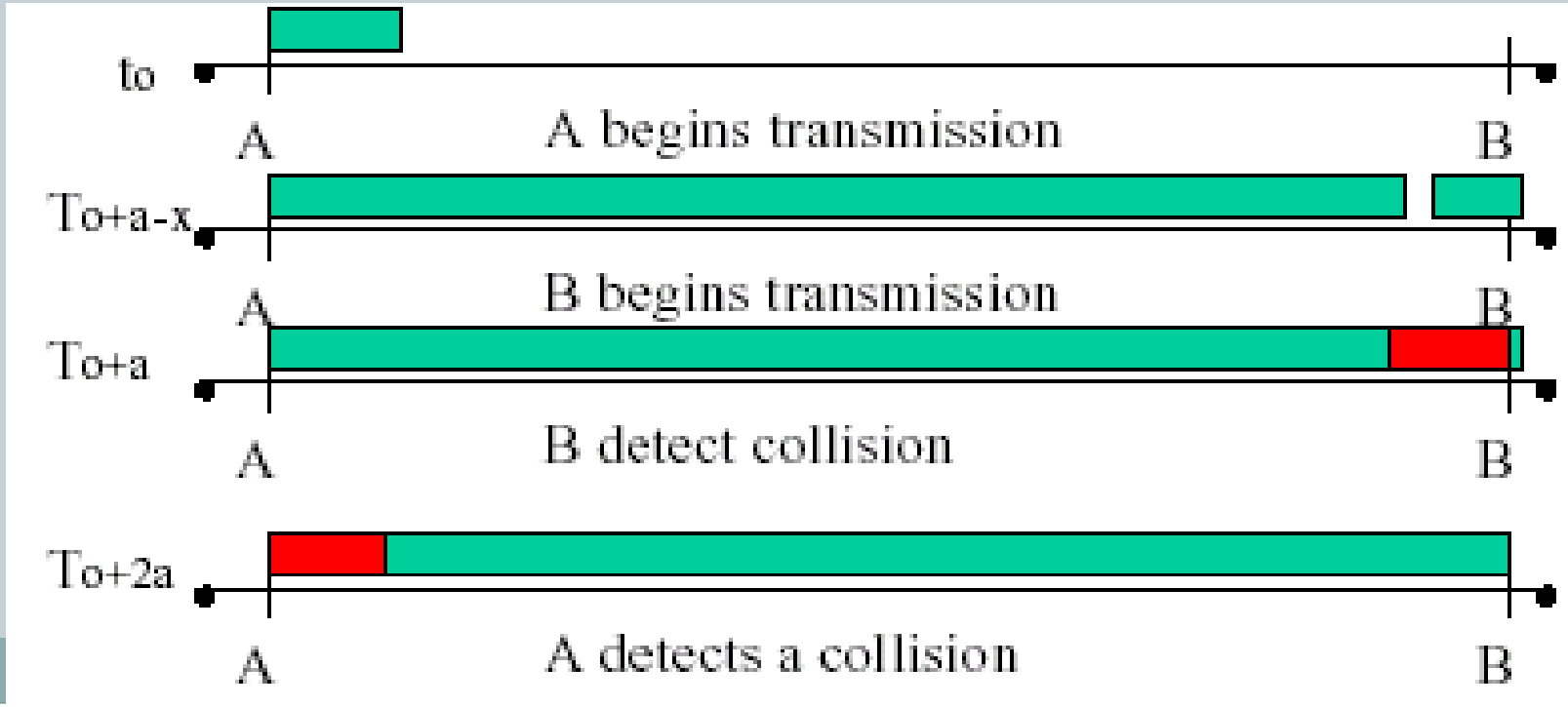
- ***Question:*** How long does it take to detect a collision?
- ***Answer:*** *In the **worst case***, **twice the maximum propagation delay of the medium**

Note: **a = maximum propagation delay**



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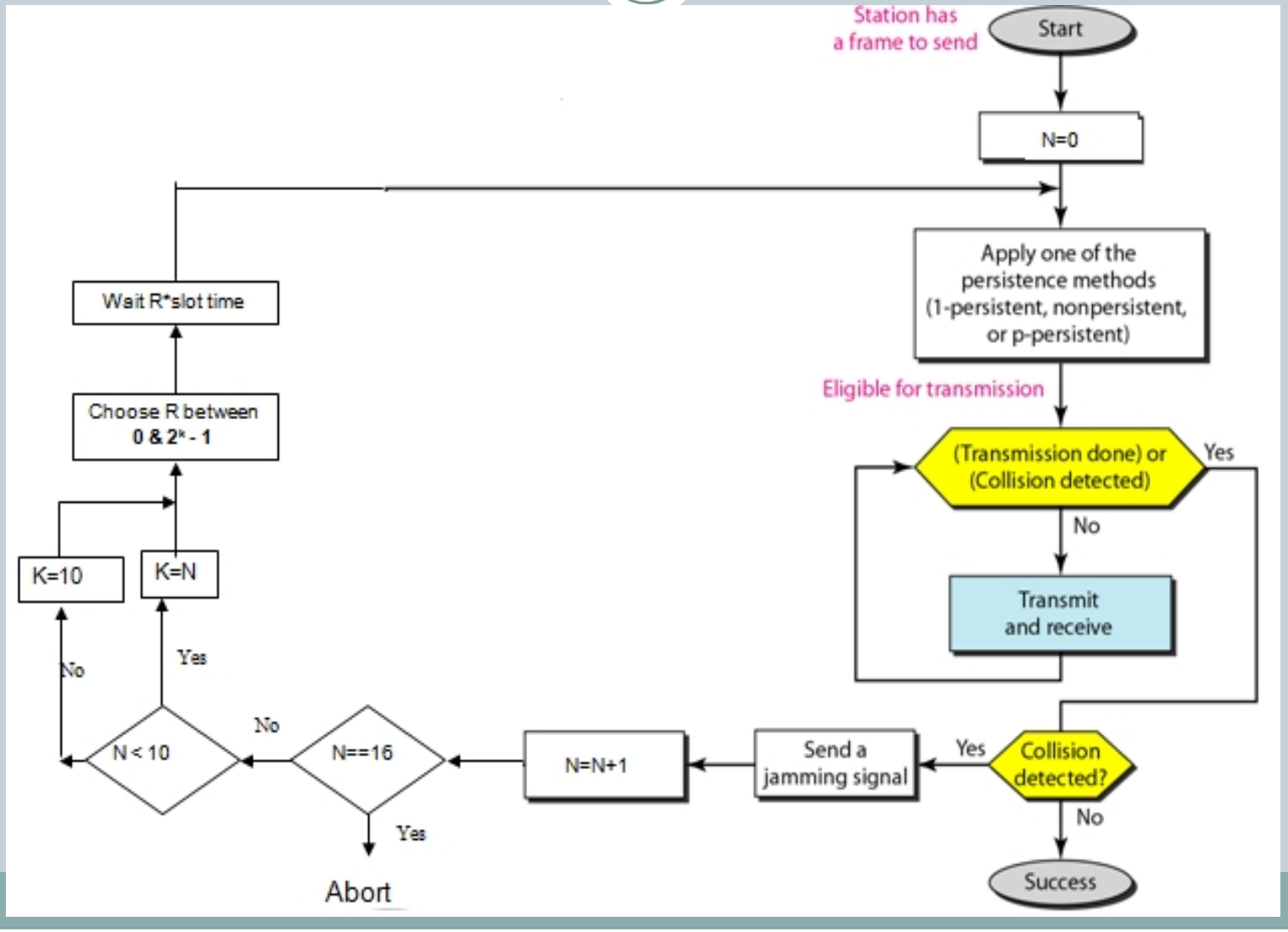
- Restrictions of CSMA / CD:
  - Packet transmission time should be at least as long as the time needed to detect a collision (2 * maximum propagation delay + *jam sequence* transmission time)
  - Otherwise, CSMA/CD does not have an advantage over CSMA

Exponential Backoff Algorithm

- Ethernet uses the exponential backoff algorithms to determine **the best duration of the random waiting period after the collision happens**
- Algorithm:
  - Set "**slot time**" equal to 2*maximum propagation delay + Jam sequence transmission time (= 51.2 usec for Ethernet **10-Mbps** LAN)
  - After K^{th} collision, select a random number (R) between 0 and 2^k –1 and **wait** for a period equal to (R***slot time**) then **retransmit** when the medium is **idle, for example:**
    - After first collision (K=1), select a number (R) between 0 and 2^1 –1 {0 ,1} and wait for a period equal to R*slot times (Wait for a period 0 usec or 1x51.2 usec) then retransmit when the medium is idle
  - Do not increase random number range, if K=10
    - ➔ Maximum interval {0 – 1023}
  - Give up after 16 unsuccessful attempts and report failure to higher layers

Flow diagram for the CSMA/CD



Exponential Backoff Algorithm

- Reduces the chance of two waiting stations picking the same random waiting time
- When network traffic is light, it results in **minimum** waiting time before transmission
- As congestion increases (traffic is high), collisions increase, stations backoff by **larger amounts** to reduce the probability of collision.
- Exponential Back off algorithm gives **last-in, first-out effect**
  - Stations with **no or few collisions** will have the chance to transmit before stations that have waited longer because of their previous unsuccessful transmission attempts.

Performance of Random Access Protocols

- Simple and easy to implement
- Decentralized (no central device that can fail and bring down the entire system)
- In low-traffic, packet transfer has low-delay
- However, limited throughput and in heavier traffic, packet delay has no limit.
- In some cases, a station may never have a chance to transfer its packet. (unfair protocol)
- A node that has frames to be transmitted can transmit continuously at the full rate of channel (R) if it is the only node with frames
- If (M) nodes want to transmit, many collisions can occur and the rate for each node will not be on average R/M