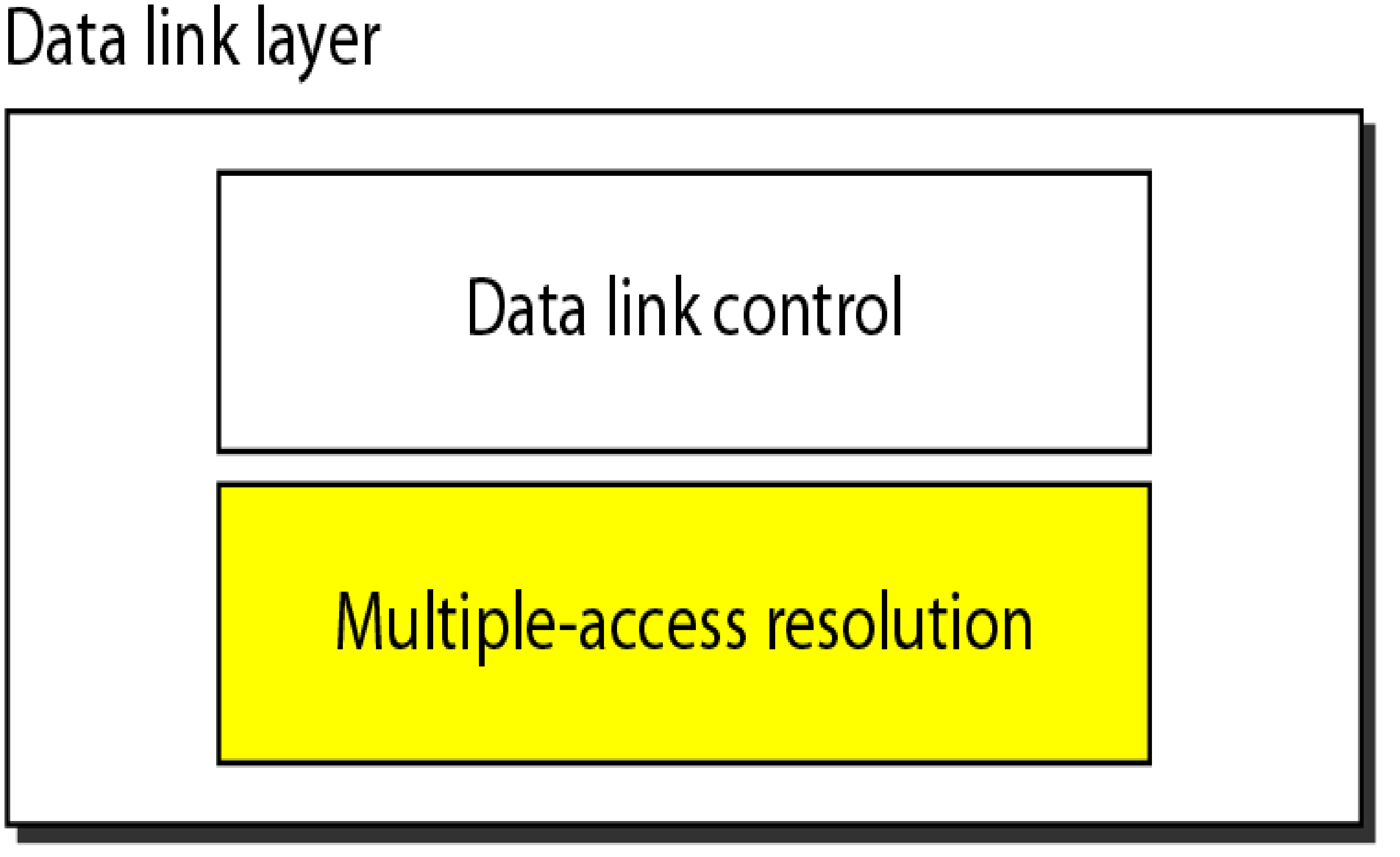
Multiple Access Control / Media Access Control (MAC) Protocols

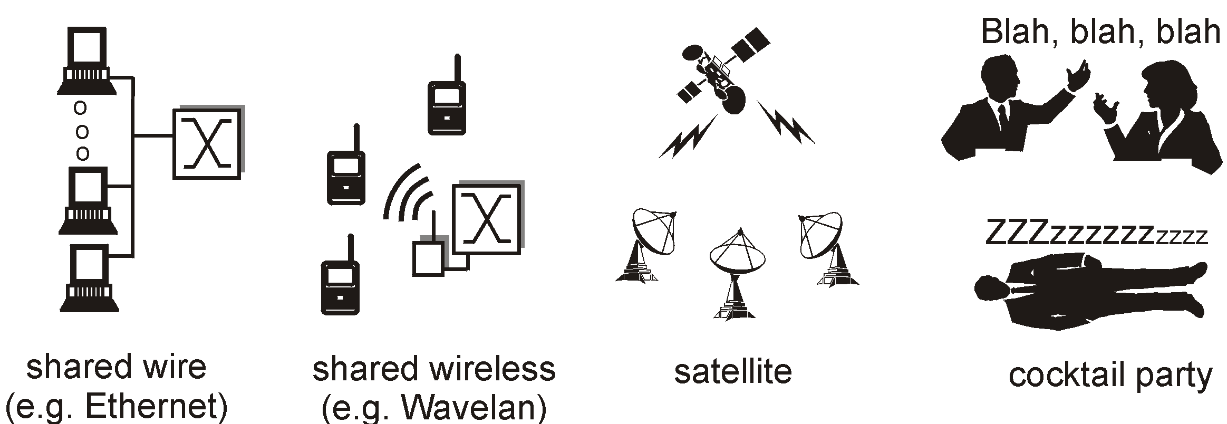
Data link layer divided into ………



Multiple Access Links and Protocols

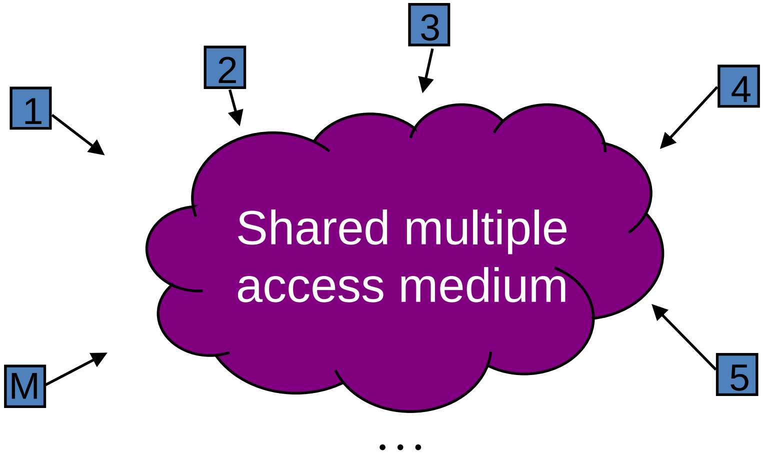
Two types of "links":

- point-to-point
  - PPP for dial-up access
  - point-to-point link between Ethernet switch and host
- broadcast (shared wire or medium)
  - Old-fashioned Ethernet
  - upstream HFC
  - 802.11 wireless LAN



Multiple Access Communications

- Shared media basis for broadcast networks
  - Inexpensive: radio over air; copper or coaxial cable
  - M users communicate by broadcasting into medium
- Key issue: How to share the medium?



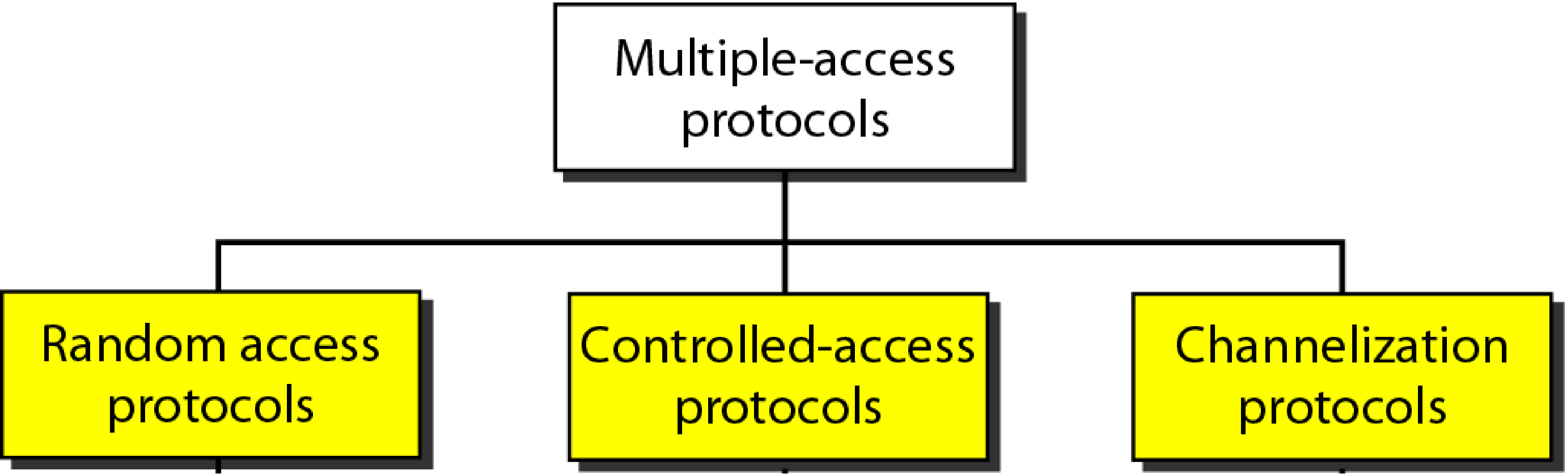
Multiple Access protocols

- single shared broadcast channel
- two or more simultaneous transmissions by nodes: interference
  - collision if node receives two or more signals at the same time

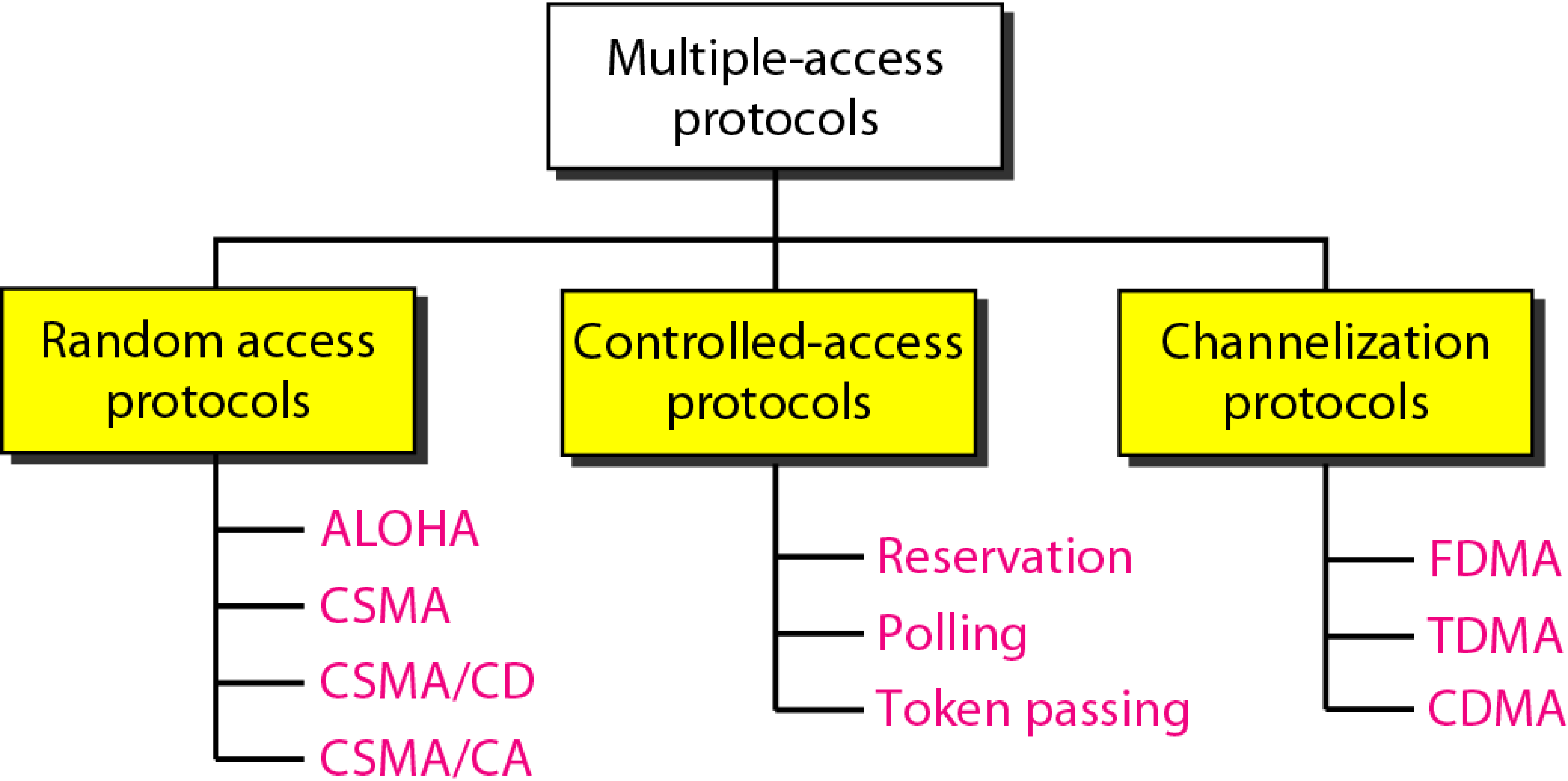
multiple access protocol

- distributed algorithm that determines how nodes share channel, i.e., determine when node can transmit
- communication about channel sharing must use channel itself!
  - no out-of-band channel for coordination

Multiple-access protocols



Multiple-access protocols



Let us study one MAC protocol
as
an example

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

Random Access Protocols

- When node has packet to send
  - transmit at full channel data rate R.
  - no *a priori* coordination among nodes
- two or more transmitting nodes ➜ “collision”,
- random access MAC protocol specifies:
  - how to detect collisions
  - how to recover from collisions (e.g., via delayed retransmissions)
- Examples of random access MAC protocols:
  - slotted ALOHA
  - ALOHA
  - CSMA, CSMA/CD, CSMA/CA

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.

RANDOM ACCESS

In a random access method, each station has the right to the medium without being controlled by any other station.

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

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?

CSMA

To minimize the chance of collision and, therefore, increase the performance, the CSMA method was developed.

The chance of collision can be reduced if a station senses the medium before trying to use it.

CSMA

CSMA 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.”

CSMA

CSMA can reduce the possibility of collision, but it cannot eliminate it.

The reason for this is (shown in Figure 12.8.) stations are connected to a shared channel (usually a dedicated medium).

CSMA

The possibility of collision still exists in CSMA because of propagation delay;

when a station sends a frame, it still takes time for the first bit to reach every station and for every station to sense it.

In other words, a station may sense the medium and find it idle, only because the first bit sent by another station has not yet been received.

CSMA

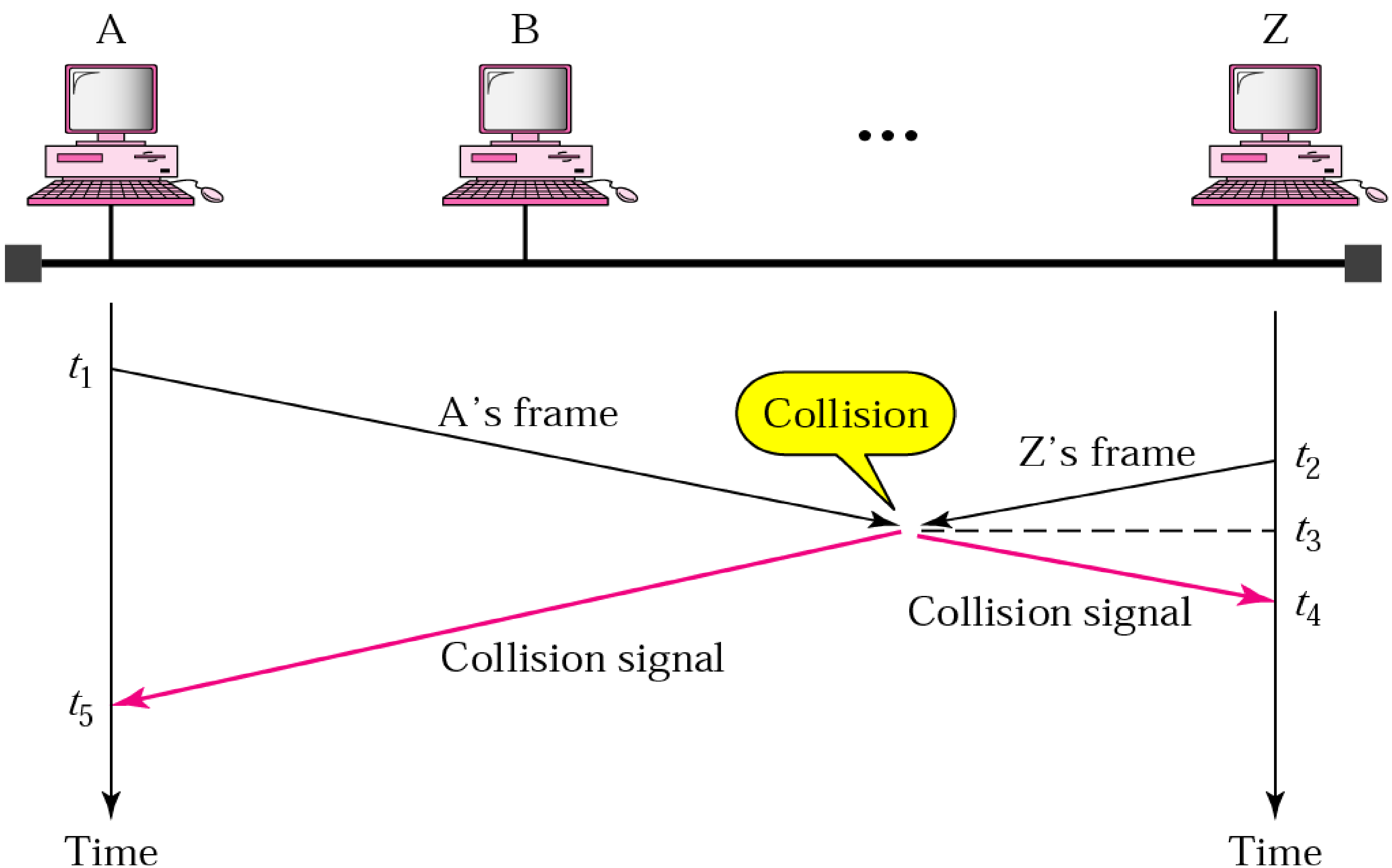
In Figure 12.8.

At time t_1 *, station A senses the medium and finds it idle, so it sends a frame.*

At time t_2 $(t_2 > t_l)$ *station Z senses the medium and finds it idle because, at this time, the first* bits from station A have not reached station Z.

Station Z also sends a frame. The two signals collide and both frames are destroyed.

Figure 12.8 Collision in CSMA



CSMA/CD

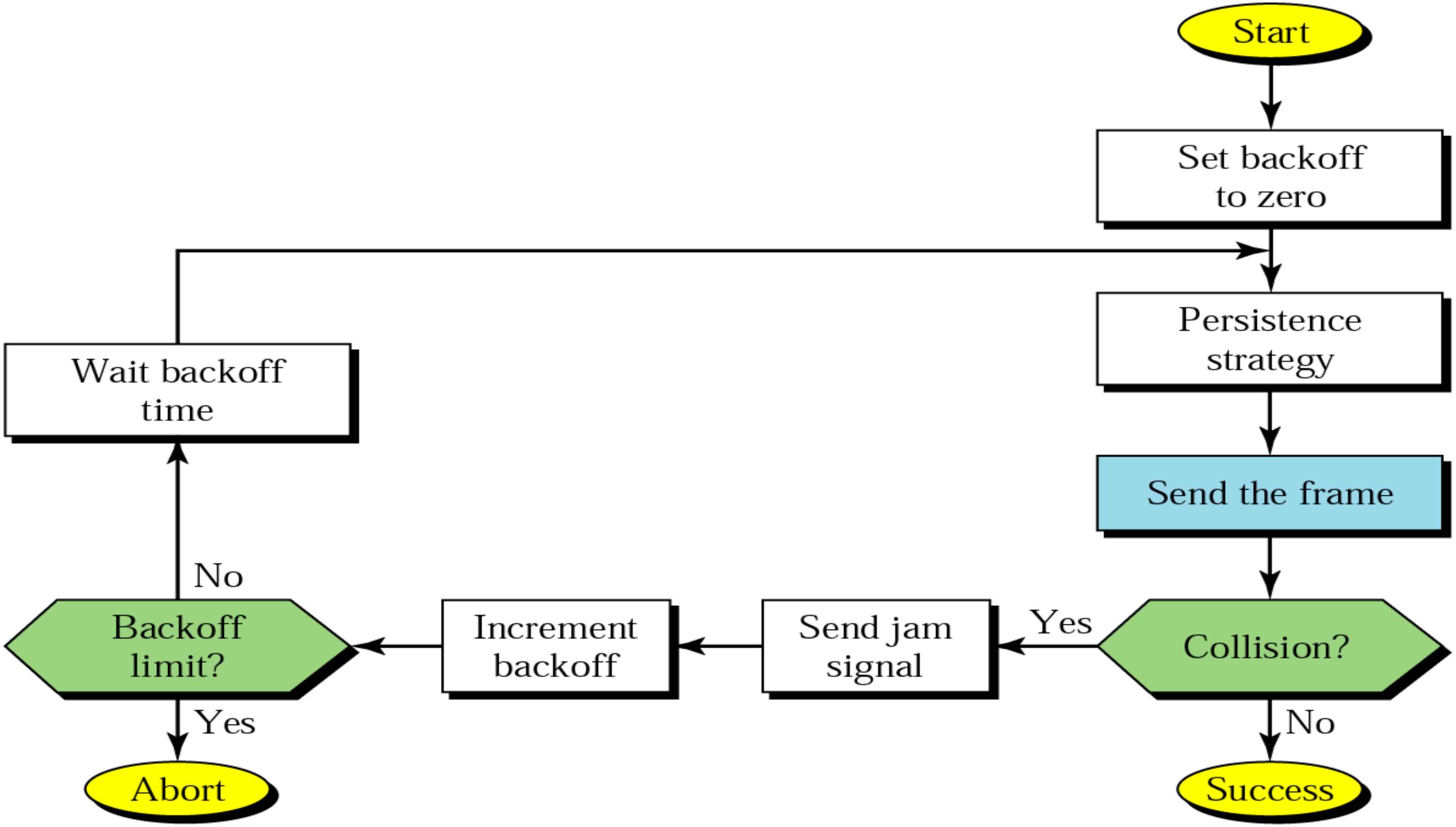
Step 1: A station with a frame to transmit waits until the channel is silent.

Step 2: When channel becomes silent, station transmits but continues to listen for collisions.

Step 3: If a collision occurs, the station aborts the transmission, waits for a random time to reattempt the transmission time.

If the collision doesn't occur within 2 propagation delay times [mini-slot time], then station knows that it has captured the channel

Figure 13.7 CSMA/CD procedure



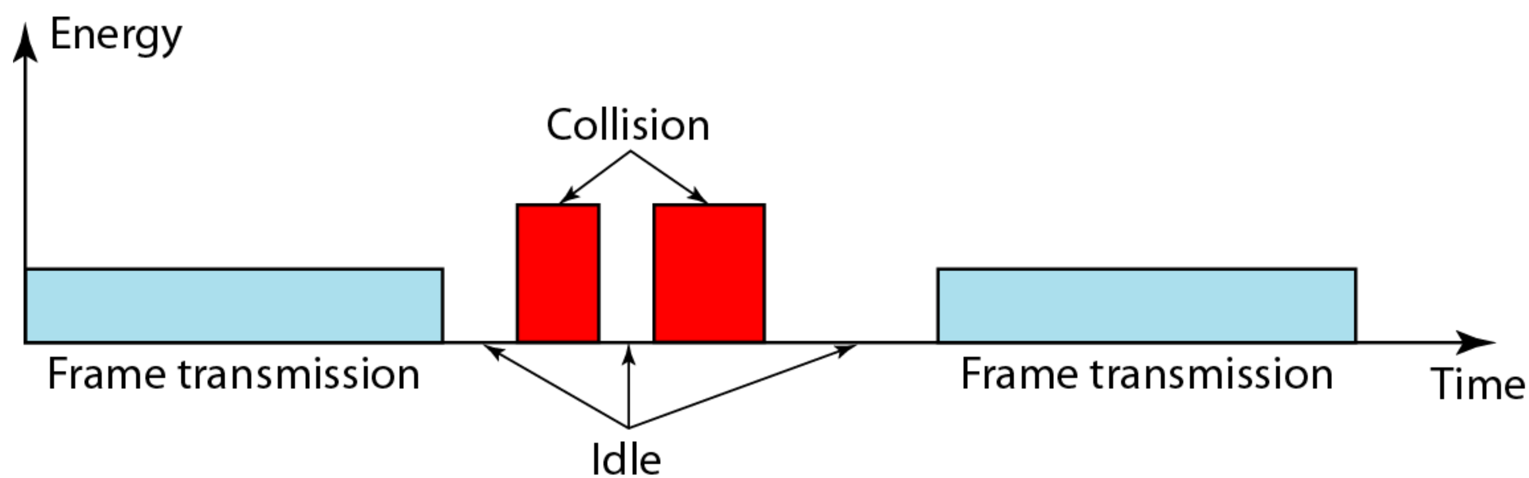
What is the significance of jam signal in CSMA/CD ?

If the station hears a collision, it sends jam signal to the line to inform other stations of the situation and to alert them that a collision has occurred

How is collision detected in CSMA/CD?

- Station uses a separate port (other than data port) to detect collision.
- In normal condition, **collision detection port** receives the normal signal or no signal.
- When collision occurs, it receives higher energy signal.

Figure 12.15 **Energy level during transmission, idleness, or collision**



CSMA/CD is not suitable for wireless LAN

Why ?

In case of wireless medium, it is difficult to sense the collision, because collided signal strength may decrease due to propagation

Hence CSMA/CD is not suitable for wireless LANs

What is the solution??

CSMA / CA Protocol

Ethernet CSMA/CD algorithm

1. NIC receives datagram from network layer, creates frame
2. If NIC senses channel idle, starts frame transmission. If NIC senses channel busy, waits until channel idle, then transmits.
3. If NIC transmits entire frame without detecting another transmission, NIC is done with frame !
4. If NIC detects another transmission while transmitting, aborts and sends jam signal
5. After aborting, NIC enters *binary (exponential) backoff:*
   - after *m*th collision, NIC chooses *K* at random from $\{0,1,2, \ldots, 2^m-1\}$. NIC waits $K \cdot 512$ bit times, returns to Step 2
   - longer backoff interval with more collisions