Medium Access Control

EE450: Introduction to Computer Networks

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Medium Access Control

- 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!

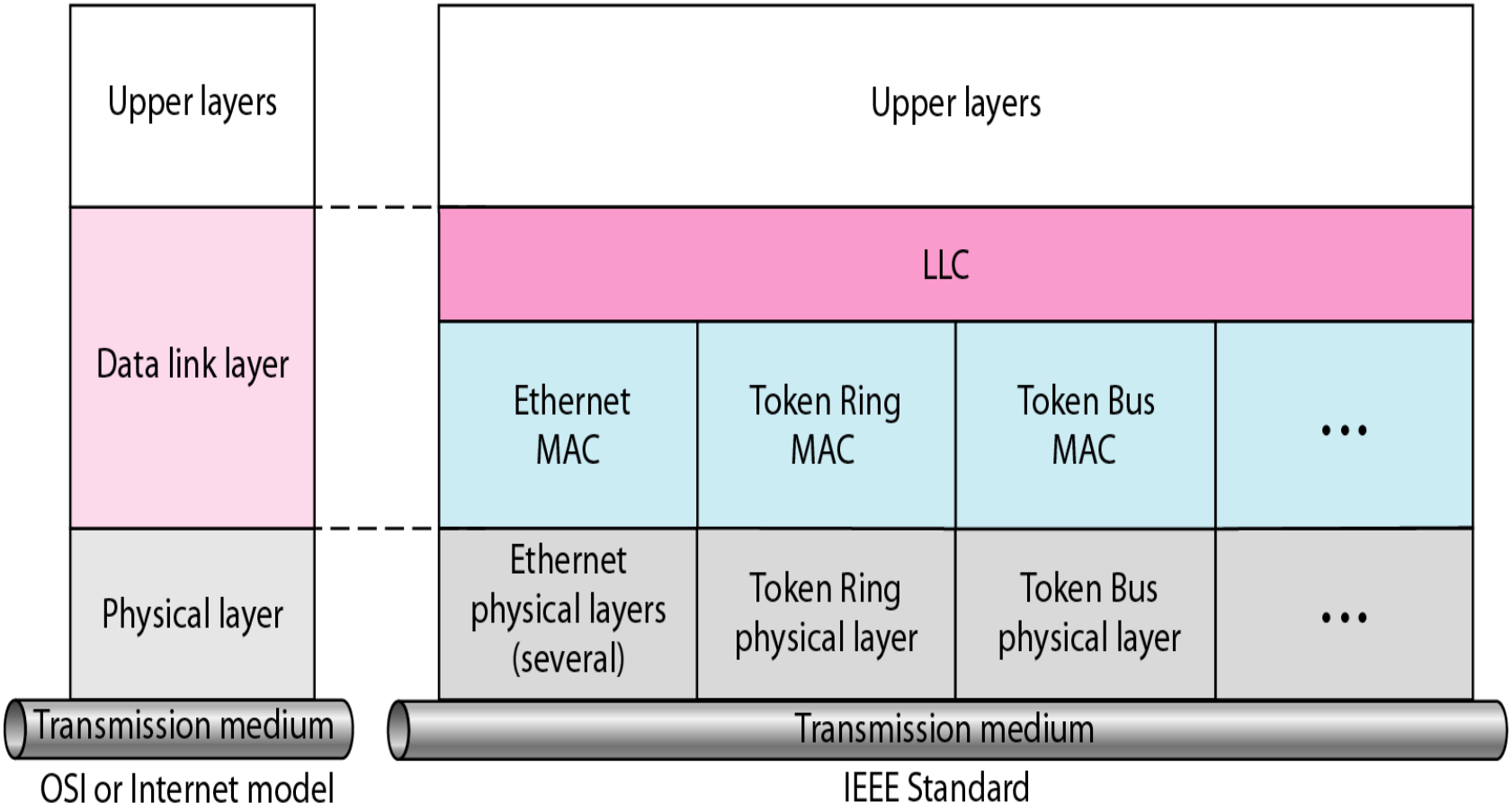
Classifications of MAC Protocols

Three broad classes:

- Channel Partitioning
  - Divide channel into smaller "pieces" (time slots, frequency, code)
  - Allocate piece to node for exclusive use
- Random Access
  - Channel not divided, allow collisions
  - "Recover" from collisions
- "Taking turns"
  - Nodes take turns, but nodes with more to send can take longer turns

IEEE802 Standards for LANs

LLC: Logical link control
MAC: Media access control



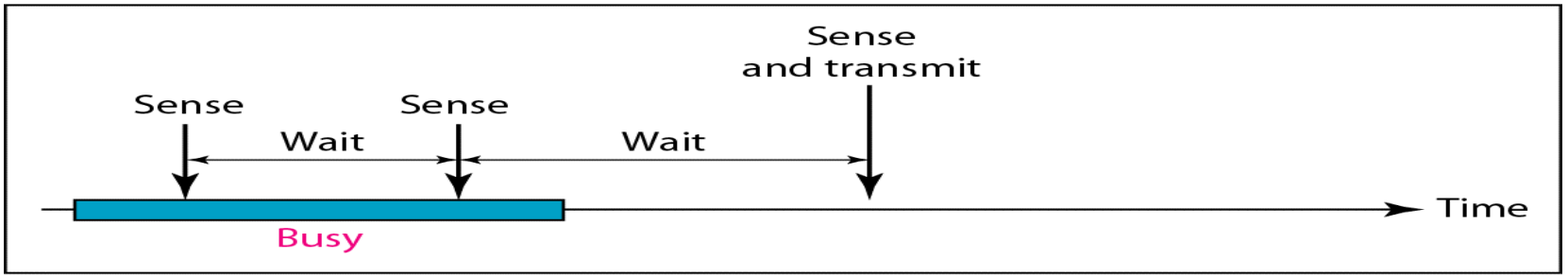
IEEE802.3 (Based on Ethernet) "Carrier Sense Multiple Access"

Carrier Sense Multiple Access

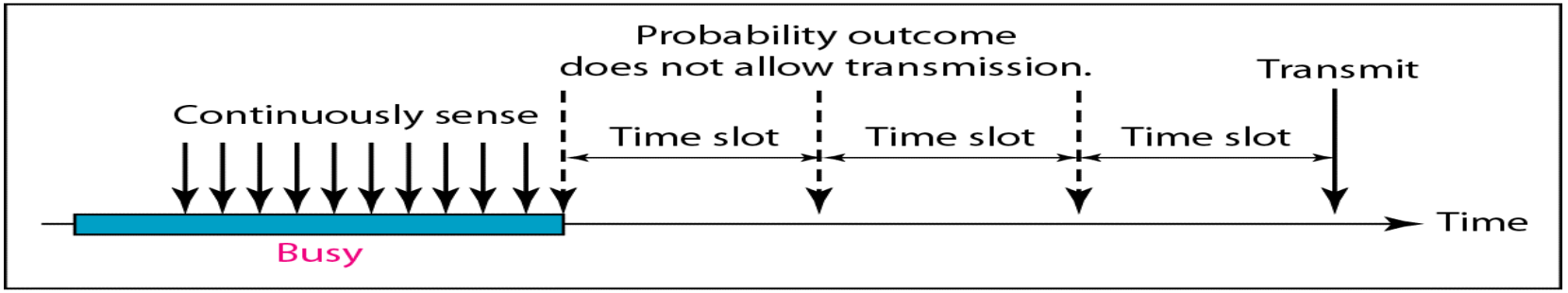
- CSMA/CD: Carrier sense, multiple access with collision detection
  - collisions detected within short time
  - colliding transmissions aborted, reducing waste
  - Persistent, non-persistent and P-persistent retransmission
- Collision Detection:
  - On baseband bus, collision produces much higher signal voltage than transmitted signal
  - For twisted pair (Hub-topology) activity on more than one port is collision

Behavior of Three Persistent Scenarios

a. 1-persistent



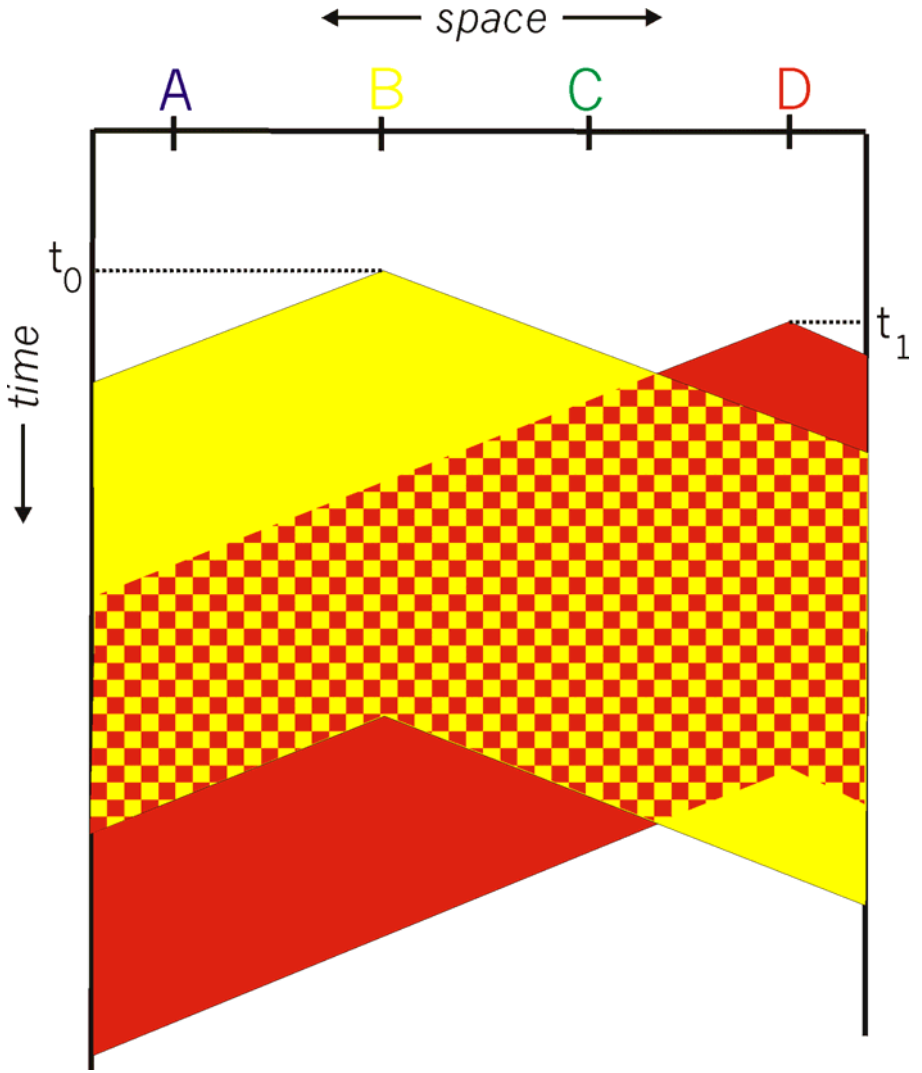
b. Nonpersistent



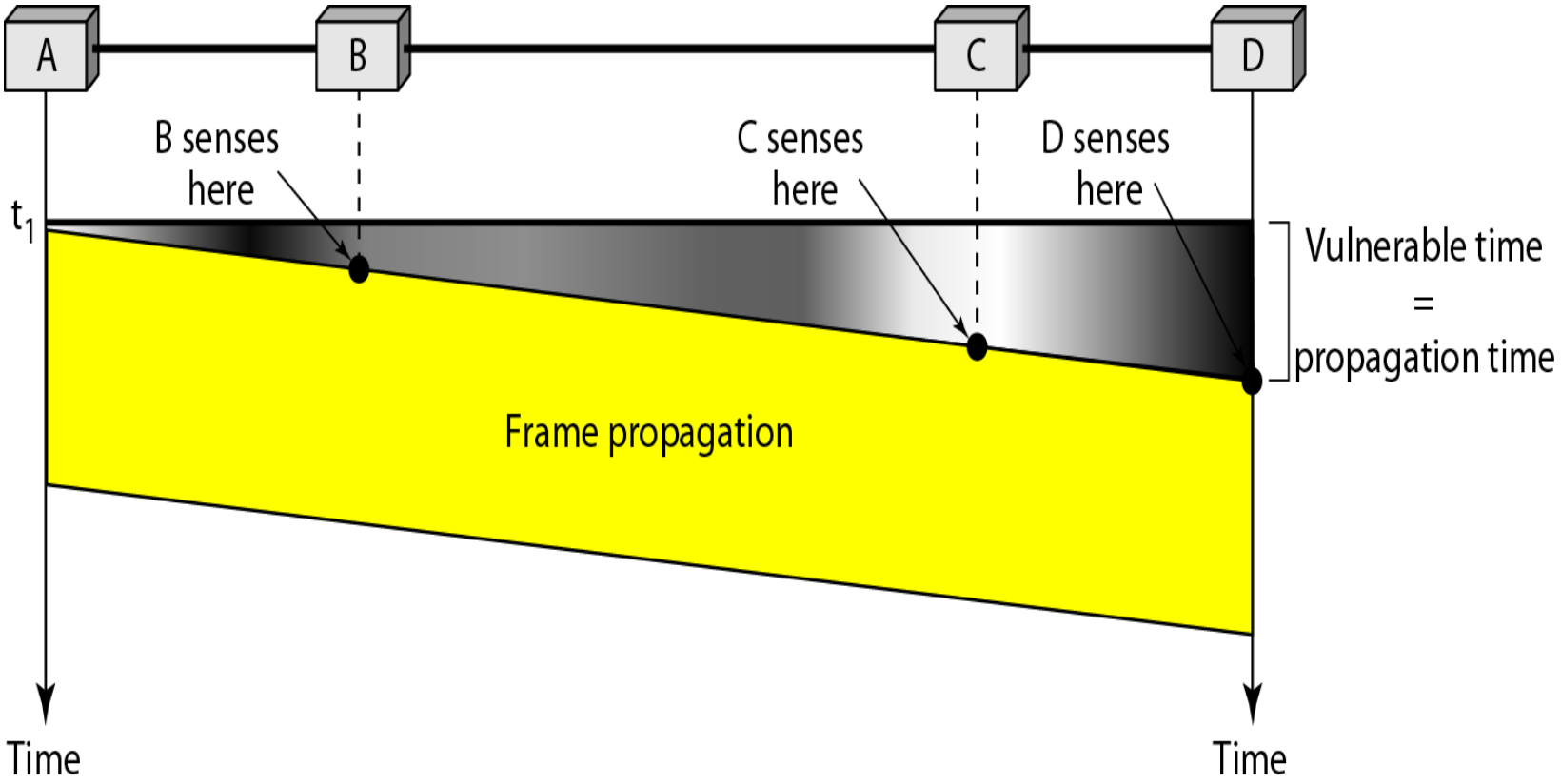
c. p-persistent

Collisions in CSMA/CD

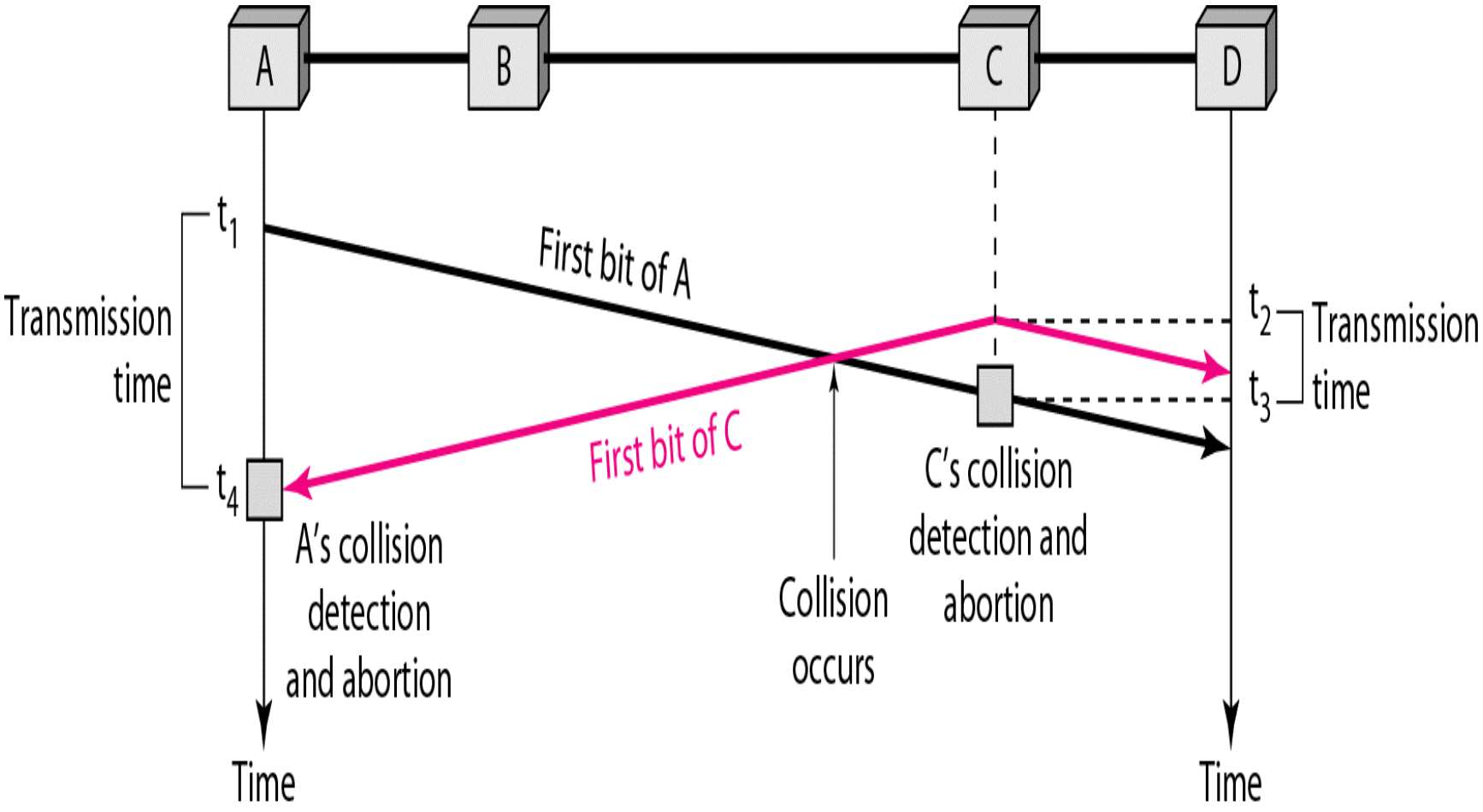
- Collisions can still occur: propagation delay means two nodes may not hear each other's transmission
- When collision occur, entire frame is wasted
- Collision is detected by comparing transmitted and received signal strengths (Hard to do in WLANs, TBD)



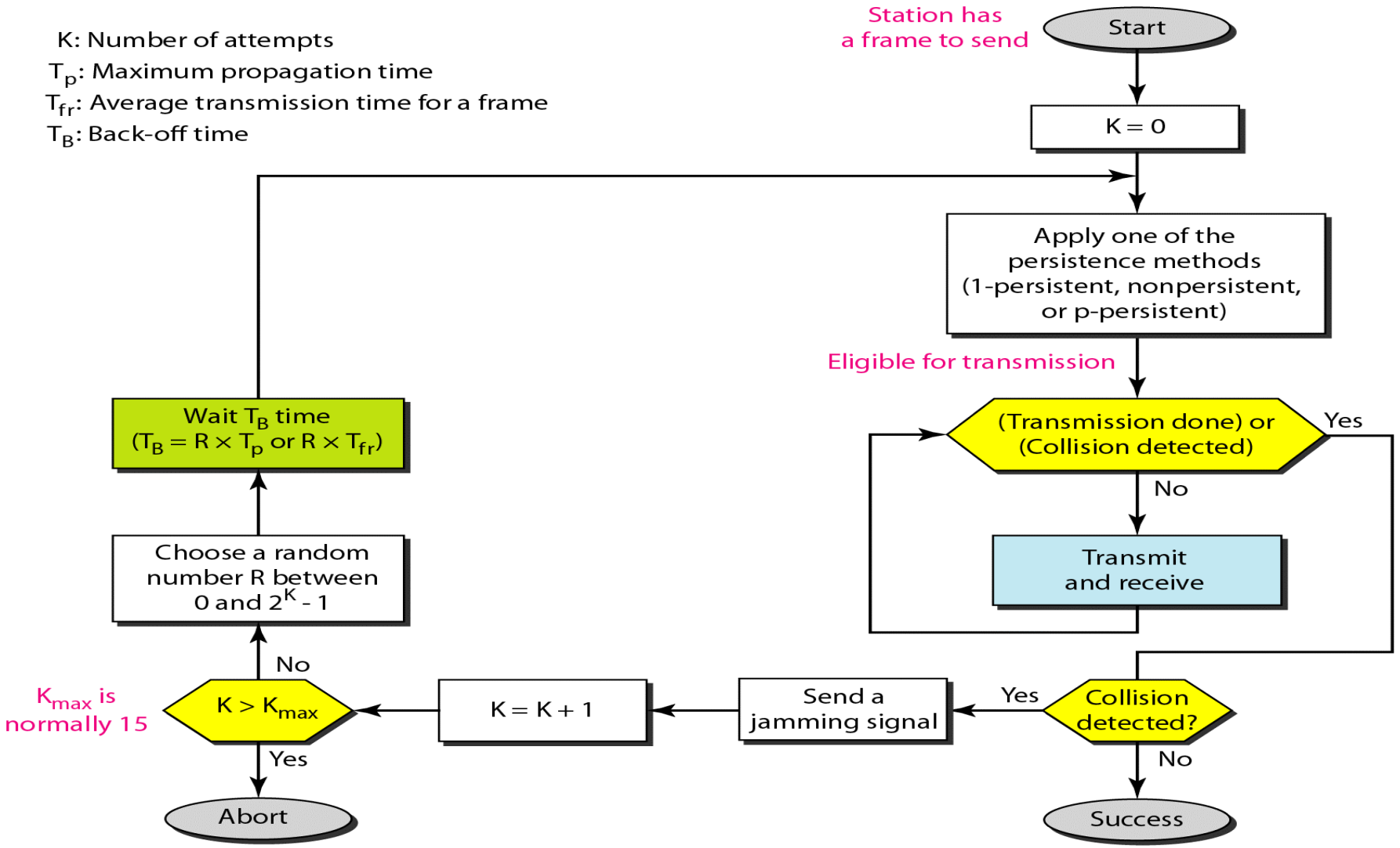
Vulnerable Time in CSMA



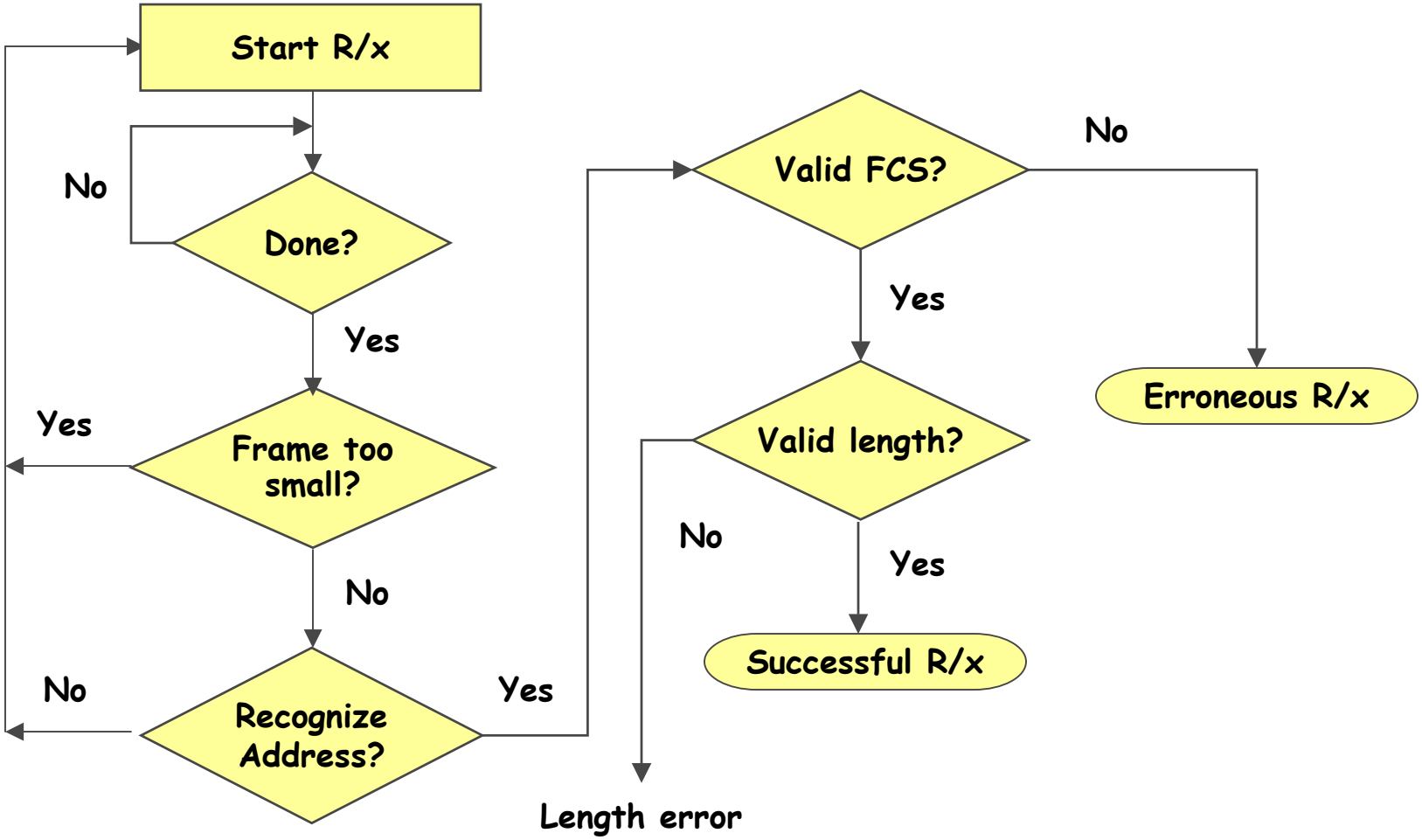
Collision Detection



Flow Chart of CSMA/CD



Receive Process in IEEE802.3

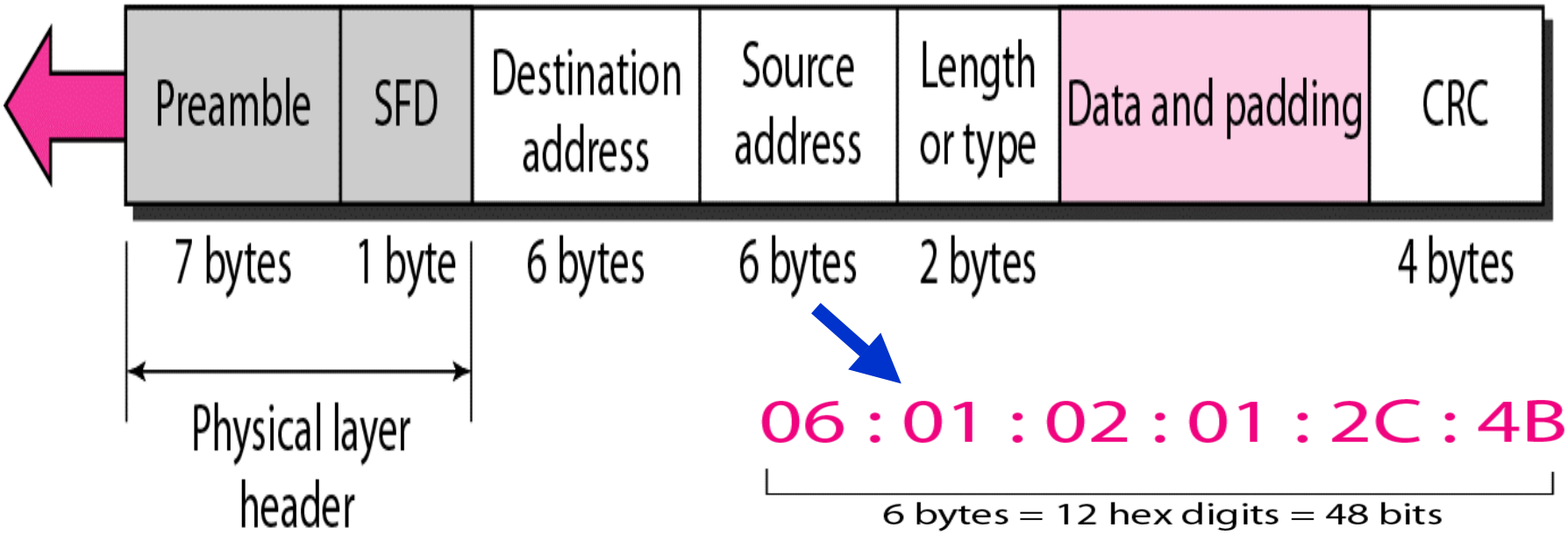


IEEE802.3 MAC Frame

Preamble: 56 bits of alternating 1s and 0s.

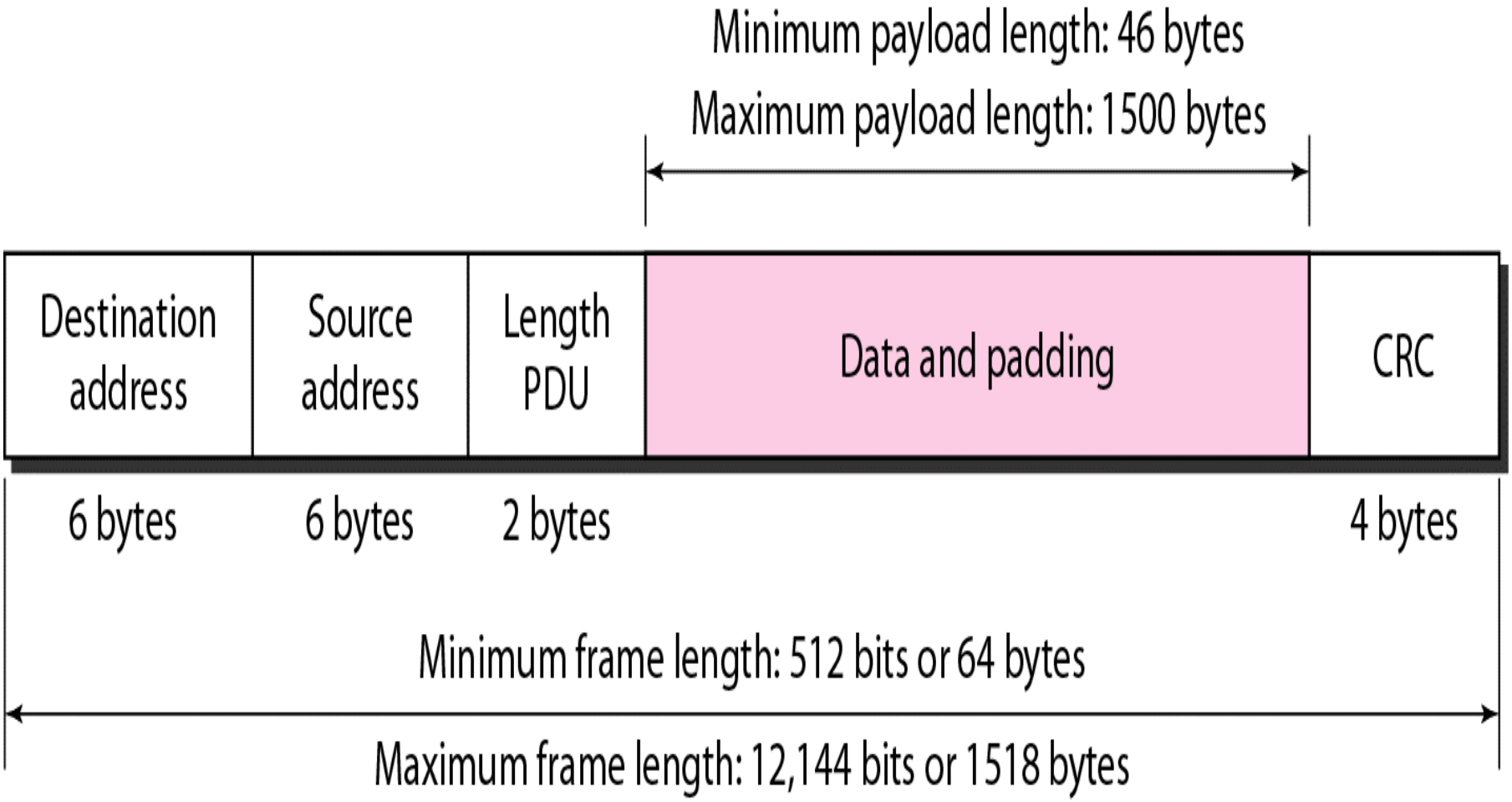
SFD: Start frame delimiter, flag (10101011)

Sending adapter encapsulates IP Packet in Ethernet frame



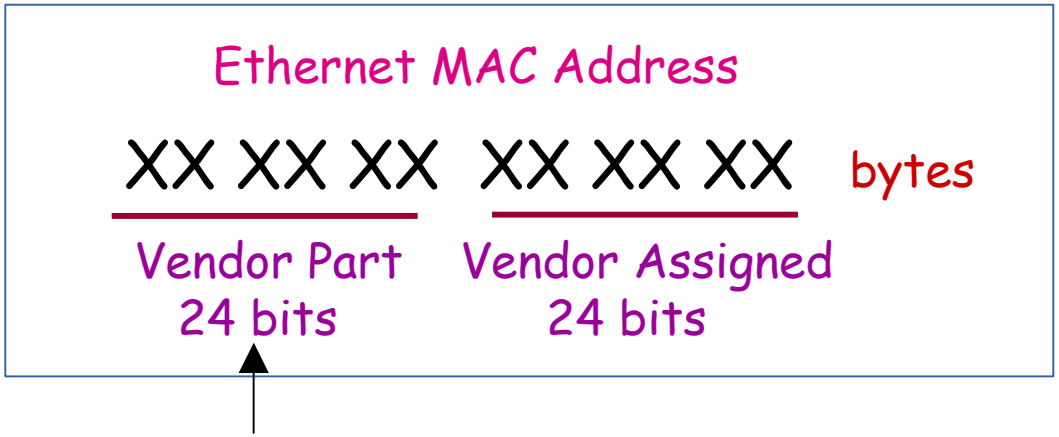
MAC address is burned in NIC ROM (sometimes software settable)

IEEE802.3 Frame Length Limits



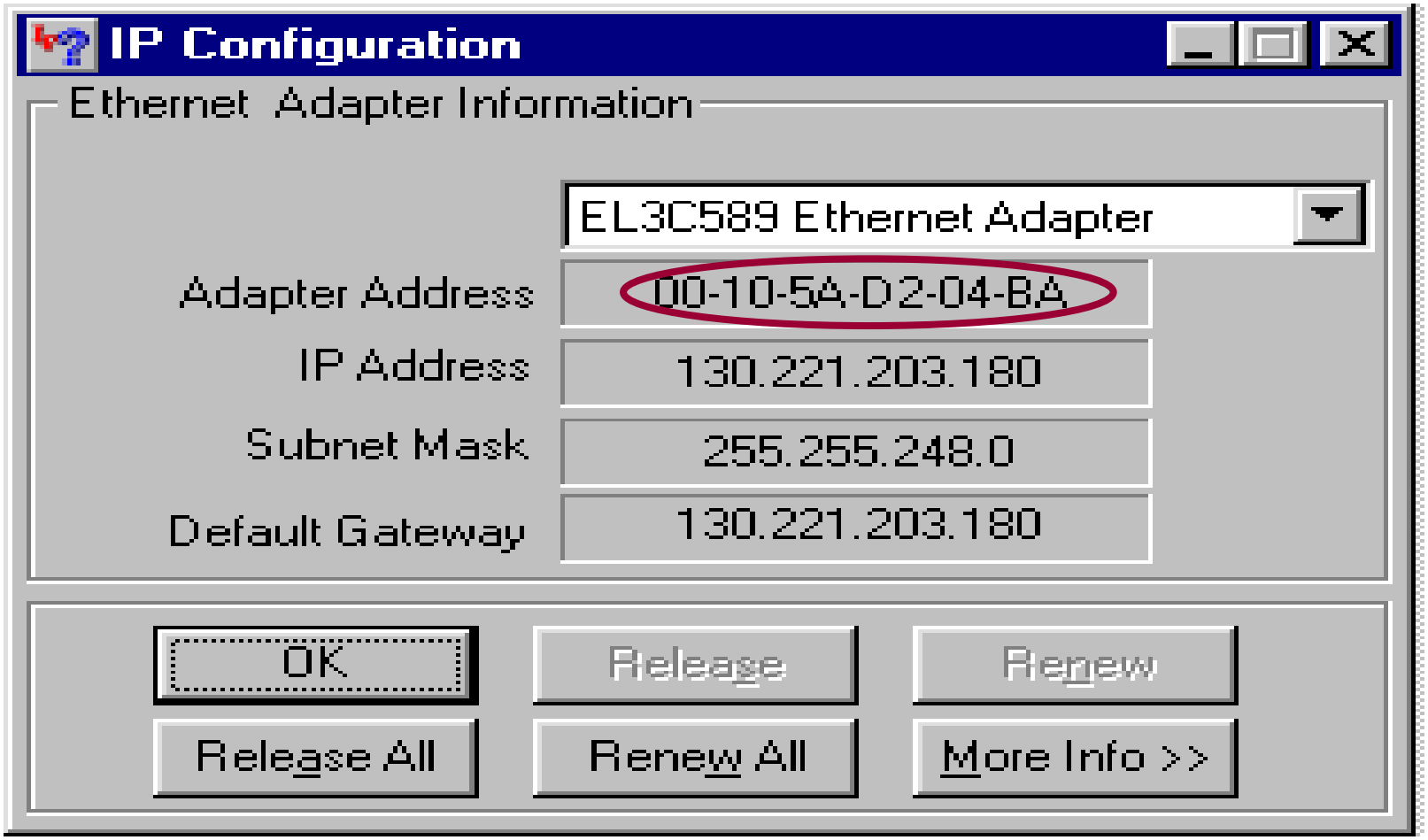
MAC Addresses

- Source and destination MAC addresses. These are the hardware addresses. They are 48-bits long each



http://standards.ieee.org/regauth/oui/
http://www.cavebear.com/CaveBear/Ethernet/

MAC Addresses (Continued)

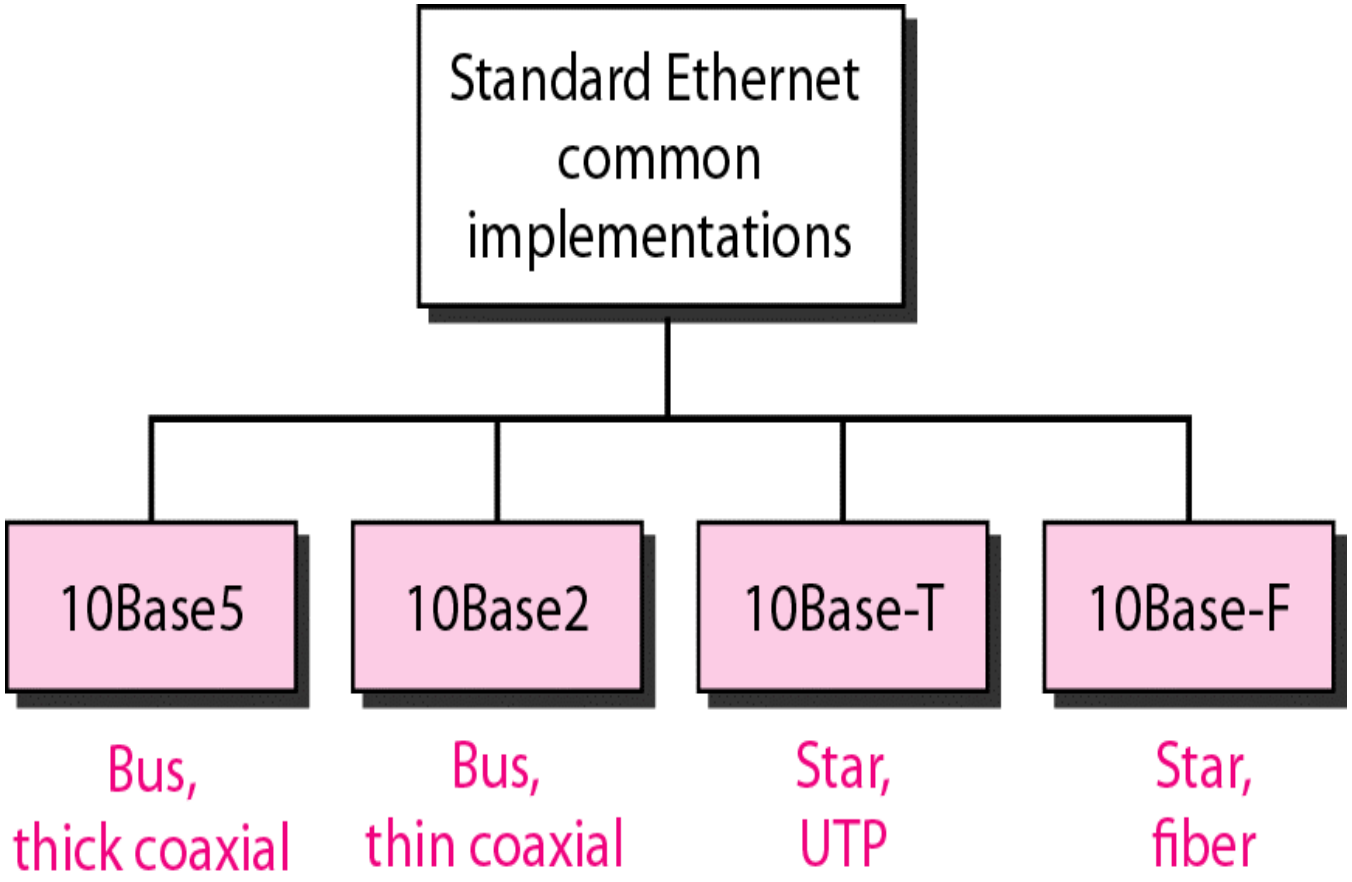


For Windows NT: MSDOS Prompt: C:\> ipconfig /all

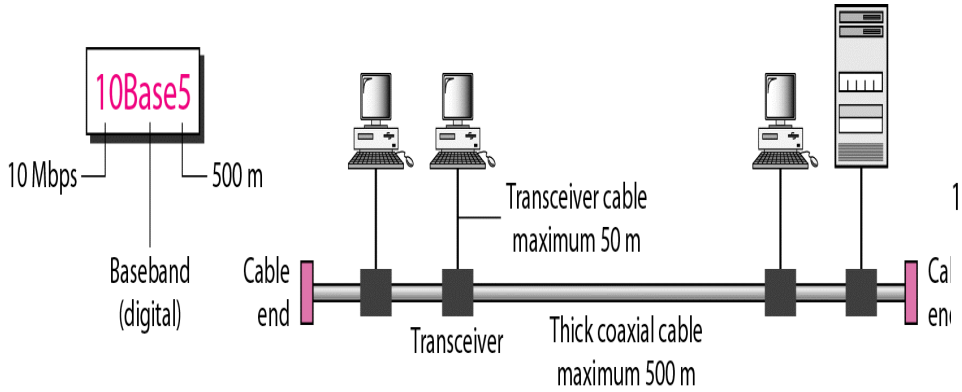
Types of MAC Addresses

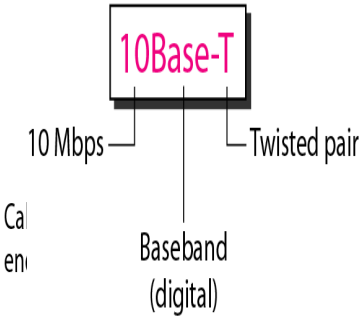
- Unicast: one interface to one interface
- Broadcast: all 1's destination address means that every attached interface to a LAN should read the frame.
  - MAC Address: FF:FF:FF:FF:FF:FF
- Multicast: an interface can be configured to read frames sent to one or more multicast addresses.

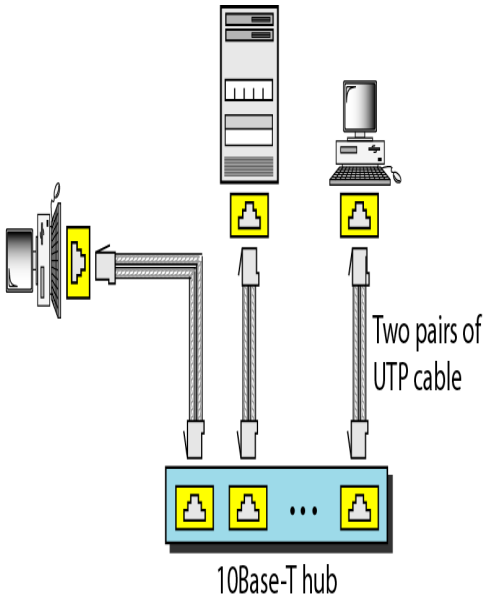
Standard Ethernet Implementations

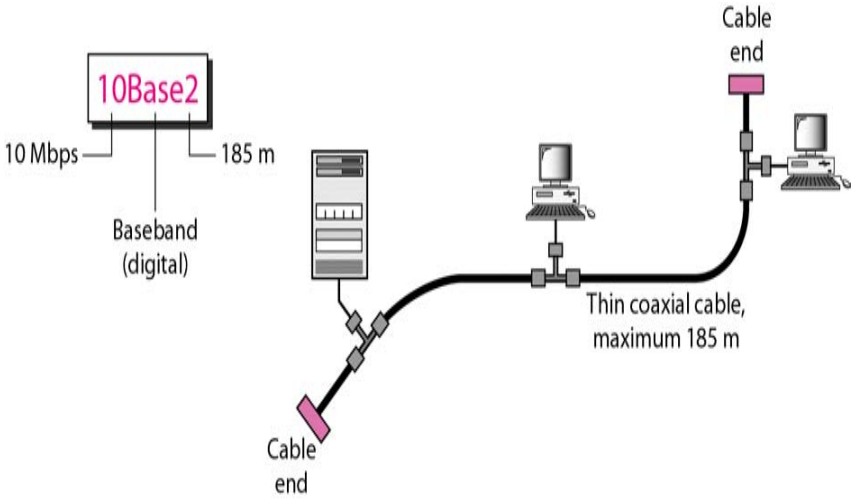


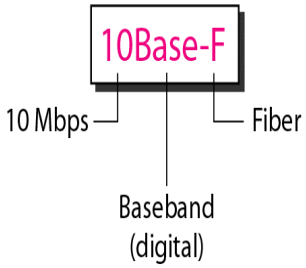
10Base? Implementations

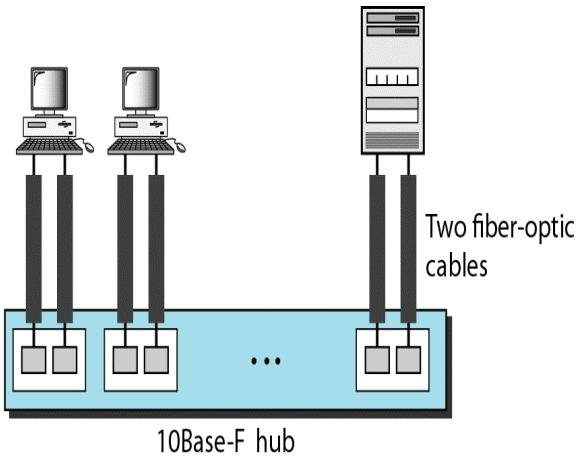












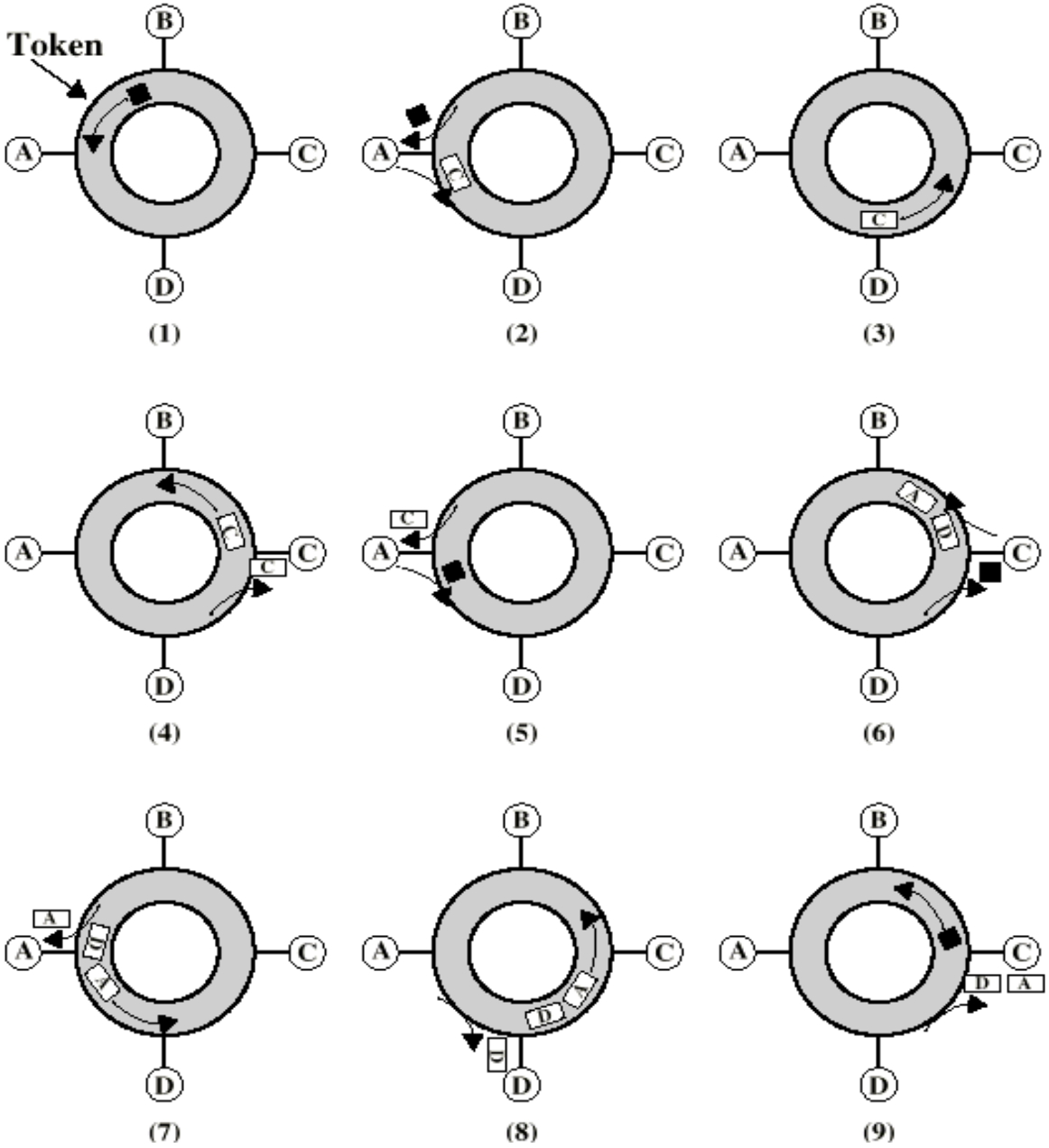
IEEE802.5 (Based on IBM) "Token-Passing Rings"

IEEE802.5 Token-Passing Rings

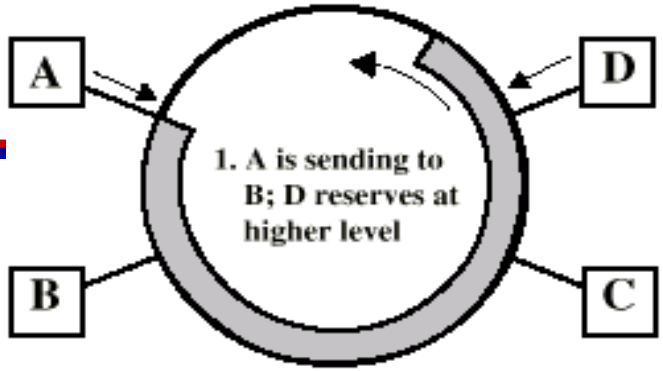
- Frames flow in one direction
- Special bit pattern (token) rotates around ring. The token is 24-bit long
- Node having a frame to transmit must capture token first
- Node must release token after done transmitting
- Node remove frame when it comes back around
- Stations get round-robin service

Token Ring

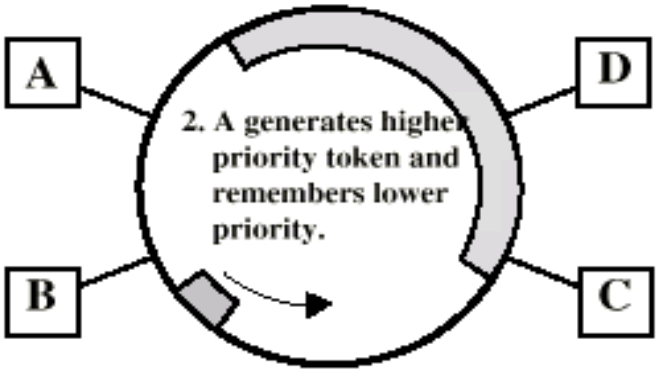
- Supports 4Mbps (UTP), 16 Mbps (STP) and 100 Mbps (Fiber)
- Token Holding Timer ~ 10 msec which limits the frame length ~ 4500 Bytes for the 4Mbps Rings and ~ 18,000 Bytes for the faster Rings



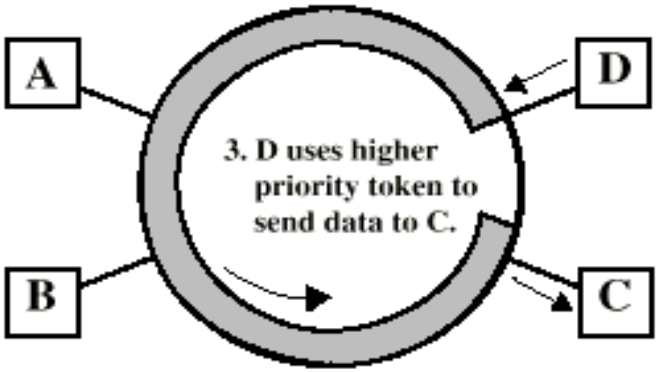
Priority

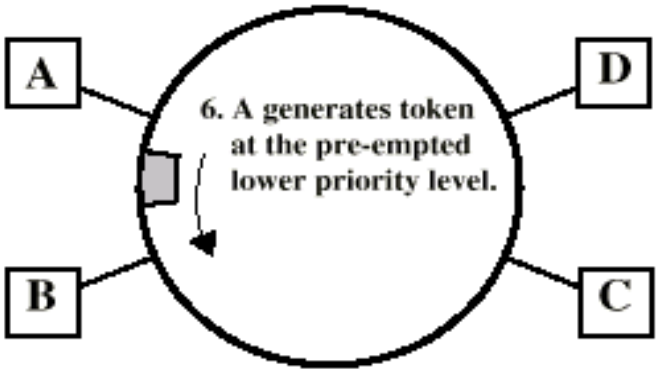

A
D
1. A is sending to B; D reserves at higher level
B
C


A
D
4. D generates token at higher priority level
B
C


A
D
2. A generates higher priority token and remembers lower priority.
B
C


A
D
5. A sees the high priority token and captures it.
B
C


A
D
3. D uses higher priority token to send data to C.
B
C

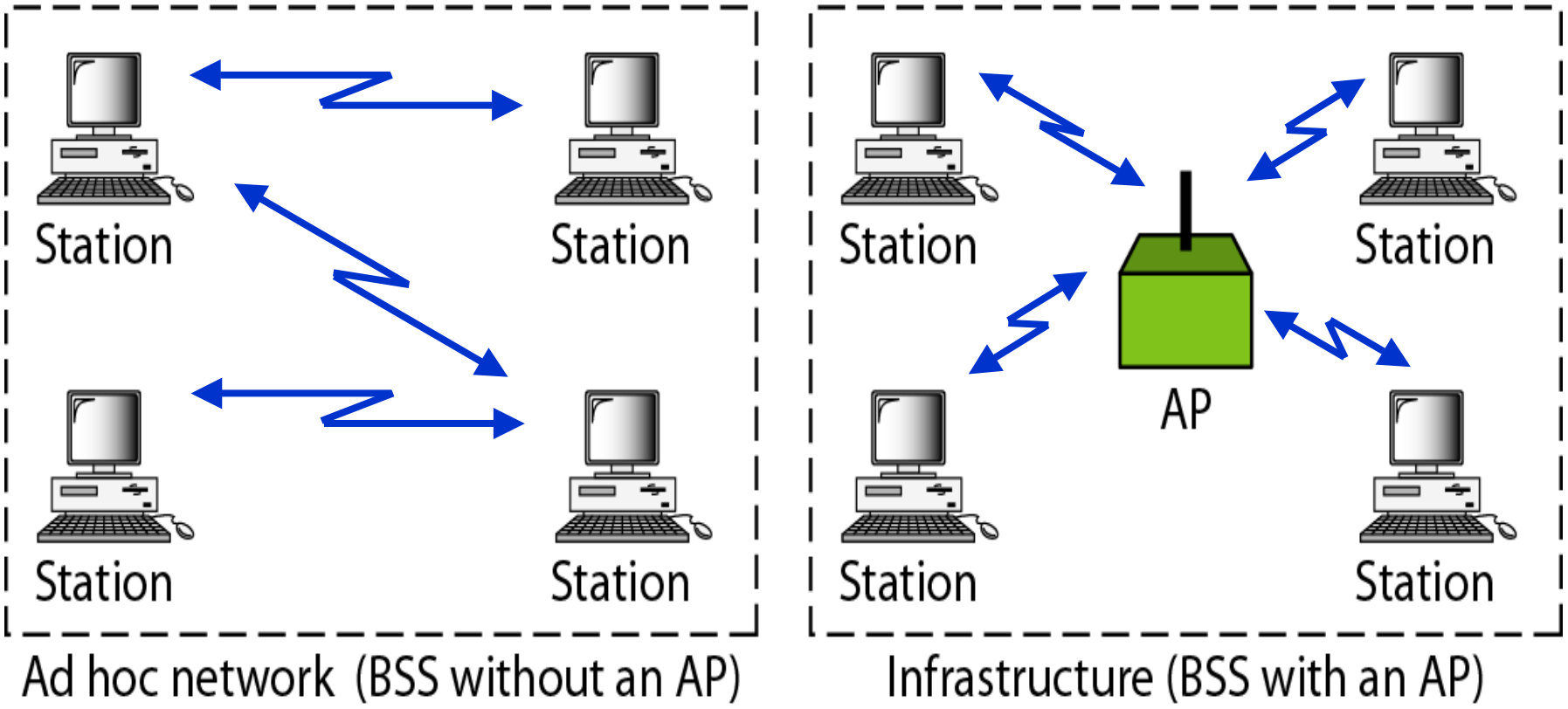

A
D
6. A generates token at the pre-empted lower priority level.
B
C

IEEE 802.11
Wireless LANs (Wi-Fi)

Ad-hoc vs. Infrastructure WLANs

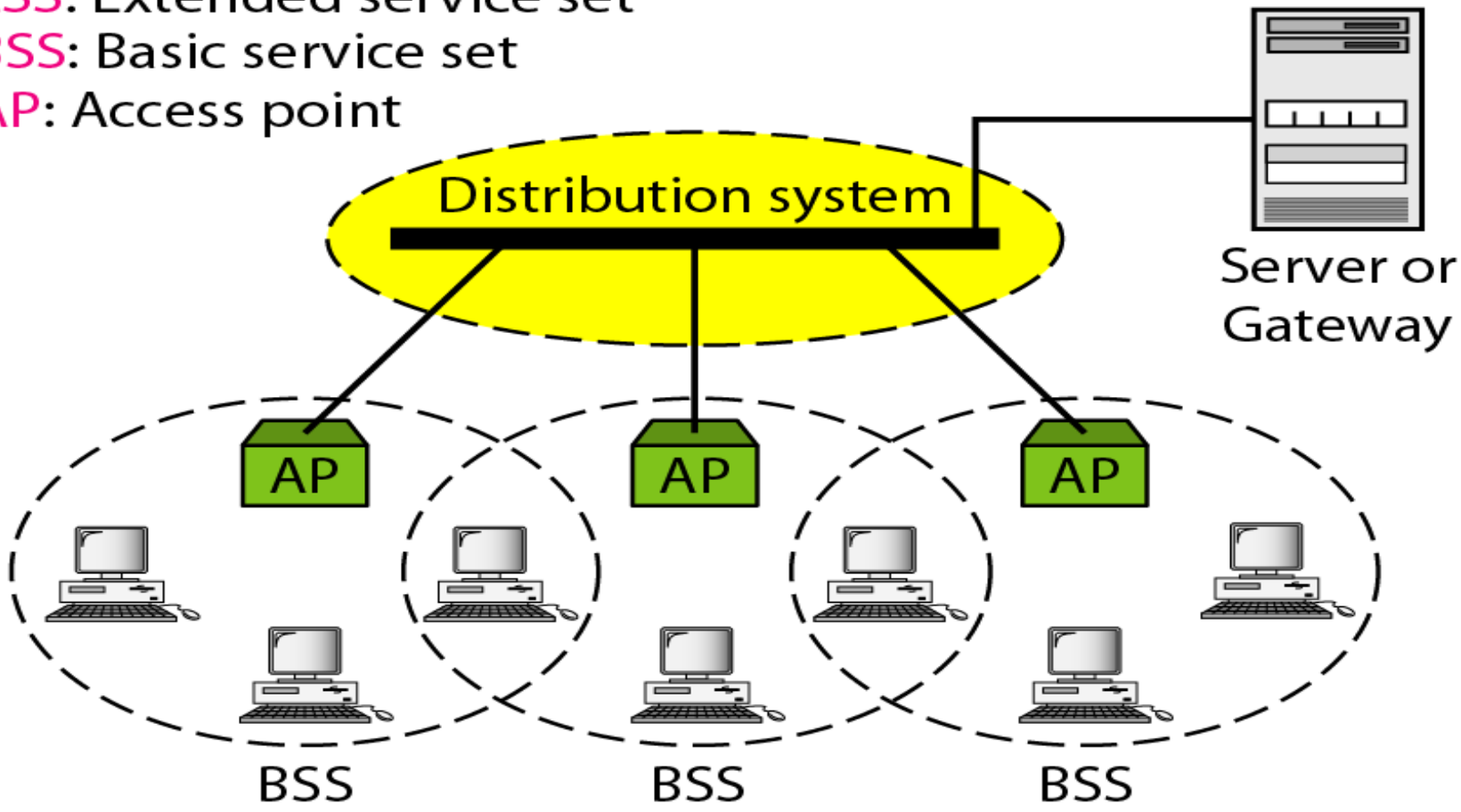
BSS: Basic service set

AP: Access point

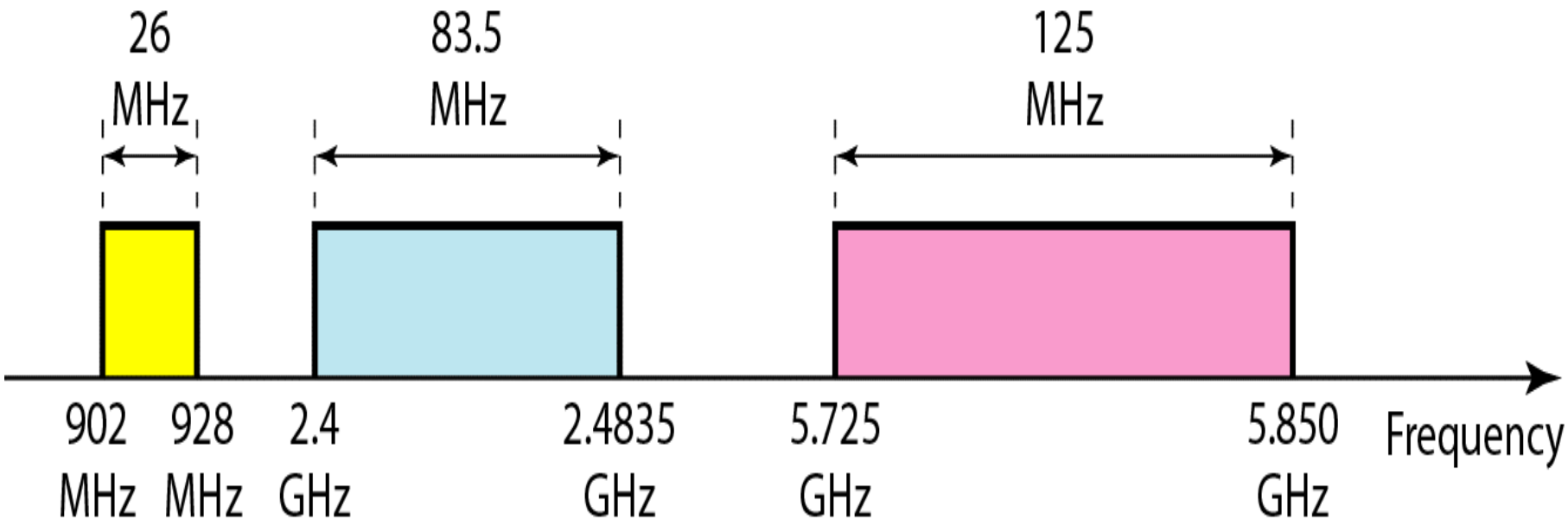


Extended Service Sets

ESS: Extended service set
BSS: Basic service set
AP: Access point



Unregulated Band (ISM)



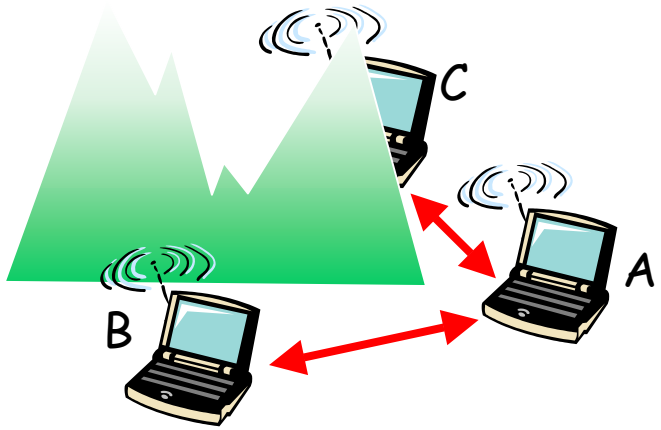
ISM: Industrial, Scientific and Medical band

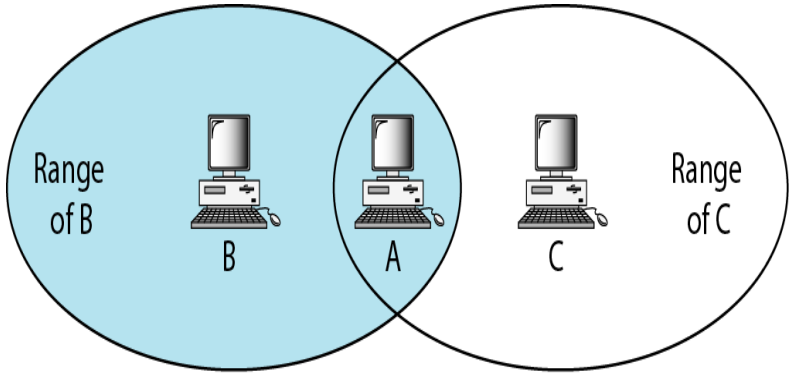
Wireless Link Characteristics

- Differences from wired link ….
  - Decreased Signal Strength: Radio signal attenuates as it propagates through matter (path loss)
  - Interference from other sources: standardized wireless network frequencies (e.g., 2.4 GHz) shared by other devices (e.g., phone); devices (motors) interfere as well
  - Multipath propagation: Radio signal reflects off objects ground, arriving ad destination at slightly different times

Hidden Terminal Problem

- Hidden terminal problem
  - B, A hear each other
  - C, A hear each other
  - B, C can not hear each other
  - Means B, C unaware of their interference at A

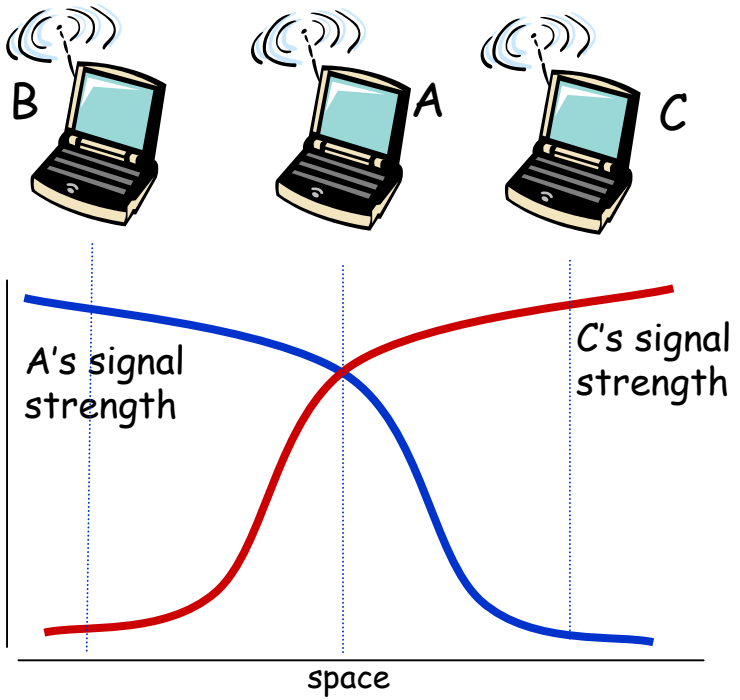




B and C are hidden from each other with respect to A.

Signal Fading

- Signal fading:
  - A, B can hear each other
  - A, C can hear each other
  - B, C can not hear each other interfering at A
  - Signal losses its strength as distance increases



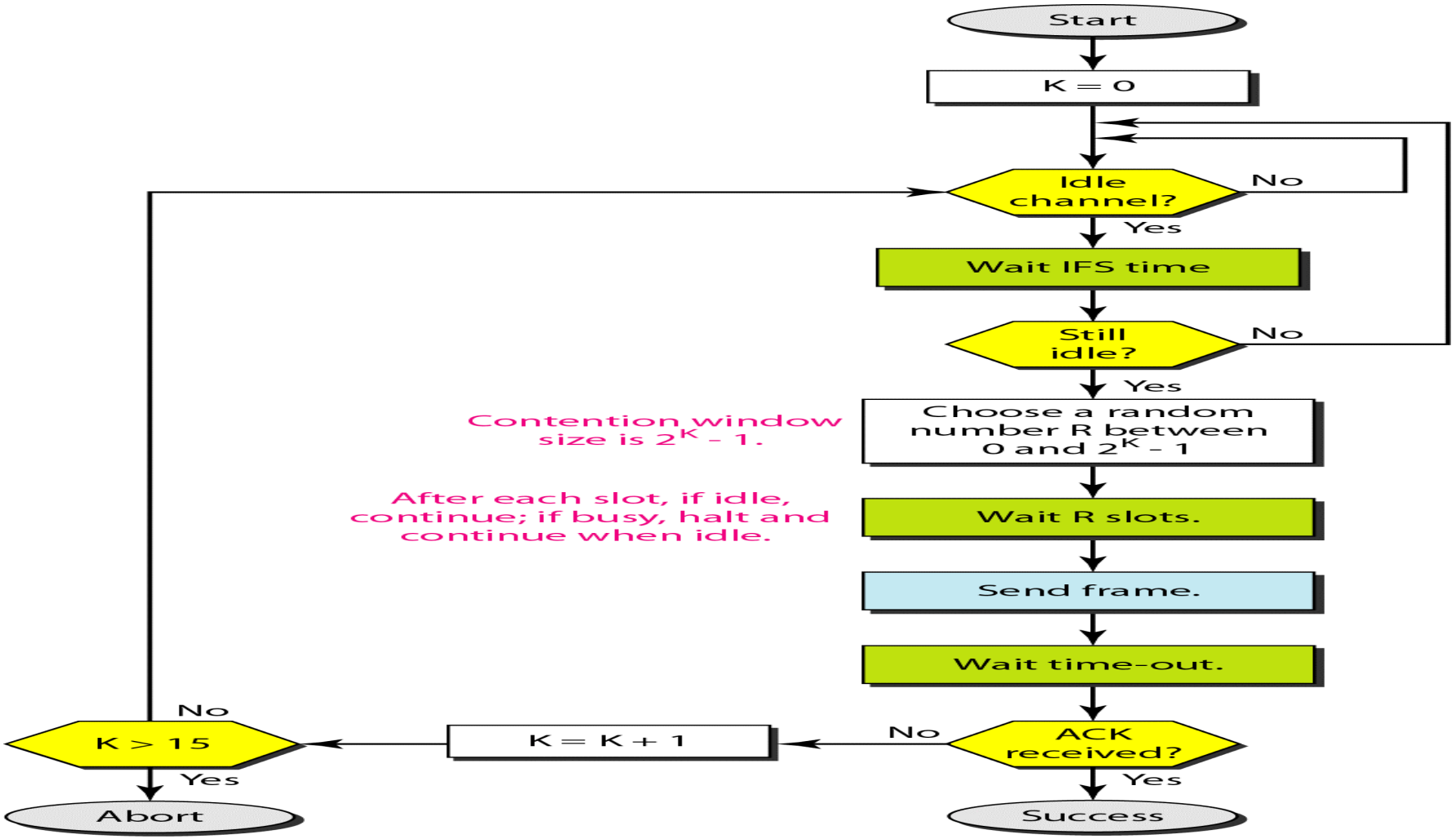
Channel Association

- 802.11b: 2.4GHz-2.485GHz spectrum divided into 11 channels at different frequencies
  - AP admin chooses frequency for AP
  - Interference possible: channel can be same as that chosen by neighboring AP!
- Host: must *associate* with an AP
  - Scans channels, listening for Beacon frames containing AP's name (SSID) and MAC address
  - Selects AP to associate with
  - May perform authentication
  - Run DHCP to get IP address in AP's subnet

IEEE802.11 MAC Protocol

- Avoid collisions: 2+ nodes transmitting at same time
- 802.11: CSMA - sense before transmitting
  - Don't collide with other transmissions
- 802.11: No collision detection!
  - Difficult to receive (sense collisions) when transmitting due to weak received signals (fading)
  - Can't sense all collisions in any case: hidden terminal, fading
  - Goal: avoid collisions: CSMA/C(ollision)A(voidance)

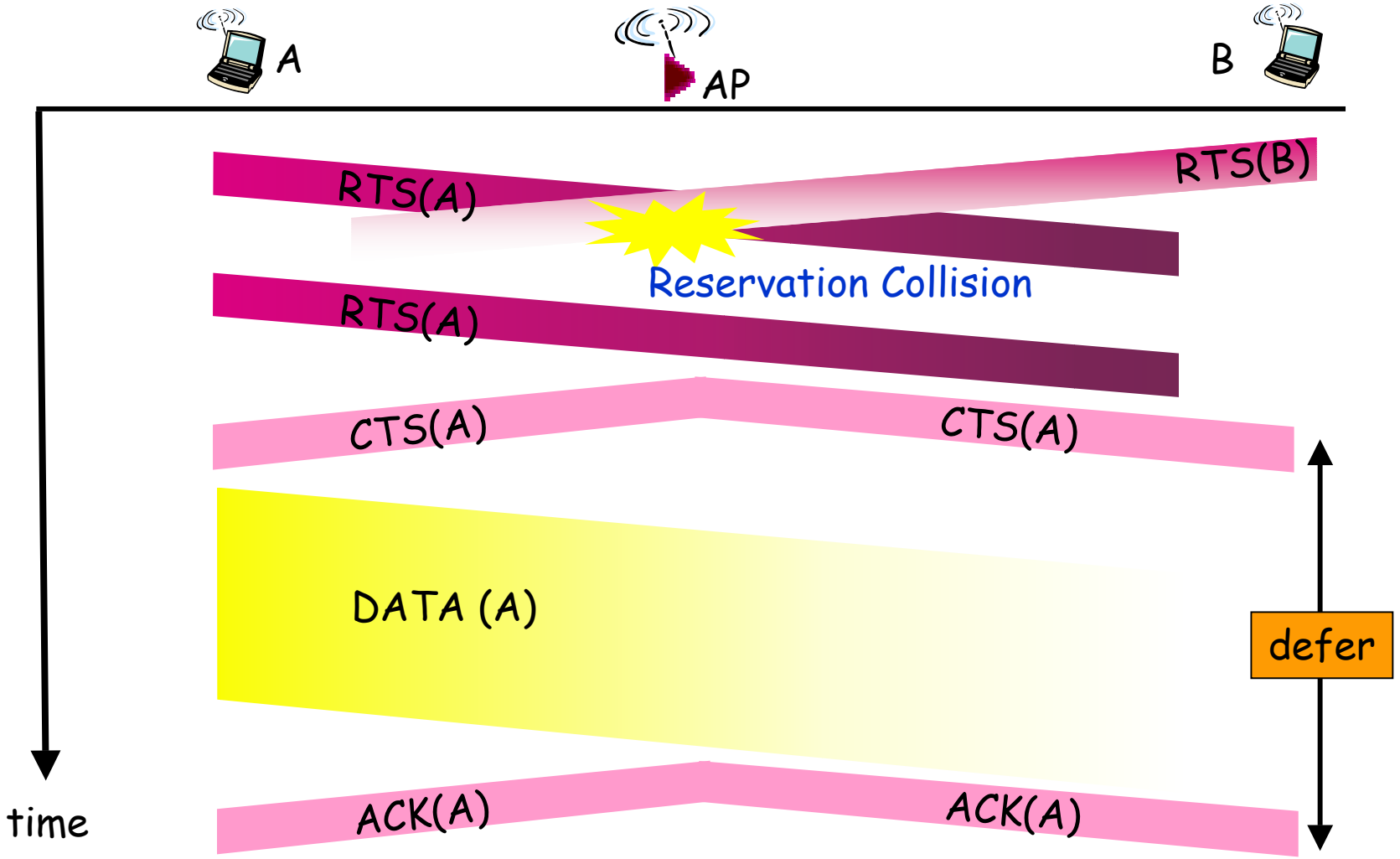
Flow Chart for CSMA/CA



Avoiding Collisions

- Idea: allow sender to "reserve" channel rather than random access of data frames: avoid collisions of long data frames
- Sender first transmits small request-to-send (RTS) frames to BS using CSMA
  - RTSs may still collide with each other (but they're short)
- BS broadcasts clear-to-send CTS in response to RTS
- CTS heard by all nodes
  - Sender transmits data frame
  - Other stations defer transmissions

Collision Avoidance with RTS & CTS



Collision Avoidance using RTS/CTS

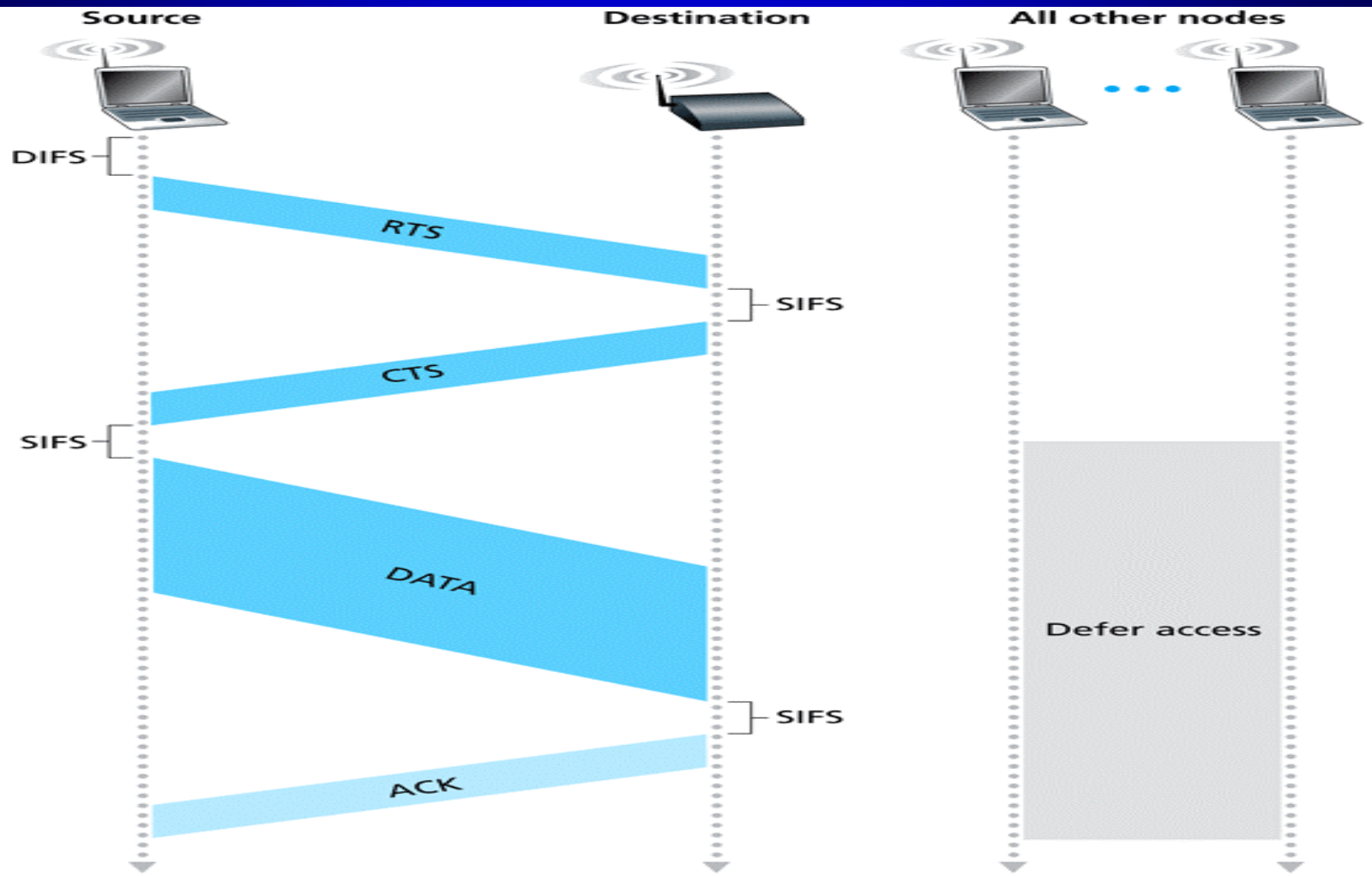
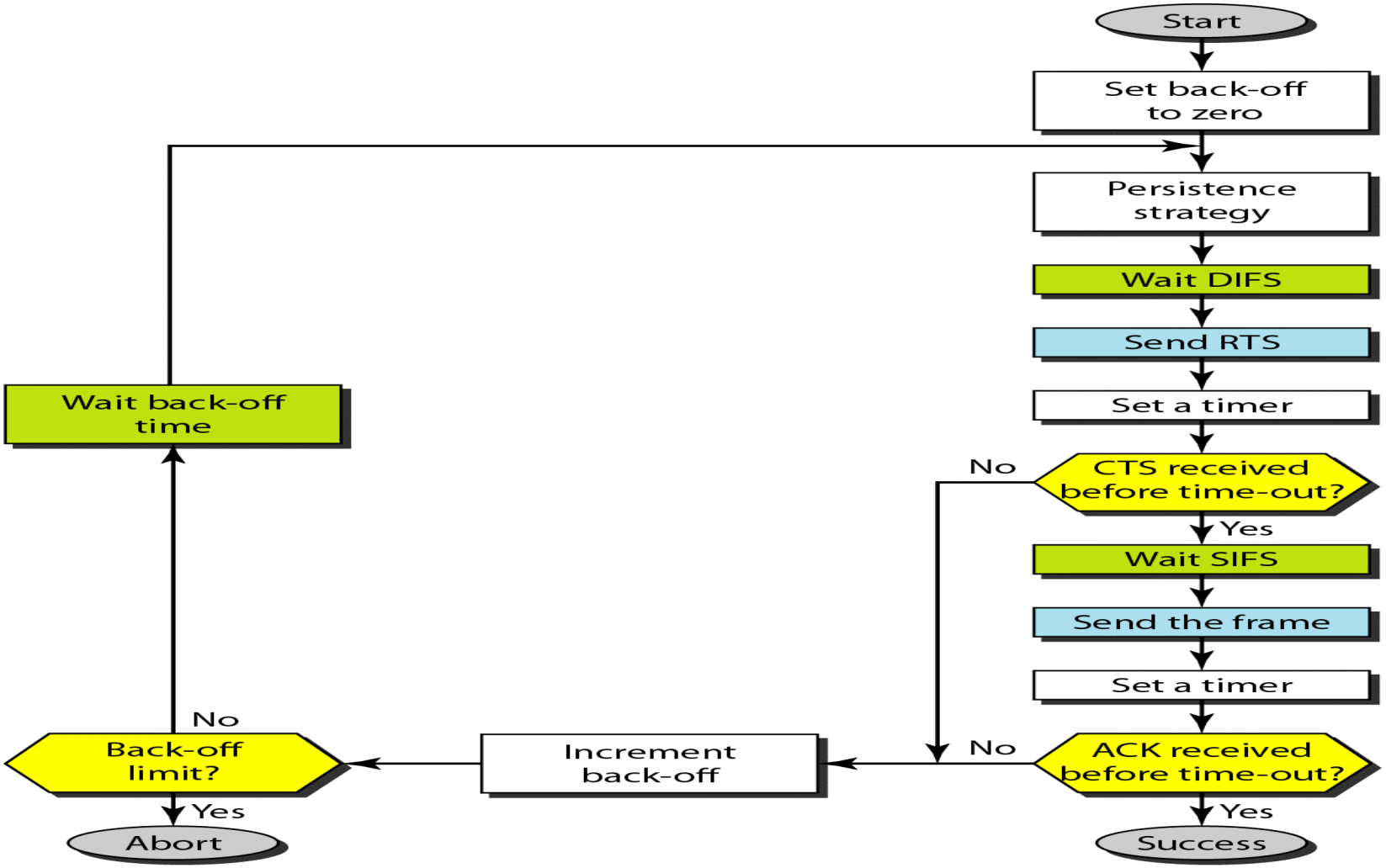
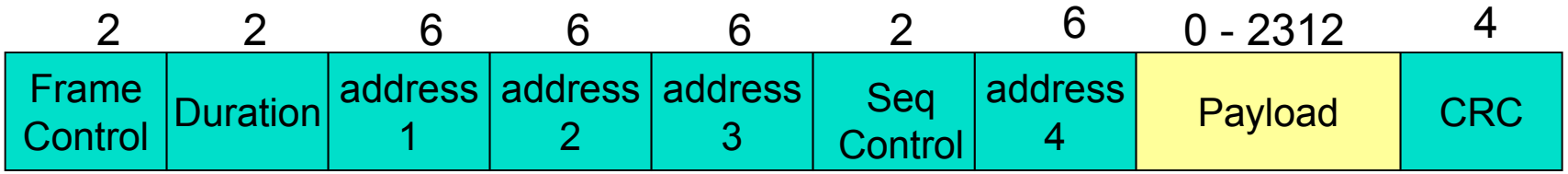


Figure 6.12 ◆ Collision avoidance using the RTS and CTS frames

RTS/CTS Scheme Flow Chart



IEEE802.11 Frame Structure



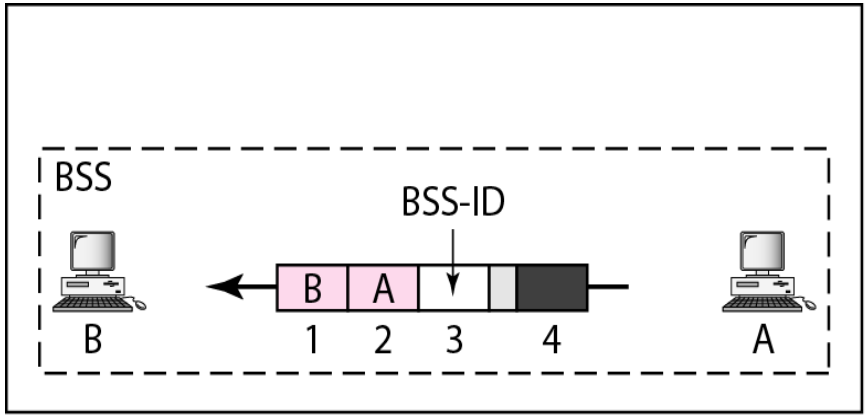
Address 1: MAC address of wireless host or AP to receive this frame

Address 2: MAC address of wireless host or AP transmitting this frame

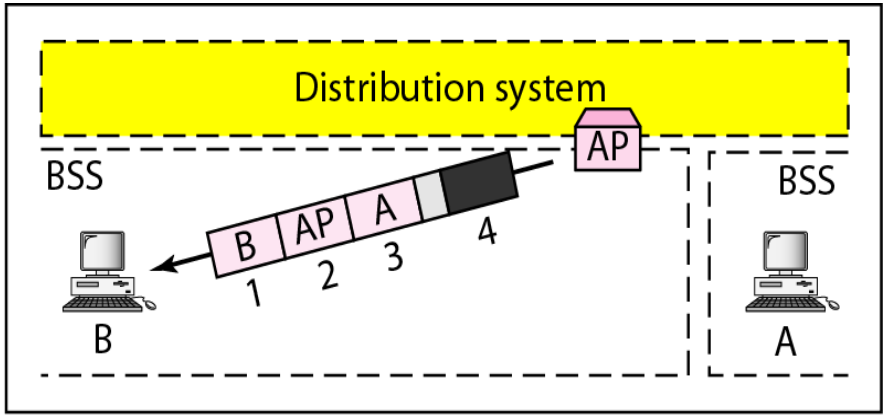
Address 3: MAC address of router interface to which AP is attached

Address 4: used only in ad hoc mode

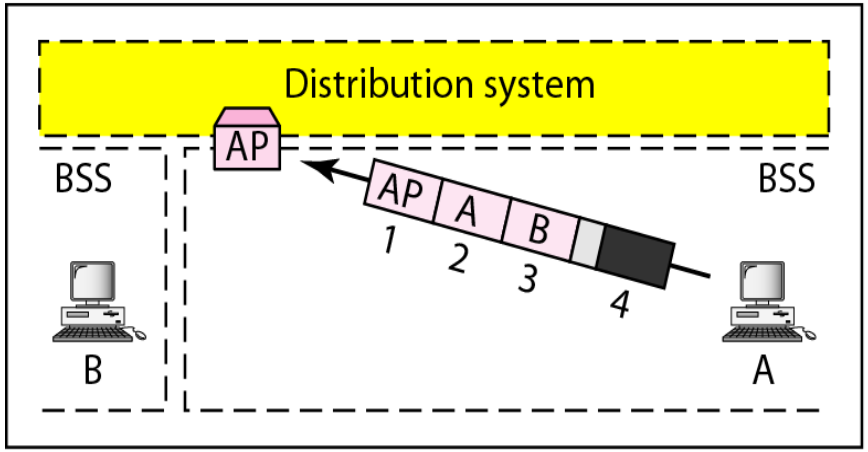
Addressing Mechanisms



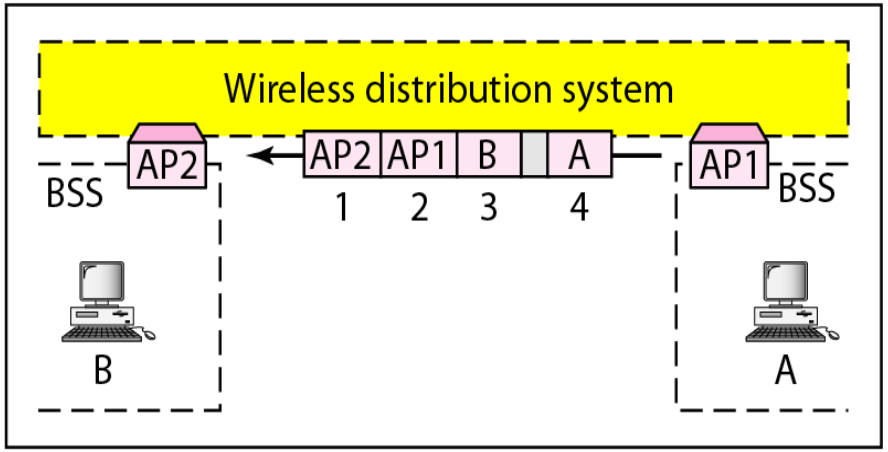
a. Case 1



b. Case 2



c. Case 3



d. Case 4

IEEE802.11 Frame Addressing