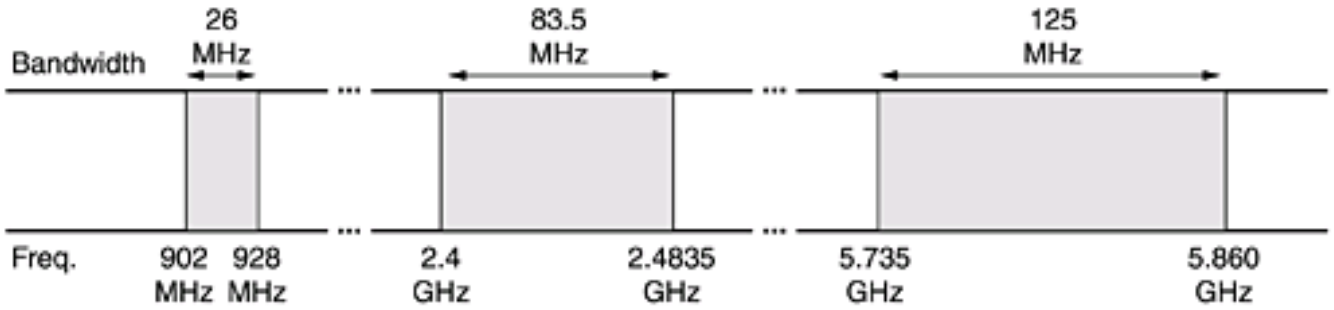
Δίκτυα τύπου IEEE 802.11

WiFi

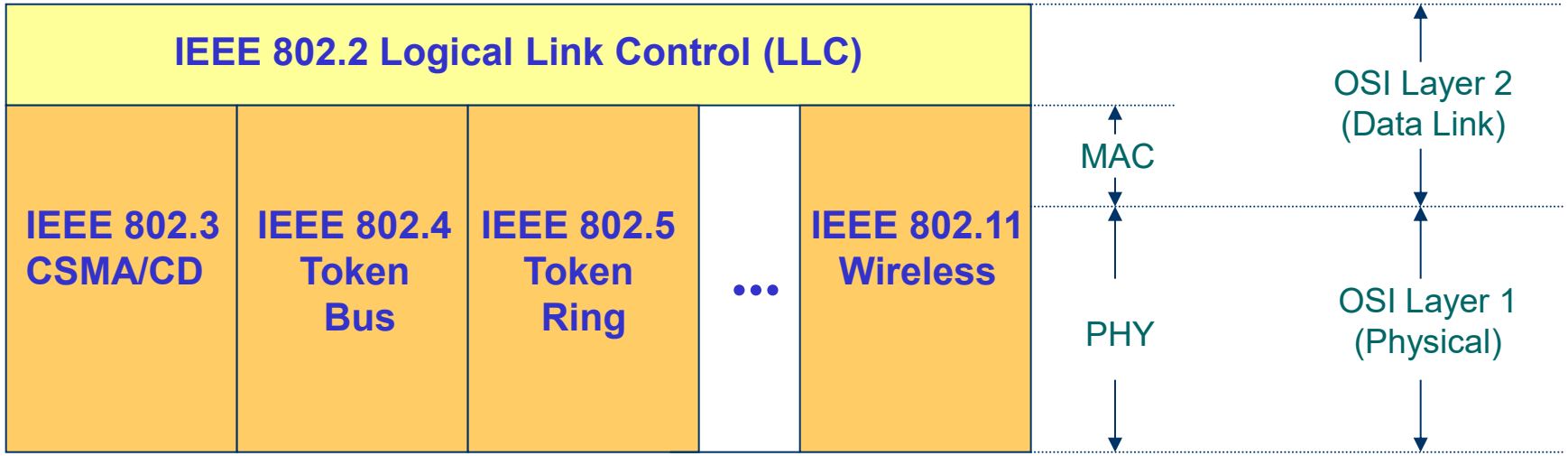
- At 1997 IEEE issued standard IEEE Std. 802.11-1997 for wireless local transmissions at the ISM band.
- The standard defines MAC and PHY layers for wireless local environments.
- Standard 802.11 provides 2Mbps at 2,4GHz (’97).
- Extension 802.11b provides 11Mbps at 2,4GHz (’99).
- Extension 802.11a provides 54Mbps at 5GHz (’99) through OFDM.
- Extension 802.11g offers 54Mbps at 2,4GHz (’02) through OFDM.
- Extension 802.11n offers up to 600Mbps at 2,4/5GHz through MIMO.

ISM Band (Industrial Scientific Medical)

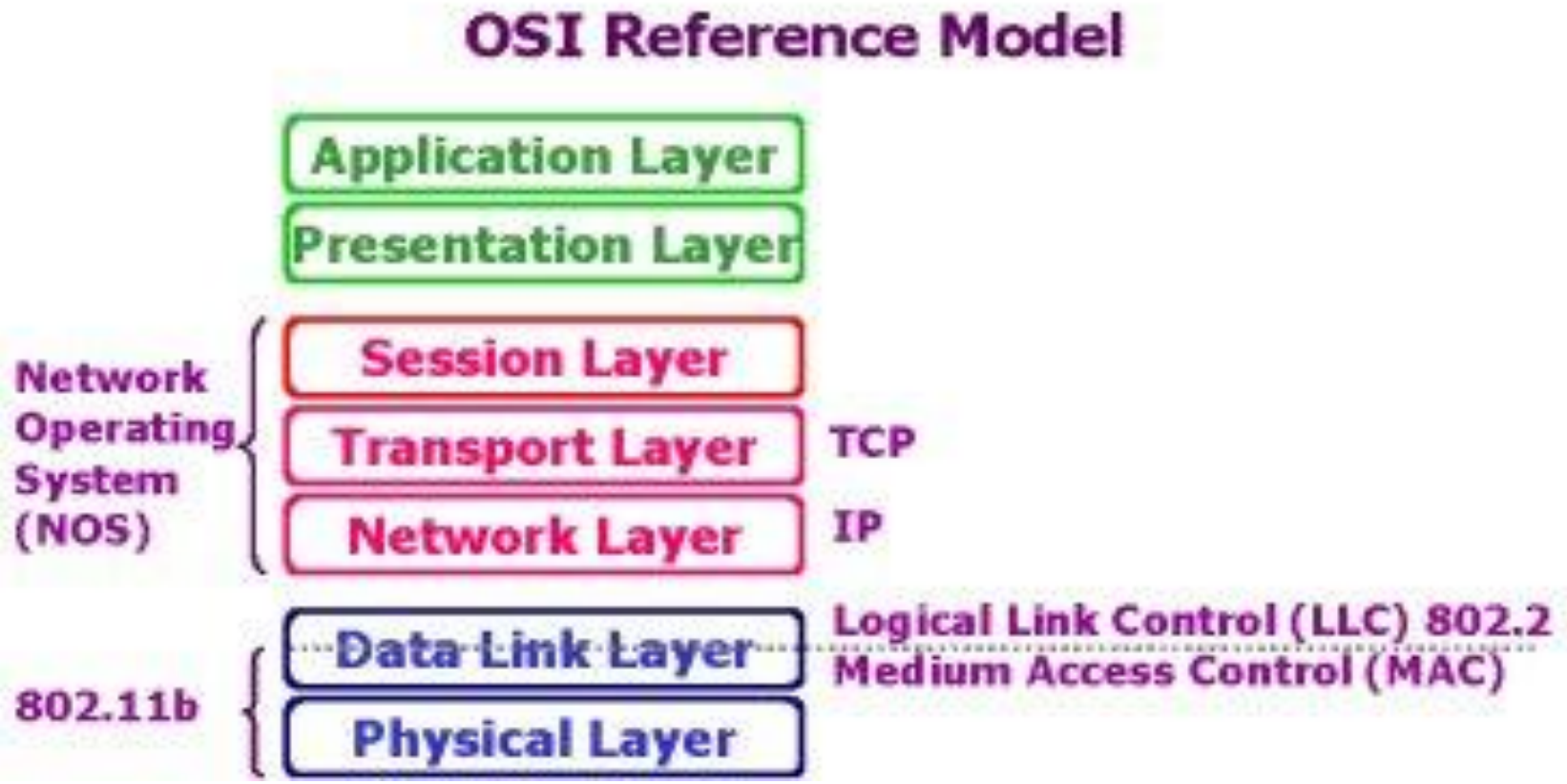


- Free to use without the need for a license
- Used mainly for WLANS

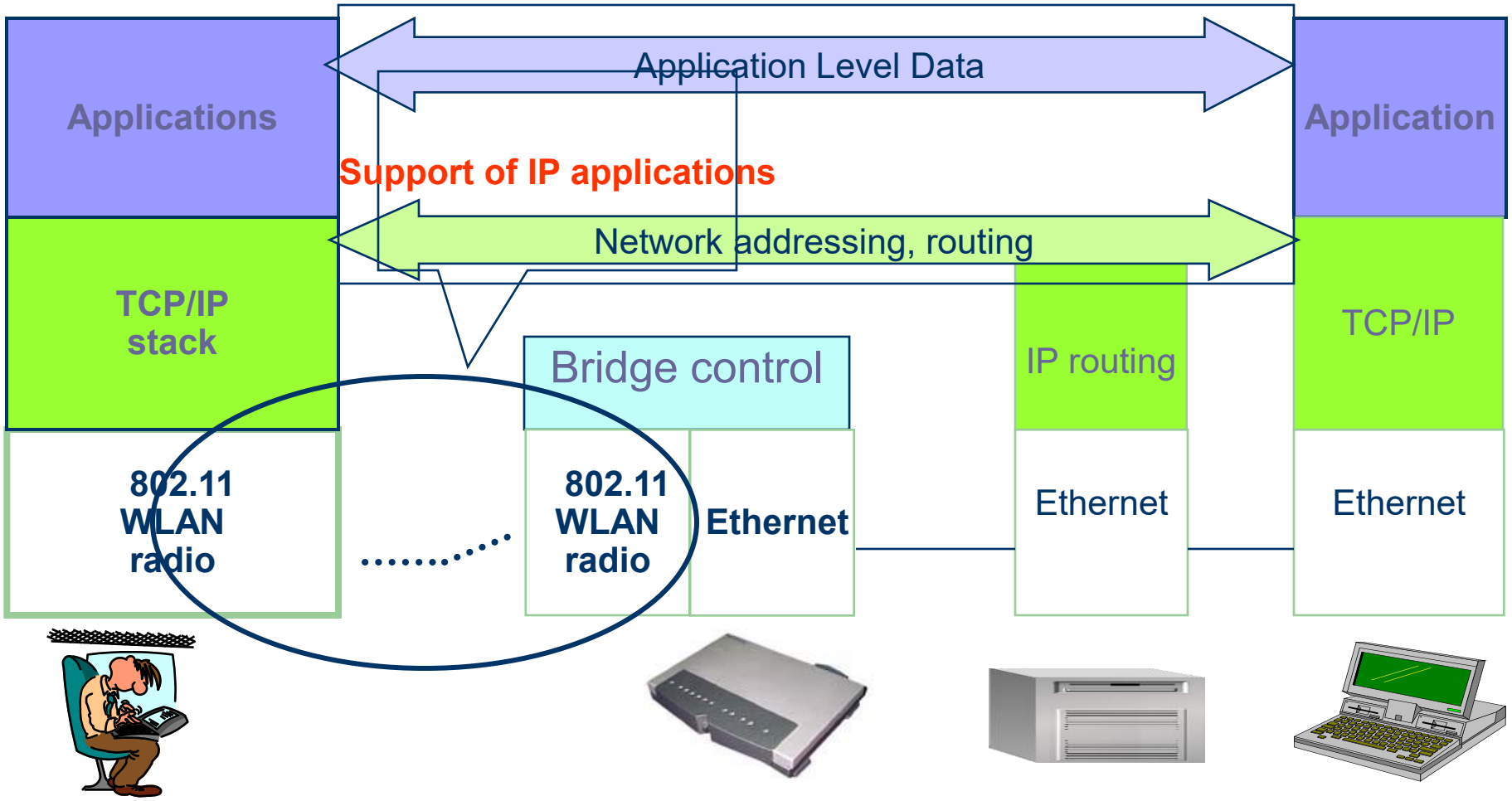
The 802.x family of standards



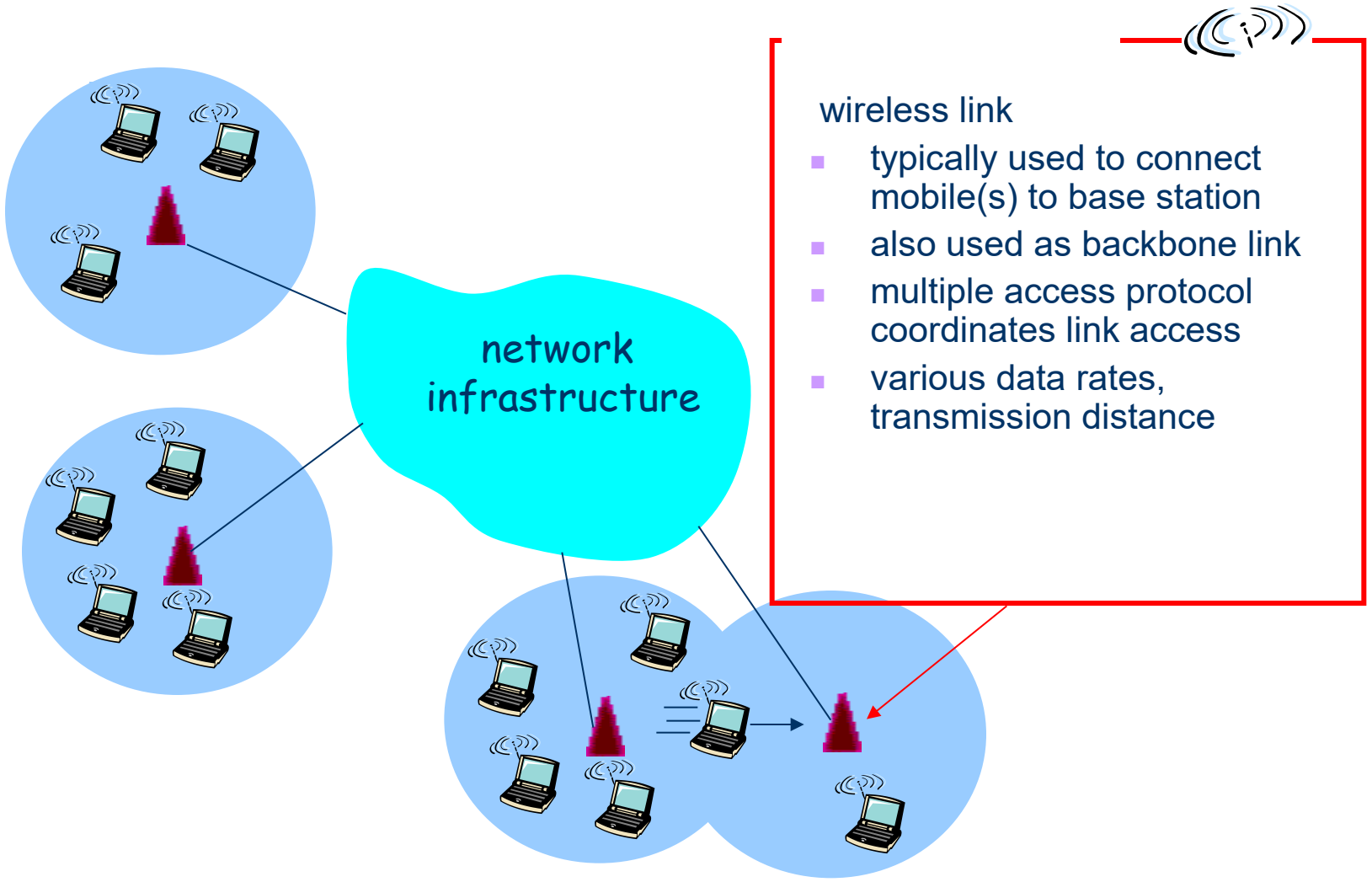
The 802.11 protocol stack



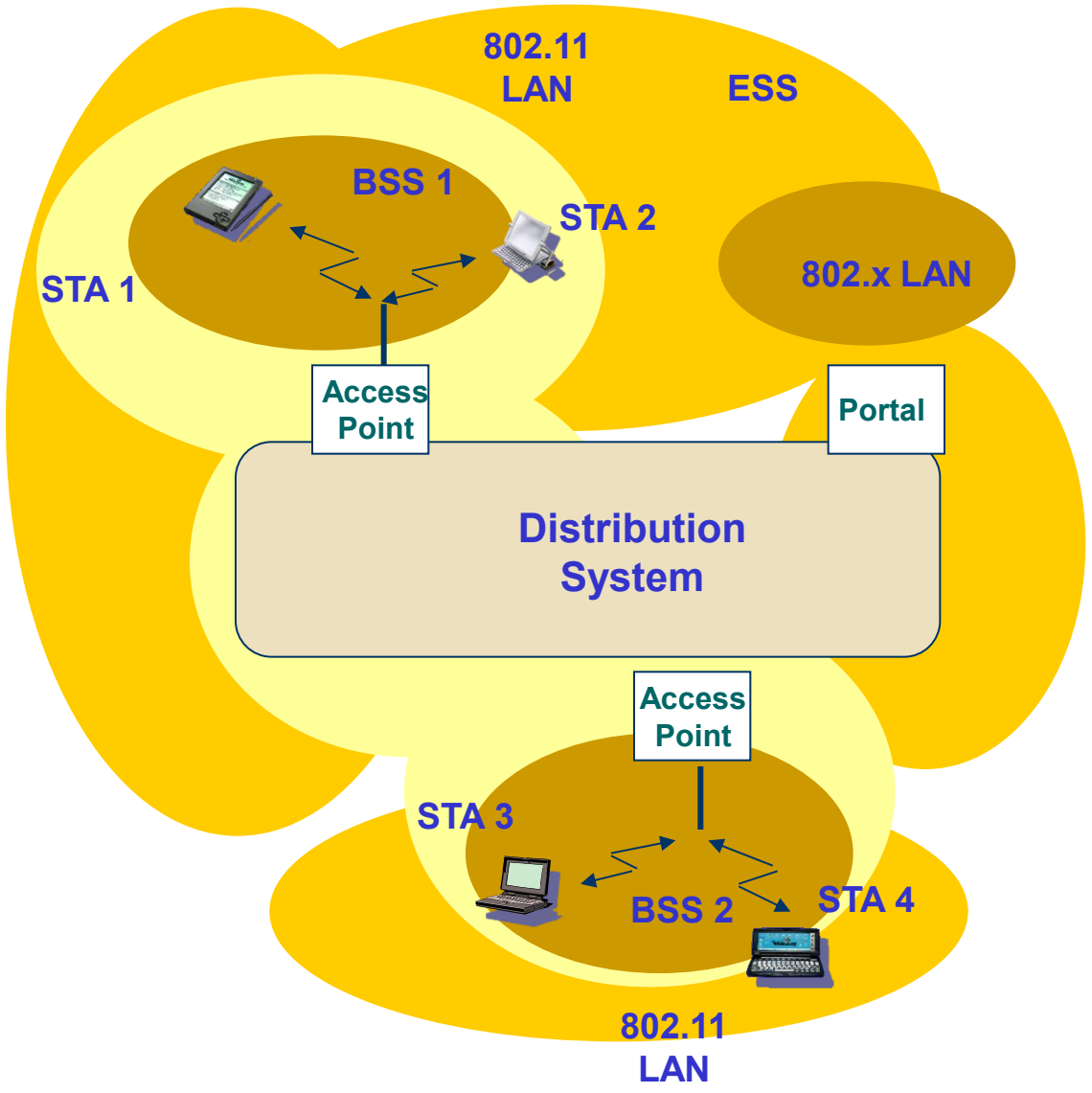
802.11 – Wireless Ethernet



Elements of a wireless network



802.11 Infrastructure based



Station (STA)

Terminal with capabilities to communicate with the AP Access Point

Basic Service Set (BSS)

Group of stations using the same radio frequency

Access Point

A station that communicates both with the wireless LAN and the distribution system

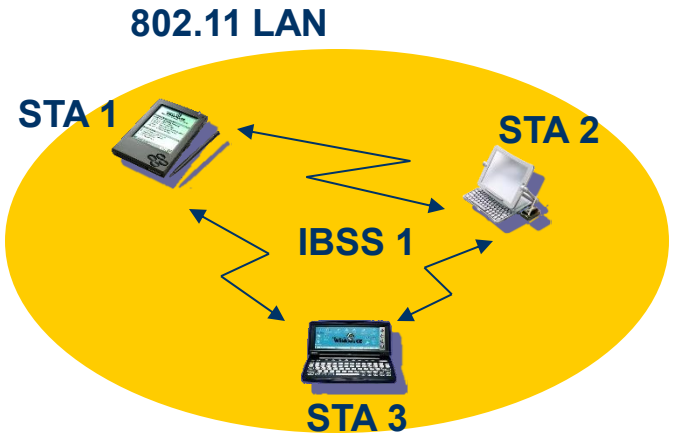
Portal

Bridge between the distribution system and external networks

Distribution System

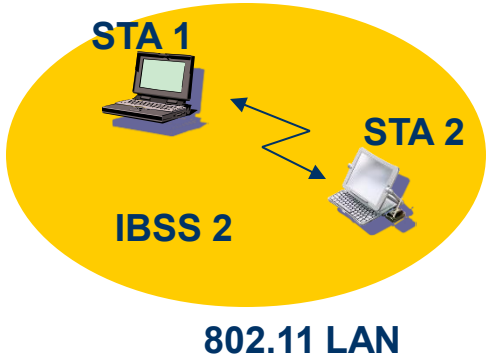
Network connection multiple BSSs in one ESS (Extended Service Set)

802.11 Ad-Hoc



Station (STA)

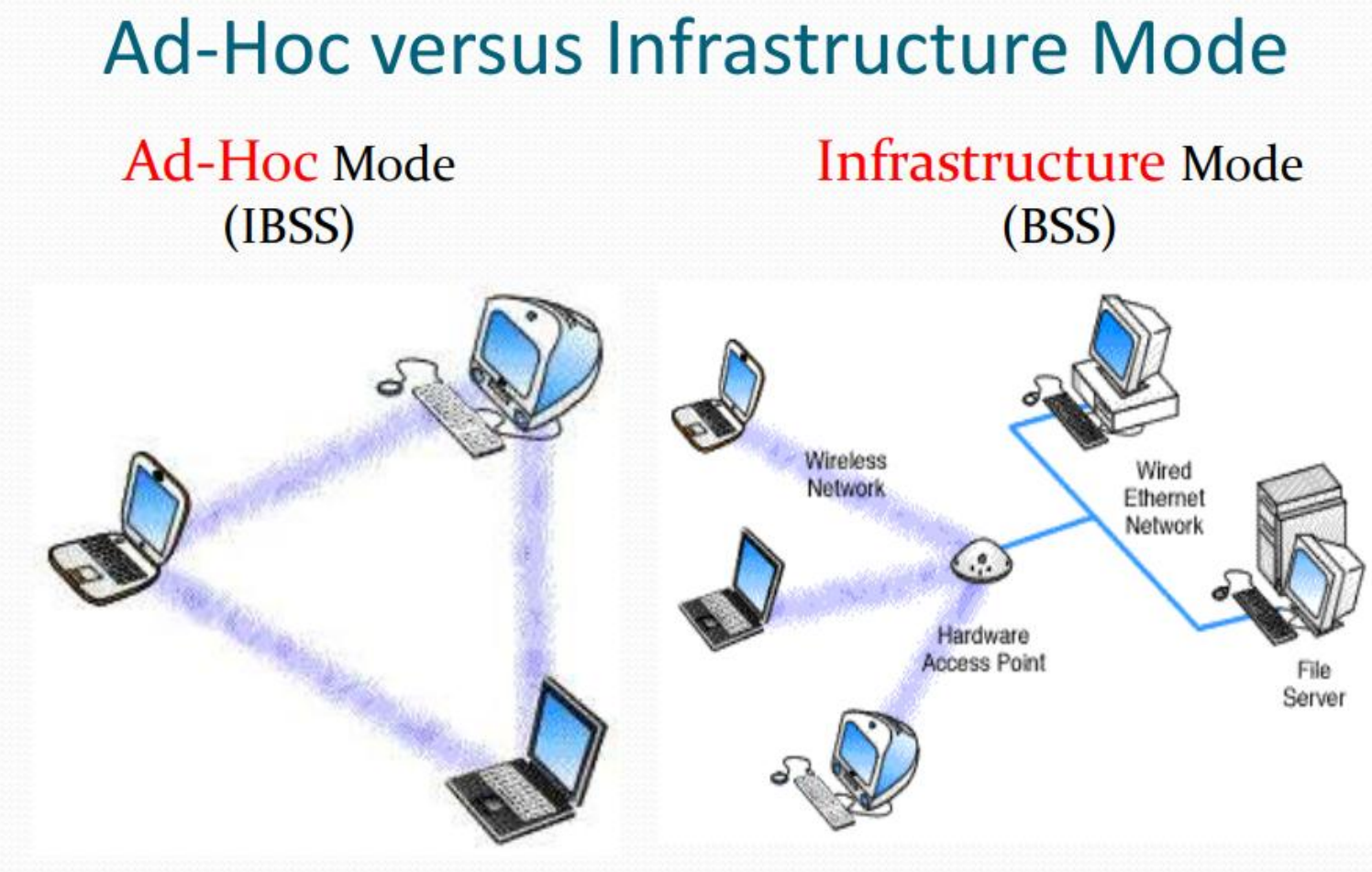
Terminal with capabilities to communicate with the AP Access Point



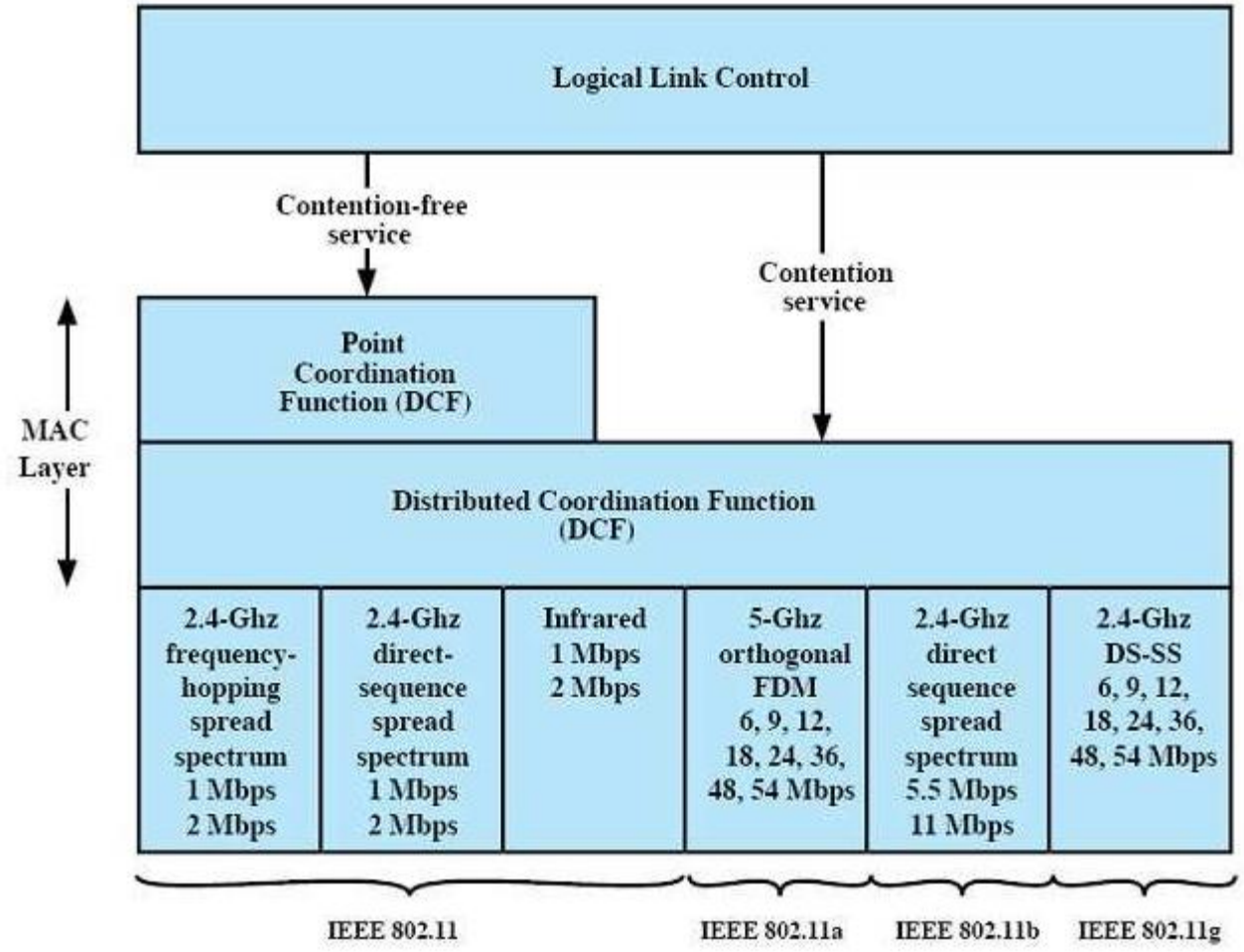
Independent Basic Service Set (IBSS)

Group of stations communicating at the same frequency without the need for an AP

Two modes of operation

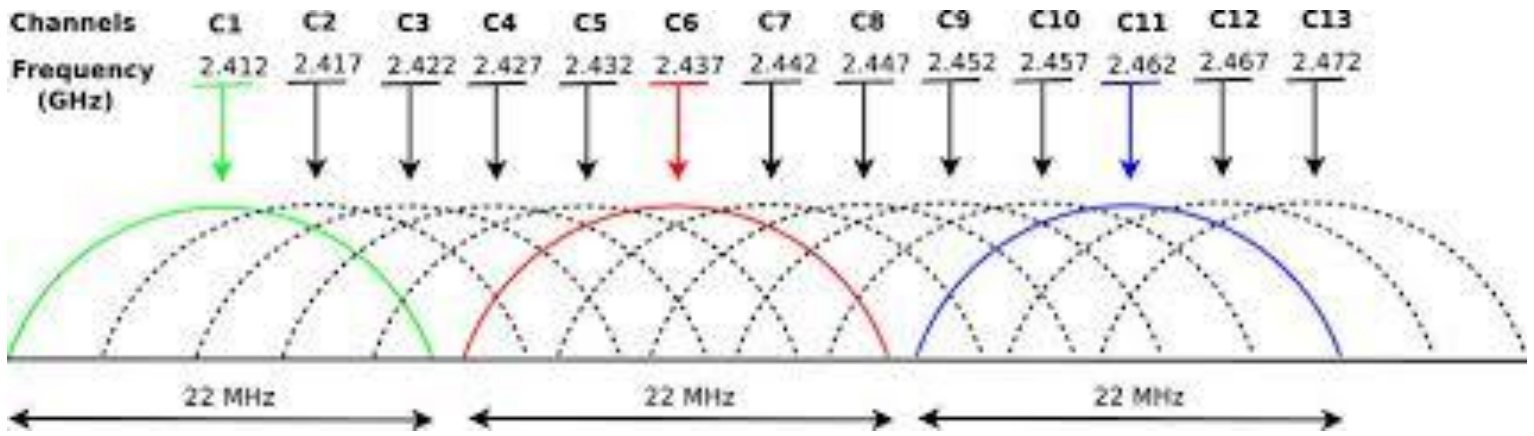


Protocol stack of 802.11

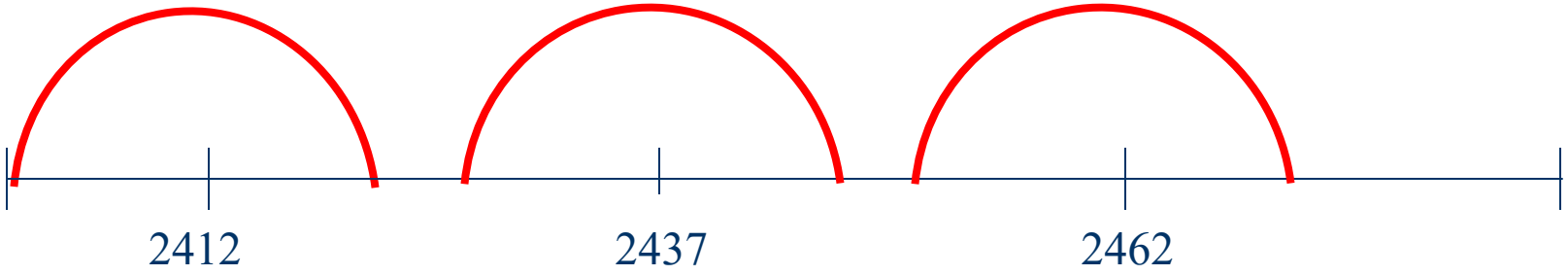


802.11b transmission channels

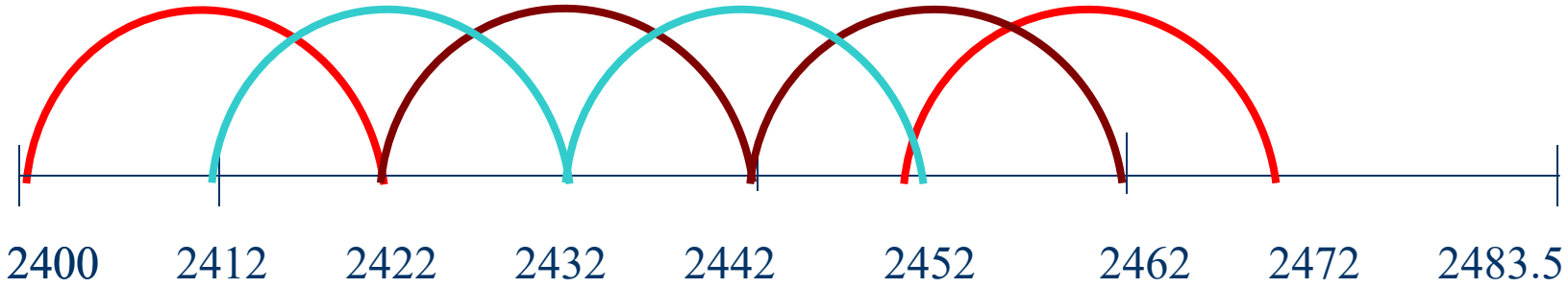
- PHY of 802.11b manages 14 channels, 22MHz wide each placed 5MHz from each other
- Channel is placed around 2.412 GHz, channel 2 around 2.417 GHz, etc, until channel 14 at 2.477 GHz
- 3 non overlapping



Non overlapping channels

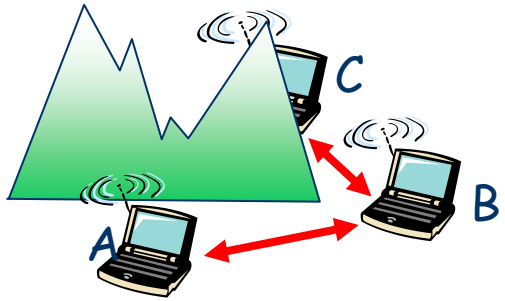


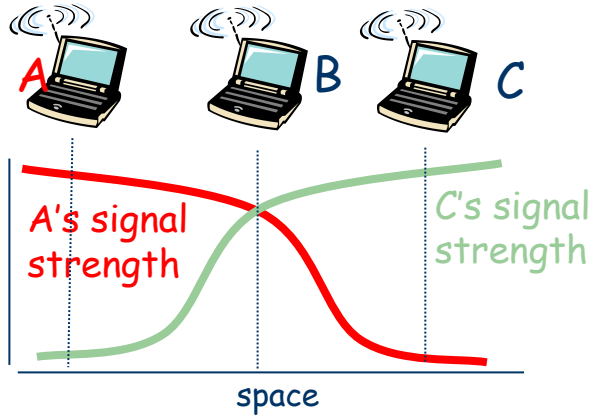
Overlapping channels



How to avoid collisions

- Collisions: 2^+ nodes transmitting at same time towards a receiver
- Carrier sensing - sense before transmitting (CSMA)
  - The transmitter may not listen an ongoing transmission
- Collision detection – detect if a collision accured (CSMA/CD)
  - Can't sense all collisions in any case: hidden terminal, fading
- Goal: *Avoid collisions:* CSMA/C(ollision)A(voidance)

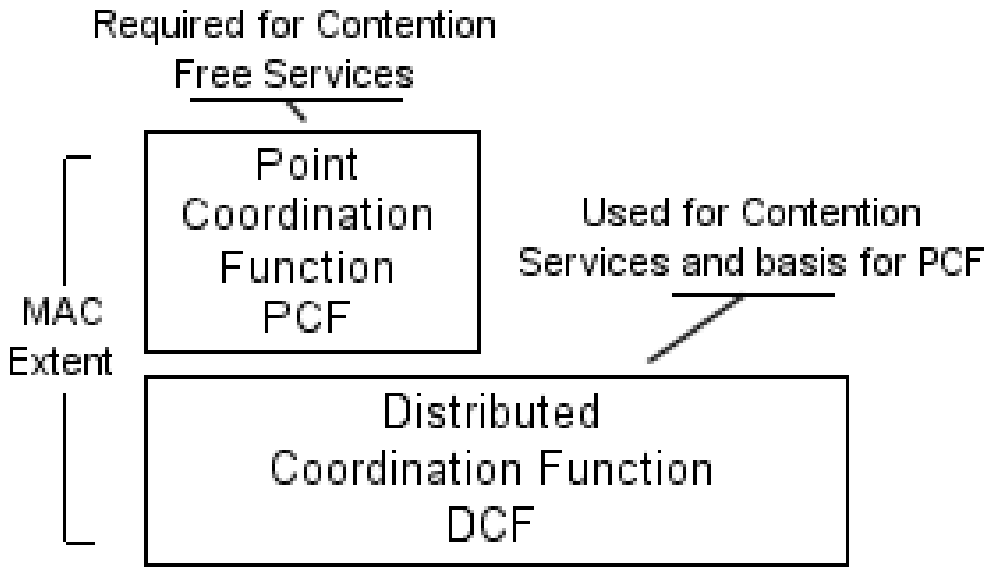


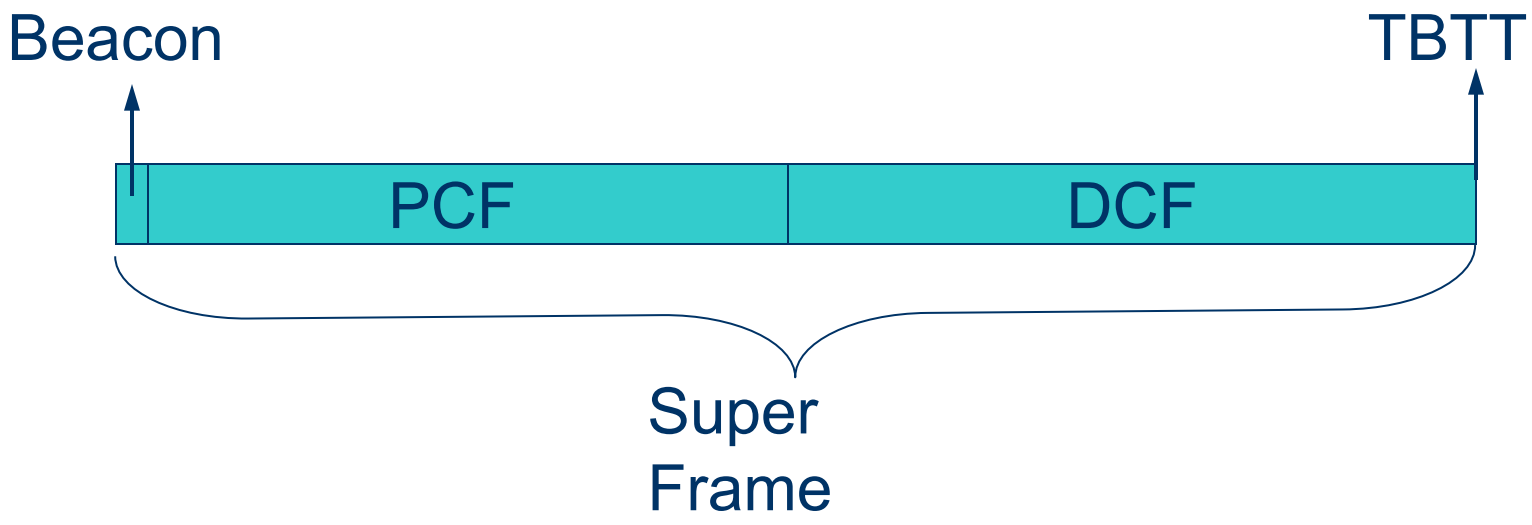


Access Methods

Distributed Coordination Function (DCF)
- Mandatory
- Main access mode
- Contention-based

Point Coordination Function (PCF)
- Optional
- Contention-free
- Lower delays in high traffic
- Only in infrastructure mode





DCF - Distributed Coordinated Function

(**Contention Period** - *Ad-hoc Mode*)

PCF - Point Coordinated Function

(**Contention Free Period** – *Infrastructure BSS*)

Beacon - Management Frame

Synchronization of Local timers

Delivers protocol related parameters (e.g., version)

TBTT (Target Beacon Transition Time)

IEEE 802.11 MAC Protocol: CSMA/CA

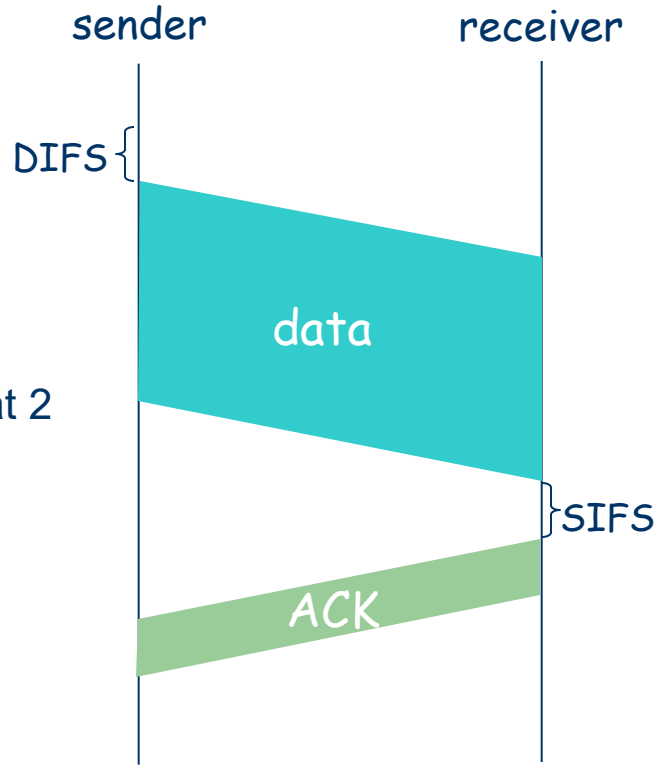
802.11 sender

1 if sense channel idle for **DIFS** then
    transmit entire frame (no CD)

2 if sense channel busy then
    start random backoff time
    timer counts down while channel idle
    transmit when timer expires
    if no ACK, increase random backoff interval, repeat 2

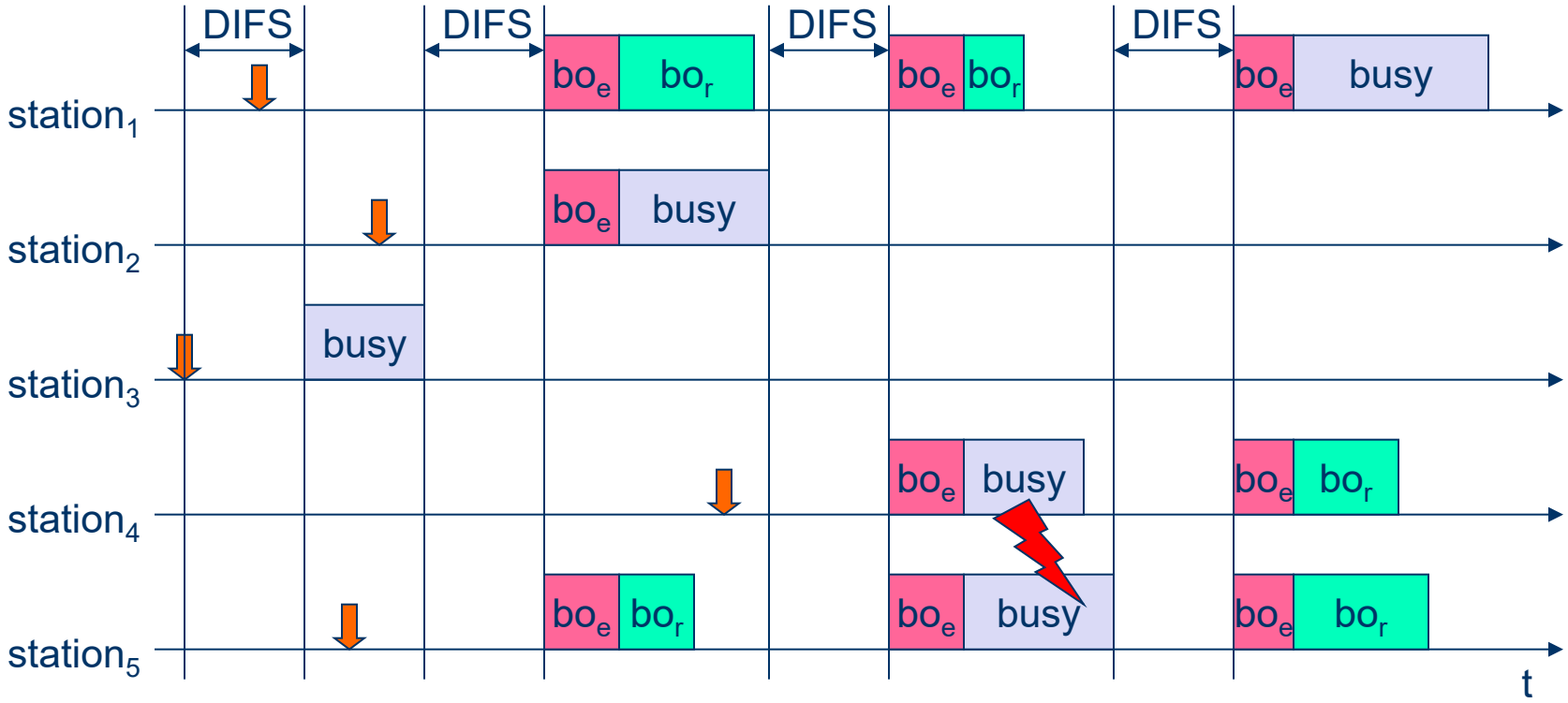
802.11 receiver

- if frame received OK
  return ACK after **SIFS** (ACK needed due to hidden terminal problem)



SIFS<DIFS

802.11 - competing stations - simple version



busy — medium not idle (frame, ack etc.)

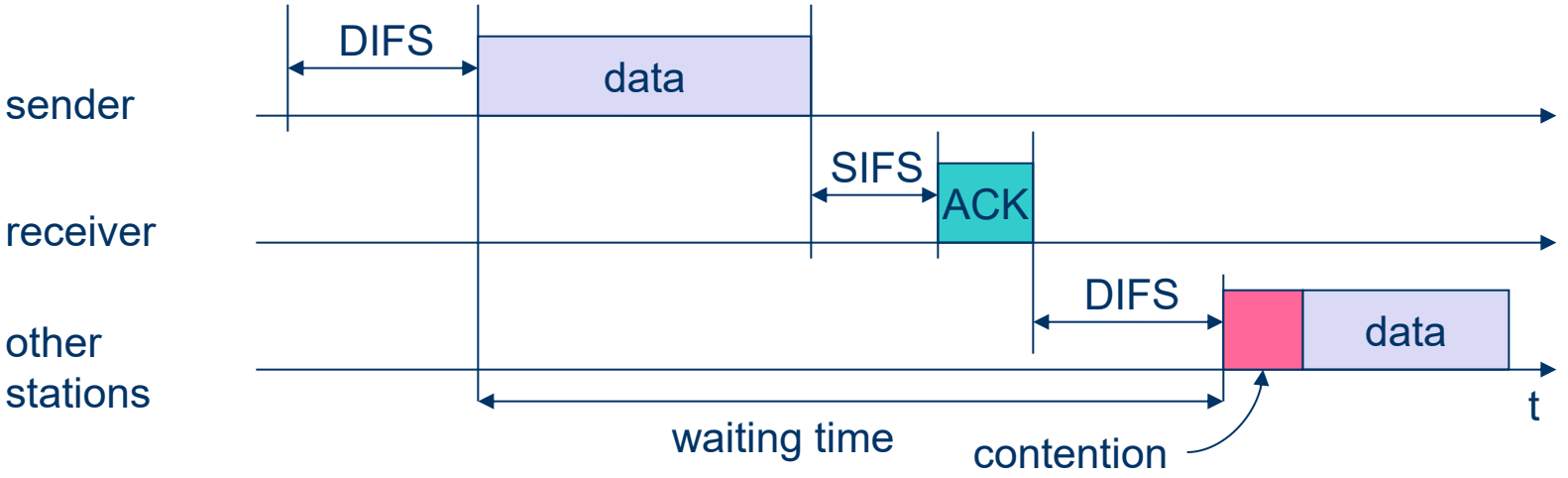
packet arrival at MAC

bo_e — elapsed backoff time

bo_r — residual backoff time

802.11 - CSMA/CA access method

- Sending unicast packets
  - station has to wait for DIFS before sending data
  - receivers acknowledge at once (after waiting for SIFS) if the packet was received correctly (CRC)
  - automatic retransmission of data packets in case of transmission errors



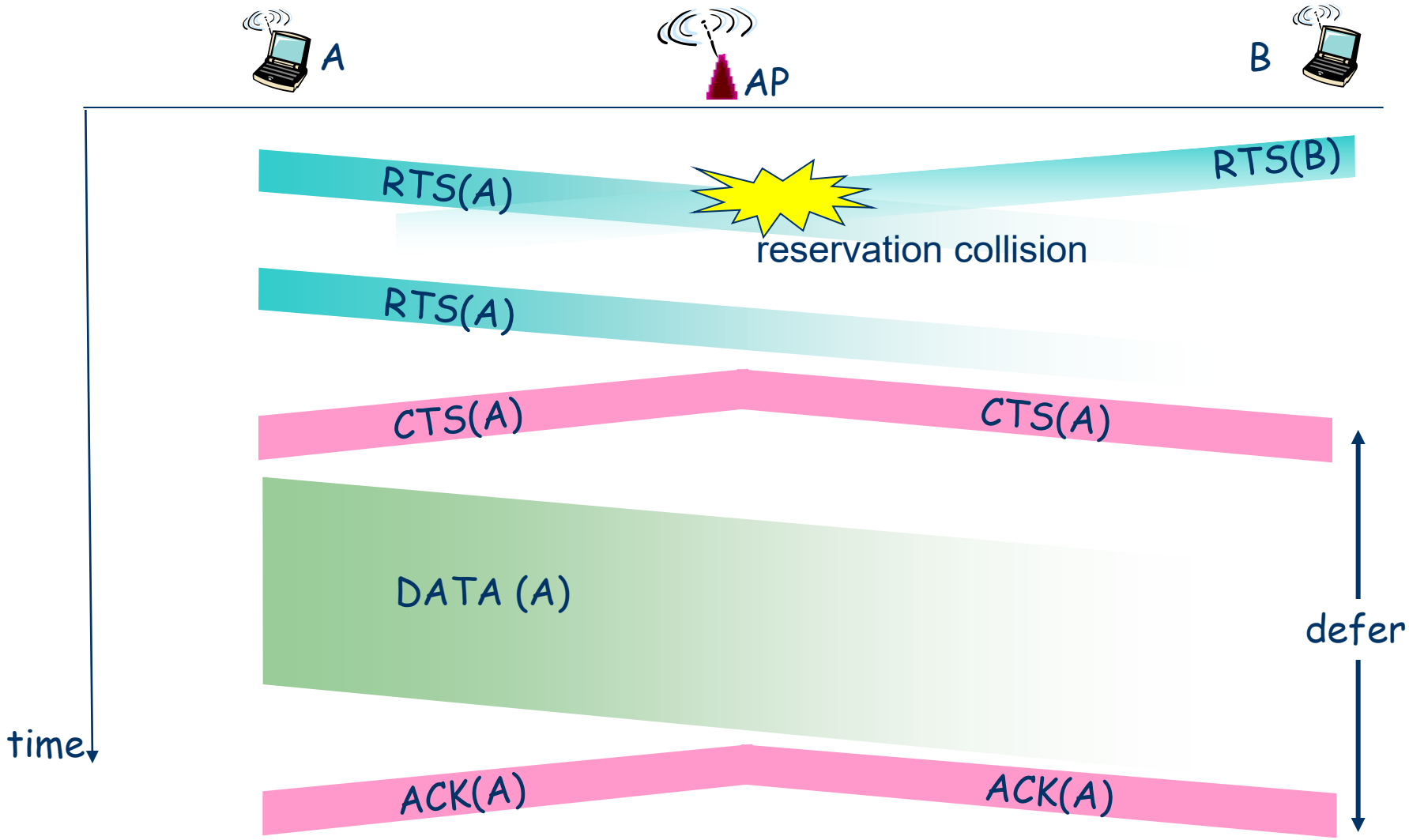
Avoiding collisions (more)

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) packets 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

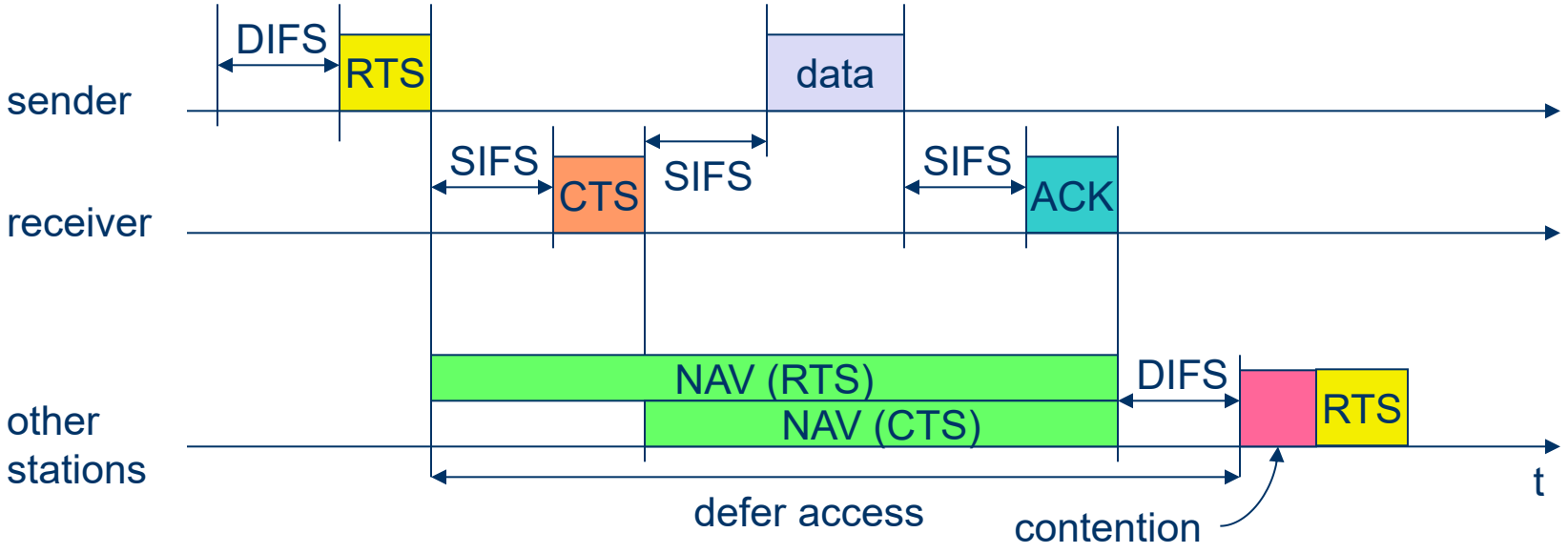
avoid data frame collisions completely
using small reservation packets!

Collision Avoidance: RTS-CTS exchange

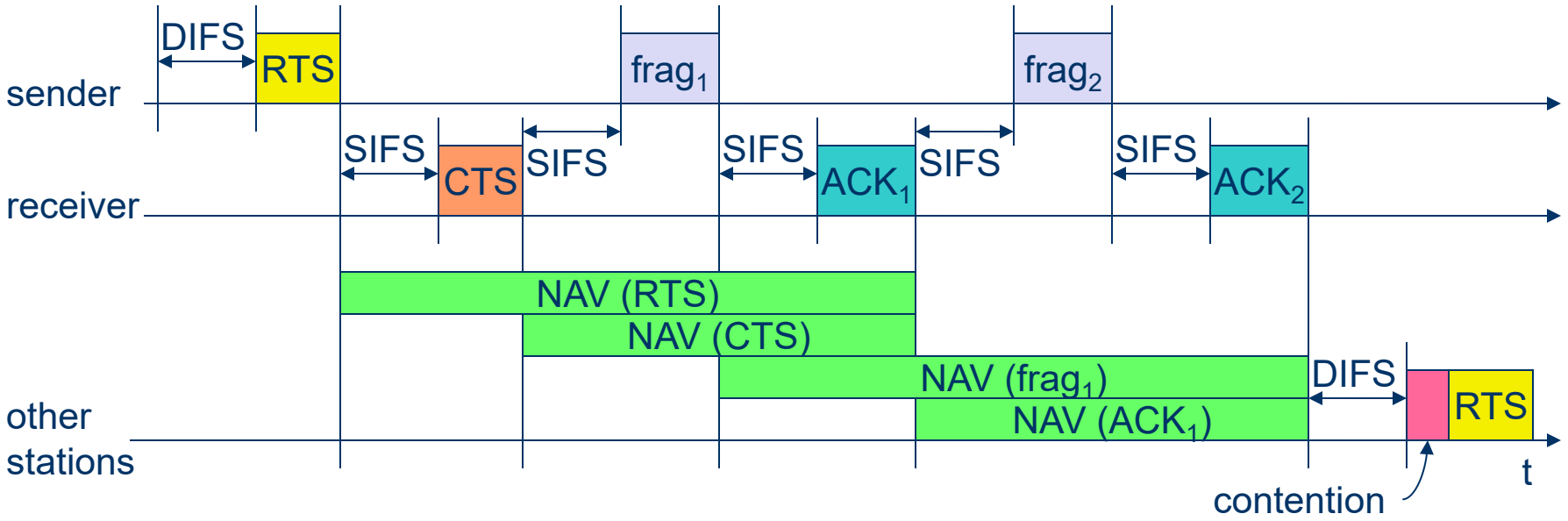


Collision Avoidance: RTS-CTS exchange

- Sending unicast packets
  - station can send RTS with reservation parameter after waiting for DIFS (reservation determines amount of time the data packet needs the medium)
  - acknowledgement via CTS after SIFS by receiver (if ready to receive)
  - sender can now send data at once, acknowledgement via ACK
  - other stations store medium reservations distributed via RTS **and** CTS

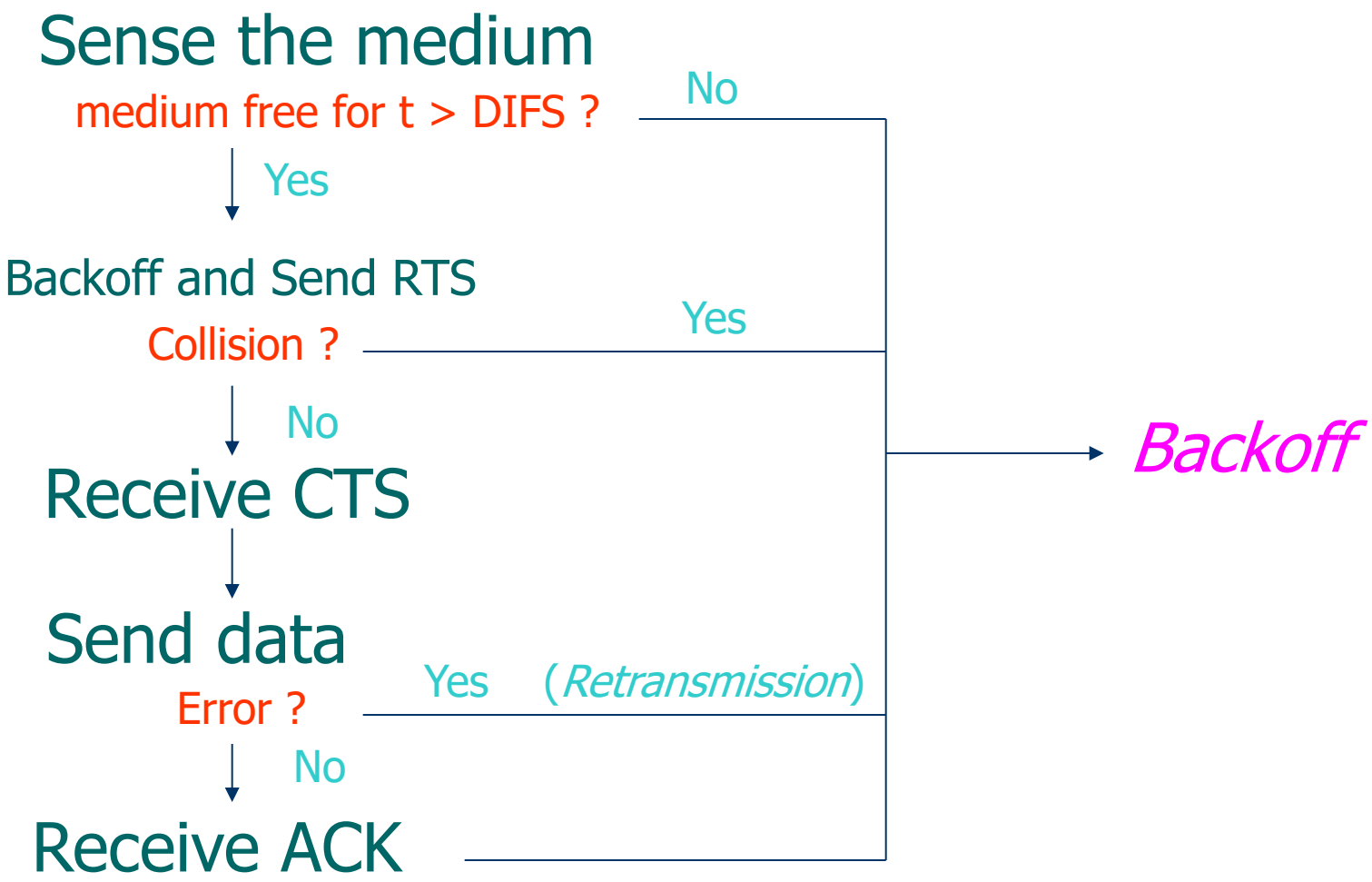


Fragmentation



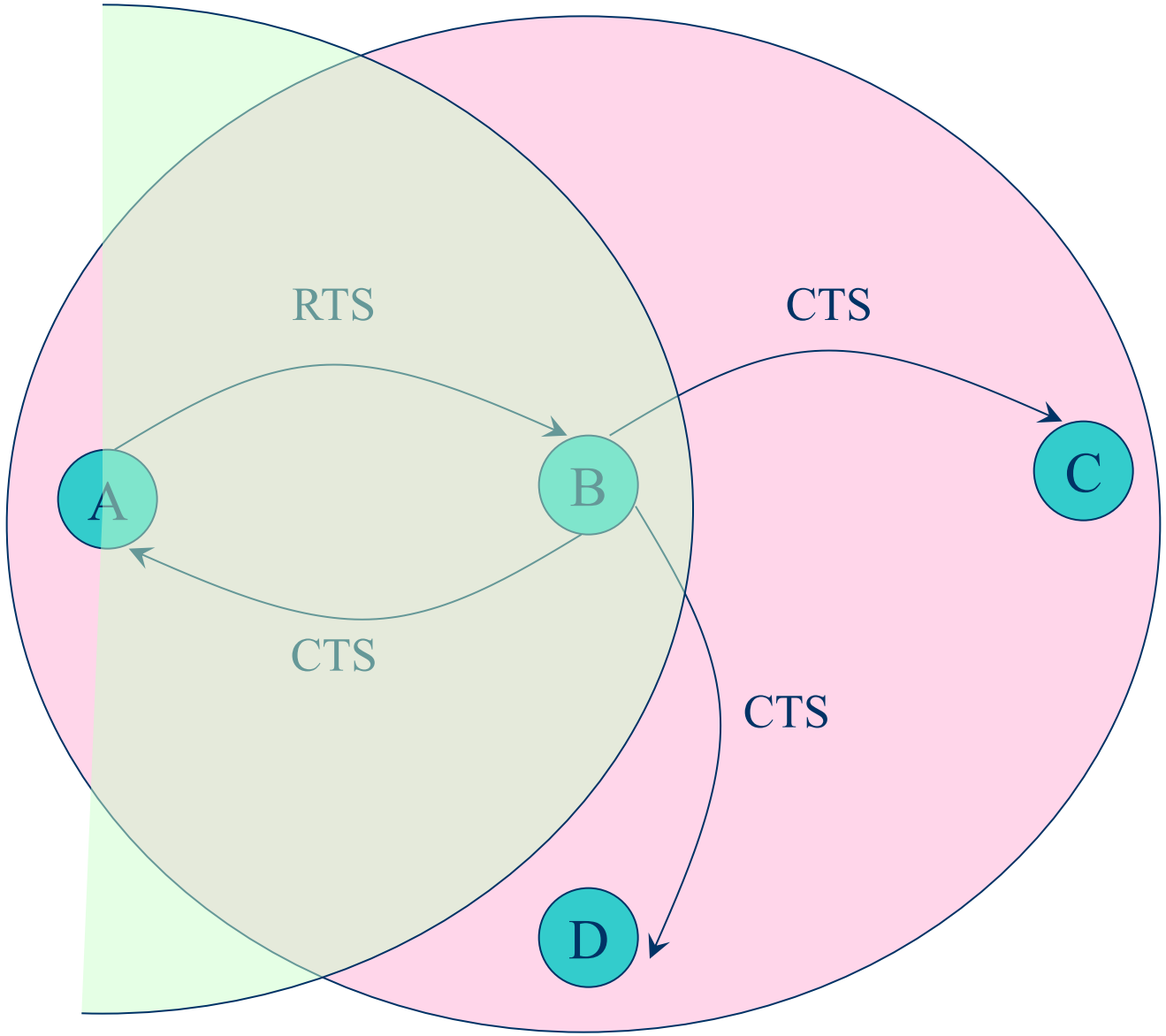
Why fragment?

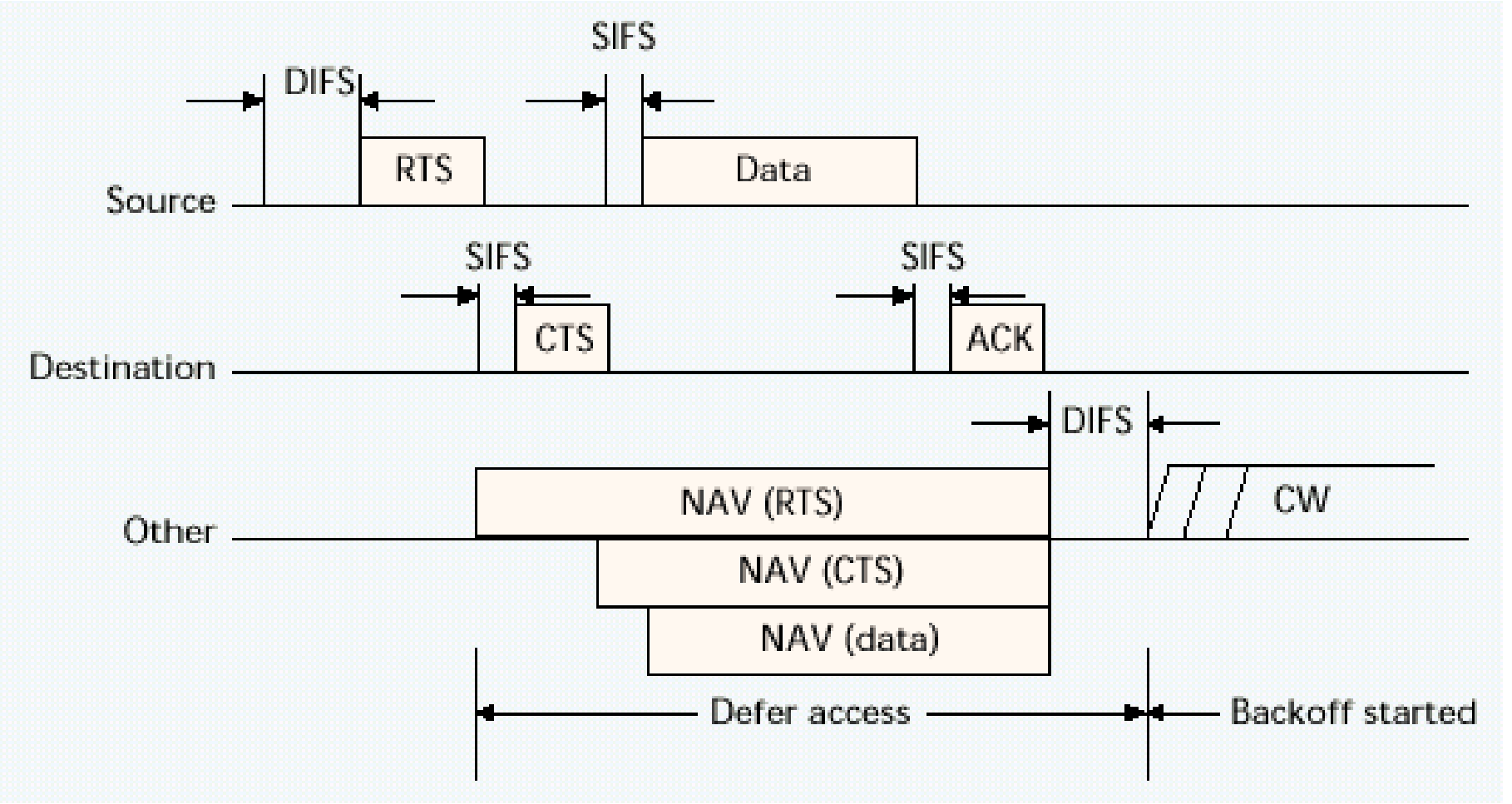
Distributed Coordination Function



DIFS: DCF Interframe Space

Collision avoidance at station B





- Always SIFS<DIFS

- Updating of NAVs (Network Allocation Vectors) very important through RTS/CTS/data packets to use power saving