Wireless LAN

Declarations

- IEEE has defined the specifications for a wireless LAN, called
- IEEE 802.11, which covers the physical and data link layers.

Infra red vs Radio Transmission

- Both technologies can be used to set up ad-hoc connections for work groups, to connect, e.g., a desk-top with a printer without a wire, or to support mobility within a small area.
- Infra Red transmits at 900 nm wavelength
- Radio wave transmits at 2.4 GHz

Infra Red

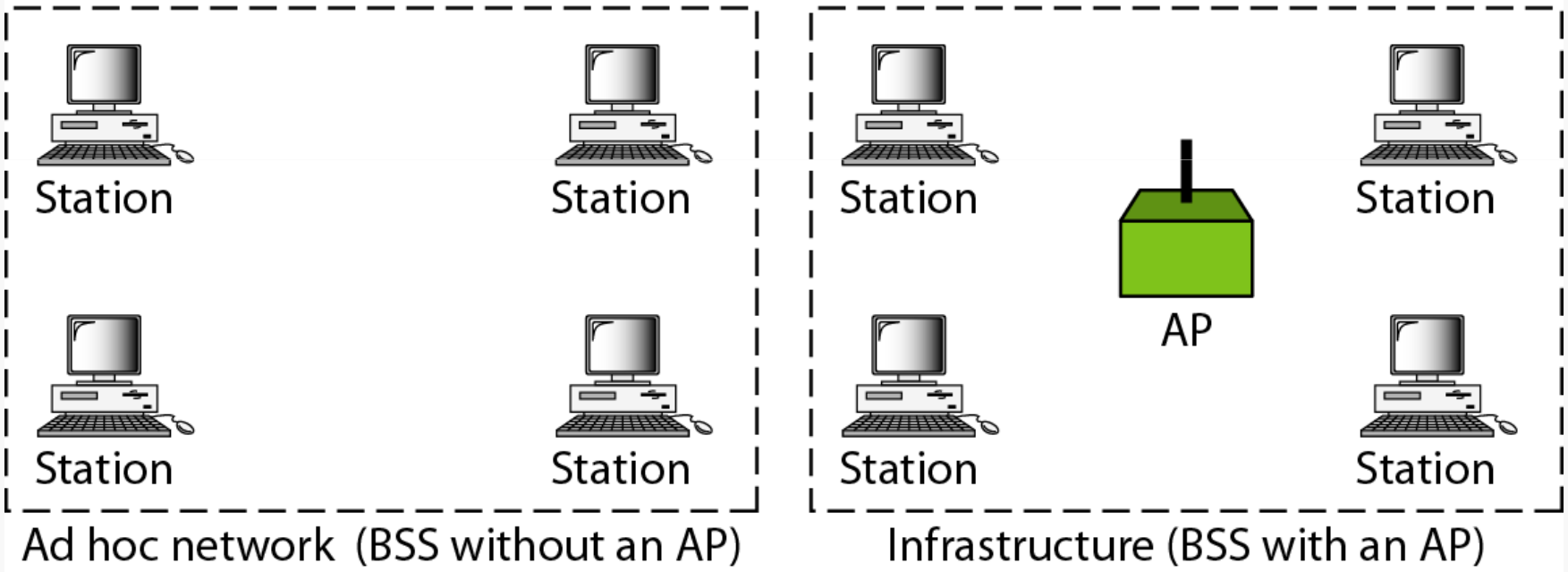
- Uses IR diodes, diffuse light, multiple reflections (walls, furniture etc.)
- Advantages
  - Simple, cheap, available in many mobile devices
  - No licenses needed
  - Simple shielding possible
- Disadvantages
  - Interference by sunlight, heat sources etc.
  - Many things shield or absorb IR light
  - Low bandwidth
- Example
  - IrDA (Infrared Data Association) interface available everywhere

Radio Wave

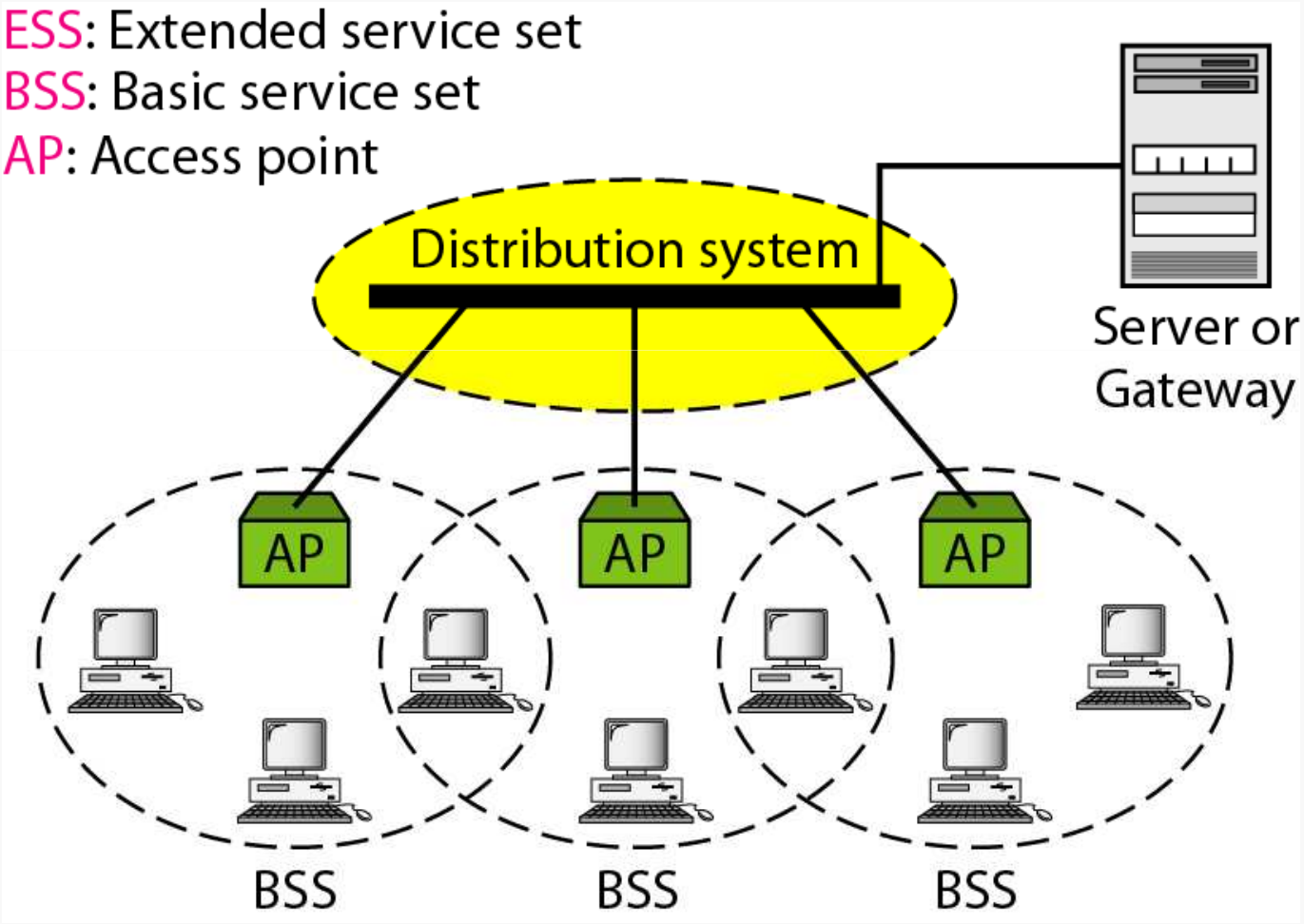
- Typically using the license free ISM band at 2.4 GHz
- Advantages
  - Experience from wireless WAN and mobile phones can be used
  - Coverage of larger areas
- Disadvantages
  - Very limited license free frequency bands
  - Shielding more difficult, interference with other electrical devices
- Example
  - Many different products

Architecture

BSS: Basic service set
AP: Access point



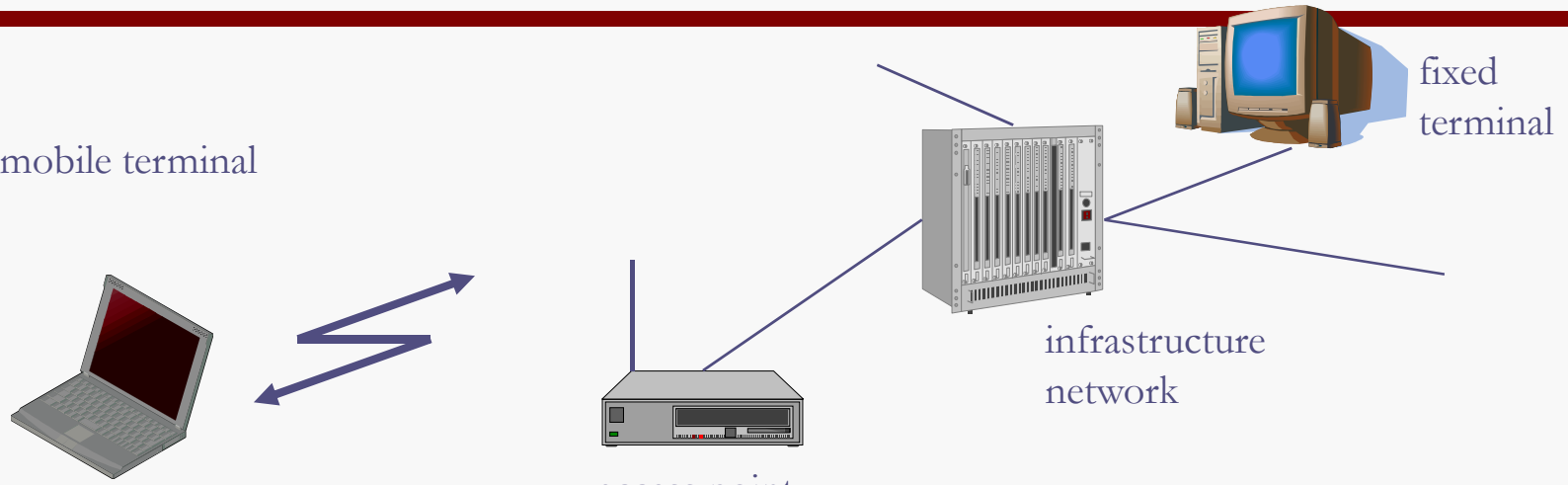
Architecture



Architecture

- Stations → are connected to access points (AP)
- Stations are terminals with access mechanisms to the wireless medium and radio contact to the AP.
- Basic Service Set → The stations and the AP which are within the same radio coverage form BSS. BSSID is used to separate different BSS.
- Distribution System connects several BSSs via the AP to form a single network. This network is now called an Extended Service Set (ESS)
- The ESSID (identifier) is the 'name' of a network and is used to separate different networks
- The distribution system connects the wireless networks via the APs with a portal, which forms the interworking unit to other LANs

Protocol Architecture

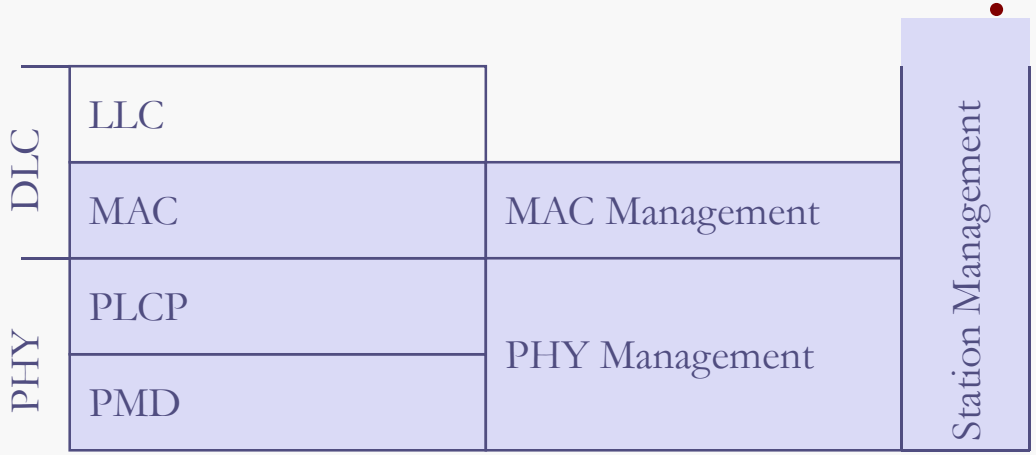


Application		
TCP		
IP		
LLC	LLC	
802.11 MAC	802.11 MAC	802.3 MAC
802.11 PHY	802.11 PHY	802.3 PHY

Application
TCP
IP
LLC
802.3 MAC
802.3 PHY

802.11 - Layers and functions

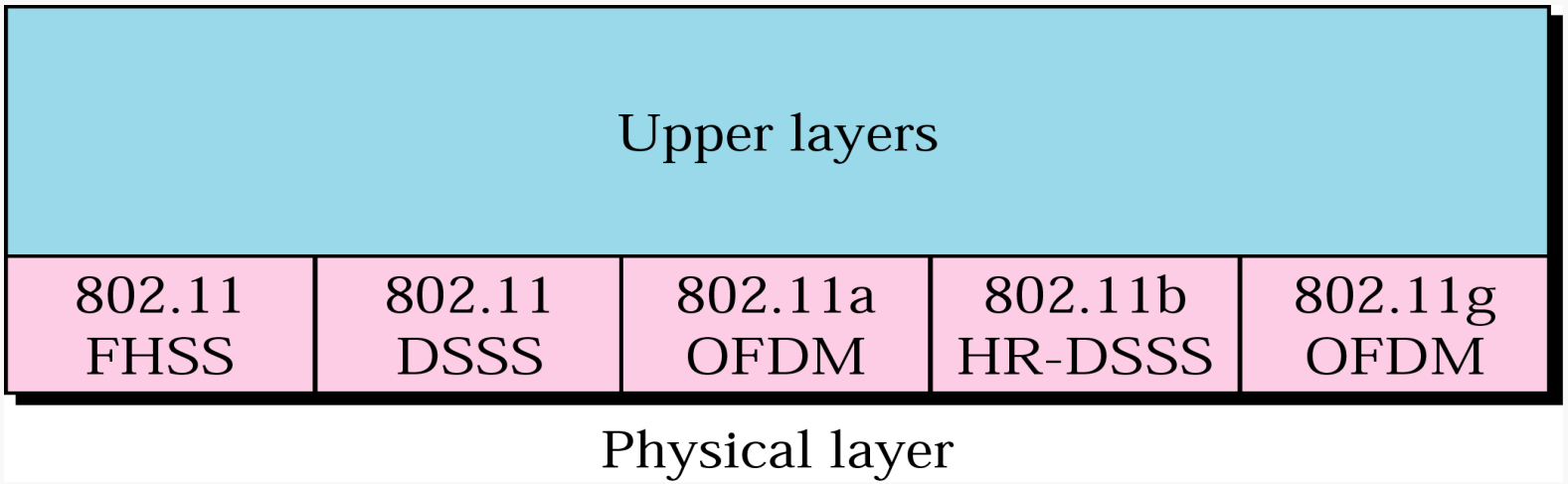
- LLC
  - Covers the differences of the medium access control layers needed for the different media.
- MAC
  - access mechanisms, fragmentation, encryption
- MAC Management
  - synchronization, roaming, MIB, power management



- PLCP Physical Layer Convergence Protocol
  - clear channel assessment signal (carrier sense)
- PMD Physical Medium Dependent
  - modulation, coding
- PHY Management
  - channel selection, MIB
- Station Management
  - coordination of all management functions

Physical Layer

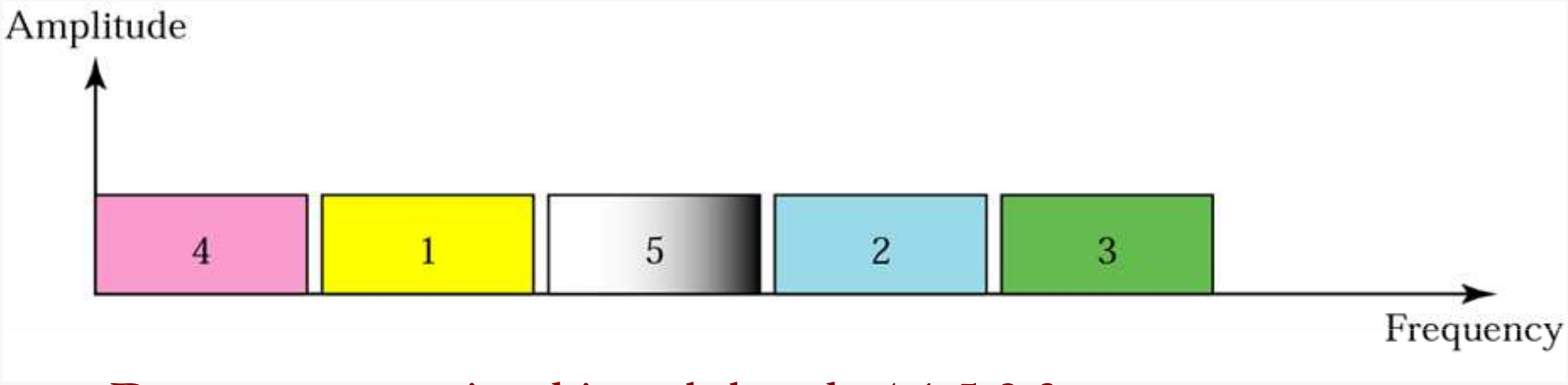
- Supports 3 versions: 2 radio wave (2.4 GHz License Free ISM Band), 1 Infra Red
  - Data rates 1 or 2 Mbit/s
- FHSS (Frequency Hopping Spread Spectrum)
- DSSS (Direct Sequence Spread Spectrum)
- Infrared



IEEE 802.11 FHSS

- Frequency Hopping Spread Spectrum with 2.4 GHz ISM Band
- Sender transmits on one carrier frequency for short period and hops to another carrier frequency for the same period and so on.
- The dwell time→ 400 ms or more
- Band → 2.4 GHz to 2.48 GHz ISM Band
- Modulation Technique → FSK
- Data Rate → 1 or 2 Mbps

IEEE 802.11 FHSS



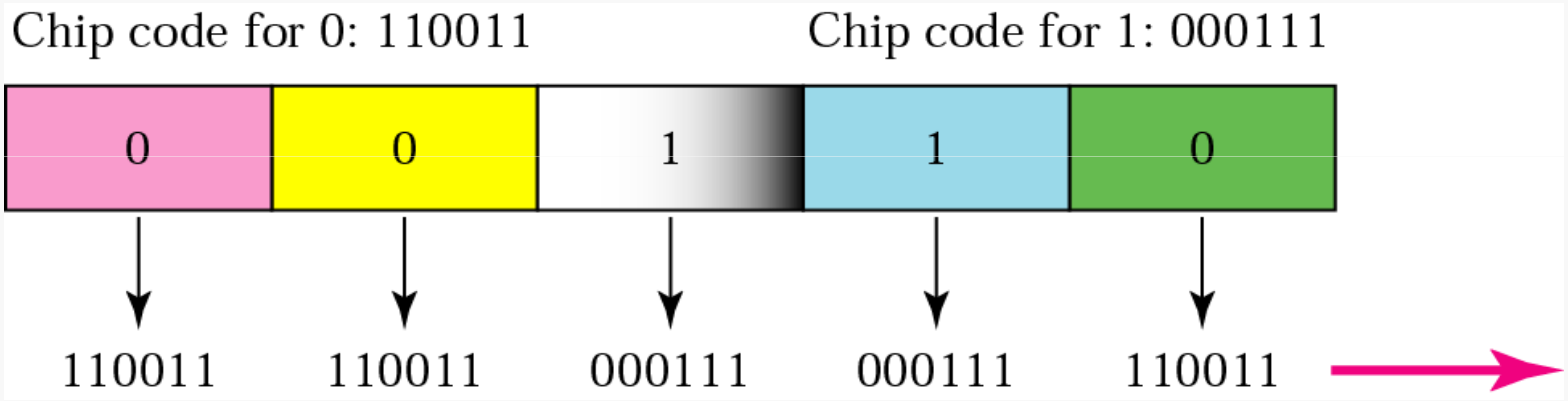
- Data are transmitted in sub bands 4,1,5,2,3.
- Receiver also receives the data with sub bands in same order.

Advantage

- Intruders/ Unauthorized uses can't sense the data as they don't know the sequence of sub bands in which data arrives.

IEEE 802.11 DSSS

- Direct Sequence Spread Spectrum with 2.4 GHz ISM Band



- Each bit is replaced by chip code

IEEE 802.11 DSSS

- N → No. of bits in Chip code
- Data Rate → 1 or 2 Mbps
- Band → 2.4 GHz
- Modulation Technique → PSK, BPSK, QPSK

IEEE 802.11a OFDM

- Orthogonal Frequency Division Multiplexing with 5 GHz ISM band
- One difference with FDM → All sub bands are used by one source at a given time
- Band → 5 GHz ISM band
- Modulation Technique → PSK, QAM
- Data Rate → 18 Mbps (PSK) or 54 Mbps (QAM)

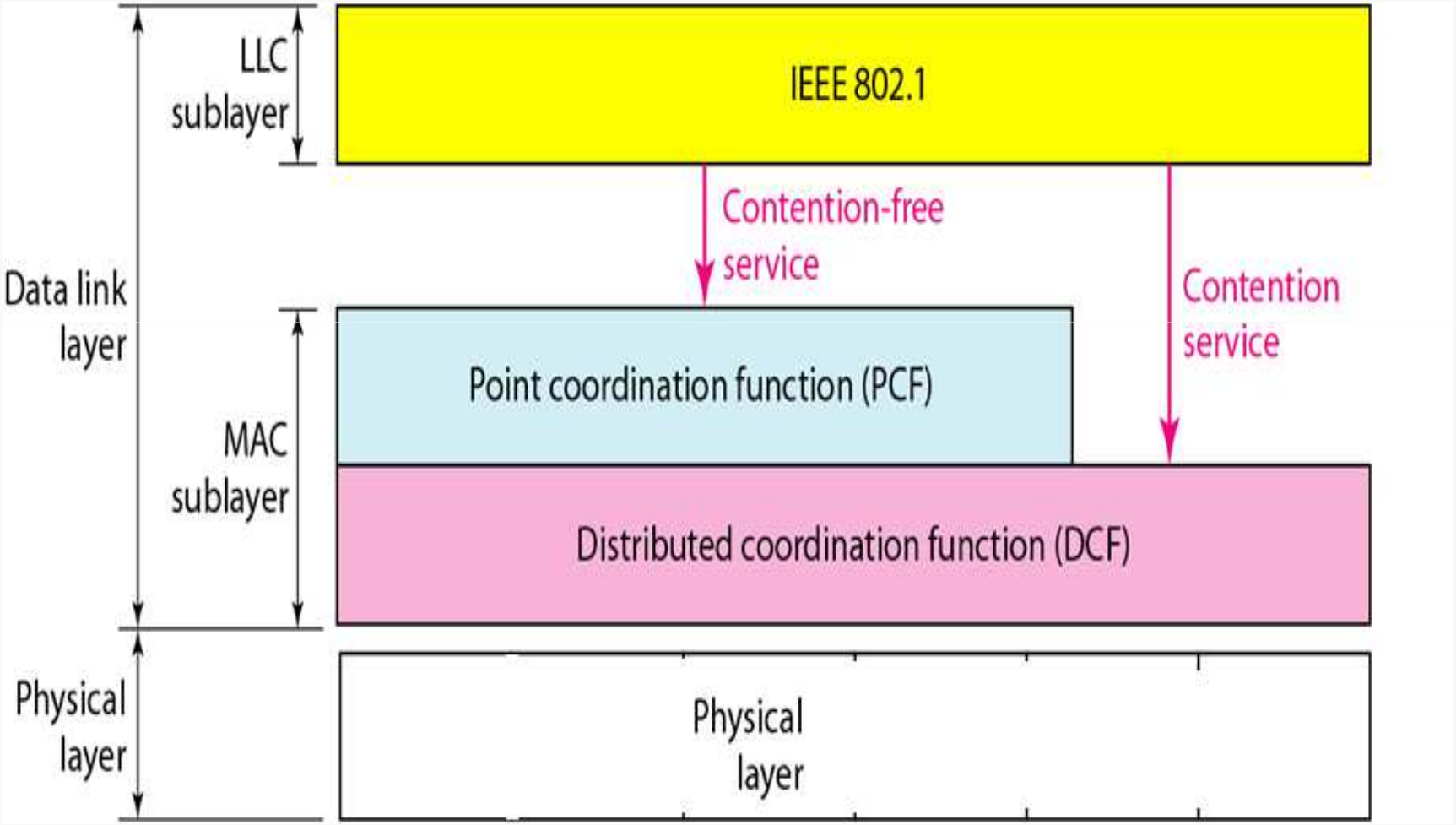
IEEE 802.11b HR-DSSS

- High Rate DSSS
- Similar to DSSS.
- Complementary code Keying is used (CCK)
- 4 or 8 bits are encoded to one CCK
- Band → 2.4 GHz ISM band
- Modulation Technique → BPSK, QPSK
- Data Rate → 1, 2, 5.5, 11 Mbps

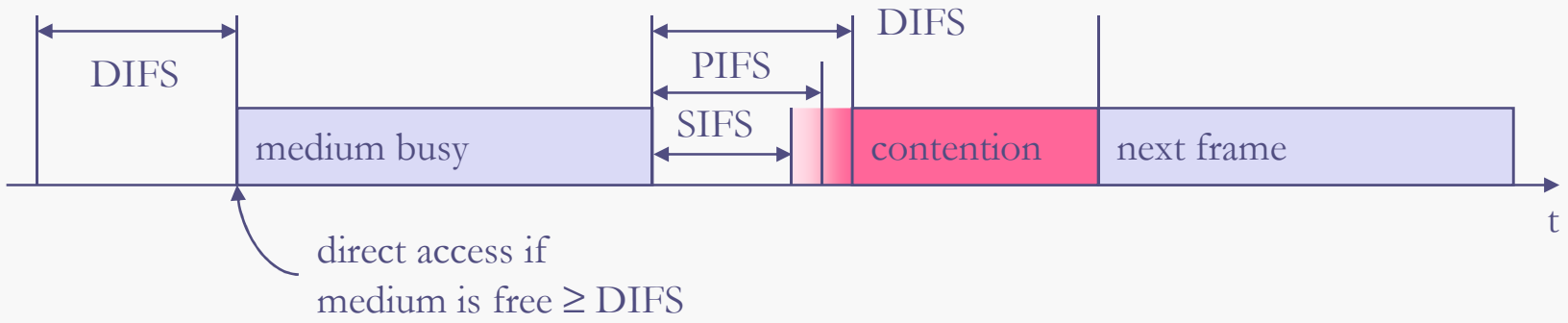
IEEE 802.11g OFDM

- Similar to IEEE 802.11a OFDM
- Band → 2.4 GHz ISM band
- Data Rate → 54 Mbps

MAC layers in IEEE 802.11 standard



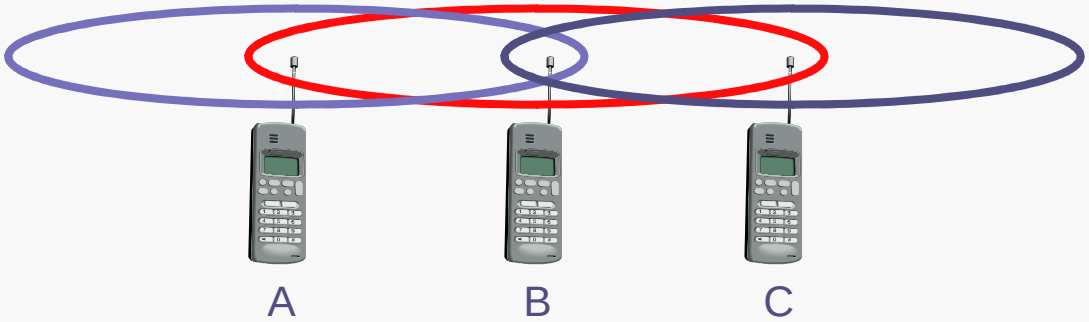
MAC Inter – Frame Spacing



- SIFS (Short Inter Frame Spacing)
  - Short Waiting Time
  - Highest priority, for ACK, CTS, polling response
  - DSSS →10 μs FHSS 28 μs
- PIFS (Point Coordination Function IFS)
  - Waiting Time between DIFS and SIFS
  - Medium priority, for time-bounded service using PCF
  - PIFS = SIFS +Slot Time
- DIFS (DCF, Distributed Coordination Function IFS)
  - Denotes long waiting Time.
  - lowest priority, for asynchronous data service
  - DIFS = SIFS +2 x Slot Time

Hidden and exposed Terminal

- Hidden terminals
  - A sends to B, C cannot receive A
  - C wants to send to B, C senses a "free" medium
  - collision at B, A cannot receive the collision
  - A is "hidden" for C



- Exposed terminals
  - B sends to A, C wants to send to another terminal (not A or B)
  - C has to wait, C senses the medium in use
  - but A is outside the radio range of C, therefore waiting is not necessary
  - C is "exposed" to B

CSMA/CA

- A node wishing to transmit data has to first listen to the channel for a predetermined amount of time to determine whether or not another node is transmitting on the channel within the wireless range.
- If the channel is sensed "idle," then the node is permitted to begin the transmission process.
- If the channel is sensed as "busy," the node defers its transmission for a random period of time.
- Collision avoidance is used to improve CSMA performance by not allowing wireless transmission of a node if another node is transmitting, thus reducing the probability of collision due to the use of a random binary exponential backoff time.

Exponential Backoff Alg.

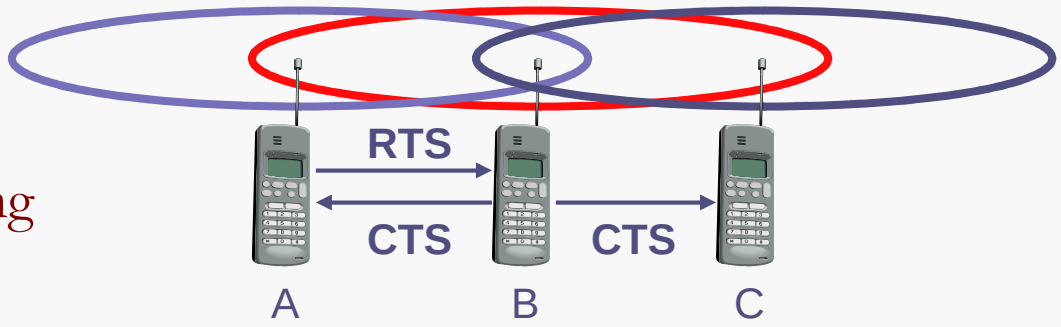
- The retransmission is delayed by an amount of time derived from the slot time and the number of attempts to retransmit.
- After *c* collisions, a random number of slot times between 0 and 2^c - 1 is chosen.
- For the first collision, each sender will wait 0 or 1 slot times.
- After the second collision, the senders will wait anywhere from 0 to 3 slot times inclusive.

Exponential Backoff Alg.

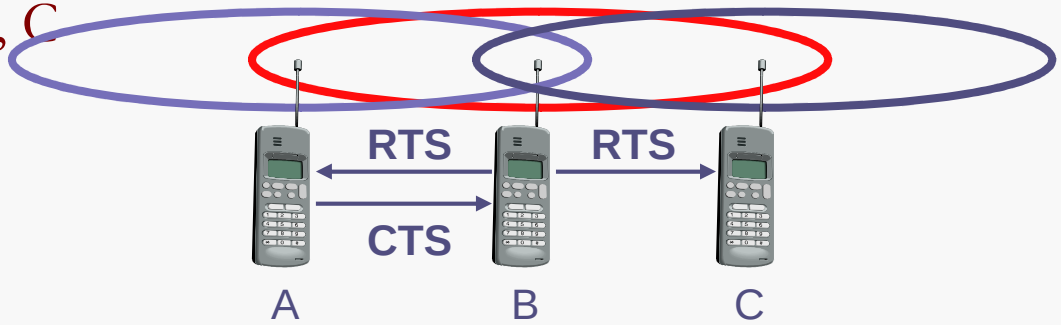
- After the third collision, the senders will wait anywhere from 0 to 7 slot times (inclusive), and so forth.
- As the number of retransmission attempts increases, the number of possibilities for delay increases exponentially.
- The 'truncated' simply means that after a certain number of increases, the exponentiation stops; i.e. the retransmission timeout reaches a ceiling, and thereafter does not increase any further.
- For example, if the ceiling is set at i = 10 then the maximum delay is 1023 slot times.

Multiple Access with Collision Avoidance

- MACA avoids the problem of hidden terminals
  - A and C want to send to B
  - A sends RTS first
  - C waits after receiving CTS from B



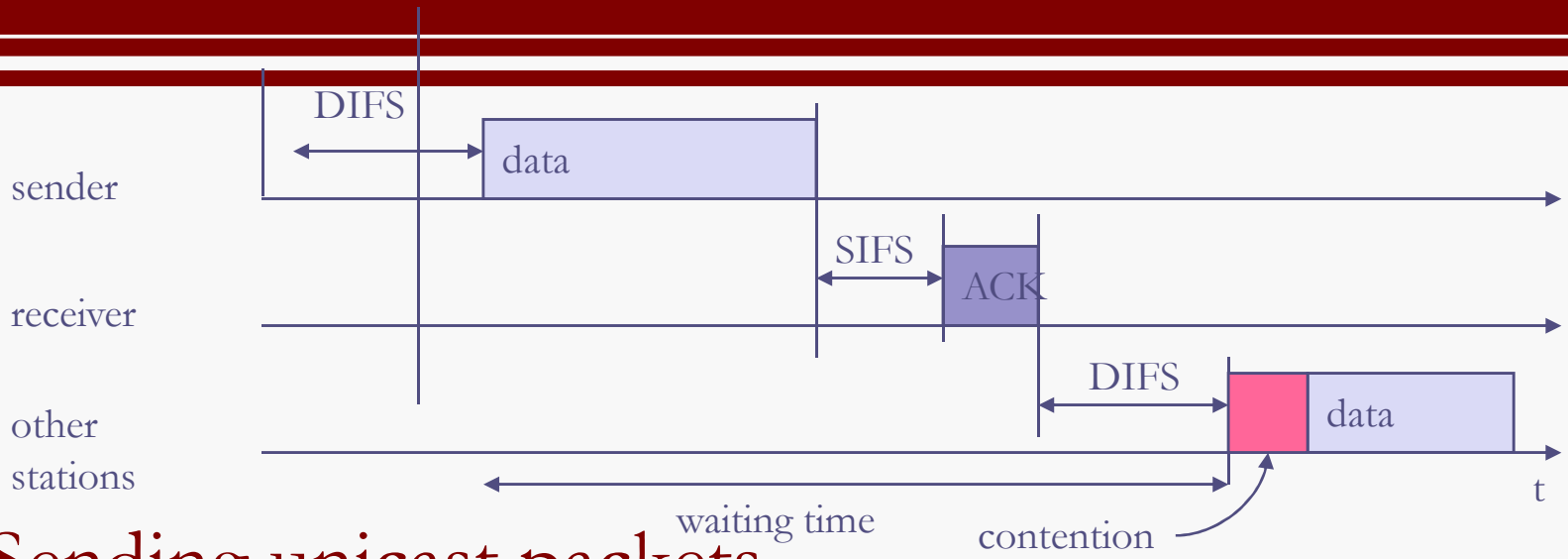
- MACA avoids the problem of exposed terminals
  - B wants to send to A, C to another terminal
  - now C does not have to wait for it cannot receive CTS from A



Access methods

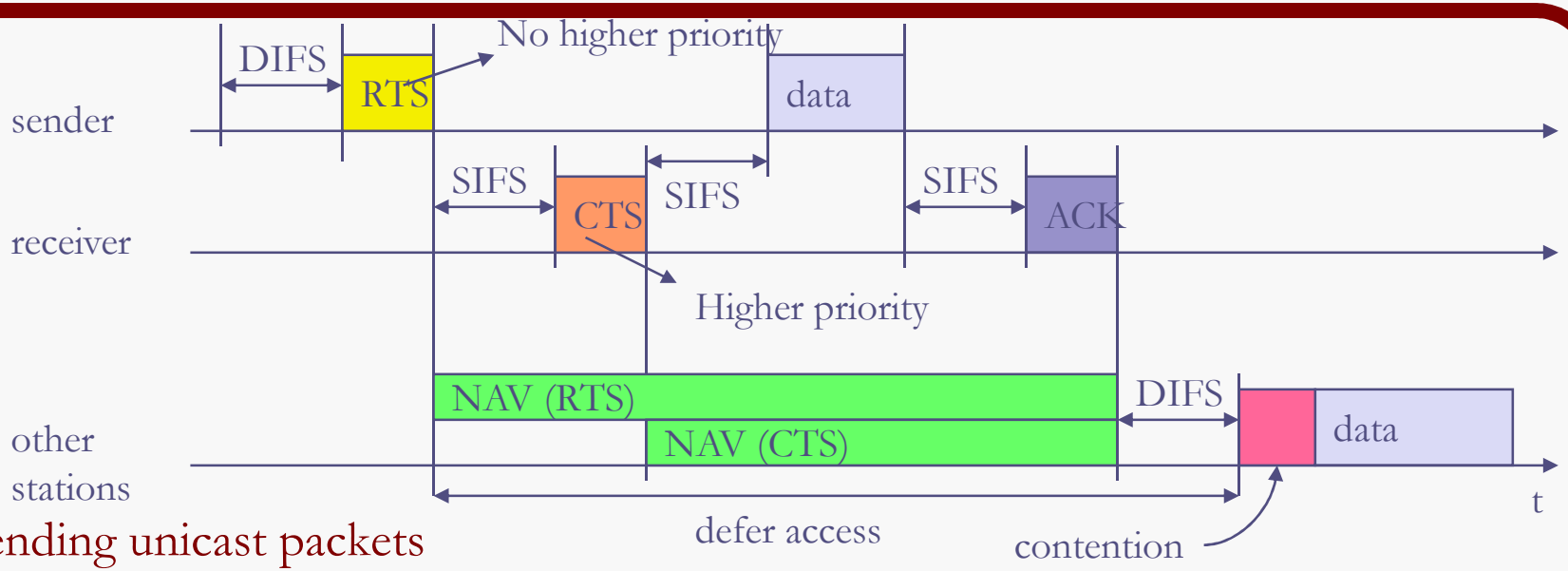
- MAC Access method is called as Distributed Foundation Wireless Media Access Control (DFWMAC)
- 3 Types
  - DFWMAC-DCF CSMA/CA (mandatory)
  - DFWMAC-DCF with RTS/CTS (optional)
  - DFWMAC- PCF (optional)

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

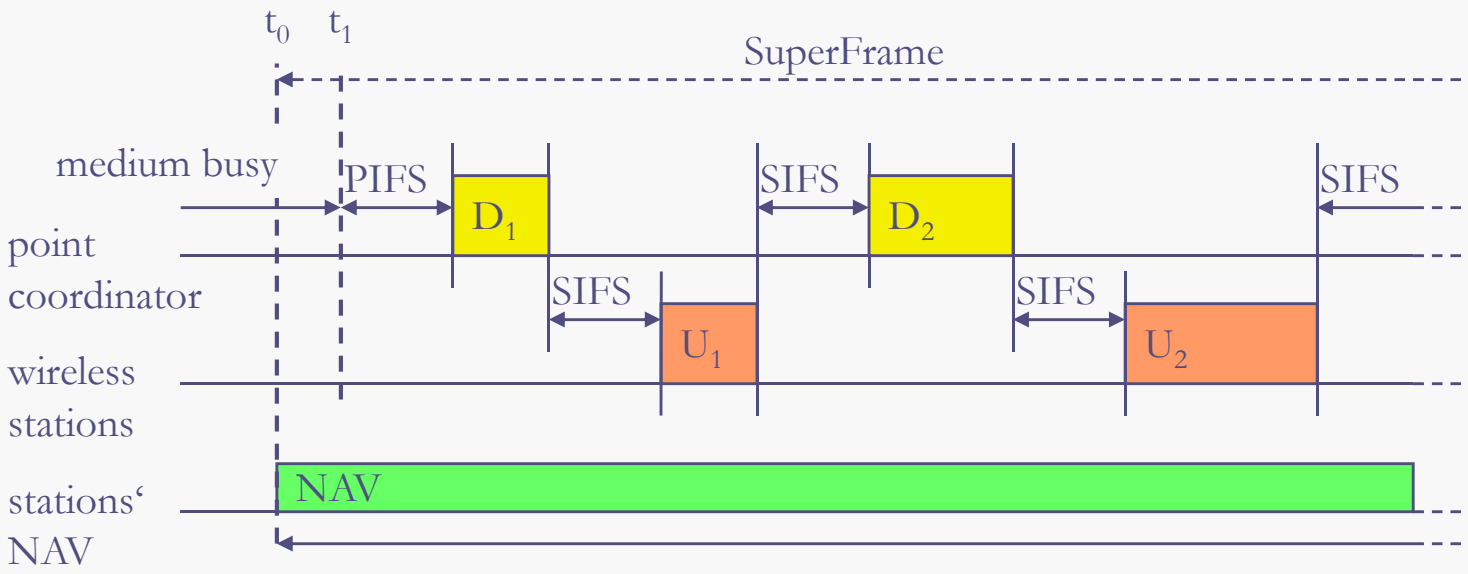
DFWMAC with RTS/CTS



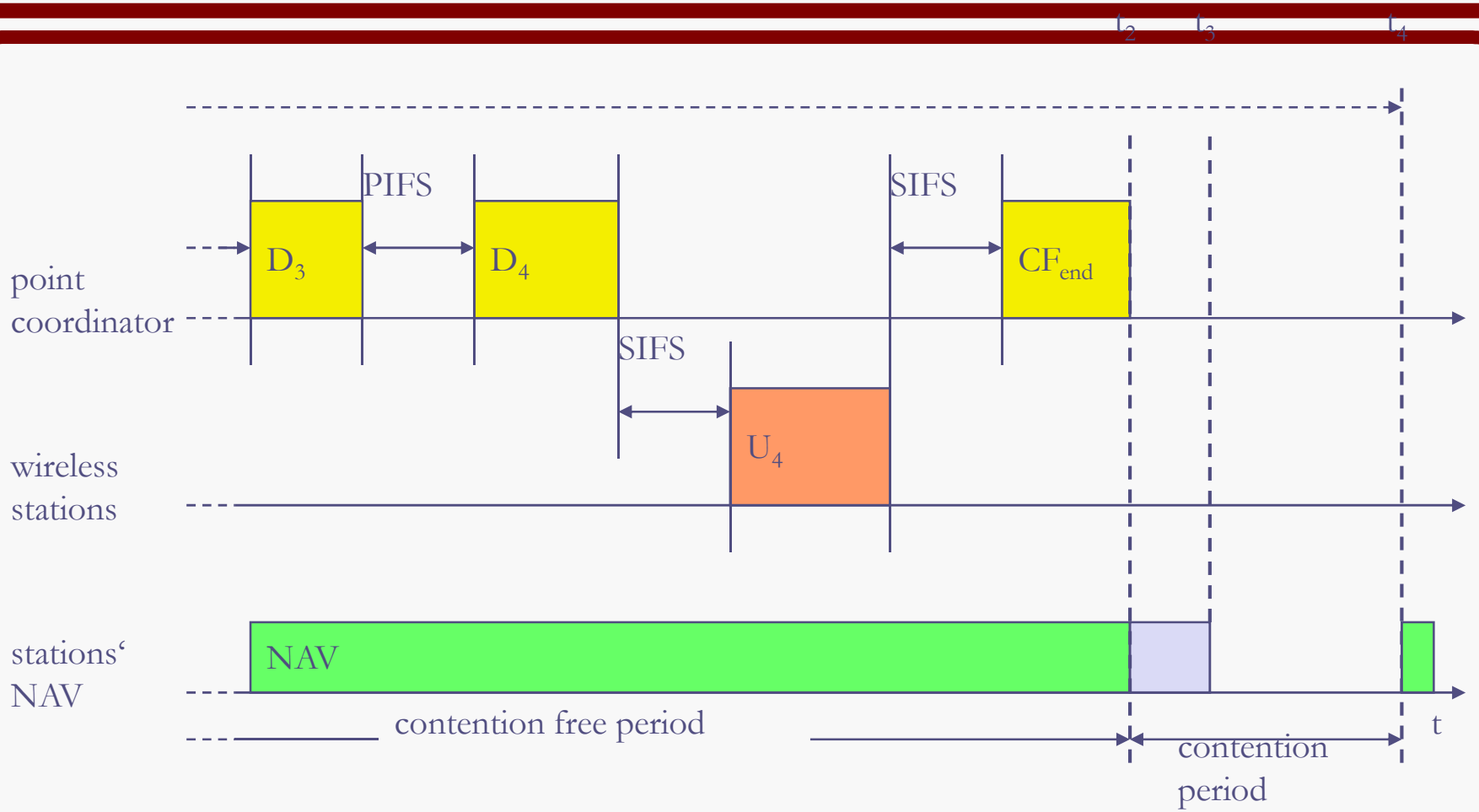
- Sending unicast packets
  - Station can send RTS with reservation parameter after waiting for DIFS (reservation determines amount of time the data packet needs the medium)
  - Acknowledgement via CTS after SIFS by receiver (if ready to receive)
  - Sender can now send data at once, acknowledgement via ACK
  - Other stations store medium reservations distributed via NAV RTS (Net Allocation Vector) **and** NAV CTS (Reserving medium for one station and so called as virtual reservation scheme)

DFWMAC- PCF with Polling

- 1st 2 methods cannot guarantee a maximum access delay or minimum transmission bandwidth.
- On the top of DCF provide the time bounded service PCF (Point Coordination Function)



DFWMAC- PCF with Polling



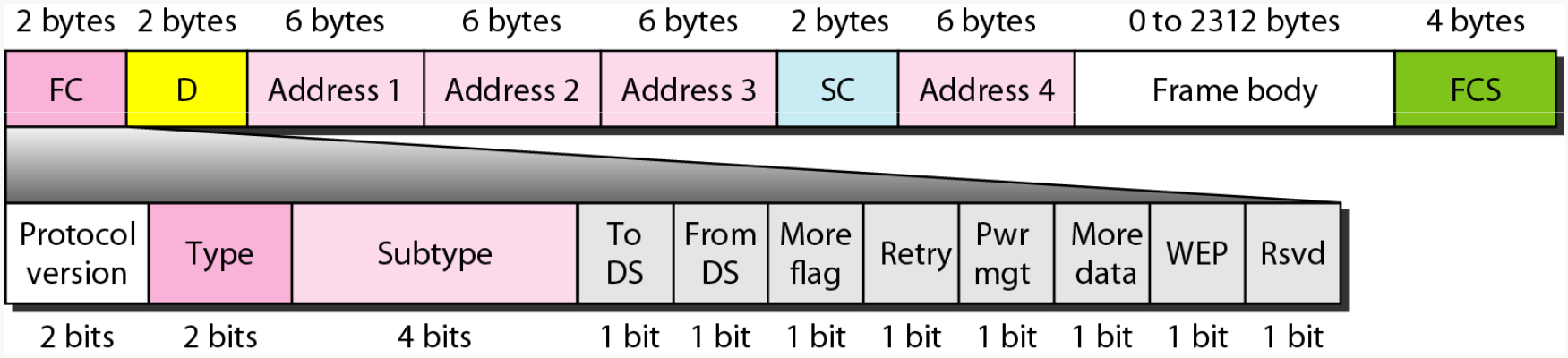
Roaming

- Moving between Access Point → Roaming
- No or bad connection? Then perform:
- Scanning
  - Searching for another access point.
  - 2 Types of scanning
    - Passive Scanning
    - Active Scanning
- Passive Scanning
  - Listens to the medium to find other network.
  - Done By receiving the beacon of another AP
- Active Scanning
  - Sending a probe signal and waiting for response.
- Beacon and probe contains the information necessary to join a new BSS

Roaming

- Reassociation Request
  - Selecting best AP based on signal strength.
  - Station sends a request to Selected AP
- Reassociation Response
  - Success: AP has answered, station can now participate
  - Failure: continue scanning
- AP accepts Reassociation Request
  - Signal the new station to the distribution system
  - The distribution system updates its data base (i.e., location information)
  - Typically, the distribution system now informs the old AP so it can release resources

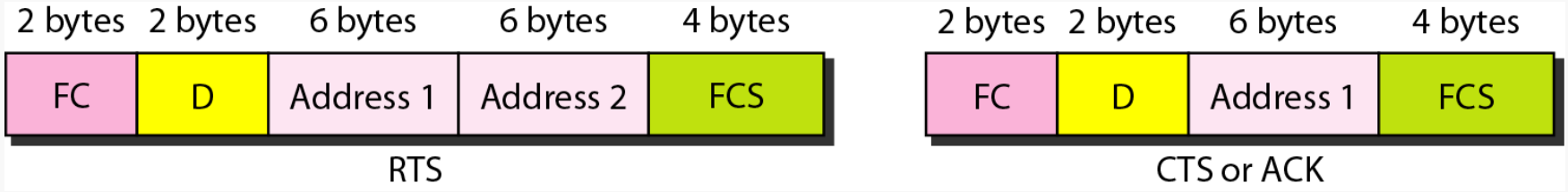
Frame format



Subfields in FC field

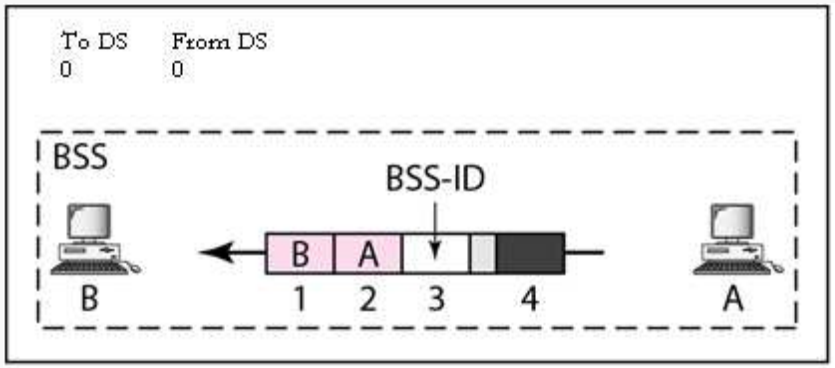
Field	*Explanation*
Version	Current version is 0
Type	Type of information: management (00), control (01), or data (10)
Subtype	Subtype of each type (see Table 14.2)
To DS	Defined later
From DS	Defined later
More flag	When set to 1, means more fragments
Retry	When set to 1, means retransmitted frame
Pwr mgt	When set to 1, means station is in power management mode
More data	When set to 1, means station has more data to send
WEP	Wired equivalent privacy (encryption implemented)
Rsvd	Reserved

Frame format

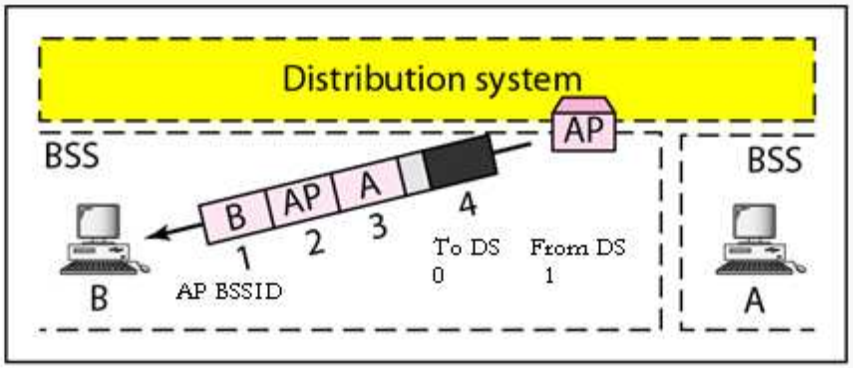


Subtype	*Meaning*
1011	Request to send (RTS)
1100	Clear to send (CTS)
1101	Acknowledgment (ACK)

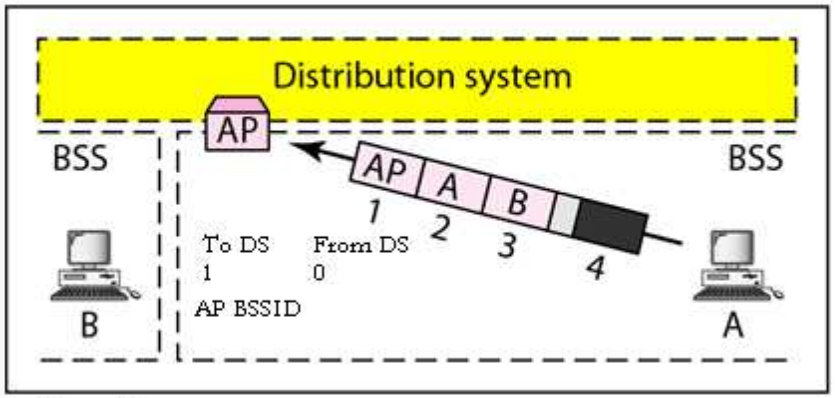
Addressing mechanisms



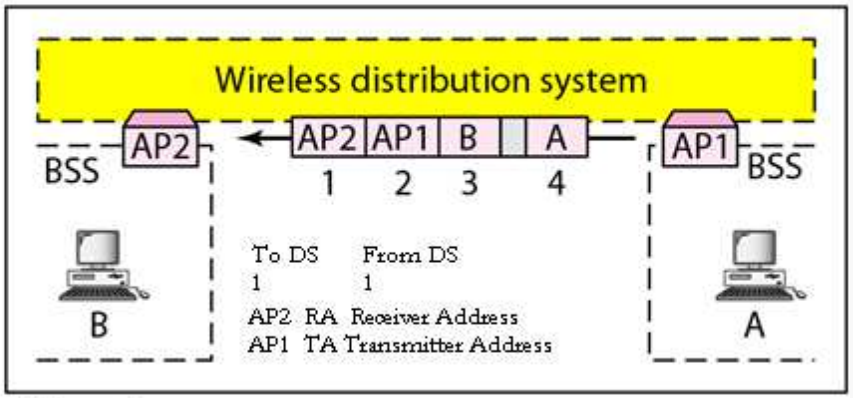
a. Case 1



b. Case 2



c. Case 3



d. Case 4