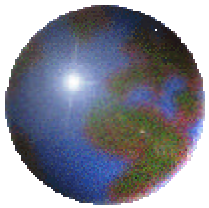
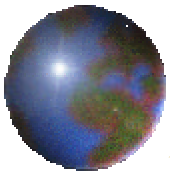


IEEE 802.11 & 802.11b

By:

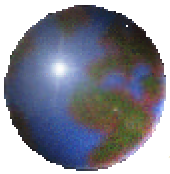
Adel A. Youssef

adel@cs.umd.edu



Contents

- 802.11 and 802.11b Technologies.
- Operating Modes.
- Protocol Architecture.
- 802.11 PHY Layer.
- 802.11b Enhancements to PHY Layer.
- 802.11 Data Link Layer
- Access Methods.
- MAC Management.



IEEE 802.11 and 802.11b Technology

- 1997 - The original 802.11 standard:

  1 Mbps and **2** Mbps data rates.

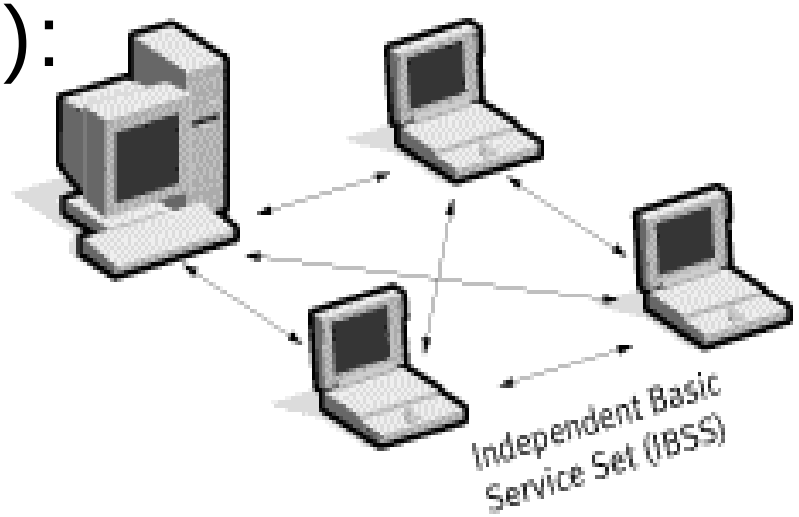
- Sep. 1999, 802.11b (802.11 HR) standard:

  up to **11** Mbps data rates.

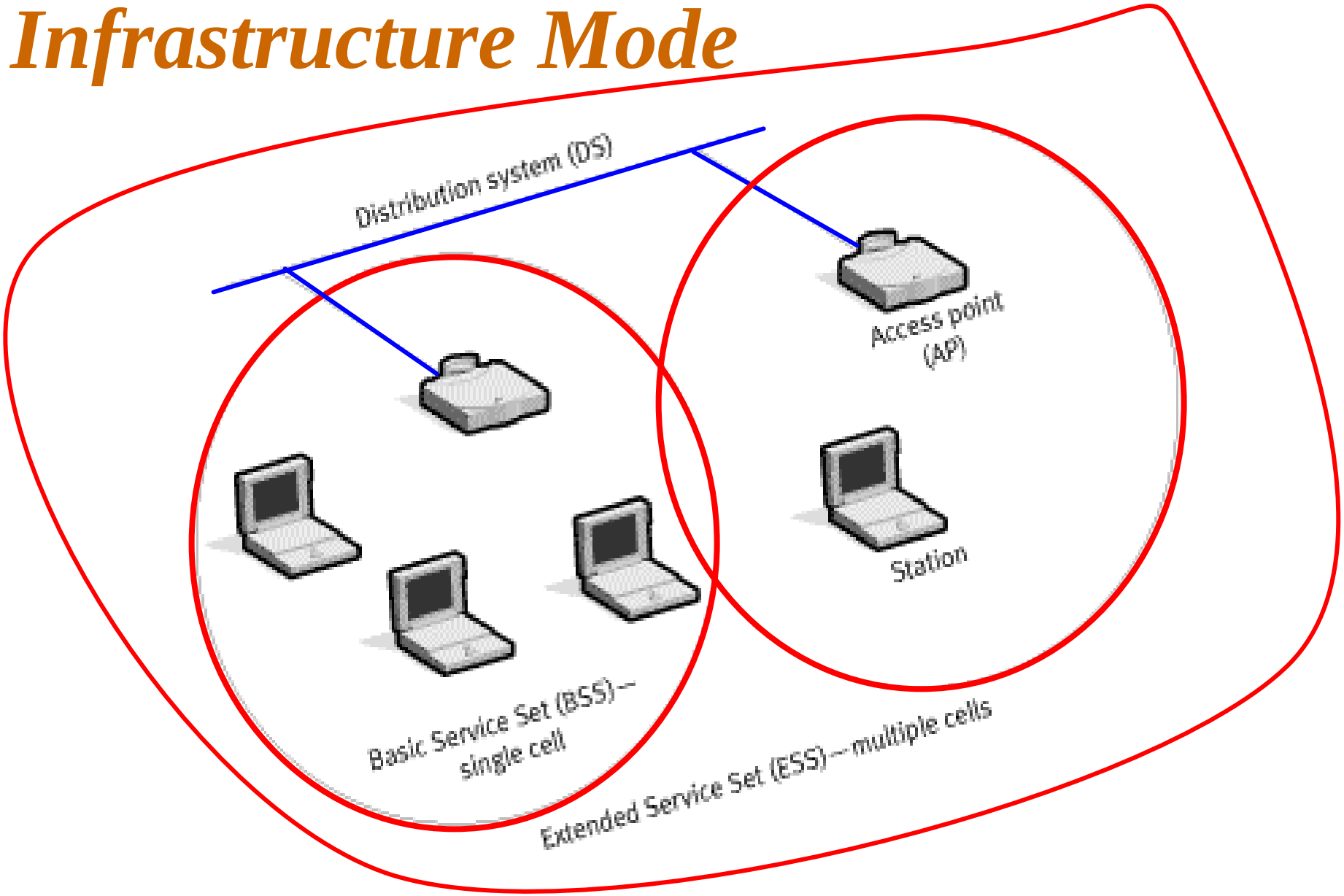
- 802.11b specs affect only the PHY layer.
- Two pieces of equipment:
  1. **AP (**radio, wired network interface, bridging software 802.1d**).**
  2. **STA.**

Operating Modes

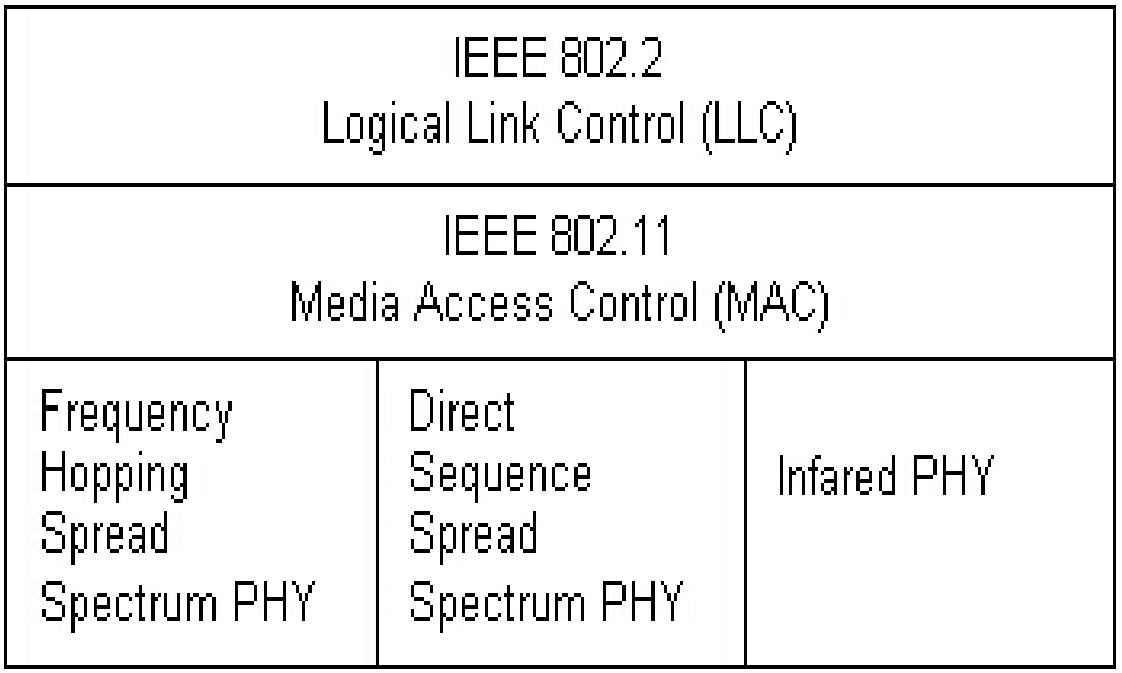
- Two modes: ad hoc and infrastructure.
- The basic building block of WLAN is the Basic Service Set (BSS).
- Ad Hoc Mode (IBSS):

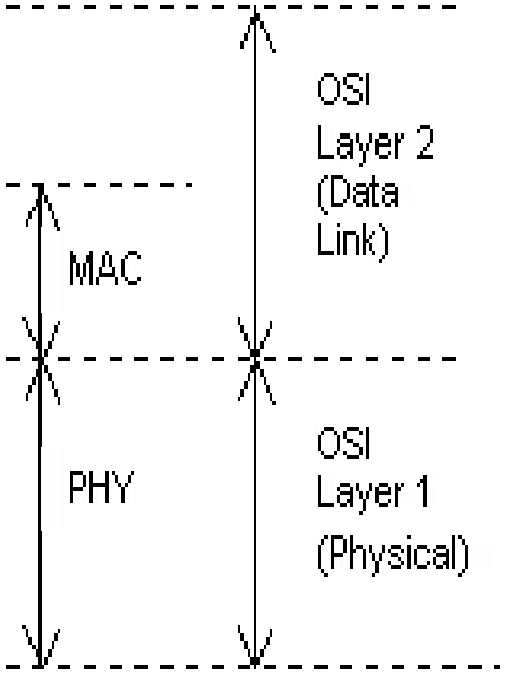


Infrastructure Mode

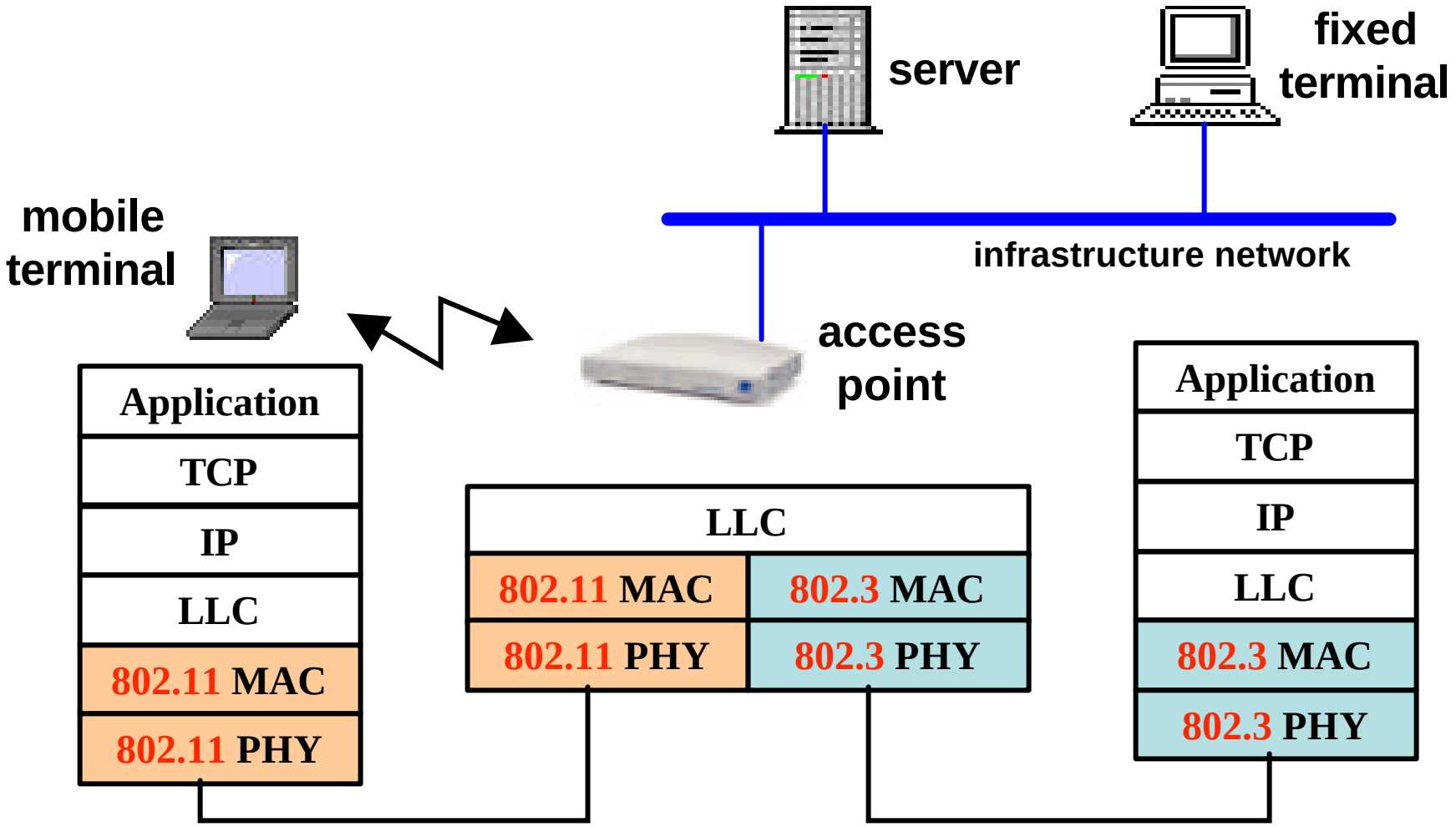


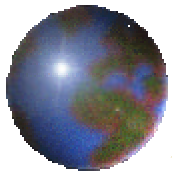
802.11 and ISO OSI Model





Protocol Architecture and Bridging



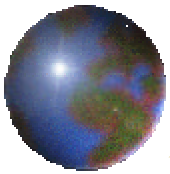


The 802.11 PHY Layer

- 802.11 defines THREE signaling techniques:

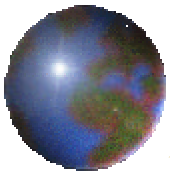
  FHSS, DSSS, IR

- FHSS and DSSS operate in 2.4 ISM band.
- Data rates of 1 Mbps and 2 Mbps via FHSS or DSSS.



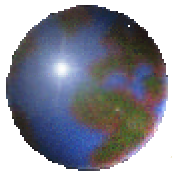
Frequency Hopping Spread Spectrum

- 75 1-MHz subchannels.
- The sender and receiver agree on a hopping pattern. Data is sent over a sequence of subchannels.
- Simple radio design.
- Limited to speed of no higher than 2 Mbps (*FCC*).



Direct Sequence Spread Spectrum

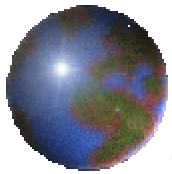
- 14 22-MHz subchannels.
- Adjacent channels overlap partially with THREE non-overlapping.
- Chipping: 11 chip sequence.
- Symbols:waveform representing a bit.
- Coding Technique: Barker Sequence.
- Modulation: 1 Mbps *BPSK*, 2 Mbps QPSK.
- Error checking and recovery.



802.11b Enhancements to PHY Layer

- Two new speeds: **5.5** Mbps and **11** Mbps.
- Only DSSS.
- Data rates of 1 Mbps and 2 Mbps via FHSS or DSSS.
- Advanced coding techniques:

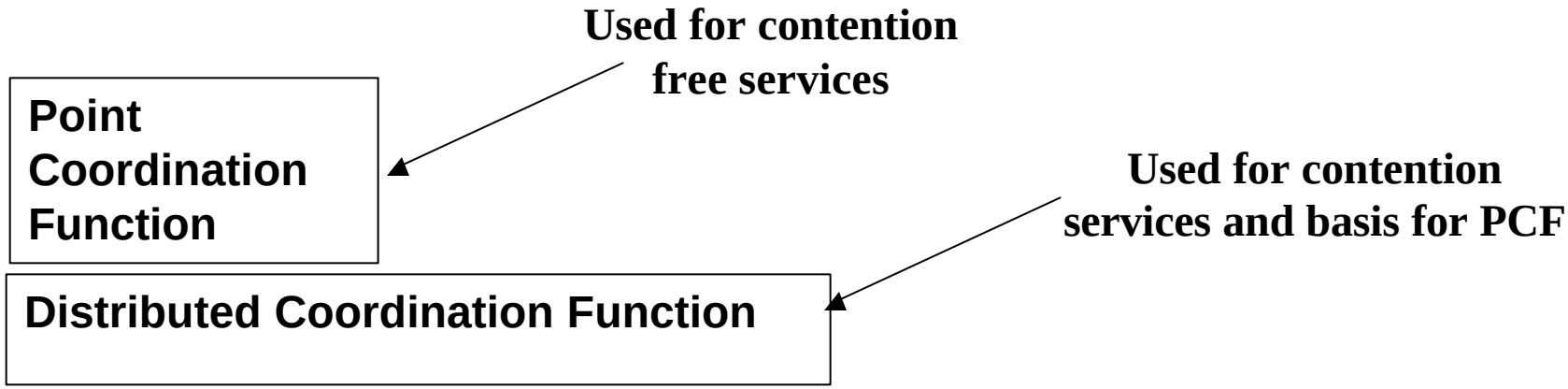
  Complementary Code Keying (***CCK***)
- Modulation: QPSK.
- Dynamic rate shifting.



The 802.11 Data Link Layer

- Two sublayers: LLC and MAC.
- Use same 802.2 LLC and 48-bit addressing as other 802 LANs.
- MAC Management:
  - 1- Synchronization.
  - 2- Association.
  - 3- Power Management.
  - 4- Security.

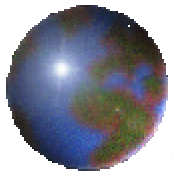
Access Methods



1- Distributed Coordination Function (DCF). **BASIC**

2- RTS/CTS extension. **OPTIONAL**

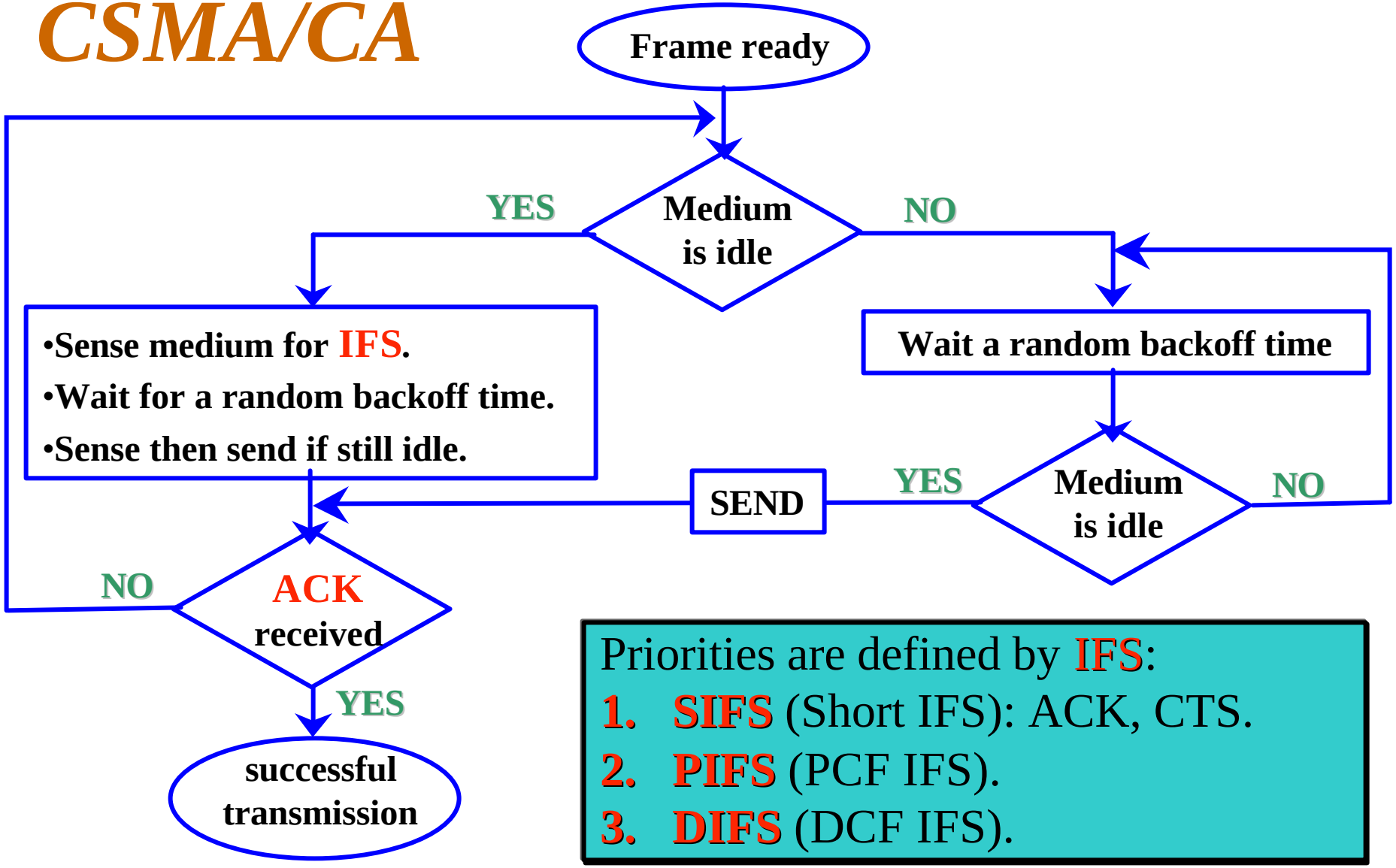
3- Point Coordination Function (PCF). **OPTIONAL**



Distributed Coordination Function (DCF)

- The Near/Far Problem: To detect collision, a STA must be able to transmit and listen at the same time. In Radio systems the transmission drowns out the ability to listen.
- Solution: use DCF or CDMA/CA.
- Explicit ACK (not used in case of broadcast or multicast frames).
- Randomized backoff.

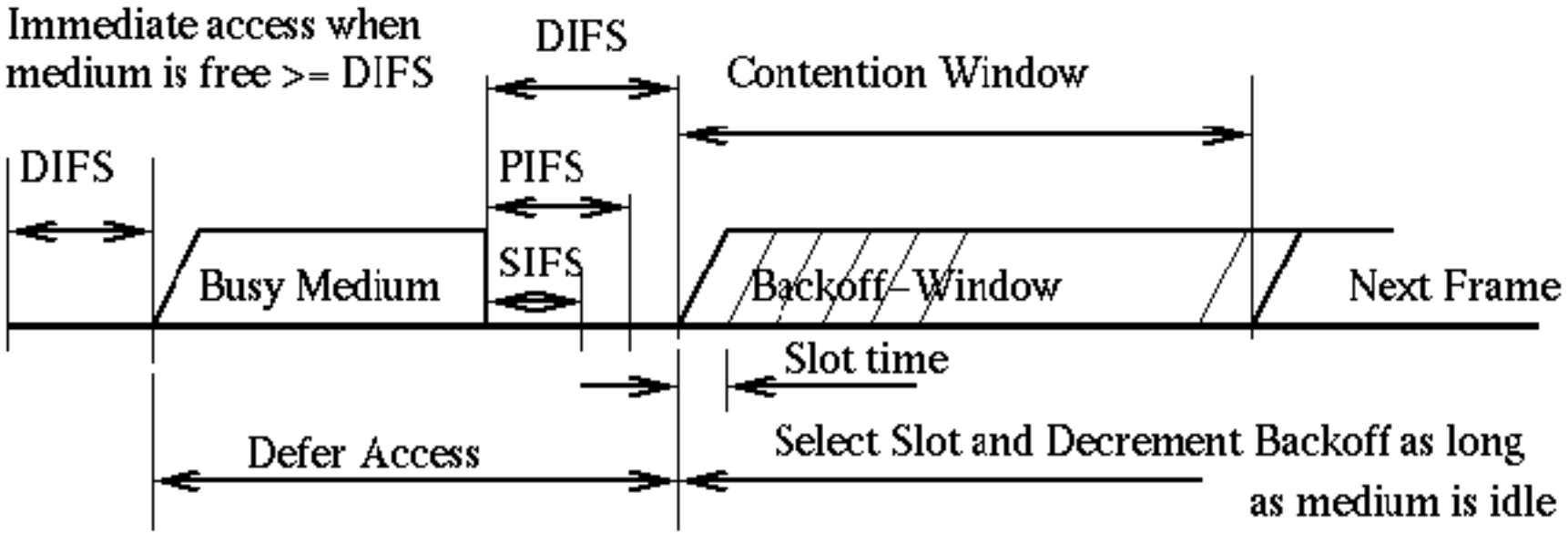
CSMA/CA



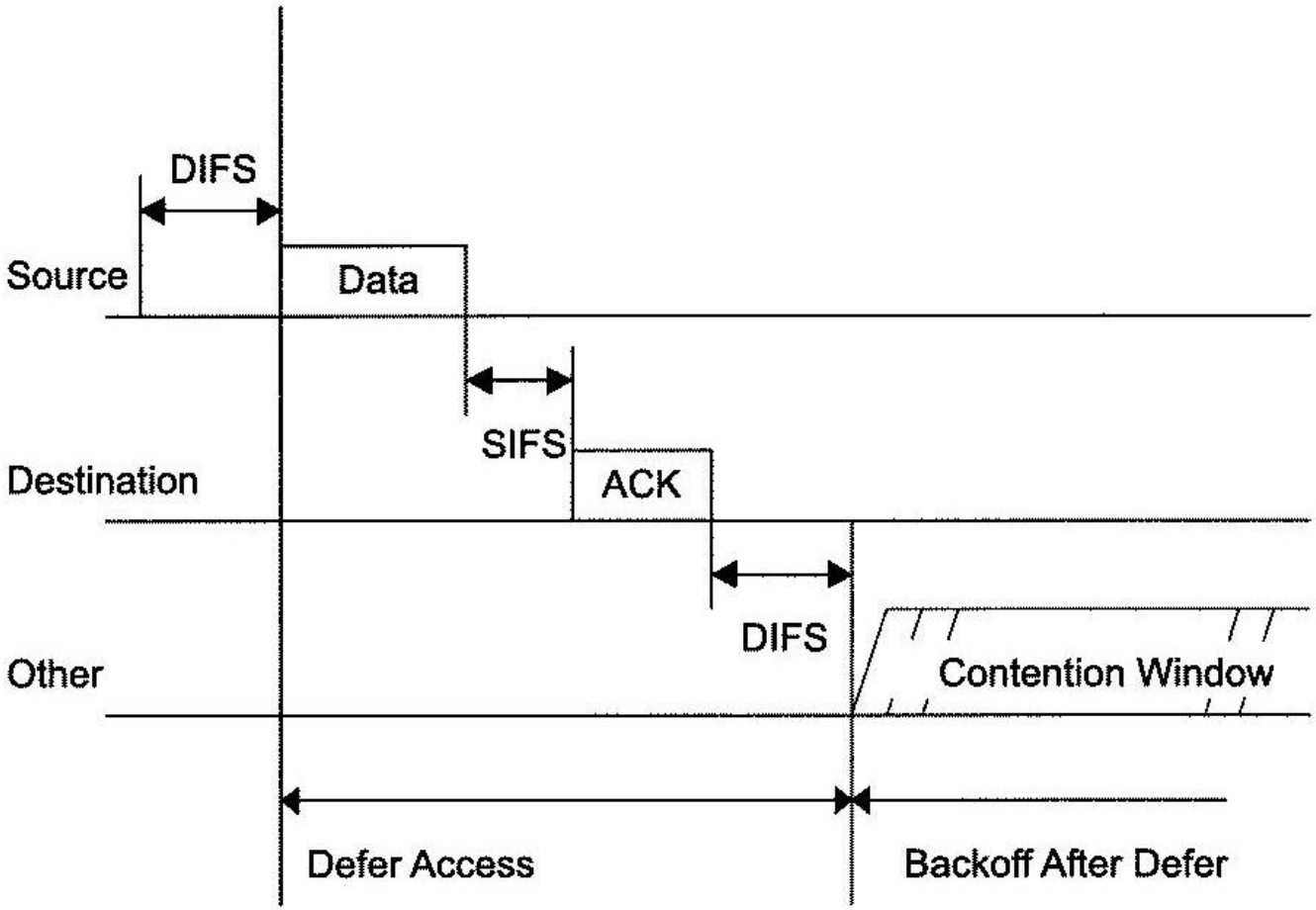
Priorities are defined by IFS:

1. **SIFS** (Short IFS): ACK, CTS.
2. **PIFS** (PCF IFS).
3. **DIFS** (DCF IFS).

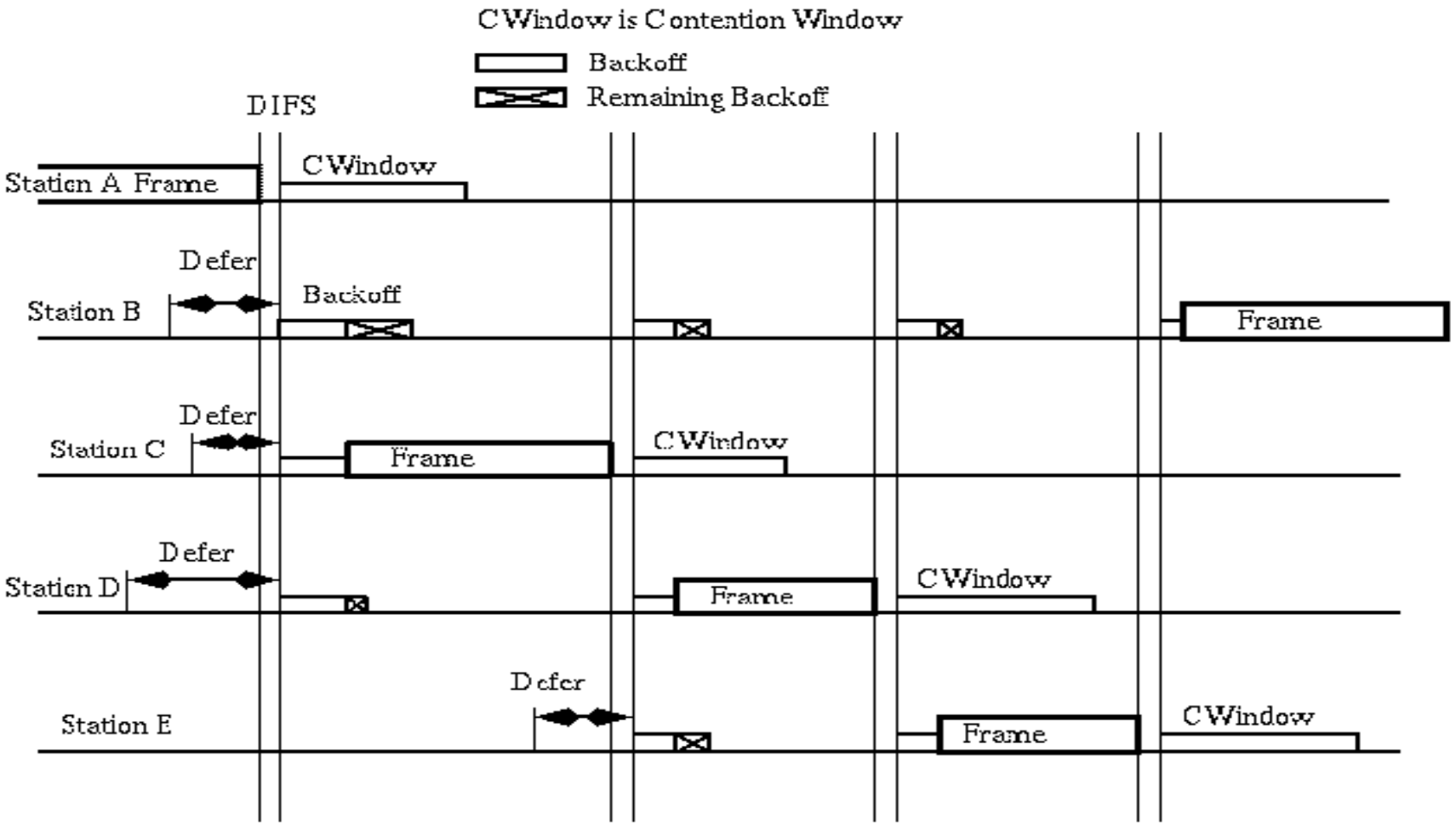
Basic Access Method



Unicast Frames (Directed Data)

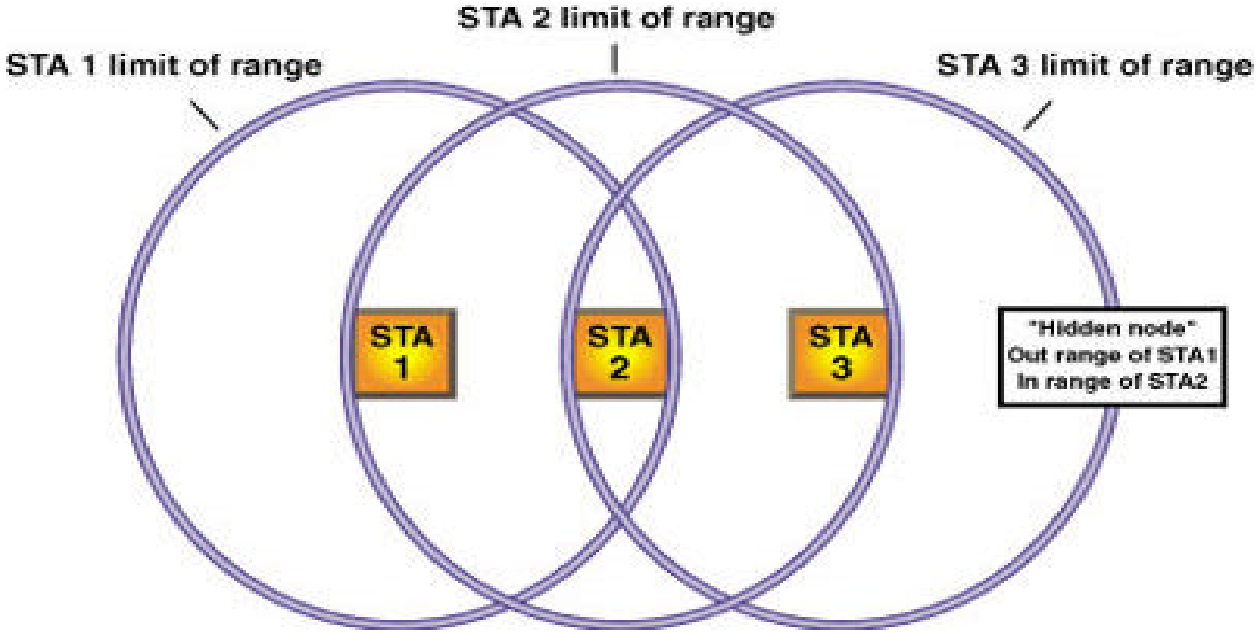


Backoff Procedure

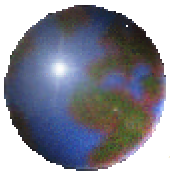


DCF with RTS/CTS Extension

- The Hidden Node Problem.



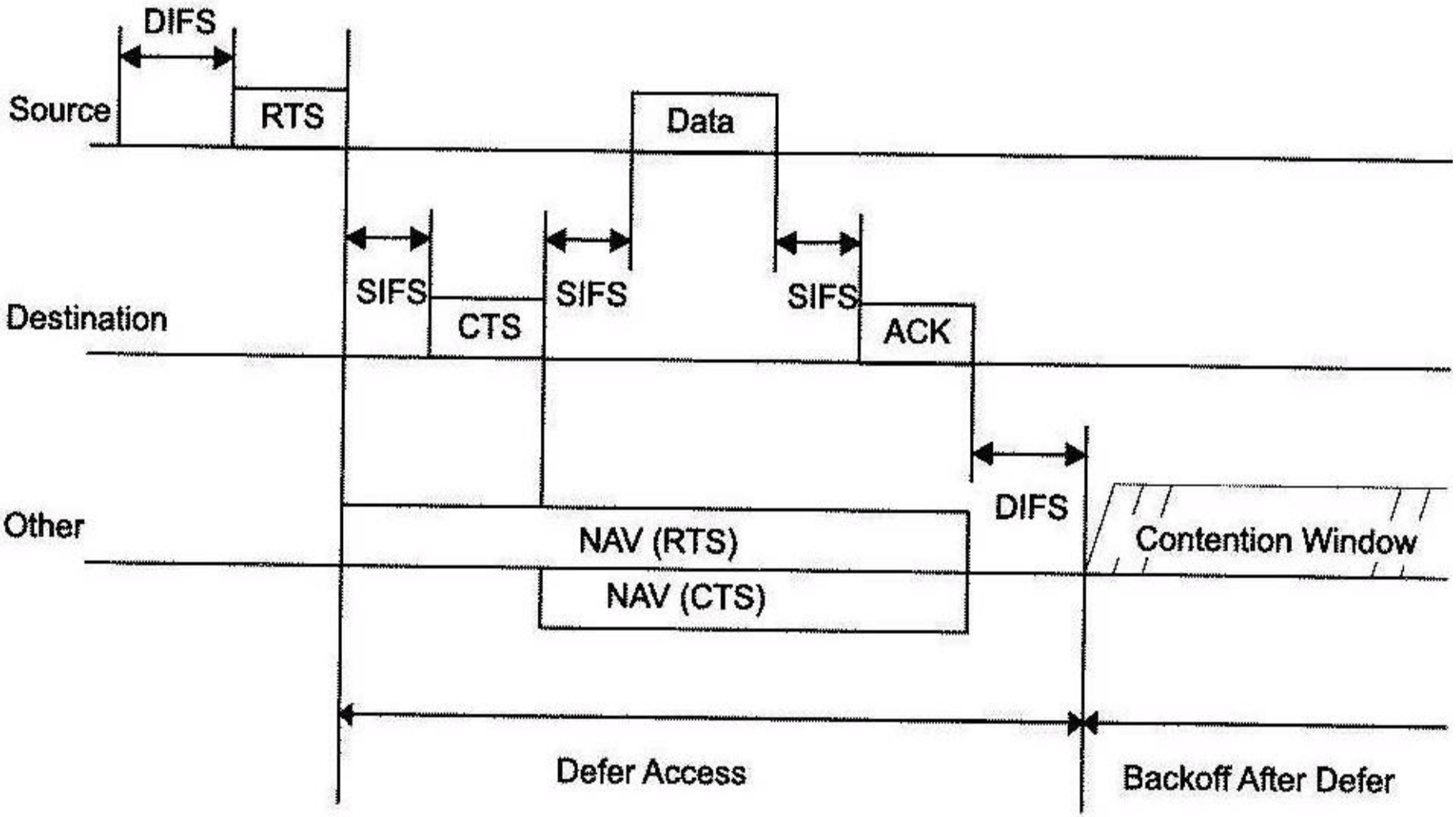
- Solution: RTS/CTS.
- Used for large size packets.
- Can not be used with broadcast and multicast.

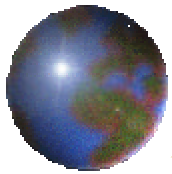


Carrier-sense Mechanisms

- Physical Vs. virtual mechanisms (*NAV*).
- NAV maintains a prediction of future traffic based on duration information in RTS/CTS frames and MAC header frames.
- All STAs within the reception range of either the originating STA (RTS) or the destination (CTS) learn of the medium reservation.

RTS/CTS/data/ACK and NAV Setting

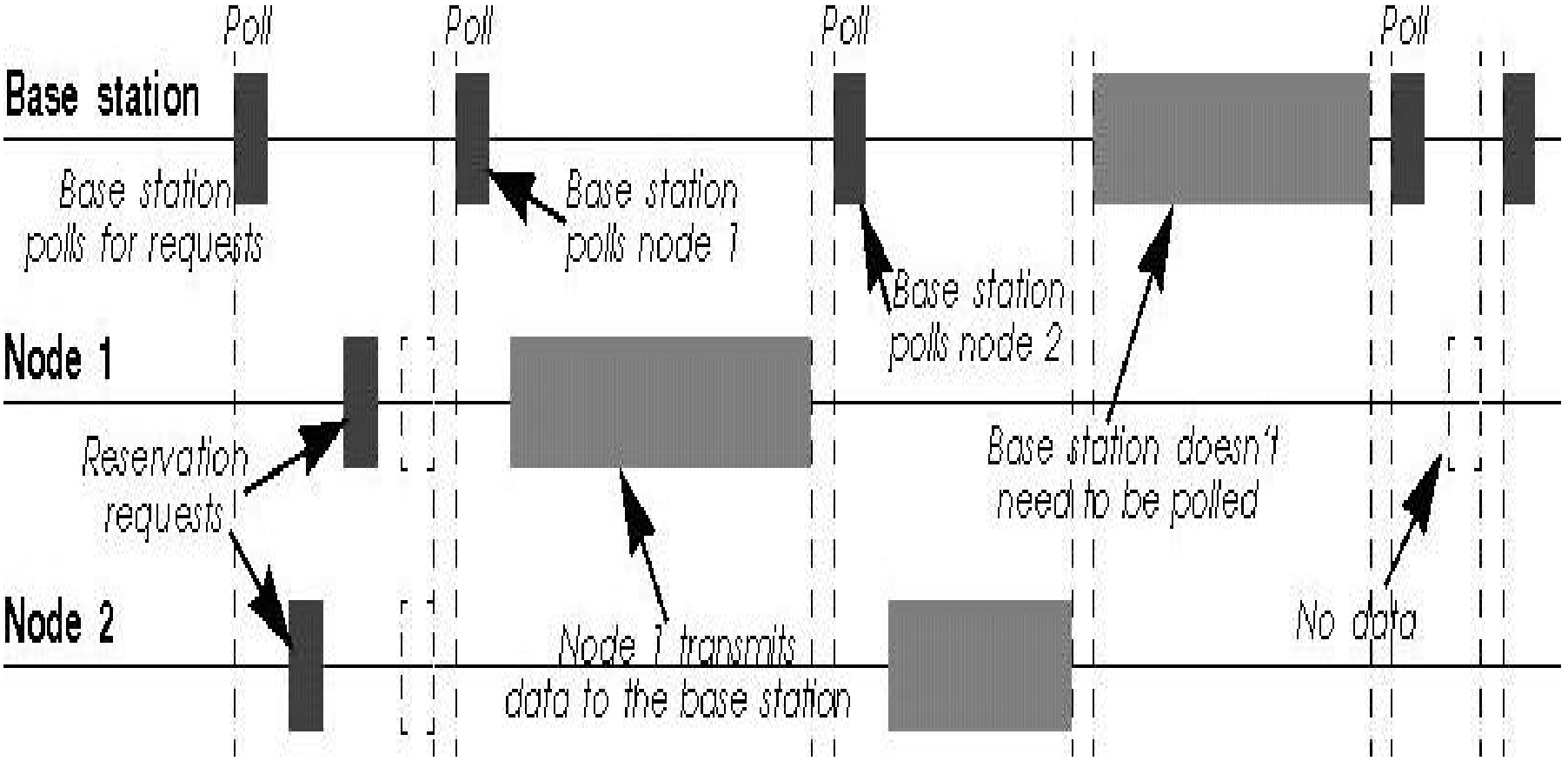




Point Coordination Function (PCF)

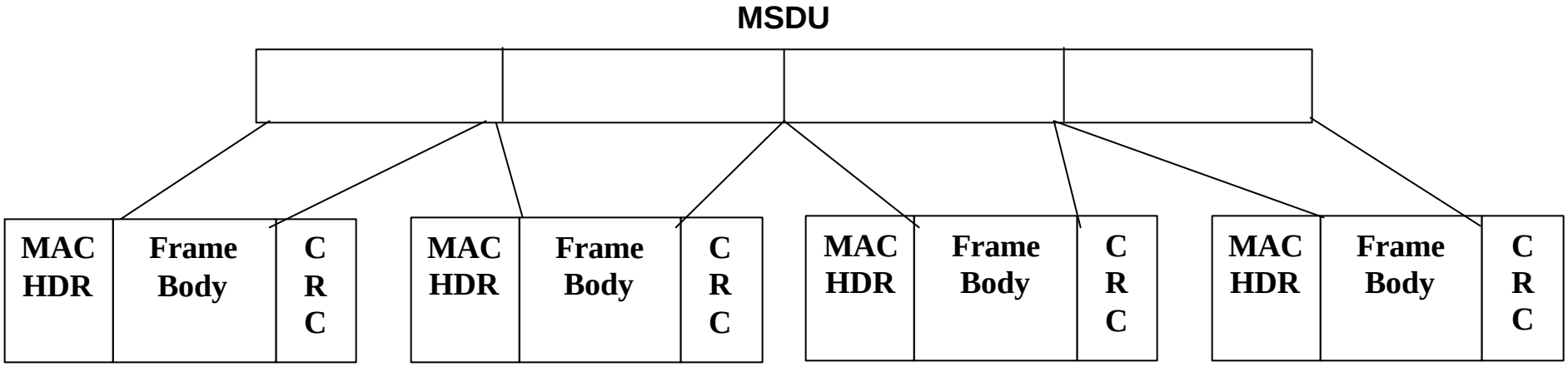
- Support of time-bounded data.
- Uses a Point Coordinator (PC) operating in the AP.
- PC polls STAs in a predetermined priority.
- No station is allowed to transmit unless it is polled.
- Not scalable, AP needs to have control of media access and must poll all stations, which can be ineffective in large networks.

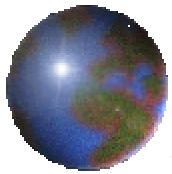
PCF (Contd.)


Poll
Poll
Poll
Poll
Base station
Base station polls for requests
Base station polls node 1
Base station polls node 2
Node 1
Reservation requests
Base station doesn't need to be polled
Node 2
Node 1 transmits data to the base station
No data

Packet Fragmentation

- The process of portioning a MAC service data unit into smaller MAC level frames.
- Increase reliability by increasing the probability of successful transmission.
- Only unicast packets are fragmented.

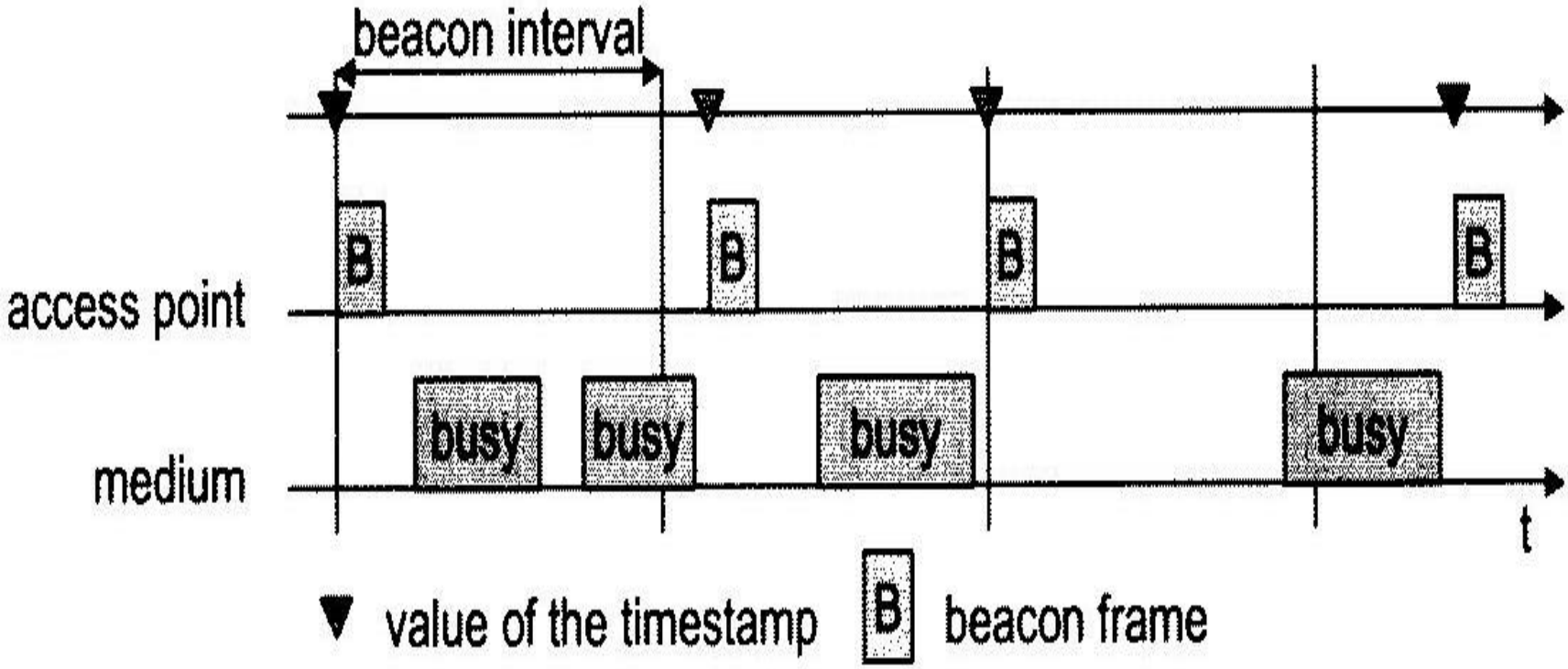


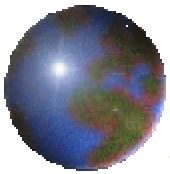


Synchronization

- A Timing Synchronization Function (*TSF*) keeps the timers for all STAs in the same BSS synchronized.
- The AP is the timing master.
- APs are not synchronized.
- Beacons contain a copy of the AP TSF timer.
- Beacons are generated every *BeaconPeriod* time.
- If the medium is busy, the AP delays the actual transmission of a beacon.
- The *BeaconPeriod* is included in Beacon and Probe Response frames.

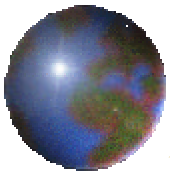
Synchronization (Contd.)



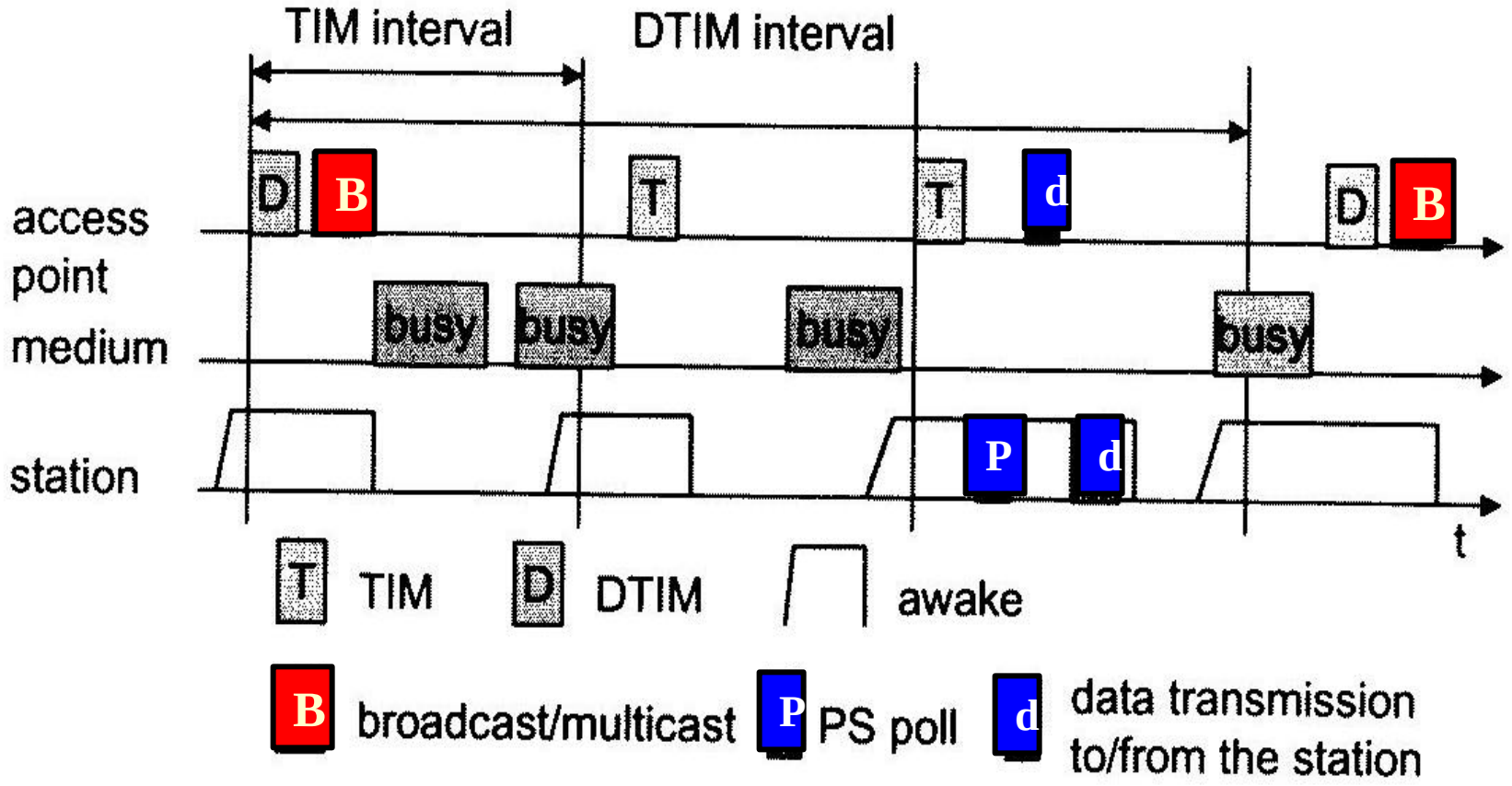


Association

- When a STA enters the range of one or more APs, it chooses an AP based on signal strength and observed packet error rates.
- A STA periodically surveys all channels to assess whether a different AP provide better performance.
- Reassociation: roaming, change in radio characteristics in the building, load balancing.



Power Management

- A STA can be in one of two states: Awake, Doze.
- Two modes: Active Mode (AM), Power Save (PS).
- Power Save (PS) Mode:
  - AP queues any data.
  - Traffic Indication Map (TIM).
  - STA periodically listens for beacons as determined by the STA's *ListenInterval* .
  - STA transmits a short PS-Poll frame to the AP.
  - AP responds with the buffered packet immediately or ACK the PS-Poll, respond with packet at a later time.
- Delivery TIM (DTIM): list of broadcast/multicast receivers.

Power Save Mode(Contd.)