Agenda for discussion

The lecture contains:

WLAN standards and technology.

- Different WLAN standards.
- Communication across different wireless technologies.
- Support for mobility and data rates.
- Modulation and spread spectrum.

Standards and Technology

Difficulties in achieving convergence

1. Multiple access technologies, and administrative domains.
2. Multiple service types, e.g., voice, data, audio, video, etc.
3. Seamless mobility.
4. Ubiquity in services.
5. Implementation of efficient traffic delivery.

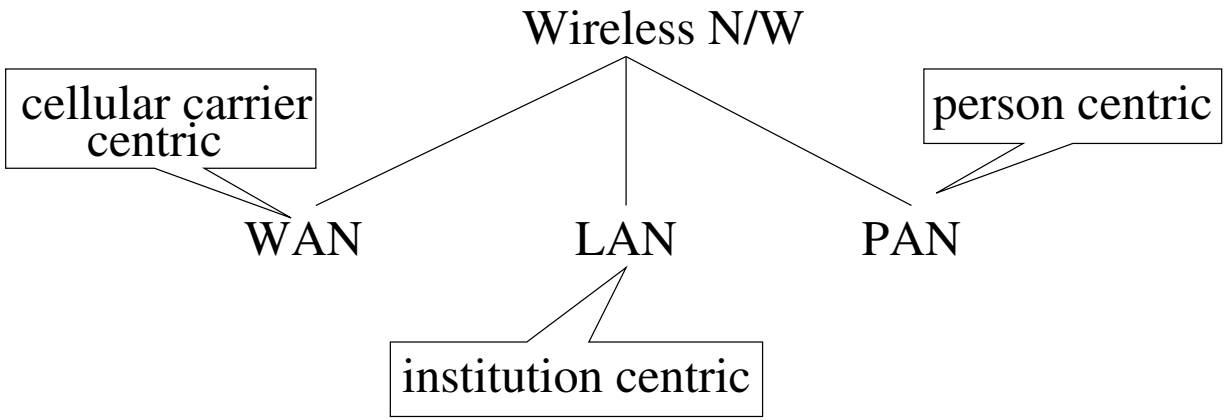
Standards and Technology

Requirement for innovation

- Solutions for convergence are more important than innovations in networking technologies.
- Yet, improvement in technology could also make the task of convergence simpler.
- Thus, a good understanding of wireless network is essential.

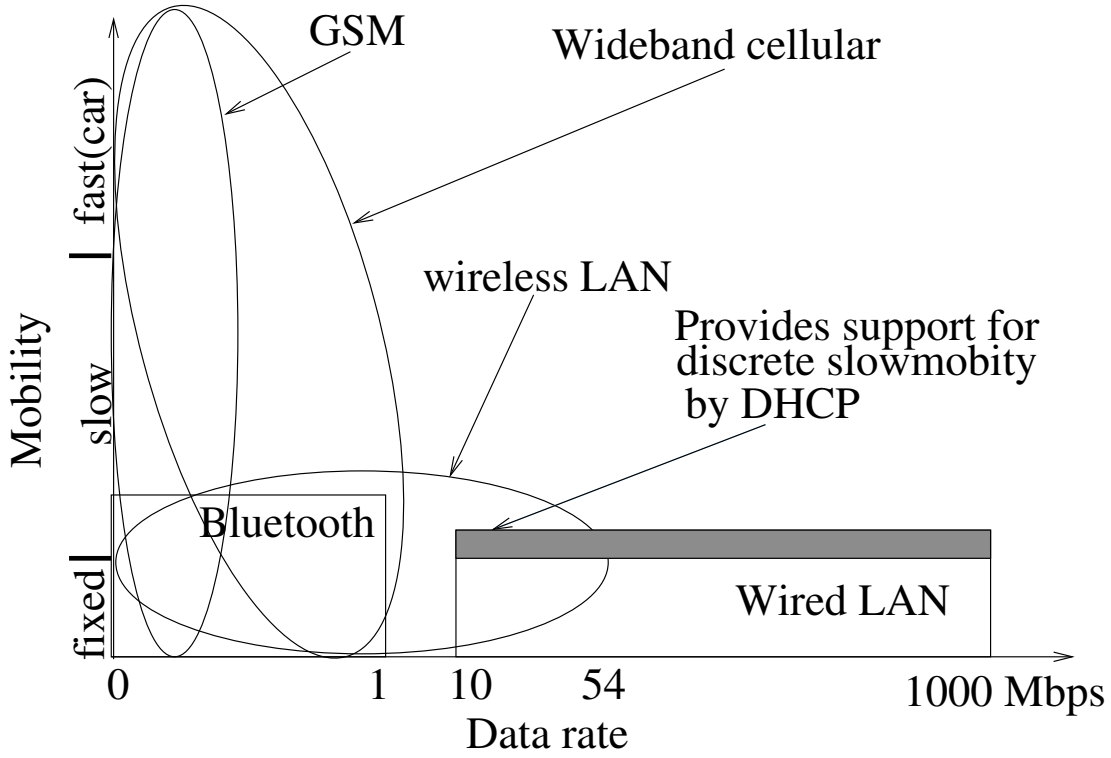
Standards and Technology

Types of wireless N/W



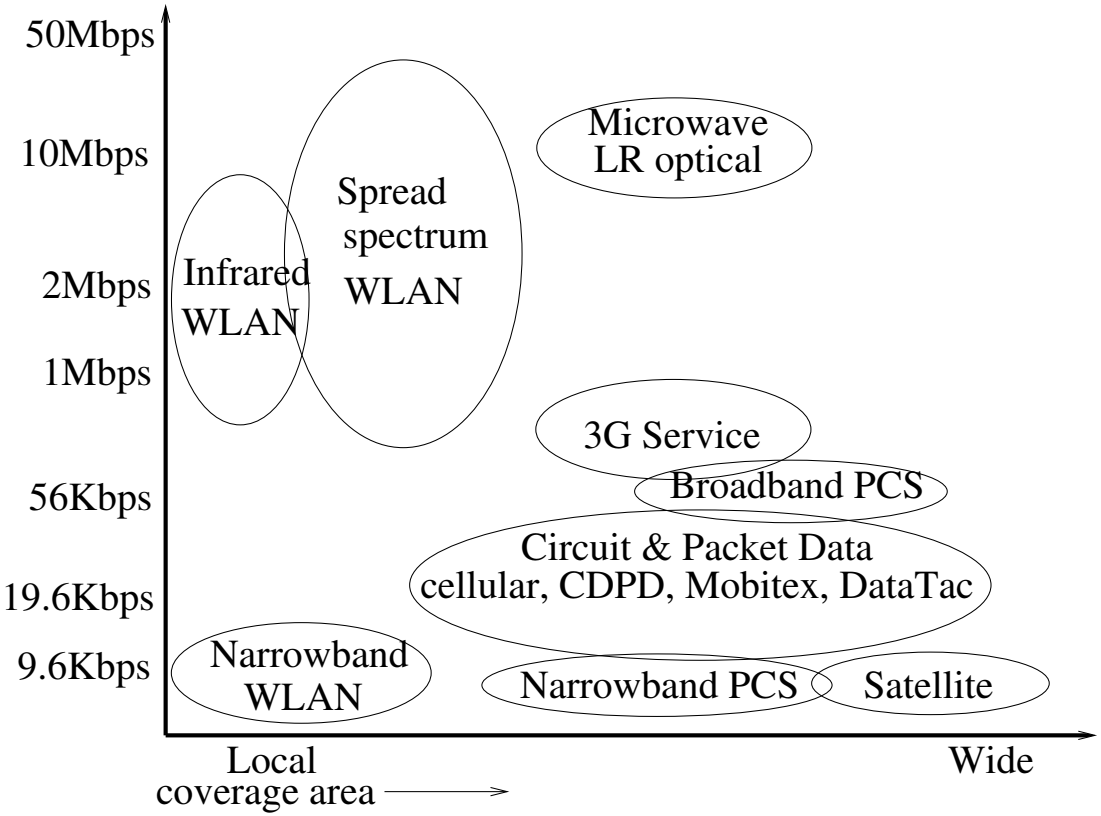
Standards and Technology

Mobility versus data rates



Standards and Technology

Technology versus coverage and data rates



Standards and Technology

Technology versus coverage and data rates

	PAN	LAN	MAN	WAN
Standards	802.15.1 802.15.3	802.11a/b/g/n	802.16	2.5G/3G/4G
Speed	<1Mbps to 1Gbps	1–600 Mbps	22+ Mbps	115Kbps to 1Gbps
Range	up to 10m	up to 100m	up to 50Km	up to 30Km
Applications	P2P	Enterprise N/W	Fixed, last mile access	PDA/mobile cellular access

Standards and Technology

Characteristics of WLAN

- WLAN is supported by wired infrastructure.
- Provides one-hop wireless connectivities within a small distance.
- The typical coverage area could be a university, small enterprise, hospital, airport, etc.
- Considering the requirements, WLAN should support high data transfer rates.
- Operates on unregulated part of wireless spectrum. So, its signal may spill over to streets and exposed to vulnerability.

Competing standards

- IEEE standards.
  - Developed by IEEE both for 2.4GHz and 5GHz spectrum.
- HiperLAN.
  - European family of standards known as ETSI standards for highspeed wireless communication in 5.13-5.25GHz and 17.1-17.3GHz spectrum
- Mobile Multimedia Access Communication.

IEEE Standards

802.11 a/b/g

- WLANs use wireless Ethernet technology based on IEEE 802.11 standards.
- There are three different operational standards: IEEE 802.11a, IEEE 802.11b and IEEE 802.11g.
- 802.11b/g use 2.4GHz unlicensed band whereas 802.11a operates in 5 GHz band.
- Shorter frequency means 802.11a can not penetrate walls.
- IEEE 802.11b, is known as WiFi and 802.11a as WiFi5.

IEEE Standards

802.11 a/b/g

- 802.11a/g use an efficient transmission technology called orthogonal frequency division multiplexing (OFDM) for physical layer.
- Data rates are: 54Mbps for 802.11a/g, 11Mbps for 802.11b.
- 802.11b/g are compatible to each other.
- 802.11g attempts to combine best of both.

IEEE Standards

802.11 a/b/g

802.11a

- Operate in regulated 5 GHz band.
- 23 channels non-overlapping.
- Nominal bandwidth: 54Mbps

802.11b/g

- Both 802.11b/g operate in unregulated 2.4GHz band.
- 13 channels, 3 (1, 6, 11) non-overlapping
- Nominal bandwidth: 11 Mbps for 820.11b, 54 Mbps for 802.11g

IEEE Standards

802.11 a/b/g

802.11a

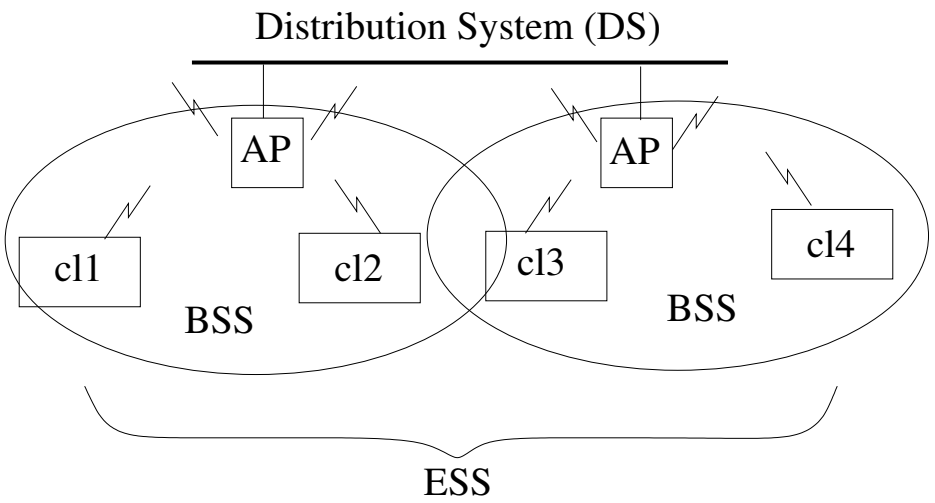
- Peak bandwidth: 25Mbps
- Not compatible with b/g
- Short range $\leq$ 50meters
- Gives better performance

802.11b/g

- Peak bandwidth: 6/25Mbps
- Can interoperate.
- Long range $\leq$ 100meters.

Basic Service Set

BSS and Organization of a WLAN



- WLAN is based on a cellular architecture where each cell is called a BSS and controlled by an AP.
- Most installations formed by APs connected through a backbone typically Ethernet.
- Cells interconnected by a WDS is known as ESS.

Basic Service Set

ID of a WLAN

- BSSID (MAC address of AP) is identifier of a BSS
- In infrastructure supported WLAN, BSSID is AP's MAC.
- In IBSS, MAC of m/c which begins IBSS is the BSSID.
- AP broadcasts BSSID.
  - If for privacy reasons broadcast is disabled BSSID should be manually supplied by clients.
- BSSID is m/c friendly, not user friendly. So SSID is used.
  - SSID, a name which can be easily remembered by users.

Basic Service Set

ID of a WLAN

- AP broadcasts one SSID on beacon.
- If AP is not configured to allow broadcast, then SSID must be provided manually.
- Client association steps are:
  - client sends probe request and AP sends response.
  - client initiates association, AP intercepts association.
  - AP adds client MAC to association table.

Joining an Existing BSS

Scanning

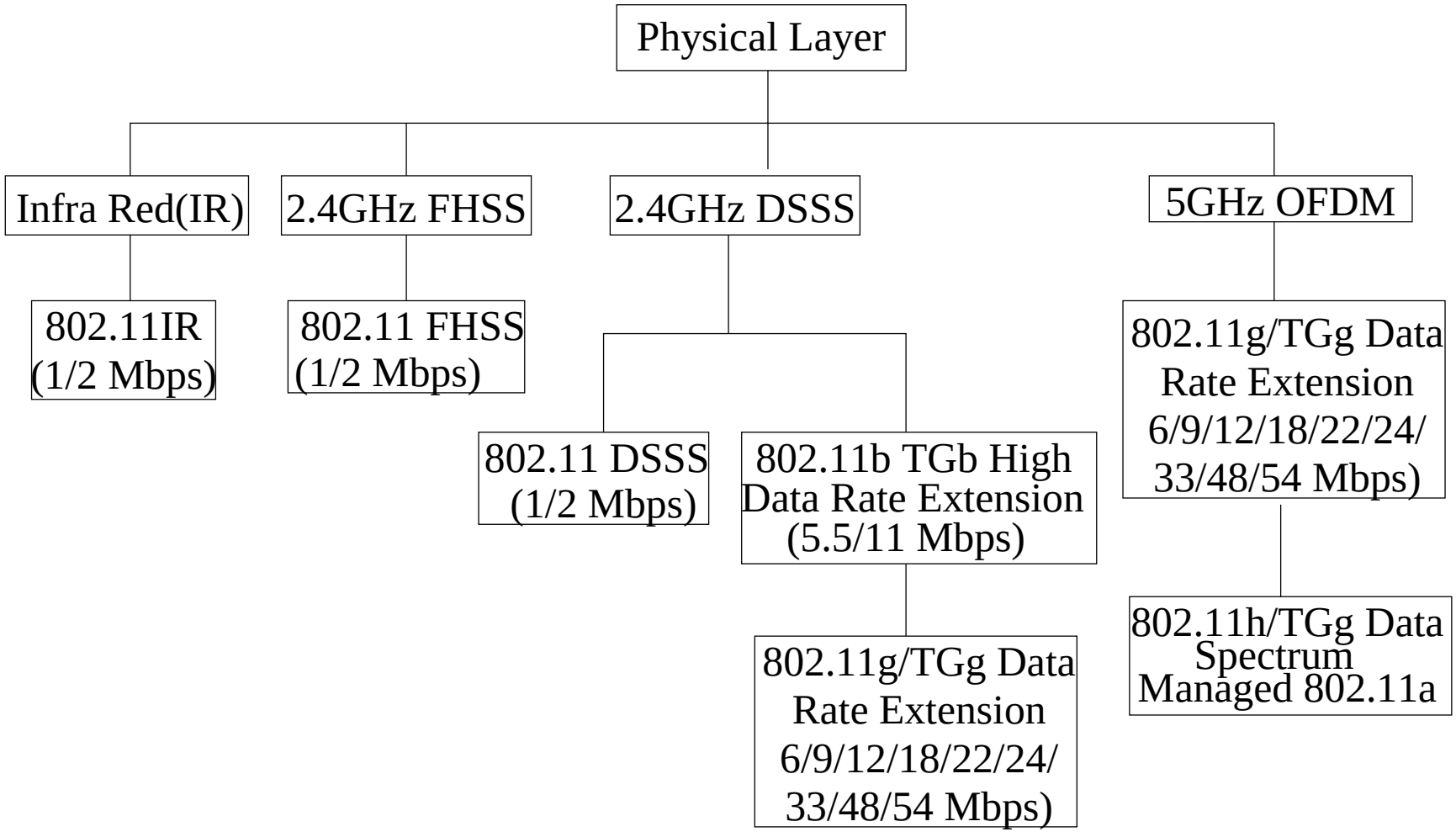
- **Passive scanning:** station after entering BSA waits for periodic beacon which includes
  - SSID,
  - AP's capabilities (eg., supported data rates)
  - Beacon period
  - Traffic indication map (TIM)
  - MAC address of AP and time stamp
- **Active scanning:** station locates AP by sending probe request frame (PRF) and waits for response from AP.

Joining an Existing BSS

Authentication & Association

- **Authentication:** proof of knowing common secret is necessary.
- **Association:** exchange of information about station and AP's capabilities.
- A station gets into polling list after association process gets over.

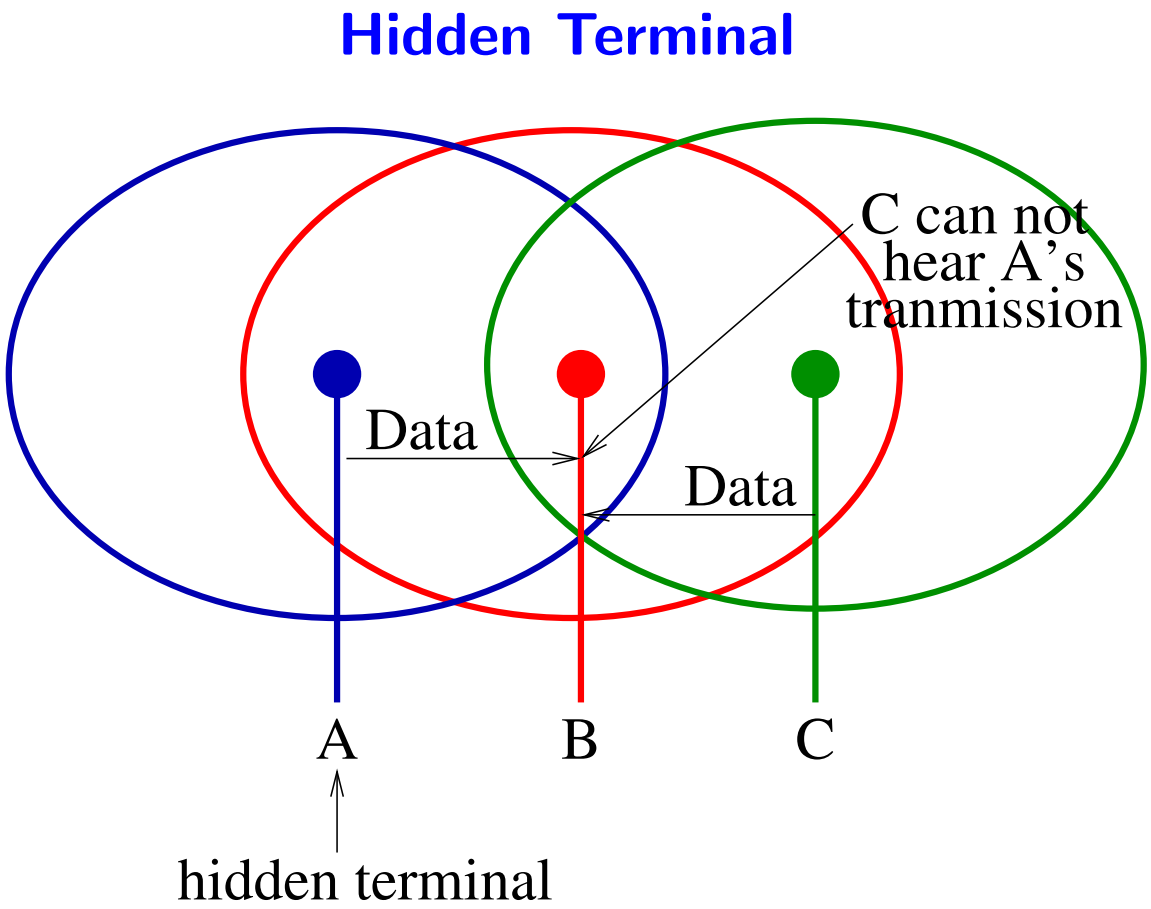
IEEE Standards for PHY



MAC Layer Functions

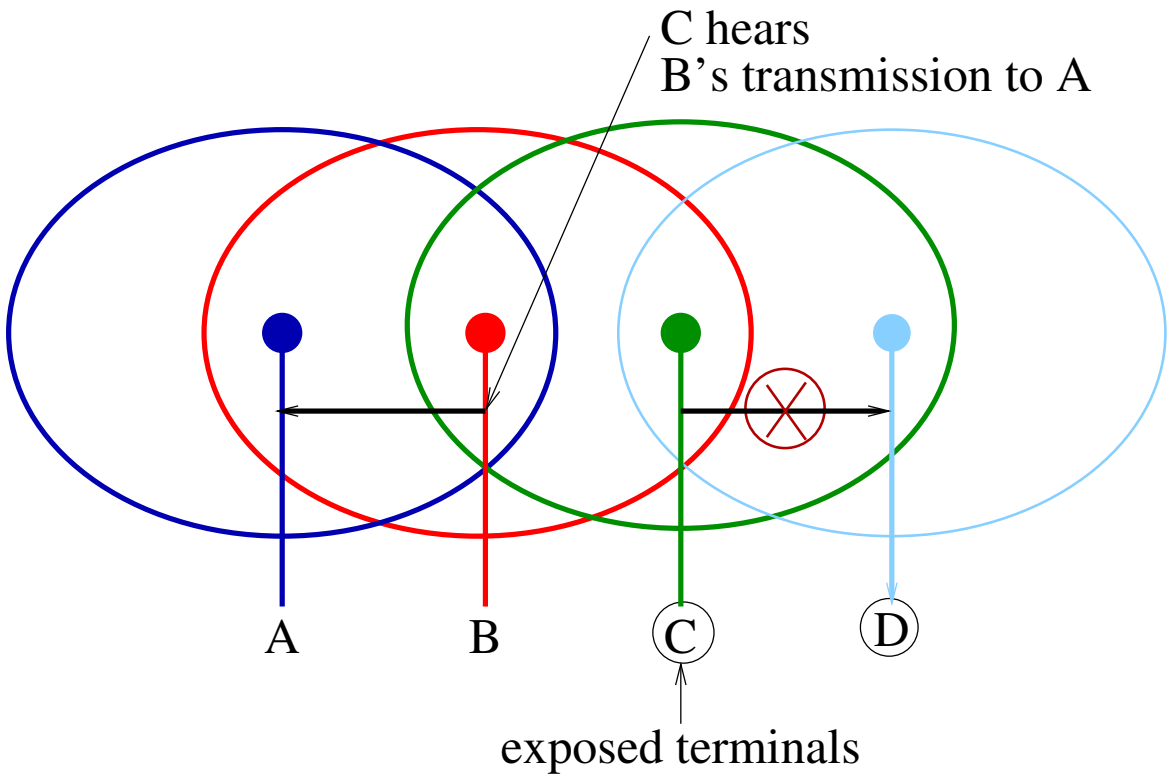
- Defines two access methods: DCF and PCF
- DCF is basically a CSMA/CA mechanism.
- In wireless medium half duplex, so, collision detection is not applicable.
- Furthermore, carrier sensing in wireless is not reliable due to short ranges, even if medium appears to be free at transmitter, it may not actually be free at receiver.

MAC Layer Functions



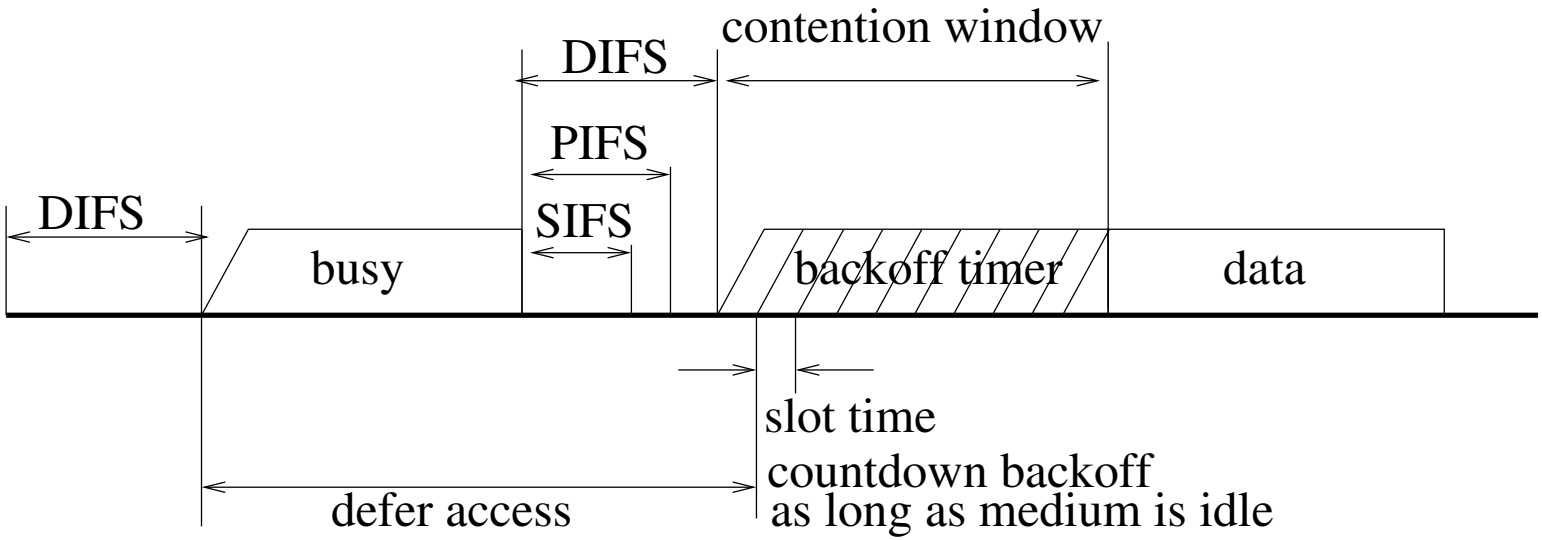
MAC Layer Functions

Exposed Terminal



DCF Basic Access Mode

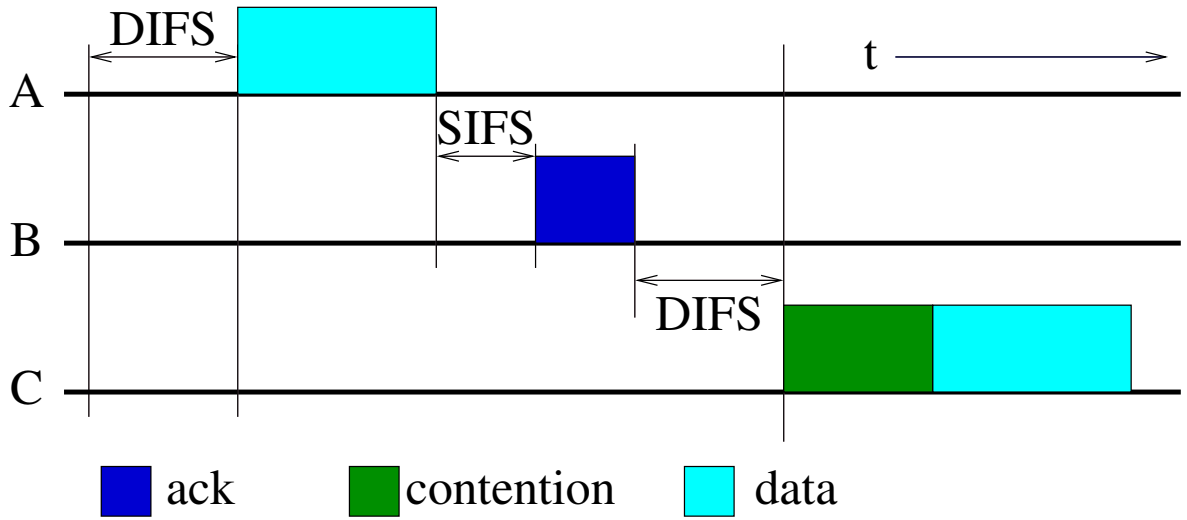
How it Works?



DCF Basic Access Mode

How ACK gets sent?

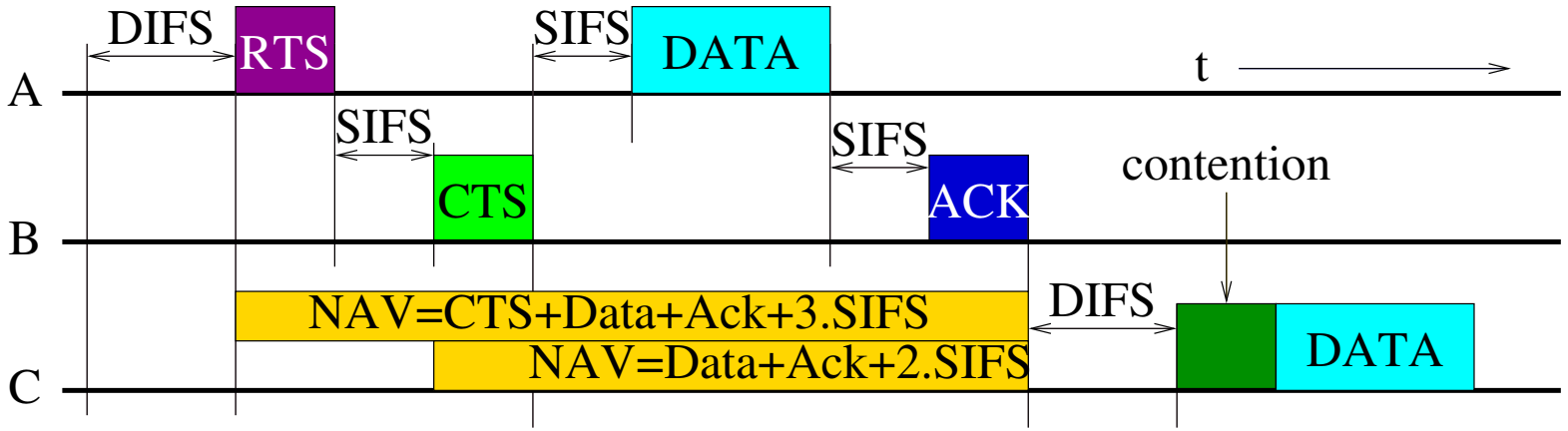
- Since SIFS (10μs) $<$ DIFS, a receiver always gets to send ACK,



Note: DIFS $= 2\times$ slot_time $+$ SIFS $= 50$ μs, SIFS (10μs) $<$ DIFS. So a receiver always gets to send ACK.

DCF Advanced Mode

RTS and CTS Dialogue

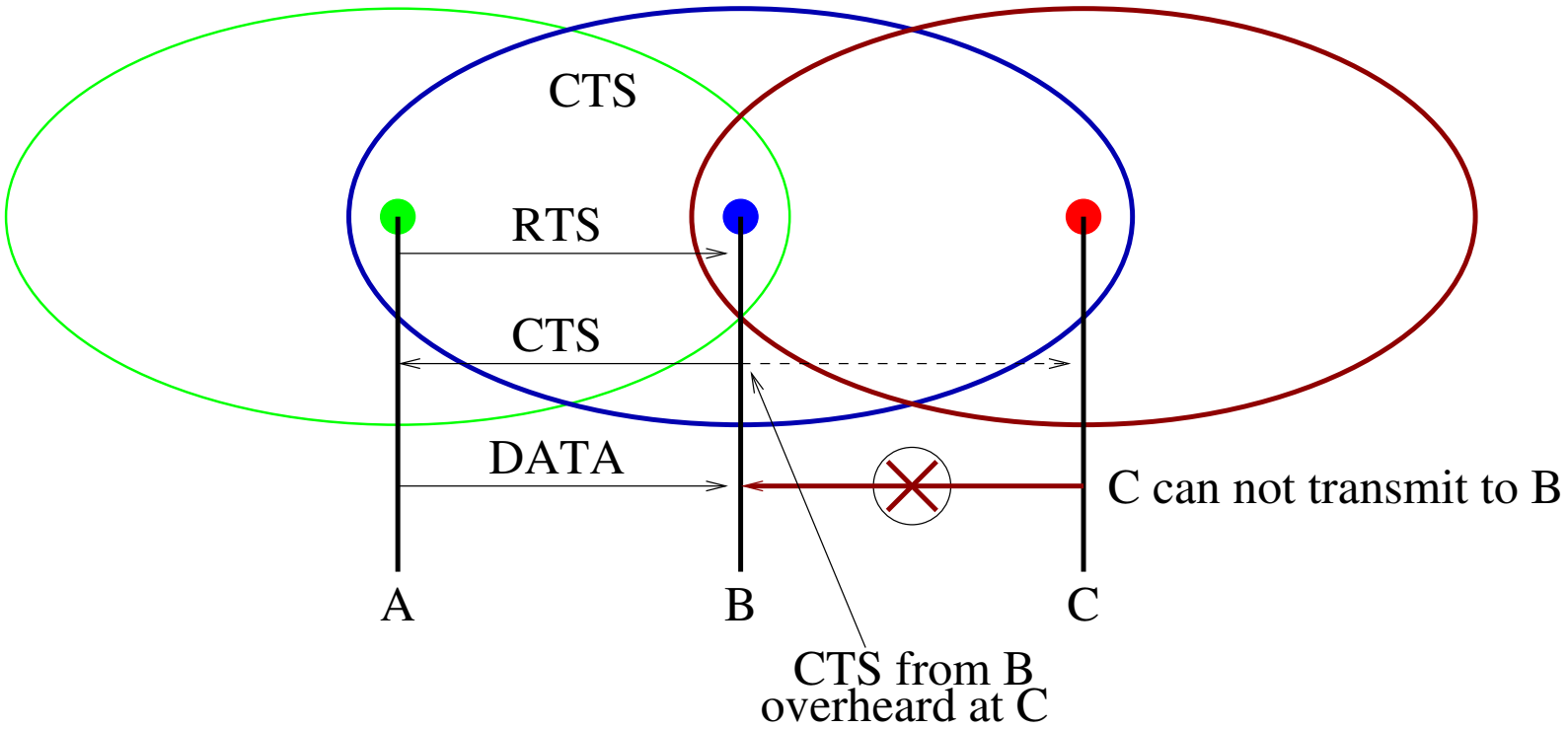


Note: NAV(RTS) does not include RTS, but carried by RTS
NAV(CTS) does not include CTS, but carried by CTS

- Sender sends a RTS (request-to-send) to receiver.
- If free, receiver sends a CTS (clear-to-send) after waiting for SIFS interval.
- C defers transmission for (NAV(RTS) + DIFS + contention)

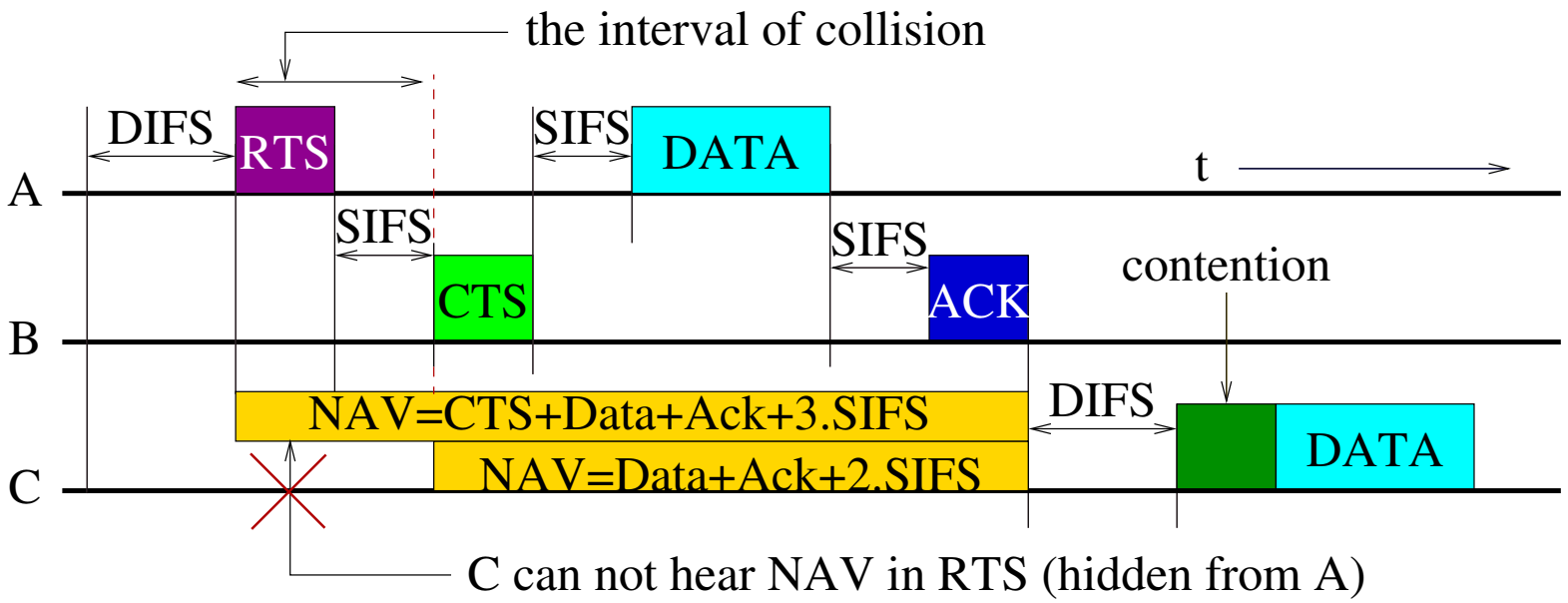
DCF Advanced Mode

Hidden Terminals Solution



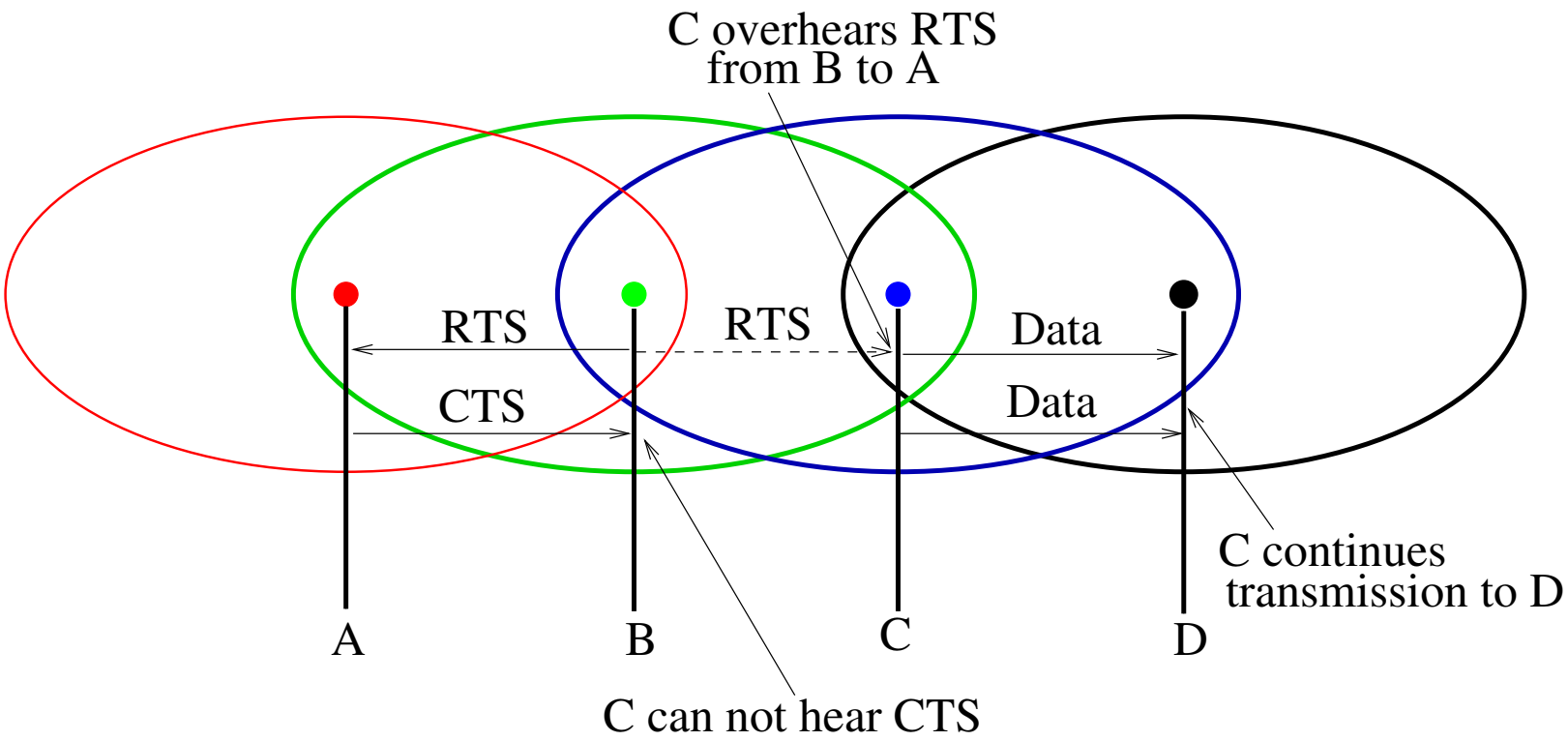
DCF Advanced Mode

Problem in Solution



DCF Advanced Mode

Exposed Terminals Solution



Point Coordination Function

Contention Free Access

- PCF function is performed by **Point Coordinator** in wireless AP within a BSS.
- Stations within BSS that operate in CFP are known as **CF-aware** stations.
- PC maintains polling table and polling sequence.
- PCF co-exists with DCF and sits on the top of DCF.

Point Coordination Function

Contention Free Access

- Within a repetition time (cycle), a portion is allotted to a **contention-free** traffic, and the remainder to **contention-based**.
- CFP interval is initiated by a **beacon frame** transmitted by AP.
- AP's one primary job is synchronization and timing.
- **CFP repetition interval**: integral multiple of **beacon frame time**.
- After establishing CFP-rate **duration of CFP** is determined.

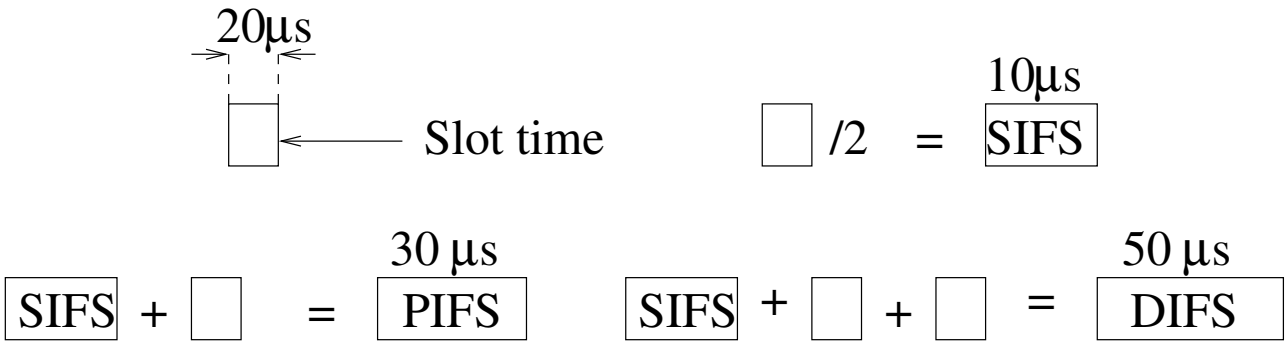
Point Coordination Function

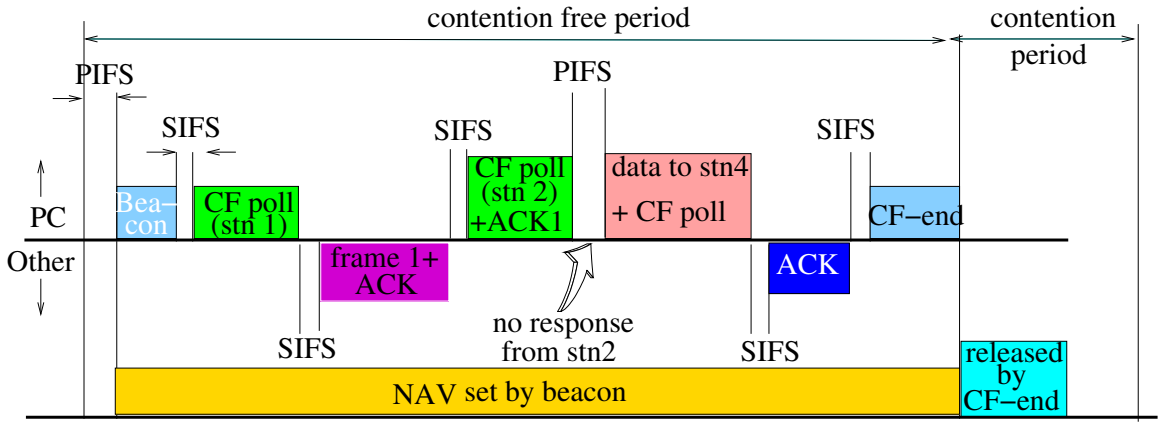
Contention Free Access

- AP transmits a beacon for starting CF-period. Beacon carries the **maximum** duration of CFP.
- Receiving stations set NAV to maximum duration to lock DCF access to the medium.
- Beacon is transmitted at regular intervals containing remaining duration of CF (for updating NAV).

Point Coordination Function

Frame Spacing, SlotTime & NAV





Summary

- WLAN is covered in this module. BSS, IBSS are discussed.
- Distributed coordination function both basic and RTS-CTS mode.
- How RTS-CTS mode of DCF operation handle hidden and exposed terminal problem.
- Point coordination function, where AP serves as a coordinator to ensure contention free accesses to medium.