# CISC 7332X T6

# C11b: Wireless LAN

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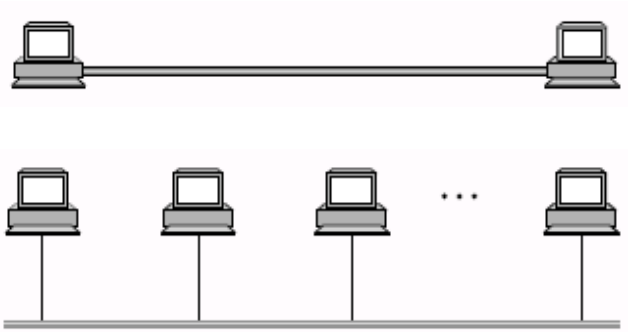
# Outline

- Challenges in desiring wireless LANs
- MACA
- Wireless LAN

# Medium Access Control

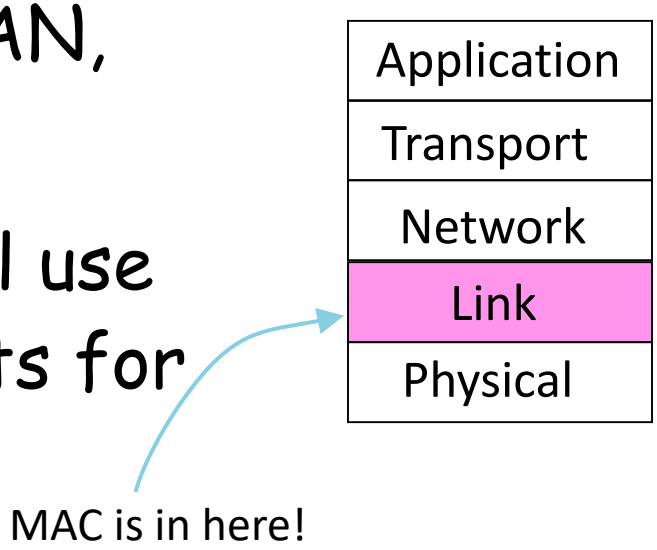
- Two types of network links
  - Point-to-point
  - Multiple access (broadcast)



- Key issue
  - Who gets to use the channel when there is a competition to it?
  - Multiaccess channel/random access channel
  - Medium Access Control (MAC)

# The MAC Sublayer

- The protocols used to determine who goes next on a multiaccess channel
- Especially important for LAN, particularly wireless LANs
- In contrast, WANs general use point-to-point links, excepts for satellite networks



# Wireless LAN Protocols

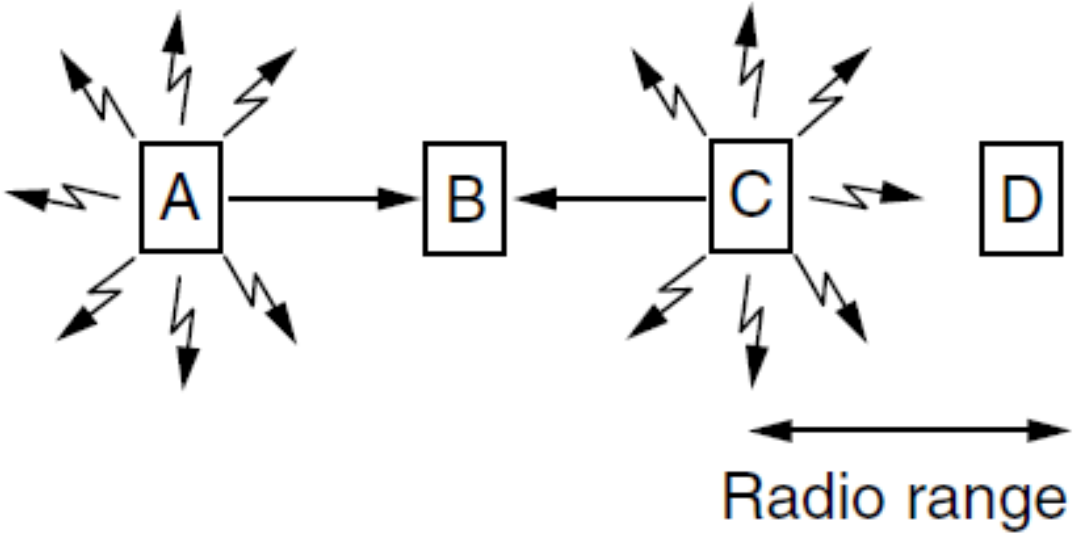
- Wireless has complications compared to wired.
  - Nodes may have different coverage regions
  - Leads to hidden and exposed terminals
- Nodes cannot detect collisions, i.e., sense while sending
  - Makes collisions expensive and to be avoided

# Hidden Terminals

- Hidden terminals are senders that cannot sense each other but nonetheless collide at intended receiver
  - Want to prevent; loss of efficiency

# Hidden Terminals: Example

- A and C are hidden terminals when sending to B

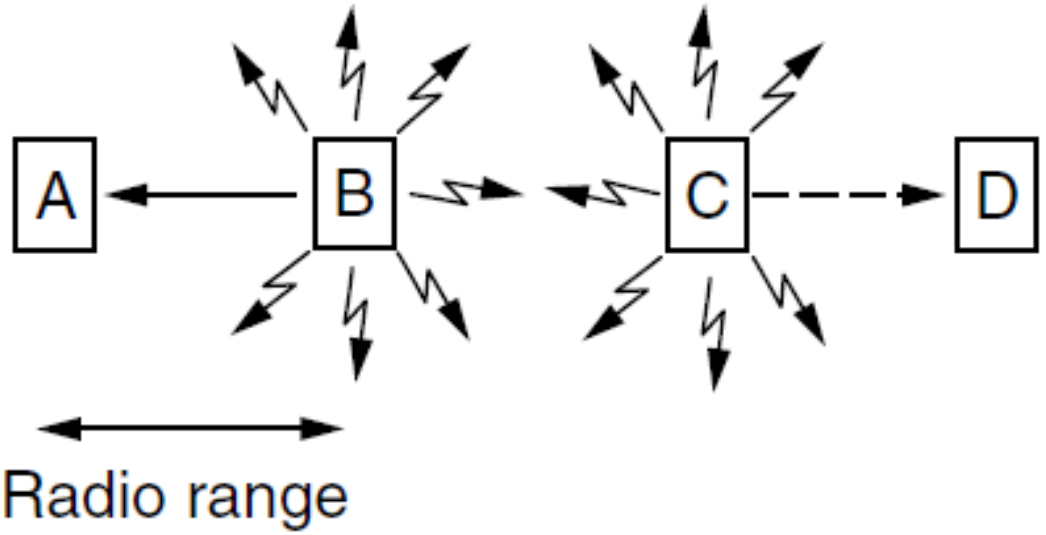


# Exposed Terminals

- Exposed terminals are senders who can sense each other but still transmit safely (to different receivers)
  - Desirably concurrency; improves performance

# Exposed Terminals: Example

- B → A and C → D are exposed terminals

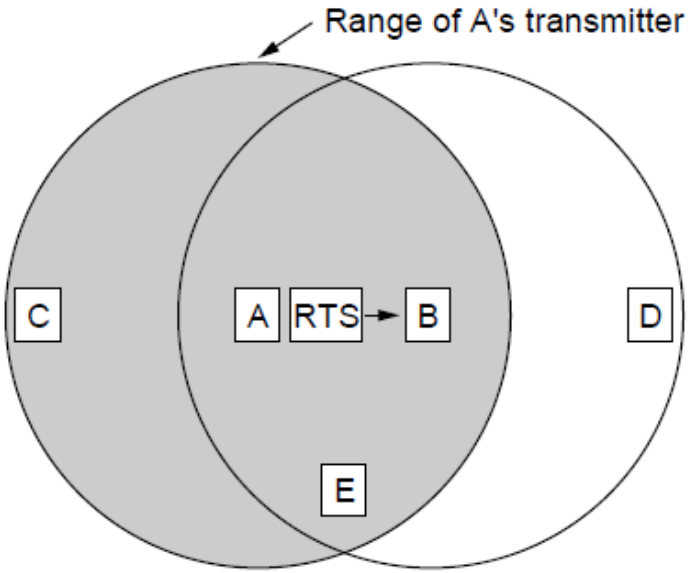


# MACA

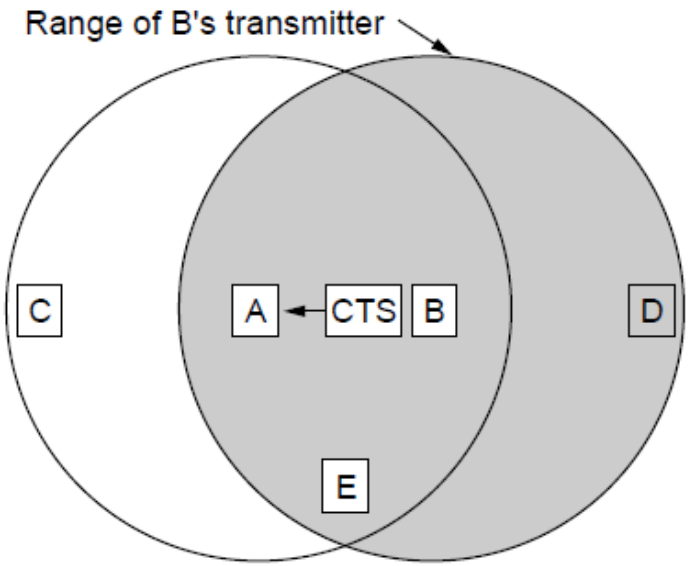
- Multiple Access with Collision Avoidance (MACA)
- MACA protocol grants access for A to send to B with a pair of messages
  - RTS (Request-To-Send) and CTS (Clear-To-Send)

# MACA: Example

- A sends RTS to B [left]; B replies with CTS [right]



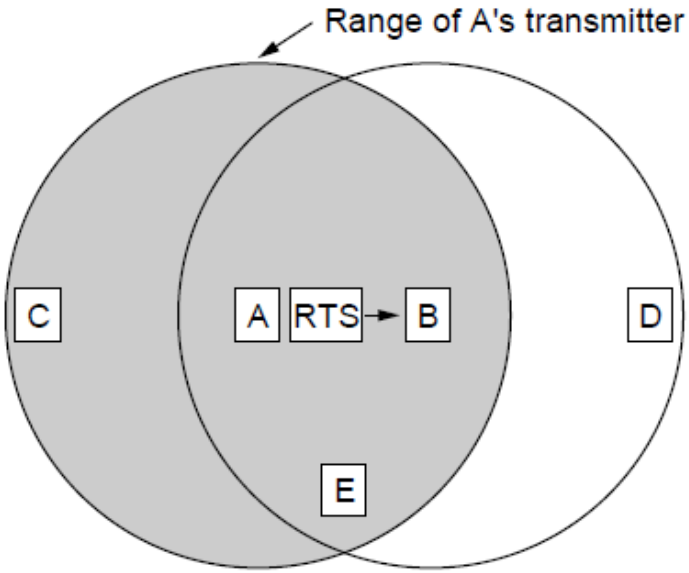

A sends RTS to B; C and E hear and defer for CTS




B replies with CTS; D and E hear and defer for data

# MACA: Example

- A can send with exposed but no hidden terminals

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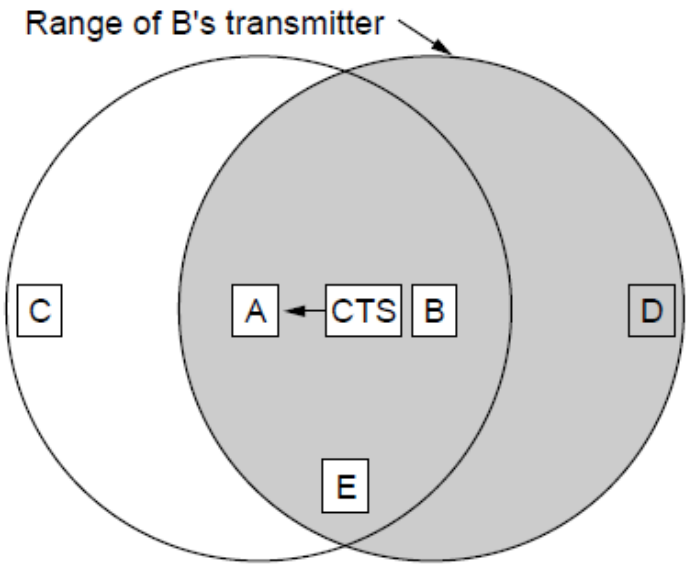



B replies with CTS; D and E hear and defer for data

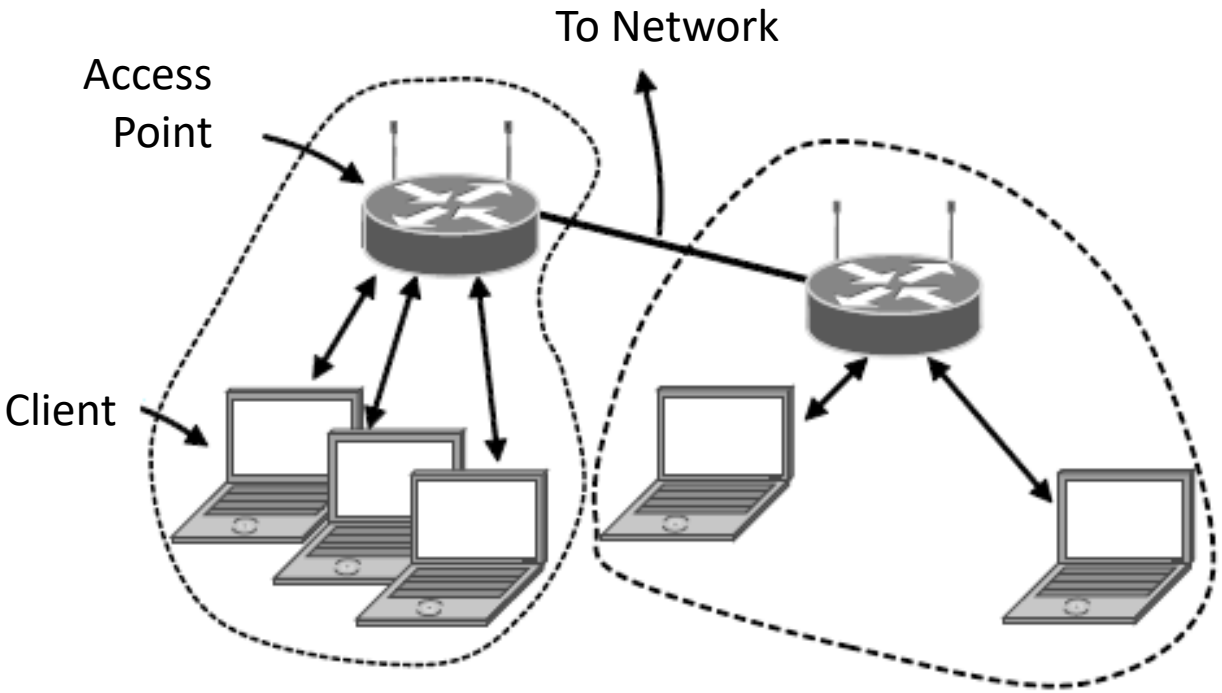
# Wireless LAN

- 802.11 architecture/protocol stack
- 802.11 physical layer
- 802.11 MAC
- 802.11 frames

# 802.11 Architecture

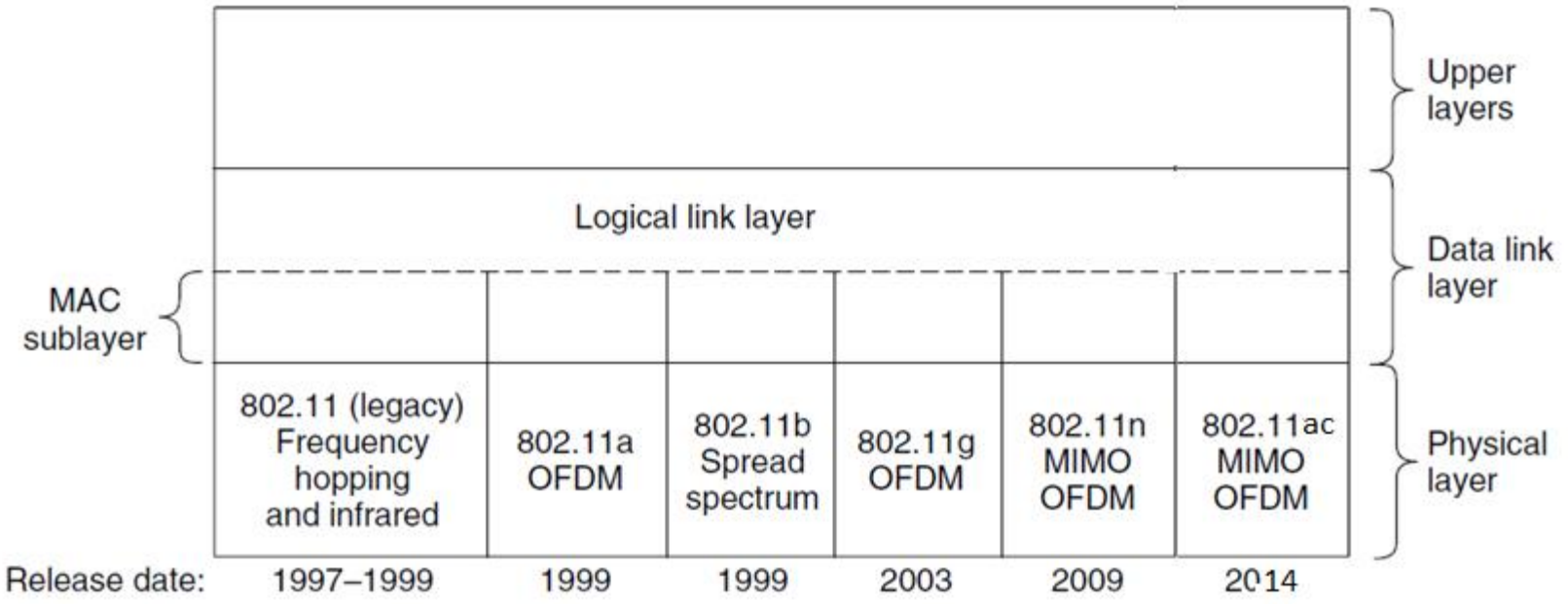
- Infrastructure mode
  - Wireless clients associate to a wired AP (Access Point)
- Ad-hoc mode
  - No access point

# Infrastructure Mode



# 802.11 Protocol Stack

- MAC is used across different physical layers
  - 802.11ax is under development



# 802.11 Physical Layer

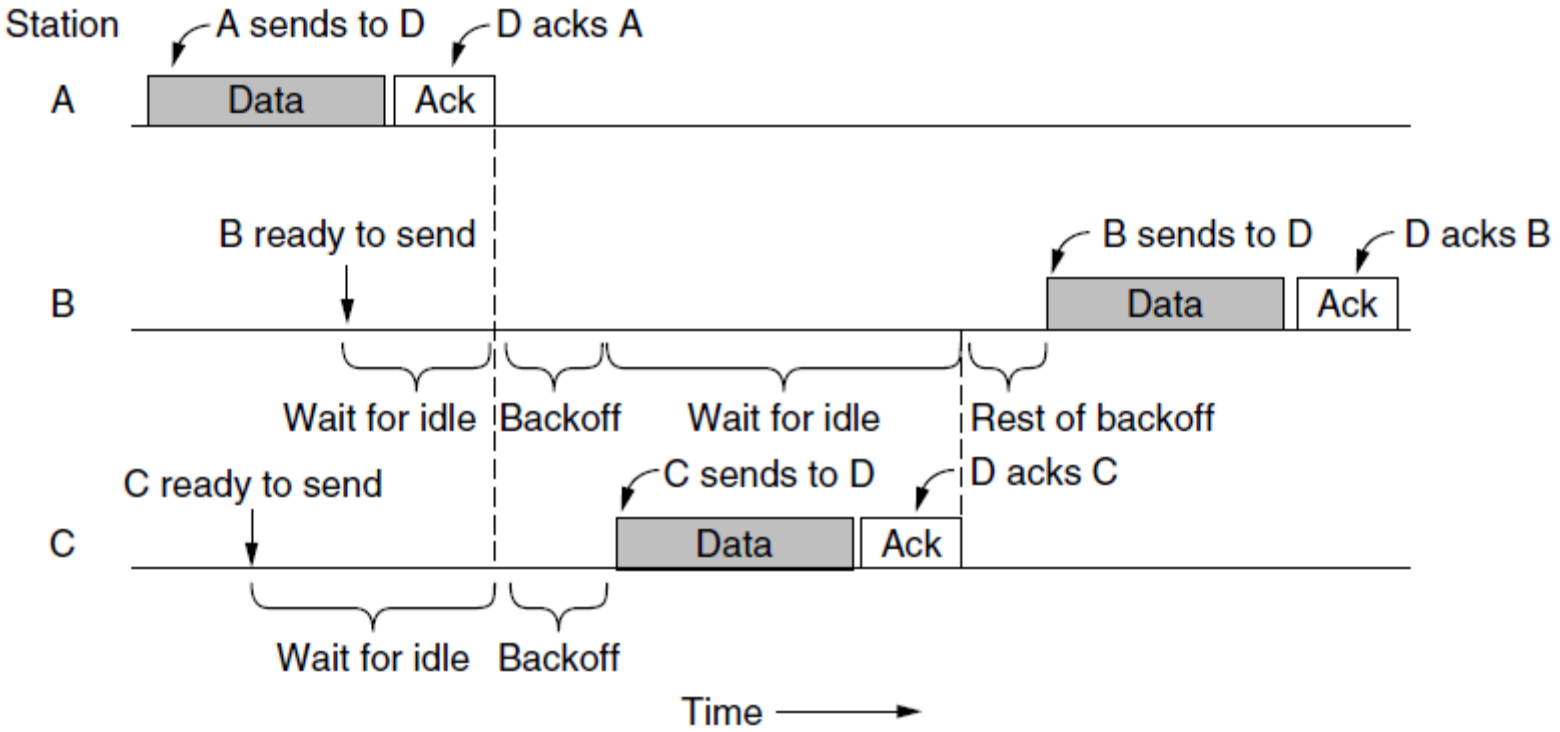
- NICs are compatible with multiple physical layers
  - E.g., 802.11 a/b/g

| Name` | Technique | Max. Bit Rate |
|---|---|---|
| 802.11b | Spread spectrum, 2.4 GHz | 11 Mbps |
| 802.11g | OFDM, 2.4 GHz | 54 Mbps |
| 802.11a | OFDM, 5 GHz | 54 Mbps |
| 802.11n | OFDM with MIMO, 2.4/5 GHz | 600 Mbps |
| 802.11ac | OFDM with MIMO and MU-MIMO, 2.4/5 GHz | 1.69 Gbps / station |

# 802.11 MAC

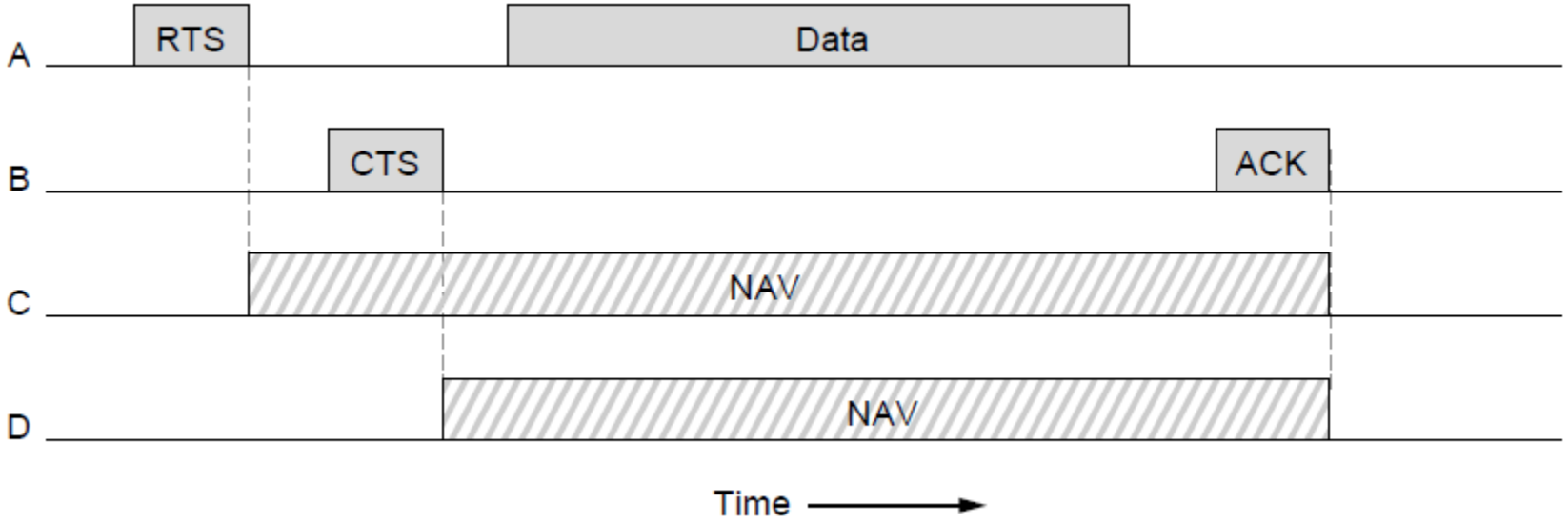
- CSMA/CA inserts backoff slots to avoid collisions
  - A realization of MACA
- MAC uses ACKs/retransmissions for wireless errors

# 802.11 MAC: Example



# 802.11 MAC: Virtual Sensing

- Virtual channel sensing with the NAV and optional RTS/CTS avoids hidden terminals
- Optional in the standard, often not used



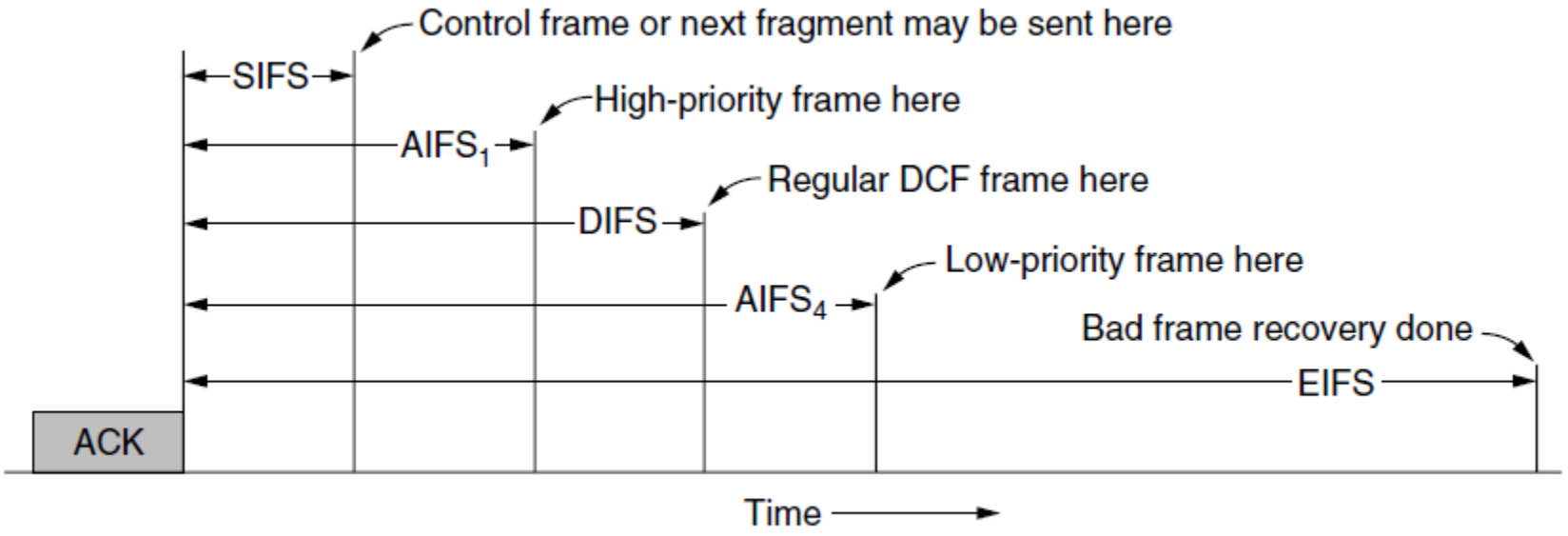
# 802.11 MAC: Quality of Service (QoS) Classes

- Different backoff slot times add quality of service
  - Short intervals give preferred access, e.g., control, VoIP
- MAC has other mechanisms too, e.g., power save

# 802.11 MAC: QoS

- The AIFS Number (AIFSN) values are administrator configurable with default values defined as the following:
  - Voice Queue: 1 SIFS + 2 * slot time (AIFSN = 2)
  - Video Queue: 1 SIFS + 2 * slot time (AIFSN = 2)
  - Best Effort Queue: 1 SIFS + 3 * slot time (AIFSN = 3)
  - Background Queue: 1 SIFS + 7 * slot time (AIFSN = 7)

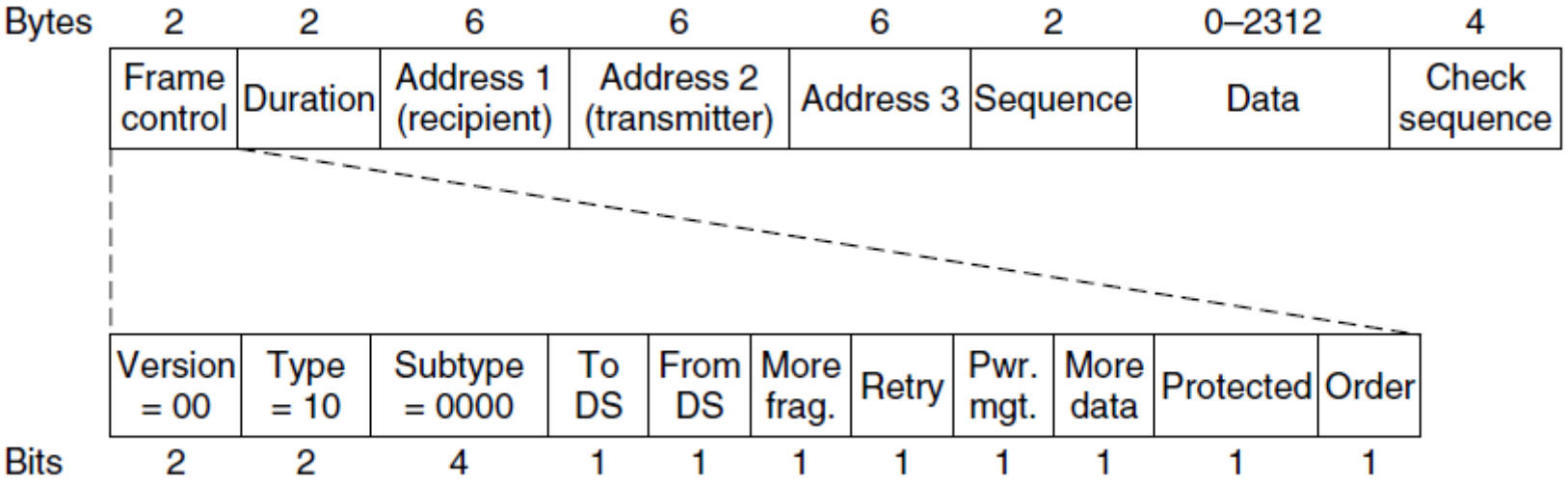
# 802.11 MAC: QoS



# 802.11 Frames

- Frames vary depending on their type (Frame control)
- Data frames have 3 addresses to pass via APs

# 802.11 Frame and Frame Control



# Questions?

- Challenges in desiring wireless LAN
- MACA
- 802.11 Wireless LAN