C:\cygwin\home\zahorjan\cse461\12au\07-802.11MAC.cp3

Example MAC: 802.11 (WiFi)

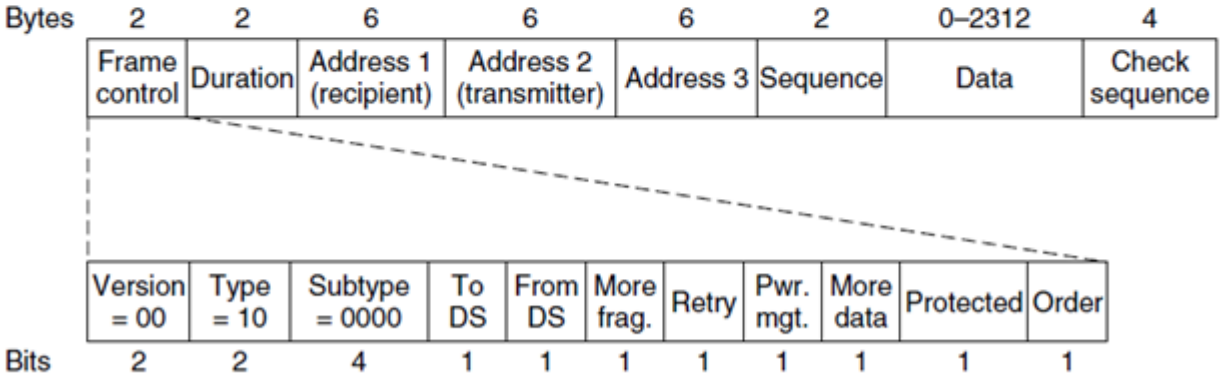
802.11 Mac versus Ethernet

- Different from Ethernet
  - CSMA/CA
  - Link layer ACKs and retransmissions
  - RTS/CTS
  - Duration vs packet length
  - Rate adaptation
  - Infrastructure mode
  - Power saving

802.11 frame versus Ethernet frame

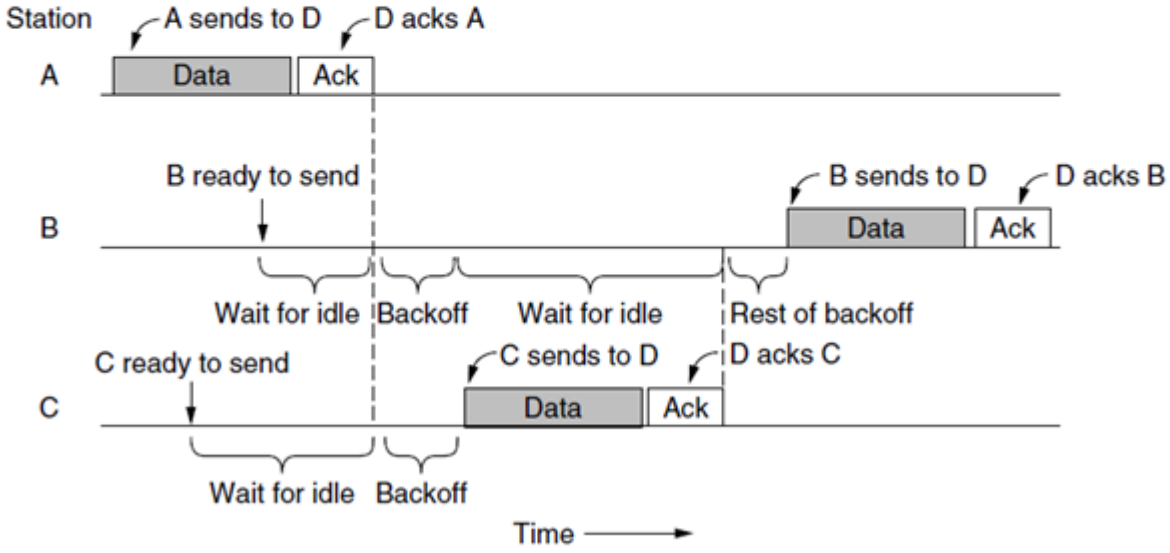
Ethernet

802.11



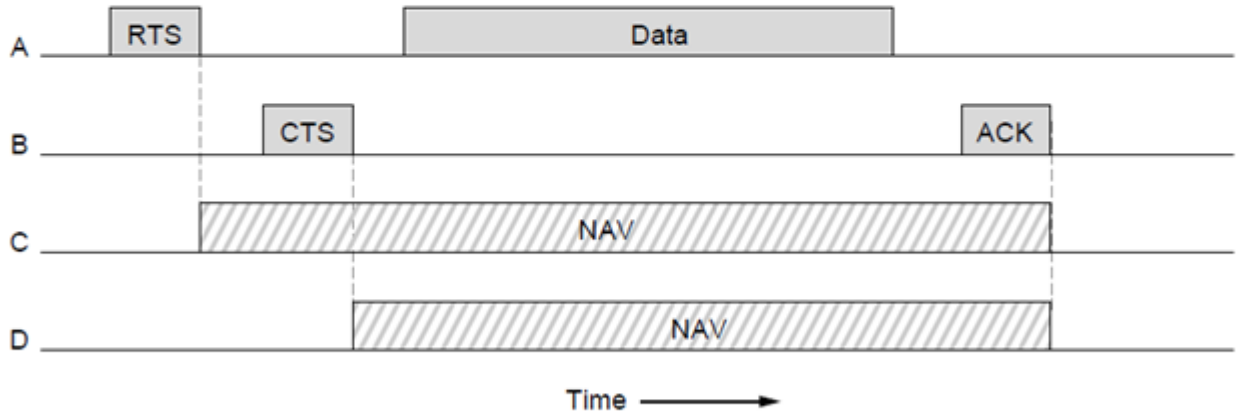
1. CSMA/CA and Retransmissions

- CSMA/CA inserts backoff slots to avoid collisions
- Slot countdown stopped when someone else is sending data



2. Virtual sensing

Virtual channel sensing with the NAV (Network Allocation Vector) and optional RTS/CTS avoids hidden terminals



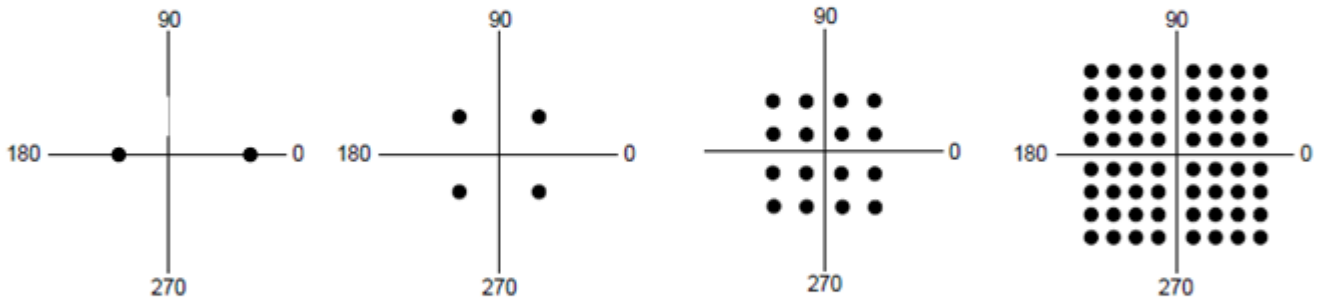
3. Rate adaptation (1)

- NICs are compatible with multiple physical layer
  - E.g., 802.11 a/b/g
  - The packet rate can vary depending on technology (and even within technology)
  - Rate determines how fast the packets are sent
  - *Why would you not send at a high rate?*

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

3. Rate adaptation (2)

- Higher rate may result in more errors
  - 802.11g can send using BPSK, QPSK, QAM-16, QAM-64



BPSK	QPSK	QAM-16	QAM-64
2 symbols	4 symbols	16 symbols	64 symbols
1 bit/symbol	2 bits/symbol	4 bits/symbol	6 bits/symbol

4. TXOP to accommodate varying rates

- *TXOP*: Transmission opportunity
- Rate anomaly:
  - Basic multiple access is fair
    - Every station has the same chance of being next
    - Means every station gets about the same number of transmissions during a busy period
  - Stations transmitting at a slower rate use more time for their turns
  - The result: Fast stations can't convey data any faster than the slow station
- TXOP fix: You win the right to transmit for a certain amount of time, not for a certain amount of data

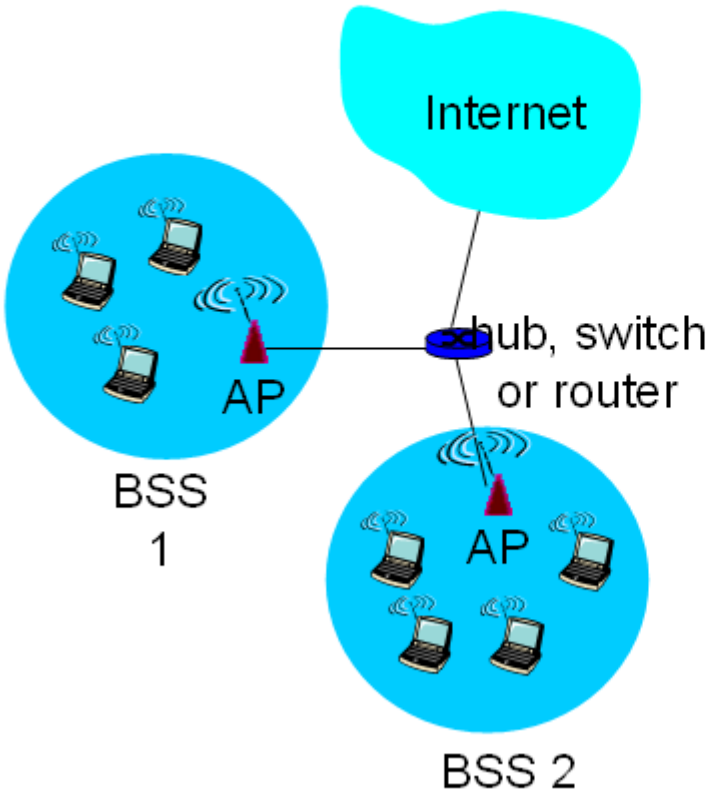
Rate Anomaly

- Each station wants to send 1500 bytes of data as fast as it can
- Station A: 11 Mbps connection
  Station B: 150 Mbps connection

5. 802.11 send smaller frames

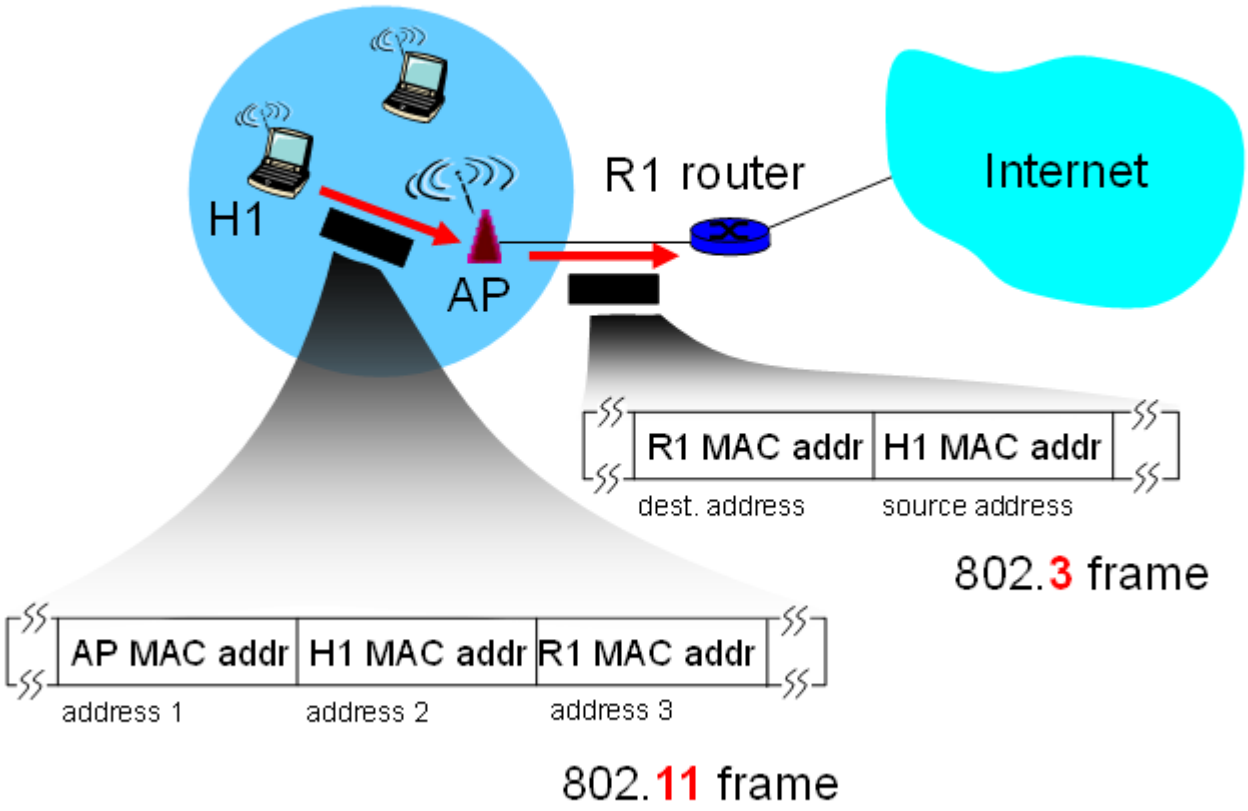
- Larger the packet size, higher the probability that there will be an error in the packet, so…
- Break large packets up into smaller frames
  - If an error occurs, you lose only part of the packet, not all of it
  - When you have to retransmit, the retransmission is smaller

6. 802.11 LAN architecture: Infrastructure Mode



- wireless host communicates with AP
- Client associates to the AP
- How do clients decide which AP to associate to?
  - Beaconing

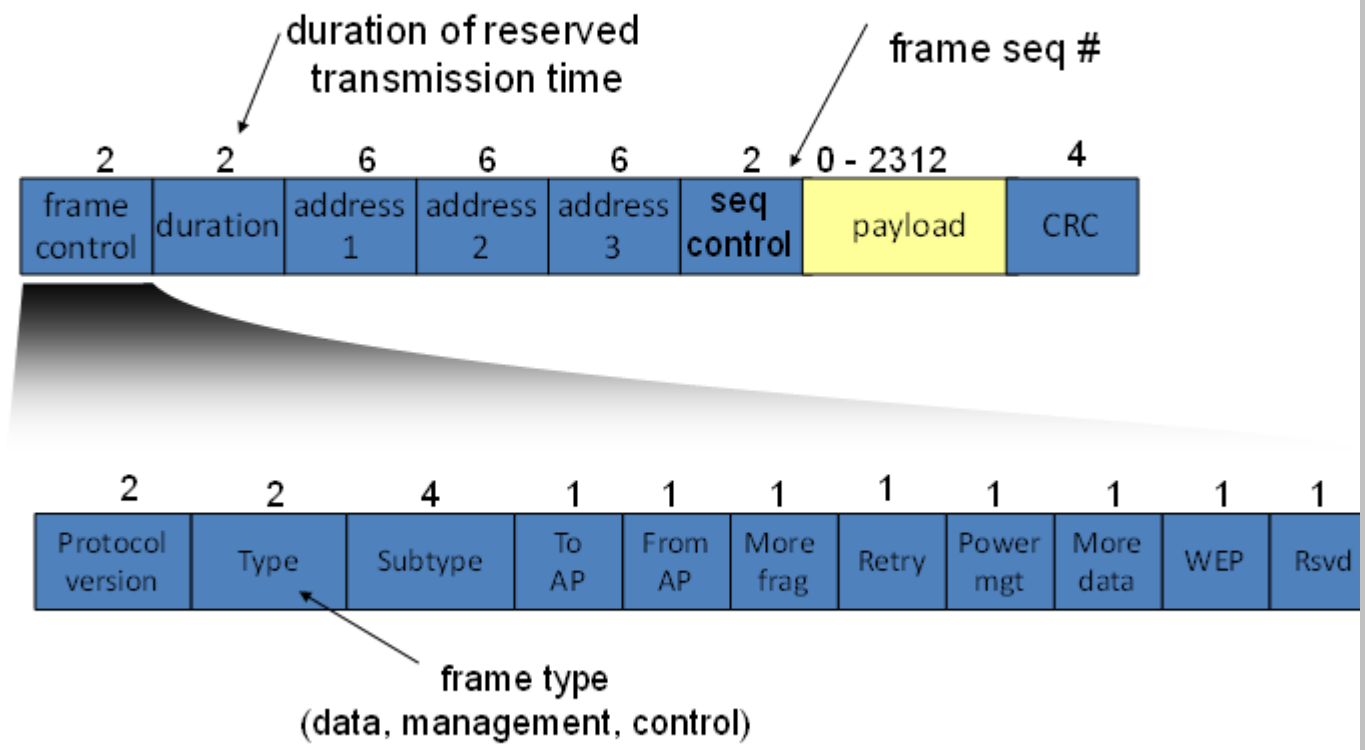
6. 802.11 LAN architecture (Frame addressing)



7. 802.11 Infrastructure mode: Power saving

- Power save mode: The client goes to sleep and periodically wakes up
  - Time scale of tens of milliseconds
- While the client is asleep, the APs buffer packets
  - AP beacons tell the clients when they have to wake up
- How often do the clients have to wake up?

802.11 Frame


duration of reserved transmission time
frame seq #
2
2
6
6
6
2
0 - 2312
4
frame control
duration
address 1
address 2
address 3
seq control
payload
CRC
2
2
4
1
1
1
1
1
1
1
1
Protocol version
Type
Subtype
To AP
From AP
More frag
Retry
Power mgt
More data
WEP
Rsvd
frame type
(data, management, control)

802.11 MAC recap

- Different from Ethernet because:
  - Higher inherent error rate
  - Can't collision detect
  - Station-dependent view of network topology
  - Power issues
- Effects on protocol:
  - Infrastructure mode
  - CSMA/CA
  - ACKs and retransmissions
  - RTS/CTS
  - Duration vs packet length
  - Rate adaptation
  - Smaller frames
  - Power saving