Wireless MAC

1 Elements of a wireless network

Wireless hosts:

- Laptop, smartphone
- Run applications
- May be stationary or mobile

Base station:

- Typically connected to wired network
- Relay - responsible for sending packets between wired network and wireless host(s) in its ”area”

Wireless link:

- Typically used to connect mobile(s) to base station
- Also used as backbone link
- Multiple access protocol coordinates link access
- Various data rates, transmission distances

Infrastructure mode:

- Base station connects mobiles into wired network
- Handoff: mobile changes base station providing connection into wired network

Ad hoc mode:

- No base stations
- Nodes can only transmit to other nodes within link coverage
- Nodes organize themselves into a network: route among themselves

Standard	Frequency Range	Data Rate
802.11b	2.4 GHz	Up to 11 Mbps
802.11a	5 GHz	Up to 54 Mbps
802.11g	2.4 GHz	Up to 54 Mbps
802.11n	2.4 GHz and 5 GHz	Up to 450 Mbps
802.11ac	5GHz	Up to 1300 Mbps

2 Wireless Link Characteristics

Important differences from wired link

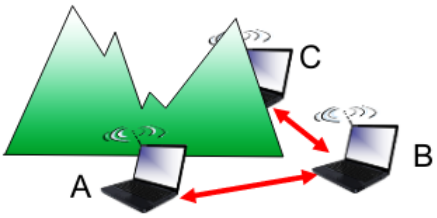
- **Decreased signal strength**: radio signal attenuates as it propagates through matter
- **Interference from other sources**: standardized wireless network frequencies shared by other devices interfere as well
- **Multipath propagation**: radio signal reflects off object ground, arriving at destination at slightly different times

Make communication across a wireless link much more difficult

Definition: Hidden terminals

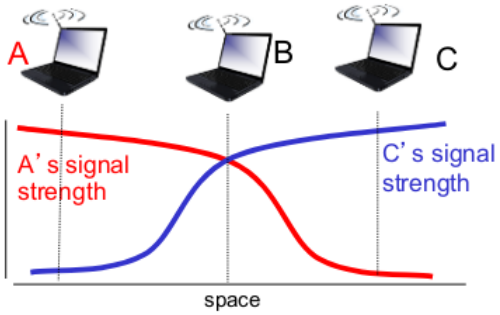
Senders that cannot sense each other but nonetheless collide at intended receiver

Multiple wireless senders and receivers create additional problems (beyond multiple access)



Hidden terminal problem

- B,A hear each other
- B,C hear each other
- A,C can't hear each other, means A,C unaware of their interference at B



Signal attenuation

- B,A hear each other
- B,C hear each other
- A,C can't hear each other interfering at B

Definition: Exposed terminals

Senders who can sense each other but still transmit safely (to different receivers)

Exposed terminals will cause collisions but it won't matter as the data gets to where it is intended anyway

3 802.11 LAN architecture

Wireless host communicates with base station:

- Base station = access point (AP)

Basic Service Set (BSS) (aka "cell") in infrastructure mode contains:

- Wireless hosts
- Access point (AP): base station
- Ad hoc mode: hosts only

4 802.11: Channels, association

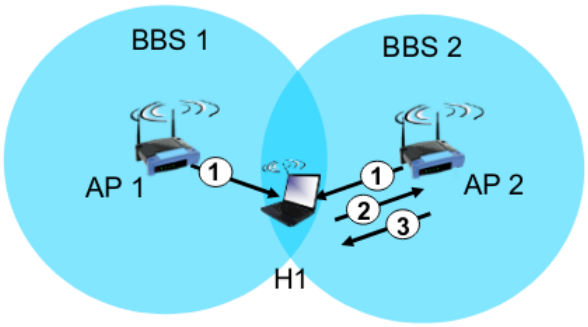
802.11b: 2.4 GHz - 2.485 GHz spectrum divided into 11 channels at different frequencies

- AP admin chooses frequency for AP
- Interference possible: channel can be same as that chosen by neighbouring AP

Host must **associate** with an AP

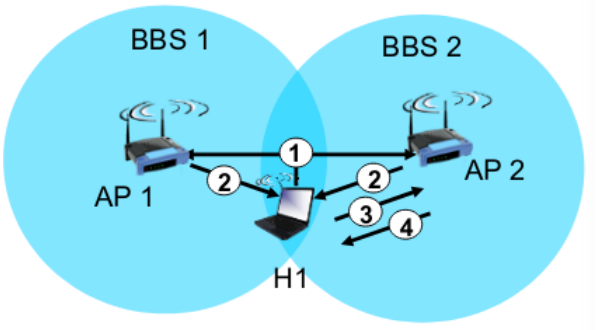
- Scans channels, listening for **beacon frames** containing AP's name (SSID) and MAC address
- Selects AP to associate with
- May perform authentication

5 802.11: passive/active scanning



Passive scanning

1. Beacon frames sent from APs
2. Association request frame sent: H1 to selected AP
3. Association response frame sent from selected AP to H1



Active scanning

1. Probe request frame broadcast from H1
2. Probe response frames sent from APs
3. Association request frame sent: H1 to selected AP
4. Association response frame sent from selected AP to H1

6 802.11: multiple access

- Avoid collisions: 2+ nodes transmitting at same time
- 802.11: CSMA - sense before transmitting - don't collide with ongoing transmission by another node
- 802.11: no collision detection
  - Difficult to receive (sense collisions) when transmitting due to weak received signals (fading)
  - Can't sense all collisions in any case: hidden terming, fading
  - Goal: avoid collisions: CSMA/CA

7 IEEE 802.11 MAC Protocol: CSMA/CA

802.11 sender

1. If sense channel idle for DIFS then transmit entire frame (no CD)
2. If sense channel busy then
   - Start random backoff time
   - Timer counts down while channel idle
   - Transmit when timer expires
   - If no ACK, increase random backoff interval, repeat 2

802.11 receiver

- If frame received OK return ACK after SIFS (ACK needed due to hidden terminal problem)

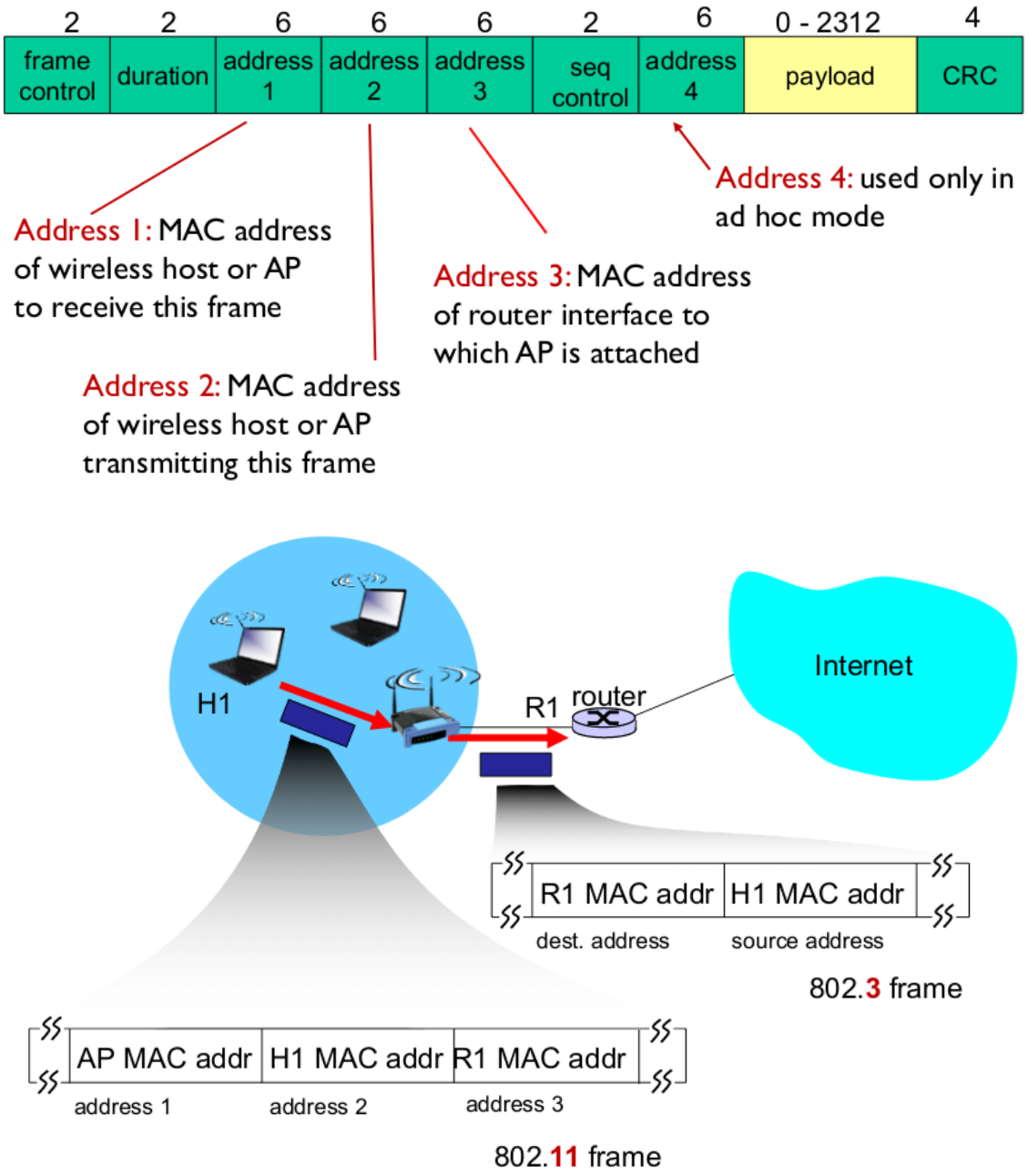
Idea: allow sender to "reserve" channel rather than random access of data frames: avoid collisions of long data frames

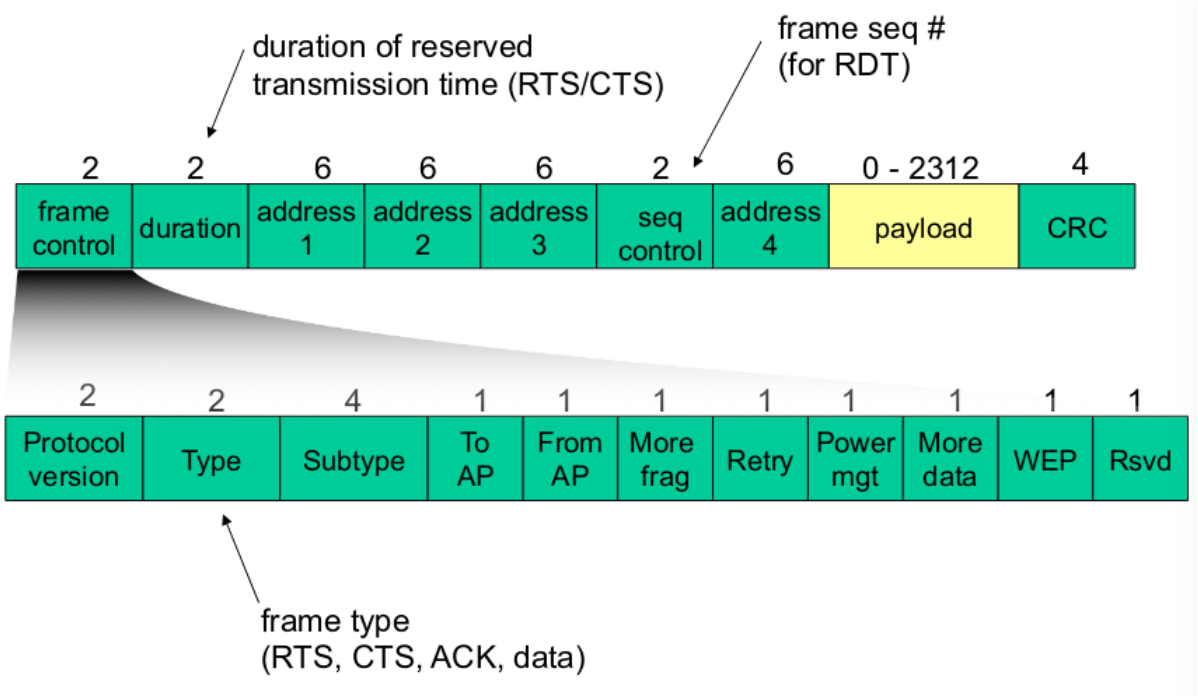
- Sender first transmits small request-to-send (RTS) packets to BS (base station) using CSMA
  - RTSs may still collide with each other (but they're short)
- BS broadcasts clear-to-send CTS in response to RTS
- CTS heard by all nodes
  - Sender transmits data frame
  - Other stations defer transmissions

Important: Collisions

Avoid data frame collisions completely using small reservations packets

8 802.11 frame: addressing




duration of reserved
transmission time (RTS/CTS)
frame seq #
(for RDT)
2
2
6
6
6
2
6
0 - 2312
4
frame control
duration
address 1
address 2
address 3
seq control
address 4
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
(RTS, CTS, ACK, data)