College of Information Studies

University of Maryland Hornbake Library Building College Park, MD 20742-4345

WiFi

Session 17

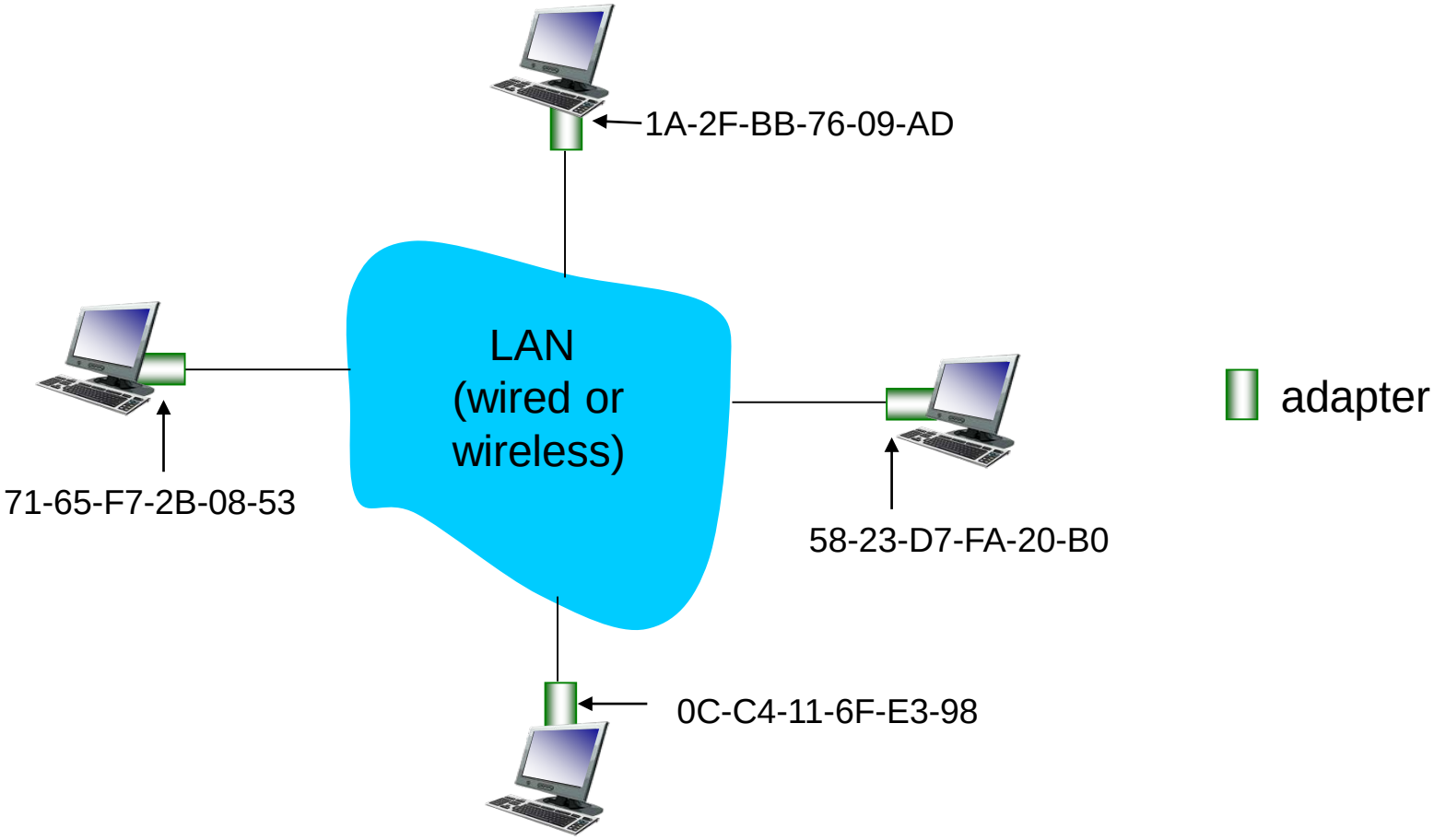
INST 346

Goals for Today

- H5
- Switched Ethernet
- WiFi
- Analysis Team 3

LAN addresses and ARP

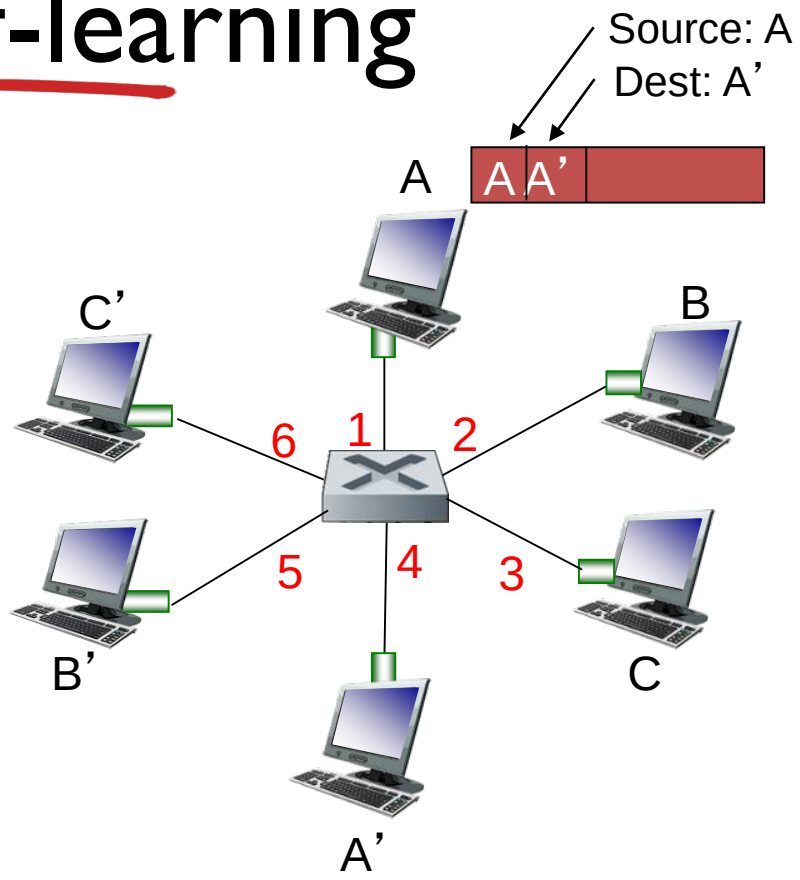
each adapter on LAN has unique *LAN* address



H5

Switch: self-learning

- switch *learns* which hosts can be reached through which interfaces
  - when frame received, switch "learns" location of sender: incoming LAN segment
  - records sender/location pair in switch table

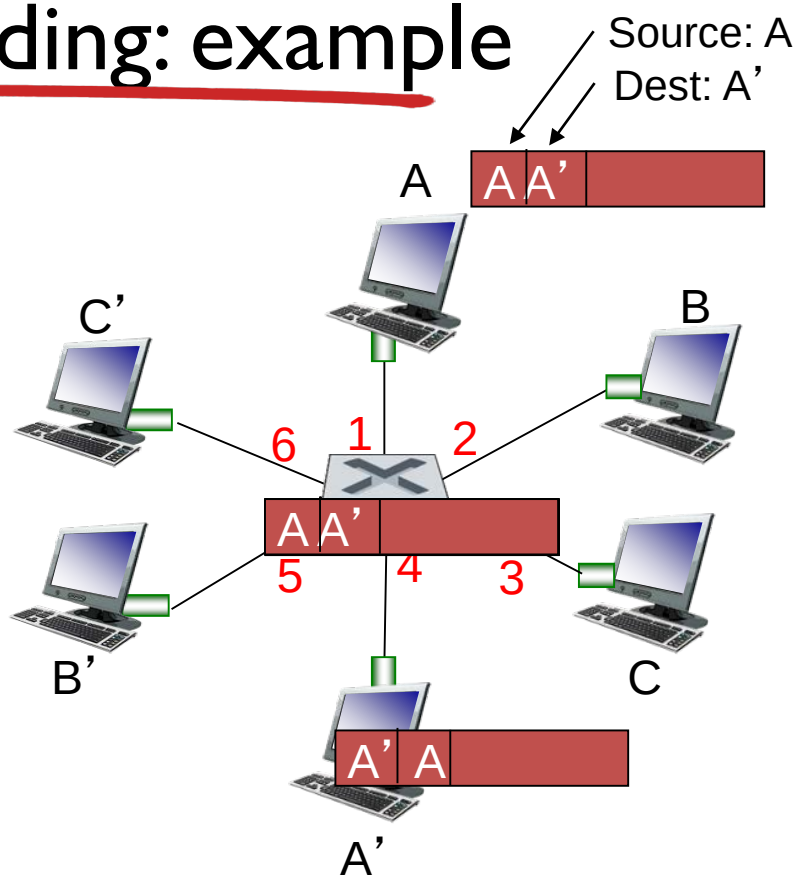


MAC addr	interface	TTL
A	*1*	*60*

Switch table (initially empty)

Self-learning, forwarding: example

- frame destination, A', location unknown: *flood*
  - destination A location known: selectively send on just one link



MAC addr	interface	TTL
A	*1*	*60*
A'	*4*	*60*

switch table (initially empty)

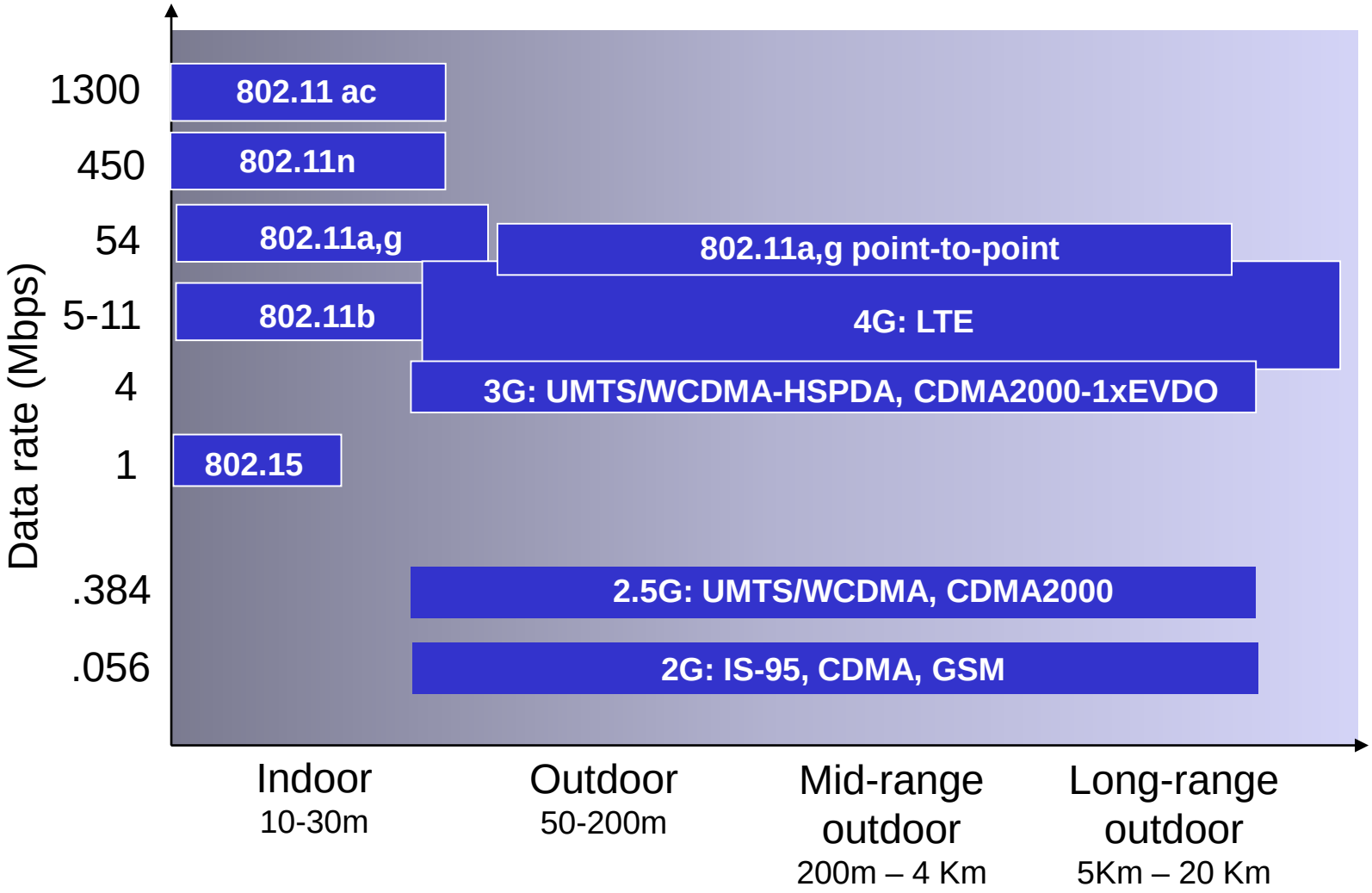
Wireless Link Characteristics (1)

important differences from wired link ….

- *decreased signal strength:* radio signal attenuates as it propagates through matter (path loss)
- *interference from other sources:* standardized wireless network frequencies (e.g., 2.4 GHz) shared by other devices (e.g., phone); devices (motors) interfere as well
- *multipath propagation:* radio signal reflects off objects ground, arriving ad destination at slightly different times

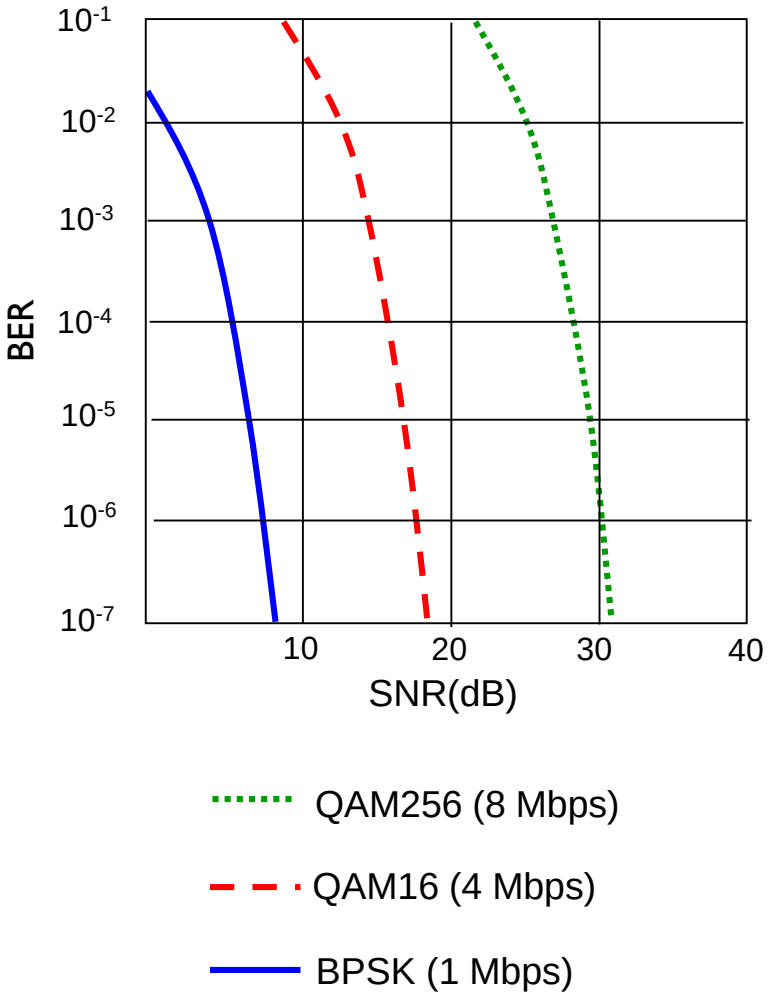
…. make communication across (even a point to point) wireless link much more difficult

Characteristics of selected wireless links



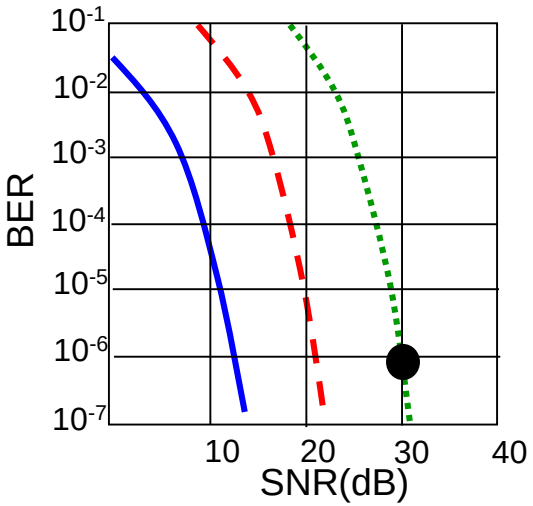
Wireless Link Characteristics (2)

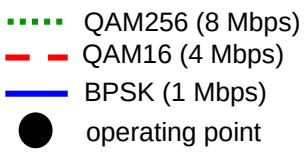
- SNR: signal-to-noise ratio
  - larger SNR – easier to extract signal from noise (a "good thing")
- *SNR versus Bit Error Rate tradeoff*
  - *given a physical layer:*
    - increase power -> increase SNR
    - Increase SNR -> decrease BER
  - *given the actual SNR:*
    - choose the physical layer with the highest throughput that meets the Bit Error Rate target
- SNR may change with mobility
  - dynamically adapt physical layer (modulation technique, data rate)



Adaptive Rate Selection

- base station, mobile dynamically change transmission rate (physical layer modulation technique) as mobile host moves

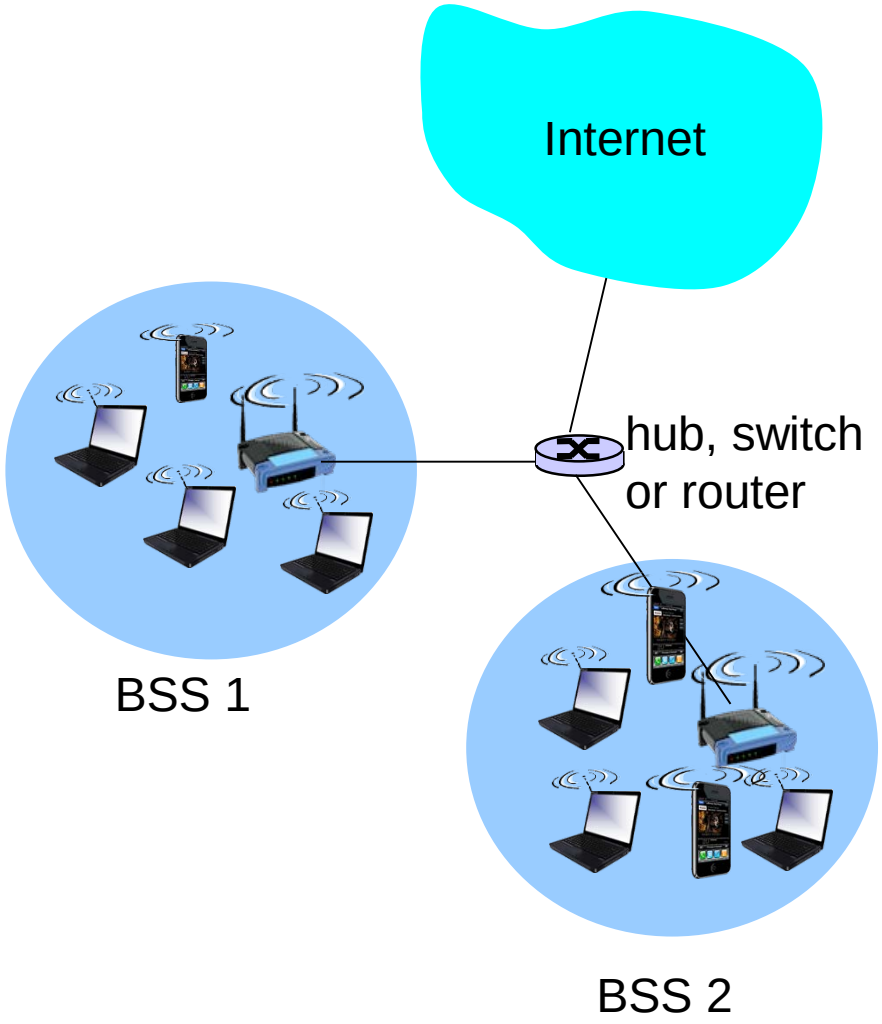




1. SNR decreases, BER increases as host moves away from base station

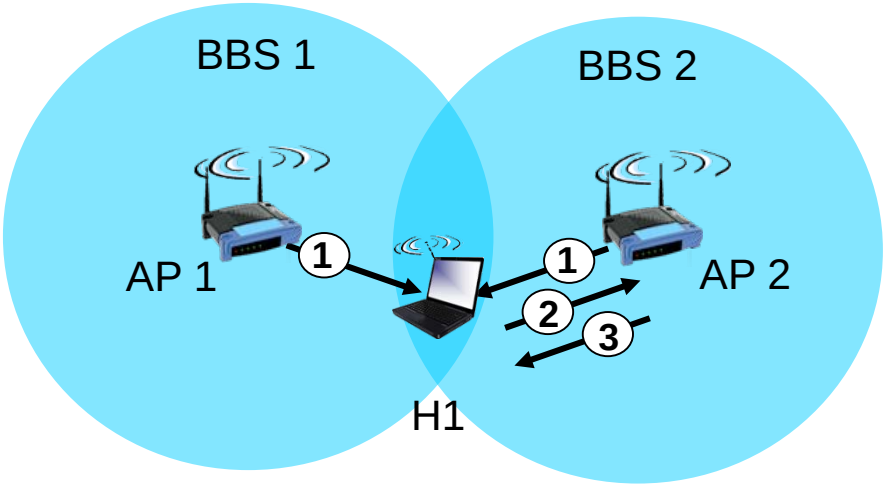
2. When BER becomes too high, switch to lower transmission rate but with lower BER

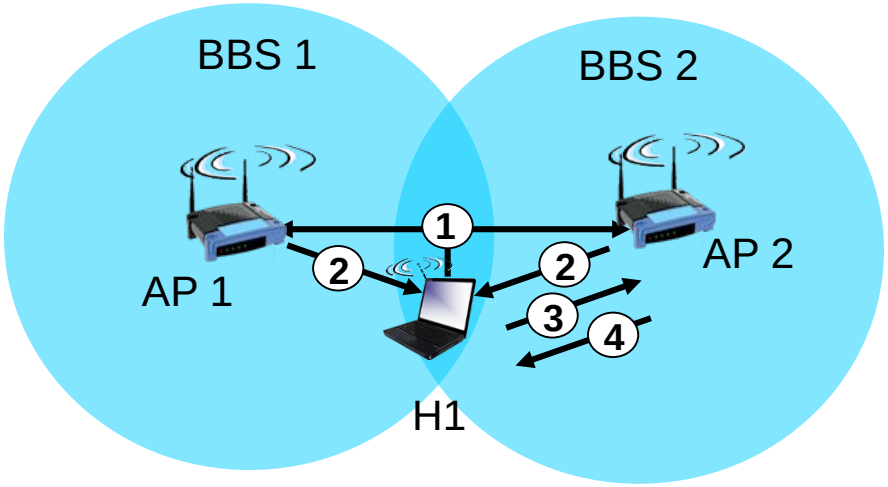
802.11 LAN architecture



- wireless host communicates with base station ("Access Point" (AP))
- Basic Service Set (BSS) in infrastructure mode contains:
  - wireless hosts
  - access point

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:

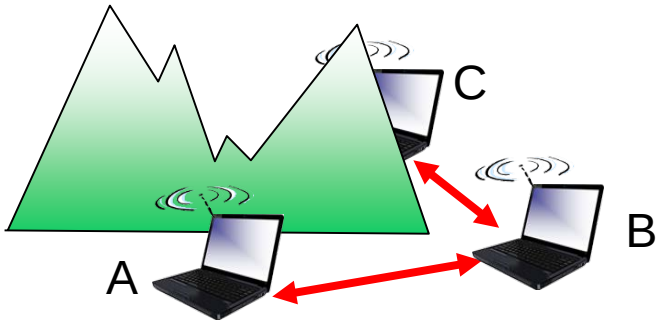
(1) Probe Request frame broadcast from H1
(2) Probe Response frames sent from APs
(3) Association Request frame sent: H1 to selected AP
(4) Association Response frame sent from selected AP to H1

802.11: Channels, association

- 802.11b: 2.4GHz-2.485GHz spectrum divided into 11 channels at different frequencies
  - AP admin chooses frequency for AP
  - interference possible: channel can be same as that chosen by neighboring 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 [Chapter 8]
  - will typically run DHCP to get IP address in AP's subnet

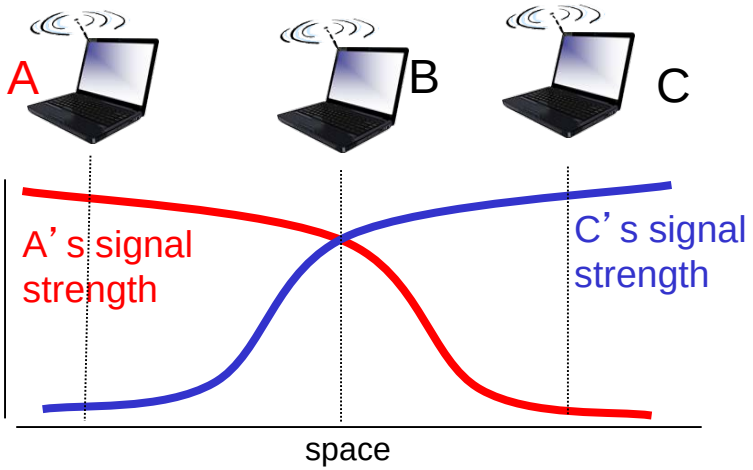
The Hidden Terminal Problem

Multiple **wireless** senders and receivers create additional problems"



Hidden terminal problem

- B, A hear each other
- B, C hear each other
- A, C can not 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 not hear each other interfering at B

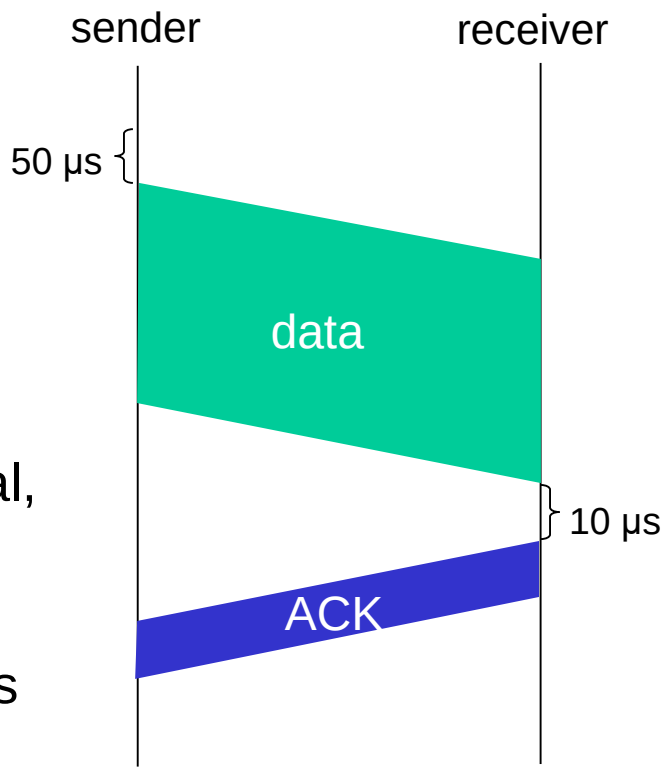
IEEE 802.11 MAC Protocol: CSMA/CA

802.11 sender

- if channel idle for 50 µs Distributed Coordination Function (DCF) Inter-Frame Space (DIFS) then
  - transmit entire frame
- if 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

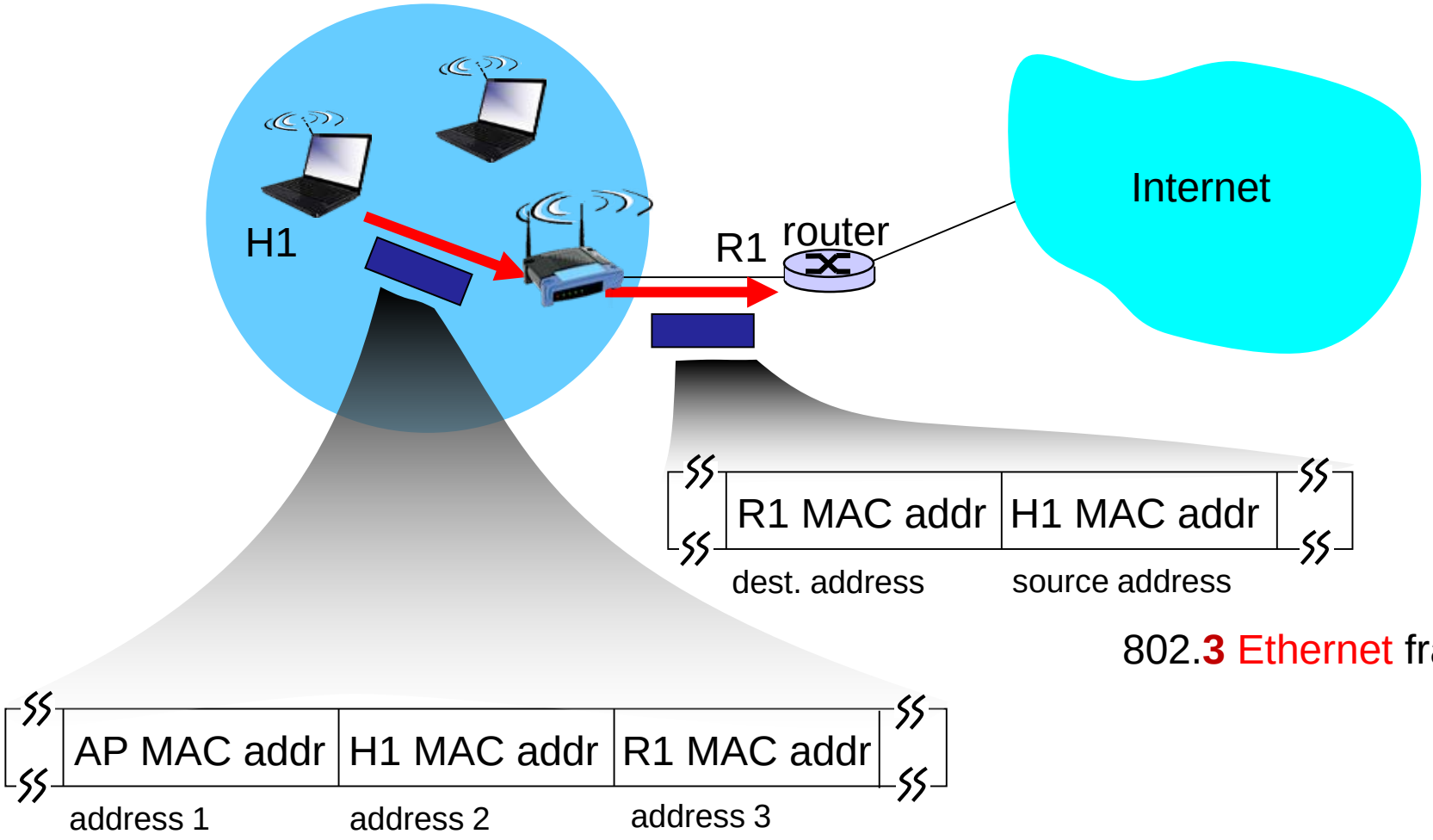
802.11 receiver

- if frame received OK, return ACK after 10 µs "Short Inter-Frame Space" (SIFS)
  - ACK is needed due to hidden terminal problem

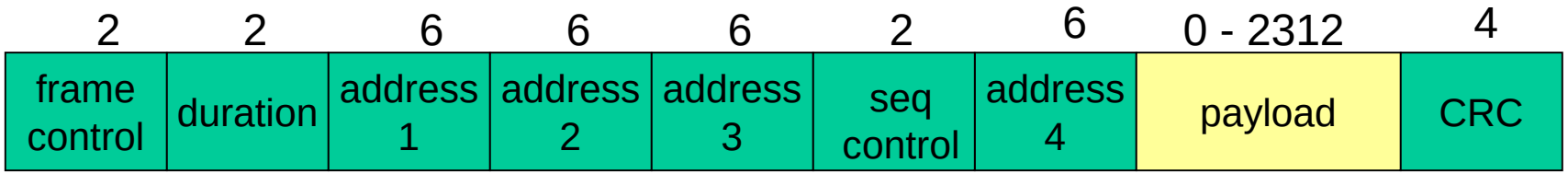


DIFS and SIFS delays are for 802.11b

802.11 frame: addressing



802.11 frame: addressing



Address 1: MAC address of wireless host or AP to receive this frame

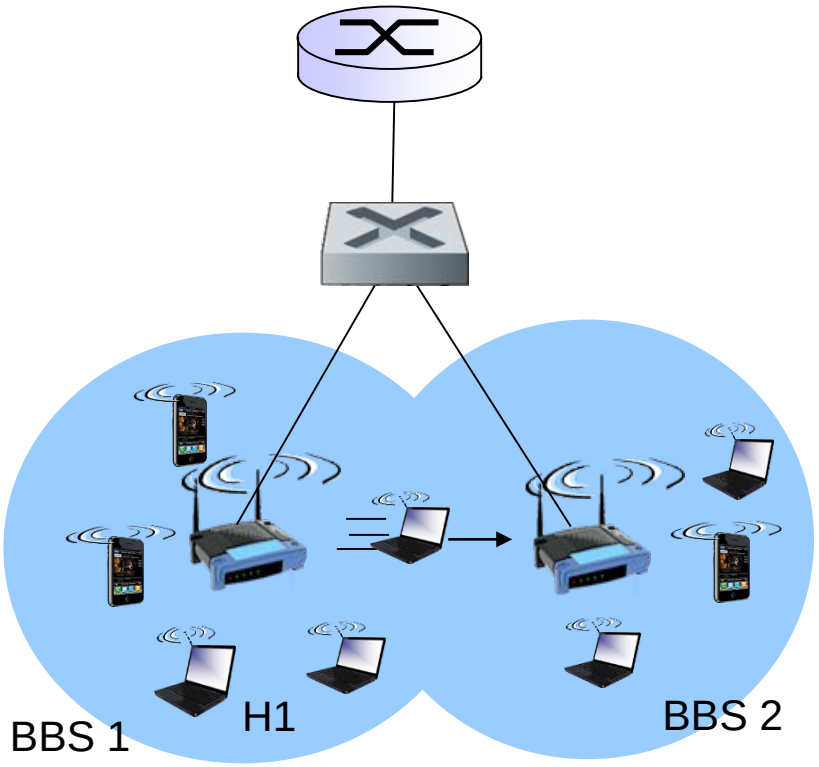
Address 2: MAC address of wireless host or AP transmitting this frame

Address 3: MAC address of router interface to which AP is attached

Address 4: used only in ad hoc mode

802.11: mobility within same subnet

- H1 remains in same IP subnet: IP address can remain same
- switch: which AP is associated with H1?
  - self-learning: switch will see the first frame from H1 through the new AP and "remember" which switch port can be used to reach H1



802.11: advanced capabilities

power management

- node-to-AP: "I am going to sleep until next beacon frame"
  - AP knows not to transmit frames to this node
  - node wakes up before next beacon frame
- beacon frame: contains list of mobiles with AP-to-mobile frames waiting to be sent
  - node will stay awake if AP-to-mobile frames to be sent; otherwise sleep again until next beacon frame

On a sheet of paper, answer the following (ungraded) question (no names, please):

What one thing could the instructor change to improve your learning?