COMP 3331/9331: Computer Networks and Applications

Week 10/11 Wireless LAN

Reading Guide: Chapter 7, Sections 7.1 and 7.3

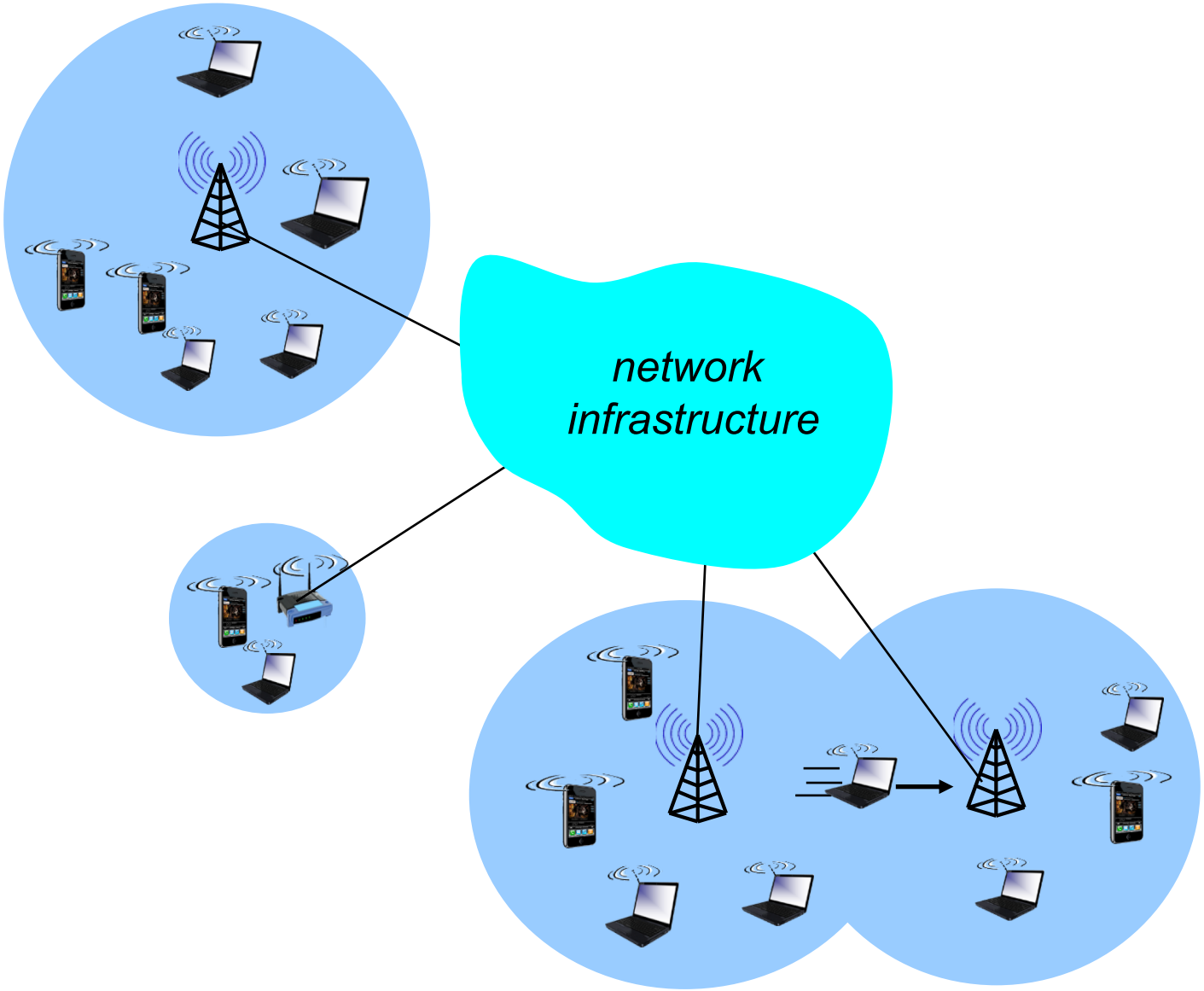
Wireless Networks

Background:

- # wireless (mobile) phone subscribers now exceeds # wired phone subscribers (5-to-1)!
- # wireless Internet-connected devices equals # wireline Internet-connected devices
  - laptops, Internet-enabled phones promise anytime untethered Internet access
- two important (but different) challenges
  - *wireless:* communication over wireless link
  - *mobility:* handling the mobile user who changes point of attachment to network

We will only focus on wireless challenges

Elements of a wireless network



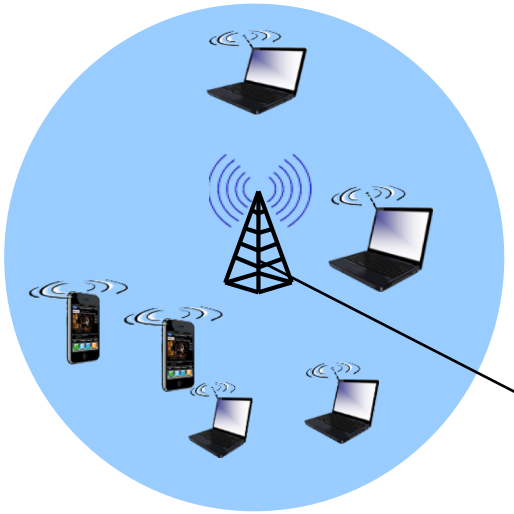
Elements of a wireless network

wireless hosts

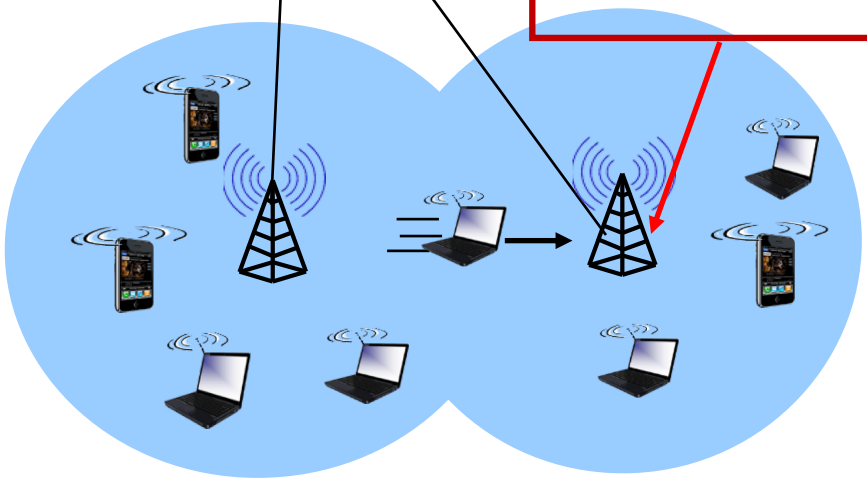
- *laptop, smartphone*
- *run applications*
- *may be stationary (non-mobile) or mobile*
  - *wireless does not always mean mobility*

network infrastructure

Elements of a wireless network



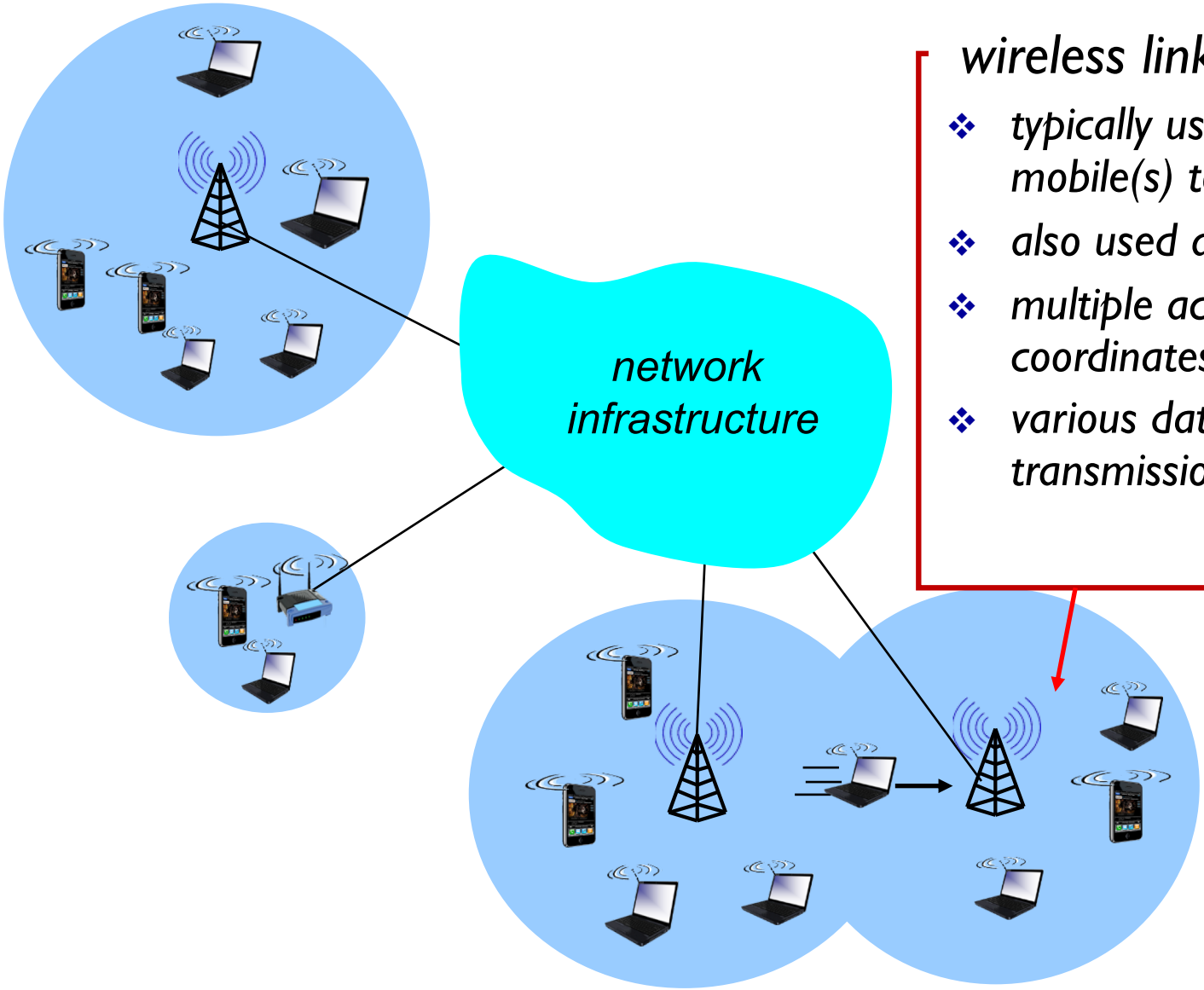
network infrastructure



base station

- *typically connected to wired network*
- *relay - responsible for sending packets between wired network and wireless host(s) in its "area"*
  - *e.g., cell towers, 802.11 access points*

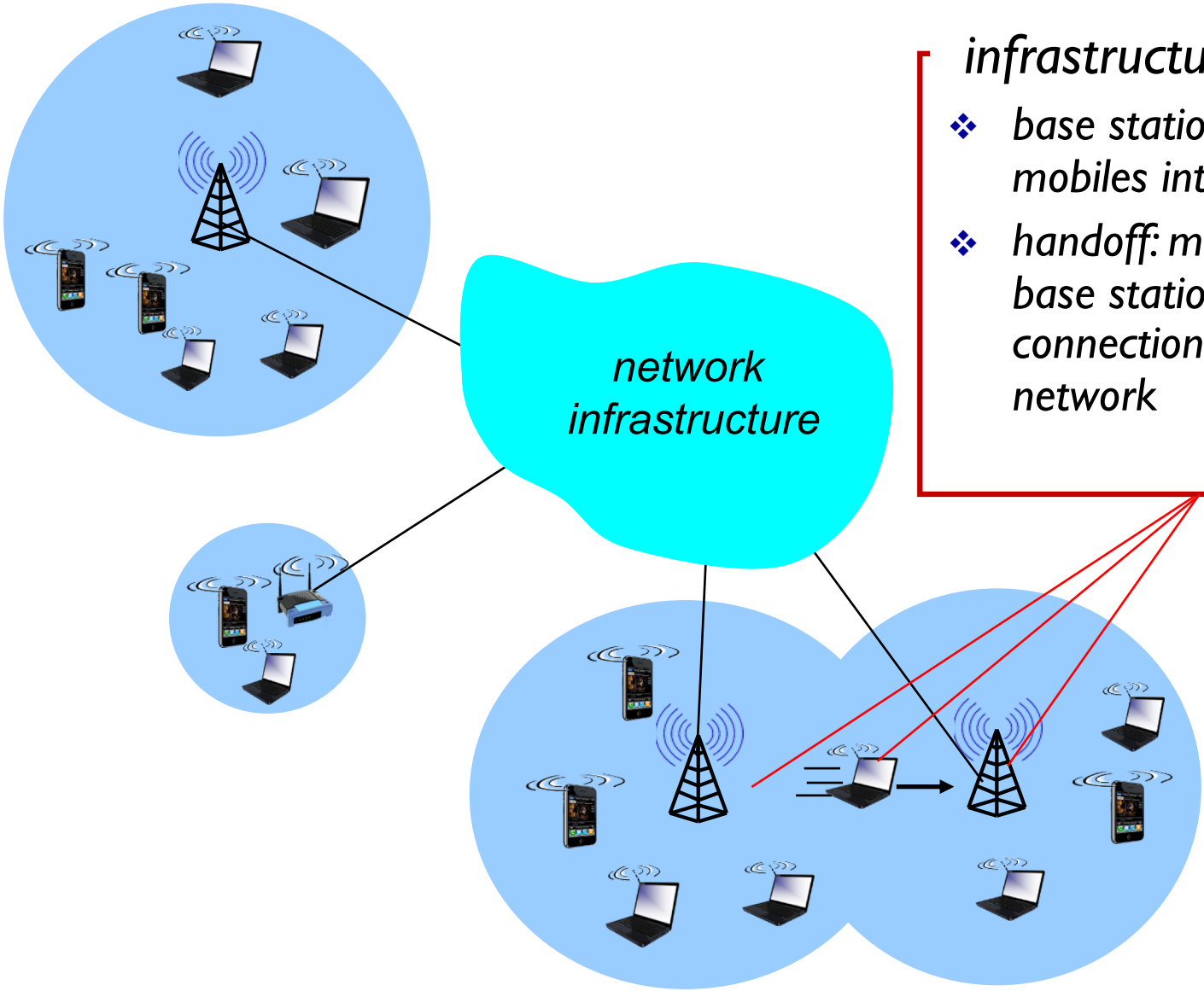
Elements of a wireless network



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 distance*

Elements of a wireless network

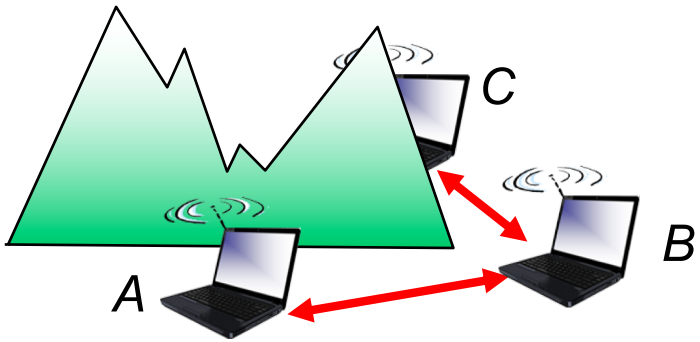


infrastructure mode

- *base station connects mobiles into wired network*
- *handoff: mobile changes base station providing connection into wired network*

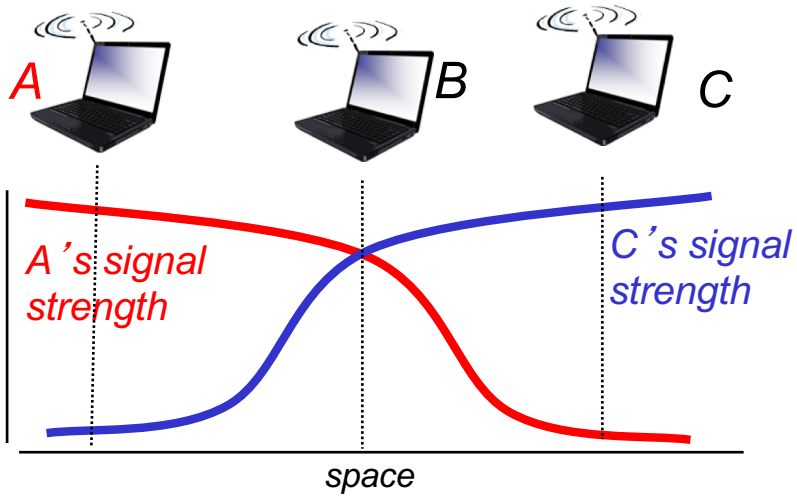
Wireless network characteristics

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 not hear each other means A, C unaware of their interference at B*
- *Carrier sense will be ineffective*

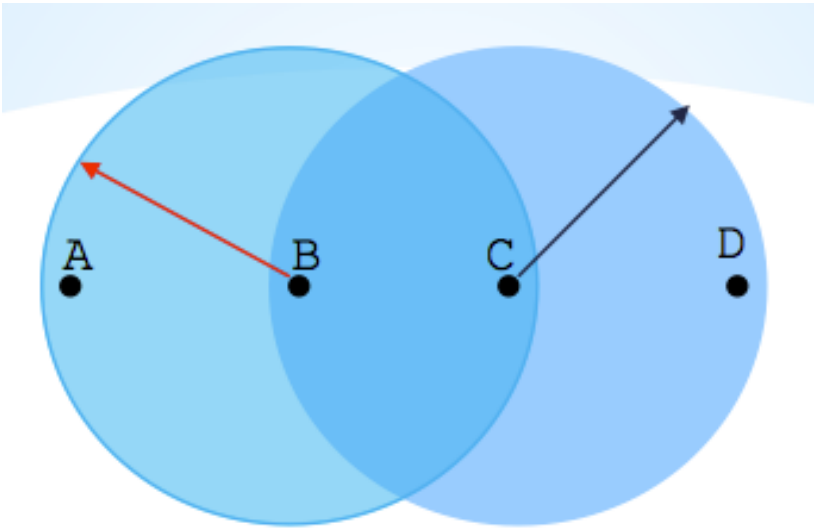


Signal attenuation:

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

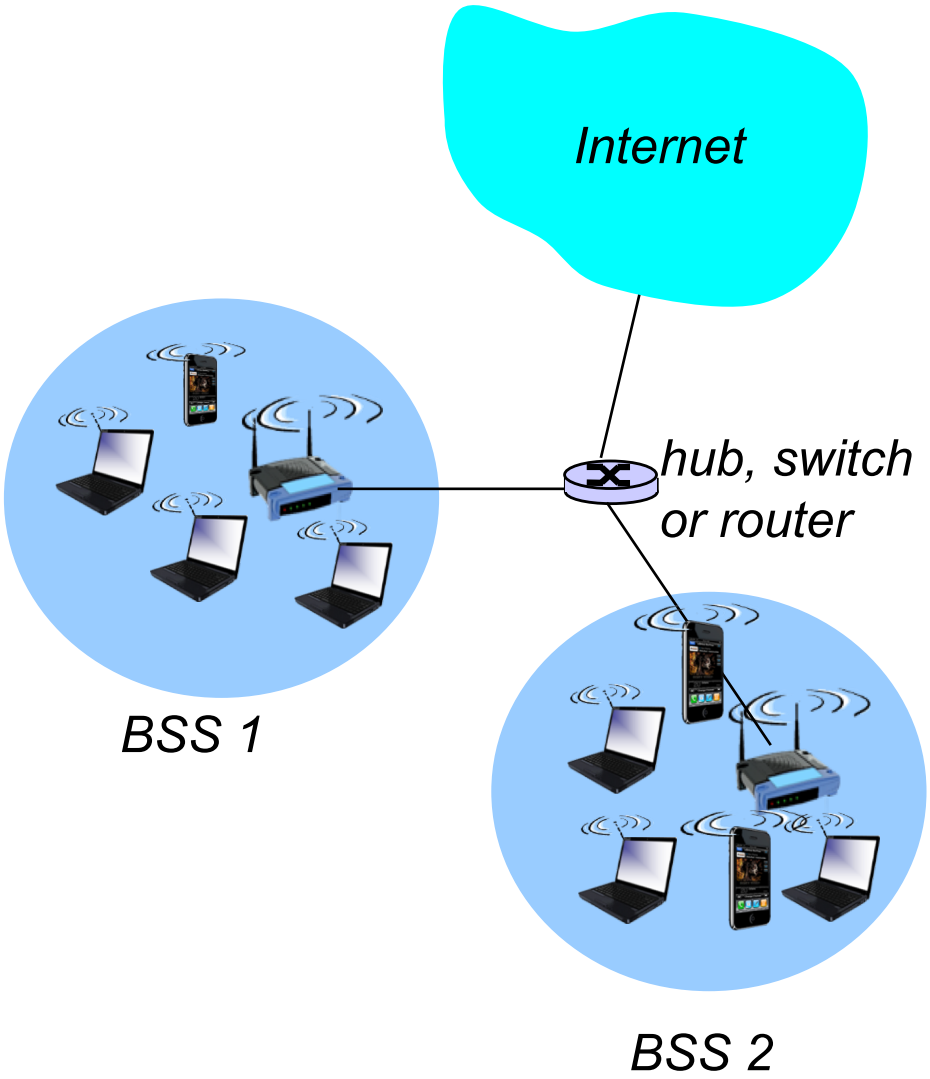
Wireless network characteristics

- Exposed Terminals



- Node B sends a packet to A; C hears this and decides not to send a packet to D (despite the fact that this will not cause interference) !!
- Carrier sense would prevent a successful transmission

802.11 LAN architecture

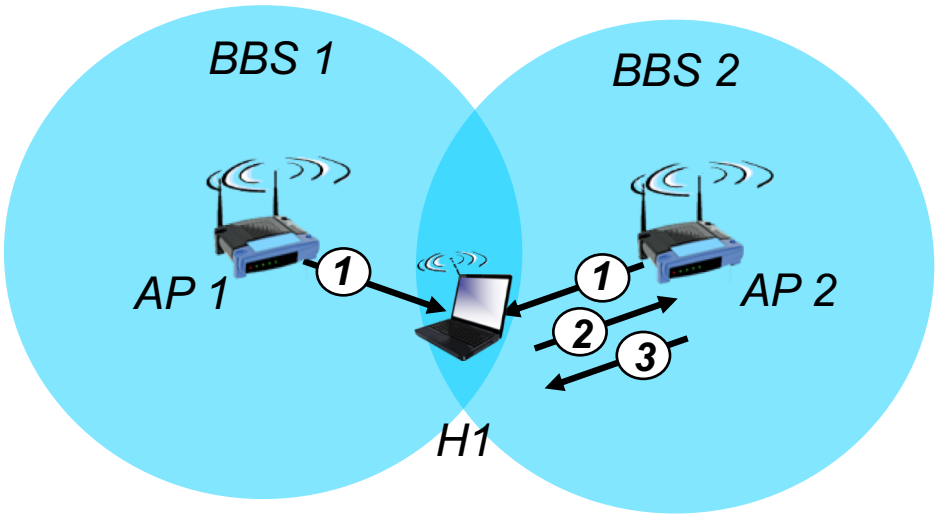


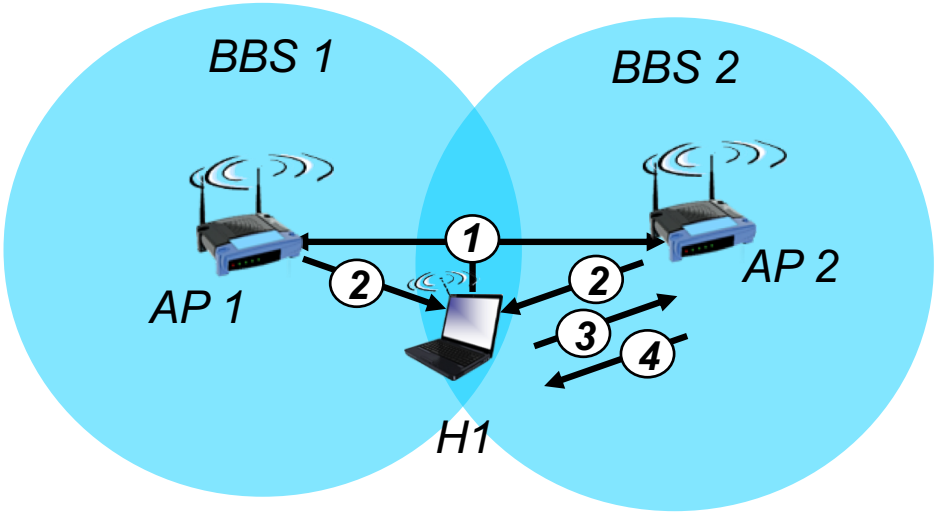
- *wireless host communicates with base station*
  - *base station = access point (AP)*
- *Basic Service Set (BSS) (aka "cell") in infrastructure mode contains:*
  - *wireless hosts*
  - *access point (AP): base station*
  - *ad hoc mode: hosts only*

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

802.11: passive/active scanning





passive scanning:

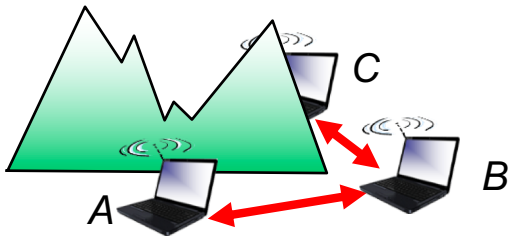
(1) beacon frames sent from APs
(2) association Request frame sent: H1 to selected AP
(3) association Response frame sent from selected AP to H1

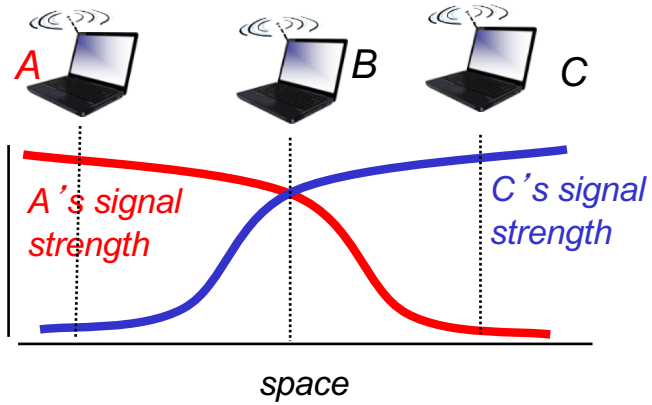
active scanning:

(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

IEEE 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 other 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 terminal, fading
  - goal: *avoid collisions:* CSMA/C(ollision)A(voidance)





Multiple access: Key Points

- No concept of a global collision
  - Different receivers hear different signals
  - Different senders reach different receivers
- Collisions are at receiver, not sender
  - Only care if receiver can hear the sender clearly
  - It does not matter if sender can hear someone else
  - As long as that signal does not interfere with receiver
- Goal of protocol
  - Detect if receiver can hear sender
  - Tell senders who might interfere with receiver to shut up

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

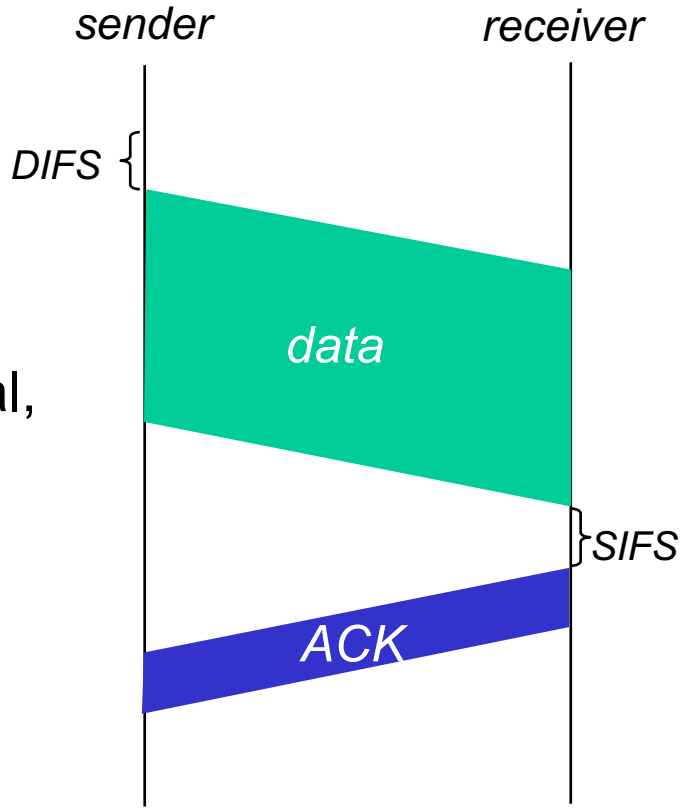
transmit when timer expires

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)



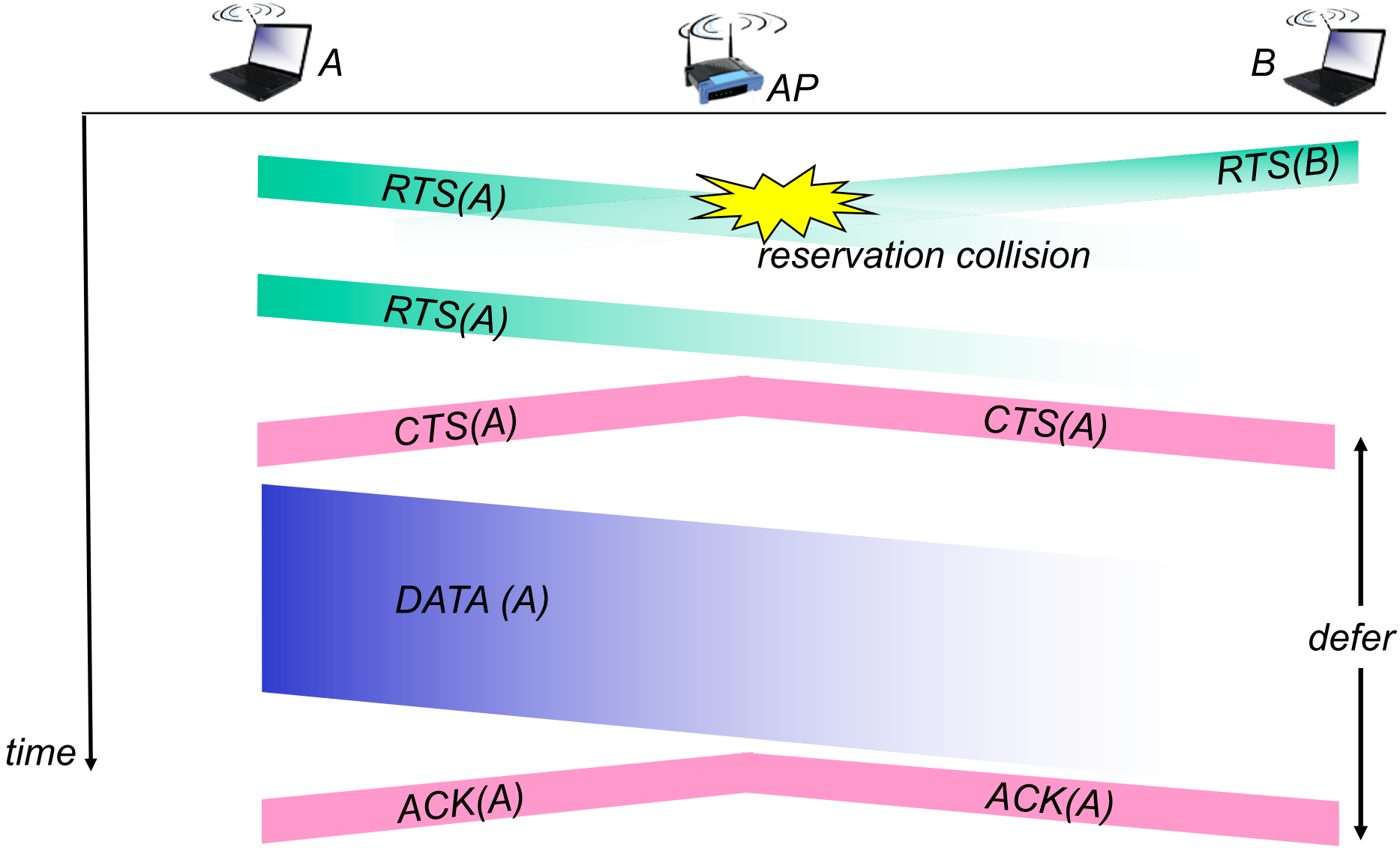
Avoiding collisions (more)

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 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

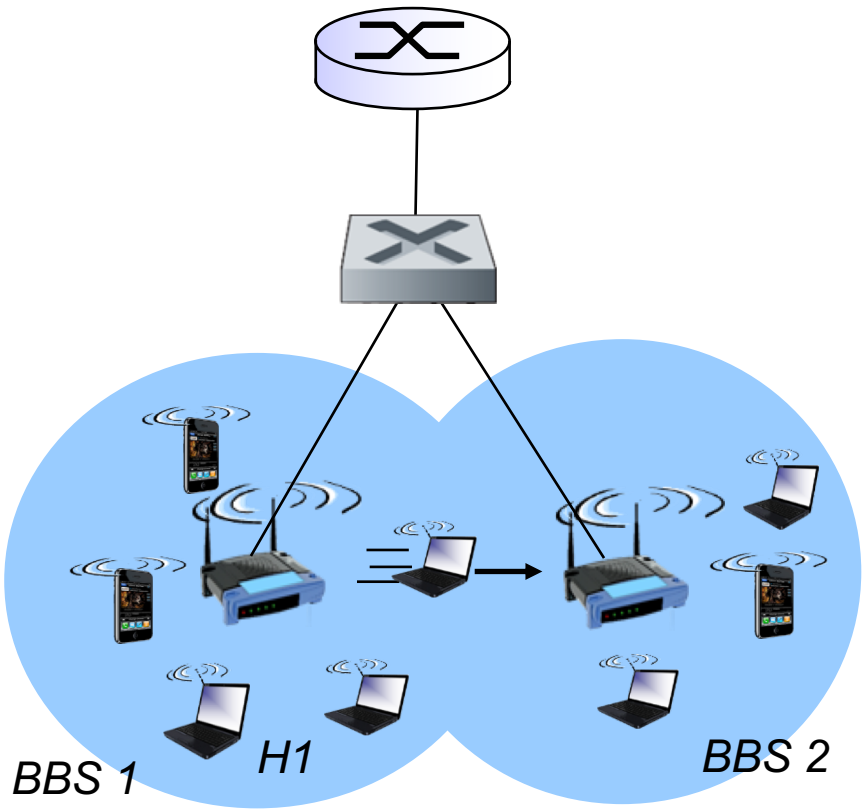
avoid data frame collisions completely using small reservation packets!

Collision Avoidance: RTS-CTS exchange



802.11: mobility within same subnet

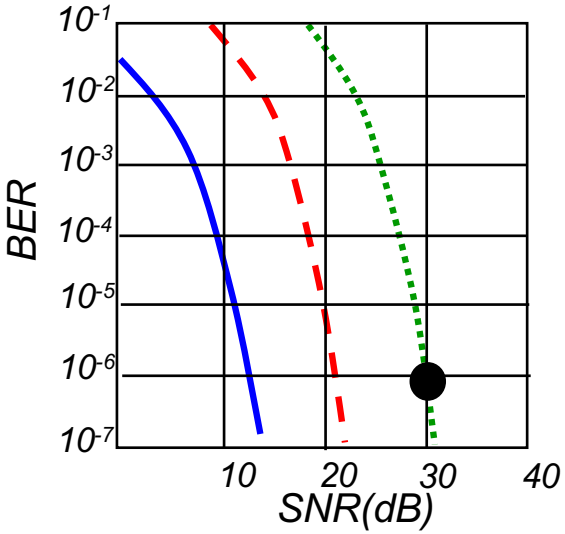
- H1 remains in same IP subnet: IP address can remain same
- switch: which AP is associated with H1?
  - self-learning (Ch. 5): switch will see frame from H1 and "remember" which switch port can be used to reach H1

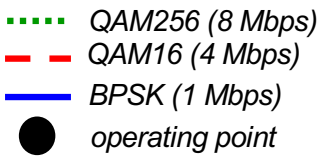


802.11: advanced capabilities

Rate adaptation

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





1. SNR decreases, BER increase as node moves away from base station

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