CS 457 – Lecture 7
Ethernet and Wireless

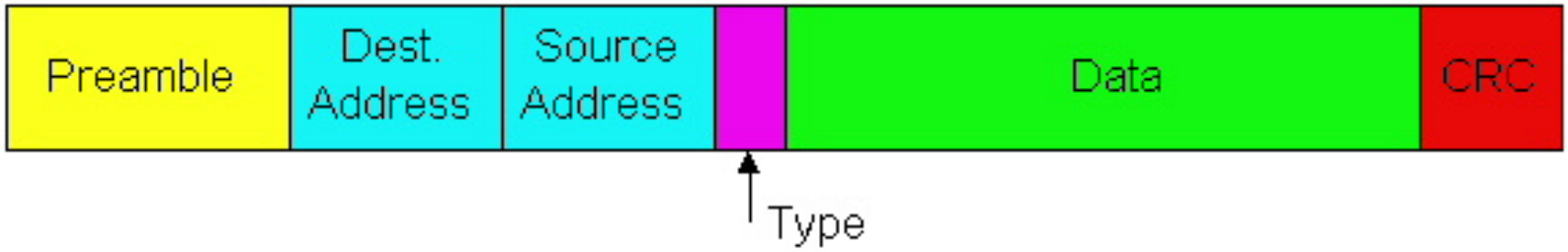
Fall 2011

Ethernet Uses CSMA/CD

- Carrier sense: wait for link to be idle
  - Channel idle: start transmitting
  - Channel busy: wait until idle
- Collision detection: listen while transmitting
  - No collision: transmission is complete
  - Collision: abort transmission, send jam signal
- Random access: exponential back-off
  - After collision, wait a random time before trying again
  - After m^{th} collision, pick K randomly from {0, …, 2^m-1}
  - … and wait for K*512 bit times before trying again

Ethernet Frame Structure

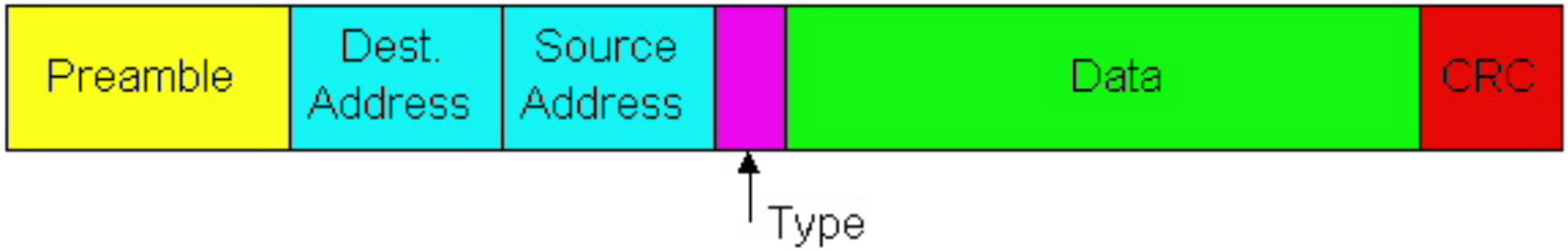
- Sending adapter encapsulates packet in frame



- Preamble: synchronization
  - Seven bytes with pattern 10101010, followed by one byte with pattern 10101011
  - Used to synchronize receiver, sender clock rates

Ethernet Frame Structure (Cont.)

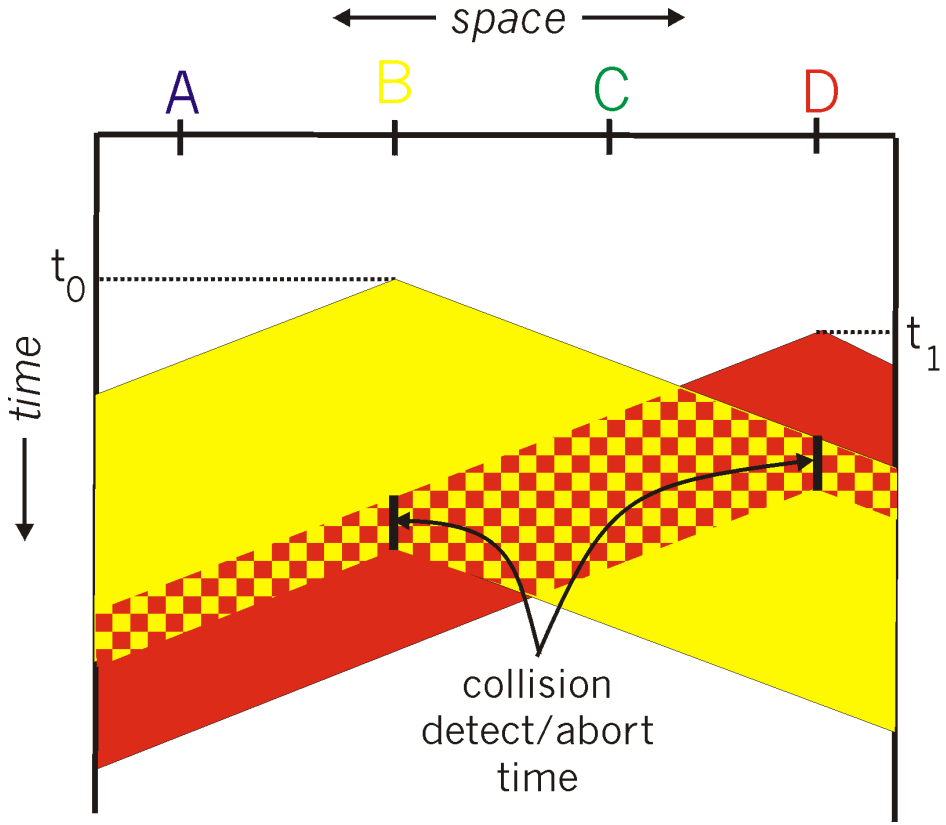
- Addresses: source and destination MAC addresses
  - Adaptor passes frame to network-level protocol
    - If destination address matches the adaptor
    - Or the destination address is the broadcast address
  - Otherwise, adapter discards frame
- Type: indicates the higher layer protocol
  - Usually IP
  - But also Novell IPX, AppleTalk, …
- CRC: cyclic redundancy check
  - Checked at receiver
  - If error is detected, the frame is simply dropped



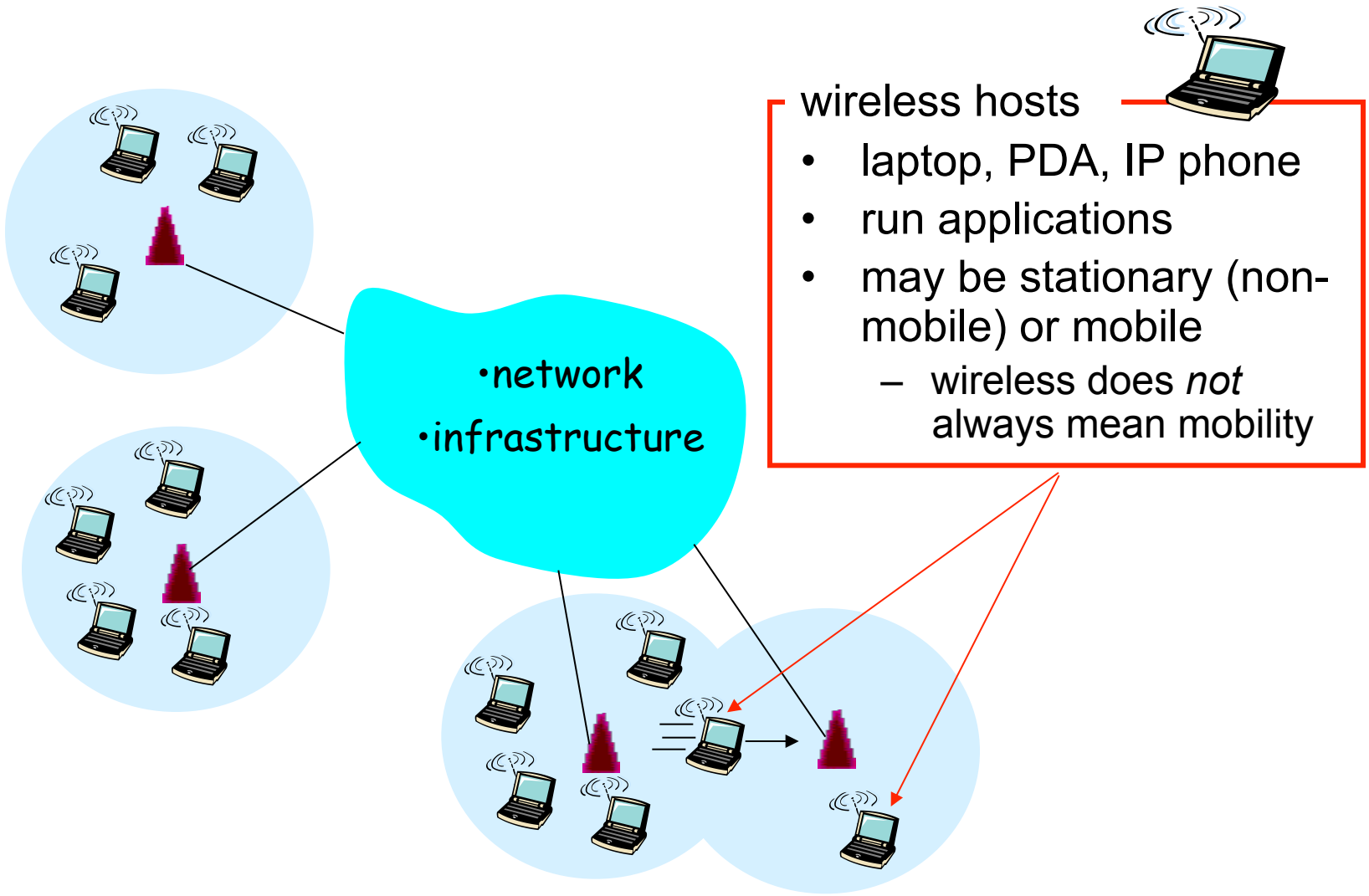
CSMA/CD (Collision Detection)

- Human analogy: the polite conversationalist
- CSMA/CD: carrier sensing, deferral if busy
  - Collisions detected within short time
  - Colliding transmissions aborted, reducing waste
- Collision detection
  - Easy in wired LANs: measure signal strengths, compare transmitted, received signals
  - Difficult in wireless LANs: receiver shut off while transmitting

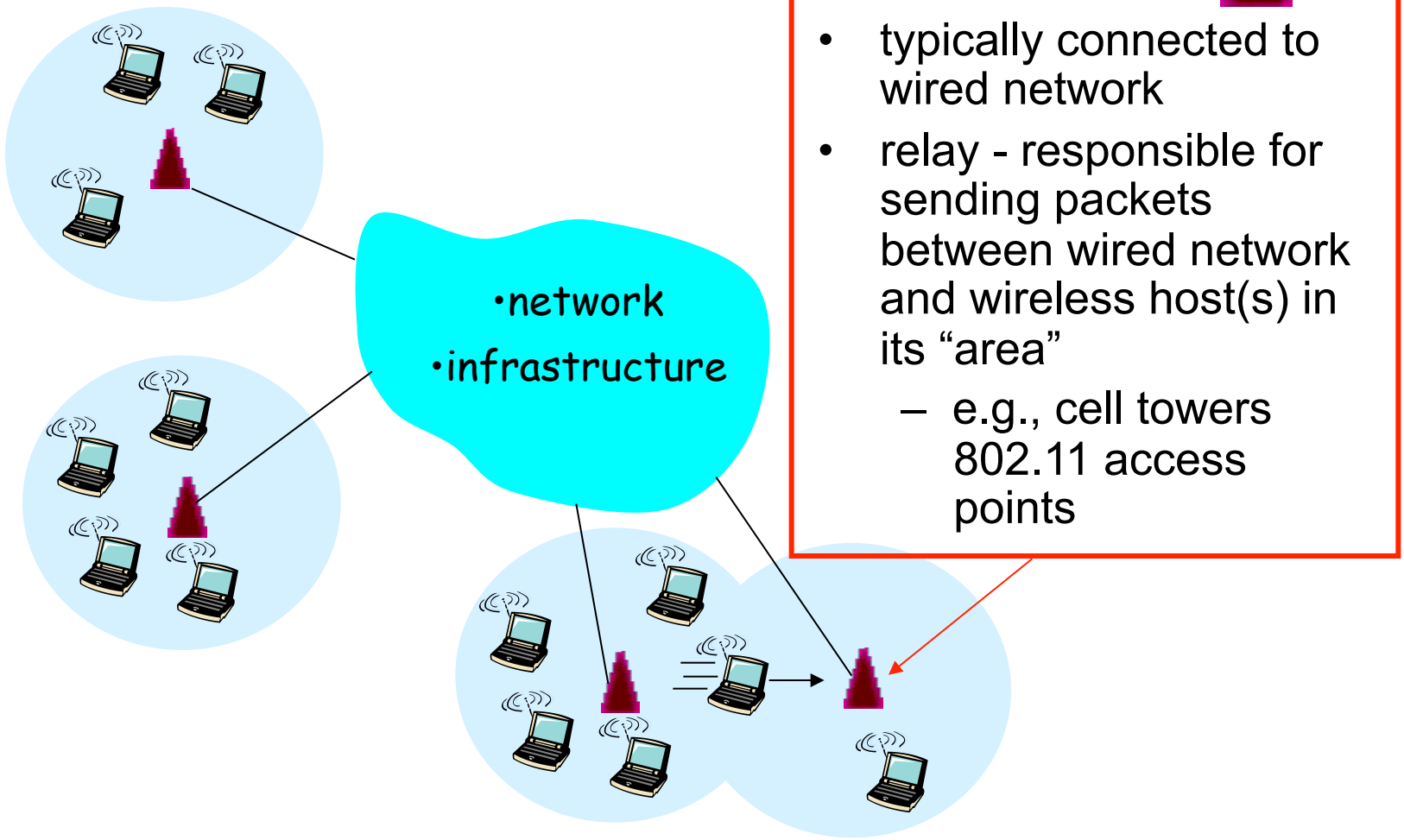
CSMA/CD Collision Detection



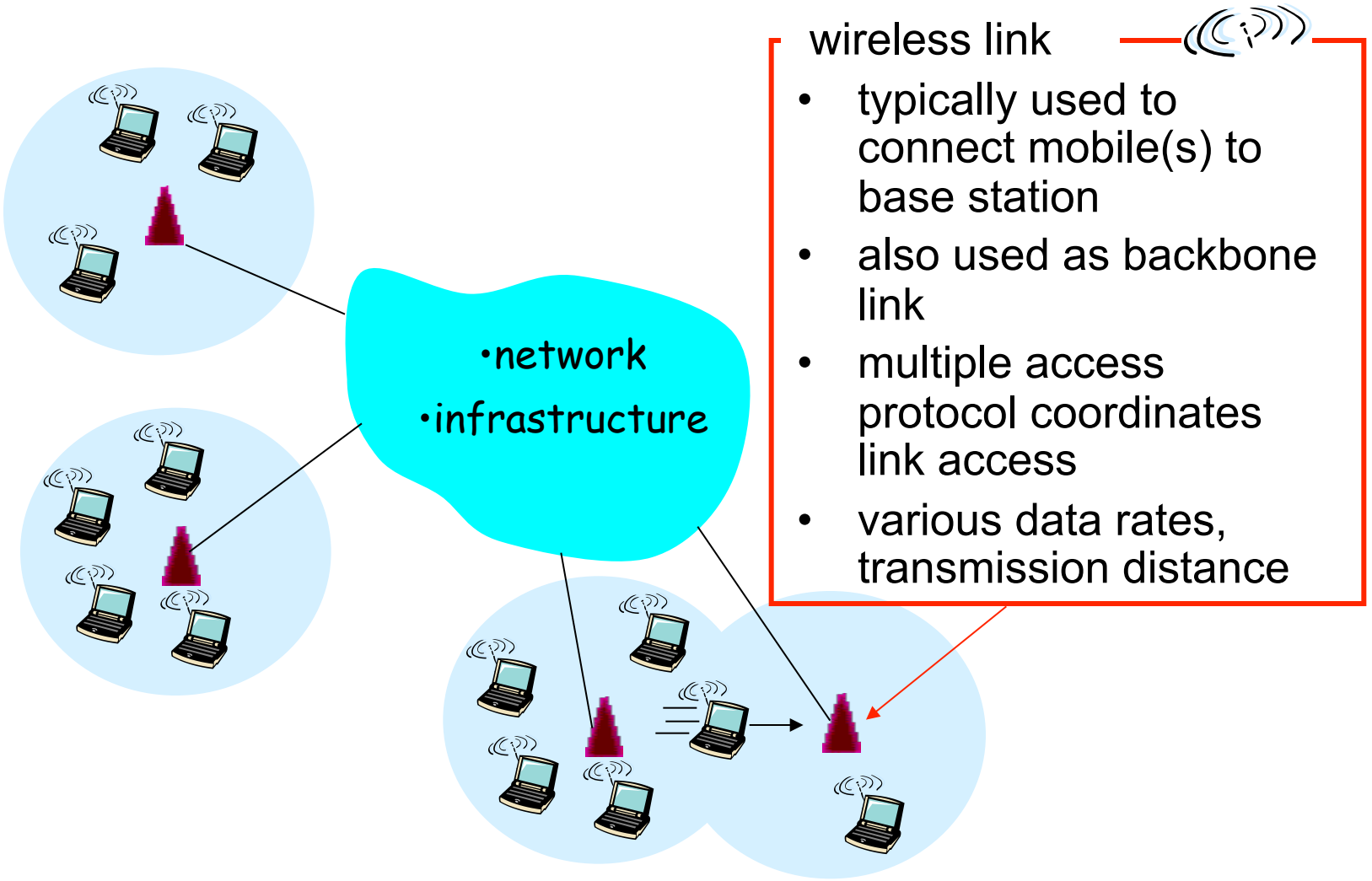
Elements of a wireless network



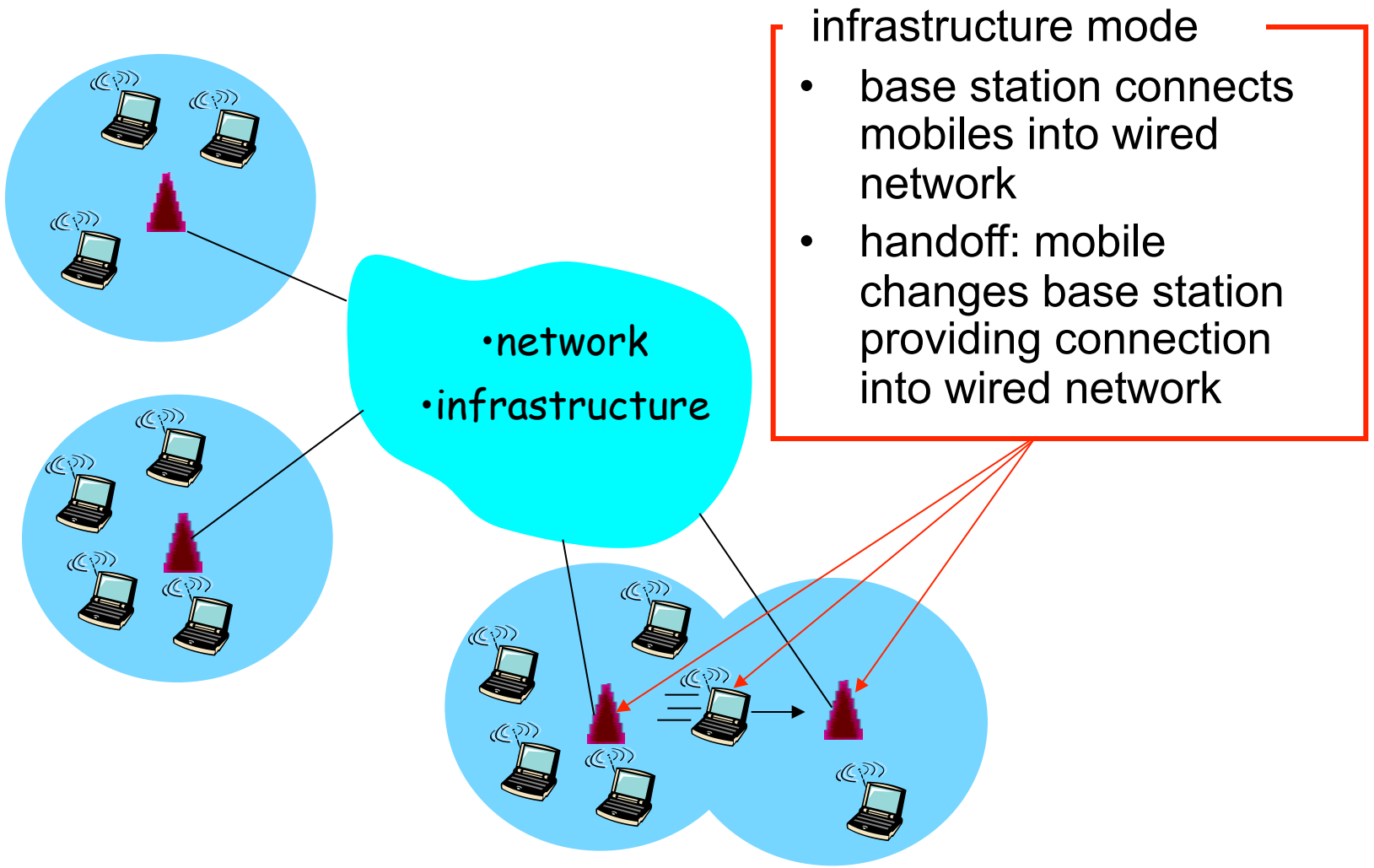
Elements of a wireless network



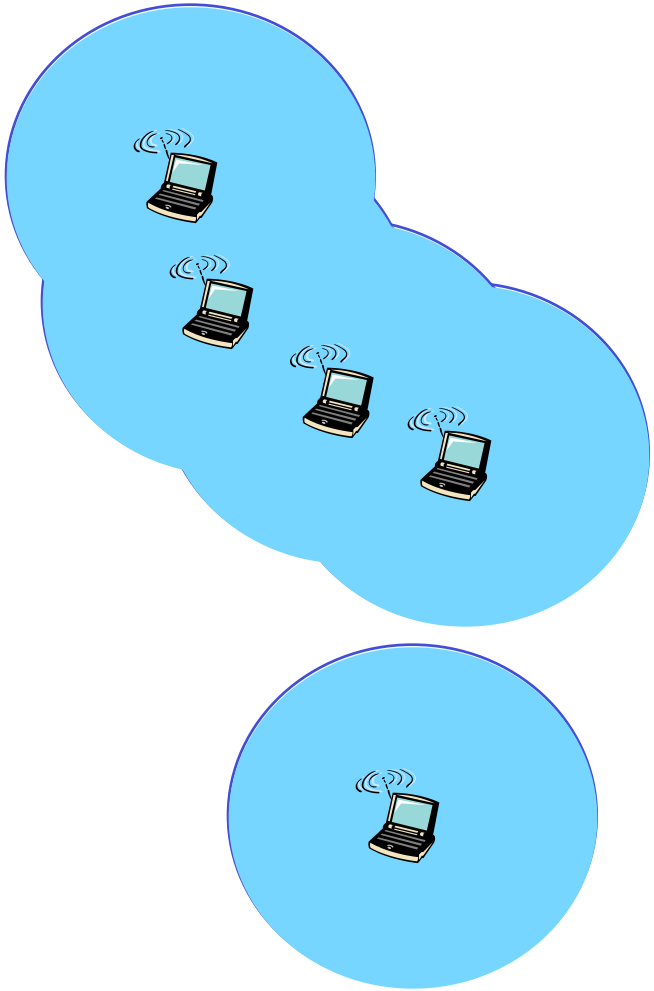
Elements of a Wireless Network



Elements of a Wireless Network



Elements of a Wireless 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

Wireless Link Characteristics

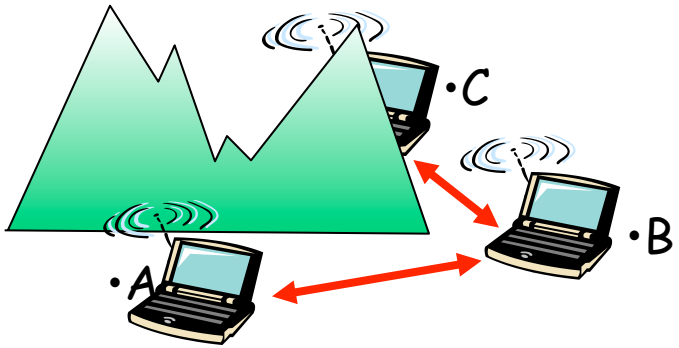
Differences from wired link ….

- 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

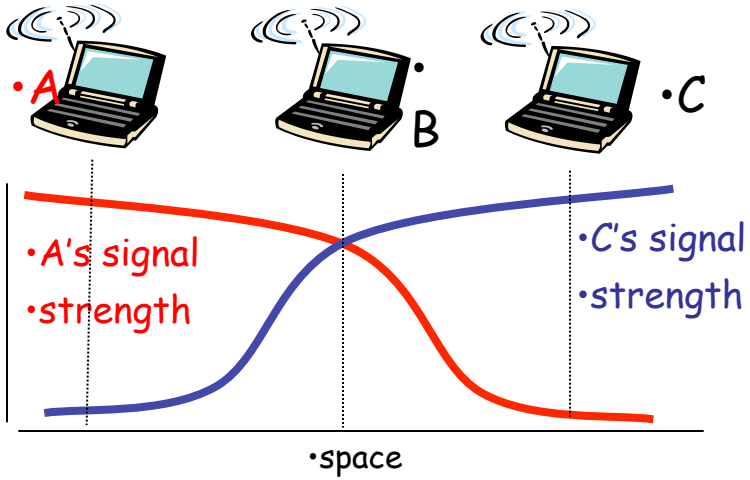
…. make communication across (even a point to point) wireless link much more “difficult”

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

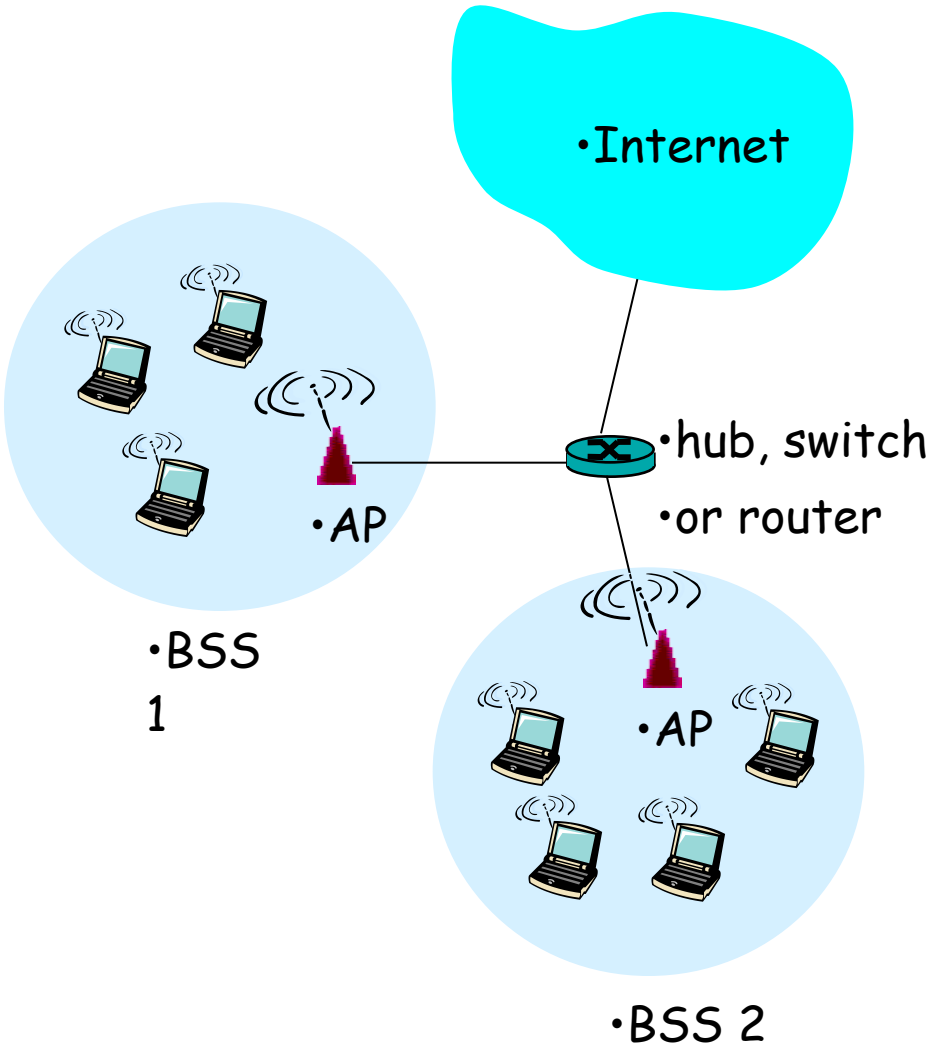


- Signal fading:
- B, A hear each other
- B, C hear each other
- A, C can not hear each other interferring at B

IEEE 802.11 Wireless LAN

- 802.11b
  - 2.4-5 GHz unlicensed radio spectrum
  - up to 11 Mbps
  - direct sequence spread spectrum (DSSS) in physical layer
    - all hosts use same chipping code
  - widely deployed, using base stations
- 802.11a
  - 5-6 GHz range
  - up to 54 Mbps
- 802.11g
  - 2.4-5 GHz range
  - up to 54 Mbps
- All use CSMA/CA for multiple access
- All have base-station and ad-hoc network versions

802.11 LAN architecture



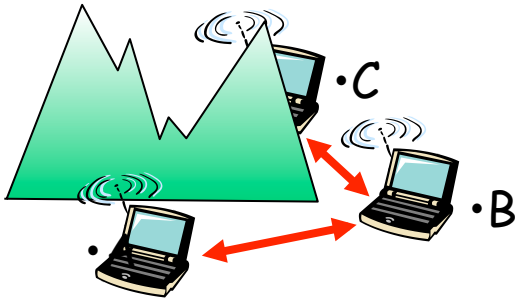
- wireless host communicates with base station
  - base station = access point (AP)
- Basic Service Set (BSS) (aka “cell”) in infrastructure mode contains:
  - wireless hosts
  - access point (AP): base station
  - ad hoc mode: hosts only

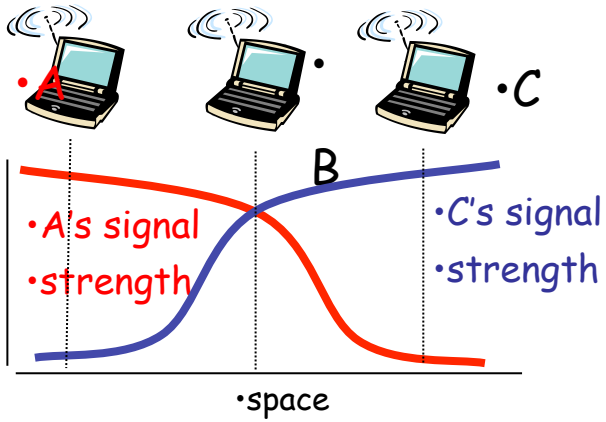
802.11: Channels, association

- 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 [Later Lectures]
  - will typically run DHCP to get IP address in AP's subnet

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)





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

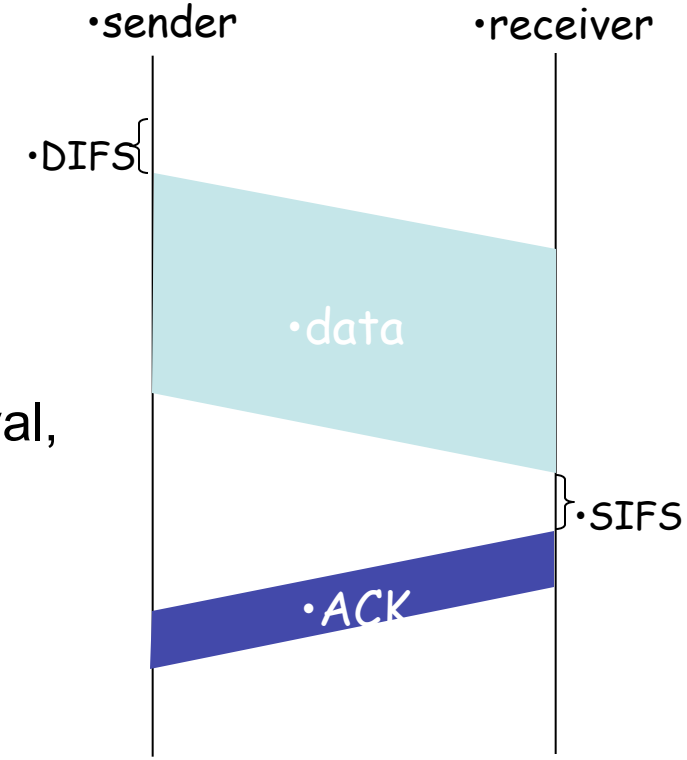
transmit when timer expires

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)

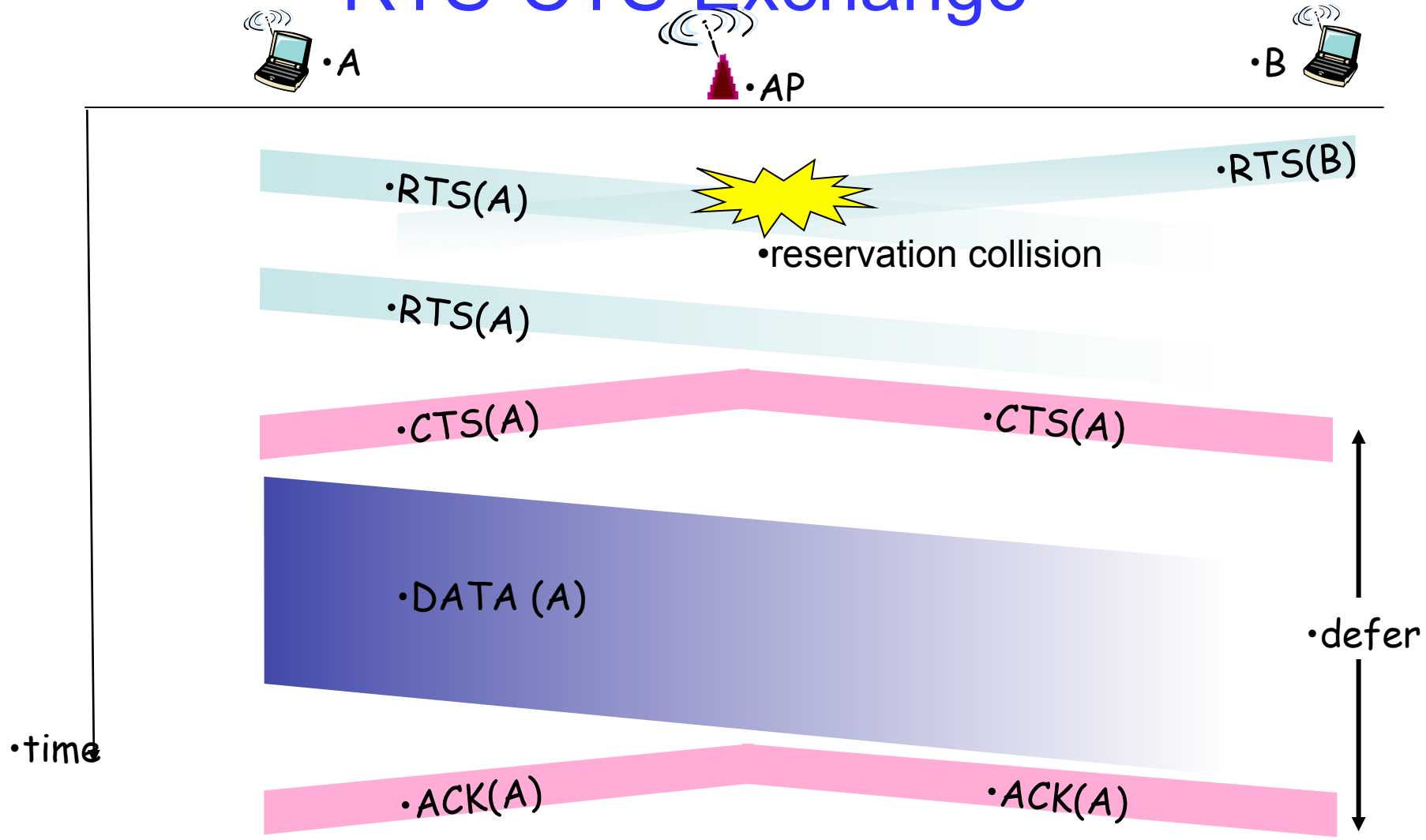
idea: allow sender to "reserve" channel rather than random access of data frames: avoid collisions of long data frames

- 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
- RTS 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



What's Next

- Read Chapter 1 and 2
- Next Lecture Topics from Chapter 3.1 and 3.2
  - Switching and Forwarding
- Homework
  - Due Thursday in Recitation
- Project 1
  - Due Friday