CS 372 Lecture #39

Wireless

- elements
- standards
- characteristics

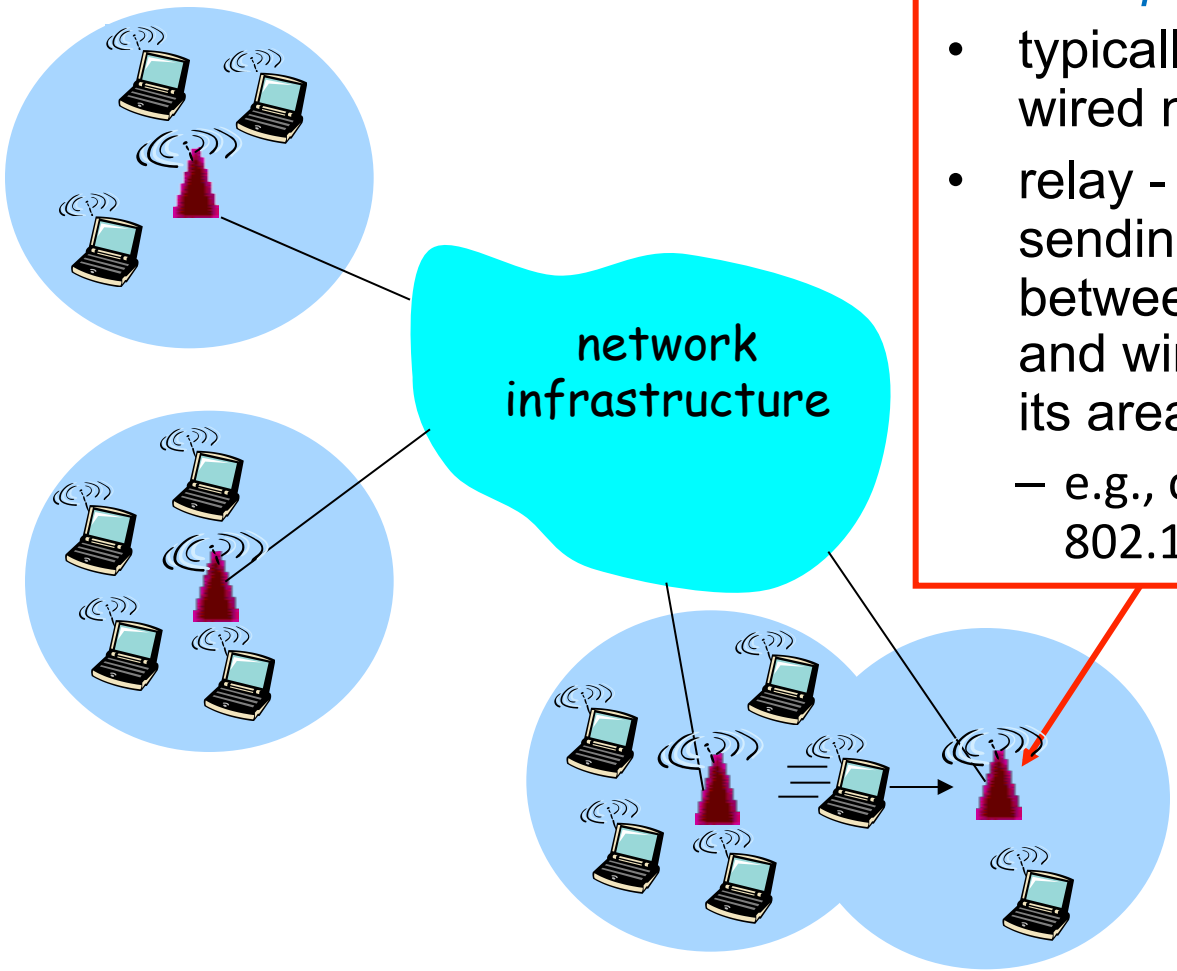
Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach,* 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

Wireless and Mobile Networks

Background:

- Wireless (mobile) phone subscribers now outnumber wired (land-line) phone subscribers (5-to-1)
- Wireless internet-connected devices slightly outnumber wired internet-connected devices
- Consumers expect anytime/anywhere internet access
- Two important (but different) challenges
  - *wireless:* communication over wireless link
  - *mobility:* handling the mobile user who changes point of attachment to network
- Much more complex than wired standards

Elements of a wireless network

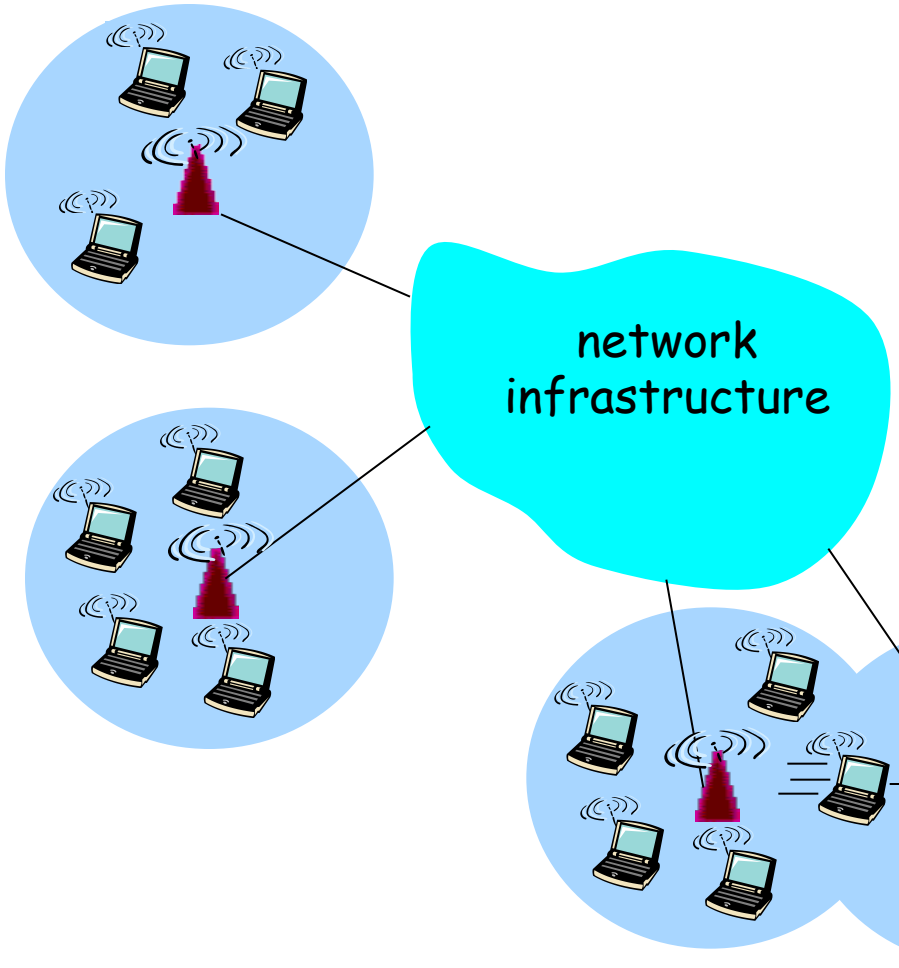


access point (AP*)

- typically connected to wired network
- relay - responsible for sending packets between wired network and wireless hosts in its area
  - e.g., cell towers, 802.11 access points

* also called *base-station*

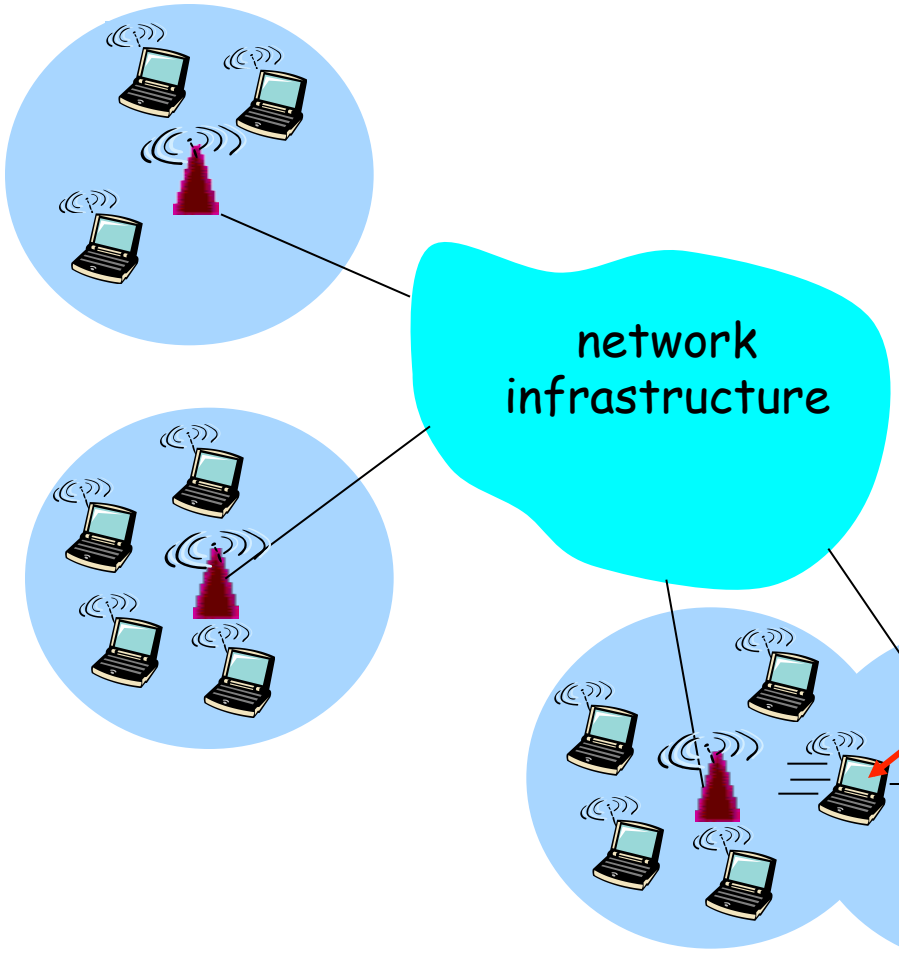
Elements of a wireless network



wireless link

- typically connect hosts to access point
- may also be AP-AP link
- link access coordinated by MA protocol
- various data rates, transmission distance, etc.

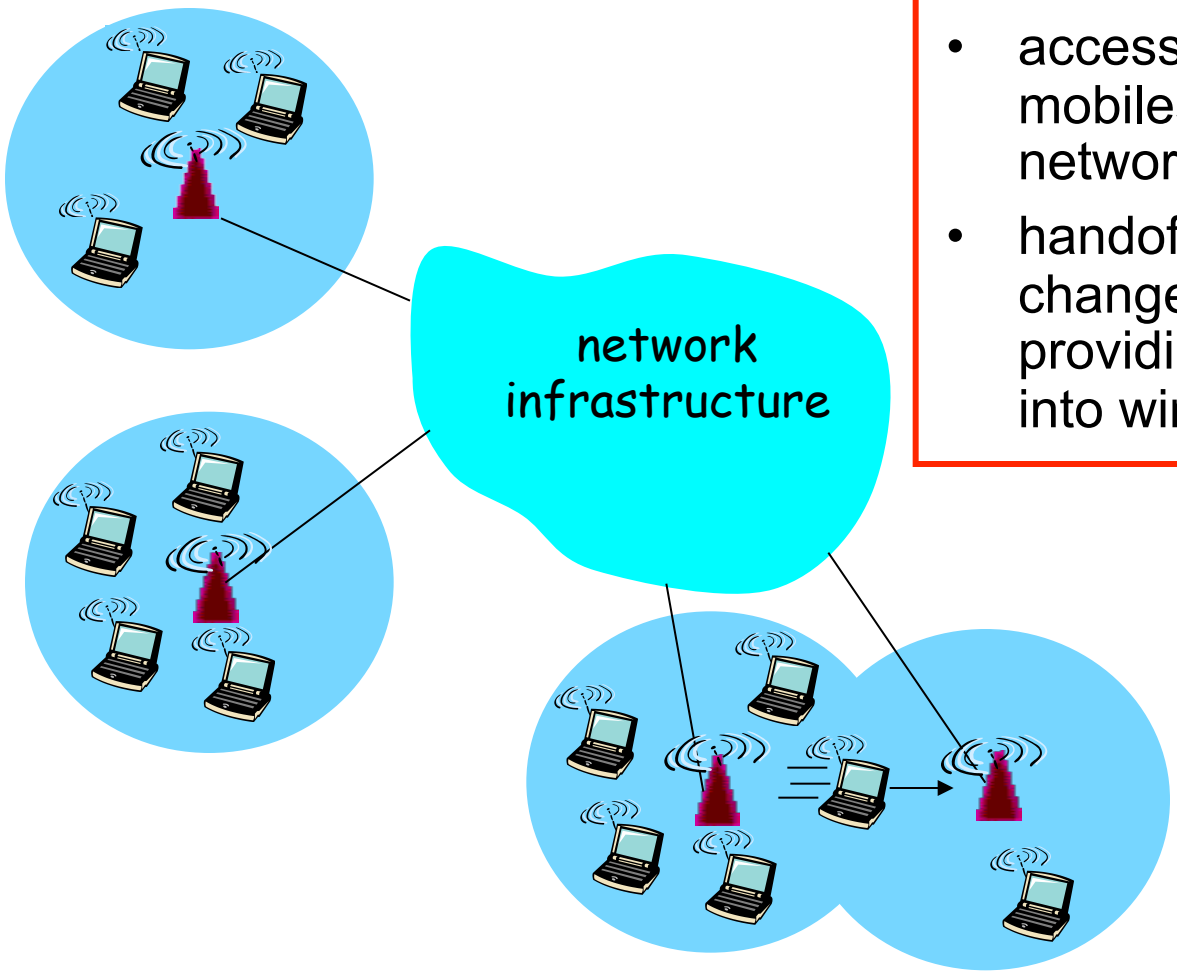
Elements of a wireless network



wireless hosts

- laptop, PDA, IP phone
- run applications
- may be stationary or mobile
  - **wireless does not always mean mobility**

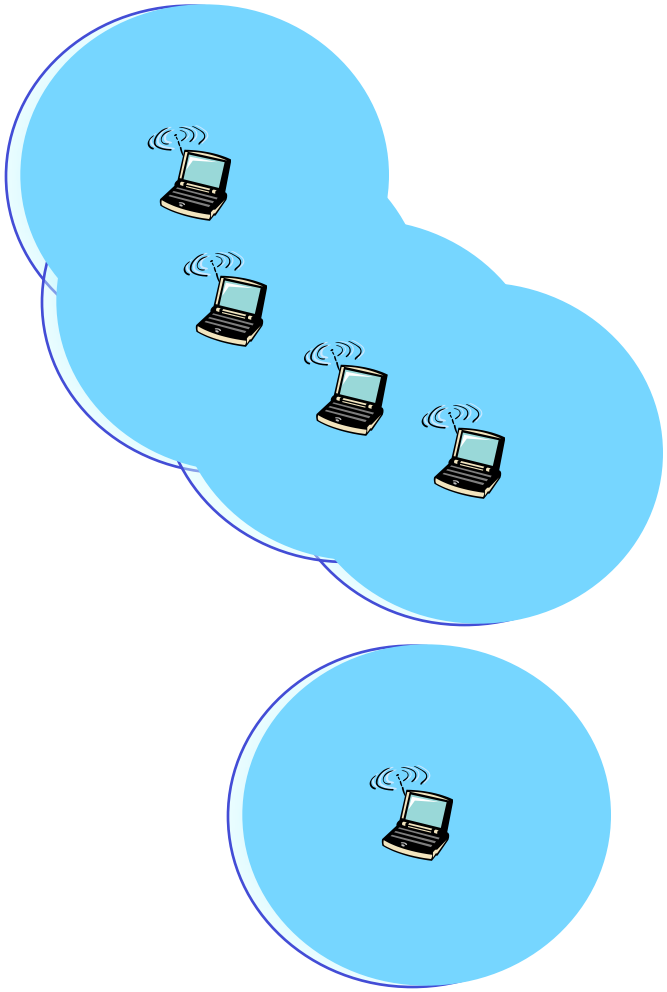
Elements of a wireless network



infrastructure mode

- access point connects mobiles into wired network
- handoff: mobile changes access point providing connection into wired network

Elements of a wireless network



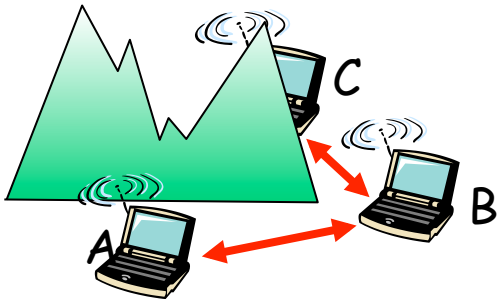
ad hoc mode

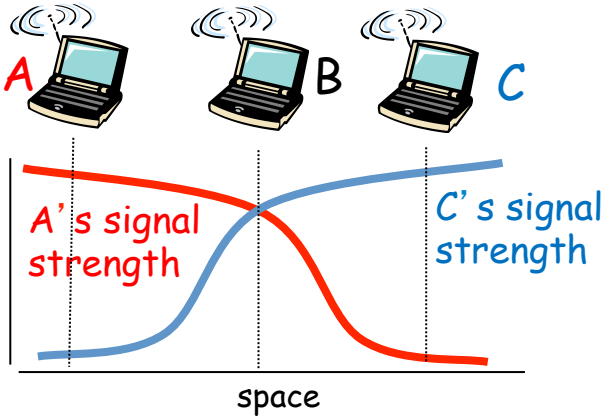
- nodes can only transmit to other nodes within link coverage
- nodes organize themselves into a network: route among themselves
  - e.g. ZigBee
- internet access … if at least one node can reach an access point

Wireless Link Characteristics

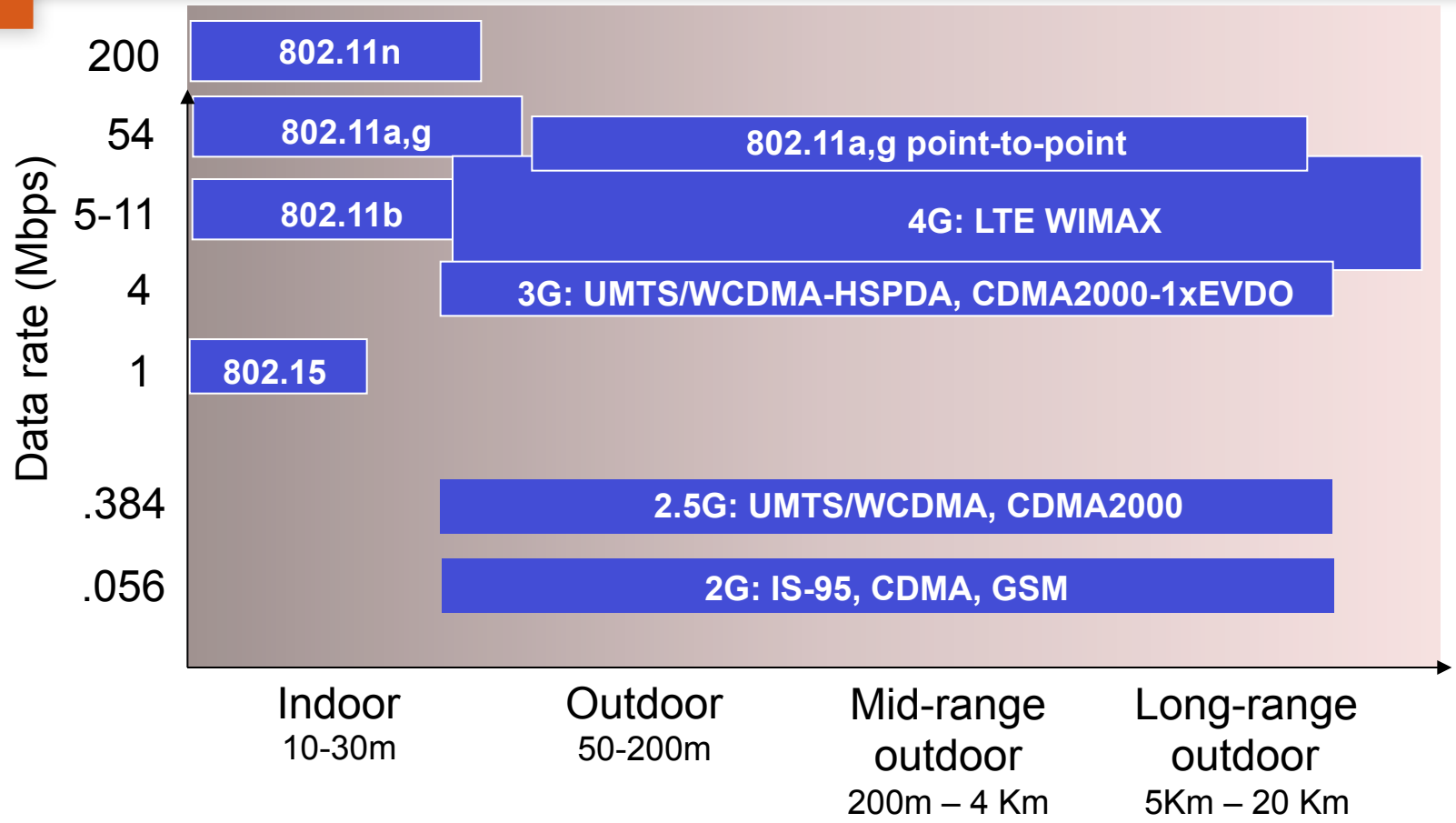
- Differences from wired link ….
  - undirected media:
    - difficult to determine destination
  - decreased signal strength:
    - radio signal fades as it propagates through solid matter (path loss)
  - interference from other sources:
    - standardized wireless network frequencies (e.g., 2.4 GHz) shared by other devices (e.g., phone)
    - interference from electromagnetic devices (motors, fluorescent lights)
  - multipath propagation:
    - radio signal reflects off objects, arriving at destination at different times

. . . make communication across wireless link much more difficult





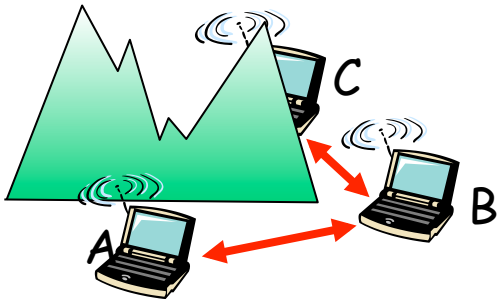
IEEE 802.11 Wireless LAN standards

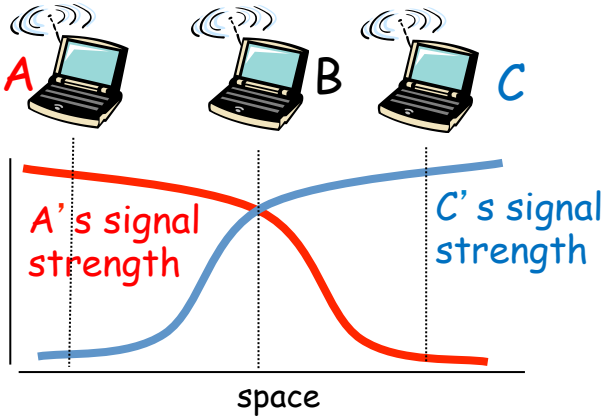


- see http://standards.ieee.org/getieee802/download/802.11-2012.pdf
- all use CSMA/CA for multiple access
- all have both infrastructure and ad-hoc network versions

IEEE 802.11: multiple access protocol

- 802.11: CSMA - sense before transmitting
  - don't start if another node is transmitting
- 802.11: no collision detection!
  - difficult to sense collisions (fading, etc.)
  - can't sense all collisions anyway (hidden terminal, etc.)
  - collision causes garbled message (drop message due to error)
- goal: *avoid collisions*
  - CSMA/CA protocol
    - Carrier Sense Multiple Access / Collision Avoidance)





Avoiding collisions: Wireless CSMA/CA

1. Allow sender to reserve channel
   a. sender first transmits *request-to-send* (RTS) packets to access point using CSMA
   b. access point broadcasts *clear-to-send* (CTS) reservation response to RTS
   c. CTS (designating sender) received by all nodes
2. Sender transmits data frame
3. Access point broadcasts *channel-open*

- Theoretically…
  - other stations defer transmissions
  - longer data packets should not collide
- Actually …
  - RTS's may collide with each other (but they're very small)
  - new node might join after CTS
    - RTS might collide with data packet

Traffic control: Wireless CSMA/CA

- Any station may receive simultaneous requests
  - Causes collision at receiver
  - **Both** requests are lost
  - Neither sender gets a reservation
  - Both senders use ethernet-style *random backoff and retry*
- Any station may receive closely spaced requests
  - Receiver selects one (priority, etc.)
  - Receiver broadcasts CTS specifying selected sender
  - Sender that is not selected uses random backoff/retry

ZigBee

- wireless (ad-hoc) mesh networking standard
- based on the IEEE 802.15.4 standard for wireless personal area networks
  - low cost allows the technology to be widely deployed in wireless control and monitoring applications
  - low power-usage allows longer life with smaller batteries
- One Laptop Per Child (OLPC) project
  - ZigBee in sparse ad-hoc environment
  - http://laptop.org/en/laptop/index.shtml
    - see blogs

Summary Lecture #39

- Definitions:
  - access point (AP)
  - infrastructure network
  - ad-hoc network
- Wireless characteristics/issues
  - signal fading
  - interference
  - reflection
  - multi-path propagation
- Wireless standards
  - IEEE 802.11
    - CSMA/CA
    - RTS/CTS