Chapter 6: Basic Wireless

- A quick intro to CDMA
- Basic 802.11
Channel Partitioning (CDMA)

We previously saw two different ways to partition channels, **TDMA** and **FDMA**. They, respectively, partition the channels up into time slots and frequency bands.

Now we will see **CDMA**, a new way to partition channels. It is frequently used in wireless applications.
Channel Partitioning (CDMA)

CDMA (Code Division Multiple Access)

- unique “code” assigned to each user; i.e., code set partitioning
- used mostly in wireless broadcast channels (cellular, satellite, etc)
- all users share same frequency, but each user has own “chipping” sequence (i.e., code) to encode data
- encoded signal = (original data) X (chipping sequence)
- decoding: inner-product of encoded signal and chipping sequence
- allows multiple users to “coexist” and transmit simultaneously with minimal interference (if codes are “orthogonal”)
CDMA Encode/Decode

sender

channel output $Z_{i,m} = d_i \cdot c_m$

receiver

$Z_{i,m}$

$M$

receiver output

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CDMA: two-sender interference

senders

channel, $Z_{i,m}$

$Z_{i,m}^1 = d_i^1 c_m^1$

$Z_{i,m}^2 = d_i^2 c_m^2$

receiver 1

$d_1^1 = \sum_{m=1}^{M} Z_{i,m}^* c_m^1$

$d_2^1 = -1$

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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
Base station approach

- Wireless host communicates with a base station
  - base station = access point (AP)
- Basic Service Set (BSS) (a.k.a. “cell”) contains:
  - wireless hosts
  - access point (AP): base station
- BSSs combined to form distribution system (DS)
Ad Hoc Network approach

- No AP (i.e., base station)
- Wireless hosts communicate with each other
  - To get packet from wireless host A to B may need to route through wireless hosts X, Y, Z
- Applications:
  - "laptop" meeting in conference room, car
  - Interconnection of "personal" devices
  - Battlefield
- IETF MANET (Mobile Ad hoc Networks) working group
IEEE 802.11: multiple access

- Collision if 2 or more nodes transmit at same time
- **CSMA makes sense:**
  - get all the bandwidth if you’re the only one transmitting
  - shouldn’t cause a collision if you sense another transmission
- Collision detection doesn’t work: hidden terminal problem
IEEE 802.11 MAC Protocol: CSMA/CA

**802.11 CSMA: sender**
- if sense channel idle for **DIFS** sec.
  then transmit entire frame (no collision detection)
- if sense channel busy
  then binary backoff

**802.11 CSMA receiver**
- if received OK
  return ACK after **SIFS**
  (ACK is needed due to hidden terminal problem)
Collision avoidance mechanisms

- Problem:
  - two nodes, hidden from each other, transmit complete frames to base station
  - wasted bandwidth for long duration!

- Solution:
  - small reservation packets
  - nodes track reservation interval with internal “network allocation vector” (NAV)
Collision Avoidance: RTS-CTS exchange

- sender transmits short RTS (request to send) packet: indicates duration of transmission
- receiver replies with short CTS (clear to send) packet
  - notifying (possibly hidden) nodes
- hidden nodes will not transmit for specified duration: NAV
Collision Avoidance: RTS-CTS exchange

- RTS and CTS short:
  - collisions less likely, of shorter duration
  - end result similar to collision detection
- IEEE 802.11 allows:
  - CSMA
  - CSMA/CA: reservations
  - polling from AP
RTS-CTS Exchange is Optional

- RTS-CTS exchange introduces extra delays and consumes channel resources.
- Should only be used to reserve channel for long data frames.
- In practice, wireless station sets a threshold frame size; for frames below threshold size, RTS packet not sent.
- Threshold is often higher than max frame size, so RTS is not used.