Chapter 6: Basic Wireless (last updated 02/05/05)

- 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.

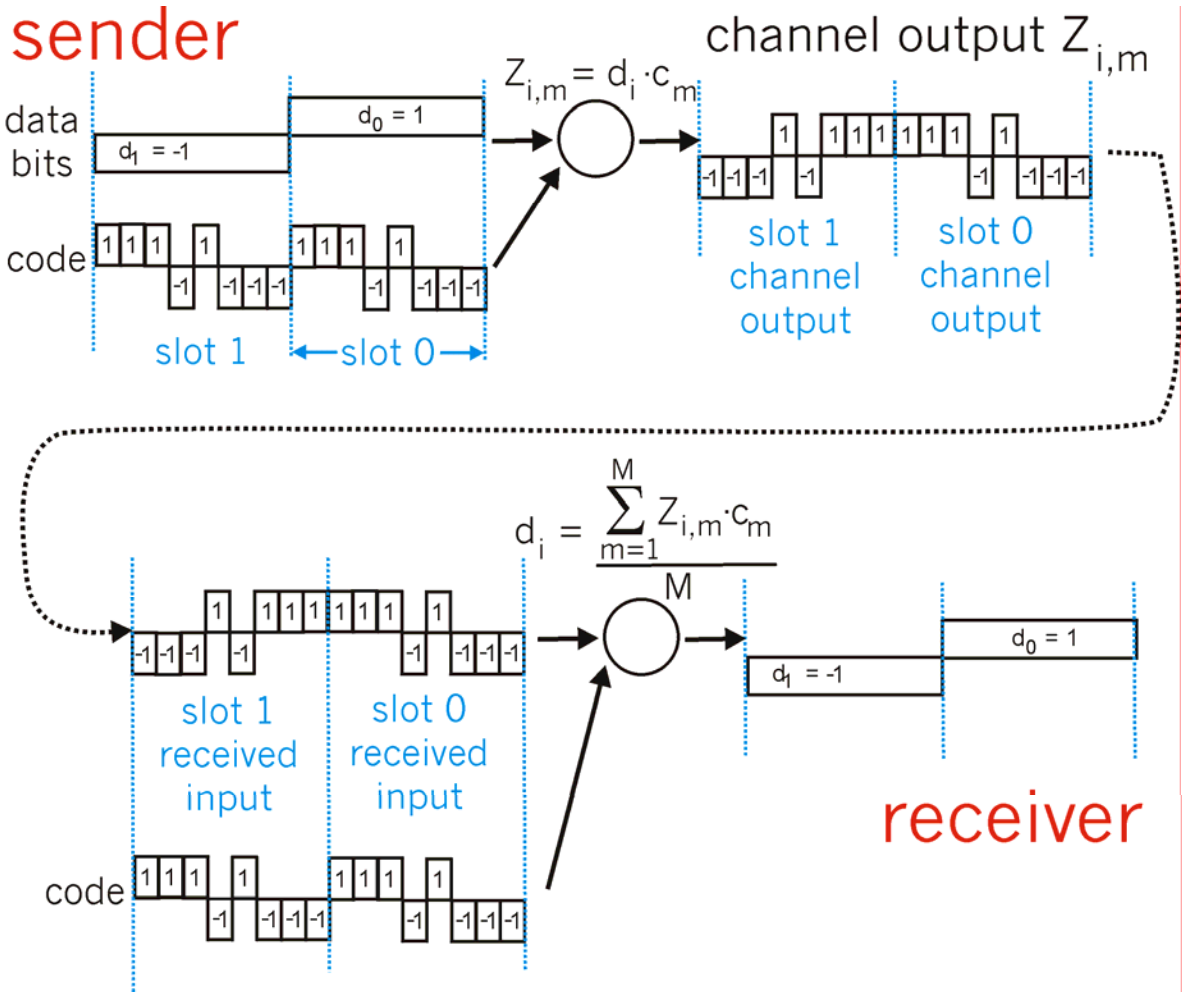
Now we will see **CDMA**, a new way to partition channels. It is frequently used in wireless applications.

Channel Partitioning (CDMA)

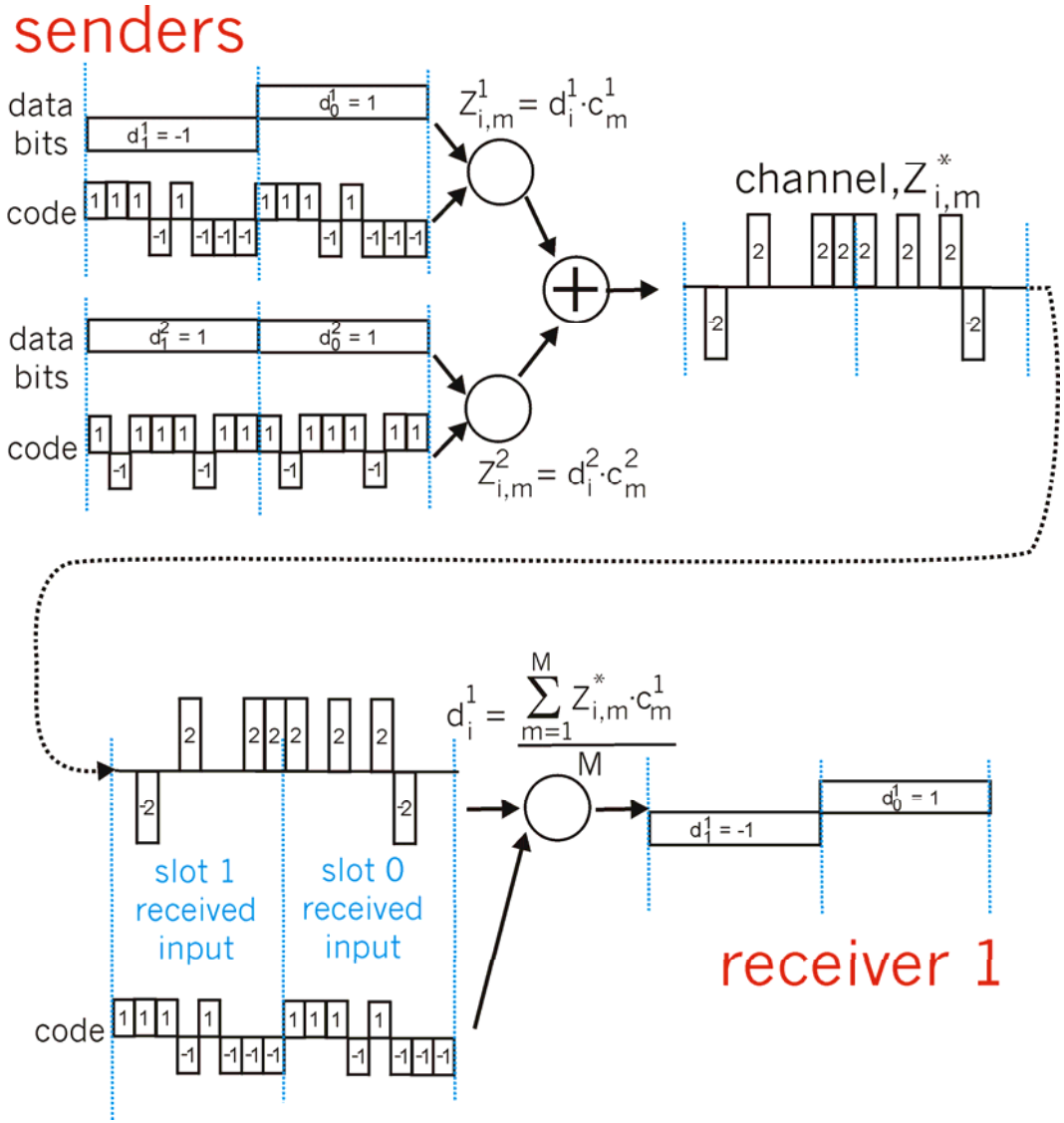
CDMA (Code Division Multiple Access)

- 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



CDMA: two-sender interference

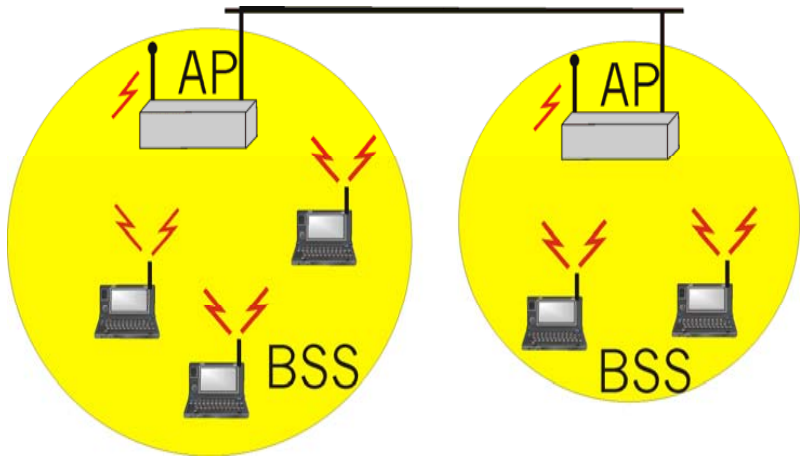


IEEE 802.11 Wireless LAN

- 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

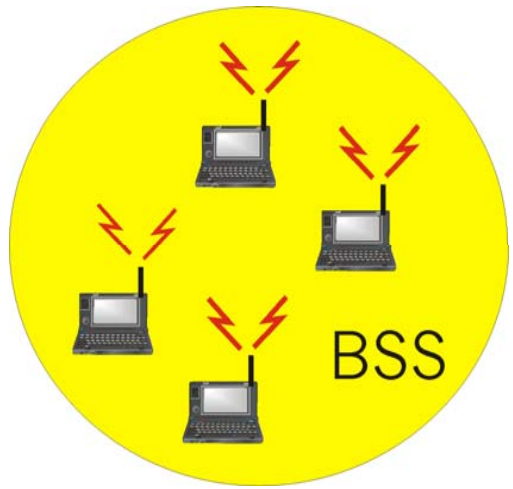
Base station approach

- 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)



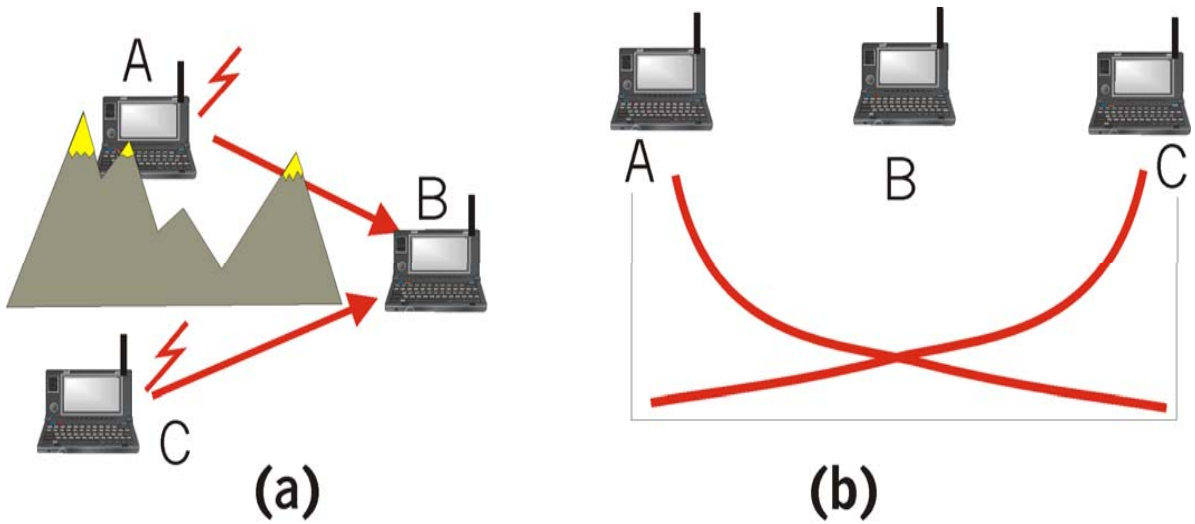
Ad Hoc Network approach

- 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 **DISF** sec.

  then transmit entire frame (no collision detection)

-if sense channel busy

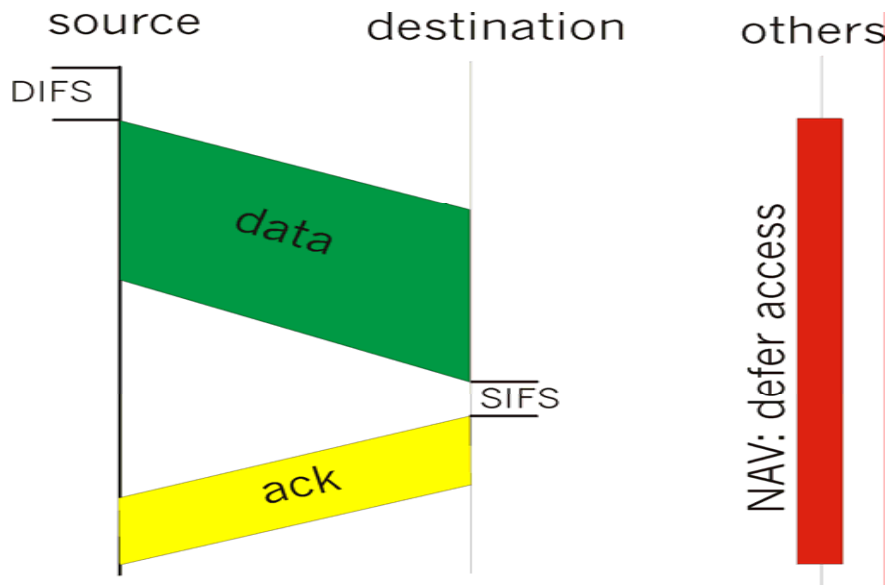
  then binary backoff

802.11 CSMA receiver

- if received OK

  return ACK after **SIFS**

  (ACK is needed due to hidden terminal problem)

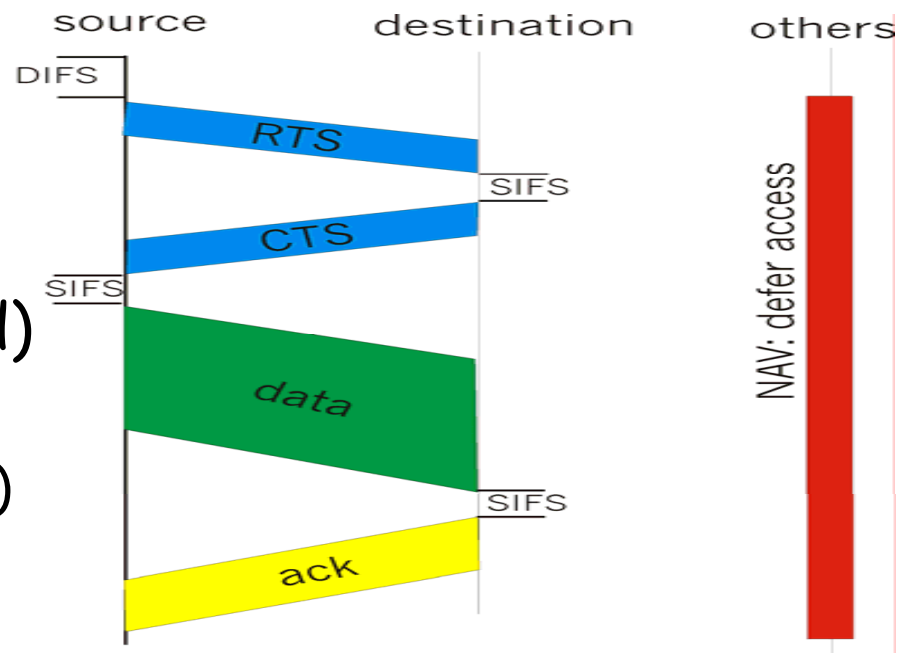


Collision avoidance mechanisms

- 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)

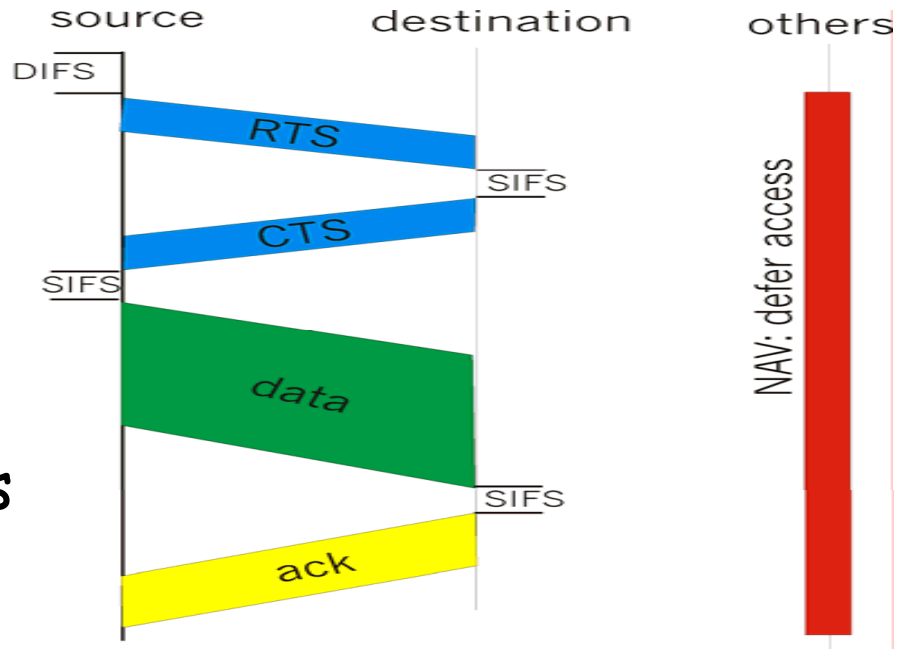
Collision Avoidance: RTS-CTS exchange

- 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