Centralized versus Distributed MAC

- Centralized approaches:
  - Controller grants access to medium.
  - Simple, greater control: priorities, qos.
  - But, single point of failure and performance bottleneck.
- Decentralized schemes:
  - All stations collectively run MAC to decide when to transmit.

Round-Robin MAC

- Each station is allowed to transmit; station may decline or transmit (bounded by some maximum transmit time).
- Centralized (e.g., polling) or distributed (e.g., token ring) control of who is next to transmit.
- When done, station relinquishes and right to transmit goes to next station.
- Efficient when many stations have data to transmit over extended period (stream).
Scheduled Access MAC

- Time divided into slots.
- Station reserves slots in the future.
- Multiple slots for extended transmissions.
- Suited to stream traffic.

Contention-Based MAC

- No control.
- Stations try to acquire the medium.
- Distributed in nature.
- Perform well for bursty traffic.
- Can get very inefficient under heavy load.

- NOTE: round-robin and contention are the most common.

802.11

- IEEE standard for wireless medium access control.
- Similar to Ethernet, i.e., contention-based.
- But, instead of collision detection, performs collision avoidance.
- Why?
  - Full-duplex radios are expensive.
- How is collision avoidance performed?
  - Transmitter and receiver exchange small control frames to reserve the medium for data exchange.

Wireless Channel Contention
**The Hidden Terminal Problem**

- A sends to B, C cannot receive A
- C wants to send to B
- If use CSMA/CA:
  - C senses a “free” medium, thus C sends to A
  - Collision at B, but A cannot detect collision
  - Therefore, A is “hidden” for C

**The Exposed Terminal Problem**

- B sends to A, C wants to send to D
- If use CSMA/CA
  - C senses an “in-use” medium, thus C waits
  - But A is outside the radio range of C, therefore waiting is not necessary
  - Therefore, C is “exposed” to B

**Wireless LANs**

- Wireless LANs use radio bridges to transmit data
  - Example: 802.11 (up to 11 Mb/s)
- An **Access Point** (a.k.a. base station) is connected to the wired LAN and communicates with the wireless card of nearby computers
- For 802.11: each Access Point only covers a radius of no more than 200 feet (and less if there are walls or obstacles)
  - Therefore, to allow for LAN access within a building, several Access Points need to be installed in the different rooms/corridors

**Wireless Local Area Networks**

- Example: WaveLan, Aironet
- Wireless LAN may be used for
  - Last hop to a wireless host.
  - Wireless connectivity between hosts on the LAN.
Other Wireless Networks

Cellular Networks

- Cellular phones: voice.
- Cellular networks: shift from voice to data.
- New wireless devices: pagers, PDAs.
- New services: Web access, e-mail, instant messaging, etc.

Cellular Concept: Motivation

- Early mobile radio systems:
  - Large coverage with single, high-powered transmitter.
  - But, no frequency re-use due to interference.
- Since finite spectrum allocation, need: high capacity (number of users) with limited spectrum and wide coverage.

Some Cellular Terminology

- Mobile.
- Base station.
- Mobile Switching Center (MSC).
- Handoff.
- Cell.
**Cellular Architecture**

- Mobile hosts can change cells while communicating.
- **Hand-off** occurs when a mobile host starts communicating via a new base station.
- **Handoff** decision made based on signal strength.

**Cellular Fundamentals**

- System-level idea, no major technological changes.
  - Many low-power transmitters instead of single, high power on (large cell).
  - Service area divided into small cells covered by each low power transmitter.
  - Each transmitter (or base station) allocated a portion of the spectrum.
  - Nearby BSs assigned different channel group to minimize interference.
  - Scalability: as more users subscribe, more BSs can be added using lower transmission power.

**Frequency Reuse**

**Handoff/Handover**
**MANETs**

- Mobile, (wireless), multi-hop ad-hoc networks.
- Formed by wireless hosts which may be mobile.
- Without (necessarily) using a pre-existing infrastructure.
- Routes between nodes may potentially contain multiple hops.
- Mobility cause routes to change.

**Multi-hop**

- May need to traverse multiple hops to reach destination.

**Why MANETs ?**

- Ease of deployment.
- Speed of deployment.
- Decreased dependence on infrastructure.

**Many Applications**

- Personal area networking.
  - Cell phone, laptop, ear phone, wrist watch.
- Military environments.
  - Soldiers, tanks, planes.
- Civilian environments.
  - “Smart” environments.
- Emergency operations
  - Search-and-rescue
  - Policing and fire fighting
  - Monitoring and surveillance.