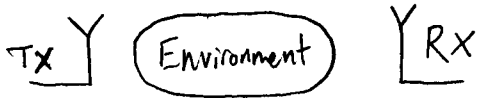
9/6/16

Wireless MAC

- Problem: Shared Medium
  - ↳ one node can transmit at any time on any frequency
    otherwise we get collision
    limited to Range

Range:
- TX power
- Environment
- Receiver Sensitivity

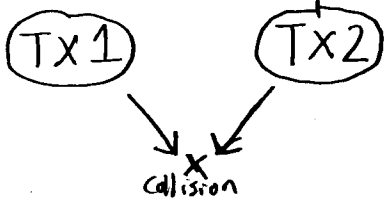


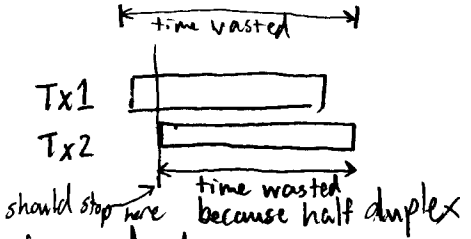
ex: -90 dBm Tx → -110 dBm RX can receive
→ -65 dBm RX Cannot receive

Types of Range:
- Detection Range: Can detect signal power
- Decoding Range: Can detect and decode signal

} typically smaller than

- Problem: Half duplex — cannot detect collision while transmitting





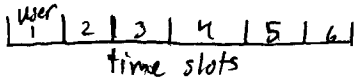
why Half duplex? Colocated Antennas. TX interferes w/ RX

MAC Protocol should be

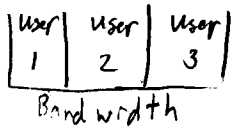
- Efficient: No idle channels, Maximize utilization, No collisions
  - No wasted time
- Fair: Avoid Starvation
  - Equality?
  - Based on Need?

MAC Protocols ↗ Reservation Based ↘ Contention Based

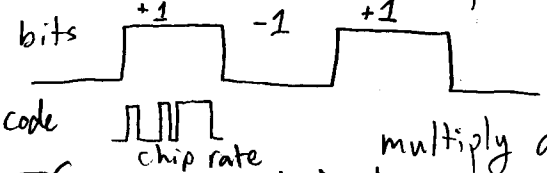
- Reservation Based
  - TDMA

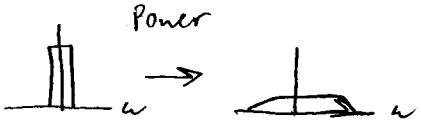


  - FDMA



  - CDMA Code division multiple access





multiply data against higher rate code

high auto correlation $\sum(bits \times code1 \times code1) = bits$

low cross correlation $\sum(bits \times code1 \times code2) = 0$

@ Rx multiply by code

- Support M Users → code length $L = 2^M$

Very expensive

- Pros
  - No collisions
  - Works well in centralized systems
    - Cellular
- Cons
  - Inefficient
  - Bad in bursty traffic

- Contention Based

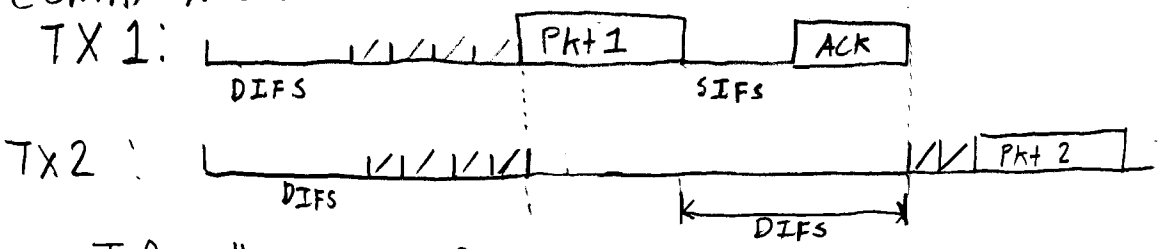
Nodes contend for the medium

Pros
- Good for bursty traffic
- Good for Distributed Systems

Cons
- Collisions. Need to avoid

- CSMA/CA : Carrier Sense Multiple Access / Collision Avoidance
  - Listen to channel : DIFS (Distributed Inter frame space)
    - Wait time = DIFS = ~50 μs
  - Randomly choose $b \in (0, CW_{max})$. Every timeslot decrement b
    - when $b = 0$ ⇒ transmit

CSMA/CA cont



- If collision → $CW_{max} = 2\,CW_{max}$
- After success → $CW_{max} = CW_{max}^{initial}$ reset Contention Window
- Effciency

  Overhead = DIFS + SIF + (b × Slot time) + ACK

  50 µs + 10 µs + 8 × 10 µs + 30 µs = 170 µs

  Data = 1500 bytes = 12 000 bits

  802.11n = 300 Mbps → Data time = 40 µs

  Throughput = 60 Mbps → 80% reduction in efficiency

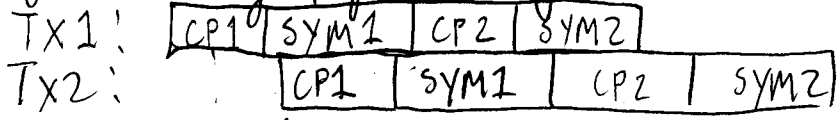
OFDM: Divide Bandwidth into N subcarriers
- → Combat ISI
- → less Guard Bands → More effecient
  - orthogonal subcarriers
- → Robust to fading/multipath
- → Channel estimation easier

- CP for alignment/ISI
- Take care CFO/SFO

OFDMA: Divide Bandwidth into subcarriers

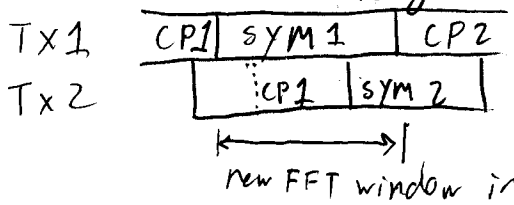
Different Users use different subcarriers
- No guard bands

- FICA use OFDMA
- Requires very high time synchronization



FFT Window includes 2 symbols. Orthogonality lost

- Solutions
  - Increase CP length



    - Too much overhead
      - FICA increases CP and sym to keep efficiency rate same
        - More/smaller bins. CFO more likely to shift bins and cause interference (ICI)
        - FFT larger
          - slower
          - More power
          - Need to change hardware