Introduction to Wireless Networks

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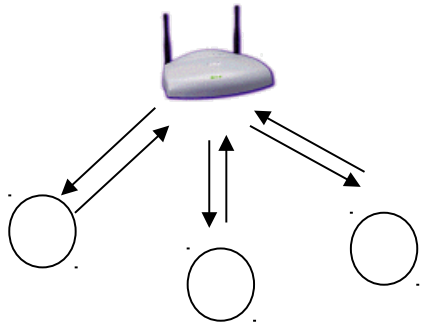
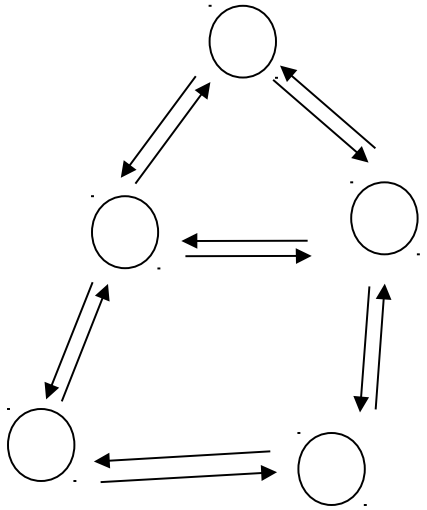
Wireless Computer Networks

- Wireless LANs
  - An Access Point (AP) which forwards packets to/from client nodes
  - One hop

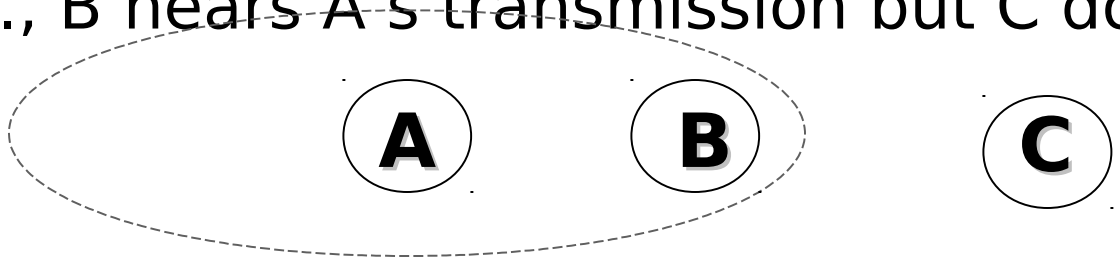


- Muti-hop Wireless Networks
  - Stationary/Mobile nodes
  - Nodes route packets for each other
  - A multi-hop network

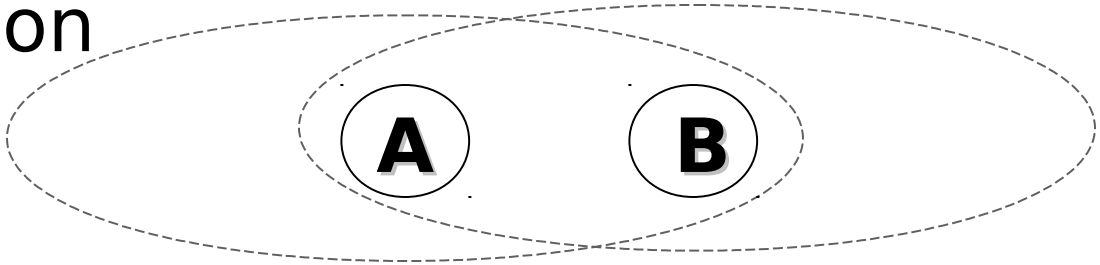


Wireless Transmission

- Sender has a radio range:
  - Only nodes within radio range can hear transmission
  - E.g., B hears A's transmission but C doesn't hear A

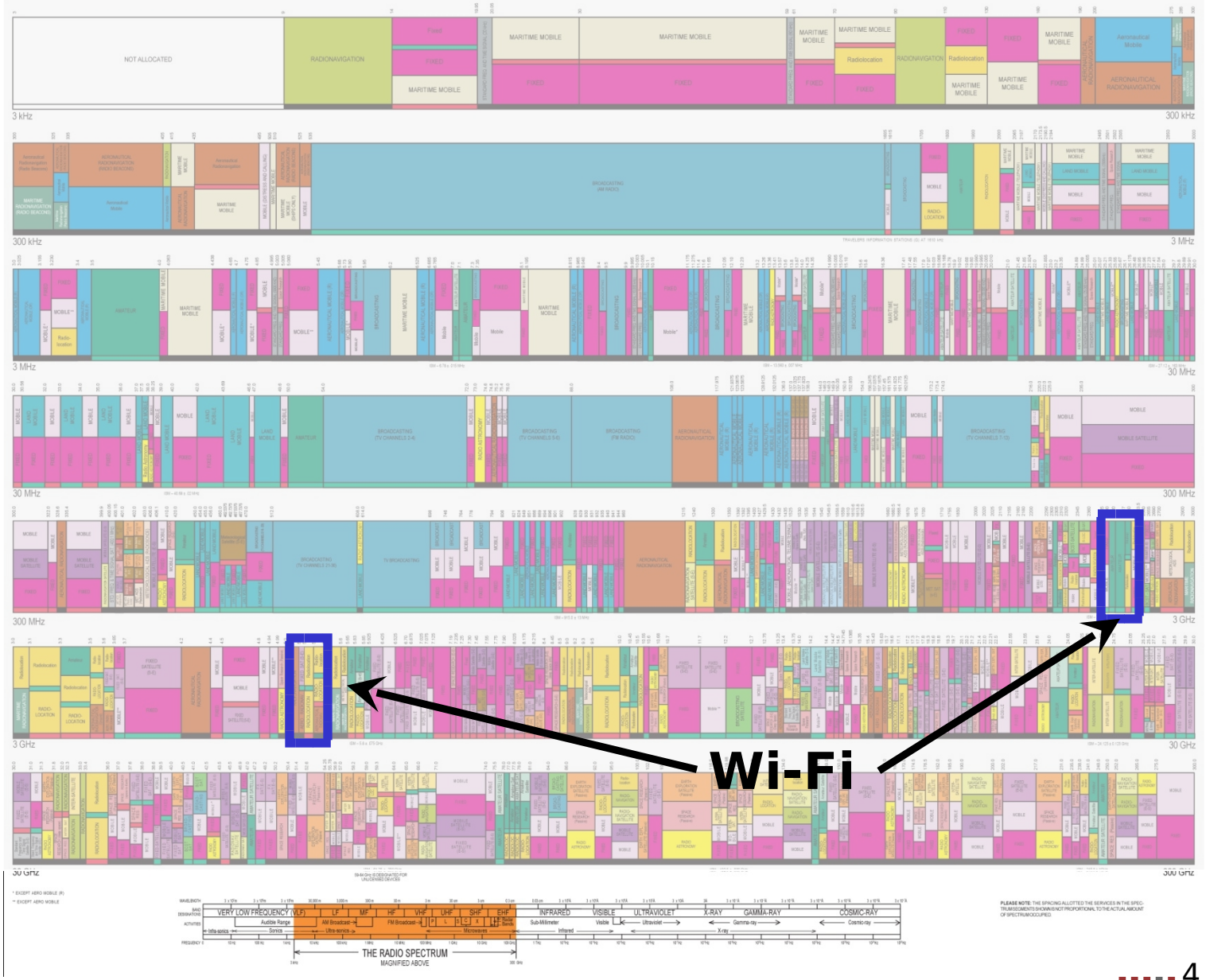


- If nearby nodes transmit simultaneously → collision



- Radio cannot transmit and receive simultaneously → Use the lack of ack to detect collision

FCC Spectrum Allocation

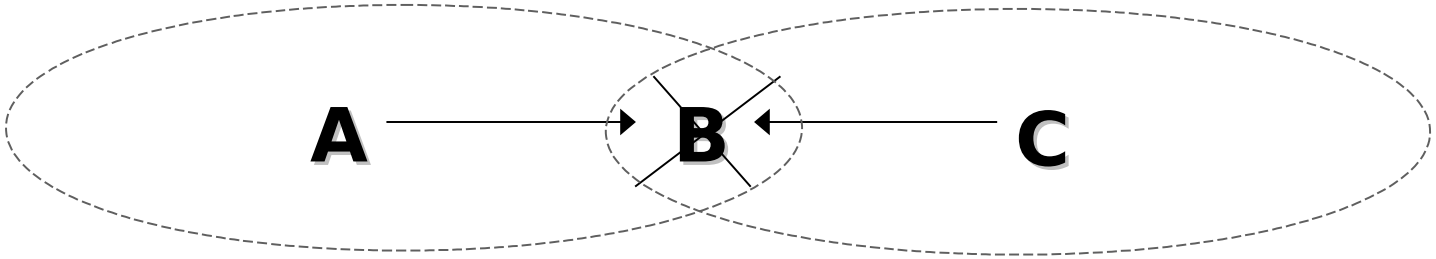


Carrier Sense Multiple Access (CSMA)

How it works (simplified)

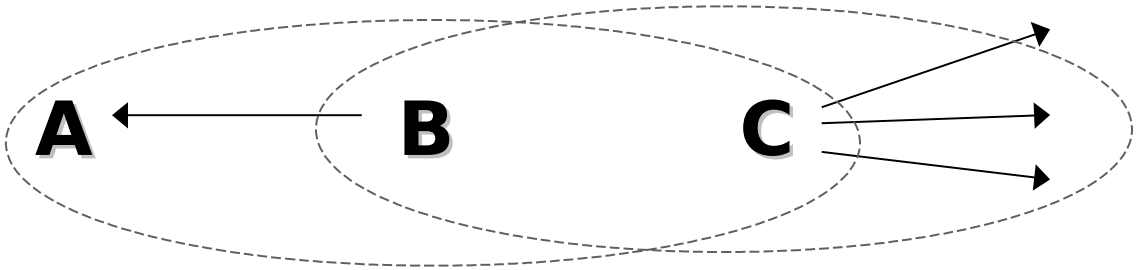
1. listen before transmitting to ensure the medium is idle
2. When the medium becomes idle, pick a random slot out of 32 possible slots and transmit
3. If the receiver does not ack the packet, back off for a short random interval and retransmit
4. Repeat steps 1-3 until receiver acks packet, or we exceed the number of retrials, and every time double the backoff interval

Hidden Terminal Problem



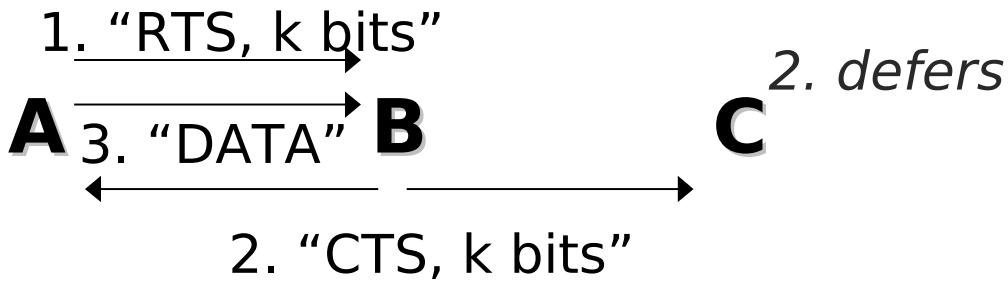
- Nodes are little less than a radio range apart
- CSMA: Node listen to determine medium is idle before transmitting
  - But, C can't hear A. So it will transmit while A is transmitting; COLLISION at B.
- CSMA is insufficient to detect all transmissions on the wireless medium
- The problem: collisions happen at the receiver, but carrier sense is performed by the sender

Exposed Terminal Problem



- B wants to deliver a packet to A
- C's transmission would not cause collision at A, but C will refuse to transmit while B is transmitting to A
- Exposed terminal reduces efficiency
- Problem is caused by: collisions happen at the receiver, but carrier-sense is performed by the sender

RTS (request to send) and CTS (clear to send)



- How does RTS-CTS work?
  - Node that hears the RTS defers until the transmission of the CTS
  - Node that hears the CTS defers until the transmission of data
- Solves the hidden terminal problem *[why?]*
- Solves the exposed terminal problem *[why?]*
- RTS and CTS can still collide at their receivers but is less likely since they are shorter

Bit Rate

- Capacity = BW log (Signal Power at Rx/Noise)
- Transmission bit rate has to be less than capacity otherwise receiver can't decode
- How to pick the bit rate?
  - 802.11 has a few options for bit rates (e.g., 6 Mb/s, 9 Mb/s, …, 54Mb/s)
  - Transmitter tries different bit rates and picks the bit rate that achieves the highest throughput (after accounting for packet loss)

Summary

- Carrier Sense Multiple Access (CSMA)
- Hidden terminal
- Exposed terminal
- RTS and CTS
- Bit rates

Video Demo
http://www.youtube.com/watch?v=sbFZPPC7REc