CSC2209
Computer Networks

Wireless MAC Protocols + Routing

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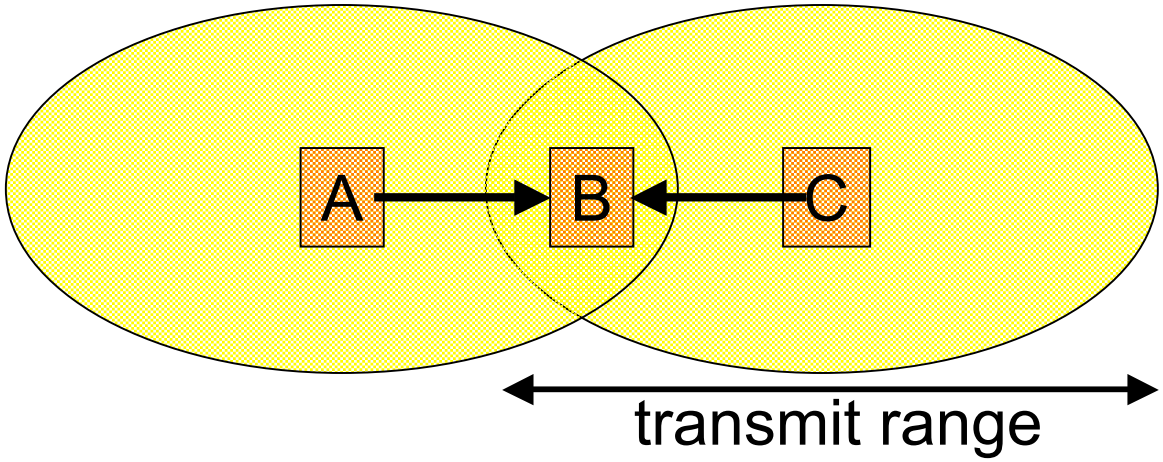
1. Wireless Communication

Wireless is more complicated than wired …

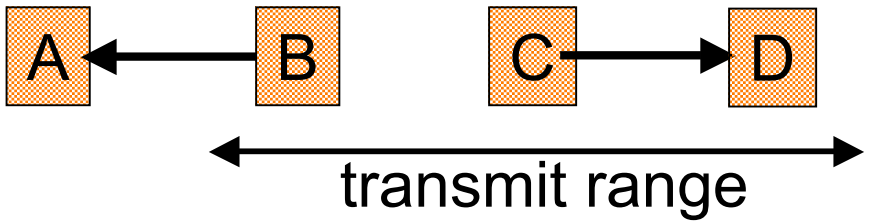
1. Cannot detect collisions
   - Transmitter swamps co-located receiver
2. Different transmitters have different coverage areas
   - Asymmetries lead to hidden/exposed terminal problems

Hidden Terminals

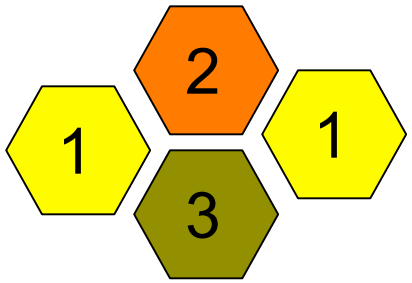


- A and C can both send to B but can't hear each other
  - A is a hidden terminal for C and vice versa
- CSMA will be ineffective – want to sense at receiver

Exposed Terminals



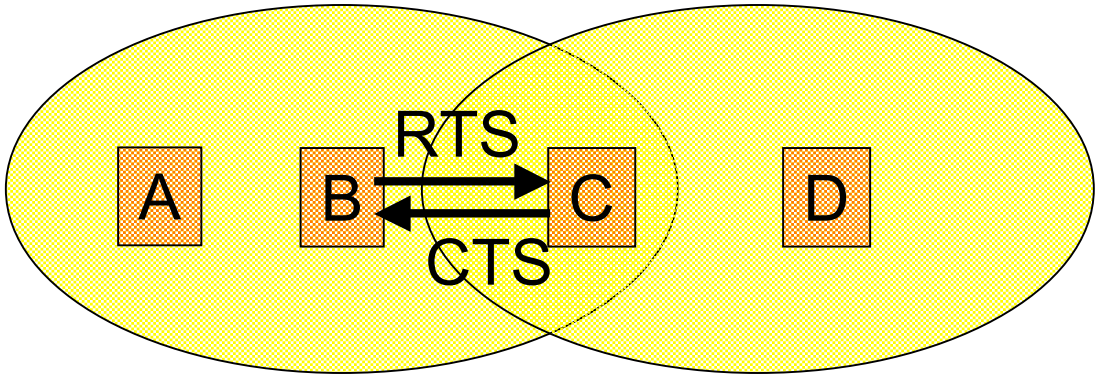
- B, C can hear each other but can safely send to A, D
- Compare to spatial reuse in cell phones:



CSMA with Collision Avoidance

- Since we can't detect collisions, we avoid them
  - CSMA/CA as opposed to CSMA/CD
  - Not greedy like Ethernet
- CS: listen before transmitting.
  - When medium busy, choose random backoff interval
  - Wait for that many idle timeslots to pass before sending
- CA: transmit short "jamming" signal before sending frame
  - essentially reserves medium, let's others know your intent to transmit
- Collisions can be inferred
  - Use CRC and ACK from receiver to infer "no collision"
  - on collision, binary exponential backoff like Ethernet

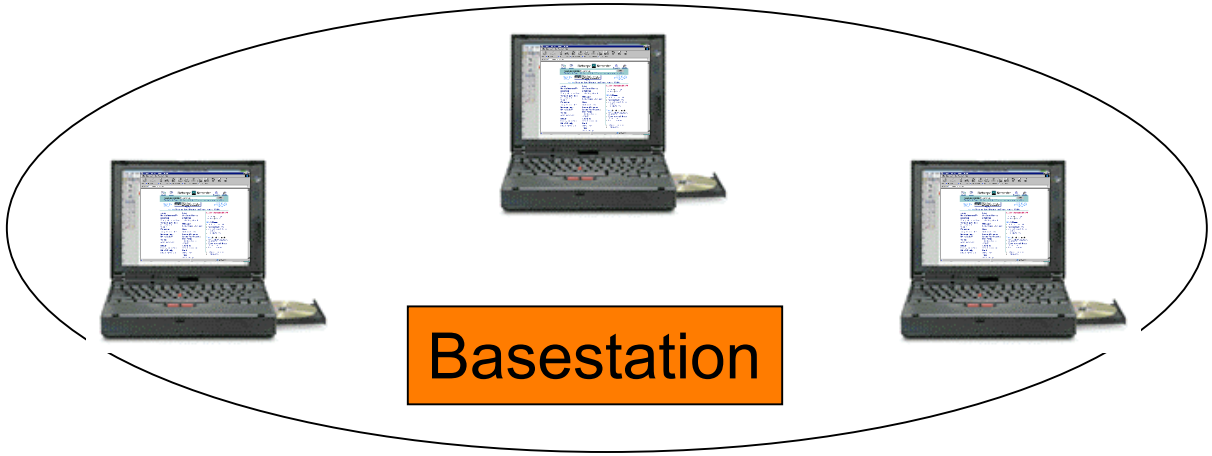
RTS / CTS Protocols (MACA)



1. B stimulates C with Request To Send (RTS)
2. A hears RTS and defers to allow the CTS
3. C replies to B with Clear To Send (CTS)
4. D hears CTS and defers to allow the data
5. B sends to C

802.11 Wireless LANs

- Emerging standard with a bunch of options/features …



- Wireless plus wired system or pure wireless (ad hoc)
- Avoids collisions (CSMA/CA (p-persistence), RTS/CTS)

802.11 Standards out there

- 802.11b
  - 2.4GHz unlicensed radio spectrum
  - Up to 11Mbps
- 802.11a
  - 5GHz range
  - Up to 54Mbps
- 802.11g
  - 2.4 GHz
  - Up to 54Mbps
- All use CSMA/CA for multiple access
- Options RTS/CTS
- All have base-station and ad-hoc network versions

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- Next contention its chances of winning are halved
- Similar to the Ethernet

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  - Include a counter back-off

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  - Link-layer ACKs (does this violate E2E argument?)

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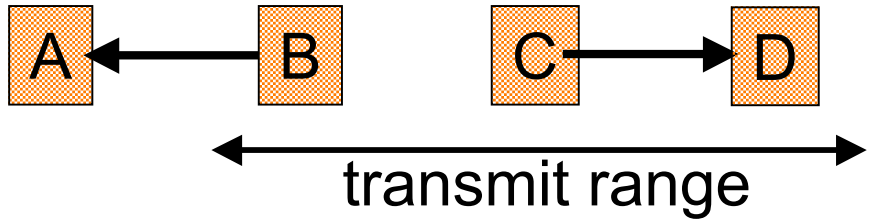
- Can we solve this?



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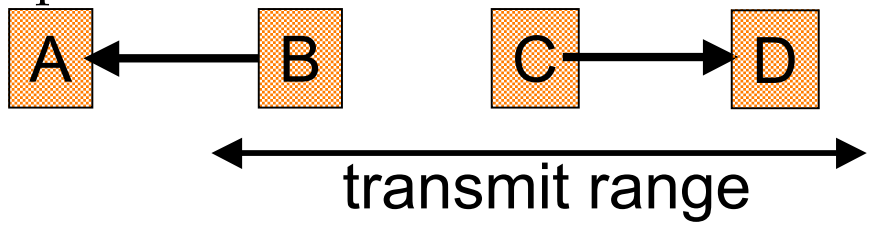

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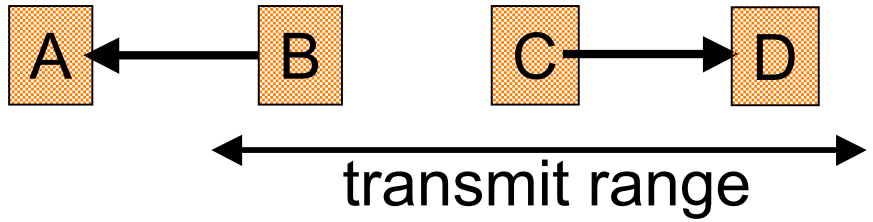
- Solution:
  - DS packet from B + ACK packet from B



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  - p-persistance

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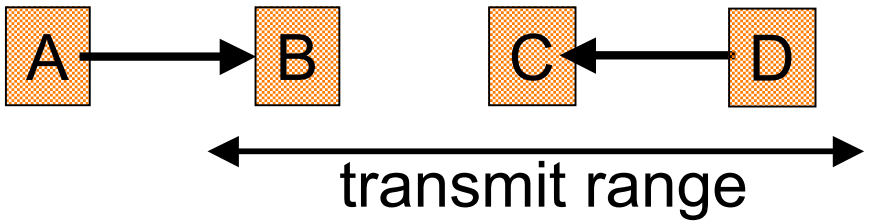

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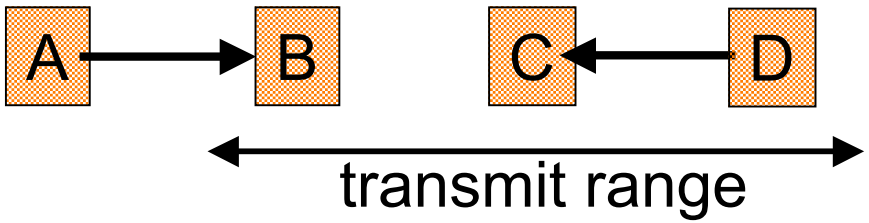
- A does not hear the DS to synchronize its RTS
  - Leads to unfairness

- Solution, B signals to A to send the RTS with an RRTS



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- Not really
  - If data size < RTS size (think TCP ACKs here!!!)

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  - Can hidden terminals problem occur on the downlink?
    - Not really, typically nearby APs are configured to operate on different channels
  - Can hidden terminals problem occur on the uplink?
    - Yes, but typically to send small packets (TCP ACKs) that excerbate the inefficiency of RTS/CTS

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- What other approaches would you investigate?
  - Directional antennas
  - TDMA/CDMA/FDMA