ECE 463
Introduction to Computer Networks

Lecture: 802.11/WiFi

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Wireless Technologies

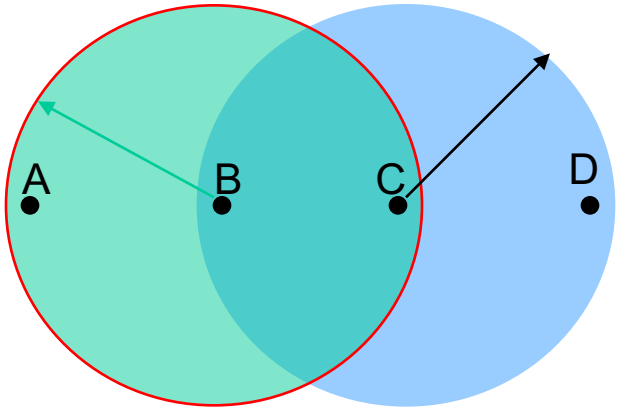
- Bluetooth (802.15.1):
  - Typical settings: 10 m, 2.1 Mbps (shared)
  - E.g. use: linking peripherals to notebook computer
- WiFi (802.11)
  - Typically 100m range, several tens or more Mbps
- Cellular
  - 4G/LTE: A few Mbps, 50-60 milliseconds or so
  - Higher bandwidth on the horizon with 5G]

802.3 Ethernet vs 802.11 Wi-Fi

- Ethernet: one shared “collision” domain
  - A node on Ethernet receives every other node’s transmission
- 802.11: radios have small range compared to overall system:
  - Not all nodes may hear a transmission
  - Collisions are local and at receiver, not sender.
- CSMA/CA not CSMA/CD
  - collision avoidance, not collision detection

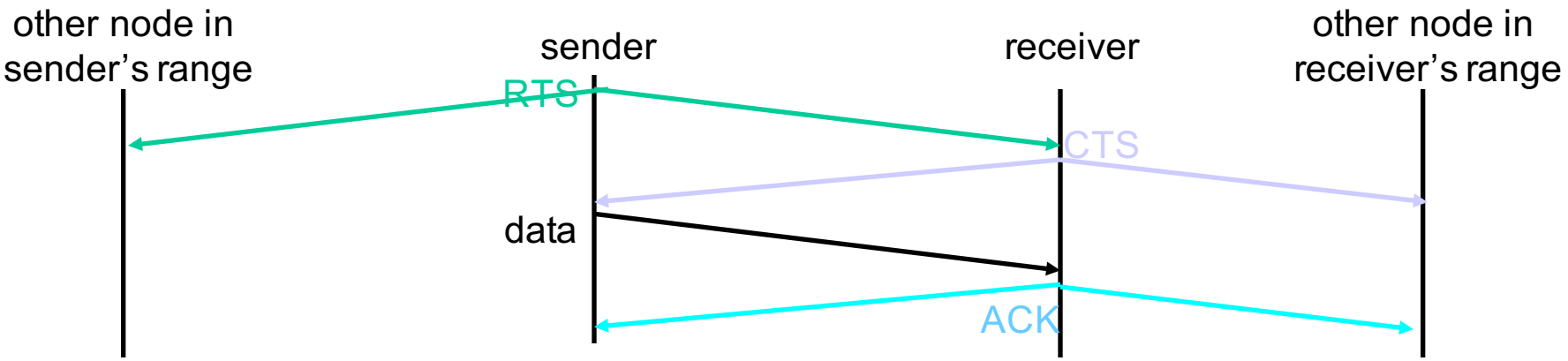
Collision Avoidance: The Problems

- Reachability is not transitive: if A can reach B, and B can reach C, it doesn't mean that A can reach C



- Hidden nodes: A and C send a packet to B; neither A nor C will detect the collision!
- Exposed node: B sends a packet to A; C hears this and decides not to send a packet to D (despite the fact that this will not cause interference)!

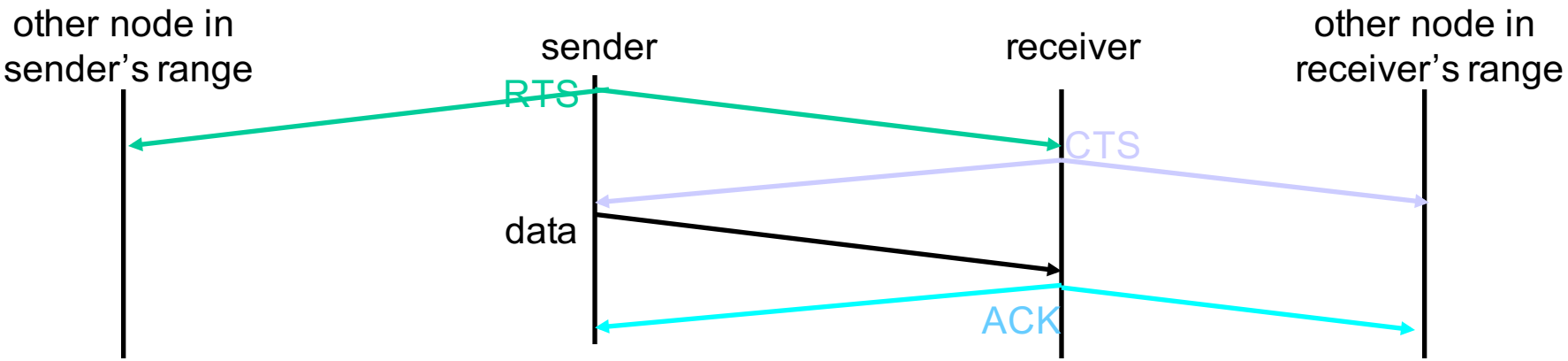
Multiple Access with Collision Avoidance (MACA)



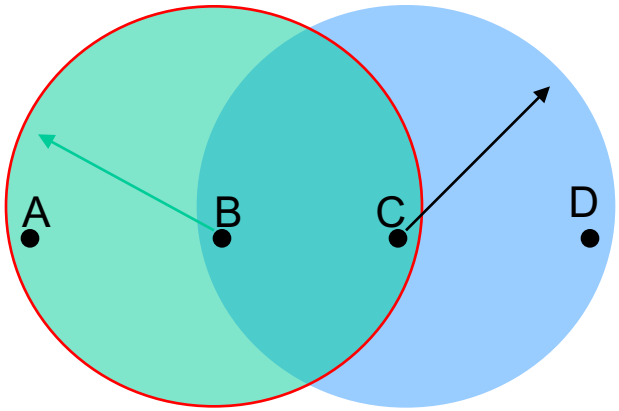
- Before every data transmission
  - Sender sends a Request to Send (RTS) frame containing the length of the transmission
  - Receiver respond with a Clear to Send (CTS) frame
  - Sender sends data
  - Receiver sends an ACK; now another sender can send data
- When sender doesn't get a CTS back, it assumes collision

Other Nodes

- When you hear a CTS, you keep quiet until scheduled transmission is over (length of DATA)
- If you hear RTS, but not CTS, you can send

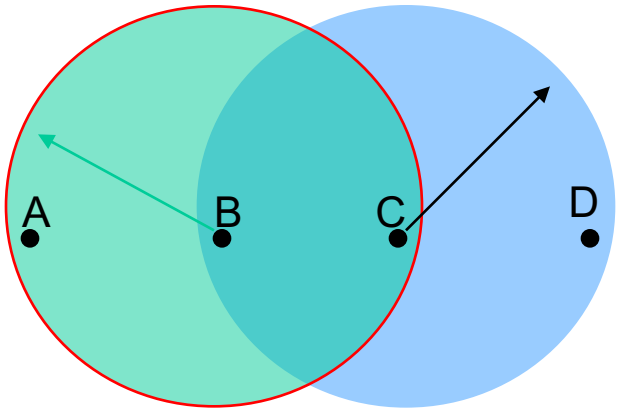


Avoiding Hidden Terminal



- Original Problem: A and C send a packet to B; neither A nor C will detect the collision
- How it is avoided:
  - Lets say A ‘s RTS reaches B first. B sends CTS to A. C hears the CTS and does not transmit for some time.
  - If A and C both send RTS close together resulting in a collision, neither will get CTS: both will retransmit after random time interval. Ok because RTS frames much smaller than data.

Avoiding Exposed Terminal



Original Problem:

- B sends a packet to A; C hears this and decides not to send a packet to D

How it is avoided:

- B sends RTS to A, A sends CTS to B.
- C hears the RTS from B, but does not hear the CTS.
- Goes ahead and transmits the data.

WiFi in practice

- Previous discussion assumes ad-hoc environment where nodes can transmit to each other directly
- In practice, moved to a base station model
- Nodes associate with base stations that transmits data on behalf of the node