

Introduction to Computer Networks

Wireless Multiple Access (§4.2.5, 4.4)



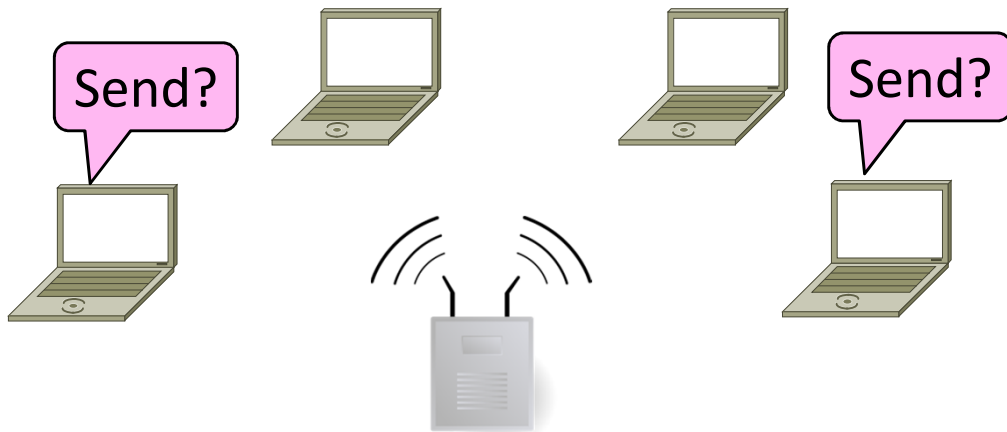
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Topic

- How do wireless nodes share a single link? (Yes, this is WiFi!)
 - Build on our simple, wired model



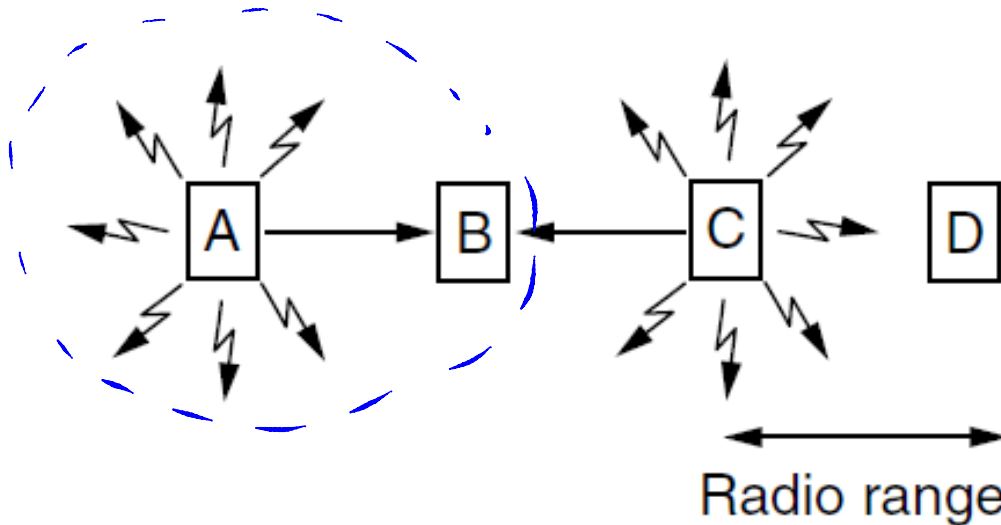
Wireless Complications

- Wireless is more complicated than the wired case (Surprise!)
 1.  Nodes may have different areas of coverage – doesn't fit Carrier Sense »
 2.  Nodes can't hear while sending – can't Collision Detect »



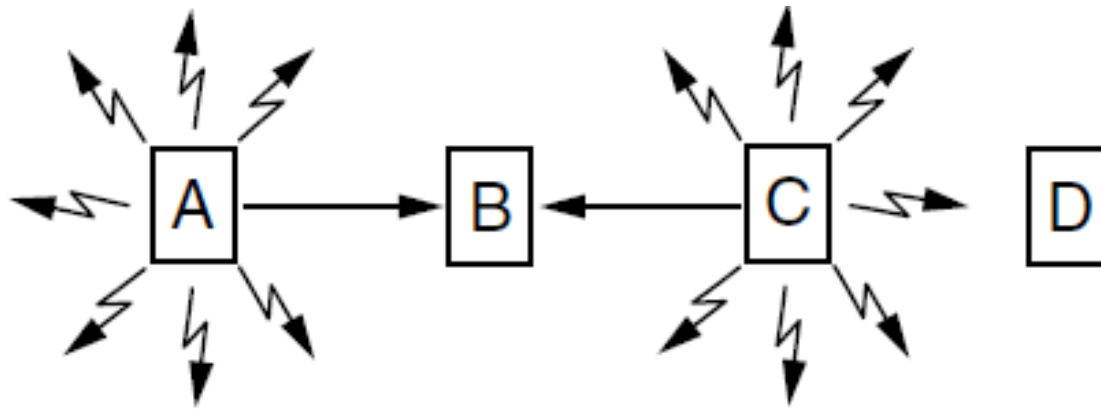
Different Coverage Areas

- Wireless signal is broadcast and received nearby, where there is sufficient SNR



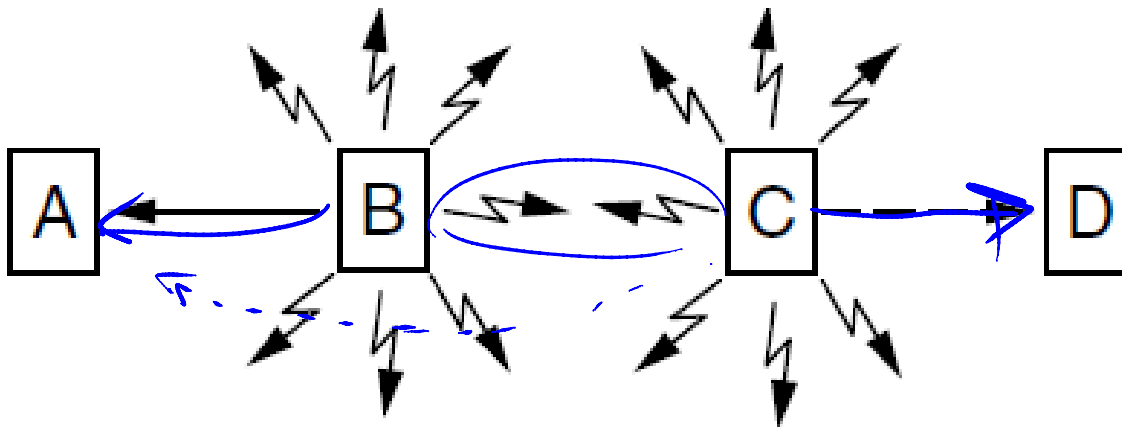
Hidden Terminals

- Nodes A and C are hidden terminals when sending to B
 - Can't hear each other (to coordinate) yet collide at B
 - We want to avoid the inefficiency of collisions



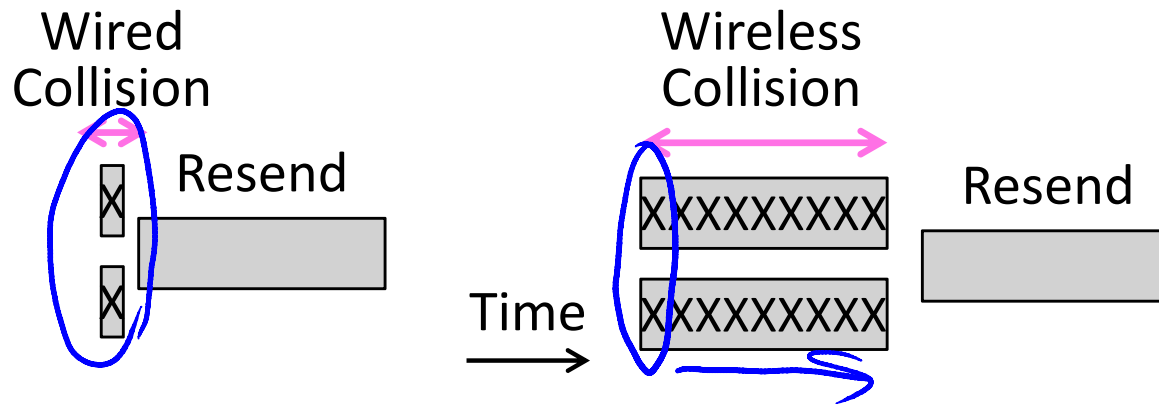
Exposed Terminals

- B and C are exposed terminals when sending to A and D
 - Can hear each other yet don't collide at receivers A and D
 - We want to send concurrently to increase performance



Nodes Can't Hear While Sending

- With wires, detecting collisions (and aborting) lowers their cost
- More wasted time with wireless



Possible Solution: MACA

- MACA uses a short handshake instead of CSMA (Karn, 1990)
 - 802.11 uses a refinement of MACA (later)
- Protocol rules:
 - 1. A sender node transmits a RTS (Request-To-Send, with frame length)
 - 2. The receiver replies with a CTS (Clear-To-Send, with frame length)
 - 3. Sender transmits the frame while nodes hearing the CTS stay silent
 - Collisions on the RTS/CTS are still possible, but less likely

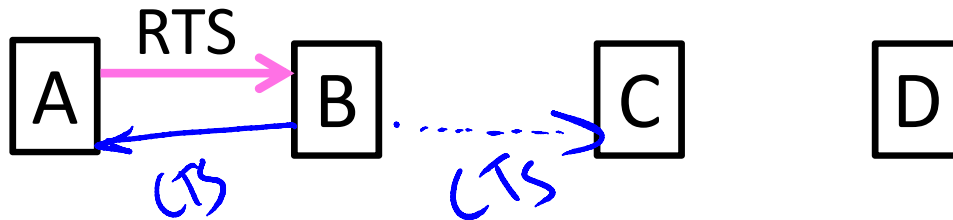
MACA – Hidden Terminals

- $A \rightarrow B$ with hidden terminal C
 1. A sends RTS, to B



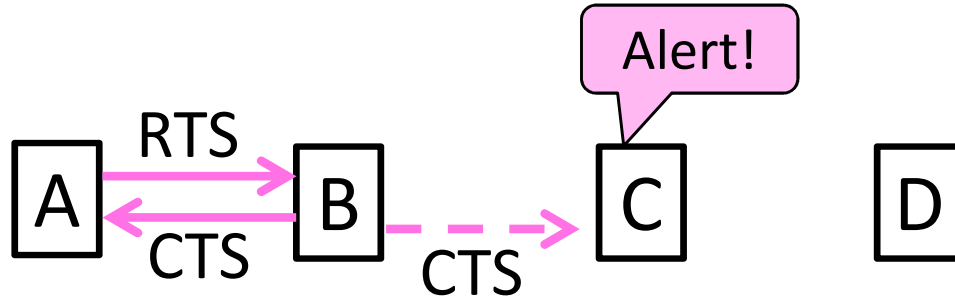
MACA – Hidden Terminals (2)

- $A \rightarrow B$ with hidden terminal C
 2. B sends CTS, to A, and C too



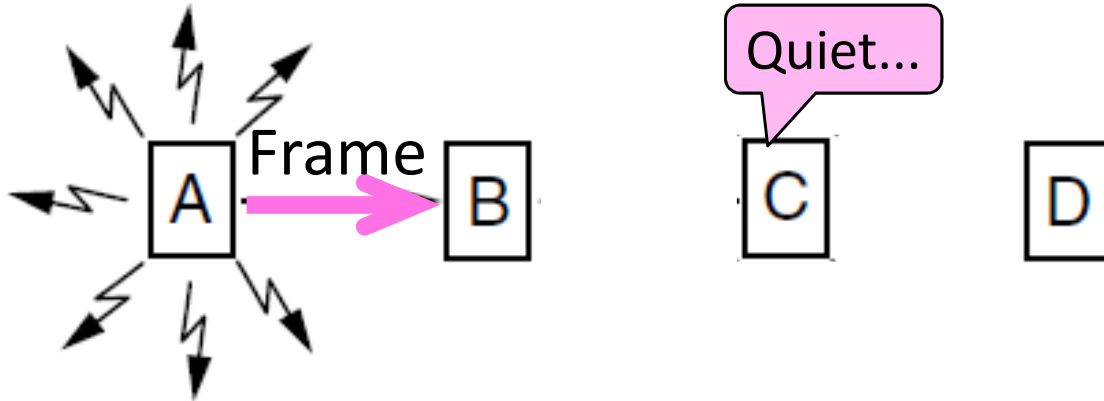
MACA – Hidden Terminals (3)

- $A \rightarrow B$ with hidden terminal C
 2. B sends CTS, to A, and C too



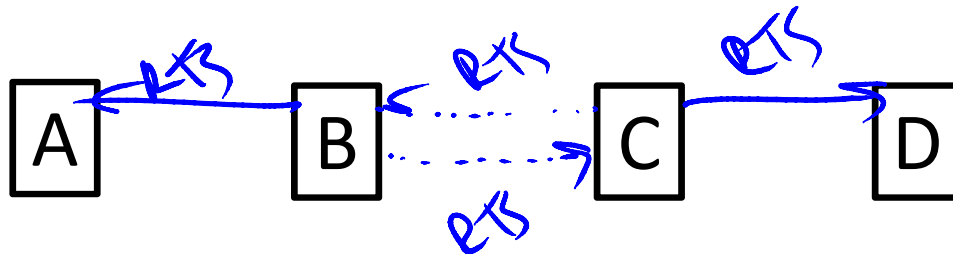
MACA – Hidden Terminals (4)

- $A \rightarrow B$ with hidden terminal C
 3. A sends frame while C defers



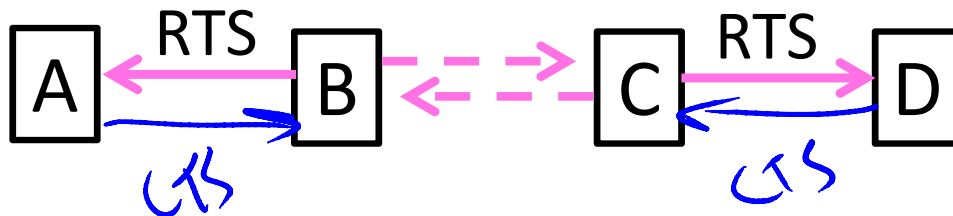
MACA – Exposed Terminals

- $B \rightarrow A$, $C \rightarrow D$ as exposed terminals
 - B and C send RTS to A and D



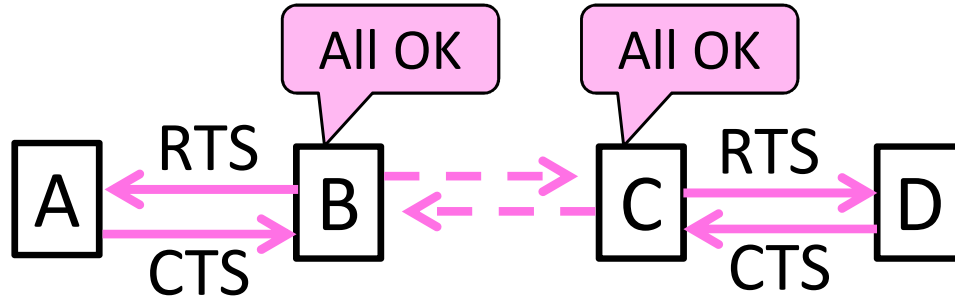
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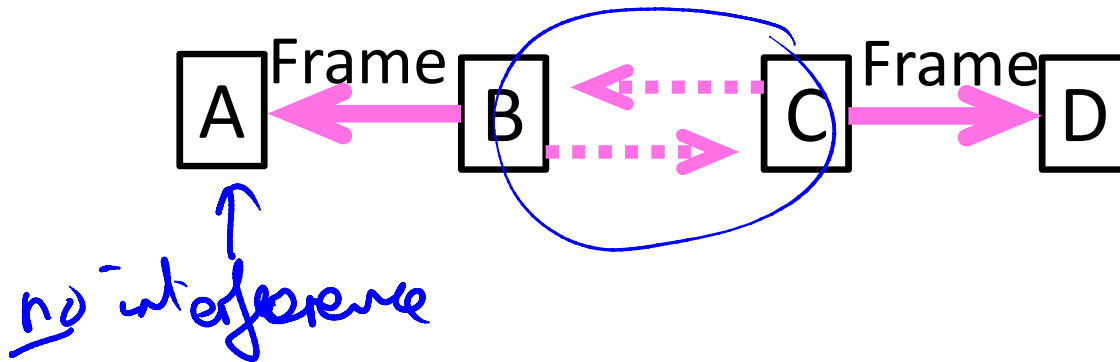
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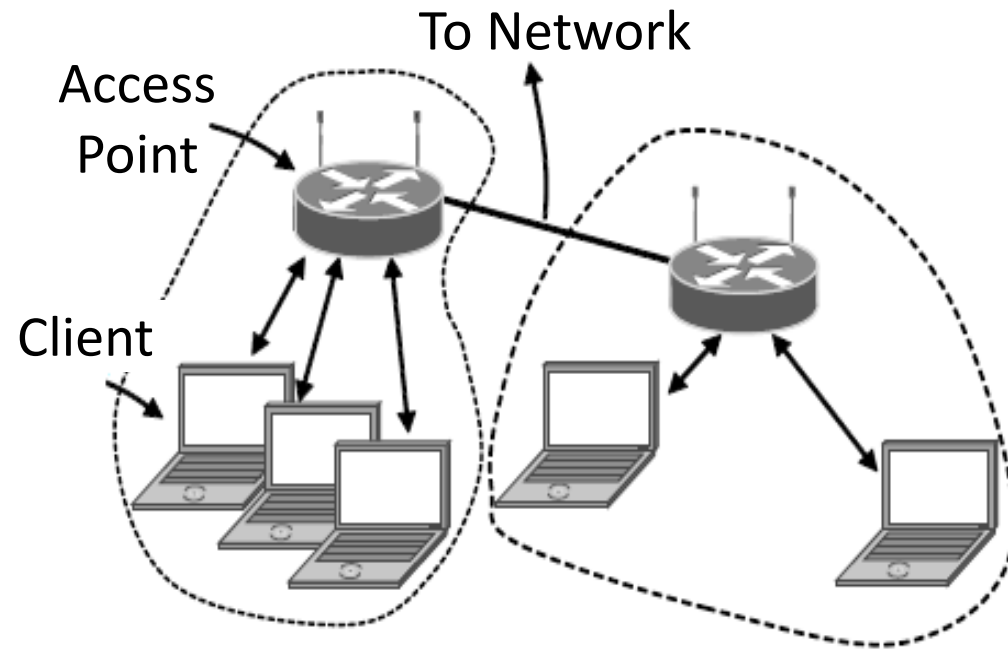
MACA – Exposed Terminals (4)

- $B \rightarrow A$, $C \rightarrow D$ as exposed terminals
 - A and D send CTS to B and C



802.11, or WiFi

- Very popular wireless LAN started in the 1990s
- Clients get connectivity from a (wired) AP (Access Point)
- It's a multi-access problem 😊
- Various flavors have been developed over time
 - Faster, more features

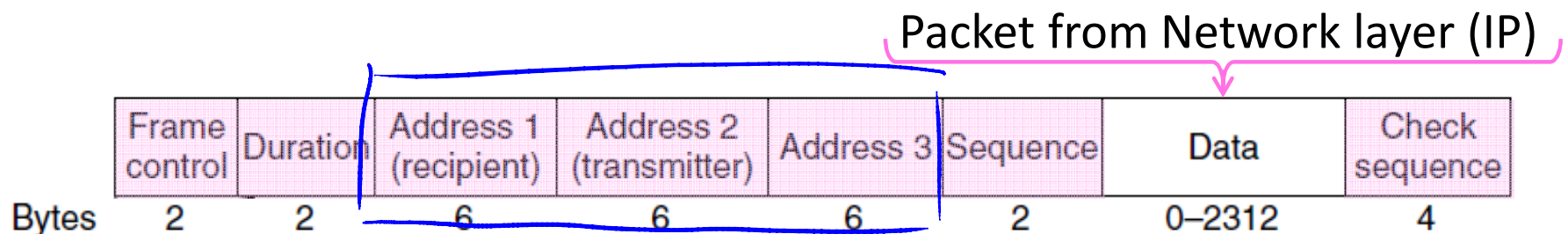


802.11 Physical Layer

- Uses 20/40 MHz channels on ISM bands
 - 802.11b/g/n on 2.4 GHz
 - 802.11 a/n on 5 GHz
- OFDM modulation (except legacy 802.11b)
 - Different amplitudes/phases for varying SNRs
 - Rates from 6 to 54 Mbps plus error correction
 - ~~–~~ 802.11n uses multiple antennas; see “802.11 with Multiple Antennas for Dummies”

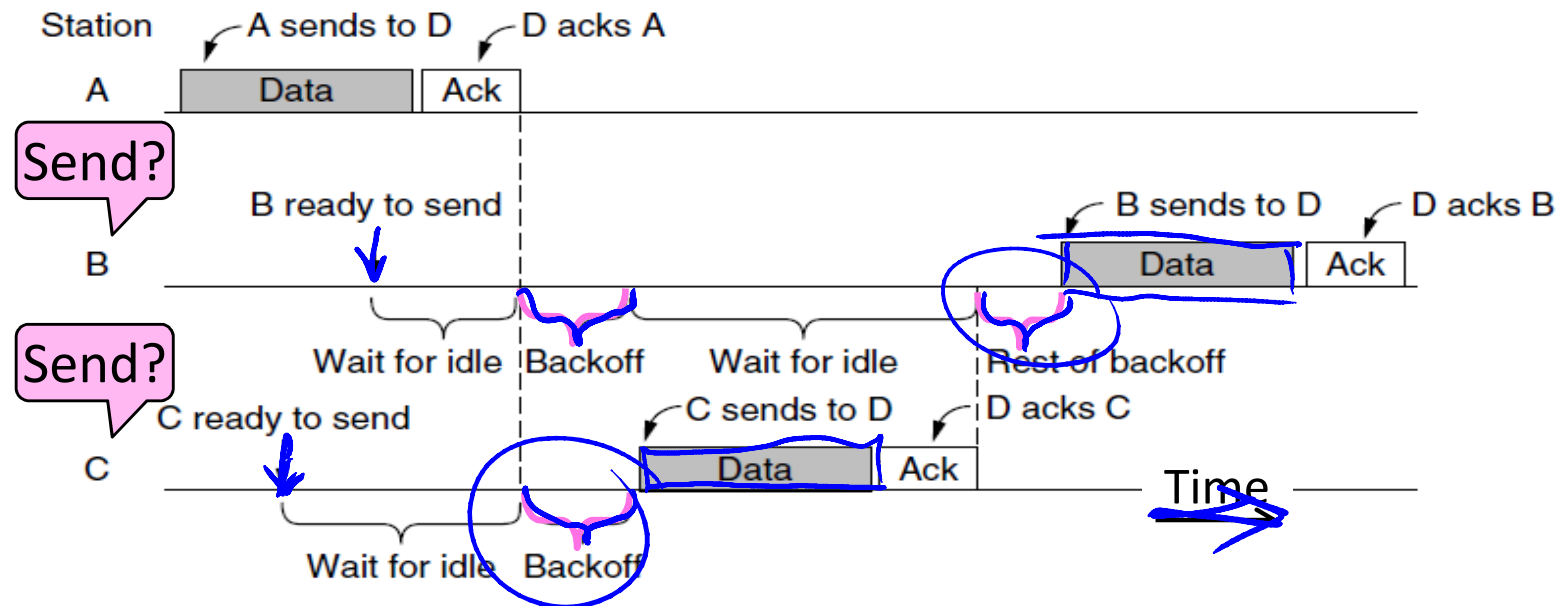
802.11 Link Layer

- Multiple access uses CSMA/CA (next); RTS/CTS optional
- Frames are ACKed and retransmitted with ARQ
- Funky addressing (three addresses!) due to AP
- Errors are detected with a 32-bit CRC
- Many, many features (e.g., encryption, power save)



802.11 CSMA/CA for Multiple Access

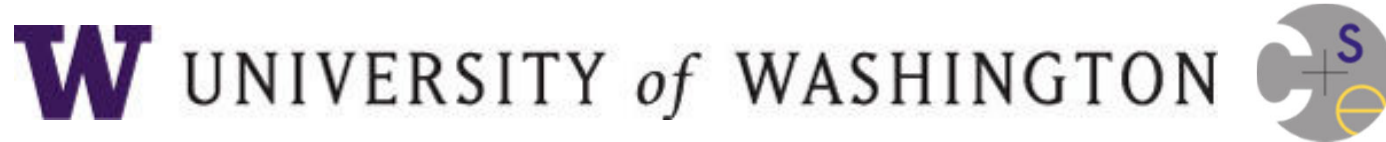
- Sender avoids collisions by inserting small random gaps
 - E.g., when both B and C send, C picks a smaller gap, goes first



The Future of 802.11 (Guess)

- Likely ubiquitous for Internet connectivity
 - Greater diversity, from low- to high-end devices
- Innovation in physical layer drives speed
 - And power-efficient operation too
- More seamless integration of connectivity
 - Too manual now, and limited (e.g., device-to-device)

END



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