WiFi Networks: IEEE 802.11b Wireless LANs

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Background (1 of 2)

- In many respects, the IEEE 802.11b wireless LAN (WLAN) standard is similar to that for classic IEEE 802.3 (Ethernet) LANs
- Similarities:
  - LAN with limited geographic coverage
  - multiple stations, with 48-bit MAC addresses
  - shared transmission medium (broadcast technology)
  - CSMA-based Medium Access Control protocol
  - comparable data rates (11 Mbps vs 10 Mbps)

Background (2 of 2)

- But there are also many distinct differences:
  - wireless (air interface) versus wired (coax)
  - wireless propagation environment (multipath)
  - higher error rate due to interference, etc.
  - successful frames are ACKed by receiver
  - mobile stations versus fixed stations
  - half-duplex versus full-duplex operation
  - “hidden node” and “exposed node” problems
  - potential asymmetries of links
  - CSMA/CA versus CSMA/CD
  - multiple data transmission rates (1, 2, 5.5, 11)

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Some WiFi Features

- Infrastructure mode vs “ad hoc” mode
- Access Point (AP) sends “beacon frames”
  - Mobiles choose AP based on signal strength
- Multiple channel access protocols supported
  - CSMA/CA (DCF); PCF; RTS/CTS
- MAC-layer can provide error control, retransmission, rate adaptation, etc.
- Direct Sequence Spread Spectrum (DSSS)
  - signal spread across 14 22-MHz channels

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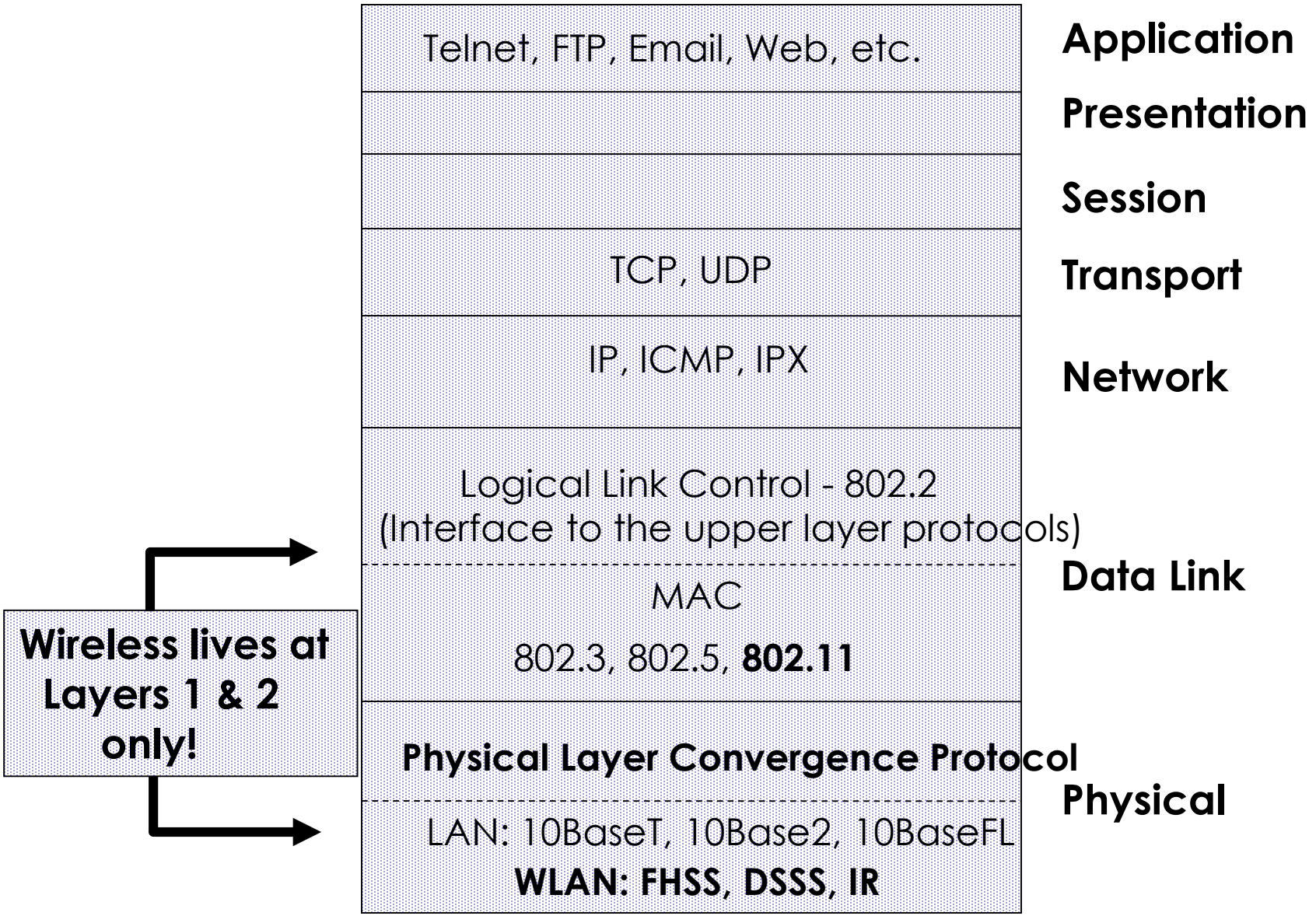
Where Does Wireless RF Live?

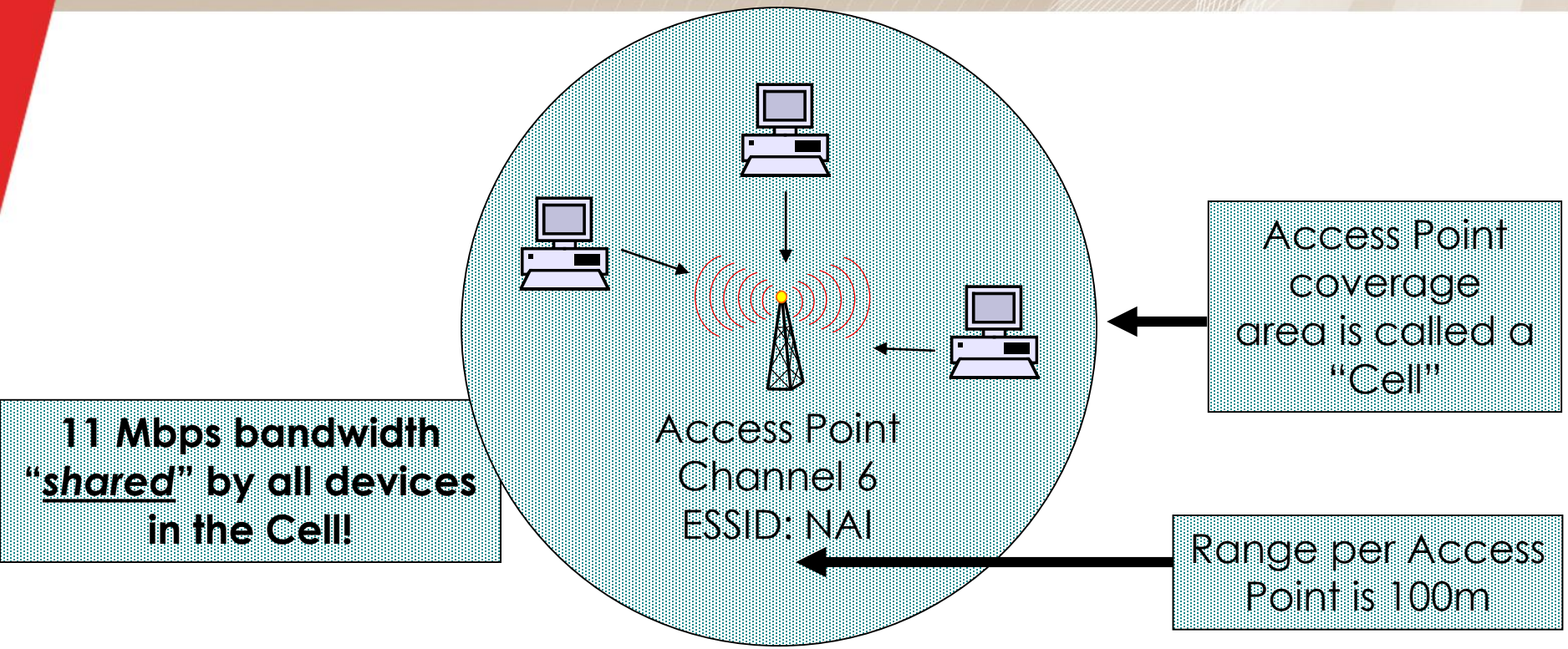
ISM (Industrial, Scientific, Medical) band

902-928 MHz	2400-2483.5 MHz	5725-5850 MHz
Old Wireless	802.11/802.11b,g	802.11a
	Bluetooth	
	Cordless Phones	
	Home RF	
	Baby Monitors	
	Microwave Ovens	

Protocol Stack View



Wireless Cells



- In Canada/US, there are *eleven* 802.11 channels
- Only channels 1, 6 and 11 are *non-overlapping*
- Computers can roam between cells

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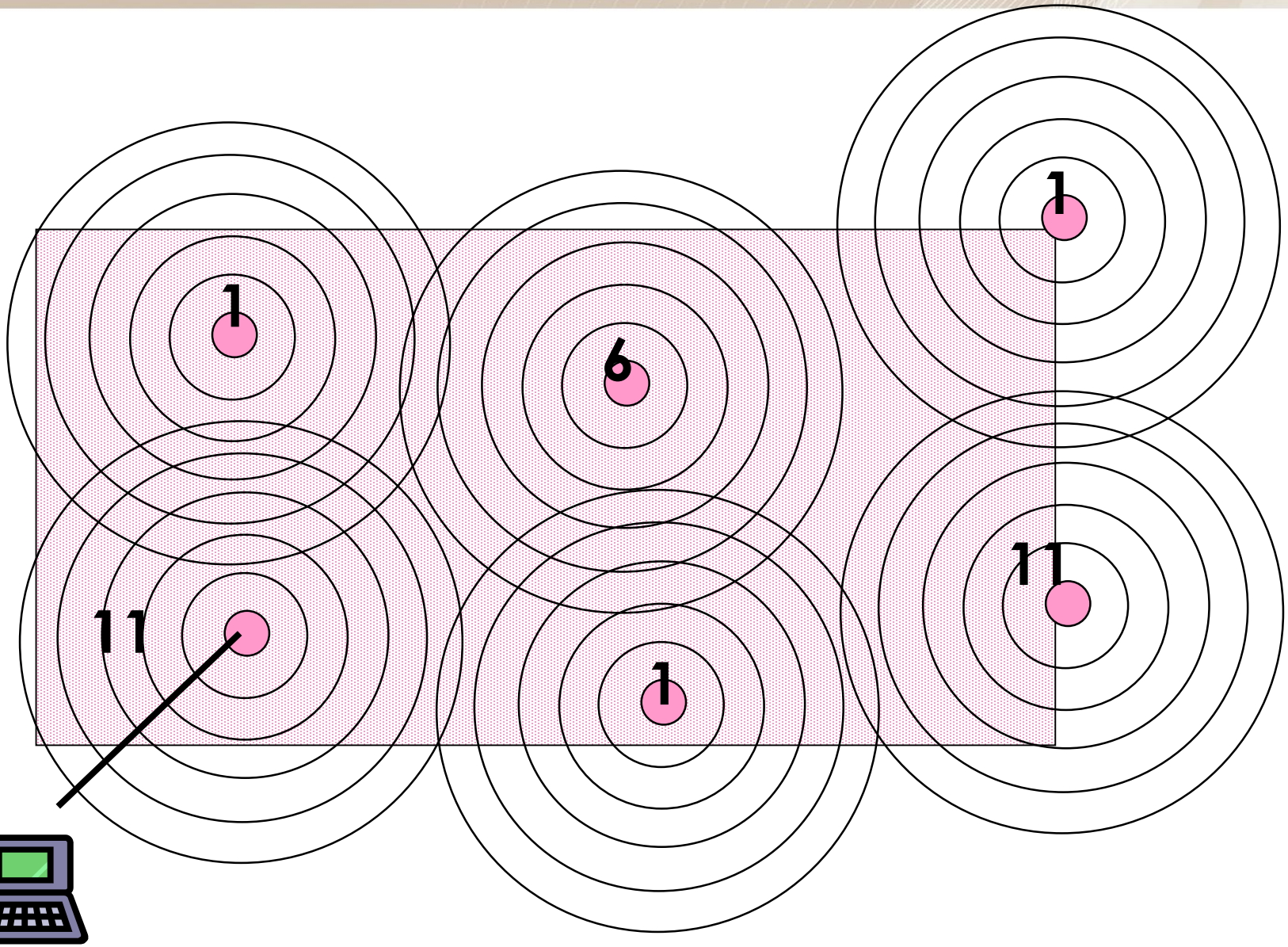
Multiple Wireless APs



Medium Access Control (MAC)

Carrier Sense Multiple Access with *Collision Avoidance*

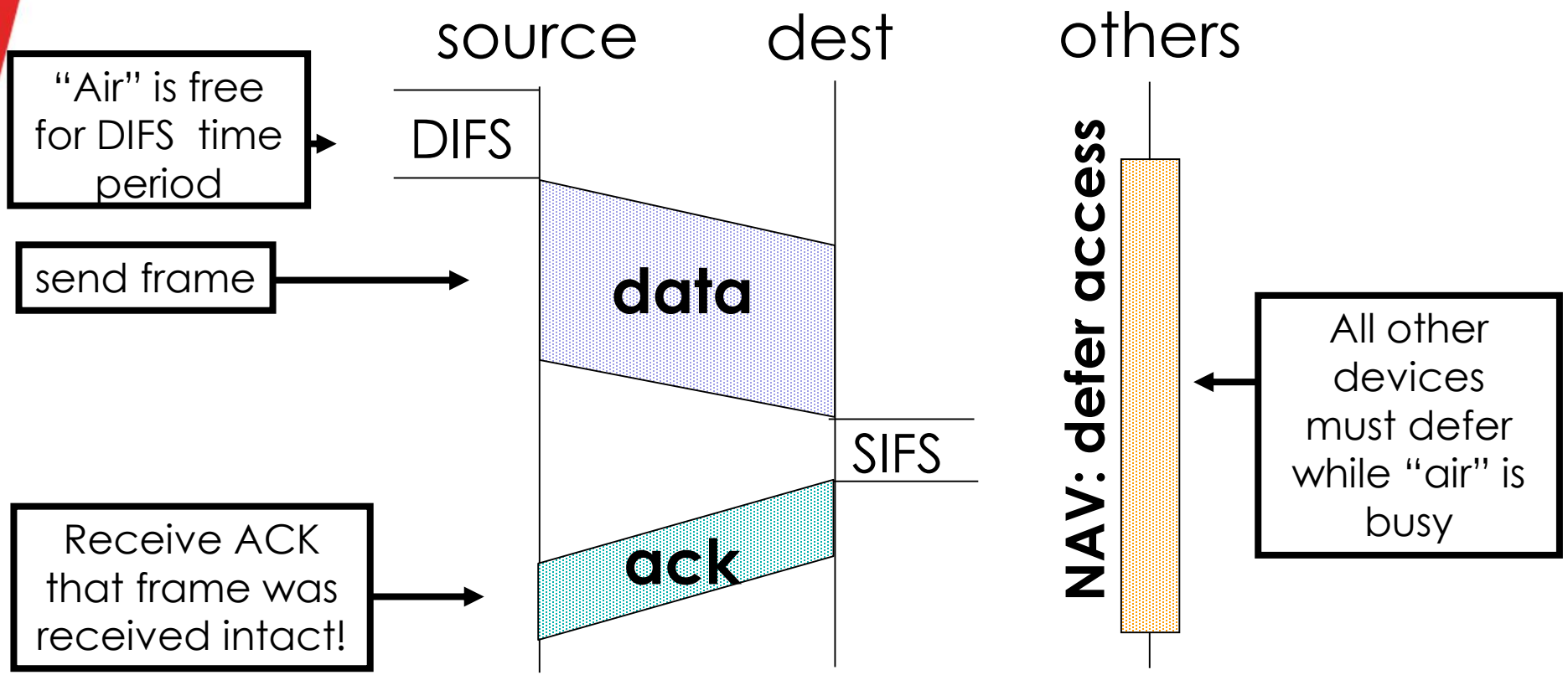
How CSMA-CA works:

- Device wanting to transmit senses the medium (Air)
- If medium is busy - defers
- If medium is free for certain period (DIFS) - *transmits*

Latency can increase if "air" is very busy! Device has hard time finding "open air" to send frame!

* DIFS - Distributed Inter-Frame Space (approx 128 µs)

MAC Protocol (Cont'd)



- **Every frame is acked - except broadcast and multicast!**

* SIFS - Short Inter-Frame Space (approx 28 μs)

MAC-Layer Retransmission

- If no ACK received “right away”, then the sender retransmits the frame again at the MAC layer
  - indicates frame (or ACK) was lost/corrupted
  - very short timeout (e.g., 1 msec)
  - exponential backoff (doubling) if repeated loss
- Typically recovers before TCP would notice
- Max retransmission limit (e.g., 8)
- May do MAC-layer rate adaptation or frame fragmentation if channel error rate is high

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Other MAC Protocols Supported

- Point Coordination Function (PCF)
  - AP polls stations in turn to see if frames to send
  - useful for real-time traffic
- Request-To-Send/Clear-To-Send (RTS/CTS)
  - reservation-based approach (ask permission)
  - useful for very large frames
  - useful for solving the “hidden node” problem
  - request asks for clearance (permission) to send
  - request also indicates time required for transmit

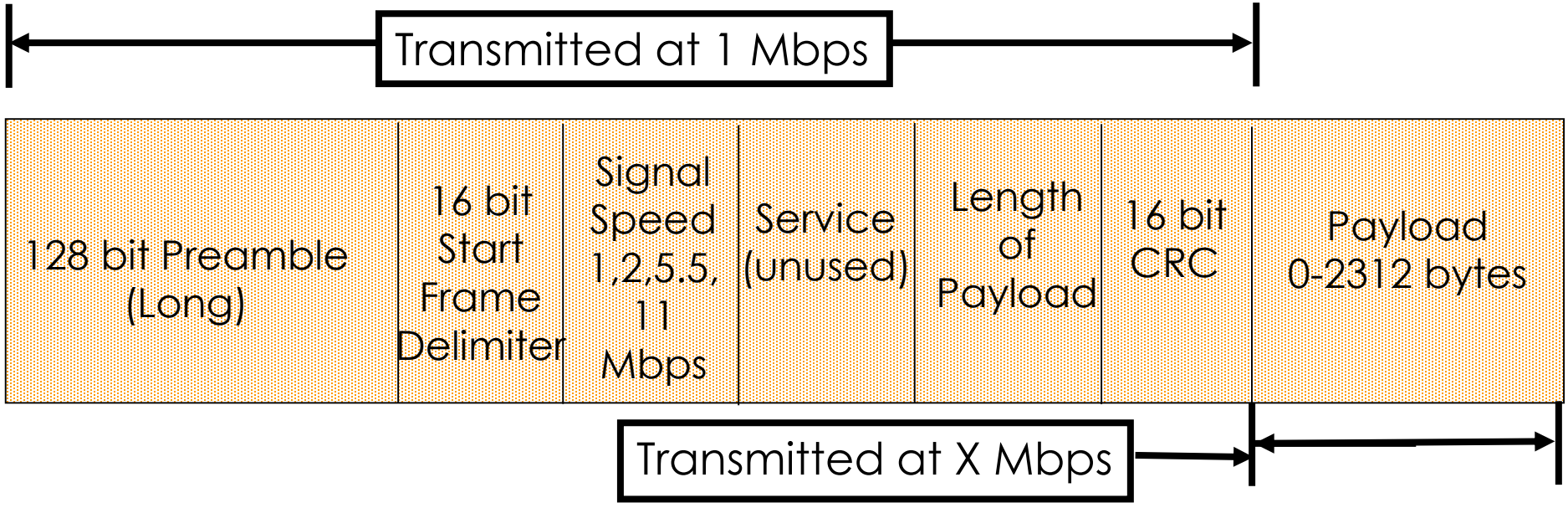
Frame Formats

- Two frame formats available:
  - long preamble
  - short preamble
- Configuration option for NIC and AP
- Variable-size frames (max 2312 data bytes)
- 16-bit Cyclic Redundancy Code (CRC) for error checking of frames

Frame Format (Long Preamble)

Long Preamble = 144 bits

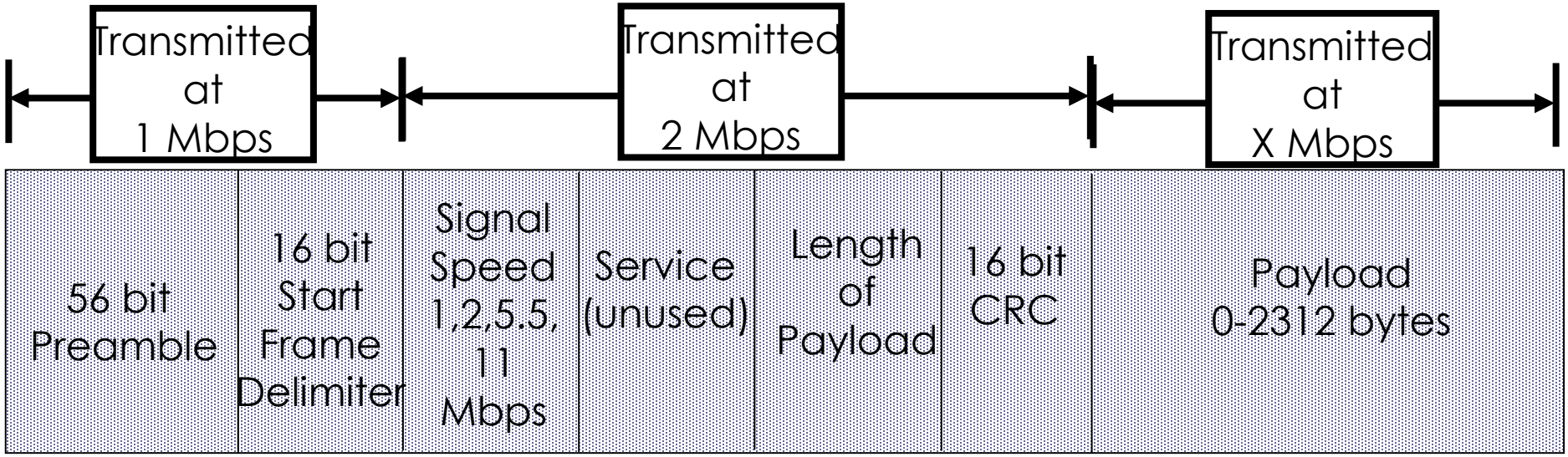
- Interoperable with older 802.11 devices
- Entire Preamble and 48 bit PLCP Header sent at *1 Mb*



Frame Format (Short Preamble)

Short Preamble = 72 bits

- Preamble transmitted at 1 Mbps
- PLCP Header transmitted at 2 Mbps
- more efficient than long preamble



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Even More Features

- Power Management
  - mobile nodes can “sleep” to save power
  - AP will buffer frames until client requests them
  - AP can use virtual bitmap field in beacons to indicate which stations have data waiting
- Security
  - Wired Equivalent Privacy (WEP)
  - not very secure at all!

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Summary

- IEEE 802.11b (WiFi) is a wireless LAN technology that is rapidly growing in popularity
- Convenient, inexpensive, easy to use
- Growing number of “hot spots” everywhere
  - airports, hotels, bookstores, Starbucks, etc
- Many deployments now have IEEE 802.11g (54 Mbps) or IEEE 802.11a (also 54 Mbps)
- Some deployments have IEEE 802.11n (> 100 Mbps)
- U of C WLAN has about 1000 WiFi Access Points (APs)