

WIFI

CPSC 441 - Tutorial 13

Winter 2018

WHAT IS WIFI?

- Wi-Fi or WiFi: Technology for wireless local area networking with products based on the IEEE 802.11 standards, it doesn't include similar wireless technologies such as Bluetooth or Zigbee
- IEEE 802.11:
 - Initial speeds were 1 and 2 Mbps
 - IEEE modified the standard in 1999 to include 802.11a (54 Mbps) and 802.11b (11 Mbps). Incidentally, 802.11b equipment was available before 802.11a
 - 802.11ac (gigabit WiFi) was added in 2013

WIRED VS WIRELESS NETWORK

- IEEE 802.11 wireless LAN (WLAN) standard is similar to that of classic IEEE 802.3 in terms of:
 - 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)

WIRED VS WIRELESS NETWORK

- Distinct differences:
 - Wireless (air interface) versus wired (cable interface)
 - Wireless propagation environment (multipath)
 - Higher error rate due to interference, fading, etc.
 - Successful frames are ACKed by receiver
 - Mobile stations versus fixed stations
 - Half-duplex versus full-duplex operation

WIRED VS WIRELESS NETWORK

- “Hidden node” and “exposed node” problems (exposed node problem occurs when a node is prevented from sending packets to other nodes due to a neighboring transmitter.)
- Potential asymmetries of links
- CSMA/CA versus CSMA/CD
- Multiple data transmission rates (1, 2, 5.5, 11)

WIFI FEATURES

- Infrastructure mode vs ad hoc mode:
 - Communicate indirectly through a central place (an access point) or directly, one to the other
- Access Point (AP) sends “beacon frames” – all the information about the network (e.g. Timestamp, Capability information)
 - Mobiles choose AP based on signal strength

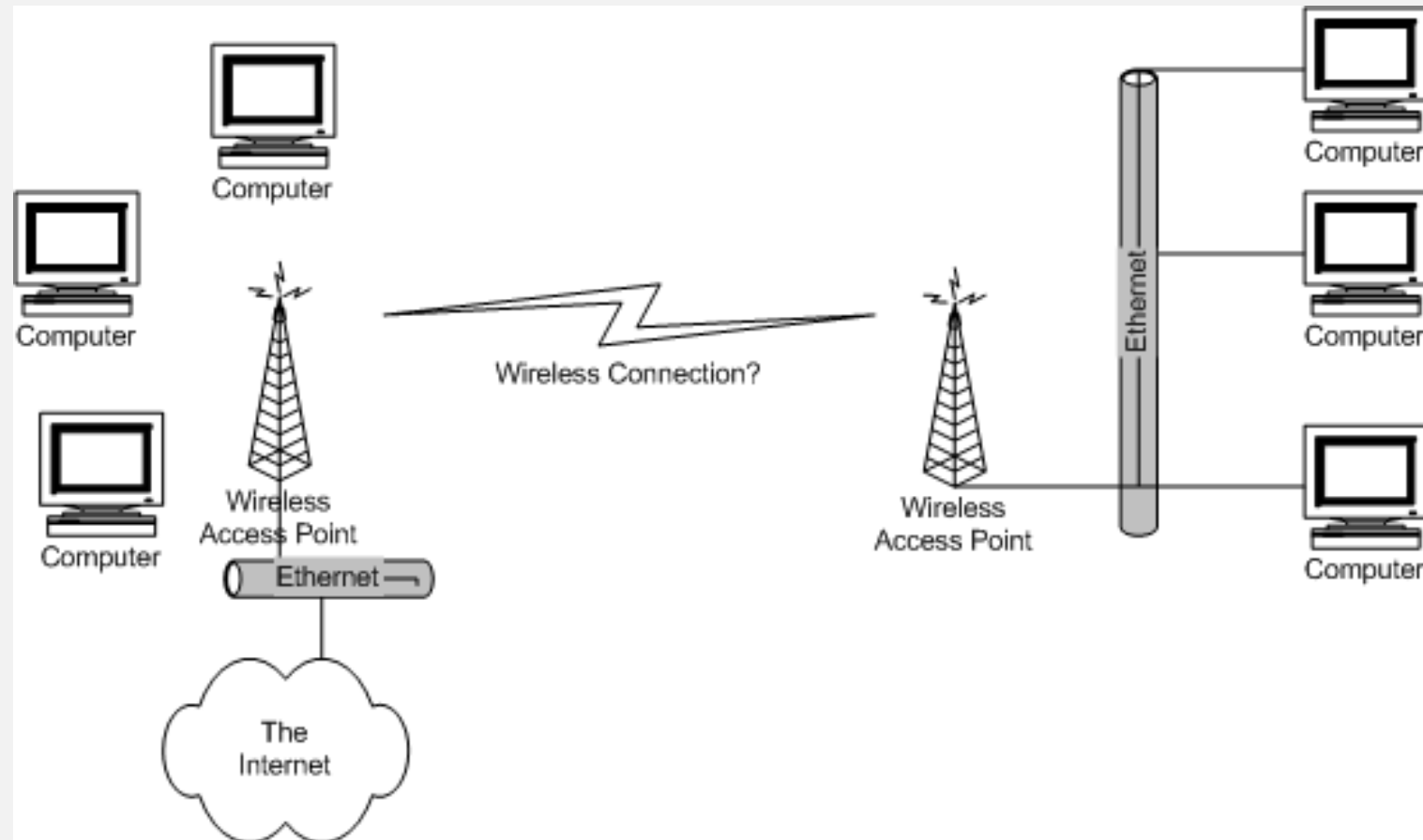
WIFI FEATURES

- Multiple channel access protocols supported
 - Distributed Coordination Function (DCF)
 - Carrier sense multiple access (CSMA-CA)
 - RTS/CTS(4-way handshaking) exchange (optional)
 - RTS stands for Request-to-Send
 - CTS stands for Clear-to-Send
 - Point Coordination Function (PCF)
 - Polled access through AP and distributed access

WIFI FEATURES

- MAC-layer can provide error control, retransmission, rate adaptation, etc.
- Direct Sequence Spread Spectrum (DSSS)
 - Modulation technique (used to reduce overall signal interference)

NETWORK LAYER ARCHITECTURE

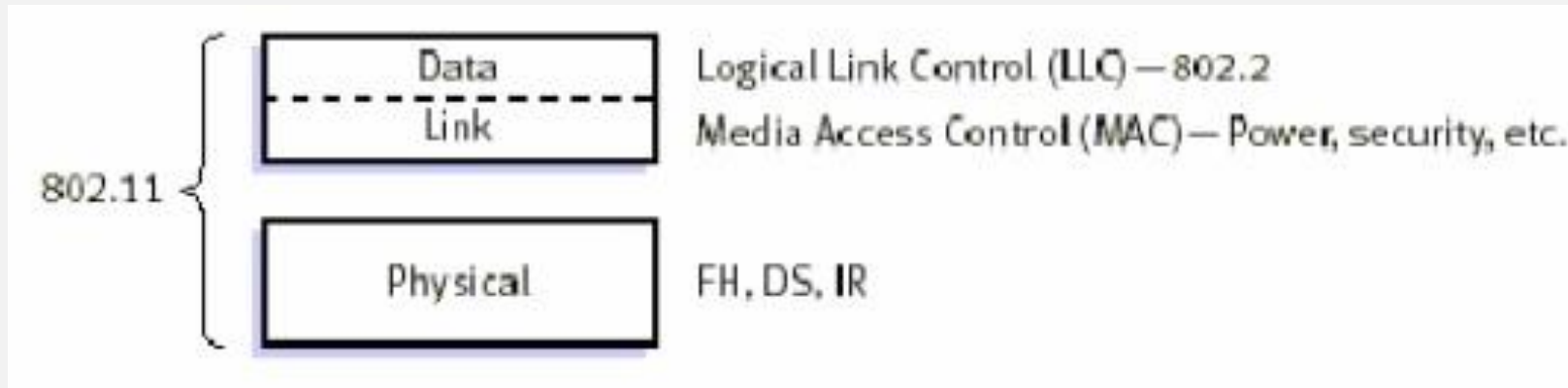


WIRELESS RADIO FREQUENCY

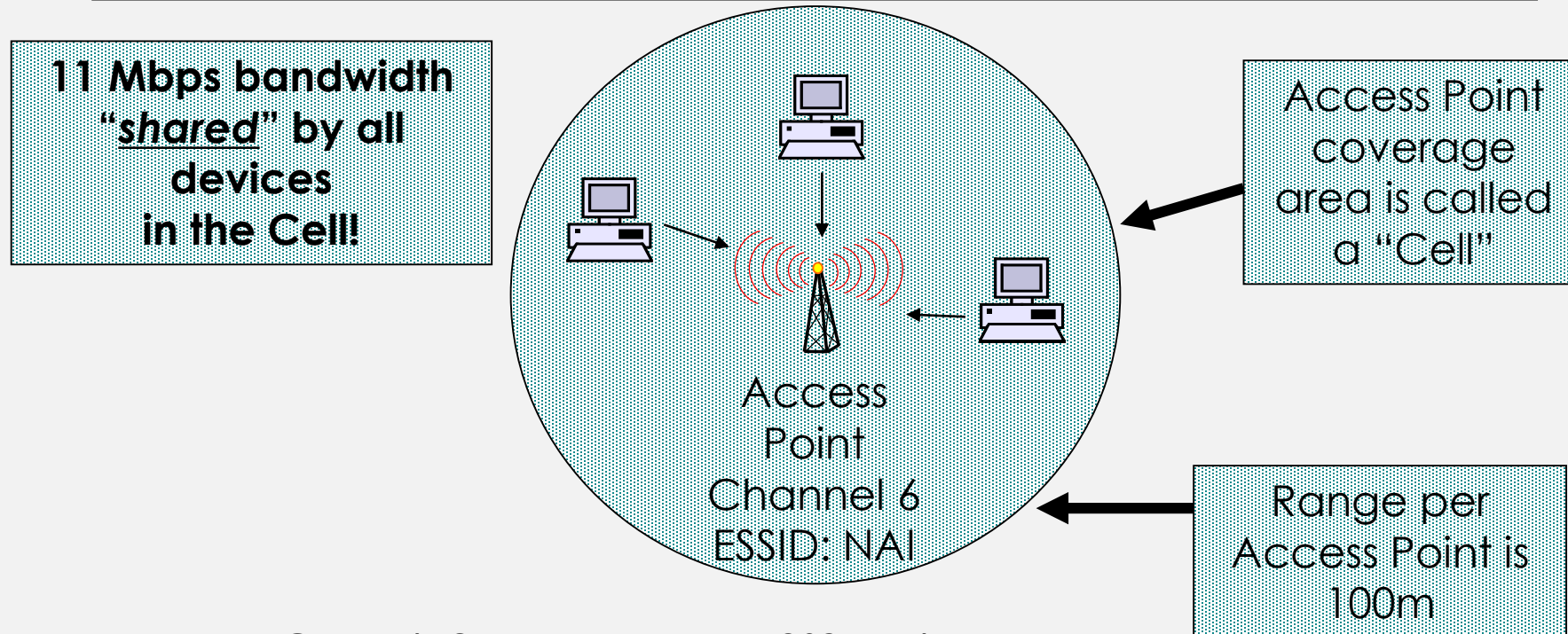
ISM (Industrial, Scientific, Medical) Radio Band

902-928 MHz	2.4 – 2.5 GHz	5.725 – 5.875 GHz	24 – 24.250 GHz	57 – 66 GHz
802.11-1997	802.11b/g/n	802.11a/n/ac		802.11ad
Cordless Phones	Cordless Phones		Amateur Satellite	
Baby Monitors	Baby Monitors			
	Bluetooth			
	Microwave Ovens			

PROTOCOL STACK VIEW

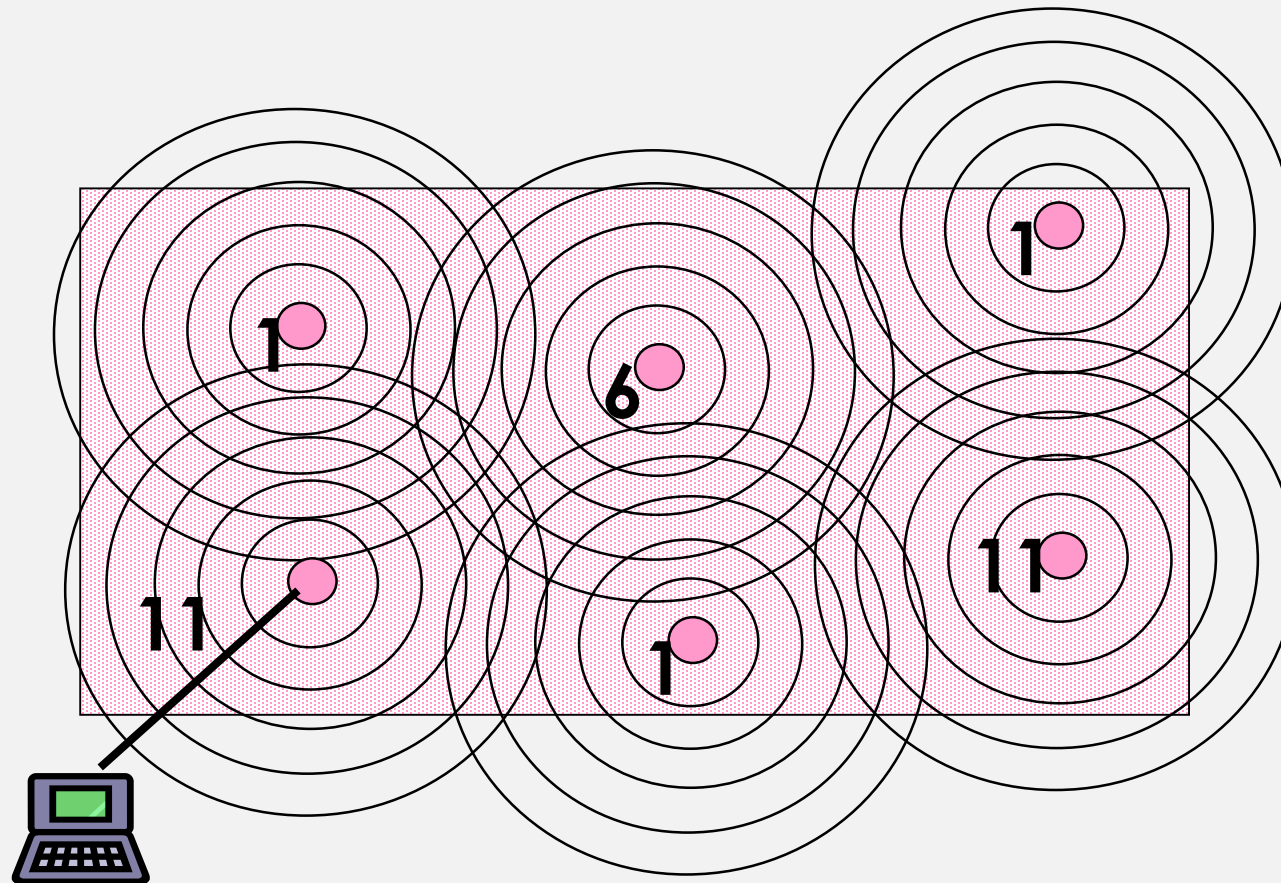


WIRELESS CELLS



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

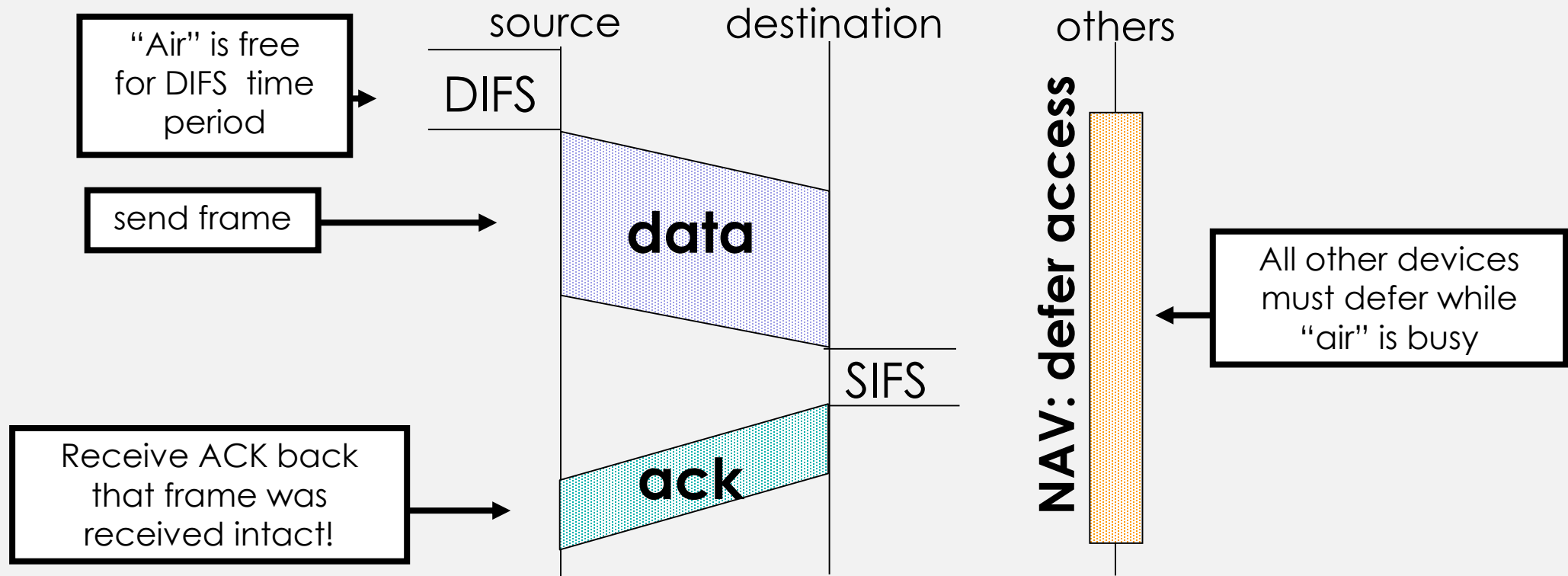
MULTIPLE WIRELESS APS



MEDIUM ACCESS CONTROL (MAC)

- Carrier Sense Multiple Access with Collision Avoidance (CSMA-CA)
 - Device wanting to transmit senses the medium (air)
 - If medium is busy, it defers
 - If medium is free for certain period (DIFS – Distributed Inter-Frame Space), it transmits frame
 - DIFS is approximately 128 μ s
 - Latency can increase if “air” is very busy since devices will have a hard time finding “open air” to send frames!

MAC PROTOCOL



- DIFS – Distributed Inter-Frame Space (approx. 128 μ s)
- SIFS – Short Inter-Frame Space (approx. 28 μ s)
- Every frame is ACKed except broadcast/multicast

MAC 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 ms)
 - exponential back off (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

OTHER MAC PROTOCOLS SUPPORTED

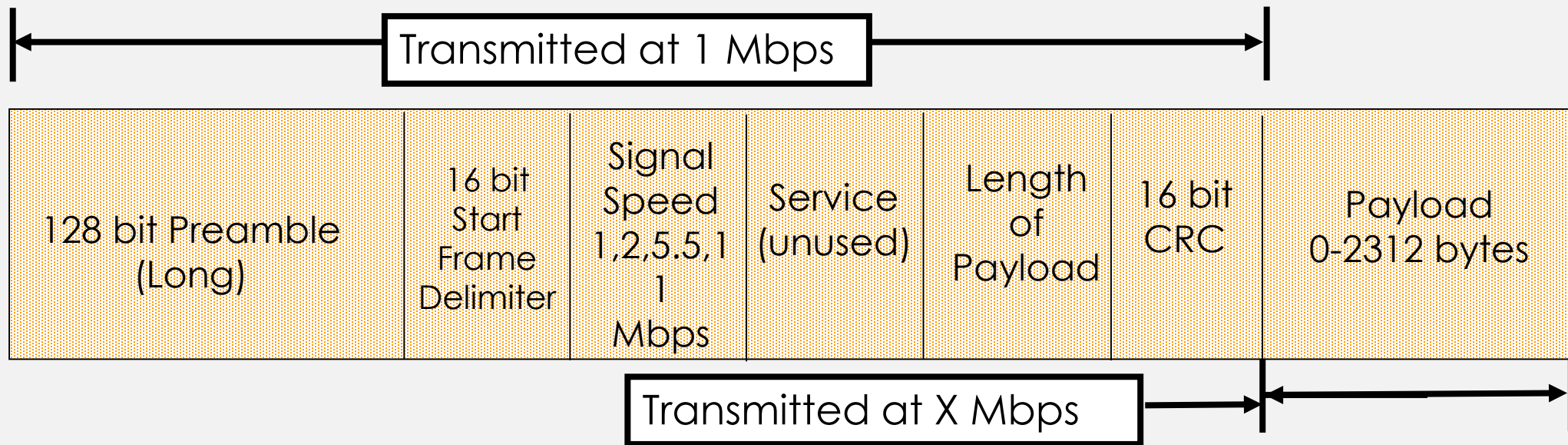
- Point Coordination Function (PCF)
 - AP polls stations in turn to see if there's frames to send
 - Useful for real-time traffic
- Request-To-Send/Clear-To-Send (RTS/CTS)
 - Reservation-based approach (ask permission)
 - Useful for very large frames
 - Useful for solving the “hidden node” problem (when a node is visible from a wireless access point (AP), but not from other nodes)
 - Request asks for clearance (permission) to send
 - Request also indicates time required for transmit

FRAME FORMATS

- Two frame formats available:
 - long preamble
 - short preamble
- Preamble Type is to help check the WiFi data transmission errors
- Older devices require Preamble Type Long to connect
- Variable-size frames (maximum of 2312 bytes for payload)
- 16-bit Cyclic Redundancy Code (CRC) for error checking of frames

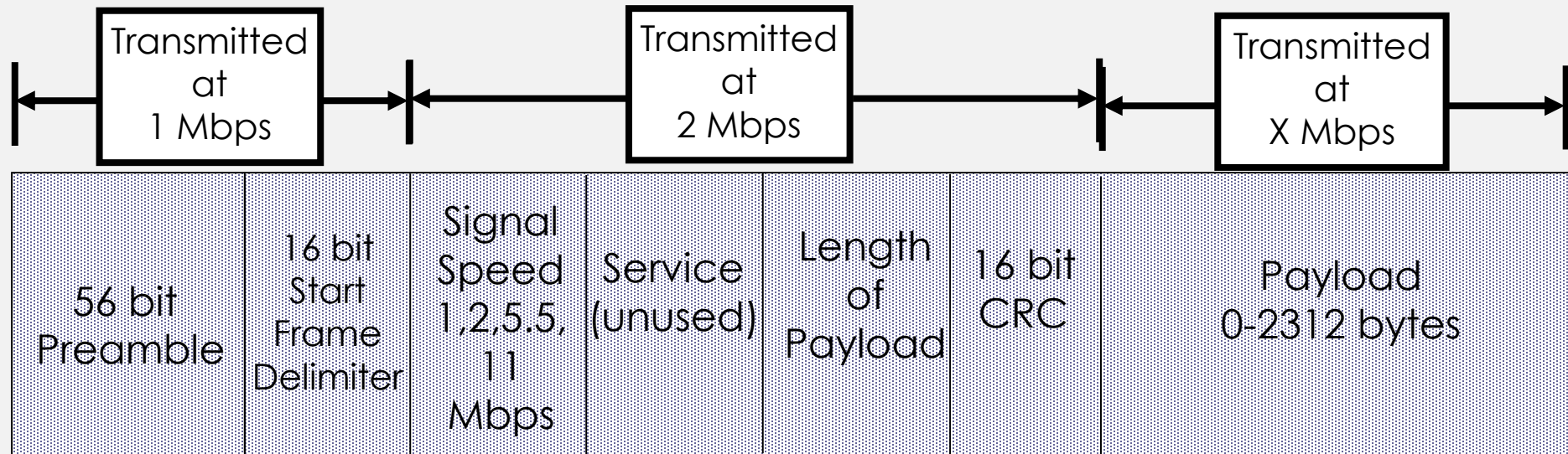
LONG PREAMBLE

- Long Preamble = 144 bits
- Entire Preamble and 48 bit PLCP (Physical Layer Convergence Protocol) header sent at 1 Mbps



SHORT PREAMBLE

- Short Preamble = 72 bits
- PLCP (Physical Layer Convergence Protocol) header transmitted at 2 Mbps



MORE FEATURES

- Power Management
 - Mobile nodes can “sleep” to save power
 - AP will buffer frames until client requests them
- Security
 - Wired Equivalent Privacy (WEP)
 - Not very secure at all!
 - To address this weakness, there is WPA2 (IEEE 802.11i)
 - Uses CCMP, an AES-based encryption mode with strong security

REFERENCES

- Wikipedia
 - <https://en.wikipedia.org/wiki/Wi-Fi>
 - https://en.wikipedia.org/wiki/IEEE_802.11
 - https://en.wikipedia.org/wiki/List_of_WLAN_channels
 - <http://www.hitchhikersguidetolearning.com/2017/09/17/802-11g-plcp-frame-formats-part-1/>