An Overview on IEEE 802.11 WLAN and Task Groups

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Institute of Electrical and Electronics Engineers IEEE

- Known as “IEEE”.
- The world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.
- Consists of different societies and councils.
- Formed in 1963 from the amalgamation of the American Institute of Electrical Engineers and the Institute of Radio Engineers.
- Corporate office in New York City and operations center in Piscataway, New Jersey.

WLANs

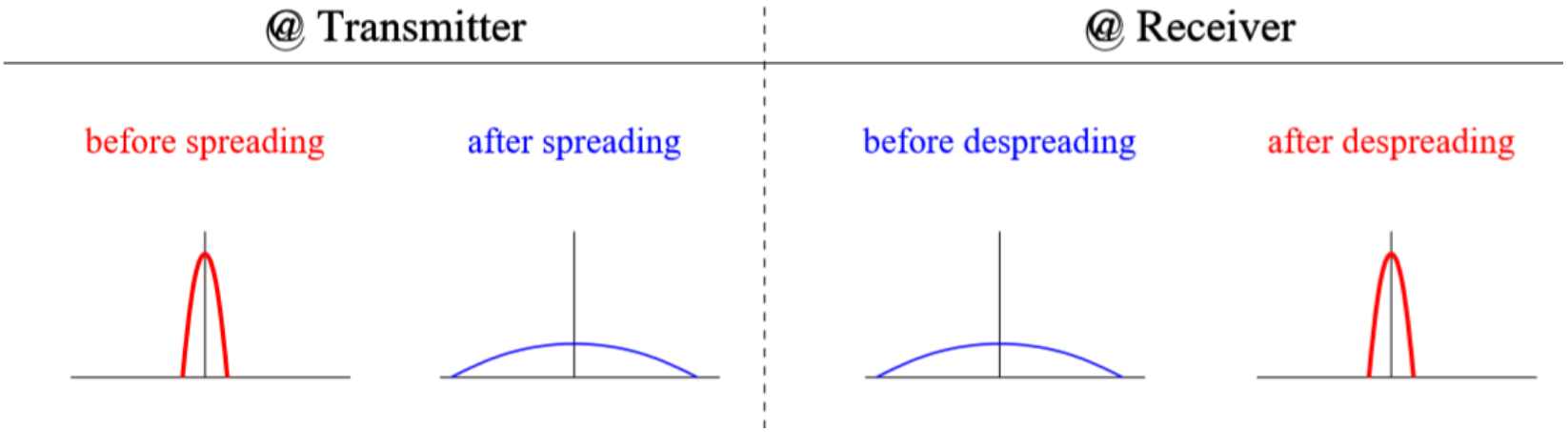
- WLAN stands for “**Wireless** Local Area Network”
- An alternative for wired networks
- Wireless computing is rapidly emerging
- It is Hard to wire some buildings
- Users do not want to being tethered off of a wired network

Basics

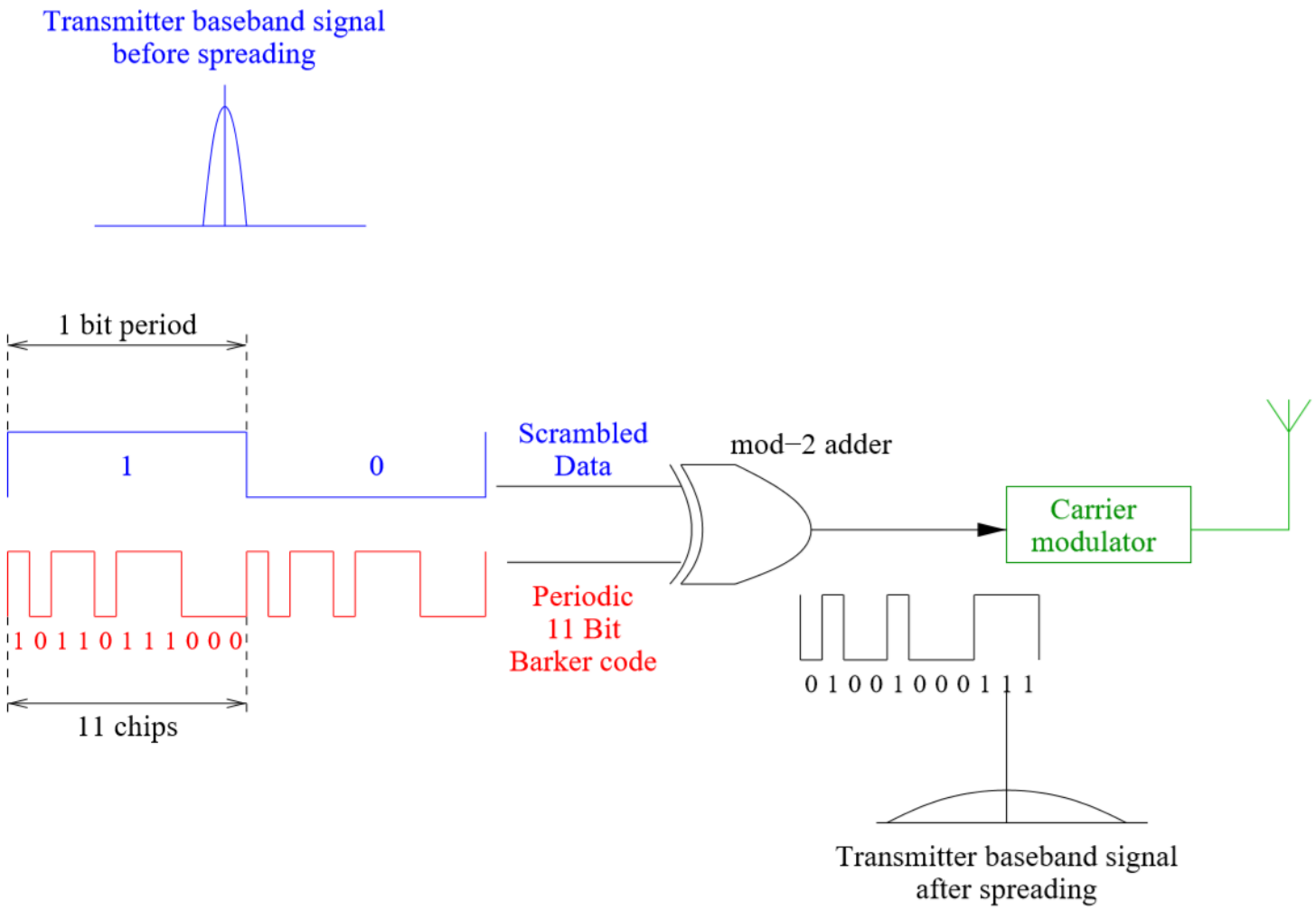
- Direct-sequence Spread Spectrum (DSSS)
- Frequency-hopping Spread Spectrum (FHSS)
- Orthogonal Frequency-division Multiplexing (OFDM)

DSSS

- A spread-spectrum modulation technique primarily used to reduce overall signal interference.
- Single code (11-chips)
- makes the transmitted signal wider in bandwidth than the information bandwidth.

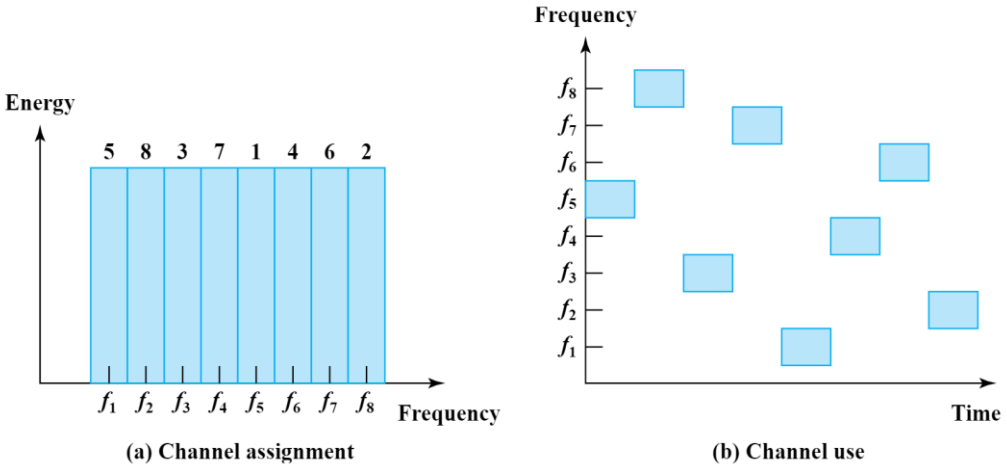


DSSS



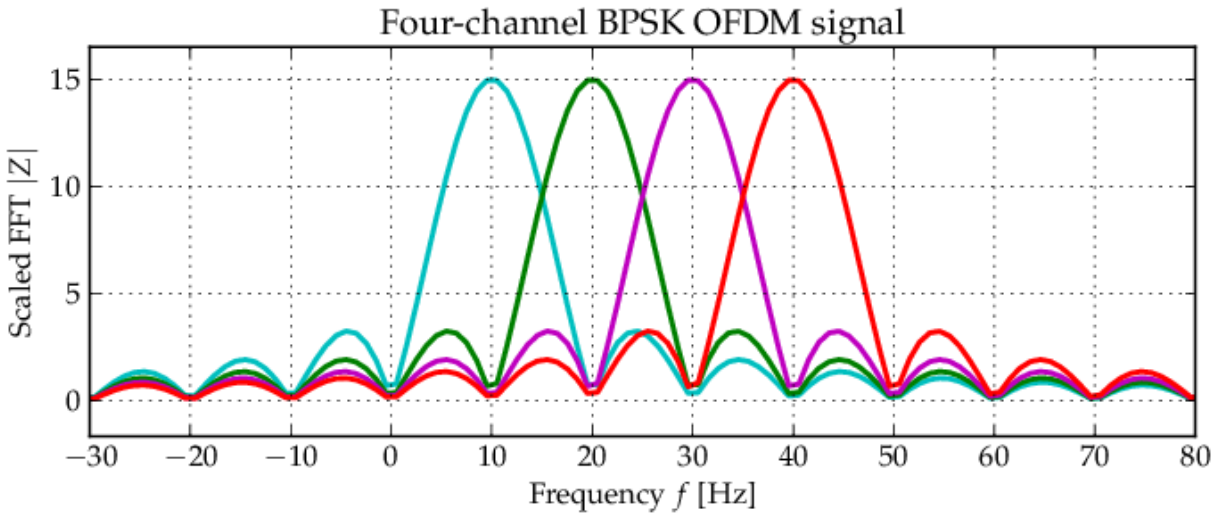
FHSS

- Rapidly changing the carrier frequency among many distinct frequencies occupying a large spectral band.
- The changes are controlled by a code known to both transmitter and receiver.
- Used to avoid interference, to prevent eavesdropping, and to enable code-division multiple access (CDMA) communications.



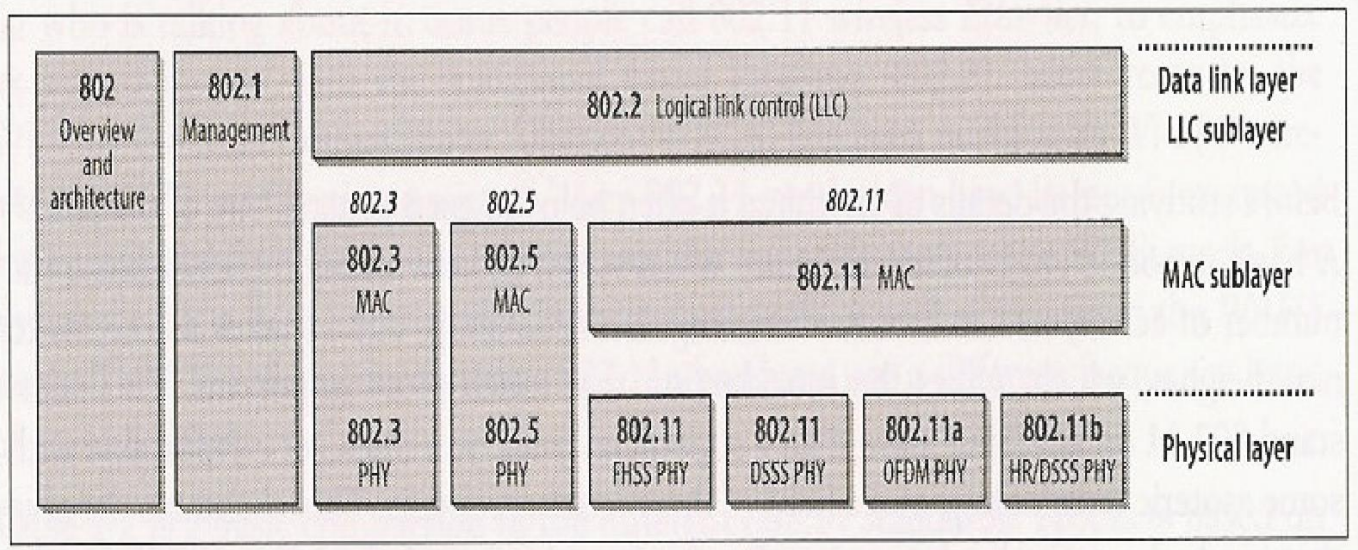
OFDM

- Work was done in 1960s, and a patent was issued in 1970.
- High-rate data is divided into several lower rate binary signals.
- Each low-rate signal modulates a different sub-carrier.
- Sub-carrier sets are orthogonal.



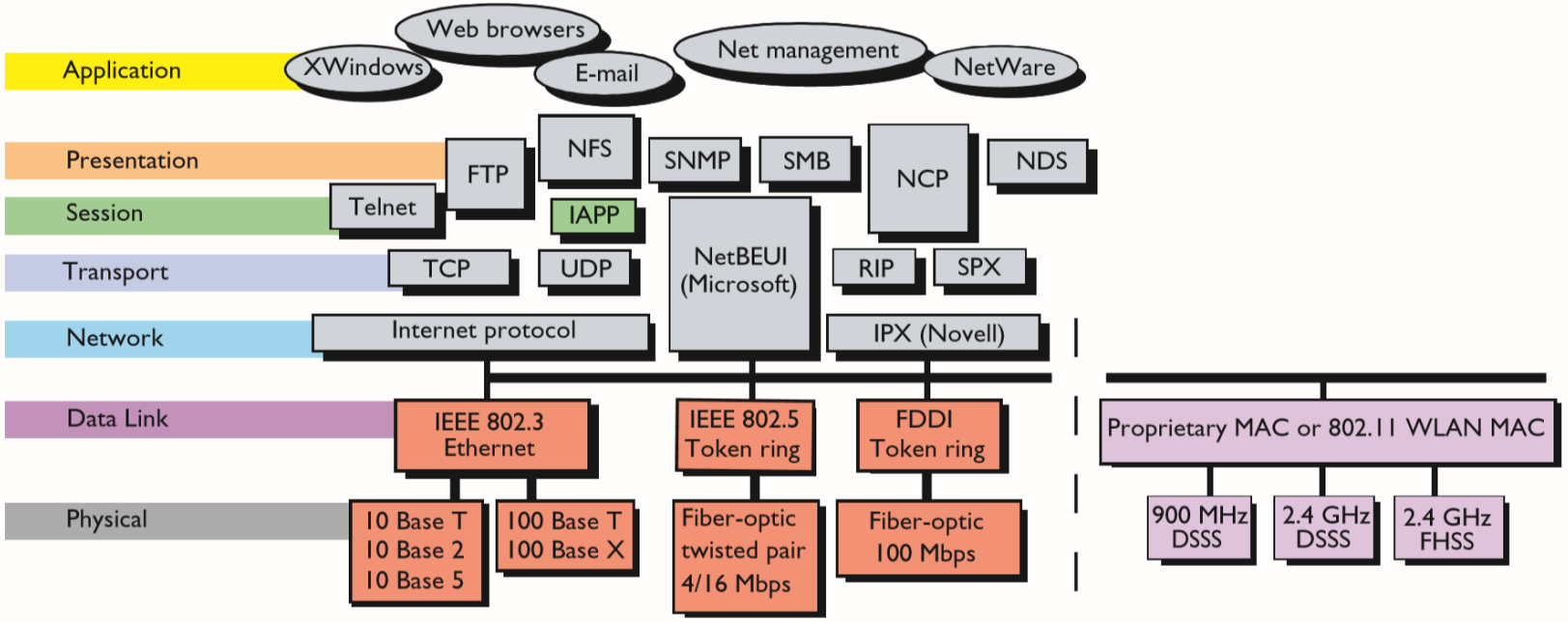
IEEE 802.11 WLAN Standard

- Part of the IEEE 802
- The world's most widely used standard in CN
- Accepted by ISO and ANSI
- Specifies the set of MAC and PHY protocols for implementing WLANs



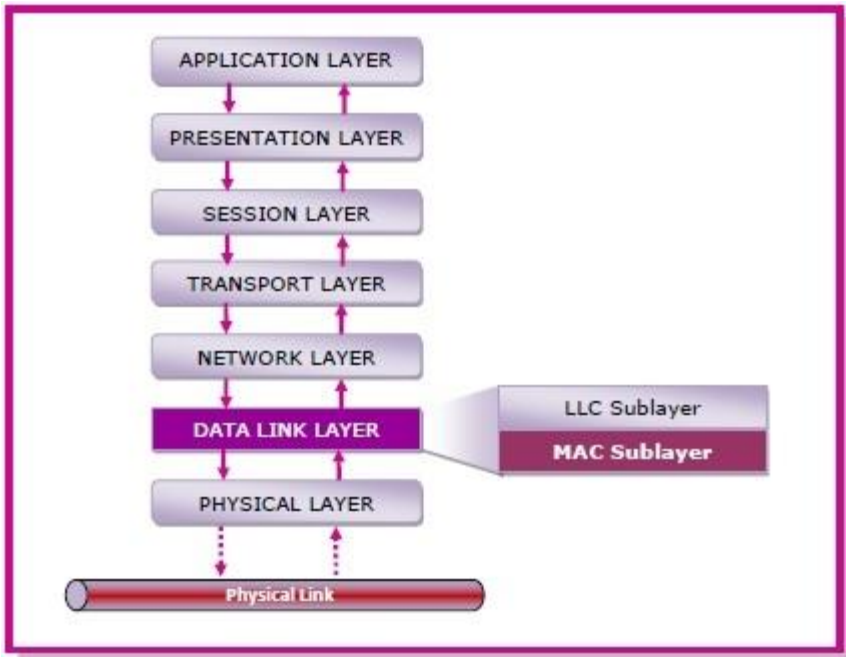
IEEE 802.11 Architecture

- Follows the common ISO and OSI models
- It causes change in MAC and PHY layers
- Due to being expandable → Same architecture in upper layers

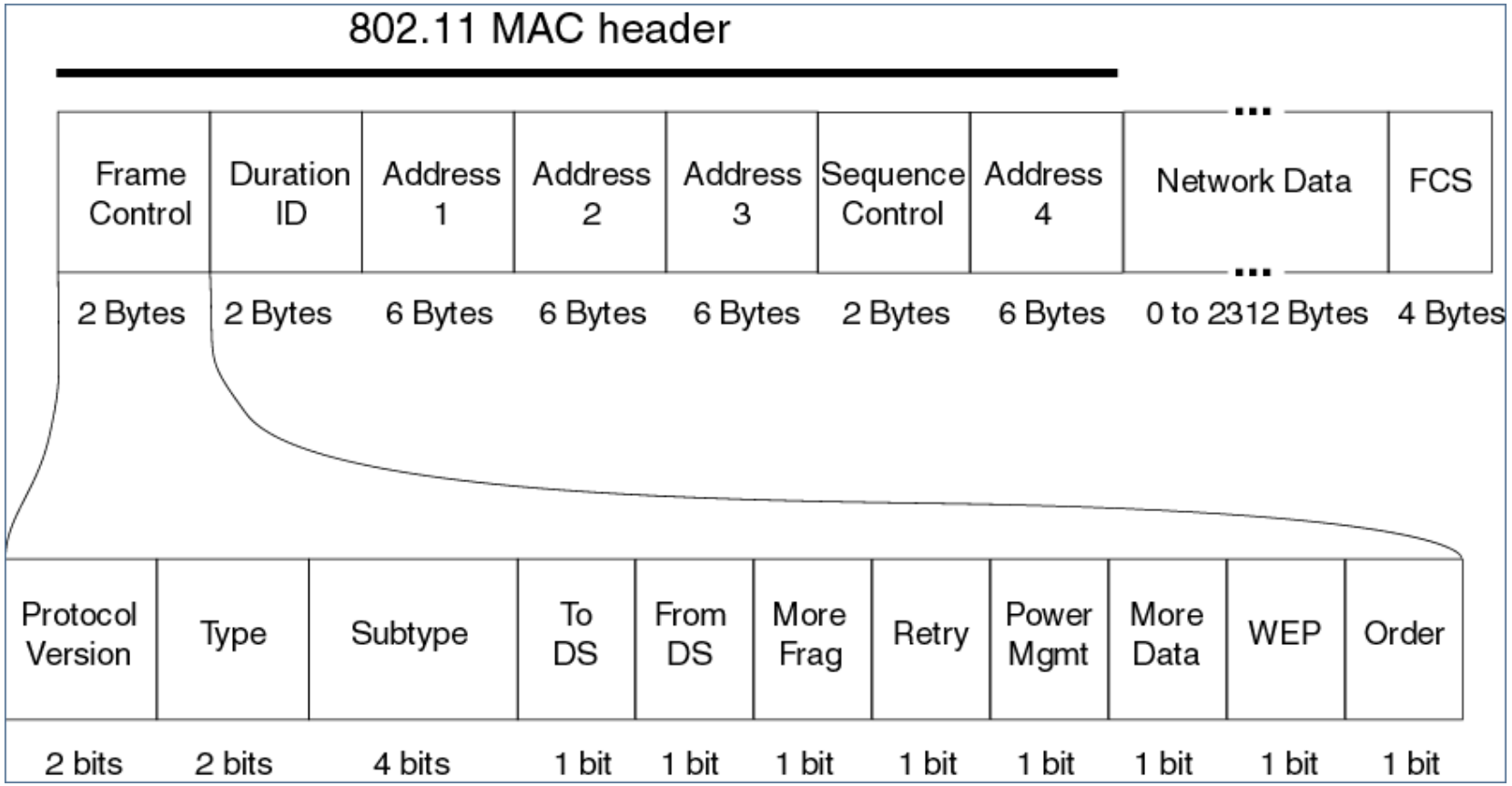


MAC Sub-layer in 802.11

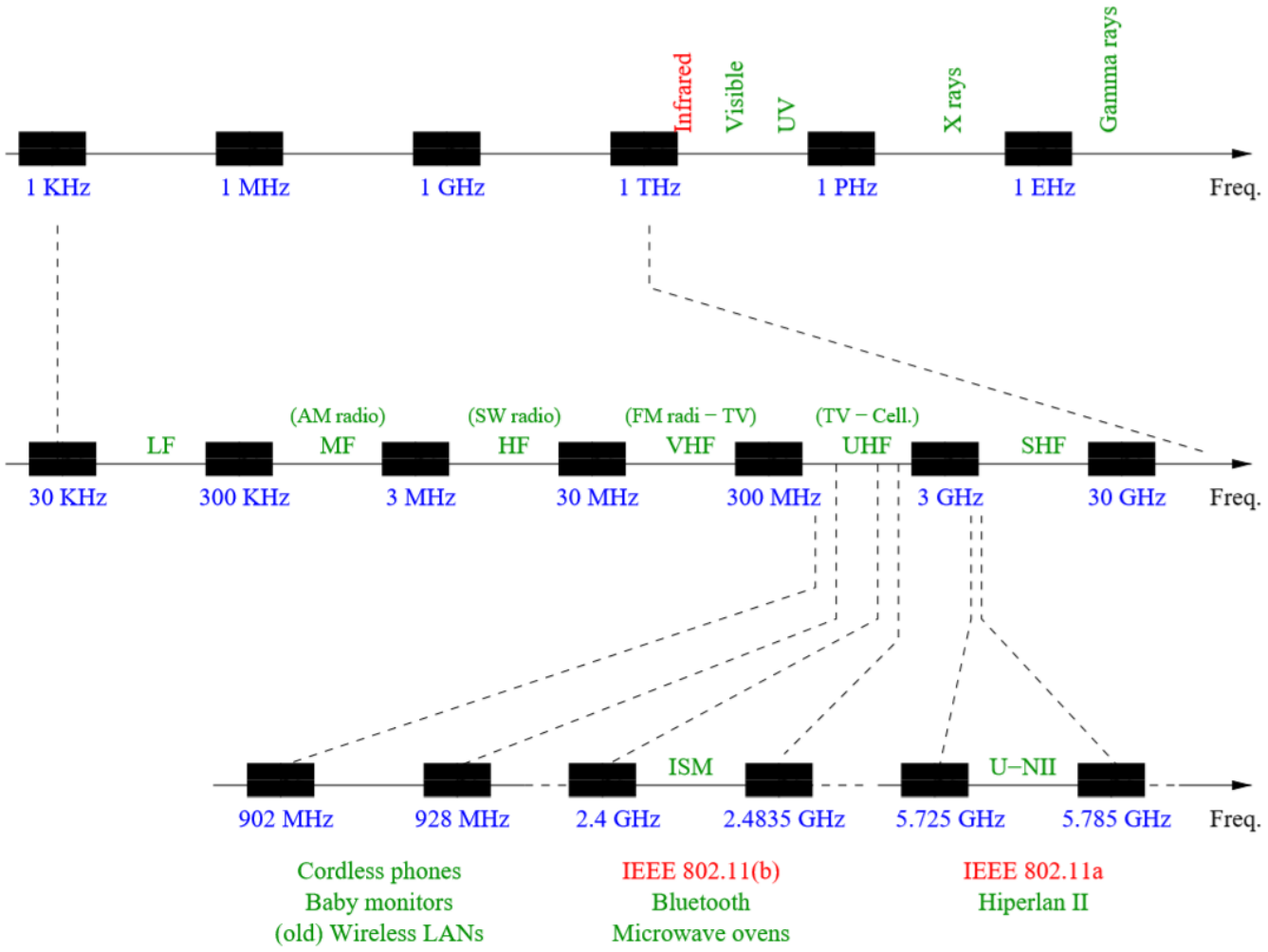
- A sublayer of the data link layer
- Provides an abstraction of the physical layer to the LLC and upper layers of the OSI network.
- Responsible for frame formatting, fragmentation and reassembly, channel allocation procedure, PDU addressing, and error checking.



IEEE 802.11 MAC Sub-layer Frame



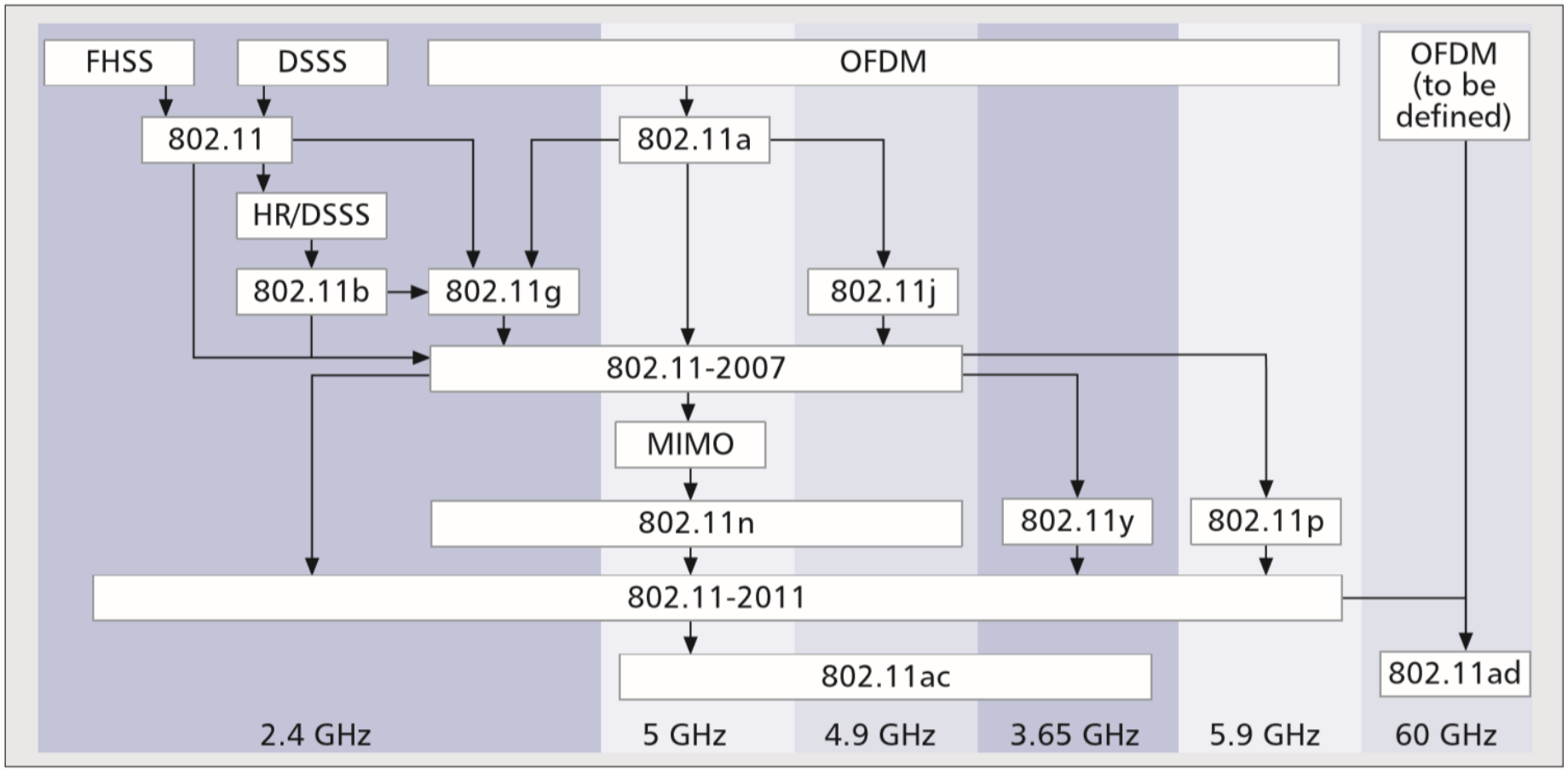
The Electromagnetic Spectrum Frequency Allocation



Physical Layer in 802.11

- First standard developed in 1997 (known as 802.11-1997)
- Specifies PHY layer including spread spectrum technique, frequency band, bandwidth, and …
- New applications require new implementations
- Which cause to develop task groups

The 802.11 PHY layer



802.11 - 1997

- First implementation of PHY layer
- 2.4 GHz frequency band
- 2 Mb maximum data transmission rate
- An approximate range of 100 meters outdoor and 20 meters indoor
- FHSS and DSSS techniques used

802.11b

- Introduced in 1999
- First widely used task group
- Still used 2.4 GHz band to reduce costs
- Only uses DSSS technique
- A maximum of 11 Mb/s rate
- About 35 meters for indoor and 140 meters for outdoor
- Microwave ovens also use 2.4 GHz frequency band

802.11a

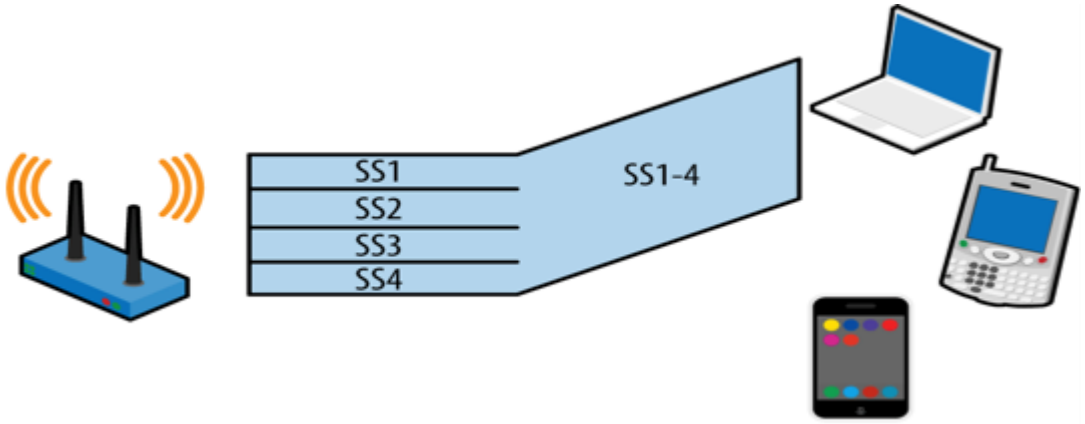
- Also introduced in 1999
- Frequency band changed to 5 GHz to reduce Interferences
- High costs – Low range
- OFDM modulation used
- Up to 54 Mb/s transmission rate

802.11g

- An extension to 802.11b group
- Developed in 2003
- A high transmission rate of 54 Mb/s, This time in 2.4 GHz

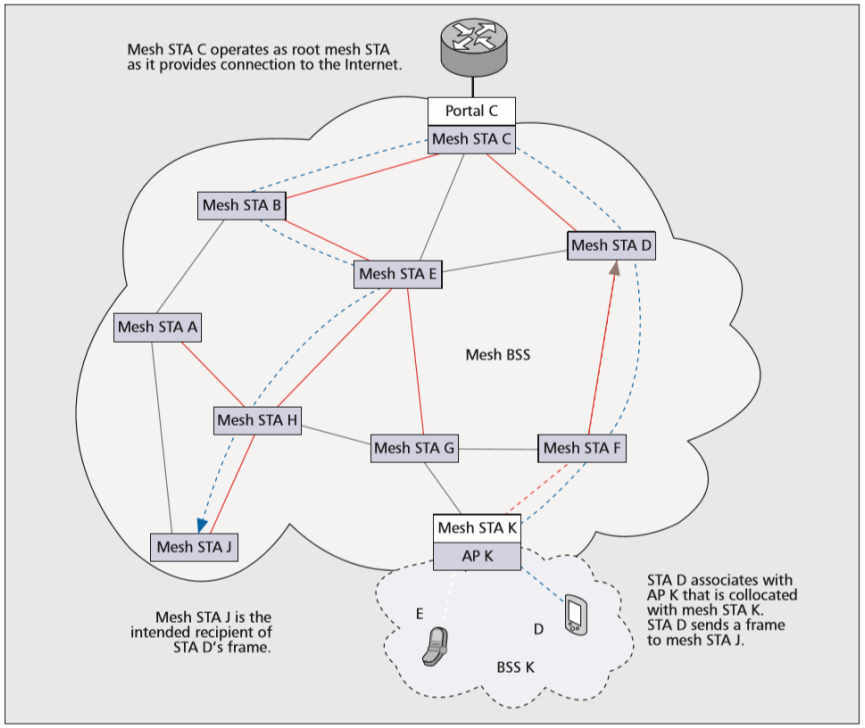
802.11n

- One of the most important releases
- Working in both 2.4 and 5 GHz
- 540 Mb/s transmission rate
- MIMO technology introduced
- Supports up to 4 antennas

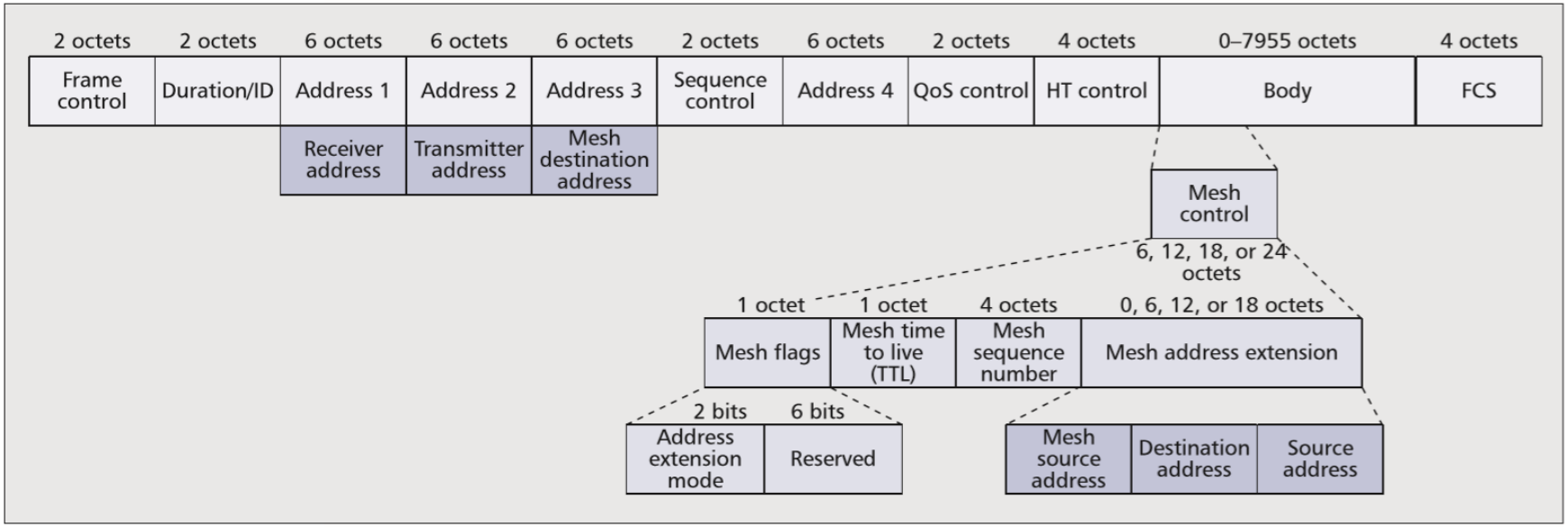


802.11s

- Single-hop communication cause a limited coverage
- Mesh networks introduced to communicate in multi-hop



The 802.11s MAC frame

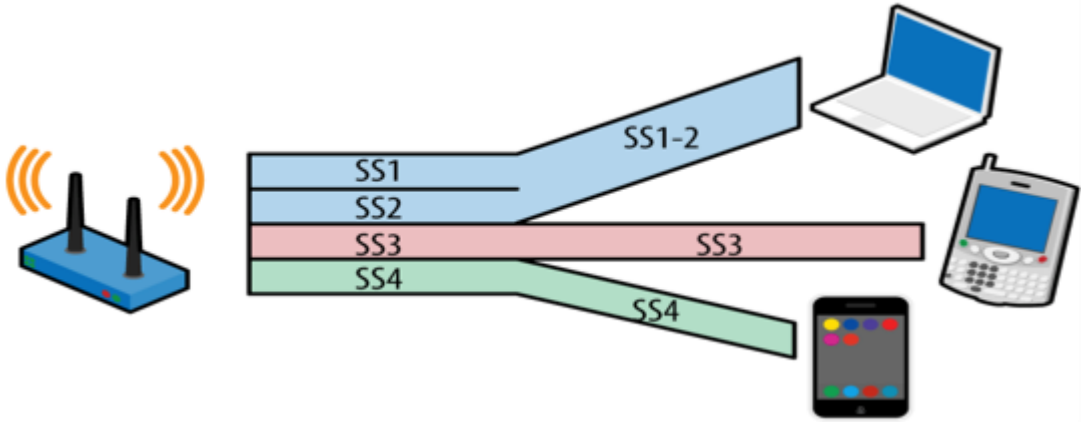


802.11ac

- Developed in 2012 for a better throughput
- Still one of the popular task groups
- Up to 6 Gb/s
- 5 GHz frequency band with 160 MHz bandwidth

802.11ax

- First task group with support of multi-user MIMO
- 20 MHz bandwidth in 2.4, 5, and 6 GHz
- Better power consumption
- Is not currently widely supported
- A good choice for IOT



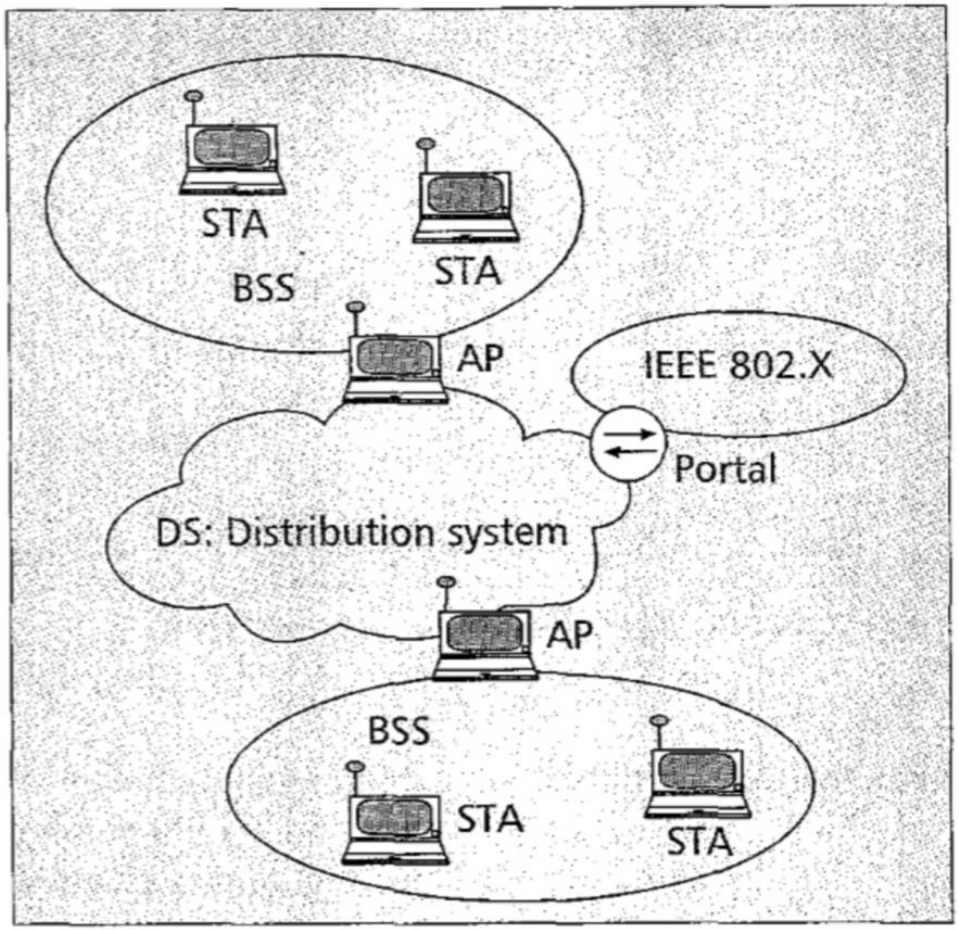
802.11ad

- A 60 GHz task group
- High frequency band → Higher speed, Lower range
- 54 times wider channels than group ‘n’
- 6.7 Gb/s transmission rate

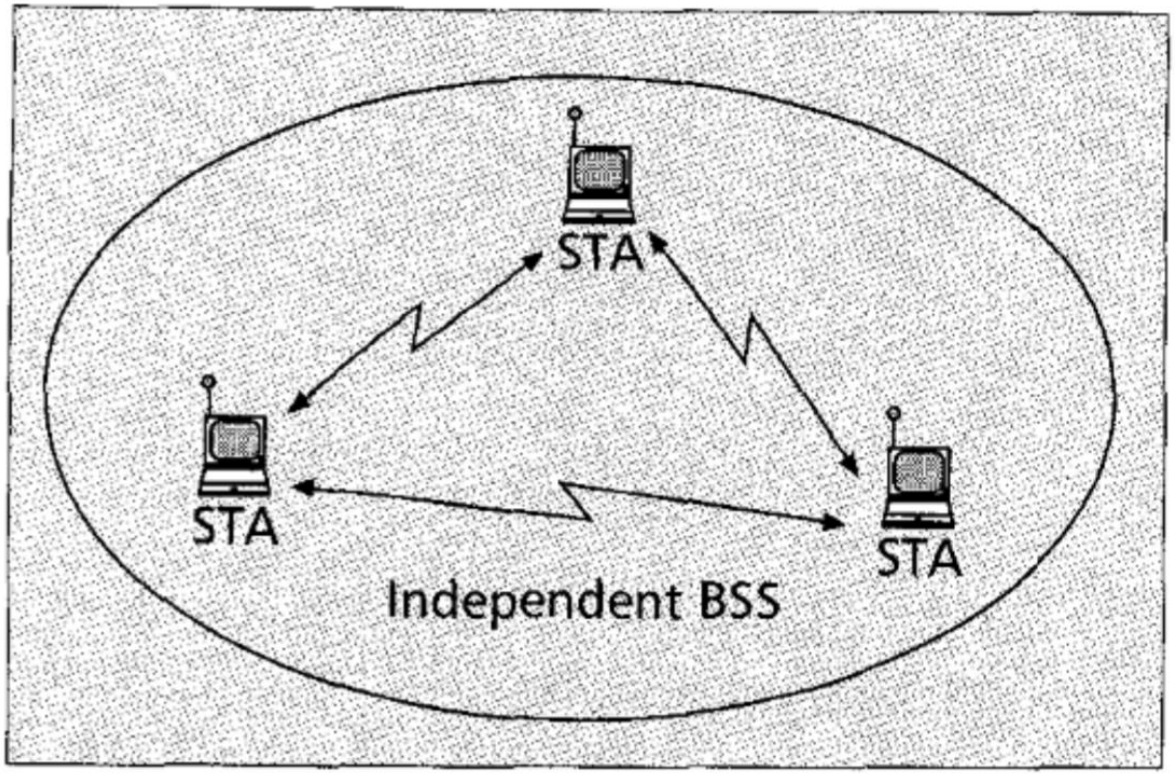
Topologies

- Access Point (Infrastructural)
- Ad Hoc

Access Point Topology



Ad Hoc Topology



Challenges in Wireless Data Communications

- Users want the same performance as the wired counterpart
- Using unguided mediums instead of guided ones make new problems
- Some common challenges:
  - Frequency allocation
  - Interference
  - Reliability
  - Power Consumption
  - Human safety
  - Throughput
  - Security

Challenges in Wireless Data Communications (cont.)

- **Frequency Allocation**
  - Countries manage the rules of allocation
  - USA accepts ISM band for Wi-Fi networks
  - ISM stand for Industrial, Scientific, and Medical

- **Interference**
  - Occurs when transmitting simultaneous in the same frequency
  - Signal fading
  - Reduces reliability
  - IEEE 802.11 uses CSMA/CA for confrontation

Challenges in Wireless Data Communications (cont.)

- **Reliability**
  - Bit Error Rate (BER)
  - Ways to reduce BER: FEC and ARQ
  - E.g. Order of 10^-2 for transmitting voice packets in 802.11

- **Power Consumption**
  - Portable working stations use battery
  - Limited battery capacity → Consumption needs to be reduced
  - Reducing power consumption → Decrease in performance

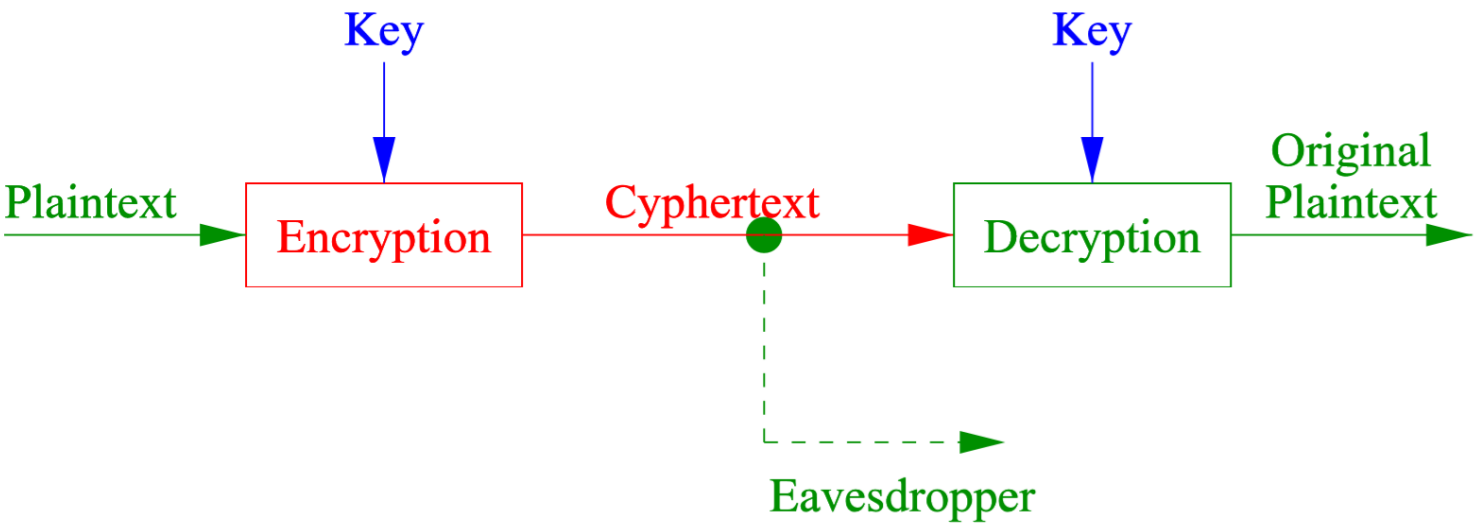
Challenges in Wireless Data Communications (cont.)

- **Human Safety**
  - Power can be increased to improve coverage and performance
  - Power increasing is not recommended
  - Researches are still ongoing

- **Throughput**
  - Shared mediums
  - A minimum of 1 Mb/s transmission rate in any situation with 802.11
  - Spread spectrum and channel division

Challenges in Wireless Data Communications (cont.)

- **Security**
  - It is more complicated in non-physical mediums
  - Packet encryption
  - 802.11 uses WEP method → RC4 symmetric key encryption algorithm



Any Question?!

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Thanks for your kind attention!