Wi-Fi Module 3

1.) What are the different 802.11 PHY layer standards? Compare their characteristics.

- There are various 802.11 PHY layer standards such as
    - 802.11b
    - 802.11a
    - 802.11g
    - 802.11n
    - 802.11ac
    - 802.11ax
    - 802.11be
- Each PHY layer standard offers improvement in areas Data rate, Modulation technique, QoS services, range etc.

2.) What are DSSS and FHSS? How do they work?

- DSSS stands for Direct Sequence Spread Spectrum.
- DSSS works by spreading a narrower bandwidth signal into a wider bandwidth signal by combining the data signal with a **pseudo-random noise (PN) sequence** (called a **chipping code**).
- FHSS stands for Frequency Hopping Spread Spectrum.
- FHSS works by rapidly hopping between different frequencies while transmitting data.
- The signal stays on each frequency for a short time before hopping to the next.

3.) How do modulation schemes work in the PHY layer? Compare different modulation schemes and their performance across various Wi-Fi standards.

- Modulation schemes directly determine the amount of data that can be transmitted in one symbol
- Higher modulation schemes mean better throughput, but the signal must not have any interference.
- Whereas lower modulation schemes support low throughput but can have some tolerances to interference.

4.) What is the significance of OFDM in WLAN? How does it improve performance?

- **OFDM** is a digital modulation technique that splits a high-speed data stream into **many slower sub-streams**, each transmitted over a **separate, narrow frequency subcarrier**, all within the same channel.
- It's significance in WLAN include,
- Better resilience to Multipath fading and interference.
- It uses the spectrum much more efficiently.
- It supports parallel transmission and higher data rates.

5.) How are frequency bands divided for Wi-Fi? Explain different bands and their channels.

- There are 3 frequency bands
    - 2.4 Ghz
    - 5 Ghz
    - 6 Ghz
- 2.4 Ghz frequency band has 14 channels spaced 5 MHz apart, but each channel is 22 MHz wide
- Only 3 non-overlapping channels: 1, 6, 11

6.) What is the role of Guard Intervals in WLAN transmission? How does a short Guard Interval improve efficiency?

- A Guard Interval is a small-time gap inserted between symbols (data blocks) in wireless communication.
- Long Guard interval means less interference, but bandwidth is wasted.
- Short Guard interval means only a less time gap is present between packets which means bandwidth is used much more efficiently.
- This is how a short Guard interval improves efficiency.

7.) Describe the structure of an 802.11 PHY layer frame. What are its key components?

- It consists of preamble, Phy header, PSDU.
- A preamble is used for synchronization purposes.
- Phy header has information on
    - Modulation type

- o Coding rate
- o Length of the payload
- o Other information
- PSDU is the Data Field.

8.) What is the difference between OFDM and OFDMA?

- OFDM is a Multiplexing technique
- OFDMA is a Multiuser access technique

9.) What is the difference between MIMO and MU-MIMO?

- MIMO stands for Multiple Input Multiple Output
- MU-MIMO stands for Multi User MIMO
- MIMO means multiple antenna single user
- MU-MIMO means multiple antennas, multiple users.

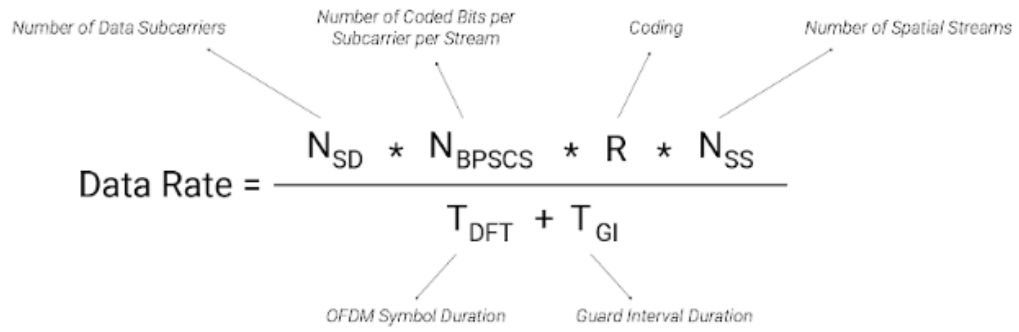10.) What are PPDU, PLCP, and PMD in the PHY layer?

- PPDU – Physical Layer Protocol Data unit
- PLCP – Physical layer Convergence protocol
- PMD - Physical Medium Dependent

11.) What are the types of PPDU? Explain the PPDU frame format across different Wi-Fi
Generations.

- There are various types of PPDU.
  - o Legacy PPDU
  - o HT PPDU
  - o VHT PPDU
  - o EH PPDU
  - o EHT PPDU

12.) How is the data rate calculated?

- Data rate is calculated using this formula,

$$\text{Data Rate} = \frac{N_{SD} \ast N_{BPSCS} \ast R \ast N_{SS}}{T_{DFT} + T_{GI}}$$

Number of Data Subcarriers

Number of Coded Bits per Subcarrier per Stream

Coding

Number of Spatial Streams

OFDM Symbol Duration

Guard Interval Duration