WiFi Training Program 2025

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Question-3:

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

Modulation schemes are crucial because they determine how data is converted into signals for transmission over the air. Digital data (bits) is translated to analog signals (radio waves) through modulation. Modulation alters one or more characteristics of a carrier wave (such as amplitude, frequency, or phase) to represent the data.

The main types used in Wi-Fi include:

- **BPSK (Binary Phase Shift Keying)**
- **QPSK (Quadrature Phase Shift Keying)**
- **QAM (Quadrature Amplitude Modulation): includes 16-QAM, 64-QAM, 256-QAM, and 1024-QAM.**

1. **BPSK (Binary Phase Shift Keying) is the simplest form of phase modulation. It transmits 1 bit per symbol by shifting the phase of a carrier wave.**
   0 → 0° phase shift ; 1 → 180° phase shift
2. **QPSK-Quadrature Phase Shift Keying - It's a type of phase modulation that transmits 2 bits per symbol by changing the phase of the carrier signal. So compared to BPSK (which transmits 1 bit per symbol), QPSK doubles the data rate without needing more bandwidth.**
3. **QAM- Quadrature Amplitude Modulation- It's a technique that combines both amplitude and phase modulation to carry more data per symbol.**

Comparison of Modulation Schemes

Modulation	Bits per Symbol	Noise	Data Rate	Used In
BPSK	1	Very High	Low	802.11b, 802.11a/g/n
QPSK	2	High	Moderate	802.11a/g/n/ac/ax
16-QAM	4	Medium	High	802.11a/g/n/ac/ax
64-QAM	6	Medium-Low	Higher	802.11n/ac/ax
256-QAM	8	Low	Very High	802.11ac/ax
1024-QAM	10	Lower	Very High	802.11ax (Wi-Fi 6)
4096-QAM	12	Very Low	Ultra High	802.11be (Wi-Fi 7)

Higher QAM levels increase throughput by encoding more bits per symbol.