Wi-Fi 6 (802.11ax) and Wi-Fi 6E (an extension of 802.11ax) share many core features but differ significantly due to Wi-Fi 6E's use of the **6 GHz frequency band** alongside the 2.4 GHz and 5 GHz bands available in Wi-Fi 6. Below is a detailed comparison and contrast of **range**, **bandwidth**, and **interference** for Wi-Fi 6 and Wi-Fi 6E.

Comparison: Wi-Fi 6 vs. Wi-Fi 6E

1. Range

- **Wi-Fi 6 (2.4 GHz and 5 GHz)**:
    - **2.4 GHz Band**: Offers the longest range and better penetration through walls and obstacles due to its lower frequency. Ideal for larger areas or devices farther from the router (e.g., IoT devices, smart home sensors).
    - **5 GHz Band**: Provides shorter range than 2.4 GHz but better than 6 GHz, with moderate wall penetration. Suitable for high-speed connections in closer proximity (e.g., laptops, gaming consoles).
    - **Overall**: Wi-Fi 6's inclusion of 2.4 GHz gives it an edge for extended coverage in scenarios requiring long-distance connectivity.
- **Wi-Fi 6E (2.4 GHz, 5 GHz, and 6 GHz)**:
    - **6 GHz Band**: Has the shortest range among the three bands due to its higher frequency, which results in slightly poorer wall penetration and signal attenuation compared to 5 GHz. Typically effective in open spaces or closer proximity to the router.
    - **2.4 GHz and 5 GHz**: Same range characteristics as Wi-Fi 6, providing flexibility for devices not compatible with 6 GHz.
    - **Overall**: Wi-Fi 6E's 6 GHz band sacrifices some range for performance, but its 2.4 GHz and 5 GHz bands ensure comparable coverage to Wi-Fi 6 for legacy devices.

2. Bandwidth

- **Wi-Fi 6 (2.4 GHz and 5 GHz)**:
    - **Channel Width**: Supports up to **160 MHz** channels in the 5 GHz band, with narrower channels (20–40 MHz) in the 2.4 GHz band.
    - **Theoretical Max Speed**: Up to **9.6 Gbps** (with 8x8 MU-MIMO and 160 MHz channels in 5 GHz, using 1024-QAM modulation).
    - **Spectrum Availability**: Limited to ~100 MHz in 2.4 GHz and ~500 MHz in 5 GHz, which restricts the number of non-overlapping channels (e.g., ~3–6 80 MHz channels or 2 160 MHz channels in 5 GHz).
    - **Performance**: High bandwidth for modern applications (e.g., 4K streaming, gaming), but performance can degrade in congested environments due to limited spectrum and channel overlap.
- **Wi-Fi 6E (2.4 GHz, 5 GHz, and 6 GHz)**:

    - **Channel Width**: Supports up to **160 MHz** channels across all bands, with the 6 GHz band offering more opportunities for wider channels due to its larger spectrum.
    - **Theoretical Max Speed**: Same as Wi-Fi 6 (~9.6 Gbps), but real-world throughput is higher in the 6 GHz band due to less interference and more available channels.
    - **Spectrum Availability**: Adds **1200 MHz** in the 6 GHz band (e.g., 5925–7125 MHz in the U.S.), enabling up to **7–14 160 MHz channels** or **59 20 MHz channels**, significantly increasing bandwidth capacity.
    - **Performance**: Excels in high-bandwidth, low-latency applications (e.g., 8K streaming, VR/AR) due to the 6 GHz band's wider channels and reduced contention.

3. Interference

- **Wi-Fi 6 (2.4 GHz and 5 GHz)**:
    - **2.4 GHz Band**: Highly congested due to overlap with Bluetooth, Zigbee, microwaves, and older Wi-Fi devices (e.g., Wi-Fi 4). Limited to 3 non-overlapping 20 MHz channels, leading to frequent interference in dense environments.
    - **5 GHz Band**: Less congested than 2.4 GHz but still faces interference from neighboring Wi-Fi networks, cordless phones, and radar systems. Channel reuse in crowded areas (e.g., apartments) can degrade performance.
    - **Mitigation**: Wi-Fi 6 uses **BSS Coloring** and **OFDMA** to reduce co-channel interference and improve efficiency, but interference remains a challenge in busy networks.
- **Wi-Fi 6E (2.4 GHz, 5 GHz, and 6 GHz)**:
    - **6 GHz Band**: Virtually free of interference because it's a new spectrum reserved for Wi-Fi 6E-compatible devices. No legacy devices (e.g., Wi-Fi 5 or older) operate in this band, creating a "clean slate" for high-performance networking.
    - **2.4 GHz and 5 GHz**: Same interference challenges as Wi-Fi 6, with identical mitigation techniques (BSS Coloring, OFDMA).
    - **Overall**: The 6 GHz band significantly reduces interference, enabling more reliable and consistent performance, especially in dense urban settings or enterprise environments.