The division of Wi-Fi frequency bands into specific ranges and channels is a carefully regulated process managed by international and regional bodies like the FCC, ITU, and ETSI. These bands—2.4 GHz, 5 GHz, and 6 GHz—are allocated within the radio spectrum to support wireless communication, with channels defined to organize frequency usage, minimize interference, and accommodate varying device needs

2.4 GHz Band Division:

Total Range: Spans 2.4 GHz to 2.4835 GHz, a 83.5 MHz-wide band.

Channel Structure: The band is divided into 14 channels, each with a nominal width of 20 MHz, though the actual occupied bandwidth is about 22 MHz due to sidebands. Channels are spaced 5 MHz apart, starting at 2.412 GHz (Channel 1) and ending at 2.484 GHz (Channel 14).

For example:
- Channel 1: 2.412 GHz
- Channel 6: 2.437 GHz
- Channel 11: 2.462 GHz
- Channel 14: 2.484 GHz (used only in Japan).

Overlapping Channels: Due to the 20 MHz width and 5 MHz spacing, channels overlap significantly (e.g., Channel 1 overlaps with Channels 2-5). Only Channels 1, 6, and 11 are non-overlapping in most regions (e.g., North America), as their center frequencies are 25 MHz apart, avoiding interference. Europe allows up to Channel 13 (2.472 GHz), but the same 1, 6, 11 rule applies.

Usage :
This band supports early standards (802.11b/g/n) and is divided to handle low-to-medium data rates, with longer range but high congestion from devices like microwaves, cordless phones, and Bluetooth.

5 GHz Band Division:

Total Range: Extends from 5.15 GHz to 5.825 GHz, approximately 675 MHz wide, segmented into sub-bands defined by the UNII (Unlicensed National Information Infrastructure) rules.

Channel Structure: The band is divided into multiple 20 MHz channels, with options for wider configurations (40 MHz, 80 MHz, 160 MHz) in standards like 802.11n/ac/ax.

The channels are grouped into four main sub-bands:
UNII-1 (5.15-5.25 GHz): Channels 36-48, centered at 5.18 GHz (Channel 36) to 5.24 GHz (Channel 48), providing 4 non-overlapping 20 MHz channels.
UNII-2 (5.25-5.35 GHz): Channels 52-64, centered at 5.26 GHz to 5.32 GHz, also 4 channels, requiring DFS to avoid radar systems.

UNII-2e (5.47-5.725 GHz): Channels 100-144, centered at 5.50 GHz to 5.72 GHz, offering 11 channels with DFS.
UNII-3 (5.725-5.825 GHz): Channels 149-165, centered at 5.745 GHz to 5.825 GHz, providing 5 channels, often with higher transmit power limits.
Wider Channels: Standards like 802.11ac/ax allow bonding of multiple 20 MHz channels into 40 MHz, 80 MHz, or 160 MHz widths. For instance, a 160 MHz channel might span Channels 36-64, though availability depends on regional rules and radar avoidance.

6 GHz Band Division (Wi-Fi 6E):

Total Range: Spans 5.925 GHz to 7.125 GHz, a 1.2 GHz-wide band, introduced with Wi-Fi 6E (802.11ax extension).

Channel Structure: Divided into up to 59 non-overlapping 20 MHz channels, with center frequencies starting at 5.955 GHz (Channel 1) and ending at 7.115 GHz (Channel 233). The band supports wider channels:
- 20 MHz channels: 59 total (e.g., Channels 1, 5, 9, up to 233).
- 40 MHz channels: Up to 29 non-overlapping pairs.
- 80 MHz channels: Up to 14 non-overlapping segments.
- 160 MHz channels: Up to 7 non-overlapping segments (e.g., Channels 1-65, 37-101).

Regulatory Constraints: Governed by new FCC rules (2020), this band requires AFC (Automated Frequency Coordination) in some regions to protect incumbent services, though it offers the most channels with minimal interference.

Usage: Designed for 802.11ax, the 6 GHz band maximizes capacity with up to 7 non-overlapping 160 MHz channels, supporting ultra-high speeds (up to 9.6 Gbps) but with the shortest range due to higher frequency attenuation.

This division optimizes Wi-Fi performance by balancing range, speed, and interference, with the 6 GHz band offering the most flexibility for future growth.