

The background is a dark blue gradient. It features several overlapping circles in light blue and purple. A prominent white shape, resembling a stylized antenna or a vertical bar with a rounded top, is positioned in the center-right. To the left of this shape, there is a yellow circle with a blue border, and several other blue circles of varying sizes are scattered across the design.

WIFI Technologies

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WiFi

is a family of wireless network protocols

Wi wireless

Fi has no meaning

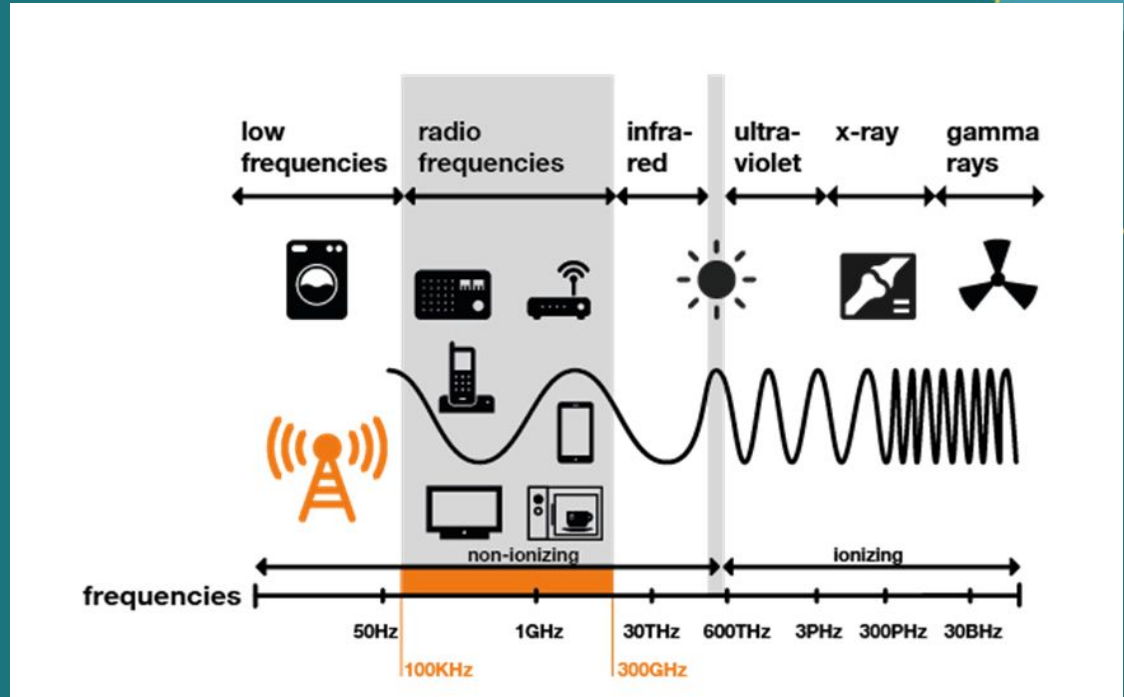
It allows devices to exchange information with one another, creating a network

Wi-Fi = TM for non-profit Wi-Fi Alliance,



WIFI SIGNALS

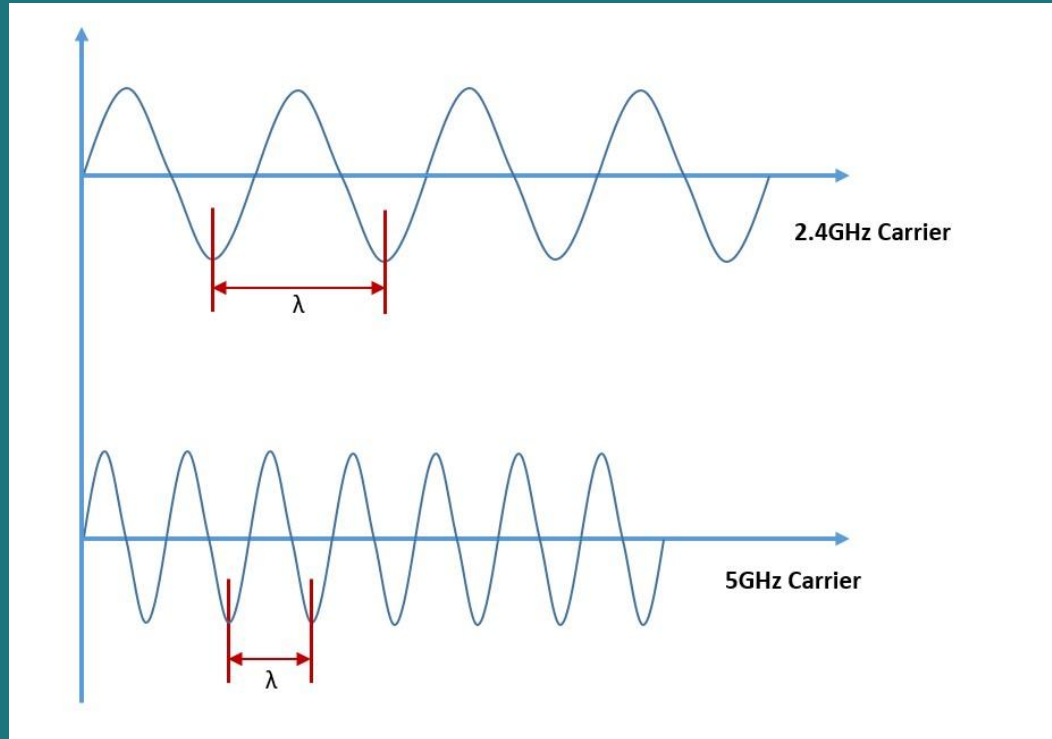
WiFi signals are a type of electromagnetic (EM) wavelengths that are transmitted in the air called radio waves. For this reason, WiFi signals are also known as RF (Radio Frequency) signals.



RADIO BANDS

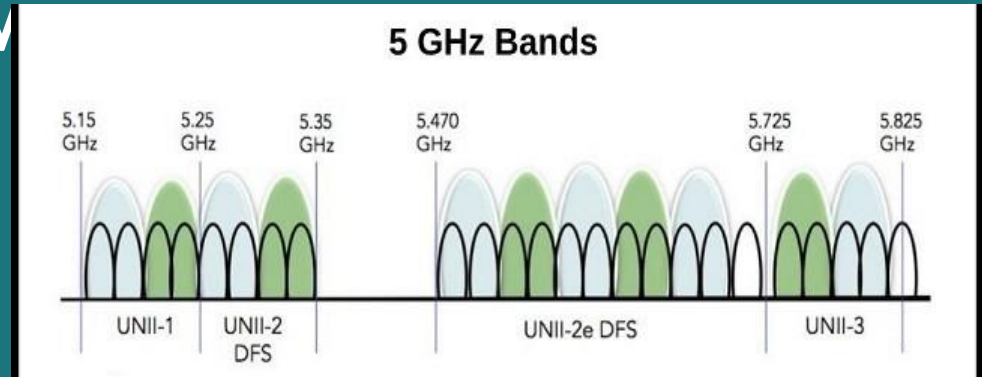
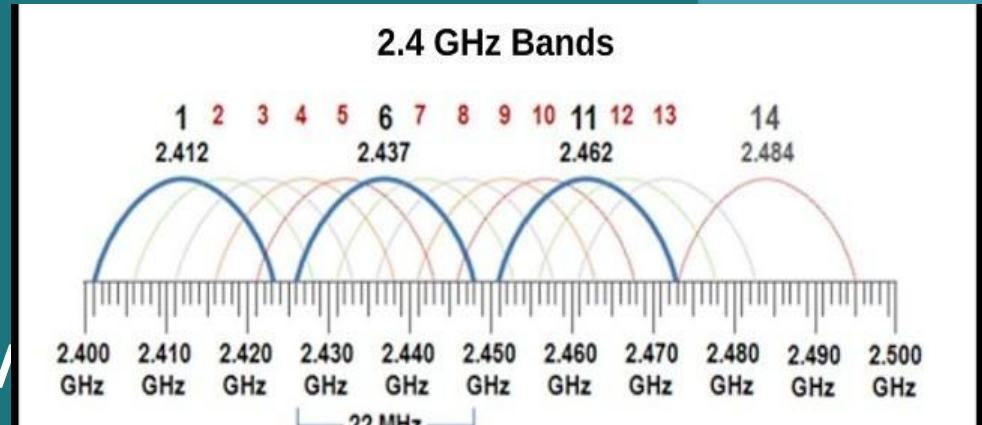


- 2.4Ghz
- 5.Ghz



Radio Bands

- 2.4GHz
11 Channels
[3 non-overlapping] [20M]
- [5.Ghz]
24 non-overlapping [20M]





WIFI STANDARDS

Year	1997	1999	1999	2003	2009	2014	2019	2020
IEEE	802.11	802.11a	802.11b	802.11g	802.11n	802.11ac	802.11ax	802.11ax
Frequency	2.4Ghz	5Ghz	2.4Ghz	2.4Ghz	2.4Ghz 5Ghz	2.4Ghz 5Ghz	2.4Ghz 5Ghz	2.4Ghz 5Ghz 6Ghz
Max Data	1Mbps	54Mbps	11Mbps	54Mbps	600Mbps	1.3Gbps	12Gbps	12Gbps
Wi-Fi Alliance		WIFI 1	WIFI 2	WIFI 3	WIFI 4	WIFI 5	WIFI 6	WIFI 6E
	SISO	SISO	SISO	SISO	SISO	MU-MIMO	MU-MIMO OFDMA	MU-MIMO OFDMA

5GHz Radio Bands



- 20, 40, 80, and 160MHz channels

5 GHz Channel Allocations

Frequency (GHz)	5.150				5.250				5.470				5.600 TDWR				5.640				5.725					5.850			
802.11 Allocations	UNII-1				UNII-2a				UNII-2c (Extended)																UNII-3				
Center Frequency	5180	5200	5220	5240	5260	5280	5300	5320	5500	5520	5540	5560	5580	5600	5620	5640	5660	5680	5700	5720	5745	5765	5785	5805	5825				
20 MHz	36	40	44	48	52	56	60	64	100	104	108	112	116	120	124	128	132	136	140	144	149	153	157	161	165				
40 MHz	38		46		54		62		102		110		118		126		134		142		151		159						
80 MHz	42				58				106				122				138				155								
160 MHz	50				114				114				114				114				114								

WIFI SIGNAL STRENGTH

- **mW - Milliwatts (1 mW = 0 dBm)**
 - Most accurate but hardest to measure; used by scientists and engineers
- **dBm** - Decibels in relation to milliwatts (usually -30 to -90)
 - Mid-accuracy; mid-comprehensible; most common; used by engineers
- **RSSI** - Received Signal Strength Indicator (usually 0-60 or 0-255)
 - The least accurate; most arbitrary; easiest to read; used by vendors



WIFI SIGNAL STRENGTH



Unusable
> -90 dBm



Not Good
> -80 dBm



Okay
> -70 dBm
Web, Email



Very Good
> -67 dBm
VoIP, Streaming
video

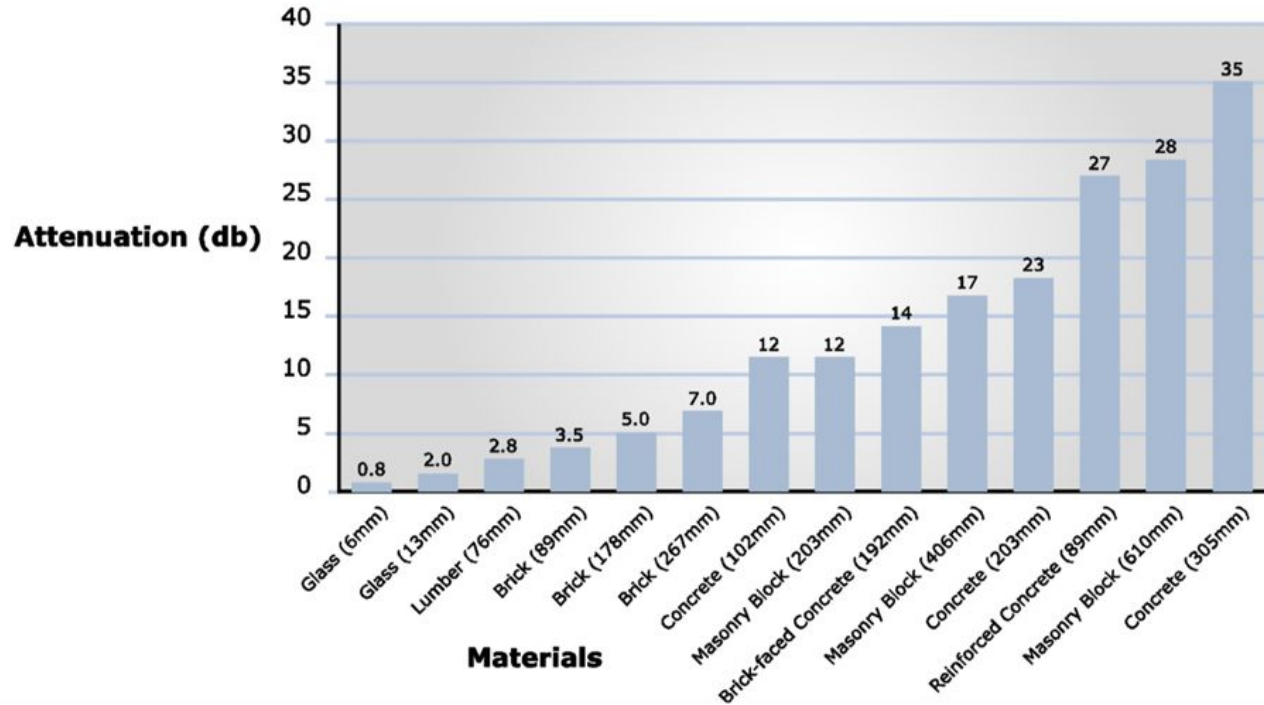


Excellent
> -30 dBm

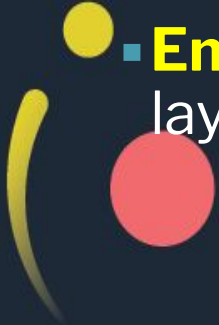
ATTENUATION

is the reduction in power of a signal through open air or as it tries to move through materials

Attenuation Measures



WHAT FACTORS AFFECT WIFI RANGE?

- **Output power:** Output power is measured in mW (milliwatts)
 - **WiFi antenna(s):** All WiFi devices use at least one WiFi antenna to broadcast the WiFi signal.
 - **WiFi technology:** Wireless 'AX' radios are capable of broadcasting to a greater distance than previous WiFi generations (g, b, a,n,ac).
 - **Environmental factors:** vary based on construction, layout, and interference.
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OUTPUT POWER

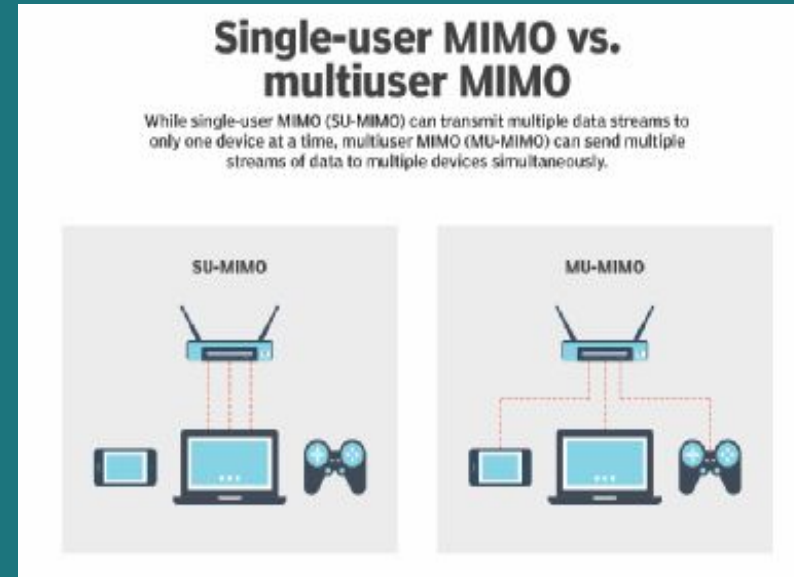
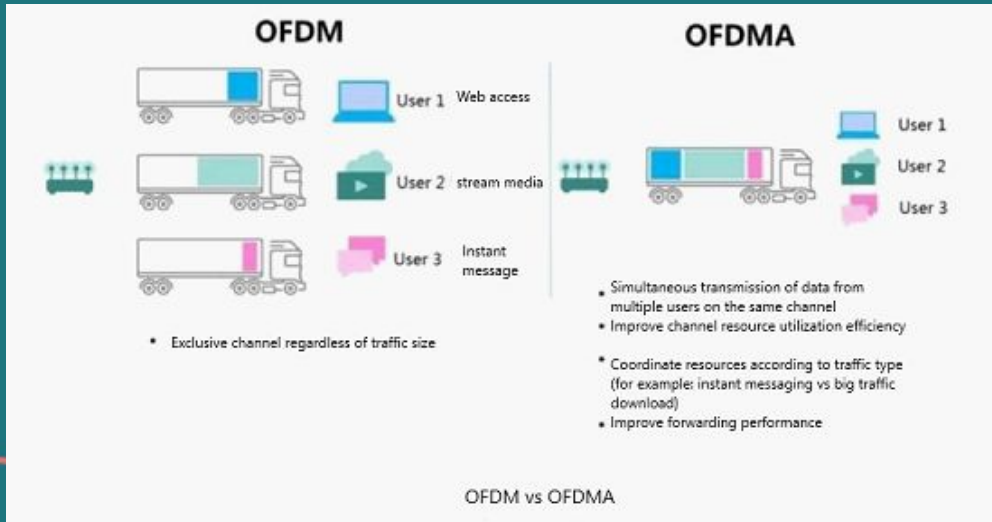
- Some manufacturers measure the output power in dBm instead of mW.
To convert to mW, you can use the formula
 $(\text{dBm} = \log_{10}(\text{mW}) * 10)$
 $\text{mW} = 10^{(\text{dBm}/10)}$,

30 dBm	- 1.00 Watt
27 dBm	- 500 mW
26 dBm	- 400 mW
25 dBm	- 320 mW
24 dBm	- 250 mW
23 dBm	- 200 mW
22 dBm	- 160 mW
21 dBm	- 130 mW
20 dBm	- 100 mW
15 dBm	- 32 mW
10 dBm	- 10 mW
5 dBm	- 3.2 mW
4 dBm	- 2.5 mW
3 dBm	- 2.0 mW
2 dBm	- 1.6 mW
1 dBm	- 1.3 mW



SISO, MIMO, SU-MIMO, MU-MIMO

- multi-user, multiple-input, multiple-output. MU-MIMO




Multiplexing vs Multi Access

SISO, MIMO, SU-MIMO, MU-MIMO


- multi-user, multiple-input, multiple-output. MU-MIMO

OFDMA



- OFDMA improves performance and efficiency
- OFDMA reduces latency
- Suitable for low bandwidth applications

MU-MIMO



- MU-MIMO boost capacity
- MU-MIMO provides high-speed connectivity for each user
- Suitable for high bandwidth applications

MU-MIMO is similar to serving multiple users simultaneously with multiple buses

Use OFDMA and MU-MIMO depending on the type of application being served

Thanks

