

Introduction to Wireless Networking

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Key concepts, components, and standards you need to know

1. What Is Wireless Networking?

Aspect	Description
Definition	Transmission of data between devices using radio waves (or other non-wired media) instead of physical cables.
Typical Use Cases	Home Wi-Fi, enterprise LANs, public hotspots, IoT sensor grids, vehicular communication, campus networks.
Advantages	Mobility, rapid deployment, reduced cabling cost, flexible topology.
Challenges	Interference, limited range, security risks, variable bandwidth, regulatory constraints.

2. Core Components

Component	Function	Typical Examples
Access Point (AP)	Central radio hub that bridges wireless clients to a wired network.	Home router, enterprise AP, outdoor mesh node.
Wireless Client	Device that connects to the AP (laptop, smartphone, sensor).	Wi-Fi NIC, Bluetooth module, Zigbee radio.
Radio Frequency (RF) Front-End	Generates, amplifies, and receives RF signals; includes antenna, filters, power amplifier.	2.4/5GHz transceiver, MIMO antenna array.
Controller / Management Software	Configures, monitors, and secures multiple APs (especially in large deployments).	Cloud-based WLAN controller, Cisco DNA Center.
Backhaul	Wired or wireless link that connects APs to the core network.	Ethernet, fiber, microwave point-to-point.

3. Frequency Bands & Propagation

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Band	Frequency Range	Typical Standards	Propagation Traits
2.4GHz (ISM)	2.400 – 2.483 GHz	802.11b/g/n, Bluetooth, Zigbee	Good wall penetration, high interference (crowded).
5GHz (UNII)	5.150 – 5.850 GHz	802.11a/n/ac/ax	More channels, less interference, shorter range.
6GHz (Wi-Fi 6E/7)	5.925 – 7.125 GHz	802.11ax (6GHz), 802.11be	Very low congestion, higher throughput, limited to newer devices.
Sub-GHz (e.g., 900 MHz, 868 MHz)	0.9 – 0.9 GHz	LoRa, Zigbee Sub-GHz, NB-IoT	Excellent penetration, long range, low data rate.
Millimeter Wave (mmWave)	24GHz, 60GHz, 77GHz	802.11ad/ay, 5G NR mmWave	Very high capacity, line-of-sight only, short range.

Propagation notes: Higher frequencies suffer greater free-space loss and are more easily blocked by walls or foliage. Lower frequencies travel farther but carry less data per hertz.

4. IEEE 802.11 Family (Wi-Fi)

Standard	Year	Frequency(s)	Max PHY Rate*	Notable Features
802.11b	1999	2.4GHz	11Mbps	First widely adopted Wi-Fi; DSSS modulation.
802.11a	1999	5GHz		