

Introduction to Mobile Networking

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Key concepts, components, and technologies that enable communication for devices on the move.

1. What Is Mobile Networking?

- **Definition:** A set of wireless communication technologies that allow devices (smartphones, tablets, IoT sensors, vehicles, etc.) to exchange data while moving across different geographic areas.
 - **Goal:** Provide seamless, reliable, and high-speed connectivity regardless of user location.
 - **Scope:** Includes cellular networks (4G/5G), Wi-Fi, Bluetooth, satellite links, and emerging mesh/vehicular solutions.
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2. Core Components

Component	Role	Typical Technologies
User Equipment (UE)	End-device that accesses the network	Smartphones, tablets, wearables, vehicle-on-board units
Radio Access Network (RAN)	Handles wireless link between UE and core	Base stations (eNodeB/gNodeB), small cells, Wi-Fi APs
Core Network	Provides routing, authentication, billing, and service control	EPC (4G), 5G Core (5GC), IMS
Backhaul	Connects RAN to the core over high-capacity links	Fiber, microwave, satellite
Transport Network	Carries data across the internet and between operators	MPLS, IP, SD-WAN
Management & Orchestration	Configures, monitors, and optimizes the network	OSS/BSS, SDN controllers, network slicing

3. Generations of Cellular Technology

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Generation	Frequency Bands	Peak Data Rate*	Key Features
1G (Analog)	800–900 MHz	~2 kbps	Voice only, analog modulation
2G (GSM, CDMA)	850–1900 MHz	~64 kbps	Digital voice, SMS, basic data
3G (UMTS, CDMA2000)	850–2100 MHz	~2 Mbps	Packet-switched data, video calls
4G LTE	600 MHz–3.5 GHz (plus mmWave)	100 Mbps (mobile) / 1 Gbps (fixed)	All-IP core, OFDMA, MIMO
5G	Sub-6 GHz & mmWave (24–100 GHz)	10 Gbps+ (mobile)	URLLC, massive MIMO, network slicing, edge computing

*Typical peak rates under ideal conditions.

4. Key Technologies & Concepts

4.1. Radio Access Techniques

- **OFDM / OFDMA** – Orthogonal frequency division multiplexing for high spectral efficiency.
- **MIMO** – Multiple-input multiple-output antennas increase capacity and reliability.
- **Beamforming** – Directs energy toward specific users, essential for mmWave.

4.2. Mobility Management

- **Handover** – Transfer of an active session from one cell/base station to another.
- **Tracking Areas** – Logical groups of cells used for location updates.
- **Paging** – Network-initiated search for a UE when incoming traffic arrives.

4.3. Quality of Service (QoS)

- **Classes** – Conversational, streaming, interactive, background (e.g., 5G QoS Identifier).
- **Prioritization** – Guarantees latency, jitter, and reliability for critical apps (e.g., autonomous driving).