

Basics of Telecommunication Technology

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(A concise, easy-to-read reference)

1. What Is Telecommunication?

Aspect	Description
Definition	Transmission of information (voice, data, video, etc.) over a distance using electronic signals.
Core Goal	Connect people, devices, and systems in real time or near-real time.
Key Components	Transmitter ? Transmission Medium ? Receiver (plus supporting infrastructure).

2. Main Types of Signals

Signal Type	Medium	Typical Use
Analog	Electrical voltage, acoustic waves, light (continuous).	Traditional telephone voice, radio broadcasting.
Digital	Binary pulses (0/1) carried by electrical, optical, or radio waves.	Internet data, mobile voice (VoLTE), video streaming.

Why digital dominates today: better noise immunity, easy compression, multiplexing, and integration with computers.

3. Transmission Media

Category	Examples	Characteristics
Wired	Twisted-pair copper, coaxial cable, fiber-optic cable	• Low latency • High reliability • Bandwidth limited by physical properties

Basics of Telecommunication Technology

Category	Examples	Characteristics
Wireless	Radio (VHF/UHF), microwave, satellite, infrared, millimeter-wave (5G)	• Mobility & coverage • Susceptible to interference & attenuation
Hybrid	Power line communication, PLC; fiber-to-the-home (FTTH) with wireless “last-mile”.	Combines strengths of both worlds.

4. Fundamental Concepts

Concept	Meaning	Typical Formula / Metric
Bandwidth	Range of frequencies a channel can carry.	$(B = f_{\text{high}} - f_{\text{low}})$ (Hz)
Data Rate (Throughput)	Bits per second actually transferred.	$(R = \frac{\text{Number of bits}}{\text{Transmission time}})$
Latency	Time for a bit to travel from source to destination.	Measured in milliseconds (ms).
Signal-to-Noise Ratio (SNR)	Ratio of signal power to noise power.	$(\text{SNR}_{\text{dB}} = 10 \log_{10} \frac{P_{\text{signal}}}{P_{\text{noise}}})$
Modulation	Process of encoding information onto a carrier wave.	AM, FM, PM, QAM, PSK, OFDM, etc.
Multiplexing	Sharing a single medium among multiple signals.	FDM, TDM, WDM, CDMA, OFDM.

5. Basic Network Elements

Element	Function
Transmitter (Tx)	Converts information into a signal (modulation).
Receiver (Rx)	Demodulates the incoming signal back to information.
Repeater / Amplifier	Boosts signal strength to overcome loss.

Basics of Telecommunication Technology

Element	Function
Switch / Router	Directs traffic based on address information (e.g., IP, telephone number).
Base Station	Wireless access point for mobile devices (cell towers, Wi-Fi APs).
Gateway	Interconnects different network types (e.g., PSTN & IP).

6. Cellular Architecture (Overview)

1. **Mobile Station (MS)** – User