COMMUNICATION TECHNOLOGIES

The Internet of Things (IoT) relies on various communication technologies for seamless connectivity between devices. These technologies can be categorized into short-range, medium-range, and long-range communication methods.

1. Short-Range Communication Technologies

These technologies are ideal for local device-to-device communication and are energy-efficient.

(a) NFC (Near Field Communication)

- **Range:** <10 cm
- **Frequency:** 13.56 MHz
- **Speed:** Up to 424 Kbps
- **Use Cases:** Contactless payments, access control, smart cards

(b) RFID (Radio Frequency Identification)

- **Range:** Up to 100 m (depends on frequency)
- **Frequency:** LF (125 kHz), HF (13.56 MHz), UHF (860-960 MHz)
- **Use Cases:** Inventory tracking, logistics, asset management

(c) Bluetooth & BLE (Bluetooth Low Energy)

- **Range:** 10-100 meters
- **Frequency:** 2.4 GHz
- **Speed:** 1-3 Mbps
- **Use Cases:** Wearables, health monitoring, smart home automation

(d) ZigBee

- **Range:** 10-100 meters
- **Frequency:** 2.4 GHz
- **Speed:** 250 Kbps

- **Use Cases:** Smart lighting, security systems, industrial automation

2. Medium-Range Communication Technologies

These technologies support moderate data transfer rates and are used in local networks.

(a) Wi-Fi

- **Range:** 50-100 meters
- **Frequency:** 2.4 GHz / 5 GHz
- **Speed:** 0.1-1 Gbps
- **Use Cases:** Smart homes, video streaming, industrial IoT

(b) 6LoWPAN (IPv6 over Low Power Wireless Personal Area Network)

- **Range:** 25-50 meters
- **Frequency:** Sub-GHz

- **Speed:** 0-250 Kbps
- **Use Cases:** Smart cities, industrial automation, environmental monitoring

3. Long-Range Communication Technologies

These technologies enable wide-area connectivity for IoT devices.

(a) LPWAN (Low Power Wide Area Network) Technologies

LoRaWAN (Long Range Wide Area Network)

- **Range:** Up to 10 km
- **Frequency:** Sub-GHz (868 MHz, 915 MHz)
- **Speed:** 40-250 Kbps
- **Use Cases:** Smart agriculture, remote monitoring, environmental sensors

NB-IoT (Narrowband IoT)

- **Range:** 1-15 km
- **Frequency:** Cellular bands
- **Speed:** 200-250 Kbps
- **Use Cases:** Smart meters, industrial IoT, asset tracking

(b) Cellular IoT (3G, 4G, 5G)

3G/4G LTE

- **Range:** Several kilometers
- **Speed:** 1-100 Mbps
- **Use Cases:** Connected cars, video surveillance, industrial automation

5G

- **Range:** 500 meters to several km
- **Speed:** 1-10 Gbps

- **Use Cases:** Autonomous vehicles, smart healthcare, real-time IoT applications