Aim: Study of Various IoT Protocols and Their Libraries

Theory:

In IoT systems, wireless protocols are essential for enabling communication between smart devices and gateways or the cloud. Each protocol offers trade-offs in terms of **range, data rate, power consumption, and complexity**.

1. Wi-Fi (IEEE 802.11)

- **Description**: High-speed wireless networking used for local area communication.
- **Range**: Up to 100 meters
- **Data Rate**: Up to 600 Mbps
- **Power Consumption**: High
- **Use Cases**: Smart homes, surveillance, media streaming, cloud communication.

Common Modules: ESP8266, ESP32
Libraries:

- Arduino: WiFi.h, ESP8266WiFi.h, WiFiClient.h
- MicroPython: network.WLAN, urequests for HTTP requests

Example Functionality:

- Connect to a router
- Send data to a cloud server (e.g., ThingSpeak or Firebase)

2. Bluetooth (IEEE 802.15.1)

- **Description**: Short-range communication protocol for personal devices.
- **Range**: ~10 meters (Bluetooth Classic), up to 100 meters (BLE)
- **Data Rate**: ~1–3 Mbps
- **Power Consumption**: Low (especially BLE)
- **Use Cases**: Wearables, health monitors, smart locks

Common Modules: HC-05 (Bluetooth Classic), HM-10 (BLE), ESP32 BLE
Libraries:

- Arduino: SoftwareSerial.h, BluetoothSerial.h (for ESP32)
- MicroPython: ubluetooth module (on ESP32)

Example Functionality:

- Pairing with a smartphone
- Sending sensor data to a mobile app

3. Zigbee (IEEE 802.15.4)

- **Description**: Low-power, low-data-rate mesh networking protocol for IoT.
- **Range**: 10–100 meters (extendable via mesh)
- **Data Rate**: ~250 kbps
- **Power Consumption**: Very low
- **Use Cases**: Home automation, industrial monitoring, smart energy

Common Modules: XBee (by Digi), Zigbee shield
Libraries:

- Arduino: XBee.h, AltSoftSerial.h, SoftwareSerial.h
- Python (via USB serial): pyserial, xbee library

Example Functionality:

- Sensor node communication in mesh
- Data relaying between Zigbee end devices and coordinator

4. LoRa (Long Range Radio)

- **Description**: Long-range, low-power communication for low-data-rate IoT applications.
- **Range**: Up to 10+ kilometers (line of sight)
- **Data Rate**: ~0.3 kbps to 50 kbps

- **Power Consumption**: Very low
- **Use Cases**: Remote agriculture, environmental monitoring, smart cities

Common Modules: SX1278, RFM95W, LoRa shields for Arduino
Libraries:

- Arduino: LoRa.h (from Sandeep Mistry), RadioHead.h
- MicroPython: Custom libraries for SX127x (via SPI)

Example Functionality:

- Node-to-gateway data transmission
- Broadcast sensor readings in remote areas