**IoT Lab 3**

**Aim: IoT 3 - Study the various IoT protocols Libraries (e.g., Wi-Fi, Bluetooth, ZigBee, LoRa)**

**Theory:**

IoT devices rely on communication protocols to transmit data between sensors, devices, and cloud platforms. Each protocol has specific use-cases depending on range, power, and data requirements:

a) Wi-Fi (IEEE 802.11)

* High data rate, short-to-medium range
* Used for internet connectivity and data transfer
* Libraries: WiFi.h (Arduino), network (MicroPython)

b) Bluetooth (Bluetooth Classic & BLE)

* Short-range, low-power
* Used for mobile device communication and wearables
* Libraries: BluetoothSerial.h (Arduino), ubluetooth (MicroPython)

c) ZigBee (IEEE 802.15.4)

* Mesh networking, low power
* Used in home automation and industrial IoT
* Libraries: XBee.h (Arduino), Digi XBee Python Library

d) LoRa (Long Range)

* Low-power, long-range (up to 10 km)
* Used for remote environmental sensing, agriculture
* Libraries: LoRa.h (Arduino), pyLoRa (Python)

e) RFID (Radio Frequency Identification)

* Uses tags and readers for identification
* No battery in passive tags
* Libraries: MFRC522.h (Arduino)

**Procedure:**

Step 1: Wi-Fi Communication

* Connect ESP32 to a Wi-Fi network using WiFi.h
* Upload a sketch to send data to ThingSpeak or print to serial monitor

Step 2: Bluetooth Communication

* Use BluetoothSerial.h to send and receive data via smartphone Bluetooth terminal app

Step 3: ZigBee Communication

* Connect two XBee modules in coordinator and router mode
* Transmit a sensor reading from one to another via serial

Step 4: LoRa Communication

* Use two LoRa modules to transmit and receive a message over a long distance

Step 5: RFID Reading

* Connect RC522 module to ESP32
* Upload code to detect and display RFID tag UID on the serial monitor

**Observations:**  
Fill in a table comparing protocol parameters:

| **Protocol** | **Range** | **Data Rate** | **Power Consumption** | **Use Case** |
| --- | --- | --- | --- | --- |
| Wi-Fi | ~100 m | High (Mbps) | High | Smart appliances, cloud |
| Bluetooth | ~10 m | Moderate (Kbps) | Low | Wearables, mobile apps |
| ZigBee | ~100 m (mesh) | Low (Kbps) | Very Low | Home automation |
| LoRa | ~10 km | Low (Kbps) | Very Low | Remote monitoring |
| RFID | ~1-10 cm | Low | Passive (no battery) | Access control, tracking |

**Conclusion:**Each IoT protocol serves a different purpose: Wi-Fi for high data, Bluetooth for proximity, ZigBee for mesh control, LoRa for long range, and RFID for contactless identification. Choosing the right protocol depends on application requirements like range, power, and data speed.