3. Aim:

To Study Various IoT Protocol Libraries: Zigbee, LoRa, Wi-Fi, Bluetooth

3.1. Theory

IoT (Internet of Things) devices require efficient communication protocols to transfer data between sensors, controllers, and cloud systems. Different protocols serve different purposes based on factors like range, power consumption, and data rate.

- **Zigbee** is a low-power, low-data-rate wireless mesh protocol often used for smart home automation and sensor networks. It operates on IEEE 802.15.4 and is ideal for short-range communication.
- **LoRa (Long Range)** is designed for long-distance, low-power communication. It is used in wide-area networks for applications like agriculture, smart cities, and environmental monitoring.
- **Wi-Fi** offers high-speed connectivity suitable for large data transfers and direct Internet access. It is commonly used in consumer IoT devices where power is not a major concern.
- **Bluetooth** is a short-range, low-energy protocol used for personal area networks, wearables, and device-to-device communication.

3.2. Features of IoT Protocols

Protocol	Frequency	Range	Data Rate	Power Consumption	Topology	Applications
Zigbee	2.4 GHz	~10–100 m	20–250 kbps	Very Low	Mesh/Star	Smart homes, sensors
LoRa	Sub-GHz	~2–10 km	< 50 kbps	Ultra Low	Star (LoRaWAN)	Agriculture, environment, logistics
Wi-Fi	2.4/5 GHz	~50–100 m	Up to 1 Gbps	High	Star/Point-to-point	Smart appliances, streaming
Bluetooth	2.4 GHz	~10–50 m	1–3 Mbps	Low (BLE)	Point-to-point	Wearables, health monitors

3.3. Key Libraries Used

Protocol	Common Libraries	Platform	Protocol
Zigbee	XBee, DigiXBee, Zigpy	Arduino, Python	Zigbee
LoRa	RadioHead, LoRa by Sandeep Mistry	Arduino, Raspberry Pi	LoRa
Wi-Fi	WiFi.h (ESP), ESP8266WiFi, socket	Arduino, Python	Wi-Fi
Bluetooth	BLEPeripheral, BluetoothSerial, bluepy	Arduino, Python	Bluetooth

3.4. Applications

- **Zigbee:** Home automation, energy monitoring, industrial sensor networks
- **LoRa:** Smart farming, disaster alert systems, GPS tracking
- **Wi-Fi:** Live camera feeds, cloud data syncing, voice assistants
- **Bluetooth:** Fitness trackers, wireless medical sensors, smart locks
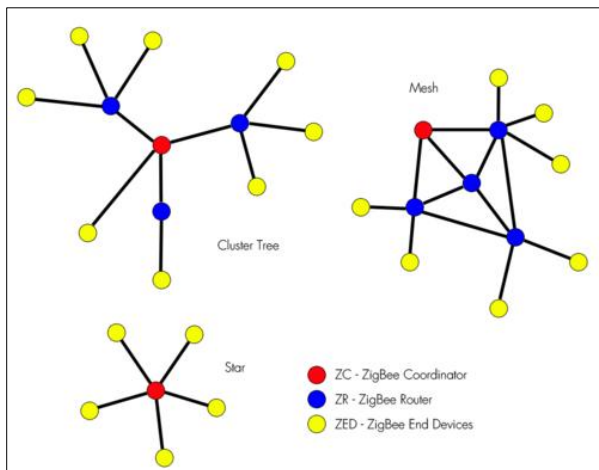

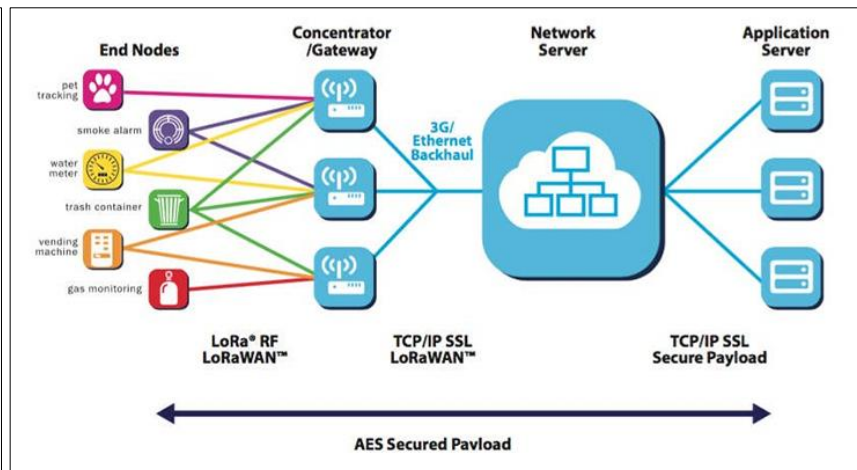## 3.5. Diagram

Figure 1: Zigbee protocol
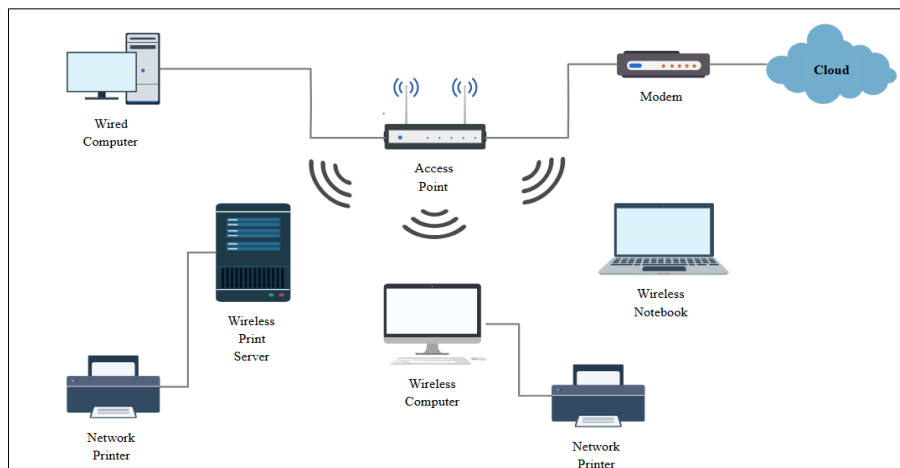

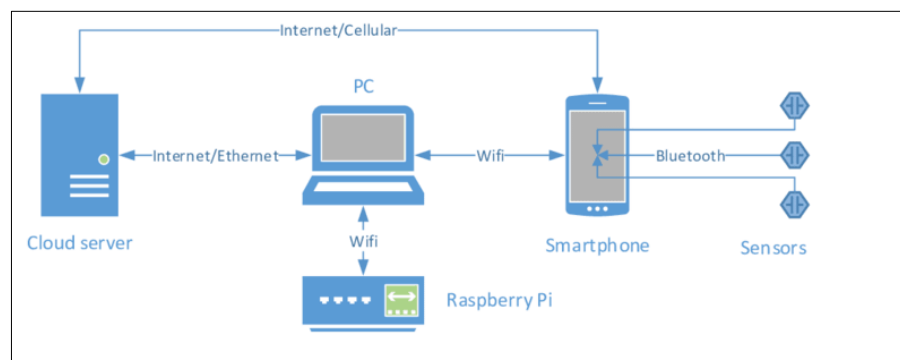Figure 2: LoRA protocol

Figure 3: Wi-fi

Figure 4: Bluetooth

3.6. Conclusion

In this practical, we studied major IoT communication protocols—Zigbee, LoRa, Wi-Fi, and Bluetooth—along with their features, libraries, and applications. Understanding these protocols helps in choosing the right connectivity solution for specific IoT use cases based on range, power, and data needs.