2. Aim: Basics of Network (CoAP, MQTT) and Cloud (ThingSpeak)

2.1. Theory

In IoT systems, communication between devices and cloud platforms is essential for data exchange, monitoring, and control. Protocols like **CoAP (Constrained Application Protocol)** and **MQTT (Message Queuing Telemetry Transport)** are widely used for their lightweight and efficient communication in resource-constrained environments.

- **MQTT** is a publish/subscribe protocol designed for low-bandwidth, high-latency networks. Devices (clients) publish messages to topics and subscribe to topics to receive messages via a central broker.
- **CoAP** is a RESTful protocol optimized for constrained devices, similar to HTTP but lighter, using UDP instead of TCP, suitable for low-power sensors and actuators.

ThingSpeak is a cloud-based platform that allows IoT devices to send data over the Internet using HTTP or MQTT. It enables data storage, real-time visualization, and basic analysis, making it ideal for prototyping and academic projects.

2.2. Features of CoAP, MQTT, and ThingSpeak

- **MQTT:**
  - Lightweight publish/subscribe protocol
  - Operates over TCP
  - Low power and bandwidth usage
  - Requires a central broker (e.g., Mosquitto)
- **CoAP:**
  - RESTful architecture (GET, POST, PUT, DELETE)
  - Works over UDP
  - Supports multicast and low-overhead communication
  - Suitable for battery-operated and low-memory devices
- **ThingSpeak:**
  - Cloud platform for IoT data collection and visualization
  - Supports HTTP and MQTT protocols
  - Provides API keys, charts, alerts, and MATLAB analysis tools
  - Ideal for real-time monitoring of sensor data

2.3. Key Components in Networking and Cloud Setup

Component	Description
MQTT Broker	Manages message traffic between publishers and subscribers
CoAP Server	Receives requests and sends responses to CoAP clients
Publisher Device	Sends data (e.g., sensor values) to the broker or server
Subscriber Device	Receives data by subscribing to specific topics
ThingSpeak Channel	Stores and visualizes IoT data from devices

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2.4. Applications

- **Smart Home:** Sensor communication and cloud control using MQTT/CoAP
- **Remote Monitoring:** Real-time data visualization with ThingSpeak
- **Predictive Maintenance:** Equipment data sent to cloud for analysis
- **Weather Stations:** Environmental data logging using MQTT + ThingSpeak

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2.5. Diagram

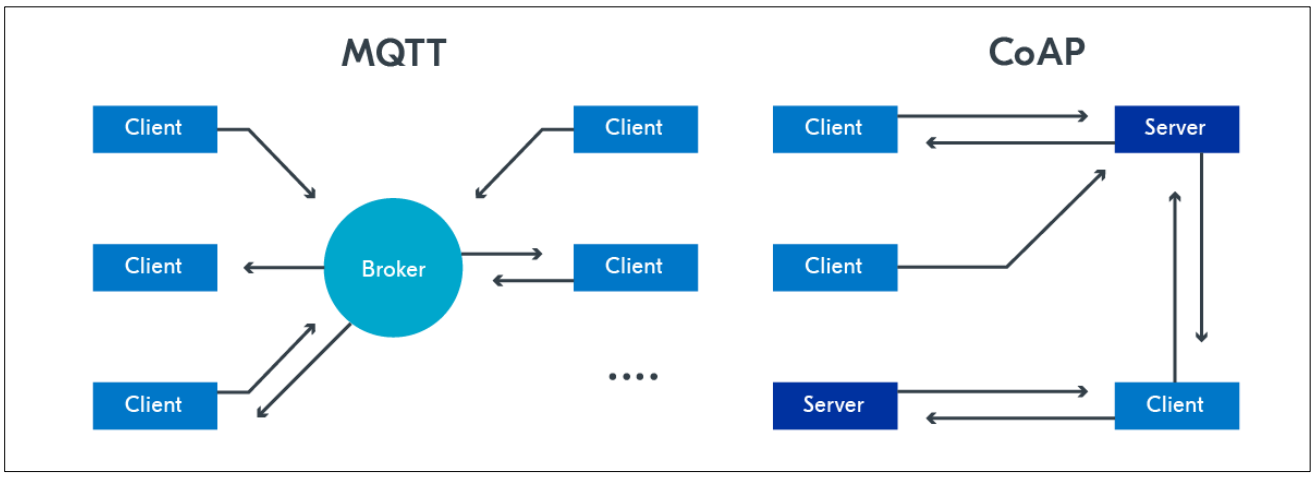

Figure 1: MQTT and COAP protocol

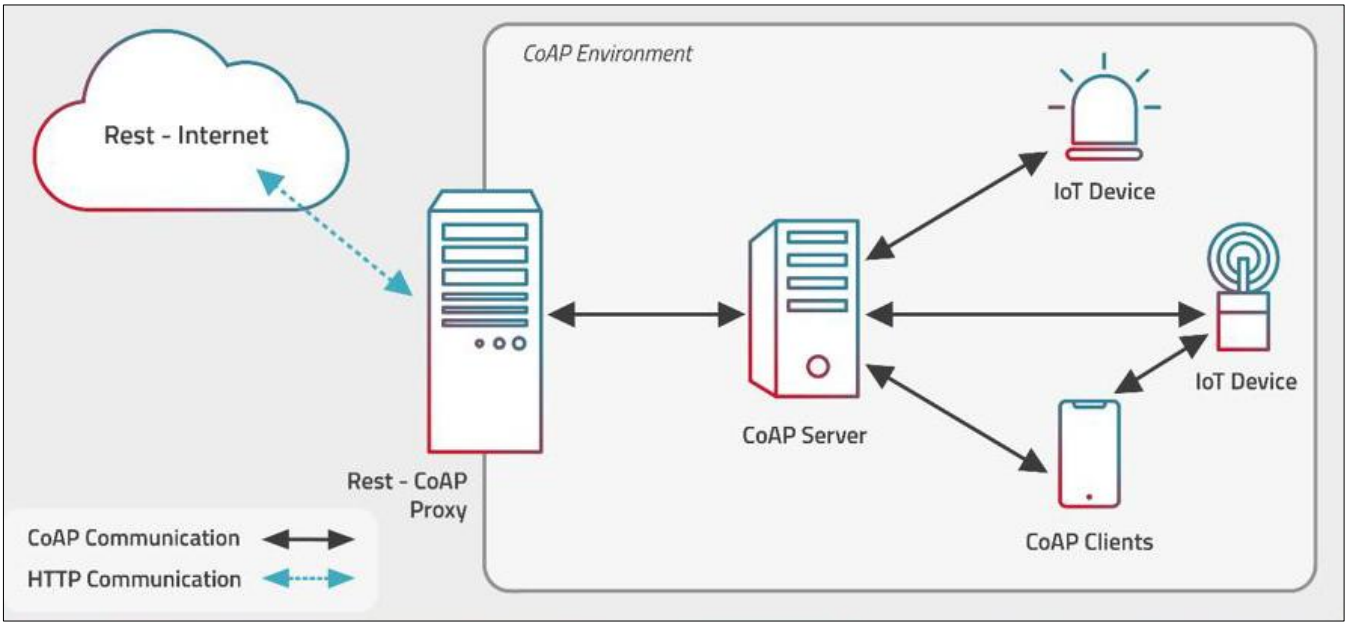

Figure 2: How CoAP works?

2.6. Conclusion

In this practical, we explored the basics of network communication in IoT using MQTT and CoAP, along with cloud integration using ThingSpeak. We learned how these technologies enable efficient data exchange and visualization, forming the foundation for real-time and remote IoT applications.