Aim: Basics of Network Protocols (CoAP, MQTT) and Cloud Platform (ThingSpeak)

Theory:

1. IoT Communication Protocols Overview:

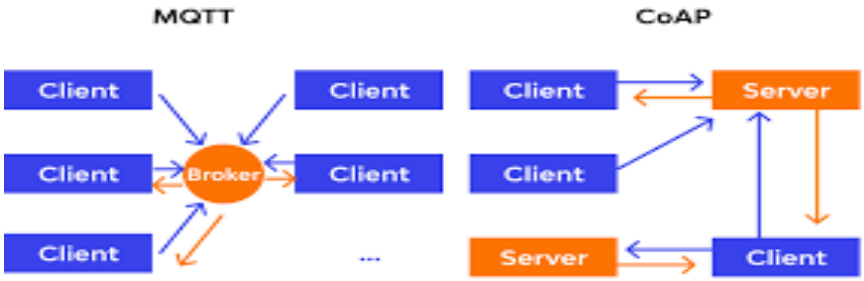
In IoT (Internet of Things), devices must communicate efficiently using low bandwidth, minimal power, and real-time messaging. Traditional protocols like HTTP are too heavy for such constrained environments, so **lightweight protocols** like **MQTT** and **CoAP** are preferred.

CoAP (Constrained Application Protocol):

- **Type**: RESTful client/server protocol similar to HTTP
- **Transport**: Runs over UDP (not TCP), making it faster and lighter
- **Designed for**: Low-power, constrained devices and networks
- **Methods**: GET, POST, PUT, DELETE (like HTTP)
- **Message Types**:
    - **Confirmable (CON)** – requires acknowledgment
    - **Non-confirmable (NON)** – no acknowledgment
    - **Acknowledgment (ACK)** – response to CON
    - **Reset (RST)** – error message
- **Features**:
    - Supports multicast
    - Asynchronous message exchange
    - Ideal for sensors and actuators in constrained environments

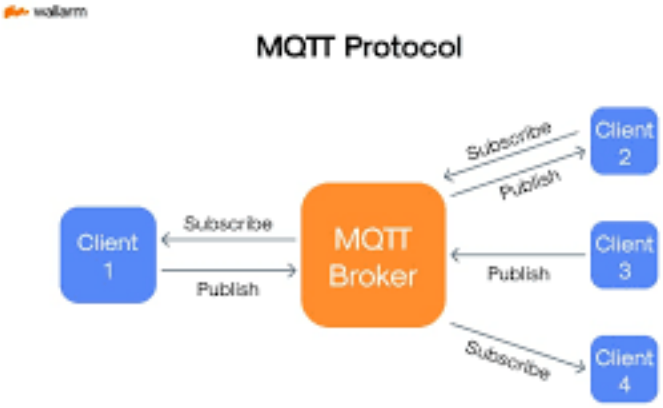
CoAP Message Format:

- **Header (4 bytes)** – includes version, message type, token length, message code, and message ID
- **Token (0-8 bytes)** – for matching responses with requests
- **Options** – encoded as Type-Length-Value (TLV)
- **Payload** – actual data, separated by a payload marker (0xFF)



MQTT (Message Queuing Telemetry Transport):

- **Type**: Publish/Subscribe messaging protocol
- **Transport**: Runs over TCP/IP
- **Lightweight**: Designed for low-bandwidth, high-latency, unreliable networks
- **Components**:
  - **Publisher**: Sends data (e.g., temperature sensor)
  - **Subscriber**: Receives data (e.g., a display or alert system)
  - **Broker**: Central server that handles message distribution (e.g., Mosquitto)
- **Key Features**:
  - Low overhead (minimal packet size)
  - QoS (Quality of Service) levels: 0 (at most once), 1 (at least once), 2 (exactly once)
  - Used in smart homes, industrial control, and telemetry systems



ThingSpeak (Cloud Platform):

- **What is ThingSpeak?**
  ThingSpeak is an open-source IoT cloud platform used for **collecting, analyzing, and visualizing sensor data** online in real-time.
- **Key Features**:
  - Allows real-time data logging and retrieval via API
  - Visualization using charts and graphs
  - Supports MATLAB for advanced analytics
  - Free for academic and non-commercial use (with limitations)
  - Easily integrates with Arduino, Raspberry Pi, ESP8266/ESP32
- **How it Works**:
  - Create a **channel** on ThingSpeak
  - Devices send data via HTTP or MQTT using **API Keys**
  - Data is stored in fields and visualized using widgets
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