

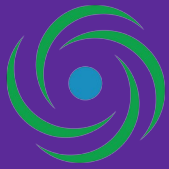
IoT School

# IoT Communication Protocols

IoT Data and Network Protocols

**Presented By:** Ochieno Eliud





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# Overview

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- **Introduction to IoT Protocols:**
  - Definition and role of IoT in connecting devices.
  - Importance of communication protocols for device interaction.
- **Types of IoT Protocols:**
  - Data Protocols (e.g., MQTT, HTTP).
  - Networking Protocols (e.g., WiFi, Bluetooth, GSM, LoRa).
- **IoT Protocol Selection & Significance:**
  - Criteria for selecting the right protocol
  - Significance of choosing the right protocol for specific IoT use cases.
  - Comparison between MQTT and HTTP
- **OSI Model & Key Layers for IoT:**
  - The seven layers of the OSI model and their importance.
  - Key layers of OSI model for IoT communication.
- **Practical Example:**
  - ESP32 and MQTT: Real-world application of IoT protocols in sensor data transmission.



# Introduction to IoT Protocols

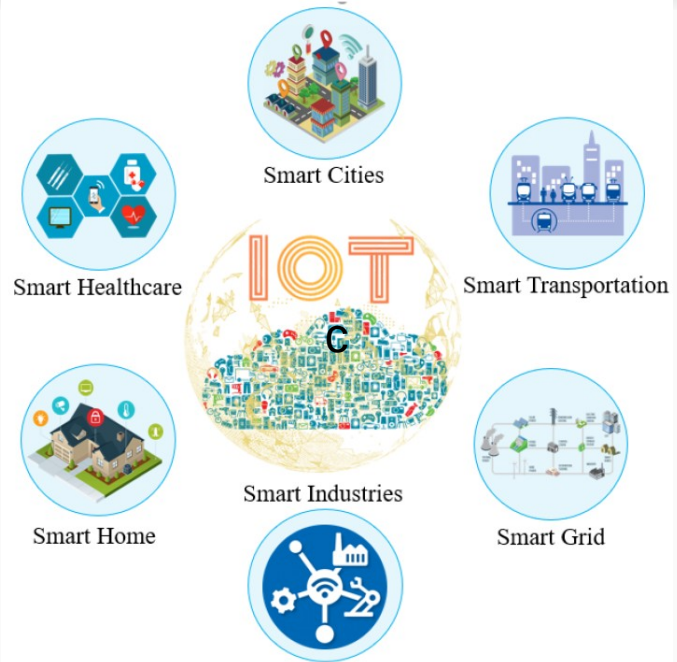
## Definitions:

### IoT:

Internet of Things (IoT) refers to a network of physical objects ("things") embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet, cellular networks among others.

### IoT communication protocols:

On the other hand, IoT communication protocols refers to a set of rules and standards that define how IoT devices exchange(send/receive) data across the various ends of their support networks.



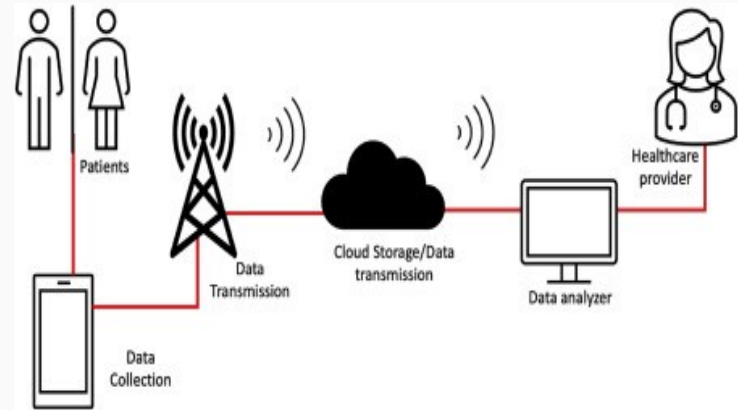
# Introduction to IoT Protocols

## Role:

IoT enables devices like smart home gadgets, industrial machines, and health monitors to communicate, share data, and perform tasks autonomously.

## Importance of communication protocols:

- Communication protocols are essential for ensuring seamless and reliable interaction between IoT devices.
- They define the rules for data transmission, ensuring devices understand and respond to each other efficiently.



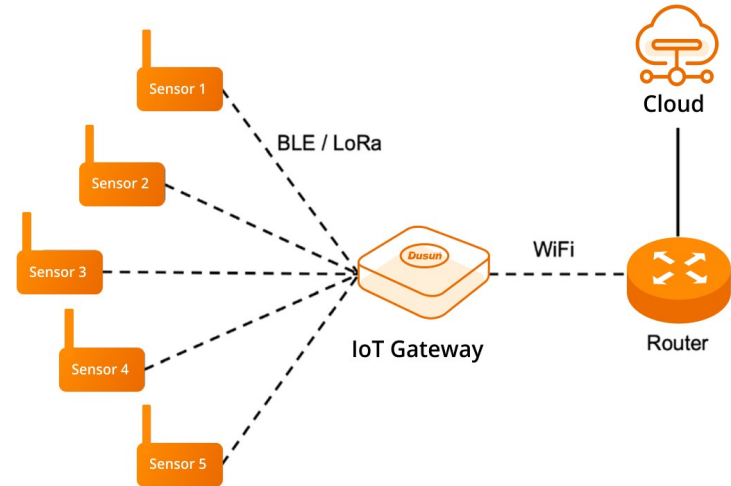
# IoT Protocols: Network Protocols

## Network Protocols:

These allow devices in an IoT network to communicate with each other hence handle data transmission over a network.

They include:

- Bluetooth
- Ethernet
- WiFi
- ZigBee
- Thread
- Cellular networks(3G,4G and 5G)
- Z-Wave
- LoraWAN



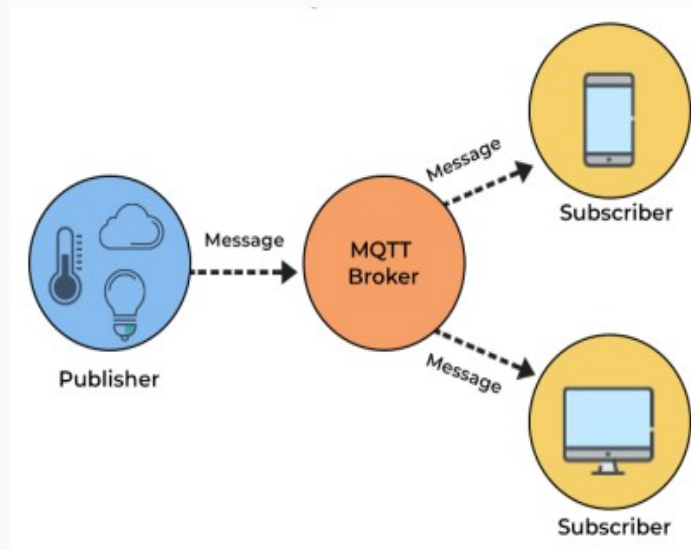
# IoT Protocols: Data Protocols

## Data Protocols:

These on the other hand manage how IoT data is formatted, encoded, and exchanged between devices and systems

They include:

- Extensible Messaging and Presence Protocol(XMPP)
- Message Queuing Telemetry Transport(MQTT)
- Constrained Application Protocol(CoAP)
- Simple Object Access Protocol(SOAP)
- Hypertext Transfer Protocol(HTTP)
- Advanced Message Queuing Protocol(AMQP)
- WebSocket



# IoT Protocols: Selection

## Choosing the right IoT Protocol

**Q:** What are the power consumption & data transmission needs?

- ie battery needs, transmission bandwidth etc

**Q:** What are the operation range & mobility requirements?

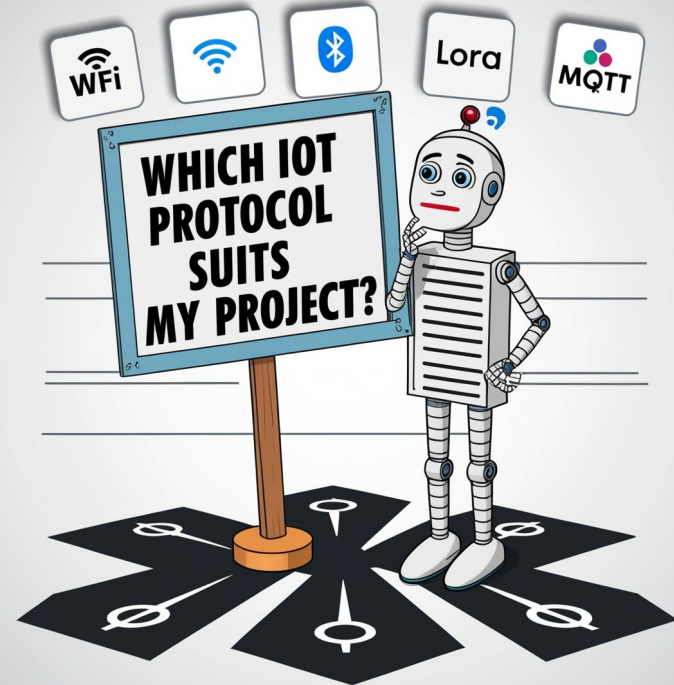
- ie operation distance, mobile/stationary solution

**Q:** What level of security is necessary?

- ie is the data sensitive or mission critical

**Q:** How scalable is the solution & what are the accepted latency ranges?

- ie number of devices to be connected, rate of data transmission etc



# IoT Protocols: Selection

## Factors that influence the choice of IoT Protocol

**Range:** Short-range for instance, bluetooth(BLE), ZigBee etc and long-range ie LoRa, 5G etc

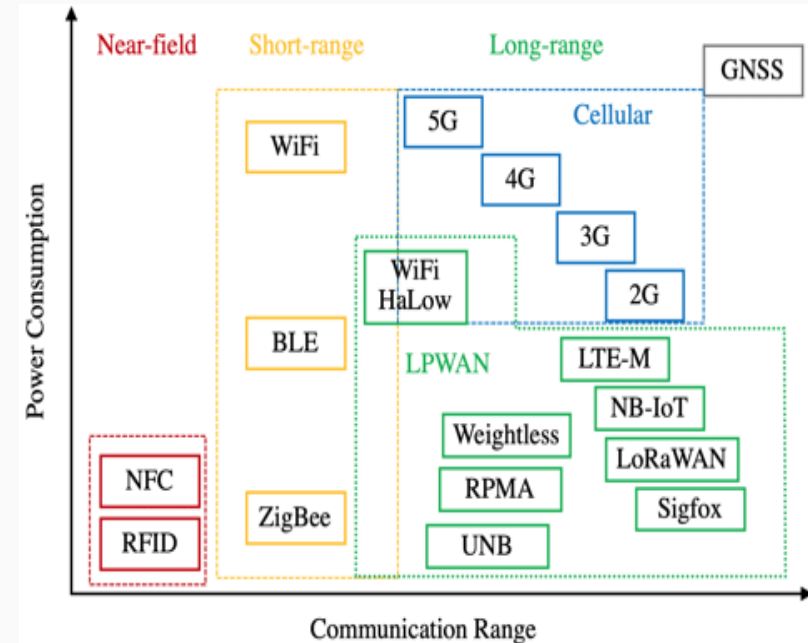
**Power consumption:** Example, for battery powered devices, low-power protocols like LoRa, BLE, ZigBee are suitable

**Data requirements:** Low data apps, low-bandwidth e.g MQTT, high data apps – high-bandwidth e.g WiFi

**Security:** Sensitive data apps require secure protocols e.g HTTPS, MQTT over SSL

**Scalability:** For instance, LoRa and GSM can handle large-scale IoT deployments, while WiFi and Bluetooth are more suited for smaller networks

**Cost:** LoRa can be cost-effective for large-scale networks while WiFi and BLE may be more economical for short-range applications.





# IoT Protocols: Significance of Right Protocol

**Interoperability:** Ensures seamless communication between devices from different manufacturers

**Energy Efficiency:** Low-power protocols extend device battery life, ideal for remote deployments.

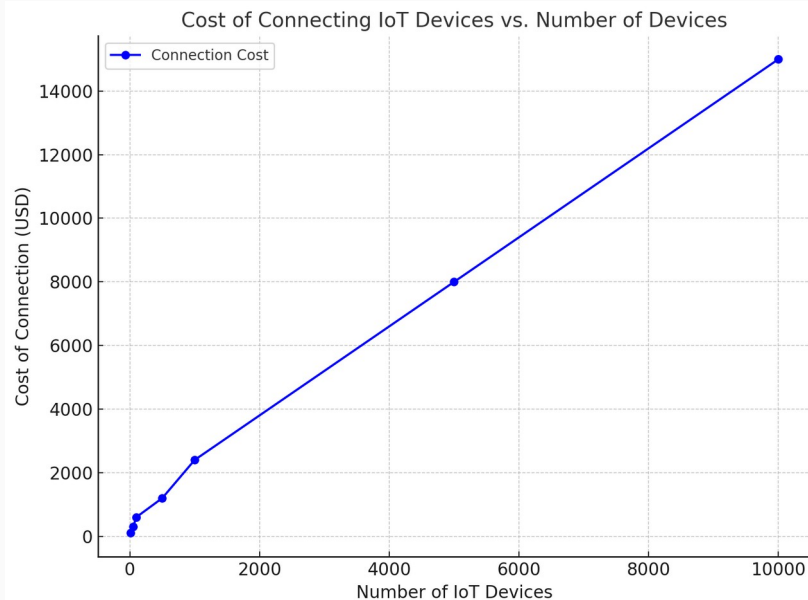
**Scalability:** Right protocol selection allows efficient handling and extensive deployment of IoT devices

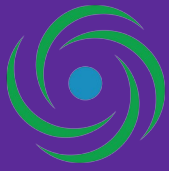
**Data Security:** Protocols like MQTT with SSL/TLS encrypt data for secure handling and transmission

**Bandwidth Optimization:** Right protocol selection ensures improved network resources utilization for data transmission.

**Real-time Communication:** With right protocols we can optimize network performance and address latency issues.

**Network Costs:** Protocol choice directly impacts operating costs, hence right choice ensures checked network cost.





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# IoT Communication Protocols

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**Any  
Questions**



# Questions:

**Q1. What are the main differences between MQTT and HTTP, and when would you use one over the other in an IoT project?**

*Think about which is better for saving power or working with many devices.*

**Q2. How do IoT protocols like MQTT and HTTP keep data safe, and why is security important when devices are sharing information?**

*Discuss how encryption or passwords can protect IoT devices from being hacked.*

**Q3. How does the choice of IoT protocol affect the battery life of your devices, especially for sensors in remote locations?**

*Think about which protocols help save energy and make devices last longer without frequent recharging.*



# HTTP / MQTT Comparison

## HTTP

- Operates on basis of Request/Response
- Heavy data transmission
- High bandwidth operation
- High power consumption
- High transmission latency
- Favorable for heavy data transmission requirements

## MQTT

- This is Publish/Subscribe based protocol
- Light-weight data transmission
- Low bandwidth
- Low power consumption
- Low transmission latency
- Favorable for light-weight data transmission applications



# OSI Model

## Definition:

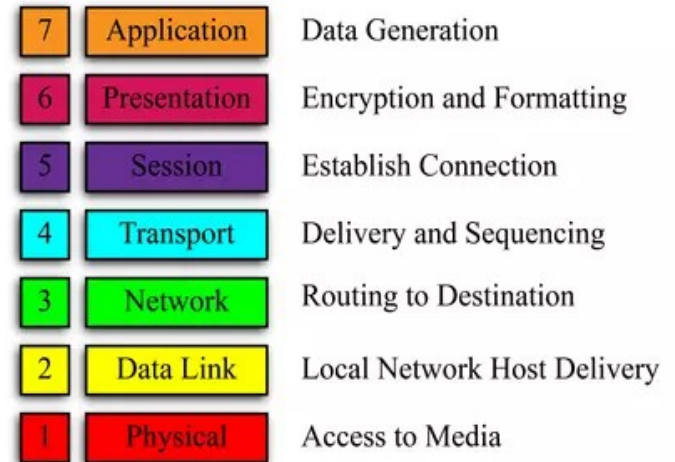
**OSI** refers to *Open Systems Interconnection*.

It is a model that forms one of the best frameworks for understanding the architecture of IoT network layers. It divides network communication into seven layers, each responsible for specific functions.

However, OSI is a conceptual model in its design and does not always depict how IoT systems appear, it presents a convenient method of analyzing in detail different types of IoT networks.

Its seven layers are as shown;

## OSI Model



# OSI Model: Layers & Functionalities

**7. Application layer:** Provides interfaces for user interaction with IoT devices through mobile and web applications.

**6. Presentation Layer:** Translates data formats for the application and network, including encryption and compression.

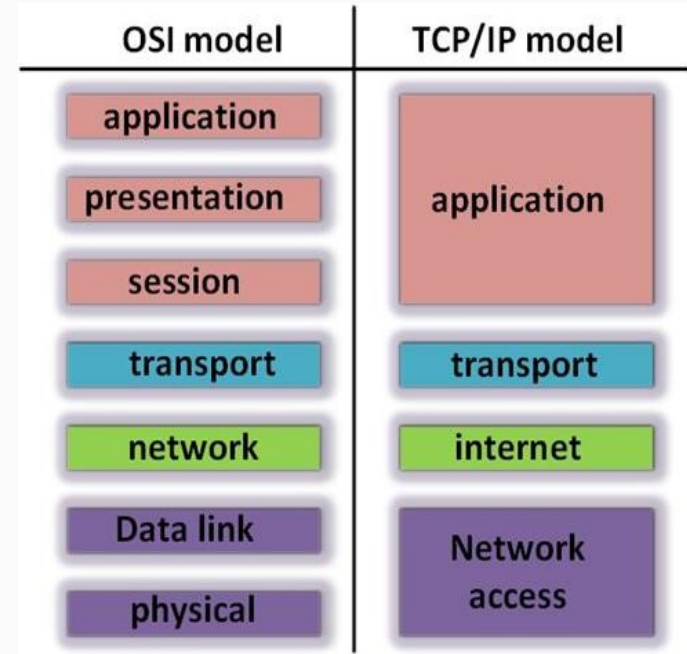
**5. Session Layer:** Establishes, manages, and terminates connections between endpoints in an IoT communication network.

**4. Transport Layer:** Manages data payload delivery and error-checking; key protocols include TCP and UDP.

**3. Network Layer:** Routes data between devices, utilizing routers and IP addresses to guide data packets to their destinations.

**2. Data Link Layer:** Facilitates data transfer between devices on the same network (e.g., Bluetooth, WiFi) and handles error detection/correction.

**1. Physical Layer:** Manages hardware components (e.g., cables, switches) responsible for transmitting raw data bits over a medium.



# OSI Model: Key Layers To IoT

## Key Layers for IoT Communication

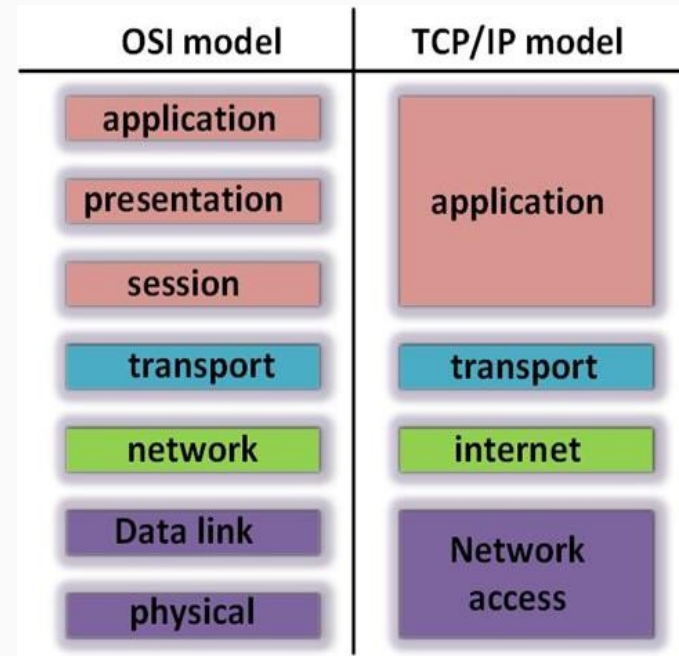
All the 7 layers of the OSI model are essential in drawing a modularized picture in reference to the IoT network operation. However, in a more simplified format, there are 3 key layers when it comes to analyzing IoT network.

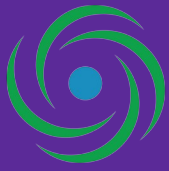
They include:

**Layer 2:** Data Link Layer: Manages direct data transfers between devices, ensuring reliable delivery.

**Layer 3:** Network Layer: Determines routing and addressing for data packets across networks.

**Layer 7:** Application Layer: Directly interacts with the software applications used by IoT devices, managing the data exchange between user applications and the network.






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**Any  
Questions**





# Questions:

**Q1. What is the role of the Application Layer in IoT communication?**

*Think about how users interact with IoT devices through apps.*

**Q2. How does the Network Layer help data find its way between IoT devices?**

*Discuss how routing and IP addresses work in this layer.*

**Q3. Why is the Physical Layer important for IoT networks?**

*Consider how hardware like cables and wireless connections help transfer data.*



# Practical Example: ESP32 with MQTT

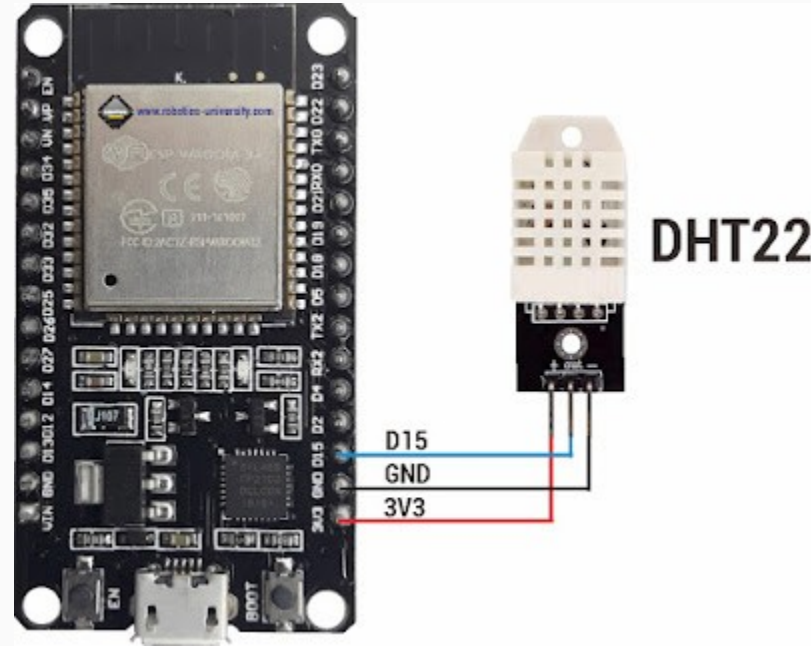
## IoT Sensor Data Transmission System:

**Task:** Use ESP32 to collect sensor data (DHT22) and send it to an MQTT broker(HiveMQ).

**Why MQTT?:** Low bandwidth, low power consumption, reliable data transmission.

## Application Use Cases:

Home automation, remote environmental monitoring.



Code resources: [GitHub](#)



# End!



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