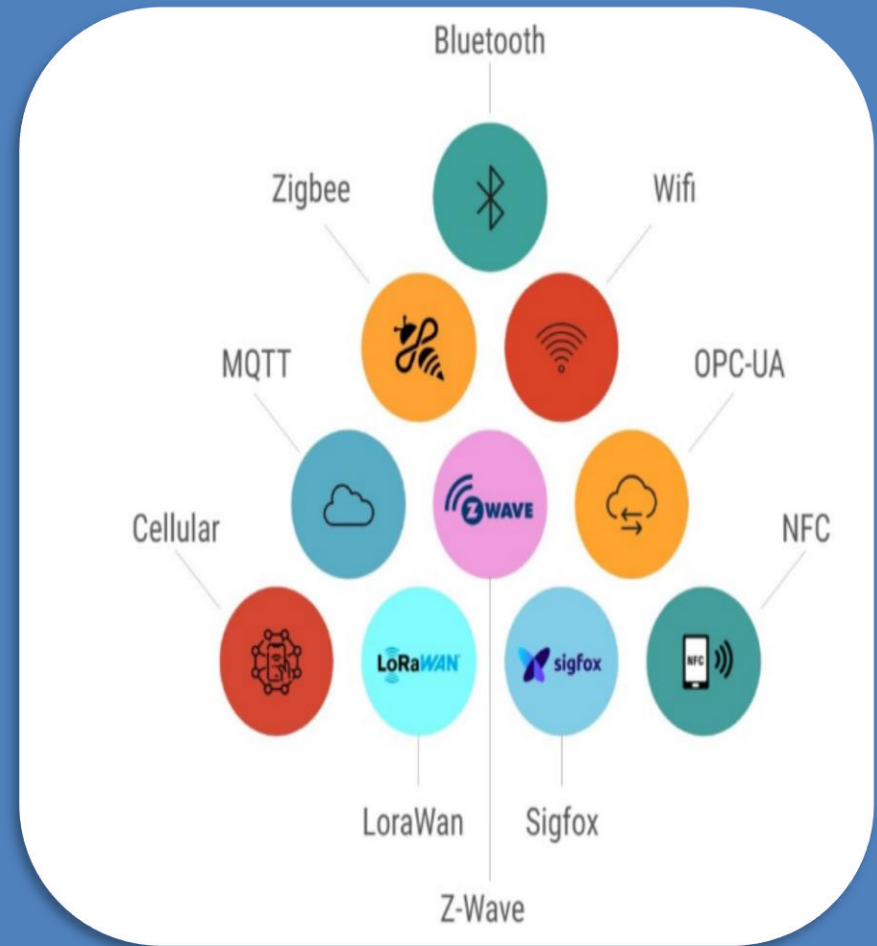


# IoT Protocols

Presented by  
Dr. Amany AbdElSamea



# Outline

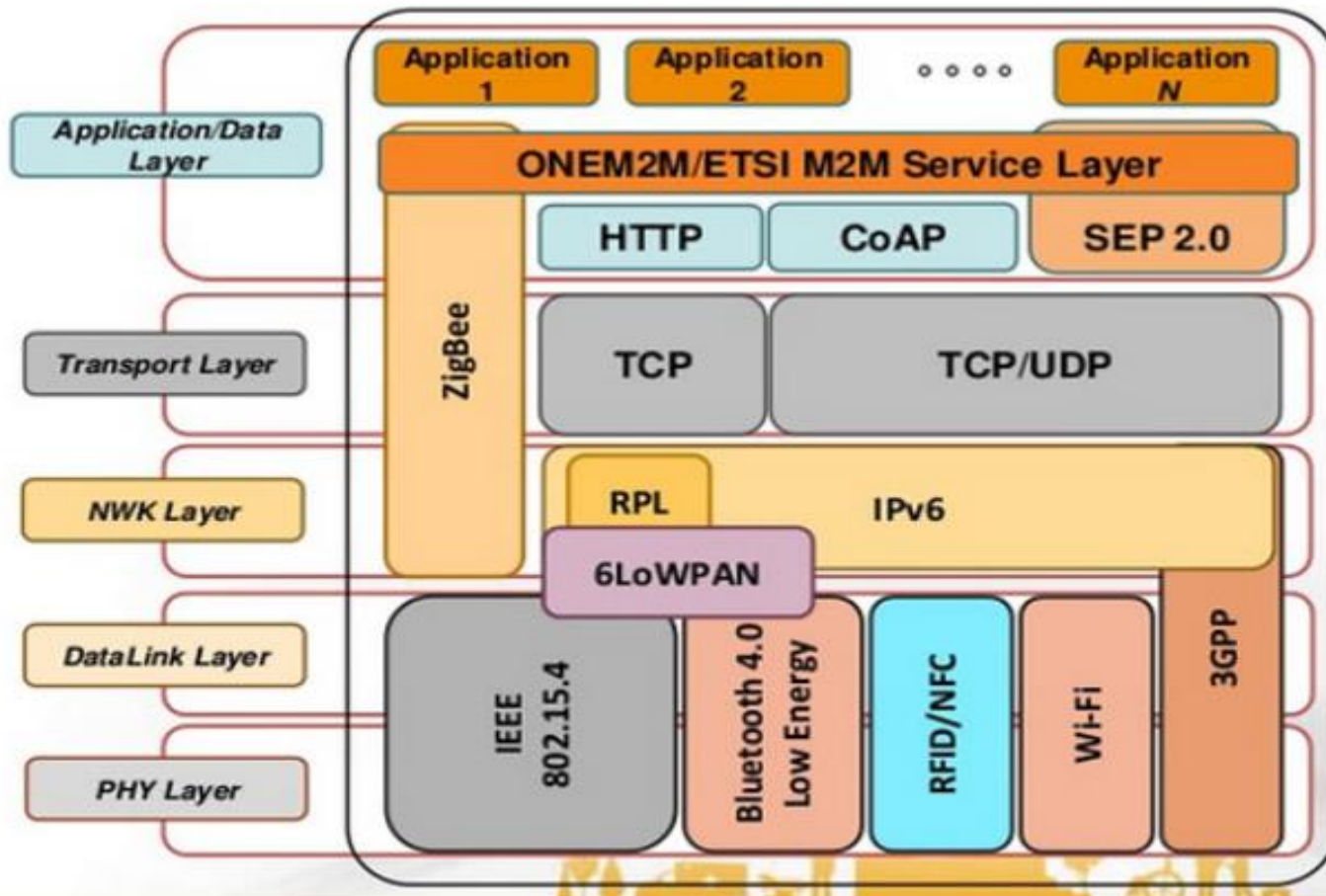
- IoT protocol stack
- IoT vs. Internet protocol stack
- Types IoT protocols
- IoT network protocols
- IoT data protocols
- Benefits of IoT wireless protocols

# IoT Protocols

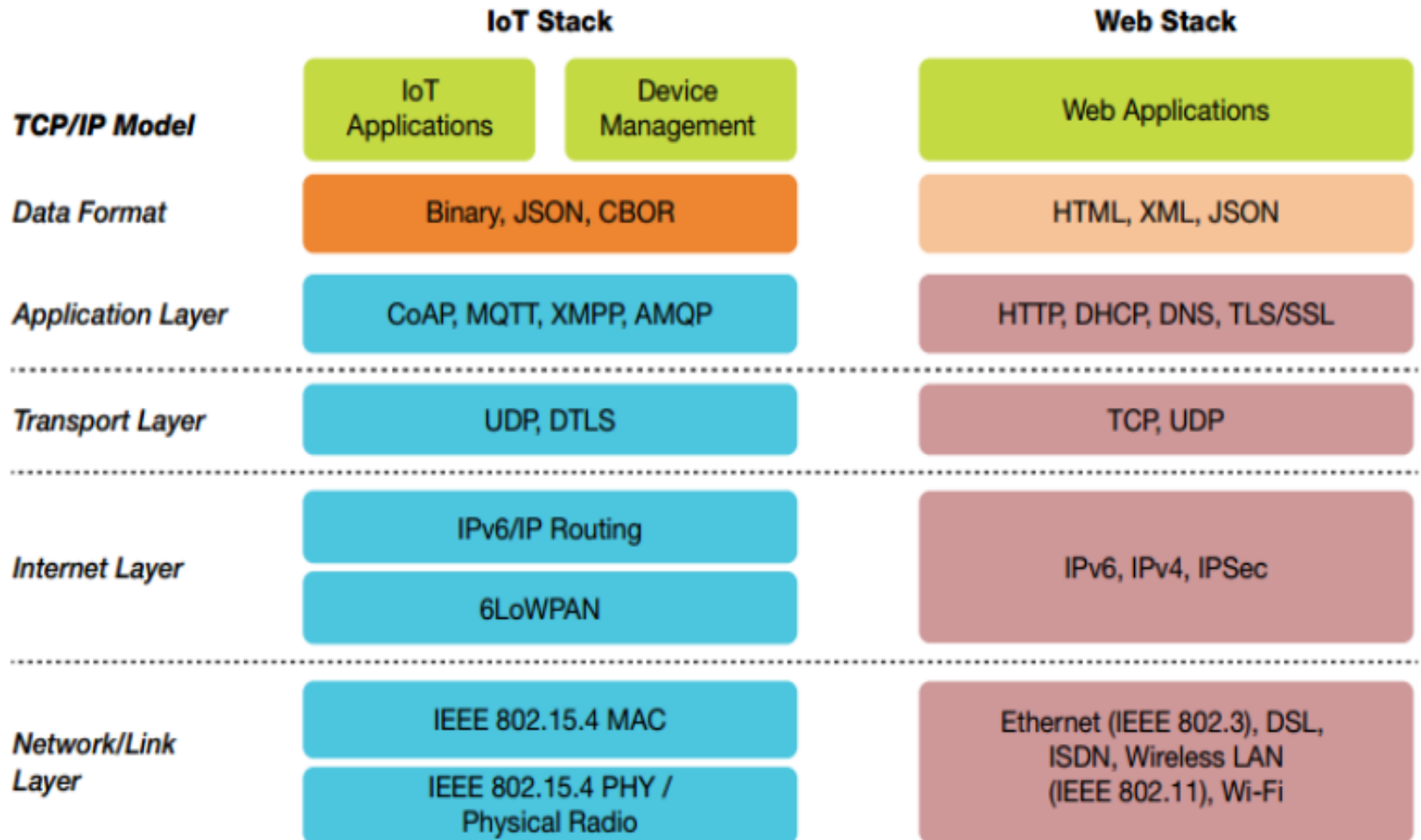
- The protocols of Internet of Things (IoT) technology stack are essential as without them, the hardware would be rendered useless, and data communication would be a challenge.
- IoT protocols aim to connect devices to IoT devices over a seamless and secure connection.
- The IoT protocols operate on four pillars:
  - Device
  - Connectivity
  - Data
  - Analytics



# IoT Protocol Stack



# IoT vs. Internet Protocol Stack



# Types of IoT Protocols



IoT Network Protocols



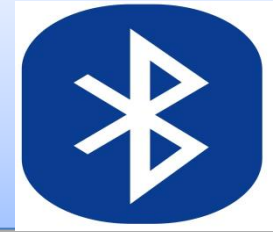
IoT Data Protocols

# IoT Network Protocols

## IoT Network Protocols

- ✓ Bluetooth & BLE
- ✓ Cellular - 4G & 5G
- ✓ Wi-Fi & Wi-Fi HaLow
- ✓ Low Power Wide Area Networks (LPWANs)
- ✓ ZigBee
- ✓ Z-Wave
- ✓ Extensible Messaging & Presence Protocol (XMPP)

# Bluetooth and BLE



- Bluetooth is widely used for short-range communication and is a standard IoT protocol for wireless data transmission preferably for personal 2.4 GHz networks.
- Bluetooth Low Energy (BLE) is its optimized version and the standard protocol for IoT architecture.
- The latest version of [Bluetooth](#) is 5.3. It was released on 13th July 2021 and it supports low data rate applications and an extended range of up to 150 meters.



# Cellular - 4G and 5G

- Cellular is a wireless mobile communication network technology that facilitates large bandwidth and reliable broadband services.
- Currently, 3G is almost on the verge of extinction. On the other hand, **4G is leading but not suited for IoT applications due to higher cost and power consumption.**
- However, the new-age **5G** is ideal for IoT applications across industries and personal usage.




# Wi-Fi and Wi-Fi HaLow

- **WiFi** (IEEE 802.11 n) is the most popular and conventional wireless network protocol for home and commercial usage. But it becomes too power-consuming for many IoT applications. So it is not very flexible and scalable for IoT purposes.
- **WiFi HaLow (IEEE 802.11 ah)** is a unique solution to overcome its challenges. This high-level communication protocol provides a long-range between 750 and 950 MHz with low-power connectivity.



802.11ah HaLow

# Low Power Wide Area Networks (LPWANs)

- **LPWANs** are a new set of wireless network protocols devised to set up communication between low-power IoT applications over long ranges. They are a cost-saving option because they operate on small and affordable batteries that are long-lasting and power-efficient.
- LoRaWAN, 6LoWPAN, Thread, NB-IoT, LTE-M, SigFox, and HayStack are purpose-built **LPWANs** for large-scale IoT deployments.
- **LoRaWAN:** 
  - LoRa is a long-range radio wide area network that provides low-cost mobile security to IoT, Smart cities, and Industrial applications. It's optimized for low power consumption and supports a large network of millions of devices.
  - Smart street lighting is a practical example, where the street lights are connected with the LoRa gateway that uses the LoRaWAN protocol.
  - It has the feature to detect the signals below the noise level along with built-in **security** and GPS-free positioning.

# ZigBee



- ZigBee is a mesh wireless communication protocol that operates on a 2.4 GHz network. It is short-range, highly interoperable, low-power consuming, and facilitates massive data transfer in a single instance with high security.
- ZigBee is **most appropriate for small, and medium ranged IoT devices such as microcontrollers, sensors, gateways**, and so on.
- Notably, due to its mesh grid structural design, the connectivity can be extended over a long distance using multi-hop routing.
- ZigBee is best suited for commercial building and innovative home automation applications. Actually, it is the safest wireless protocol for transferring real-time patient data from a sensor.

# Z-Wave



- Similar to ZigBee, the Z-Wave protocol also works on mesh network topology. However, it is most prominent for IoT home automation applications.
- Z-Wave is a Radio Frequency (RF) based, less power-consuming wireless communication technology that operates on 800-900 MHz and is purely location-dependent.
- As a result, it hardly faces any connectivity hindrance. It facilitates safe and steady data transmission with low latency.

# IoT Data Protocols

## IoT Data Protocols

- ✓ Advanced Message Queuing Protocol (AMQP)
- ✓ Data Distribution Service (DDS)
- ✓ Extensible Messaging & Presence Protocol (XMPP)
- ✓ WebSocket
- ✓ Open Platform Communication Unified Architecture (OPC UA)

# Advanced Message Queuing Protocol (AMQP)

- AMQP is widely used in banking and finance as a message-oriented open standard software protocol.
- It comprises three crucial message components - Exchange, Queue, and Routing.
- It is based on the Transmission Control Protocol and works on the architecture of "publish/subscribe" and "request/response" types. In addition, the guaranteed delivery or transaction message makes AMQP interoperable, secure, and reliable.

# Data Distribution Service (DDS)

- DDS is a UDP based "publish/subscribe" API that facilitates secure real-time M2M data sharing between the [connected IoT devices](#).
- Furthermore, it works on broker-less scalable architecture, i.e., it operates independently of any hardware or software platform.
- Its multi-purpose function simplifies IoT deployment for both small devices and high-performance networks.



# Extensible Messaging and Presence Protocol (XMPP)

- XMPP is a decentralized, open-source, and secure protocol developed using XML language to enable real-time data exchange. It operates as a presence indicator by reflecting the status of available servers and devices.
- XMPP-IoT is a lightweight version of XMPP and is the best for consumer-oriented IoT deployments as it is extensible, scalable, and flexible.

# WebSocket

- Introduced by HTML5, WebSocket is an event-triggered independent TCP-based IoT protocol or API. It establishes full-duplex real-time communication between the client and server.
- Using advanced technology streamlines complexities involved in the bi-directional transmission over the internet. And, it is suitable to maintain constant connectivity across heterogeneous IoT devices. Notably, WebSocket is much faster than HTTP.

# Open Platform Communications Unified Architecture (OPC UA)

- OPC UA is a next-generation data model technology ideal for Industry 4.0 and IoT. It operates on a platform-independent, encrypted, and extensible multi-layered architecture. In addition, its service-oriented framework supports both "publish/subscribe" and "request/response" models.
- As per the latest press release published by [OPC Foundation](#), leading IoT vendors such as SIEMENS, SAP, Microsoft, IBM, AWS, and Google Cloud are already leveraging OPC UA for edge-to-cloud applications.

# Benefits of IoT wireless protocols

Wireless IoT protocols have become the first choice solution for personal and industrial usage. The rising demand for wireless IoT protocols is because of the core benefits:

- Affordability
- Less time and energy consumption
- Robust security and data privacy
- Good network coverage and connectivity
- Automated and streamlined communications
- Faster data transfer and smoother operations
- Easy setup and deployment in the IoT infrastructure
- Simple to use while resulting in enhanced productivity

# Questions