**Embedded networking**

The field of embedded networking deals with the network design and topology, hardware devices, and data exchange protocols needed to connect and exchange information between embedded systems.

Embedded system is an electronic system having a software and is embedded in computer hardware. It is programmable or non- programmable depending on the application, the Apollo Guidance Computer was one of the earliest applications of an embedded computer system. Embedded system applications range from digital watches and microwaves to hybrid vehicles and avionics. As much as 98 percent of all microprocessors manufactured are used in embedded systems. Embedded systems are today used in a range of industrial, commercial, and residential applications that range from controlling manufacturing systems to enabling vehicle safety features to powering home security systems and smart appliances.

 the International Organization for Standardization (ISO) developed The earliest conceptual model of computer networks that is the OSI (the Open System Interconnection) model.

The OSI model – that does not include any actual specifications for network implementation- provides a framework for understanding the components of a complete network communication system.

The OSI model defines a seven-layer architecture for a complete communication system:

1-the application layer: is the first layer of the OSI model where the identification of services and communication partners, user authentication, and data syntax are dealt with. Data transmissions originate in the application layer of the origin device and terminate in the application layer of the target device. Application layer has many protocols as HTTP (hypertext transfer protocol), Telnet and FTP (file transfer protocol).

2-The presentation layer: is a software layer where data that will be sent across a network is formatted and encrypted, ensuring compatibility between the transmitting device and the receiving device. It also includes protocols such as ASCII, JPEG, MPEG.

### 3- session layer: is created for data transfer to occur between applications on separate devices. its purpose is to manage, synchronize, and terminate connectivity between applications, ensuring coordinated data exchange while minimizing packet loss. It provides for full-duplex, half-duplex, or simplex communications.

### 4- Transport Layer: is where the conversion of the messages from the data layer to smaller units that can be handled by the network layer happens.

### 5-The network layer: provides the features and functions for data transfer sequences from the host device to destination device, along with routing network traffic and reporting delivery errors, as well as dividing outgoing messages into packets then assembling the incoming packets into messages. Some protocols like IP, ICMP, and IPX are used by network layer devices.

### 6- Data Link Layer: is where data packets are encoded and decoded into bits, which may be divided into two sub-layers:

### -media access control (MAC): supports physical addressing.

### -logical link control (LLC): deals with data synchronization, error checking, and flow control.

### The data link layer has protocols like IEEE 802.5/ 802.2, IEEE 802.3/802.2, and the Point-to-point protocol (PPP).

### 7- The physical layer: is where data encoding and the conversion of digital bits into electrical signals is managed as well as it defines the electrical and physical requirements for networked devices with control over the transmission and reception of unstructured raw data over the network. Devices that operate at the physical layer include network interface cards (NICs), repeaters (strengthen signal over distance), and hubs.

Not all embedded systems need all the functionalities that are in the model. so, it is up to the specialized engineer to determine which features are required and to implement suitable protocols from the layers.

## There is three Different Types of Embedded Networking:

### 1-Embedded Networking with CAN (Control Area Network) Bus:

### CAN is a specification for a serial network which establishes local connections between the microcontrollers in a motor vehicle. Its protocol is a two-wire, half-duplex system that works very good for applications demanding high-speed transfer for short messages.

### 2-Embedded Networking with I2C Bus

### It provides good support for communication with various slow, on-board peripheral devices that are accessed intermittently, while being extremely modest in its hardware resource needs. It is a simple, low-bandwidth, short-distance protocol.

### 3-Embedded Networking with Ethernet

Embedded devices connected to local area networks or the internet can be implemented using Ethernet technology. Its connections are often done as part of a protocol stack known as the Internet Protocol Suite, sometimes defined as TCP/IP. The TCP/IP protocol stack includes four layers that are close to the OSI network model:

a-Application Layer

b-Transport

c-Internet

d-Network Interface