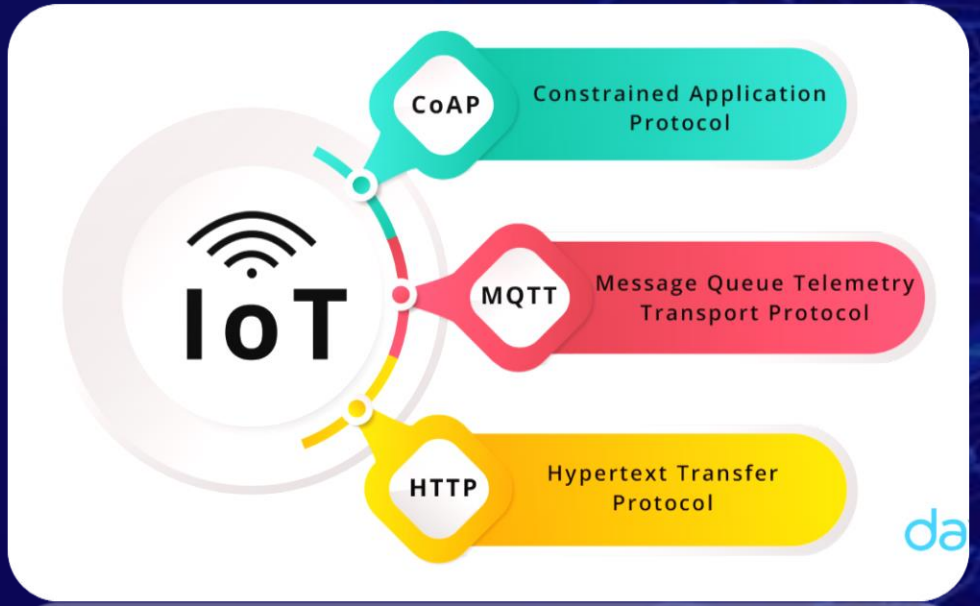
Unit 3

IoT Protocol and Cloud Integration



Reference

Disclaimer

The content is curated from online/offline resources and used for educational purpose only

Learning Objectives

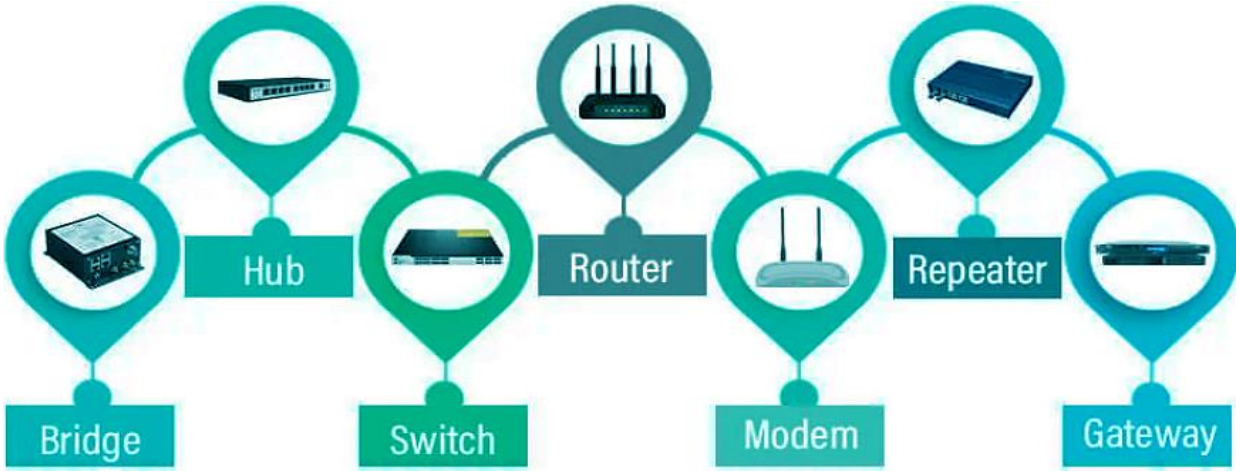
- Networking Devices
- Types of Networking Devices
- Local and Personal

  Area Network (LAN/PAN) for IoT
- IoT WAN
- IoT NODE
- IoT Gateway
- IPv4 and IPv6
- Multi Homing
- IoT Protocol
- Wireless Communication Protocols in IOT
- Cloud Integration IoT services

Types of Networking Devices

Here is the common network device list:

- Hub
- Switch
- Router
- Bridge
- Gateway
- Modem
- Repeater
- Access Point

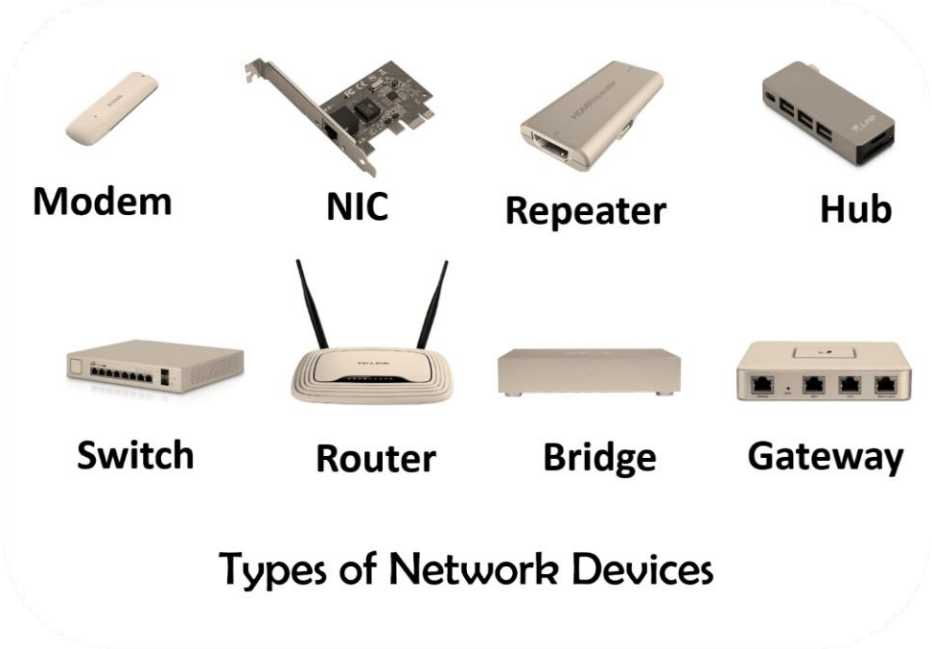


Click here

Reference link

What are Networking Devices?

- An IoT network refers to a collection of devices such as sensors, gadgets, appliances, and software that communicate with each other and exchange information and data without the need for human intervention.
- Network devices, or networking hardware, are physical devices that are required for communication and interaction between hardware on a computer network.

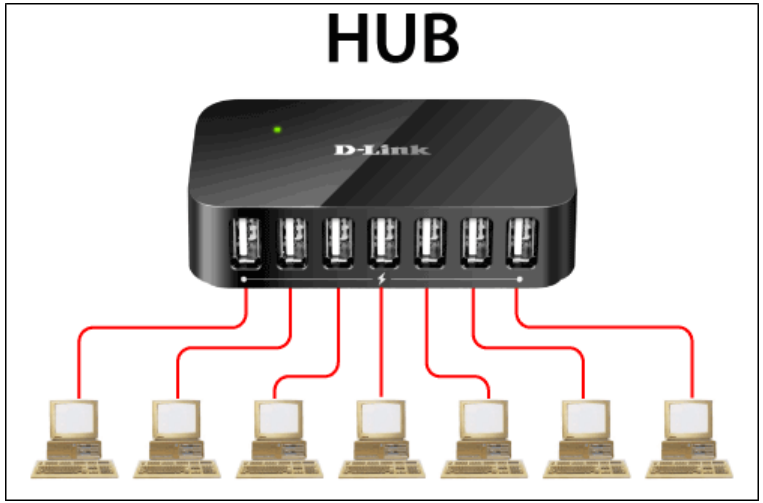


Click here

Reference link

Hub

- A hub is basically a multiport repeater.
- A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices.
- Hubs categories in three categories, Active hub, Passive Hub and Intelligent hub
- Hub is used to create small home networks.
- It can be used to create a device that is available thought out of the network.

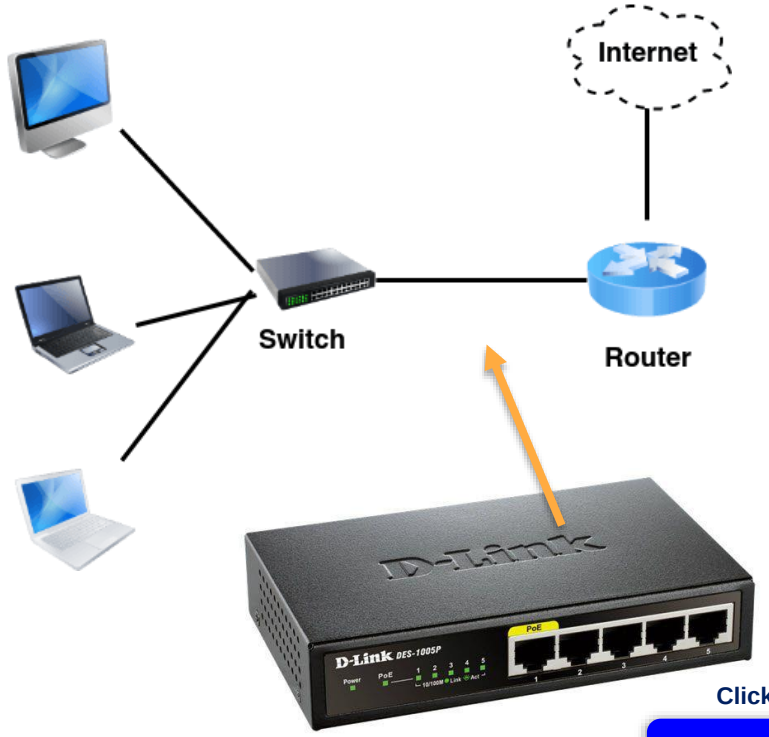


Click here

Reference link

Switch

- A switch is a multiport device that improves network efficiency. The switch maintains limited routing information about nodes in the internal network, and it allows connections to systems like hubs or routers.
- switches can read the hardware addresses of incoming packets to transmit them to the appropriate destination.
- The switches transmit the data with enhanced security and efficiency. The network address is used as a medium for the identification of the devices connected to the switch.

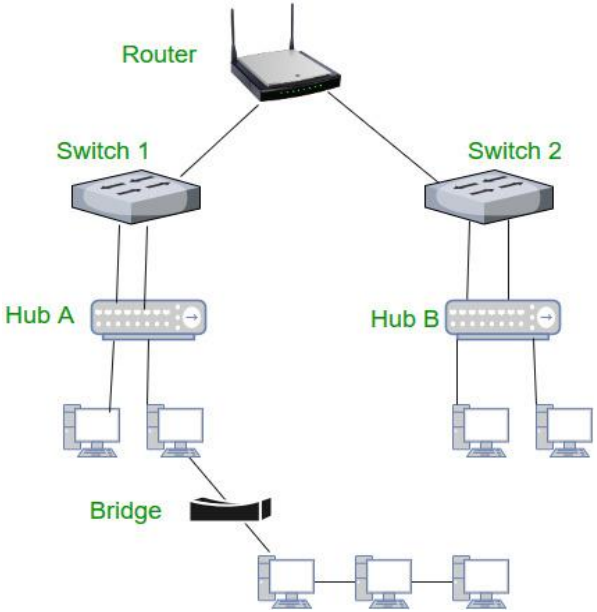


Click here

Reference link

Router

- A router is a device like a switch that routes data packets based on their IP addresses.
- The router is mainly a Network Layer device. Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets.
- A router is more capable as compared to other network devices, such as a hub, switch, etc., as these devices are only able to execute the basic functions of the network.
- For example, a hub is a basic networking device that is mainly used to forward the data between connected devices, but it cannot analyse or change anything with the transferring data. On the other hand, the router has the capability to analyse and modify the data while transferring it over a network, and it can send it to another network.



Click here

Reference link

Difference between Hub, Switch and Router

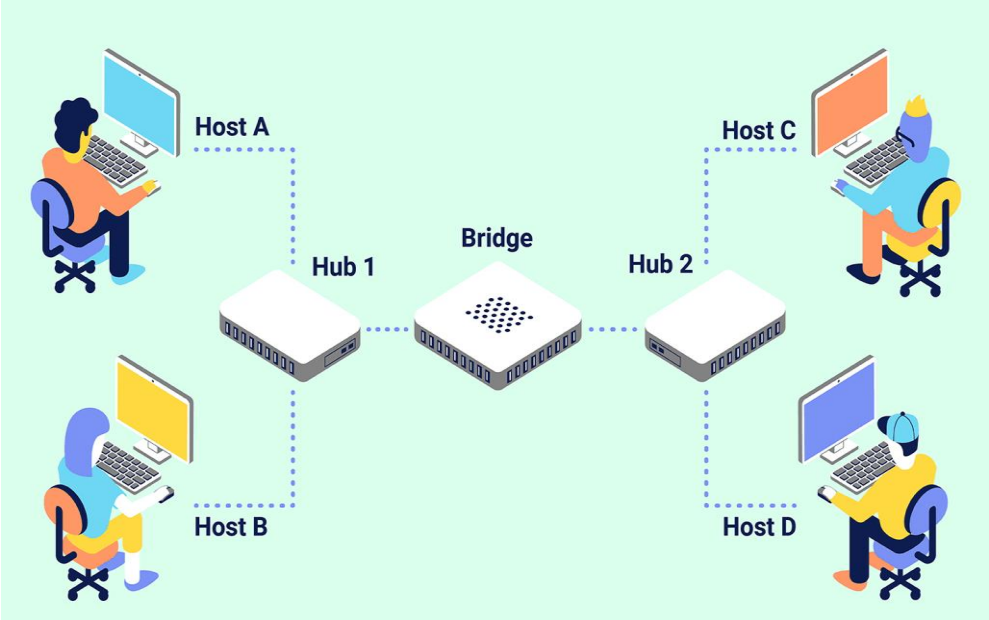
Sr. No	Hub	Switch	Router
1.	Hub is a physical layer device i.e. layer 1.	Switch is a data link layer device i.e. layer 2.	Router is a network layer device i.e. layer 3.
2.	A Hub works on the basis of broadcasting.	Switch works on the basis of MAC address.	A router works on the basis of IP address.
3.	A Hub is a multiport repeater in which a signal introduced at the input of any port appears at the output of the all-available ports.	A Switch is a tele-communication device which receives a message from any device connected to it and then transmits the message only to the device for which the message is intended.	A router reads the header of incoming packet and forward it to the port for which it is intended there by determines the route. It can also perform filtering and encapsulation.
4.	Hub is not an intelligent device that may include amplifier on repeater.	A Switch is an intelligent device as it passes on the message to the selective device by inspecting the address.	A route is more sophisticated and intelligent device as it can read IP address and direct the packets to another network with specified IP address. Moreover, routers can built address tables that helps in routing decisions.
5.	At least single network is required to connect.	At least single network is required to connect.	Router needs at least two networks to connect.
6.	Hub is cheaper as compared to switch and router.	Switch is an expensive device than hub.	Router is a relatively much more expensive device than hub and switch.
7.	Speed of original hub 10Mbps and modern internet hub is 100Mbps.	maximum speed is 10Mbps to 100Mbps.	maximum speed for wireless is 1-10 Mbps and maximum speed for wired connections is 100 Mbps.
8.	Hubs are used in LANs.	Switch is used in LANs.	Routers are used in LANs, MANs and WANs.

Bridge

- A bridge operates at the data link layer.
- A bridge is a repeater, with add on the functionality of filtering content by reading the MAC addresses of source and destination.
- It is also used for interconnecting two LANs working on the same protocol.
- Types of Bridge

  a)Transparent Bridge

  b)Source routing Bridge



Click here

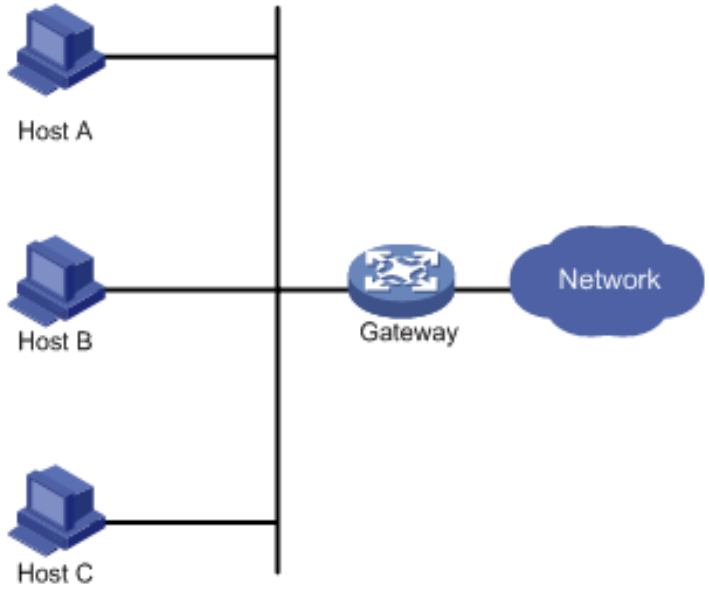
Reference link

Difference between Router and Bridge

Routers	Bridges
Routers operates in netwok layer of OSI Model.	Bridge operates in data link layer of OSI Model.
Router is use to connect the LAN and WAN.	Bridge is use to connect two different LAN segments.
Router transmits data in the form of packets.	Bridge transmit data in the form frames.
Router reads the IP Address of a device.	Bridge reads the MAC Address of a device.
Router has more ports compare to bridge.	Bridge has only two ports.
Router uses routing table for sending data.	Bridge does not use any routing table for sending data.

Gateway

- A gateway, as the name suggests, is a passage to connect two networks together that may work upon different networking models.
- They basically work as the messenger agents that take data from one system, interpret it, and transfer it to another system.
- Gateways are also called protocol converters and can operate at any network layer.

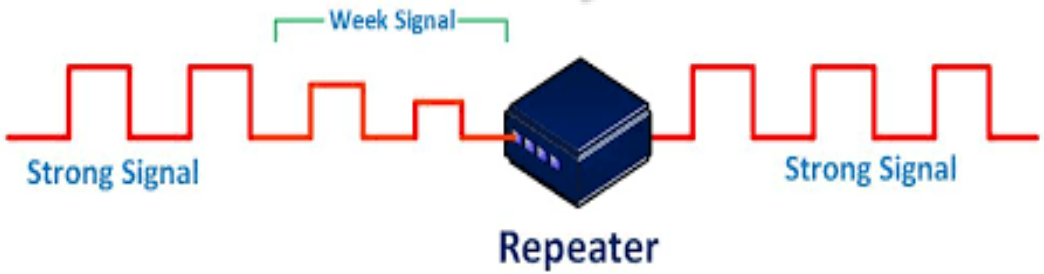


Click here

Reference link

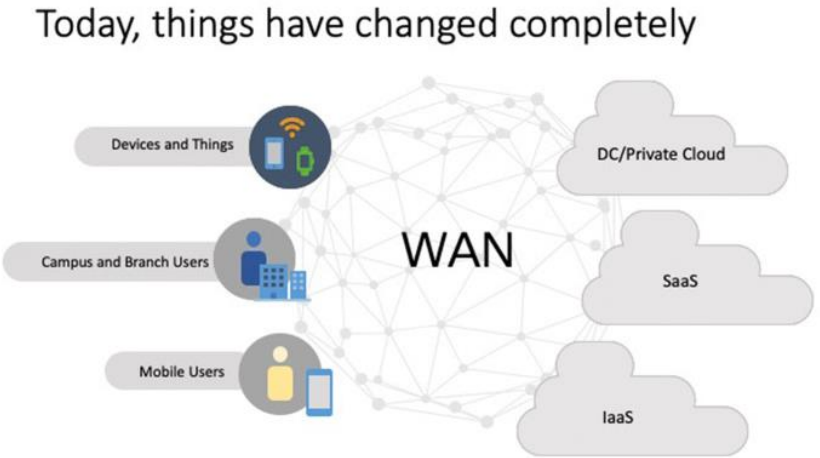
Repeater

- A repeater operates at the physical layer.
- Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network.



IoT WAN

- A wide area network (also known as WAN), is a large network of information that is not tied to a single location.
- WANs can facilitate communication, the sharing of information and much more between devices from around the world through a WAN provider.
- An Internet of Things (IoT) gateway is a device which serves as the connection point between IoT devices and the cloud.



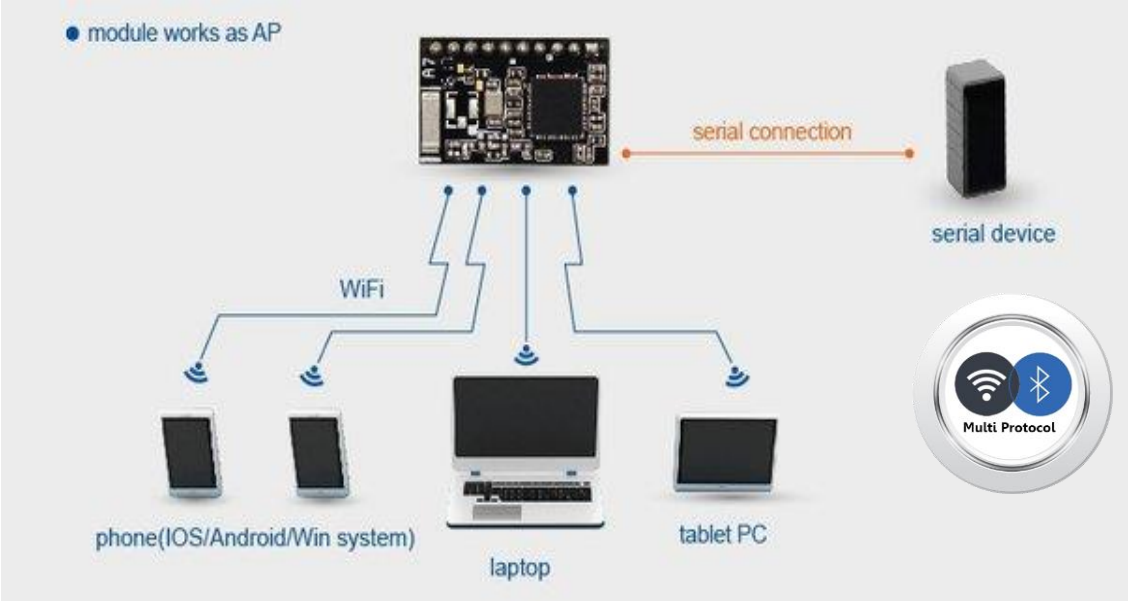
Click here

Reference link

PAN/LAN

- Networks that cover fairly short distances are called personal area networks (PAN) and local area networks (LAN).
- PAN and LAN networks are considered to be fairly cost-effective, but the transfer of data can sometimes be unreliable.

Ex. Bluetooth, Wi-fi



Click here

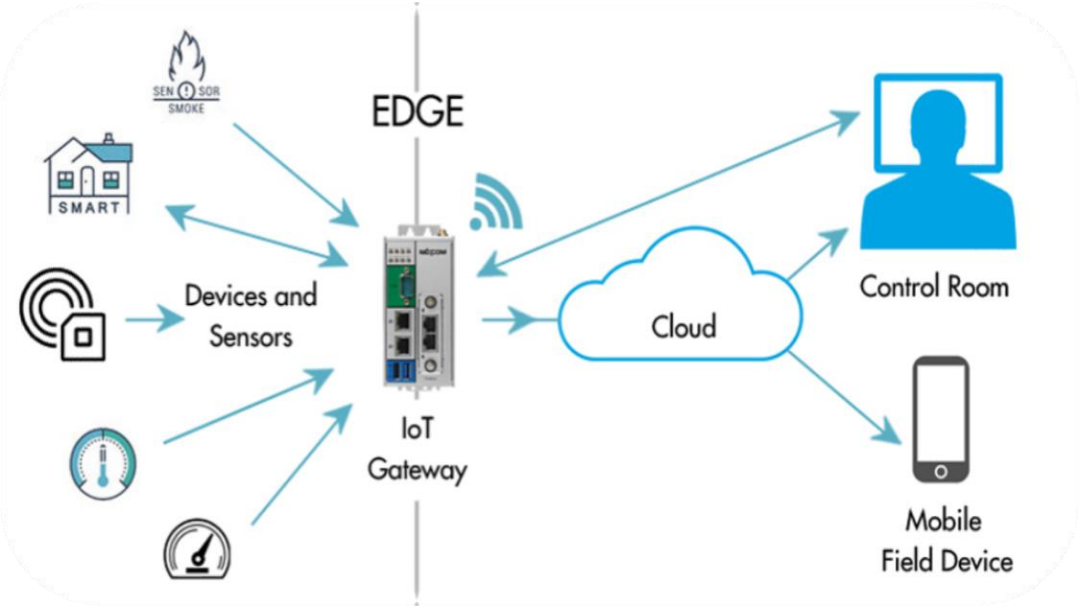
Reference link

IoT Node

- The most numerous type of device in the IoT can be referred to as the node.
- These are all the exciting devices that are providing sensor data, or devices that are being controlled from the cloud.
- This means things like door locks, security sensors, temperature sensors, and more

IoT Gateway

- Secure connection between Device and Cloud
- Data/information sharing between cloud and device
- Smart Gateways perform edge analytics on data produce by IoT device



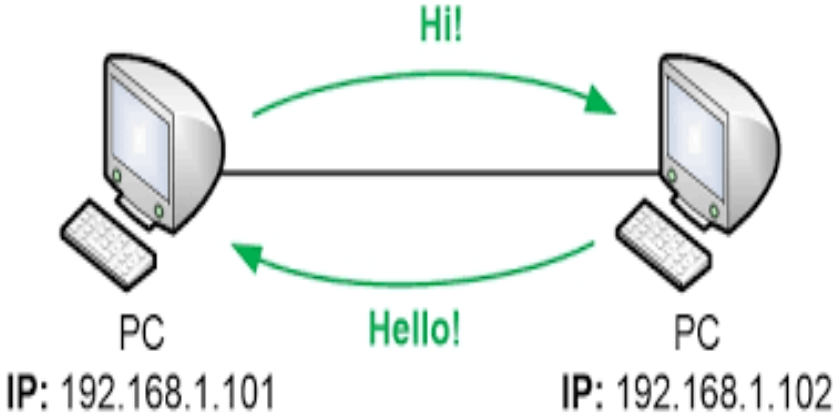
Click here

Reference link

IPv4 and IPv6

What is IP?

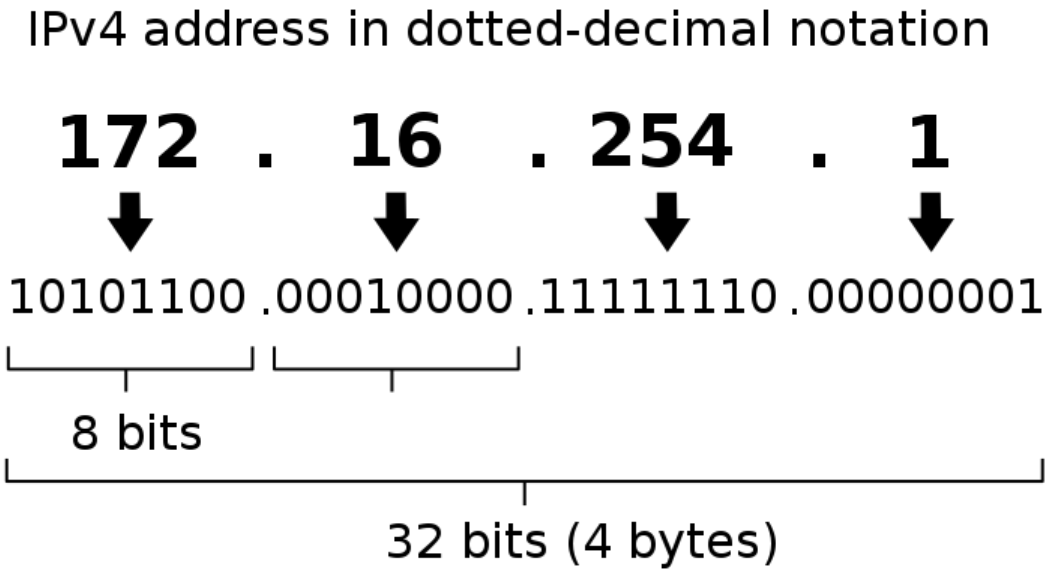
- An IP (Internet Protocol) address is a numerical label assigned to each device connected to a computer network that uses the IP protocol for communication.
- An IP address acts as an identifier for a specific device on a particular network. The IP address is also called an IP number or Internet address.



Click here

Reference link

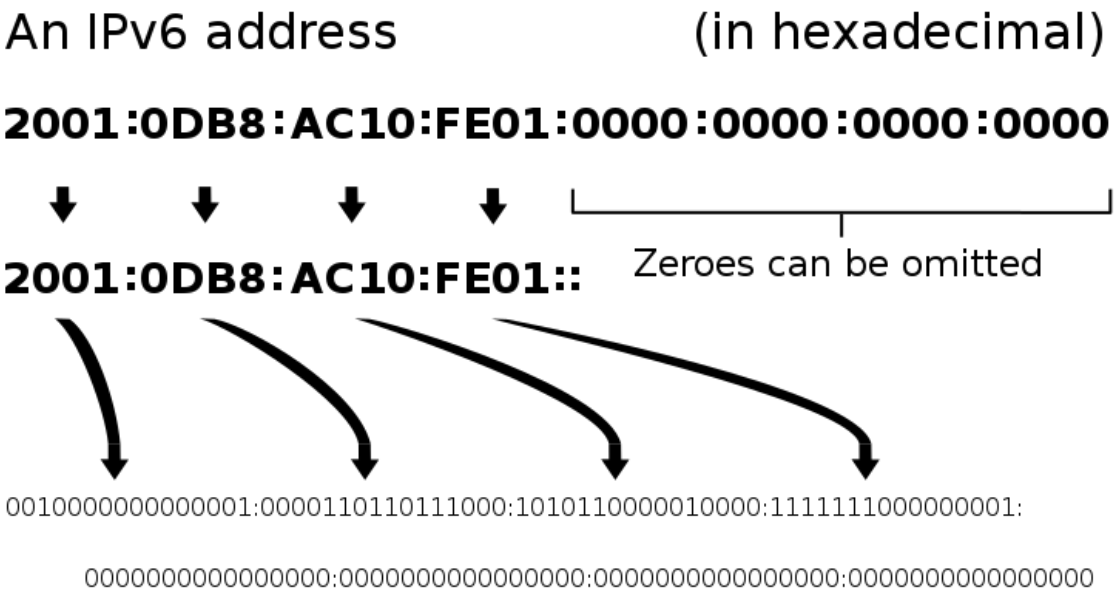
IPv4 – Internet Protocol Version 4



Click here

Reference link

IPv6 – Internet Protocol Version 6



Click here

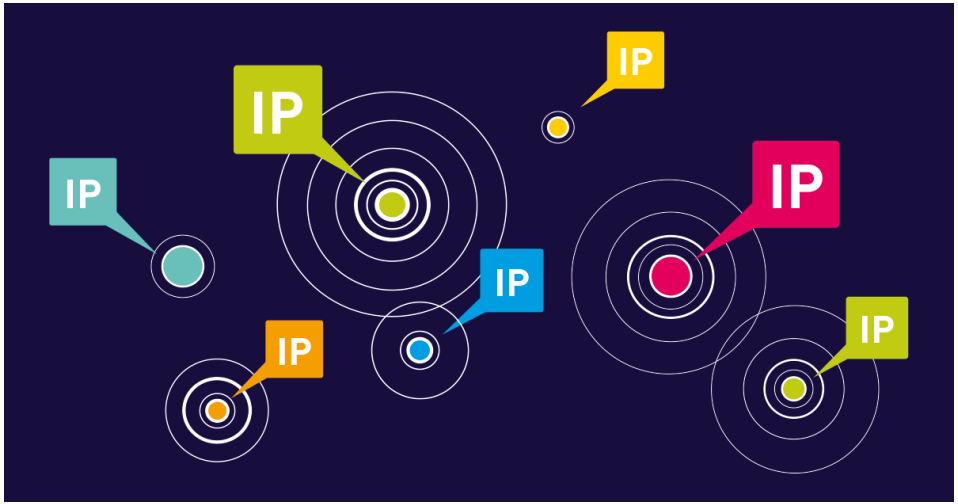
Reference link

IPv4	IPv6
Deployed 1981	Deployed 1998
32-bit IP address	128-bit IP address
4.3 billion addresses Addresses must be reused and masked	**7.9×10^{28} addresses** Every device can have a unique address
Numeric dot-decimal notation 192.168.5.18	Alphanumeric hexadecimal notation 50b2:6400:0000:0000:6c3a:b17d:0000:10a9 (Simplified - 50b2:6400::6c3a:b17d:0:10a9)
DHCP or manual configuration	Supports autoconfiguration

Source

Multi Homing

- Multi-homing is a method of configuring one computer, called the host, with more than one network connection and IP address. The multi-homed method provides enhanced and reliable Internet connectivity without compromising efficient performance.

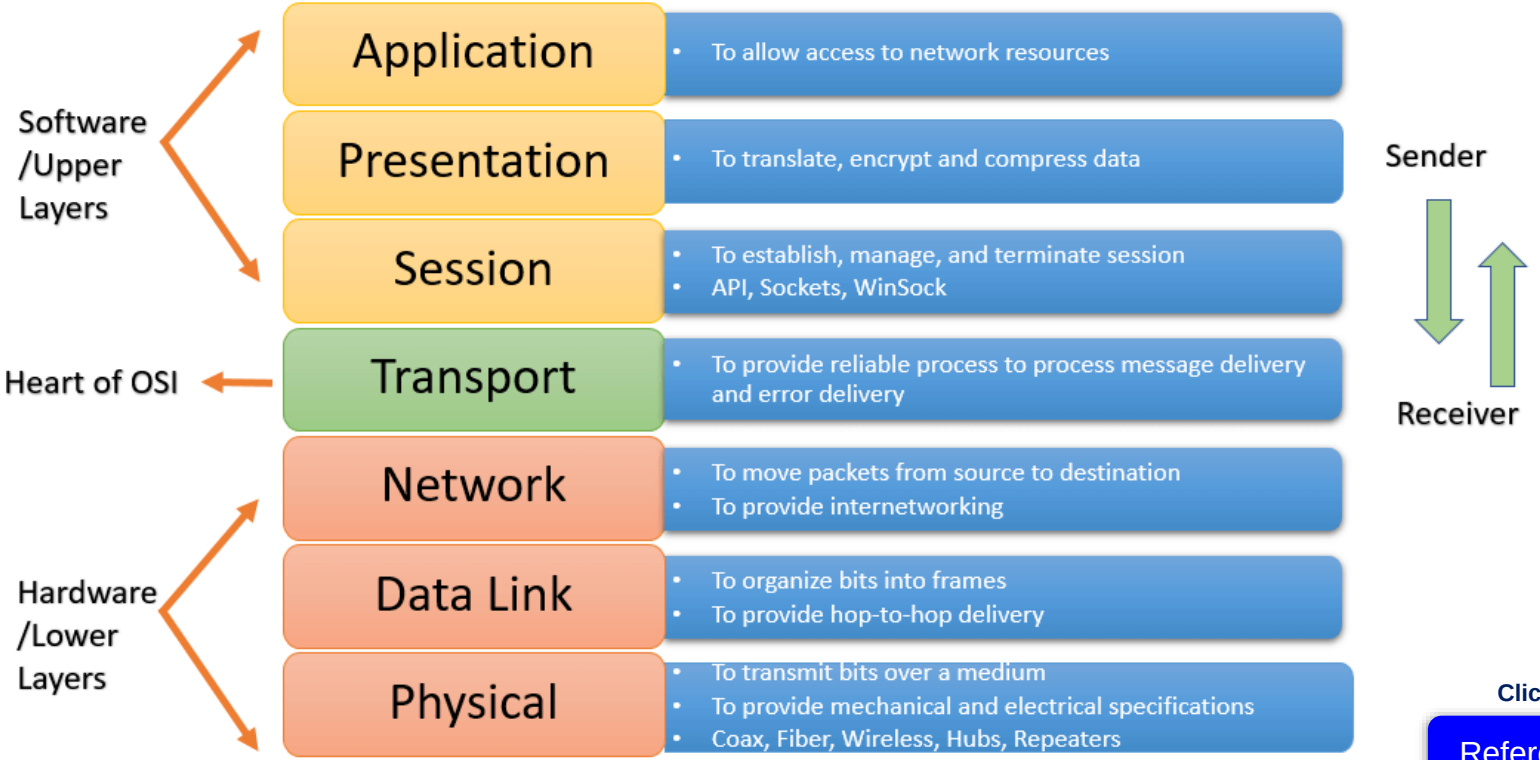


- Why multi-homing in IOT?
- In IOT particular Node or an IoT device or the sub network, IoT sub network can be connected with multiple networks for improving the reliability.
- So, basically multi-homing is a concept that is used for improving the overall liability of the network in that way.

Click here

Reference link

Network Stack



Click here

Reference link

IoT Protocol Stack

OSI Model	TCP/IP Model	Layer functions	Protocols
Application	Application	Directly interact with and support user's applications	MQTT, HTTPS, AMQP, CoAP
Presentation			
Session			
Transport	Transport	Handle reliability, flow control, congestion avoidance, and error correction	TCP, UDP
Network	Internet	Involve logical addressing and define how data is routed from sources to final destination hosts identified by IP addresses (traffic directing)	IP (e.g. IPv6, 6LoWPAN...)
Data Link	Network access & physical	Define the physical connection of end devices to the network	LPWAN, WiFi, LTE, BLE, Zigbee
Physical			

Link Layer Protocol

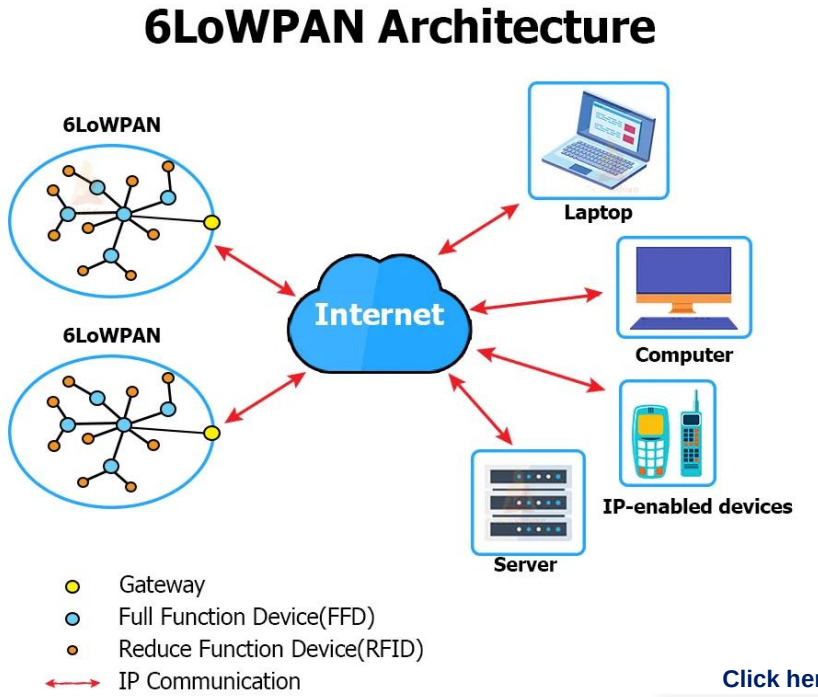
- 802.3 Ethernet
- 802.1 Wi-Fi
- 802.16 WiMAX
- 802.15.4 LR-WPAN
- 2G/3G/4G Mobile Comm.

Click here

Reference link

Network / Internet Layer Protocol

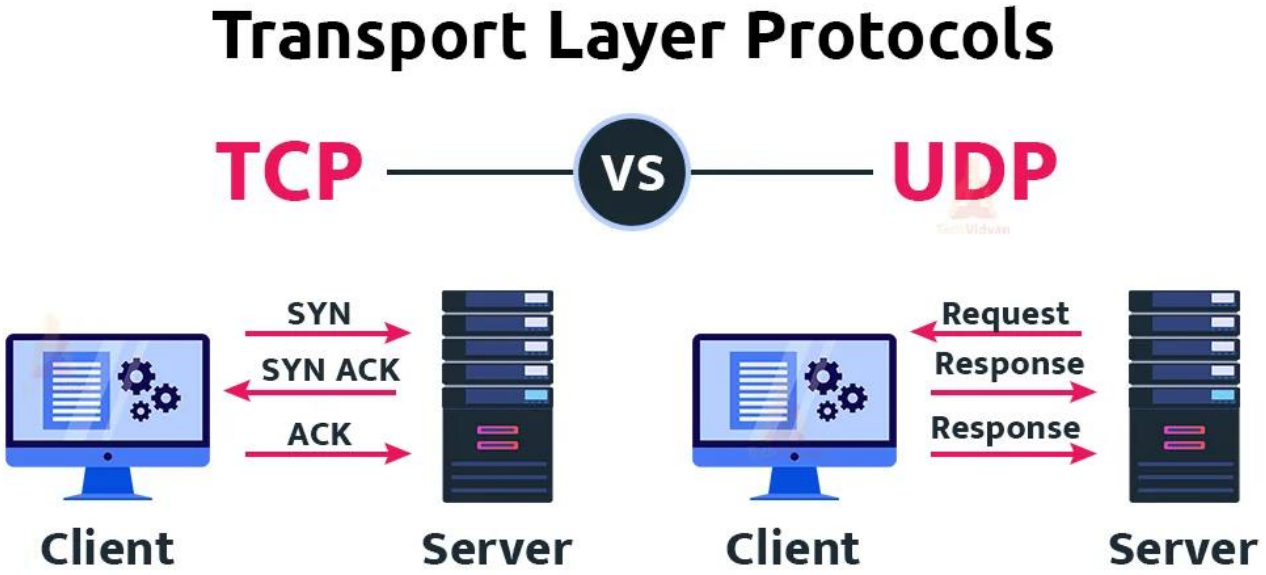
- IPv4
- IPv6
- 6LoWPAN



Click here

Reference link

Transport Layer Protocol



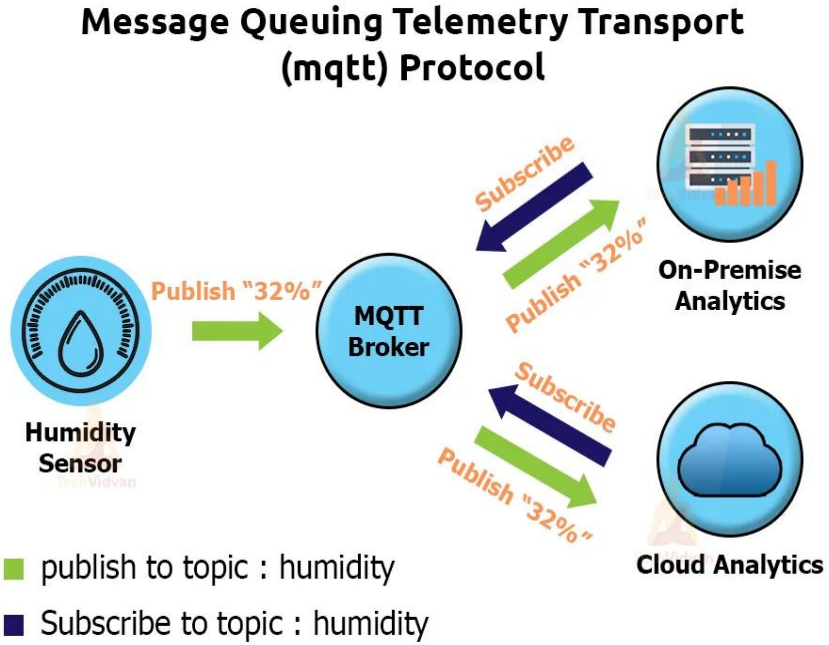
Click here

Reference link

Application Layer Protocol

MQTT

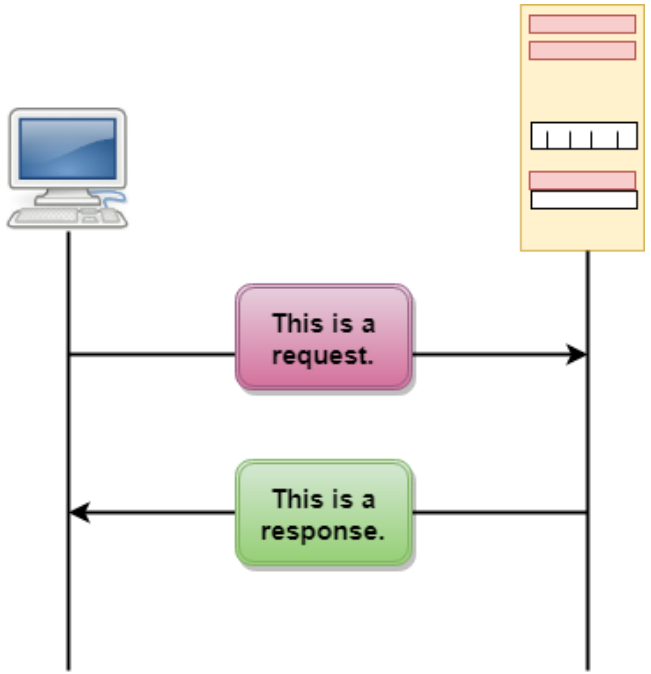
- Message Queue Telemetry Transport it is a lightweight message protocol based on public - subscribe model.
- MQTT uses a client server Architecture by the clients such as an IoT device connect to the server also called the MQTT broker and publishers' message to topic on the server.



Application Layer Protocol

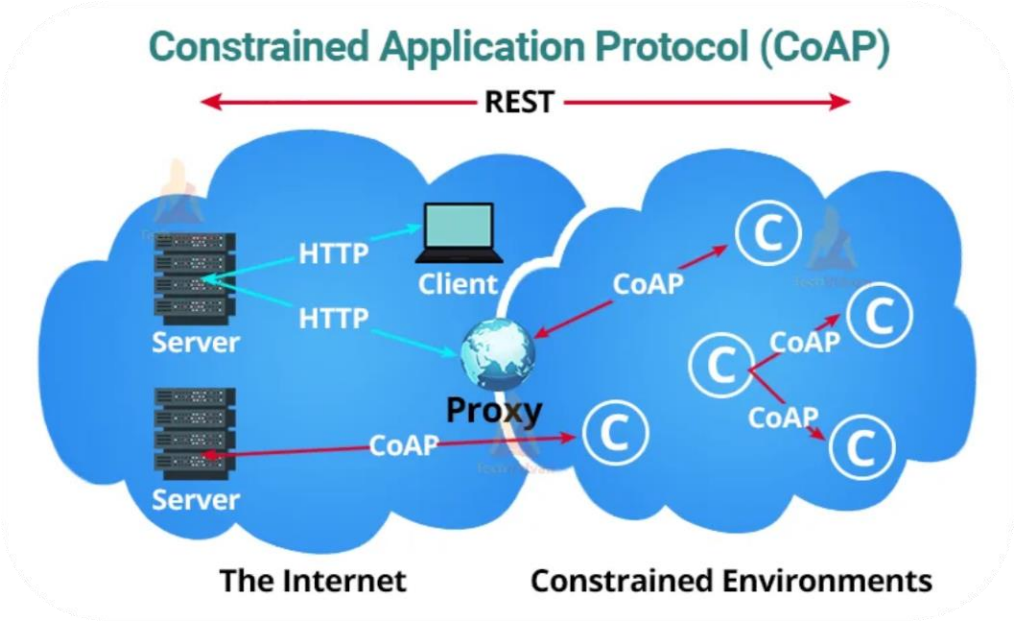
Hypertext Transfer Protocol - HTTP

- HTTP is a connectionless protocol.
- HTTP client initiates a request and waits for a response from the server. When the server receives the request, the server processes the request and sends back the response to the HTTP client after which the client disconnects the connection.
- The connection between client and server exist only during the current request and response time only.



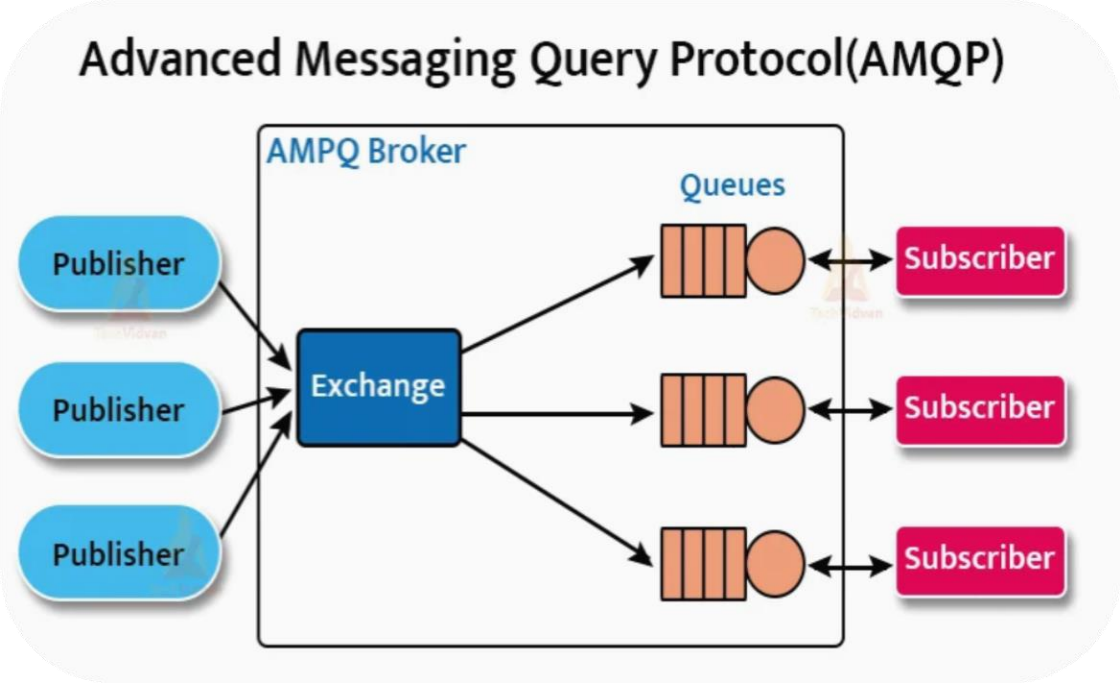
Application Layer Protocol - CoAP

- Constrained Application Protocol (CoAP) is a specialized web transfer protocol for use with constrained nodes and constrained networks in the Internet of Things.
- In CoAP, a smart “thing” is capable of acting both as a server and client.
- A client sends a request for a server resource through a method code.
- The server replies with a respond code.
- It is generally used for machine-to-machine (M2M) applications such as smart energy and building automation.



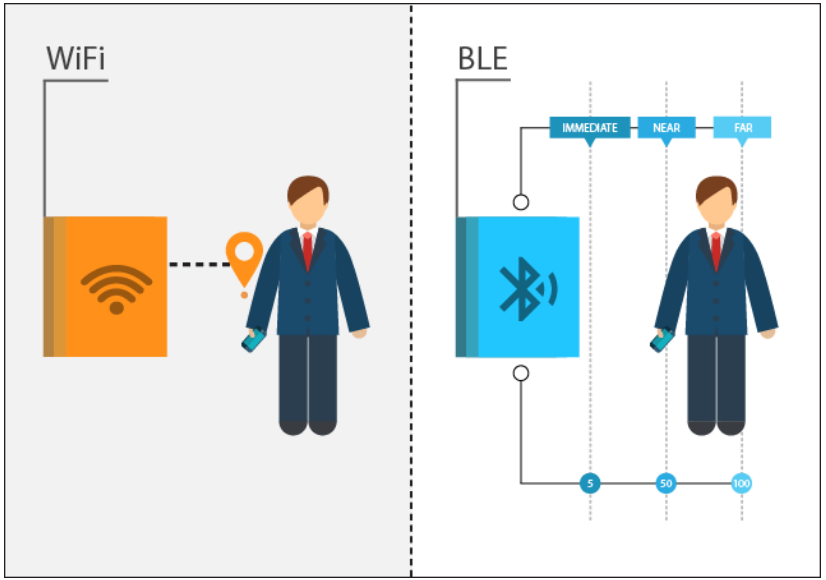
Application Layer Protocol - AMQP

- Advanced Message Queuing Protocol (AMQP)
- It is an open application layer protocol for business messaging.
- AMQP support point to point and publish - subscribe model routing and queuing



Wireless Communication Protocols in IOT

- Wi-Fi
- Bluetooth
- BLE



Click here

Reference link

Wi-Fi

- Wi-Fi provides Internet access to devices that are within the range of about 20 - 40 meters from the source. It has a data rate up to 600 Mbps maximum, depending on channel frequency used and the number of antennas.

- In terms of using the Wi-Fi protocol for IOT, there are some pros & cons to be considered. The infrastructure or device cost for Wi-Fi is low & deployment is easy, but the power consumption is high, and the Wi-Fi range is quite moderate. So, the Wi-Fi may not be the best choice for all types of IOT applications, but it can be used for applications like Home Automation.

Click here

Reference link

Bluetooth

- Bluetooth is a technology used for exchanging data wirelessly over short distances and preferred over various IOT network protocols.

- The Bluetooth that is used in devices for communication has many applications in IOT/M2M devices nowadays. It is a technology using which two devices can communicate and share data wirelessly. It operates at 2.4GHz ISM band and the data is split in packets before sending and then is shared using any one of the designated 79 channels operating at 1 MHz of bandwidth.

Click here

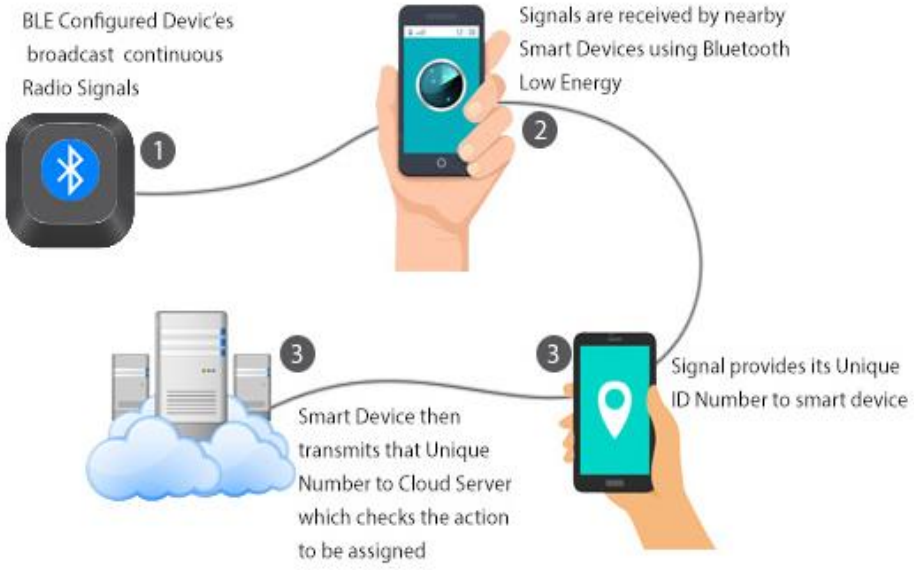
Reference link

BLE

- BLE (Bluetooth 4.0, Bluetooth Low Energy)
- The BLE has a single main difference from Bluetooth that it consumes low power. With that, it makes the product of low cost & more long-lasting than Bluetooth.

Applications

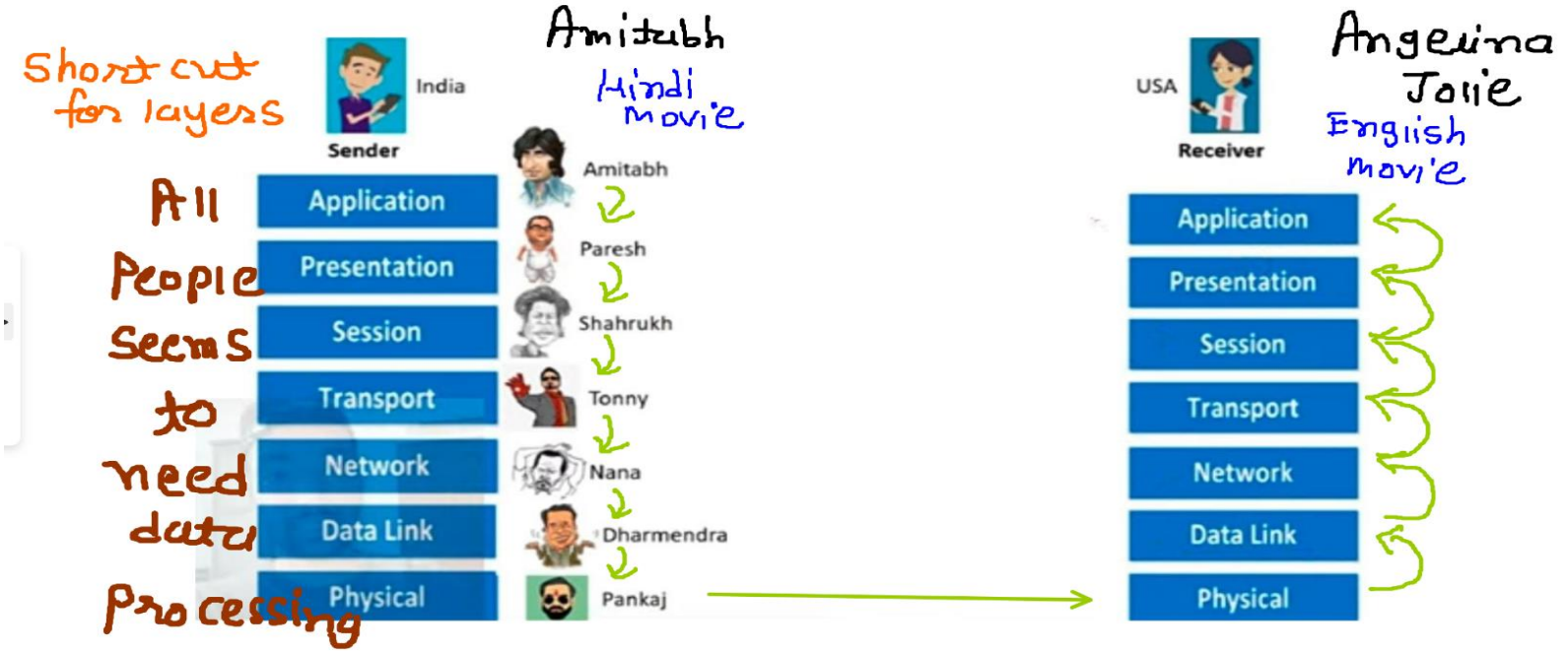
- Healthcare
- Fitness
- Home entertainment industries



Click here

Reference link

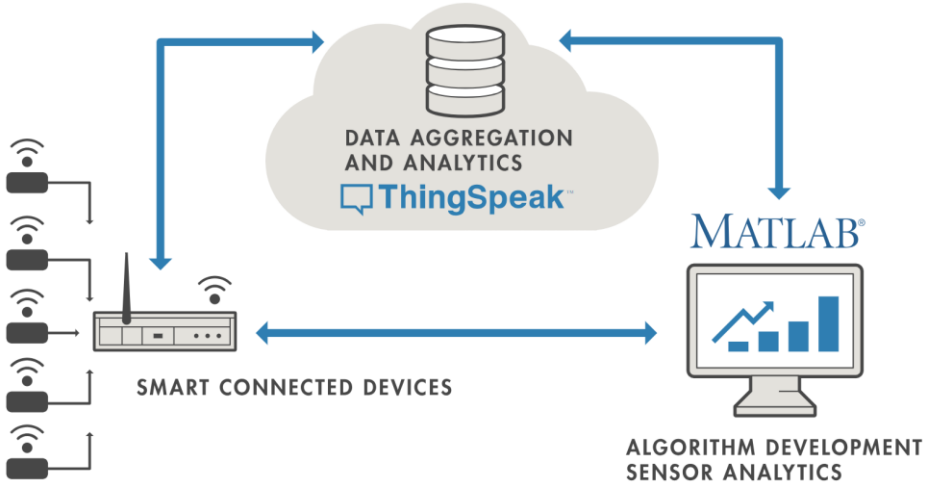
Let's understand with Example for complete IoT protocal



Cloud Integration IoT services

ThingSpeak for IoT

- ThingSpeak™ is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud.
- ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.



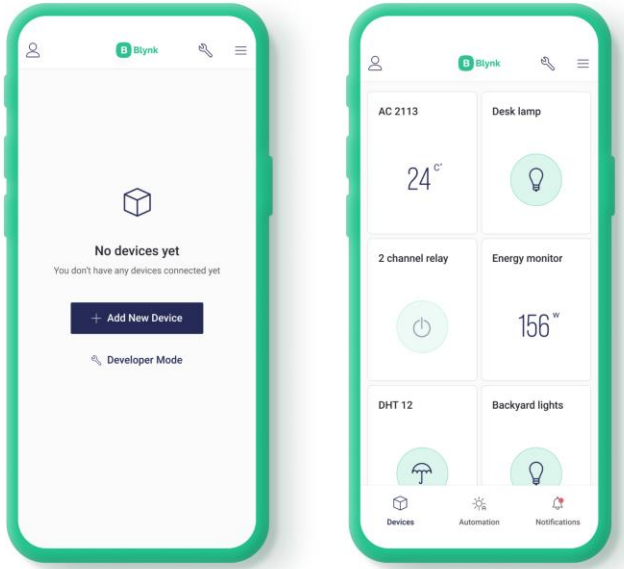
Click here

Reference link

Cloud Integration IoT services

Blynk

- Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.
- Blynk is a comprehensive software suite that enables the prototyping, deployment, and remote management of connected electronic devices at any scale.



Click here

Reference link

Summary

IoT (Internet of Things) networking involves connecting a diverse range of devices, sensors, and objects to the Internet or local networks.

These connected devices collect, exchange, and process data to enable automation, monitoring, and control in various applications such as smart homes, industrial systems, healthcare, and more.

IoT networks use specialized devices like sensors, actuators, gateways, and routers to enable seamless communication. Different networking technologies, including Wi-Fi, Bluetooth, Zigbee, and cellular networks, are utilized based on the specific requirements of each IoT application.

Security, scalability, and efficient data management are paramount in designing IoT networks to ensure reliable and secure connectivity in the rapidly evolving world of interconnected devices.

Quiz

1. The standard length of the MAC address is

a) 16 bits
b) 48 bits
c) 32 bits
d) 8 bits

Answer: b)

Quiz

2. Among the following layers, identify the one which is used for wireless connection in IoT devices.?

a) Datalink layer
b) Transport layer
c) Application layer
d) Network layer

Answer: a)

Quiz

3. Identify the one that is not a networking device.

a) Switch
b) Traffic analyzer
c) Bridge
d) Router

Answer: b)

Quiz

4. On what is MQTT based upon?

a) Public - Subscriber Architecture
b) client-server Architecture
c) Both A & B
d) none

Answer: a)

Quiz

5. MQTT stands for _____

a) Message Query Telemetry Transport
b) MetaQuery Telemetry Transport
c) Multiple Query Telemetry Transport
d) Multi-Queue Query Telemetry Transport

Answer- a)

Reference

- https://techvidvan.com/tutorials/communication-protocols-in-iot/
- https://www.arubanetworks.com/en-in/solutions/internet-of-things/
- https://www.javatpoint.com/computer-network-http
- https://iotdesignpro.com/articles/different-types-of-wireless-communication-protocols-for-iot
- https://thingspeak.com/pages/learn_more
- https://knepublishing.com/index.php/Kne-Social/article/view/4128/8495
- https://docs.blynk.io/en/
- https://en.wikipedia.org/wiki/Bluetooth_Low_Energy
- https://radiocrafts.com/technologies/coap-constrained-application-protocol/
- https://www.celona.io/network-infrastructure/iot-network
- https://www.javatpoint.com/hub
- https://www.javatpoint.com/router
- https://www.javatpoint.com/switch

Thank you...!