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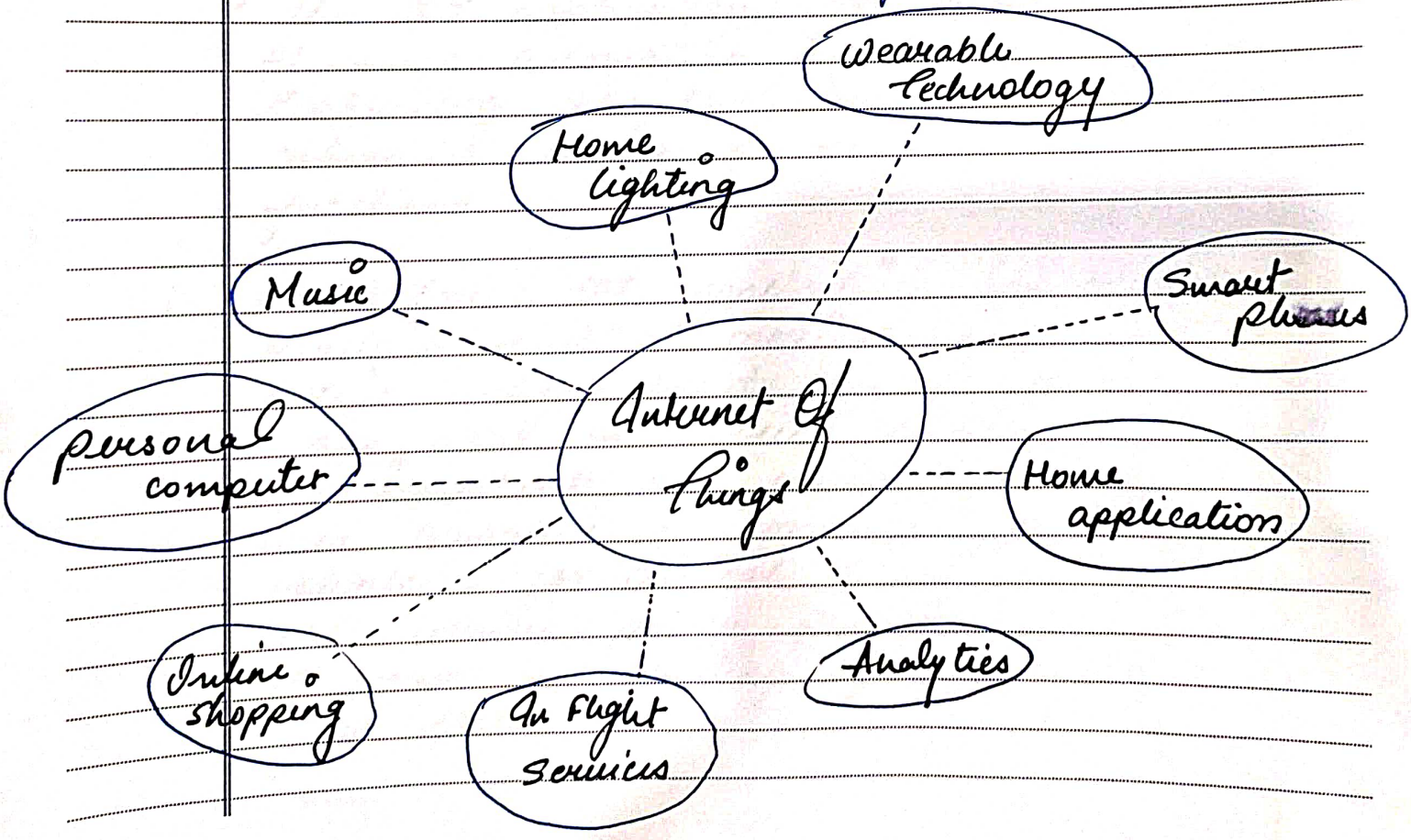
Ques-1 Define Internet of Things. Write applications of Internet of Things in details.

The Internet of Things (IOT) provides the ability to interconnect computing devices, mechanical machines, objects, animal or unique identifiers and people to transfer data across a network without the need for human-to-human or human-to-computer is a system of communication.



Applications of IOT :

1. Wearables - Wearable technology is the hallmark of IOT applications & one of the earliest industries to deploy IOT. We have fit bits, heart rate monitors and smartwatches these days.

2. Smart Home Applications : The smart home is probably the first thing when we talk about the IOT applications. The example we see the AI home automation is employed by Mark Zuckerberg. Alan Pan's home automation system, where a string of musical notes uses inhouse functions

3. Health Care : IOT applications can transform reactive medical medical-based systems into active wellness-based systems. Resources that are used in current medical research lack important real world information. It uses controlled environments, leftover data, and volunteers for clinical trials. The IOT improves the devices power, precision & availability. IOT focuses on building systems rather than just tools.

4. Smart Cities : Smart city uses technology to provide services. The smart city includes improving transportation and social services, promoting stability and giving voice to their citizens. Governments and engineers uses the IOT to analyze the complex factors of town & each city. IOT applications help in the area of water management, waste control and emergencies.

5. Agriculture : By the year 2050, the world's growing population is estimated to have reached about 10 billion. To fed such a large population, agriculture needs technology to get best results. One of them is smart Greenhouse.

6. Industrial Automation : IOT will prove as a game changer. In industrial automation, IOT is used in the following areas :

- Product flow monitoring
- Factory digitization
- Inventory management
- Safety & security
- Logistics & Supply chain optimization
- Quality control
- Packaging customization

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Ques-2 With a neat diagram. Explain Architecture & Characteristic of IOT.

4-Stage IOT Architecture

Flow control ↑

Application Layer Smart applications & Management	Smart Applications
Data Processing Layer Processing unit, Data Analytics / Decision unit.	Process information
Network Layer Internet Gateways / Network Gateways Network Technologies	Data Transmission
Sensing Layer Physical Objects Sensors & actuators	Data Gathering

The 4 layers are:

1. Sensing Layer:- This is the first layer of the IOT architecture and is responsible for collecting data from different sources. This layer includes sensors and actuators that are placed in the environment to gather information about temperature, humidity, light, sound & other physical parameters. These devices are connected to the network layer through wired or wireless communication protocols.

2. Network Layer: This layer is responsible for providing communication & connectivity between devices in IOT system. It includes protocols & technologies that enable devices to connect & communicate with each other & with other internet. Examples of network technologies that are commonly used in IOT include WiFi, Bluetooth, Zigbee, and cellular networks such as 4G & 5G.

3. Data Processing Layer: It refers to the software & hardware components that are responsible for collecting, analyzing & interpreting data from IOT devices. This layer is responsible for receiving raw data from the devices, processing it & making it available for further analysis or action. The data processing layer includes a variety of technologies

and tools, such as data management systems, analytics platforms, and machine learning algorithms. Example of this layer is a data lake, which is a centralized repository for storing raw data from IOT devices.

4. Application Layer: This layer of IOT architecture is the topmost layer that interacts directly with the end user. It is responsible for providing user-friendly interfaces & functionalities that enable users to access & control IOT devices. This layer includes various software and applications such as mobile apps, web portals & other user interfaces that are designed to interact with the underlying IOT infrastructure. It also includes middleware services that allow different IOT devices and systems to communicate & share data seamlessly. It also includes analytics & processing capabilities that allow data to be analyzed & transformed into meaningful insights. This can include machine learning algorithms, data visualization tools, and other advanced analytics capabilities

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Ques·3 Write a detailed note on logical & physical design of IOT.

Logical design of an IOT system refers to an abstract representation of the entities and processing without going into the low level detail of the implementation. The logical design is more conceptual and abstract than the physical design. Here, you look at the logical relationships among the objects. It focuses on satisfying the design factors such as requirements, risks, assumption & constraints. It can be graphical, textual or both.

Physical design is very detailed, how you look at the most effective way of storing and retrieving the objects. Here physical design means more than than creating products, but forming an overall intelligent system. It focuses on specific solutions i.e. how they are assembled & configured. It is more graphical than textual, but can be both.

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Ques-4 What are the elements of M2M IOT architecture Explain ?

M2M - Machine to Machine communication
It is a concept that enables networked devices to perform actions by exchange information without the manual assistance of humans. It refers to direct communication between devices using wired or wireless communications channels.

Key components of an m2m system include :

- Sensors
- RFID
- a wifi or cellular communications link &
- to help a network device to interpret data & make decisions, the need for Autonomic computing software programmed.

Applications :

- Remote monitoring
- Product tracking
- traffic control, Telemedicine services.

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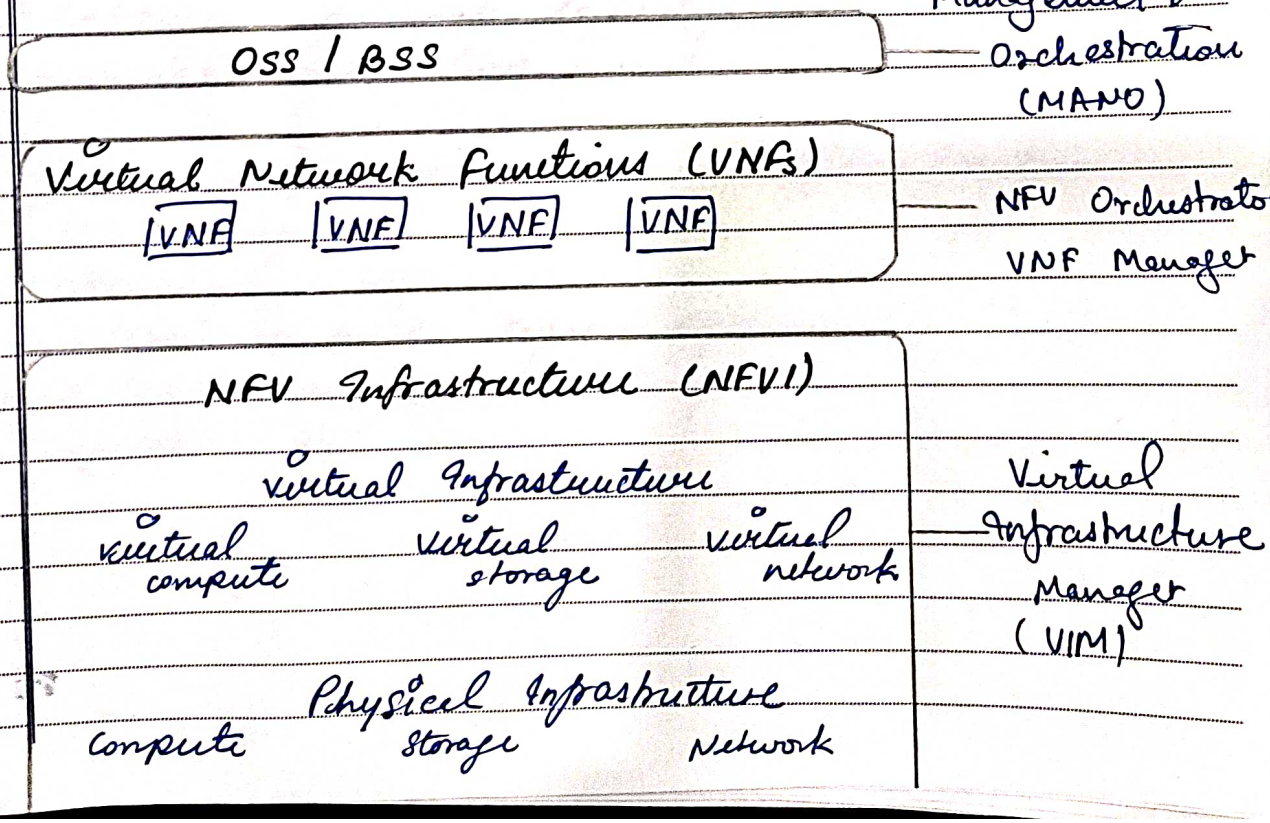
Ques-5 Discuss the Network function Virtualization (NFV) to address connectivity interoperability challenge in IOT.

NFV - Network Function Virtualization is an approach to network architecture that involves replacing dedicated network hardware devices with software based virtualized network functions (VNFs) that run on standard server, storage & switches.

Components of NVF architecture :



Overall, NFV enables organizations to deploy network functions more quickly & cost effectively while also providing greater flexibility, scalability & agility. By virtualizing network functions, operators can create a more dynamic and efficient network architecture that can adapt to changing business & user requirements.

Benefits of NFV:

- Cost savings
- Agility & flexibility
- Scalability
- Enhanced network security
- Service innovation

Risk of Network Function Virtualization

- Complexity
- Security
- Integration with legacy systems
- Performance & reliability
- Vendor lock-in

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Ques-6 What is IP addressing? Why IPV6 is required to implement the concept of IOT?

IP addressing: An IP address is a unique address that identifies a device on internet or a local network. IP stands for 'Internet Protocol', which is the set of rules governing the format of data sent via the internet or local network. In essence, IP addresses are the identifier that allows information to be sent between devices on a network; they contain location info & make device accessible for communication.

Types of IP address:

IPv4: Internet protocol version 4. It consists of 4 numbers seperated by dots, each no. can be from 0-255 in decimal number.

IPv6: It is an Internet Layer protocol for packet switched internetworking & provides end-to-end datagram transmission across multiple IP networks. Advance version of IPv4.

Reasons IPv6 is required to implement the concept of IOT:

1. Security: An imp. feature also organizations & individuals have learned or the real & imminent threat that hackers pose in past years. IPv6 can run end to end encryption, VPN are standard component in IPv6.

2. Scalability: It means as many as devices can be connected without any change to the IOT system, so IPv6 are the better option than IPv4 for this.

3. Connectivity: It means allowing network connected devices to 'speak' to each other ie. vital. With IPv4 there were quite issues with allowing IOT products to speak with one other. IPv6 allows IOT products to be uniquely addressable without having to work around all of traditional NAT & Firewall issues.

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Ques.7 Explain SOAP, REST, HTTP, COAP, CIOM2M, RFID, ZigBee.

1. **SOAP:** Simple Object Access Protocol (SOAP)
It is an XML-based messaging protocol for exchanging information among computers. SOAP is an application of the XML specification.

- It is a communication protocol designed to communicate via internet.
- It can extend HTTP for XML messaging.
- It provides data transport for web service.
- SOAP is platform & language independent.
- SOAP is the XML way of defining what information is sent & how.
- SOAP enables client applications to easily connect to remote services & invoke remote methods.

2. **REST:** REpresentational State Transfer
REST is a software architectural style that defines the set of rules to be used for creating web services. Web services which follow the REST architural style are known as RESTful web services. It allows requesting systems to access & manipulate web resources by using a

uniform & predefined set of rules.
A Restful system consists of a:

- a client who requests for the resources.
- server who has the resources

Architectural constraints of RESTful API: There are six architectural constraints which makes any web service are listed below:

- Uniform Interface
- Stateless
- Cacheable
- Client server
- Layered System
- Code on demand.

3. HTTP: Hypertext Transfer Protocol (HTTP) It is an application level protocol for distributed, collaborative, hypermedia information systems. This protocol used to access the data on the world wide web (WWW).

Features of HTTP:

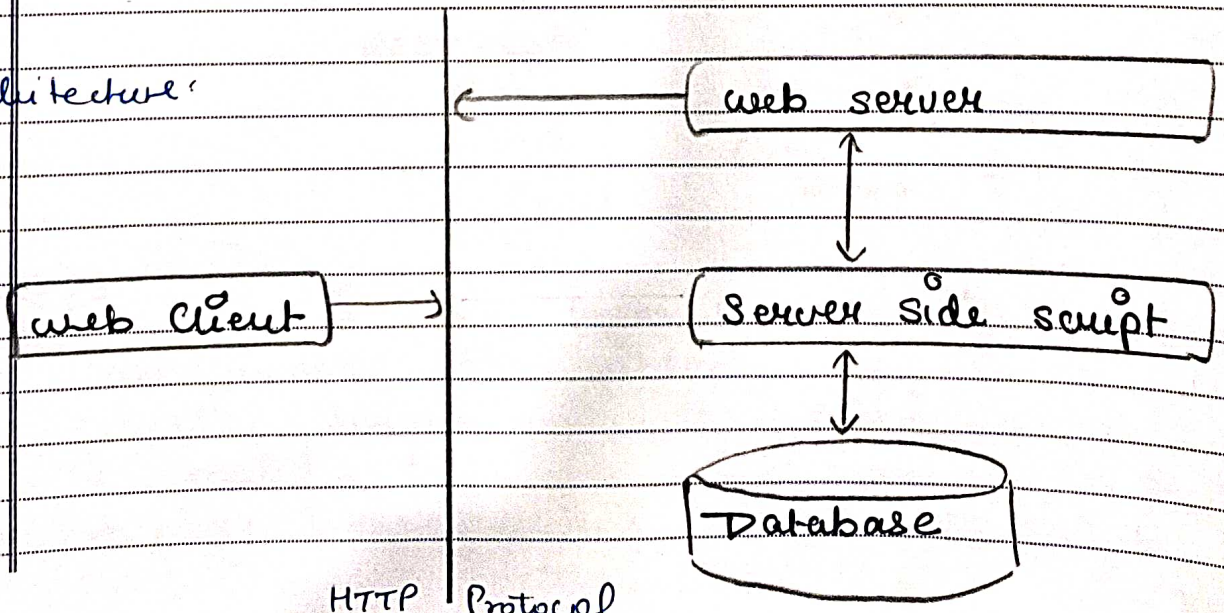
- Connectionless Protocol: HTTP is a connectionless protocol, the connection between client

and server exist only during the current request and response time only.

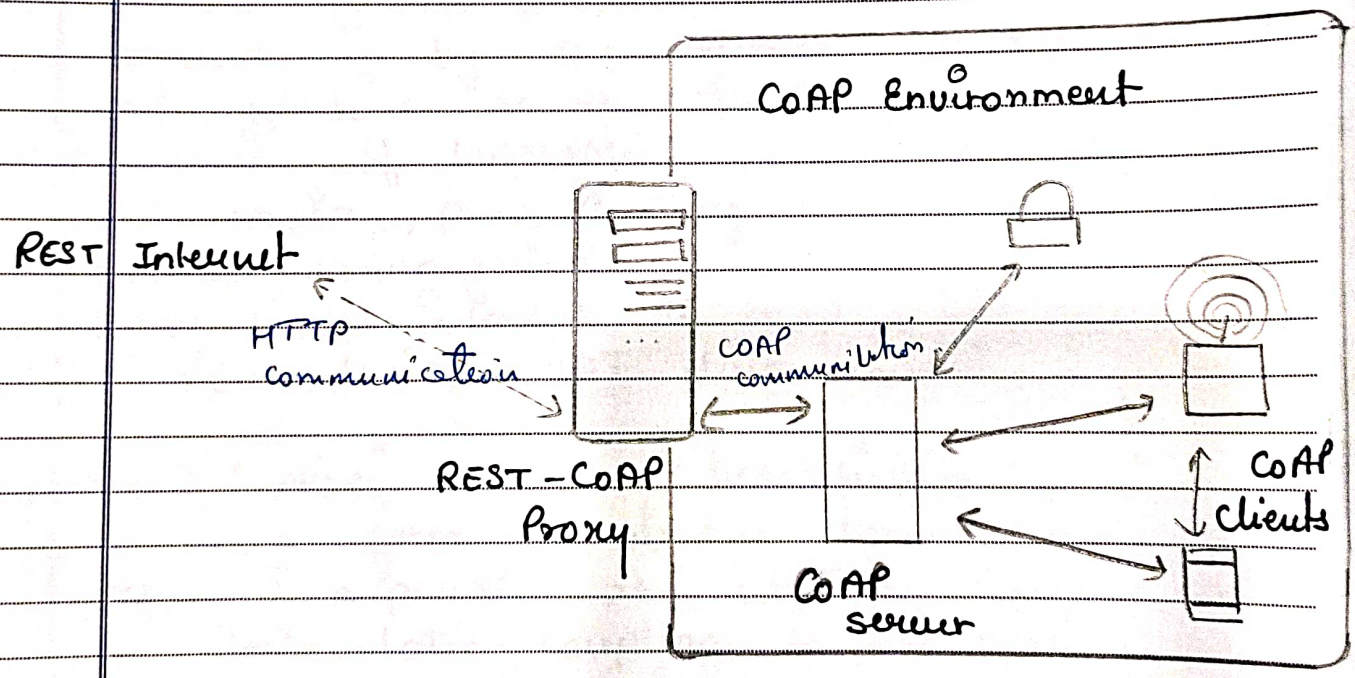
> Media independent : HTTP protocol is a media independent as data can be sent as long as both client & server know how to handle the data content. It is required for both the client & server to specify the content type in MIME-type header.

> Stateless : It is stateless as both client & server know each other only during the current request. Due to this nature of protocol both client & server do not retain the info. between various requests of web pages.

Basic architecture:



4. COAP : Constrained Application Protocol
It is a session layer protocol that provides the RESTful (HTTP) interface between HTTP client & server. Designed by IETF constrained RESTful Environment (CoRE) working group. It is designed to use devices on the same constrained network between devices and general nodes on the Internet.

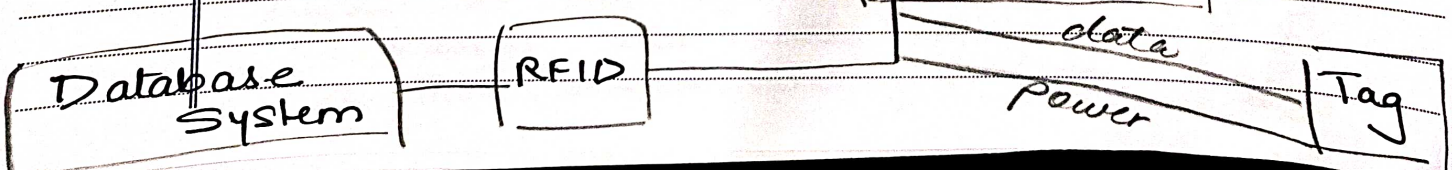


The data is sent from CoAP clients (such as smartphones, RFID sensors, etc) to the CoAP server and the same message is routed to REST CoAP proxy. The REST CoAP proxy interacts outside CoAP environment &

uploads data over REST internet

5. LWM2M : Lightweight M2M
It is an open protocol from the Open Mobile Alliance (OMA) that is designed for addressing the needs of mobile low power devices with very little compute power. It provides a standardized way to manage these devices & send telemetry data drawn in by the sensors quickly & cost effective to the cloud.
Benefits of LWM2M :
- self-service, plug & play
- Remote management
- Easy-to use interface to map with the Cumulocity IOT data model.

6. RFID : Radio Frequency Identification
It is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the ratio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person.



Types of RFID:

- Passive RFID: Passive RFID tags does not have their own power source. It uses power from the reader.
- Active RFID: In this device, RF tags are attached by a power supply that emits a signal & there is an antenna which receives the data. means, active tag uses a power source like battery. It has its own power source, doesn't require power from source/reader.

Applications of RFID:

- In tracking shipping containers, trucks & railroad, cars.
- credit cards
- ID badging
- Counterfeit prevention

7. ZigBee: ZigBee is a Personal Area Network task group with low rate task group 4. It is a technology of home networking. ZigBee is an open, global, packet-based protocol designed to provide an easy to use architecture for secure, reliable,

low power wireless networks. Flow or process control equipment can be place anywhere and still communicate with the rest of the system.

ZigBee specification supports star and two kinds of peer-to-peer ~~technology~~ topologies, mesh & cluster tree.
ZigBee complaint devices are sometimes specified as supporting point-to-point & point-to multipoint topologies.

Types of ZigBee devices:

- ZigBee Coordinator Device: communicates with routers
- ZigBee Router: Used for passing the data between devices
- ZigBee End devices: It is the device that is going to be controlled.

Characteristics of ZigBee:

- Low power consumption
- Short Range (75-100 m)
- Low Data Rate (20-250 Kbps)
- Network join time (~30 msec)
- low cost of products & cheap implementation