E1_Megha Lohar_49398

PAGE:
DATE: / /

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# Internet of Things (IOT)

## Rapid Fire Questions.

### Question 1

What do you mean by IOT ? And where it is used.

IOT

* IOT stands for Internet of Things (IoT).
* The IoT describes the network of physical objects - "things" - that are embedded with sensors, software, and other technologies for the purpose of connecting & exchanging data with other devices and systems over the internet.
* Kelvin Ashton, in a presentation of Procter & Gamble in 1999, coined the term "Internet of Things".
* IOT (Internet of Things) is an advanced automation & analytics system which exploits networking, sensing, big data, and artificial intelligence technology to delivers complete systems for a product or service.
* These systems allow greater transparency, control & performance when applied to any industry or system.
* IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment.
* They enhance data collection, automation, operations & much more through smart device and powerful enabling technology.

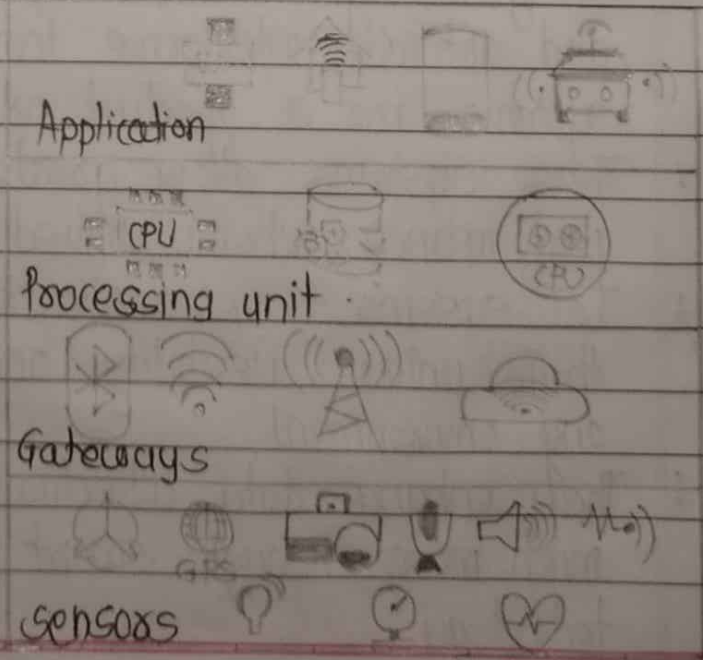
PAGE:
DATE: / /

IOT use cases
1) Smart home
2) Smart city
3) Smart grids
4) Industrial internet
5) Connected car
6) Connected health
7) Smart Retail
8) Smart Supply Chain
9) Smart Farming
10) Wearable Technology.

Question 2

What are the important Components of Internet of Things?

Major components of Internet of Things :-
Sensors.
Network / Connectivity.
Data Processing.
Application Layer



PAGE:
DATE: / /

## Sensors

- The most important hardware in IoT might be its sensors.
- Sensors or Actuators are the devices that are able to emit, accept & process data over the network.
- These sensors or actuators may be connected either through wired or wireless.
- E.g.
  - Temperature Sensors
  - Proximity Sensor
  - Pressure Sensor
  - Water Quality Sensor
  - Chemical Sensor
  - Gas Sensor
  - Smoke Sensor
  - IR Sensor
  - Level Sensors
  - Motion Detection Sensors
  - Accelerometer Sensors
  - Gyroscope Sensors
  - Humidity Sensors

## Hardware

The hardware utilized in IoT systems includes devices for a remote dashboard, devices for control, servers a routing or bridge device & sensors.

## Network / Connectivity

- The collected data is sent to a cloud infrastructure, but it needs a medium for transport.

PAGE:
DATE: / /

- The sensors can be connected to the cloud through various mediums of communication and transports such as

RFID & NFC

RFID (radio-frequency identification) and NFC (near-field communication) provide simple, low energy, and versatile options for identity & access tokens, connection bootstrapping, and payments.

Low-Energy Bluetooth

This technology supports the low-power, long-use need of IoT function while exploiting a standard technology with native support across systems.

Radio Protocols

- ZigBee, Z-wave & Thread are radio protocols for creating low-rate private area networks.
- These technologies are low-power, but offer high throughput ~~while~~ unlike many similar options.
- This increases the power of small local device networks without the typical costs.

Low-Energy Wireless.

- This technology replaces the most power hungry aspect of an IoT system.
- Low-energy wireless not only reduces consumption, but also extends the life of the device through less use.

Cellular

- LTE-A or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency & raising its through-put.

PAGE:
DATE: / /

## Data Processing

- Once the data is collected the software performs processing on the acquired data.
- This can range from something very simple, such as checking that the temperature reading on devices such as AC or heaters is within an acceptable range.
- It can sometimes also be very complex, such as identifying objects (such as intruders in your house) using computer vision on video.
- But there might be a situation when a user interaction is required, example temp. in house.

## Application Layer

- The information made available to the end-users in some way.
- This can achieve by triggering alarms on their phones or notifying through texts or emails.
- Also, a user sometimes might also have an interface through which they can actively check in on their IOT system.
- There are also cases where some actions perform automatically by establishing & implementing some predefined rules.

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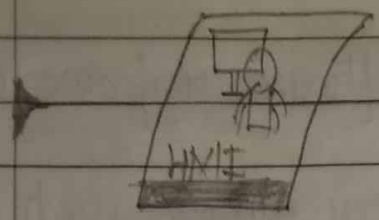
### Question 3

Explain different layers of IOT device. In other words, explain IoT protocol stack.

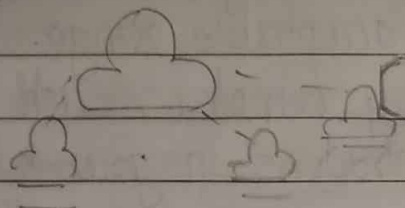
EL Megha Lohar - 49398

PAGE:
DATE: / /

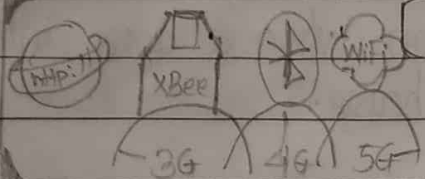



Business Layer — System Management
Business Models

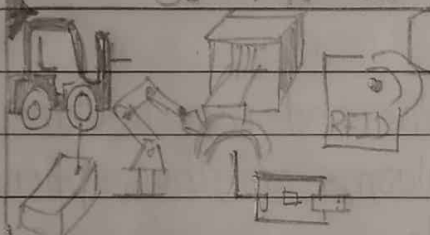
Application Layer — Smart Applications
Graphic Data Representation



Middleware Layer — Process Information
Decision Unit
Data Analytics




Network Layer — Data Transmission
Network Technologies




Perception Layer — Data Gathering
Physical Objects
Sensors & Actuators

## IoT Layers

**Perception Layer:**
that manages smart devices across the system.

**Connectivity / Transport Layer**
allows transferring data from the cloud to devices & vice-versa. different aspects of gateways & networks.

**Processing Layer.**
that controls & manages IoT levels for streamlining data across the system.

PAGE:
DATE: 11

**Application Layer**
that aids in the procedures of analytics, device control & reporting to end-users.

**Business layer**
that derives information & decision-making analysis from data.

**Security layer**
that covers all aspects of protecting the whole IOT architecture.

**Edge Computing Layer**
that works at an edge or near the device information collection.

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## Question 4

Explain the basic architecture of IoT network:

* The architecture of IoT depends upon its functionality & implementation in diff sectors. Still, there is a basic process flow based on which IoT is built.

* The basic fundamental architecture of IoT.
i.e. 4 stage of IoT architecture.

PAGE:
DATE: / /

| | |
|---|---|
| Application Layer | ⇒ Smart appl$^n$ |
| Data Processing Layer | ⇒ Process info |
| Network Layer | ⇒ Data transmission |
| Sensing Layer | ⇒ Data Gathering |

## Sensing Layer

Sensors, actuators, devices are present in this sensing layer. This sensors or actuators accepts data, processor data & emits data over network.

## Network Layer

Internet / Network gateways, Data Acquisition System (DAS) are present in this layer. DAS performs data aggregation & conversion function.

Advanced gateways which mainly opens up connection between sensor network & internet also performs many basic gateway functionalities like malware protection & filtering also some time decision making based on inputted data & data management services etc.

## Data Processing Layer

This processing unit of IoT ecosystem. Here data is analyzed & pre-processed before sending it to data center from where data is accessed by software appl$^n$ often termed as business appl$^n$ where data is monitored & managed & further actions are also prepared. So here

edge. I edge analytics comes into picture.

Application Layer

Data centers or cloud is management stage of data where data is managed & is used by end-user appln like agriculture, health care, aerospace, farming defense etc.

## Question 5

Explain various communication technologies used in IoT.

Communication technologies used in IoT.

* The wireless communication protocol in IoT is the set of rules used to exchange data between electronic devices.
* Bluetooth, ZigBee, LoRa, NBIoT, WiFi and Thread are the most commonly used protocols.

Bluetooth

An important short-range IoT communications Protocols / Technology. Bluetooth, which has become very important in computing & many consumer product markets. It is expected to be key for wearable products in particular, again connecting to the IoT albeit probably via a smartphone in cases.

The new Bluetooth Low-Energy (BLE) - or Bluetooth Smart, as it is now branded - is a significant protocol for IoT applications.

ZigBee

ZigBee is similar to Bluetooth & is majorly used in industrial

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settings. It has some significant advantages in complex systems offering low-power operation, high security, robustness & high & is well positioned to take advantage of wireless control and sensor networks in IoT applications.

## Wi-Fi

Wi-Fi connectivity is one of the most popular IoT communication protol. often an obvious choice for many developers, especially given the availability of Wi-Fi within the home environment within LANs.

There is a wide existing infrastructure as well as offering fast data transfer and the ability to handle high quantities of data.

Currently, the most common WiFi standard used in homes and many businesses is 802.11n, which offers range of hundreds of megabit per second, which is fine for file transfers but may be too power-consuming for many IoT applications.

## LoRaWAN

LoRaWAN is one of popular IoT Technology, targets wide-area network (WAN) applications. The LoRAWAN design to provide low-power WANs with features specifically needed to support low-cost mobile secure communication in IoT, smart city & Industrial appl$^{ns}$.

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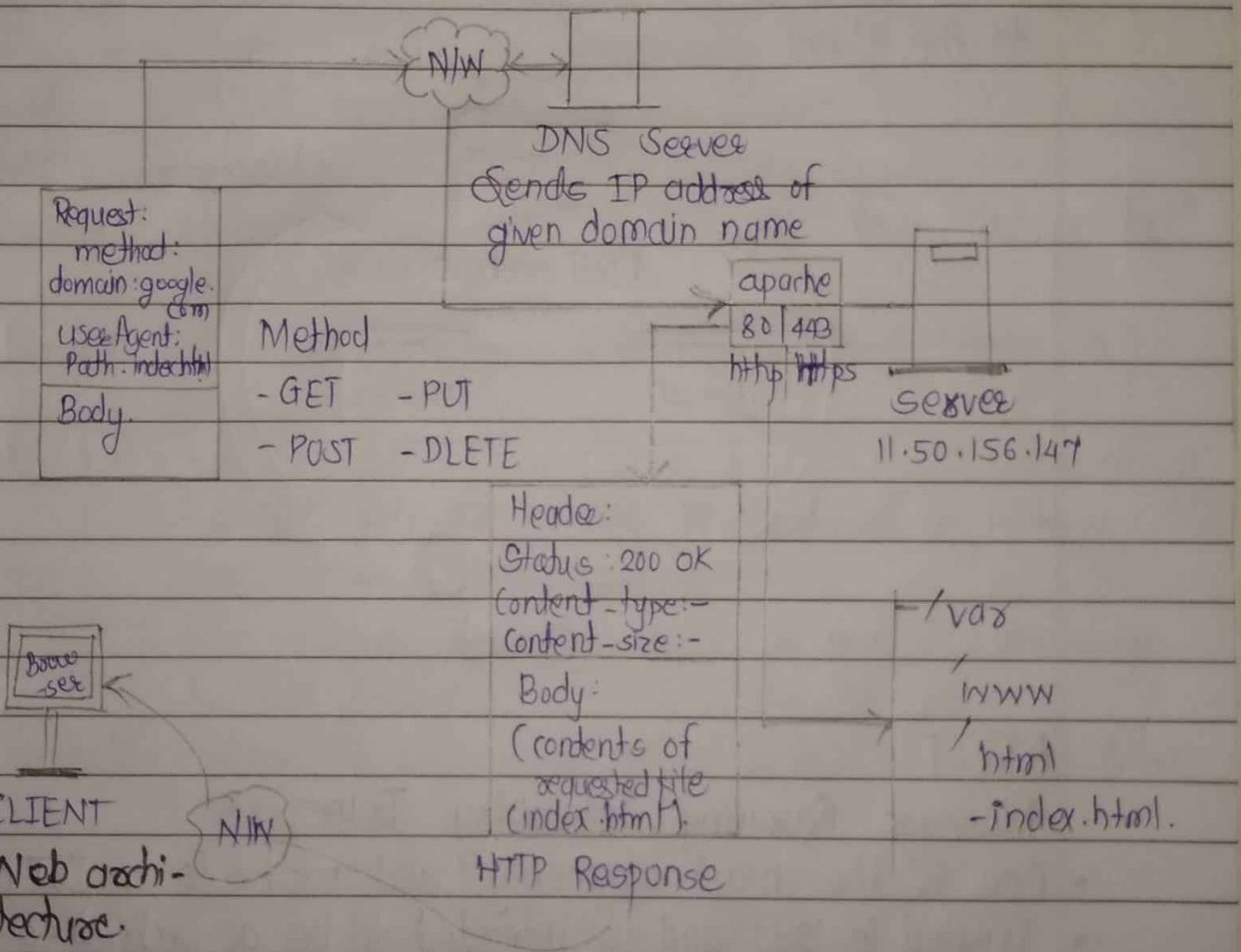
PAGE:
DATE: / /

## Question 6

Explain IoT protocols - REST, MQTT, CoAP.

### REST

REpresentational State Transfer.




- a REST Server simply provides access to resources & REST client accesses and modifies the resources.
- HTTP methods.

GET :- Provides a read only access to a resource.
POST :- Used to create a new resource.
DELETE :- Used to remove a resource.
PUT :- Used to update a existing resource.

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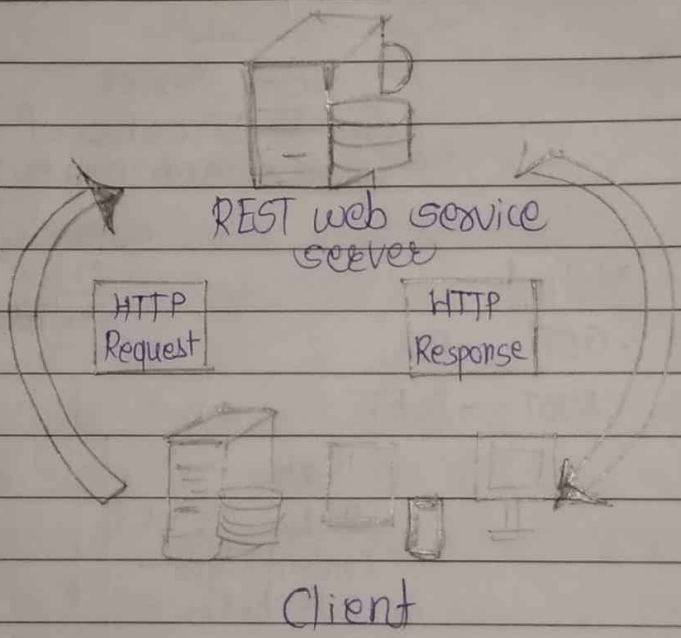
## Architecture

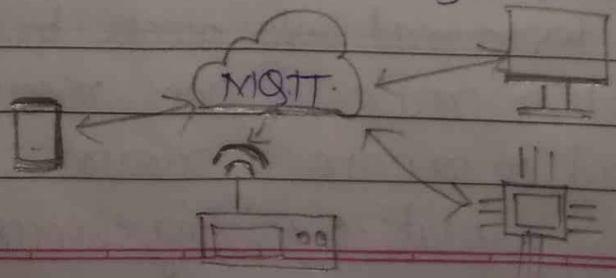
- REST uses client-server architecture.
- Client sends HTTP Request having all the parameters to the server.
- Server processes the request and sends the response back to client.
- Client process the response and shows the output to the client.




## MQTT

Message Queuing Telemetry Transport

* One of the most commonly used protocols in IoT projects.
* Created in 1999 and is intended to be a publish-subscribe based "light-weigh" messaging protocol for IoT and M2M.
* It is based on the idea that TCP and HTTP are good protocols (MQTT makes them lighter)



PAGE:
DATE: 11

## MQTT

* It is a lightweight protocol. So, it's easy to implement in software and fast in data transmission.
* It's based on a messaging technique.
* Minimized data packets. Hence, low network usage.
* Low power usage. As a result, it saves the connected devices battery.
* It's real time! That's is specifically what makes it perfect for IOT applications.

MQTT Components

Brokers: the server that handles the data transmission bet$^n$ the clients

Topic: the place a device want to put or retrieve a message to/from

Message: the data that a device receives "when subscribing" from a topic or send "when publishing" to a topic.

Publish: the process a device does to send its message to the broker.

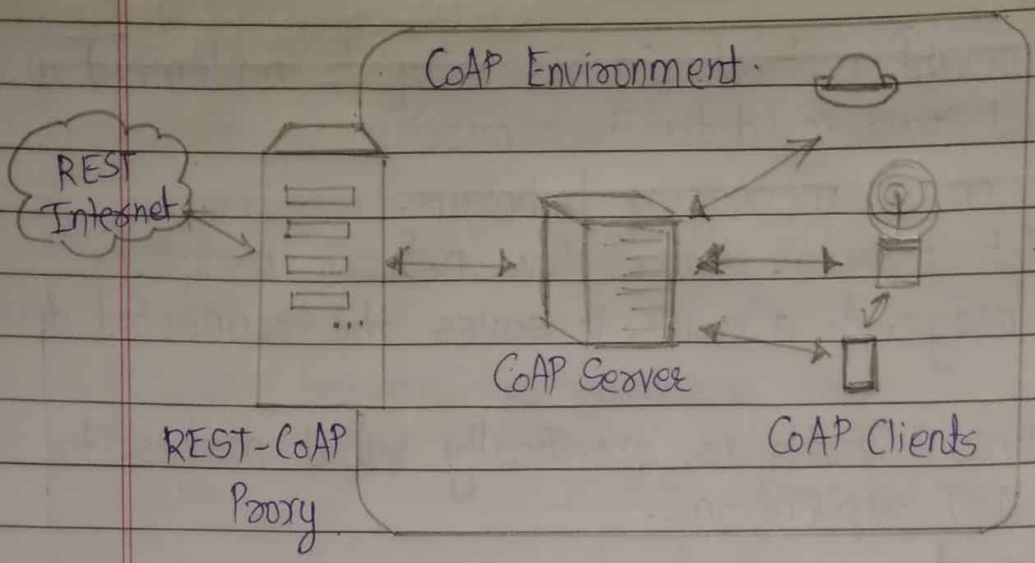
Subscribe: where a device does to retrieve a message from the broker.

## CoAp

Constrained Application Protocol.

* An internet application layer protocol for constrained device.
* Built specially for IoT systems based on http protocols.
* Makes use of UDP protocol for lightweight implementation.
* Used within mobiles & social network based applications.

PAGE:
DATE: / /




CoAP Communication ←→
HTTP Communication <-->

**Endpoint**
- An entity that participates in the CoAP protocol. Usually, an Endpoint is identified with a host.

**Sender**
- The entity that sends a message.

**Recipient**
- The destination of a message.

**Client:**
- The entity that sends a request & the destination of the response.

**Server**
- The entity that receives a request from a client and sends back a response to the client.

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Question 7

Explain differences between TCP & UDP.

| | TCP | UDP |
|---|---|---|
| 1. | TCP is a connection-oriented protocol. [Connection-orientation means that the communicating devices should establish a connection before transmitting data & should close the connection after transmitting the data] | UDP is the Datagram oriented protocol. [there is no overhead for opening a connection, maintaining a connection, and terminating a connection. UDP is efficient for broadcast & multicast type of network transmission] |
| 2. | TCP is reliable as it guarantees delivery of data to the destination router. | The delivery of data to the destination cannot be guaranteed in UDP. |
| 3. | TCP provides extensive error checking mechanisms. It is because it provides flow control & acknowledgement. | UDP has only the basic error checking mechanism using checksums. |
| 4. | Sequencing of data is one of the features. | There is no sequencing of data in UDP. |

# NOTES

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| | TCP | UDP |
|---|---|---|
| 5. | TCP is comparatively slower than UDP. | UDP is faster, simpler & more efficient than TCP |
| 6. | Retransmission of lost packets is possible in TCP. | There is no retransmission of lost packets. |
| 7. | TCP has a (20-80) bytes variable length header. | UDP has a 8 bytes fixed length header. |
| 8. | TCP is heavy-weight. | UDP is lightweight. |