CBCS SCHEME

USN | | | | | | | | | | BETCKH205/BETCK205H

Second Semester B.E./B.Tech. Degree Examination, June/July 2023
Introduction of Internet of Things (IoT)

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Explain broad categories of computer networks based on network reachability.	7	L2	CO2
	b.	Explain various networking components of IoT.	7	L2	CO2
	c.	Differentiate between IoT and M2M.	6	L2	CO1
		OR			
Q.2	a.	Explain communication between two hosts following TCP/IP suite with neat block diagram.	7	L2	CO2
	b.	Discuss different IoT planes along with various enabling technologies of IoT	7	L2	CO3
	c.	Classify network types based on physical topology with example.	6	L2	CO3
		Module – 2			
Q.3	a.	Outline simple sensing operation in IoT node with its functional blocks.	8	L2	CO2
	b.	Define sensor and explain characteristics of sensor.	6	L2	CO1
	c.	Compare mechanical, soft and shape memory based actuators.	6	L2	CO2
		OR			
Q.4	a.	Explain different categories of sensors based on sensing environment.	8	L2	CO2
	b.	Outline basic difference between transducer, sensor and an actuator.	6	L2	CO2
	c.	With neat diagram, explain working mechanism of actuator	6	L2	CO3
		Module – 3			
Q.5	a.	Differentiate between structured and unstructured data with examples.	5	L2	CO2
	b.	Explain different data offloading strategies with locations and decision making.	10	L2	CO2
	c.	Discuss with neat diagram, event detection using offsite Remote processing topology.	5	L2	CO2
		OR			
Q.6	a.	With neat diagram, explain onsite processing topology.	5	L2	CO2
	b.	Discuss various processing topologies.	10	L2	CO2
	c.	Discuss the importance of data processing in IoT and offload decision making approaches.	5	L2	CO2

		Module – 4			
Q.7	a.	What is virtualization and explain its different types?	6	L2	CO2
	b.	Differentiate between Network based computing and cloud computing.	6	L2	CO1
	c.	Explain the architecture of sensor cloud platform.	8	L2	CO1
		OR			
Q.8	a.	Explain components of Agricultural IoT.	6	L2	CO2
	b.	What is Service Level Agreement (SLA), explain its importance and metrics used while defining SLA.	6	L2	CO2
	c.	Explain how agricultural IoT help in efficient distribution of water in agricultural field.	8	L2	CO2
		Module – 5			
Q.9	a.	Explain fog framework for intelligent public safety in vehicular environment FISVER with block diagram.	10	L2	CO2
	b.	Discuss the advantages and risks associated with health care IoT.	5	L2	CO2
	c.	With neat diagram, explain types of machine learning.	5	L2	CO2
		OR			
Q.10	a.	Explain the hardware components and front end design features of Ambusense system.	10	L2	CO2
	b.	Explain the challenges in using machine learning.	5	L2	CO2
	c.	Why privacy and security are important in health care IoT? Explain.	5	L2	CO2

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Module-I

Q1 a) Explain broad categories of computer networks based on network reachability.

-> Network reachability :- computer networks are divided into four broad categories based on network reachability:

i) Personal Area Networks (PAN)

ii) Local Area Networks (LAN)

iii) Wide Area Networks (WAN)

iv) Metropolitan Area Networks (MAN)

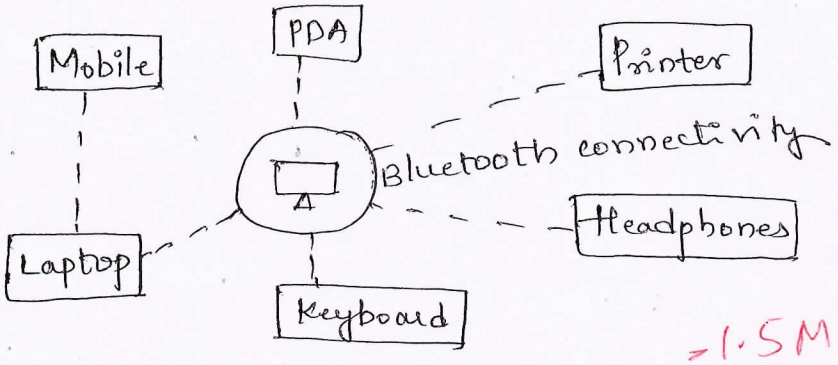
- 1M

i) Personal Area Networks (PAN)

- It is computer network that connects computers / devices within the range of a person
- It provides a network range within a person's range typically range of 10 meters.
- Examples of PANs may be connected wire-less headphones, wireless speakers, printers, Laptops, Smartphones, wireless keyboards, wireless mouse, and entertain-ment devices like speakers, video game

consoles, etc

- Generally, PANs are wireless networks, which make use of low-range and low-power technologies such as Bluetooth.



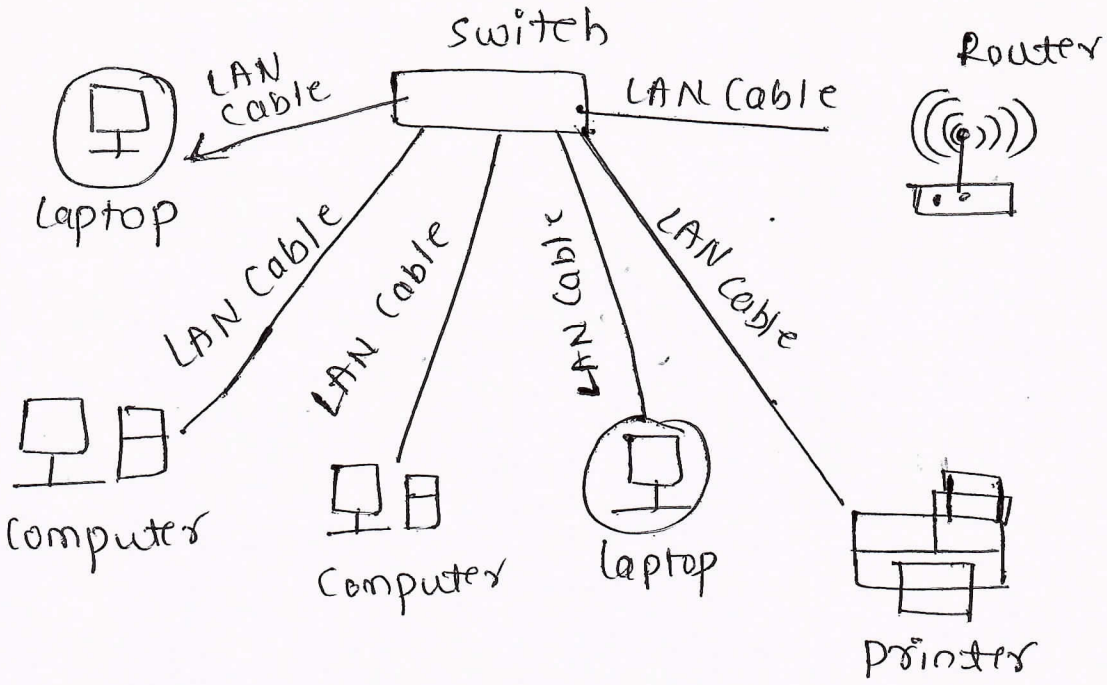
=1.5M

ii) Local Area Network (LAN)

- A LAN is a collection of hosts linked to a single network through wired or wireless connections.
- They are restricted to buildings, organizations, or campuses.
- They cover a range limited to a few kilometers and are privately owned.
- Commonly used network components in a LAN are servers, hubs, routers, switches, terminals, and computers.
- The data speed ranges from 10Mbps to 1000 Mbps.

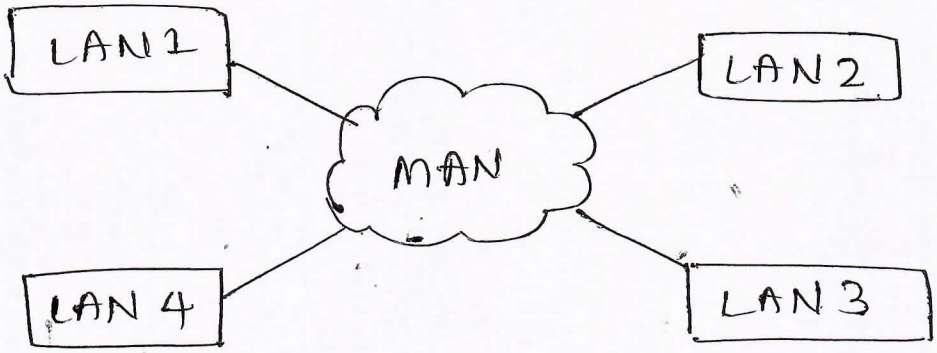
-1.5M

P.T.O



iii) Metroplitan Area Networks (MAN):

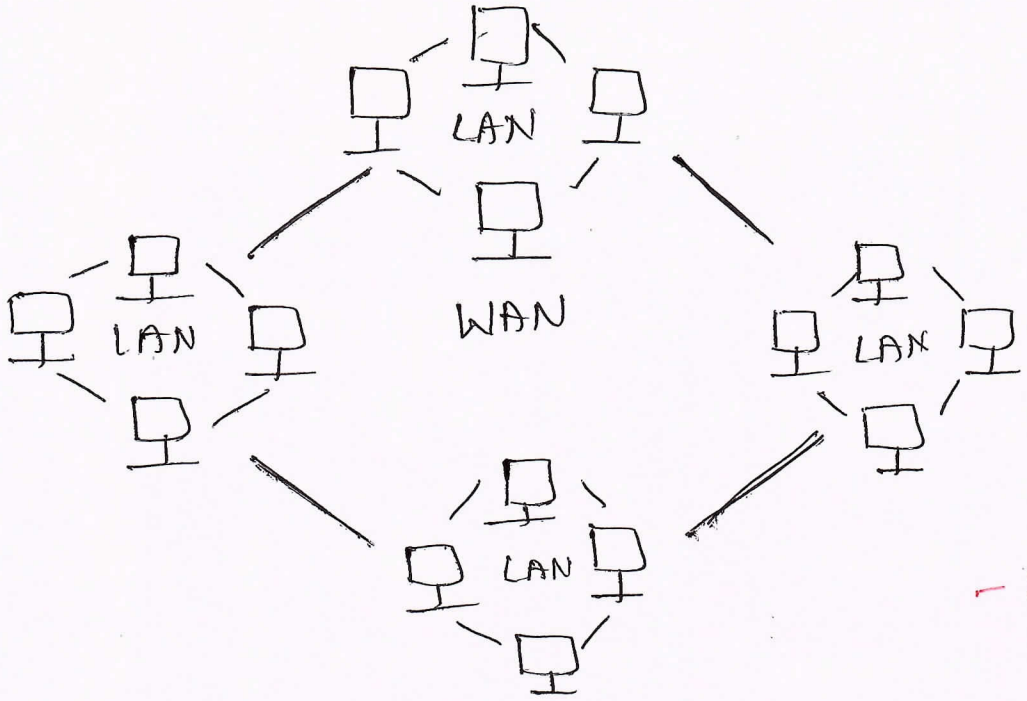
- MANs connect various organizations or buildings within a given geographic location or city as shown in figure 8.
- It connects two or more computers that are apart but reside in the same or different cities.
- An example of a MAN is an Internet service provider (ISP) supplying Internet connectivity to various organizations within a city.
  - MAN is designed for customers who need high-speed connectivity.
  - Speeds of MAN range in terms of Mbps.
  - Typical networking devices / components in MANs are modems and cables.



- 1.5M

iv) Wide Area Networks (WAN);

- WAN is a collection of local-area networks (LANS) or other networks that communicate with one another.
- WAN is a computer network that extends diver-se geographic locations. However, they are restricted within the boundaries of a State or country.
- The data rate of WANS is in the order of a fraction of LAN'S data rate,
- Typically, WANs connecting two LANS or MANs may use public switched telephone networks (PSTNS) or Stellite-based links.
- Due to the long transmission ranges, WAN's tend to have more errors and noise during transmission and are very costly to maintain
- The fault tolerance of WANs is also generally low and moderate speed.



-1.5

1(b) Difference between Network based computing and cloud computing.

→ IoT networking components are broad categories into SIX types

(1) IOP node (2) IOT routers (3) IOT LAN (4) IOT WAN (5) IOT gateway (6) IOT proxy.

the description each components is as fallows.

① IOT node
② IOT router
③ IOT LAN
④ IOT WAN
⑤ IOT Gateway
⑥ IOT proxy

-1M.

(i) IoT Node :- these are the networking devices within an IoT LAN. Each of these devices is typically made up of a sensor, a processor and a radio. the nodes may be connected to other nodes inside a LAN directly or using a common gateway for that LAN.

(ii) IoT Router :- An IoT router is a networking equipment that the routing of packets b/t various entities in the IoT network, It keeps The traffic flowing correctly within the network.

(iii) IoT LAN :- The local area network [LAN] enables local connectivity like within a building or an organization. Typically consist of shoort-range connectivity technologies. IoT LANs may or may not be connected to the Inter-net.

(iv) IoT WAN :- The wide area network [WAN] connects various network segments such as LANs. They are typically organizationally and geographically wide, with their operational range lying b/t a few kilometers to hundreds of kilometers.

(v) IoT Gateway : An IoT gateway is simply a router connecting the IoT LAN to a WAN

on the Internet. Gateways can implement several LANs and WANs. Their primary task is to forward packets between LANs and WANs.

(vi) IoT Proxy :- Proxies actively lie on the application layer and perform application layer functions between IoT nodes and other entities. Typically, application layer proxies are a means of providing security to the network entities under it.

1 X 6M = 6M → 7M

1 (c) Differentiate between IoT and M2M.

→

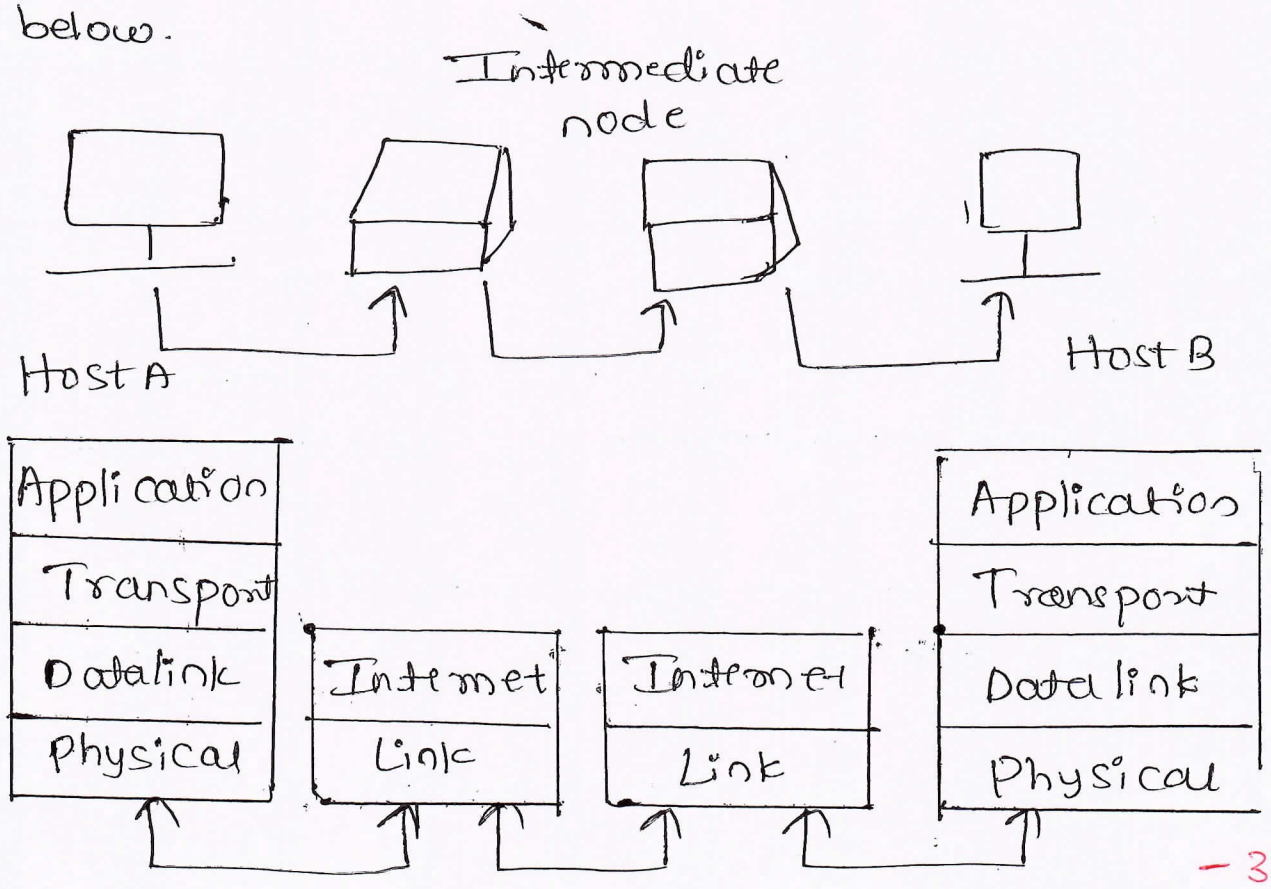
IOT	M2M
* Abbreviation for Internet of things.	* Abbreviation for Machine to Machine communication
* Devices are necessary to rely on the Internet	* Devices & communication are not dependent on the Interne
* IoT is Information & Service-centric	* M2M is communication & device-centric.
* The connection type is a point to multipoint & vice versa	* The connection type is a point to point
* many users can connect at a time over the Internet	* communicate with a single machine at a time
* System Involves the usage of both Hard-ware & Software	* Mostly hardware-based technology.

* It has more devices Scalability * It uses IP-based protocols * It supports open type APIs (Application prog-ramming interfaces) * Business type : B2C (Business to Customers) and B2B	* A limited number of devices Scalability * It uses either proprietary or non-IP-based protocols. * It does not support open-type APIs. * Business type :- Only B2B (Business to Business) is used.

– 6M

2 (a) Explain communication between two hosts following TCP/IP Suite with neat block diagram.

→ A networked communication between two hosts following the TCP/IP model is shown on the figure below.



– 3M

1 Link Layer :-

- A link layer is the lowest layer of the TCP/IP model. It is also known as the network interface layer.
- This layer is the combination of the Physical layer and Data Link layer defined in the OSI reference model.
- It defines how the data should be sent physically through the N/w
- This layer is mainly responsible for the transmission of the data between two devices on the same N/w.

— 1M

2. Internet Layer

* An internet layer is the second layer of TCP/IC model
* An internet layer is also known as the Network layer
* It is responsible for addressing, address translation, data packaging, data disassembly & assembly, routing & packet delivery tracking operations.
* protocols associated with this layer
  - Internet protocol (IP)
  - Address resolution protocol (ARP)
  - Internet Control Message protocol (ICMP) — 1M
  - Internet Group management Protocol (IGMP)

3. Transport layer

* The transport layer is responsible for the reliability, Segmentation, flow control & error control of data that is being sent over the Nlw

* The two main protocols of this layer are transmission Control protocol (TCP) & user Datagram protocol (UDP) to take care of connection-oriented or connectionless service respectively blw two more hosts or networked device

- 1M

4. Application layer

* An application layer is topmost layer in the TCP/IP model

* this layer enables an end-user to access the service of the underlying layers and defines the protocol for the transfer of data.

- HTTP
- FTP
- SMTP
- DNS
- RIP etc

- 1M

- 2M

2b) Discuss different IoT planes along with its various enabling technologies of IoT.

→ ① service plane
② Local connectivity plane
③ Global connectivity plane
④ Processing plane

- 1M

Diagram - 2M

① The Service plane :-

It composed of two parts

ⓐ Things or Devices :- the things may be wearabl Computers, smartphones, household applinces, smart glasses, factory machinery, Vending machines, vehicles, robotics.

ⓑ Low-power Connectivity :-

the low-power connectivity is used to connect the things in local implementation. Commonly use such as WiFi, Zigbee, RFID, Bluetooth, 6LoWPAN, LoRA, DASH, Insteon & Others. The range of these Connectivity technology is servely restricted, they are responsible for the Connectivity blw the things of the IoT & the nearest hub or gateway to access the internet.

② Local Connectivity

It is responsible for distribution interet access to multiple local IoT deployments. This distribution may be based on the physical placement of the things, based on the application domains, or even based on providers of Services.

③ Global Connectivity

This plane plays a significant role in the enabling IoT in the real sense by allowing for worldwide implementation & Connectivity between things, users, controllers

& applications. This plane also falls under purview of IoT management.

④ The processing plane

Can be considered a top-up of the basic IOT networking framework. The continuous rise in the usefulness & penetration of IoT in various application areas such as industries, transportation, healthcare & others is the result of this plane. The members in this plane are IoT tools. -1×4=4M

⇒ (7M)

2(5) classify Network types based on physical topology with example

→ ① Star topology

* Every host has point to point link to Central hub ..
* Direct Communication not possible blw two devices is only through hub.

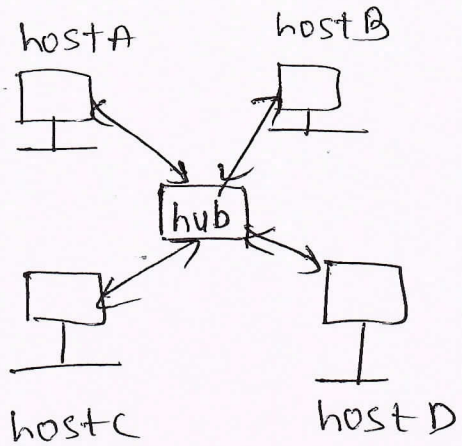
◉ Advantages

* simple & easier to install
* easy fault detection
* very reliable
* no data Collision happen

◉ Disadvantages

* requires more cable
* if hub fails, the whole Network fails

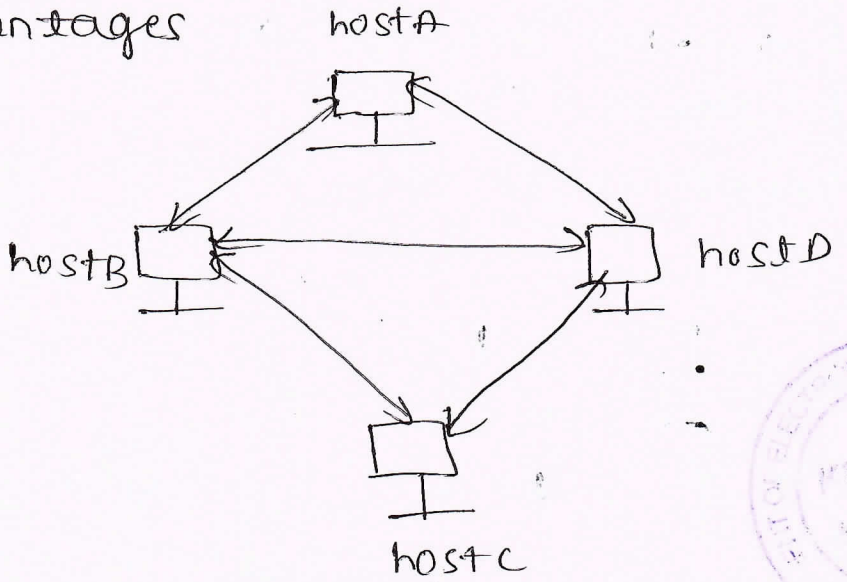
-1.5M



② Mesh topology

* all hosts are connected each other
* where $n(n-1)/2$ dedicated full duplex links blw the hosts
* every node point-to-point connection is done.

◎ Advantages



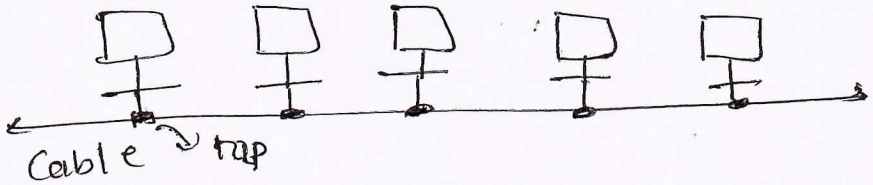
* high privacy & security
* Failure during single device won't brak the NIW
* Addition also possible

◎ Disadvantages

* more complex & costly
* Installation is also difficult
* high maintainance

-1.5M

③ Bus topology

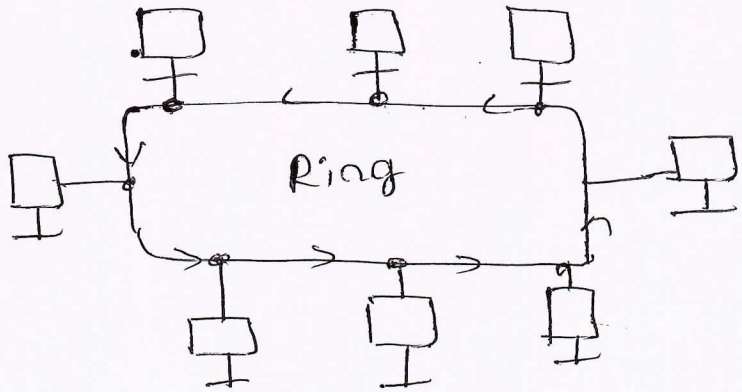


* one cable, for which all hosts connected through taps.
* if cable fails, all Nlw fails.
* easy to construct & cheaper.

-1.5M.

④ Ring Topology

* Nlw configuration where devices connection created a circular data path.
* Works on the principle of a dedicated point-to-point connection.
* The repetition of this system forms a ring.



⊙ Advantages

* cheap to install & expand
* Equal access to resources
* Fault detection easy

-1.5M

⊙ Disadvantages

* Difficult to troubleshoot the ring
* if Repeater fails, entier Nlw fails

→ (6M)

Module-2

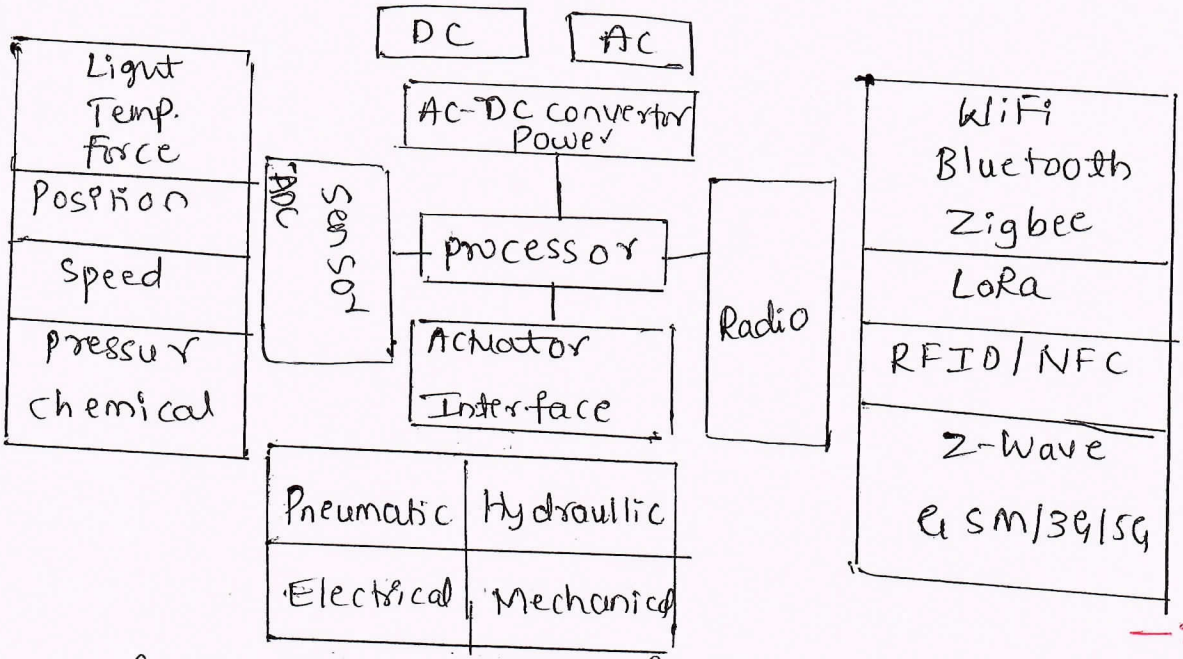
3a) outline simple sensing operation in IOT node with it's functional blocks.

→ A sensor node is made up of combination of

(a) Sensor/ sensors (b) processor Unit (c) Radio unit

(d) Power unit (e) Actuator Unit

—1M.



—2M

fig. The Functionblocks of a typical sensor node in IOT

Description of sensors node: The nodes are capable of sensing the environment they are set to measure & communicate the information to other sensor nodes or a remote host. Typically, a sensor node should have low-power requirements are be wireless. The wireless nature of sensor nodes would also allow them to be freely relocated & deployed in large numberes without bothering about managing wires. The functional outline of a typically IOT sensorr node is shown in fig. and the function of each

P.T.O

of each block explain below

- Processor :- It is a heat sensor node it process all the relevant data, capable of executing arbitrary code

- Sensors and actuators : The actual interface to the physical world, device that can observe or control physical physical parameters of the environment

- Radio (communication) : It sends & receive information over a wireless channel

- Power supply : Some forms of batteries are necessary to provide energy . Use both AC & DC power supply

-4M

→ (8M)

3b) Define Sensor & explain characteristics of sensors

→ Sensors :-

Sensors are devices that can measure, quantify, or respond to ambient changes in their environment. For example, a temperature sensors converts heat into electrical signals.

Sensor Characteristics -2M.

(i) Sensor resolutions-

the smallest possible changes that a sensor can detect is referred to as the resolution of a sensors. For example, sensors A can detect 0.5 degree Celsius changes in temperature ; whereas another sensor B can detect up to 0.25 degree Celsius in temperature . therefore the resolution of sensors B is higher than the resolution of sensors A . The more the resolution

of a sensor, the more accurate the precision. A sensor's accuracy does not depend upon its resolution.

(ii) sensor Accuracy : The accuracy of a sensor is the ability of that sensor to measure the value of a system as close to its true measure as possible. For example, a weight sensor detects the weight of a 100kg mass as 99.98 kg. We can say this sensor is 99.98% accurate, with an error of 0.02%.

(iii) Sensor precision: The principle of repeatability of measurment defines the precision of a sensor. For example, the temperature sensor measure 25.8°C in repetitive measurements (10 times) & actual value is 25°C the sensor is precise but not accurate.

- 1X3 = 3M
→ (6M)

3c) Compare mechanical, Soft & shape memory based actuators

→ Mechanical actuators:- These actuators Convert the rotary motion of the actuator is converted into linear motion to execute some movement. The use of gears, rails, pulley, chains and other devices is necessary for these actuators to operate. These actuators can be easily used in conjuction with pnematic, hydraullic, or electrical actuators. An example, of a mechanical actuator is a rack & pinion mechanism.

Soft actuators :-

These actuators Convert molecular-level microscopic changes into tangible macroscopic

deformations on the materials. These actuators consist of elastometric polymers that are used as embedded fixtures in flexible materials such as cloth, paper, fiber, particles & others. These actuators have a high stake in modern day robotics. They are designed to handle fragile objects such as agricultural fruit harvesting or perform precise operations like manipulating internal organs during robot-assisted surgeries

Shape memory polymers (SMP): SMP is considered smart materials that respond to some external stimulus by changing their shape, and then revert to their original shape once the affecting stimulus is removed. Features such as high strain recovery, biocompatibility, low density, and biodegradation characteristics these materials. SMP-based actuators function similarly to our muscles.

- 2 X 3 = (6M)

4a) Explain different categories of sensors based on sensing environment

→ Sensing types

(1) Scalar Sensing
(2) Multimedia Sensing
(3) Hybrid sensing
(4) Virtual Sensing

(1) Scalar Sensing

* the sensors used for measuring scalar quantities such as temperature, current, atmosphere pressure, rainfall, light, humidity, etc are refferd to as

sensors.

* Scalar values do not have a directional or spatial property, simply by measuring changes in the amplitude of the measured values over time

* A simple scalar temperature sensing of a fire detection event is shown. — 2M

(2) Multimedia Sensing

* The sensors used for measuring quantities such as images, direction, flow, speed, acceleration, sound, force, mass and energy are known as multimedia sensors. are called "Vector sensors".

* A simple camera-based multimedia sensing using surveillance as an example is shown. — 2M

(3) Hybrid Sensing

* The sensors are used to measure both scalar as well as multimedia quantities at the some time and are reffered to as hybrid sensors.

* For example, in an agricultural field, measure collectively the soil moisture, soil temperature and color of the leaves to decide to plant's health by a camera sensors. — 2M

(4) Virtual Sensing

* Virtual sensing techniques are also soft sensing or proxy sensing. A virtual sensing system uses information available from each other measurements and process parameters to calculate an estimate

of the quantity of interest. For example, A's sensors and being used for the actual measurement of parameters; whereas virtual data is used as advising B. This is the virtual sensing paradigm.

- 2M

→ (8M)

4b) Outline basic difference between transducer, sensor and an actuator.

→

parameters	Transducer	Sensors	Actuators
Defination	convert energy from one form to another	Convert virous form of energy into electrical signals	Converts electrical signals into various form of energy, typically mechanical energy
Domain	Can be used to represent a sensor as well as an actuator	It is an input transducer	It is an output transducer
Function	Can work as a sensor or an actuator but not simultaneously	used for quantify-ing environmental stimuli into signal	Used for converting signals into proportional mechanical or electrical outputs
Examples	Any sensor or actuator	Humidity sensors, Temperature sensors, Anemometers (measure flow velocity), Manometers, (measure fluid pressure), Accelerometer (measure the acceleration of a body) etc.	motors, Force heads and pumps

→ (6M)

4c) With neat diagram, explain working mechanisms of actuator.

* An actuator is a component of a machine that responsible for moving and controlling a mechani-sm or system for example by opening a valve.

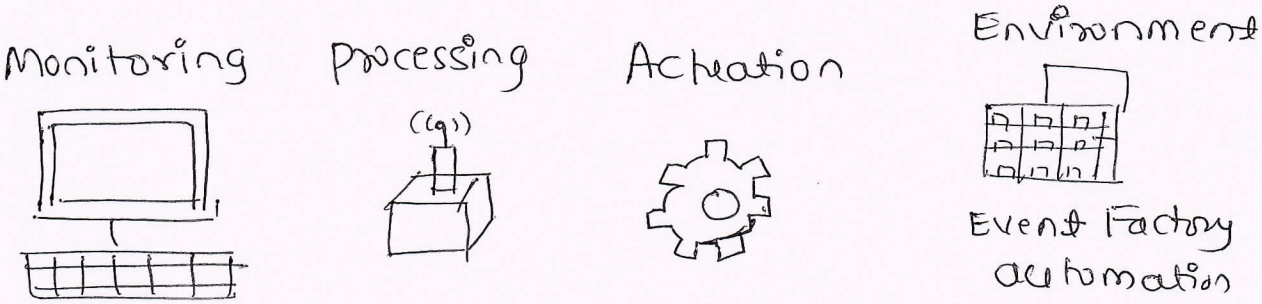
* The system activities the actuator through a control signal, which may be digital or analog.

* An actuator can be a mechanical or electrical system, a software-based system.

* figure shows the outline of simple actuation system. A remote user sends commands to a processor.

-4M.

* The robotic arm finally moves the designated boxes, which was it's assigned task



-2M

fig. The outline of a simple actuation mechanisms.

→ 6M.

Module - 3

5) a) Differentiate between structured and unstructured data with examples.

Structured data	unstructured data
1) Data have predefined structures	no predefined structure.
2) Associated ~~data~~ with RDBMS	no fixed formats associated with data
3) Established languages such as SQL are used to access data in RDBMS.	Query languages such as no SQL is used to access data.
4) data is limited in length. ex: phone numbers may in light or train communication systems	ex: emails, videos, images. phone recordings.

SM

5) b). Explain different data offloading strategies with locations and decision making.

1) offload location: the choice of offload location decides the applicability cost & sustainability of the IOT application & deployment. the offload loca -tion into FOUR types. — 1M.

a) Edge

offloading processing to the edge implies that the data processing is facilitated to a location at or near the source of data generation itself

b) Fog

For computing is a decentralized computing infrastructure, the data, computing storage & applications are shifted to a place between the data source & the cloud resulting in significantly reduced latencies & new bandwidth usage.

c) Remote server

a simple remote server with good processing power may be used with IoT-based applications to offload the processing from resource con -ined IoT devices.

Pg.

d) Cloud

a cloud is provisioned for processing offloading so that processing resources can be rapidly provisioned with minimal effort over the internet, which can be accessed globally. cloud enables massive scalability of solutions.

2) Offloaded decision making.

the choice of where to offload & how much to offload is addressed considering data generation rate, network bandwidth, the criticality of applications, processing resources available at the offload site, & other factors.

- 4 X 1.5 = 6M.

main 3 approaches are as follows.

a) Naive approach

this rule based approach, in which the data from IoT devices are offloaded to nearest location based on achievement of certain offload criteria.

b) Bargaining - based approach.

to maximize the quality of service by reaching a point where the quality-ins of certain parameters are reduced.

c) Learning based approach.

It relies on past behaviour & trends of data flow through the IoT architecture.

- 1 X 3 = 3M.

→ (10M)

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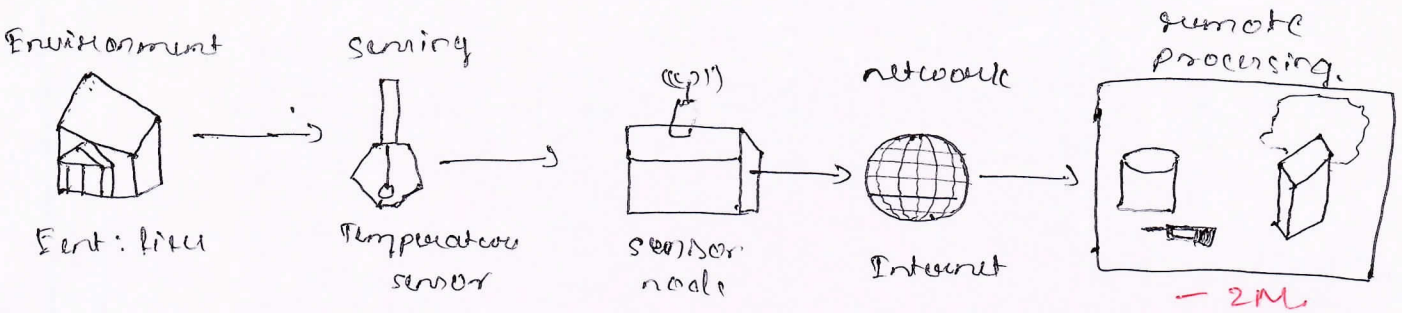
5) c) Discuss with neat diagram, event detection using offsite Remote processing topology.

Remote processing

It is the most common processing topology used in present-day IoT solutions. It encompasses sensing data by various sensor nodes; the data is then forwarded to a remote server or a cloud-based infrastructure for further processing and analytics. the figure shows the outline of one such paradigm, where the sensing of an event is performed locally, & the decision-making is outsourced to a remote processor.



– 2M

(Fig 5.1): Event detection using an off-site remote processing topology.

Advantages:

* massive cost & energy savings by enabling the reuse & reallocation of the same processing resources.
* It enhances the massive scalability of solutions, without significantly affecting the cost of the deployment.

Drawbacks

* It requires a lot of network bandwidth.
* Need good network connectivity between the sensor nodes & the remote processing infrastructure.

– 3M

→ 5M

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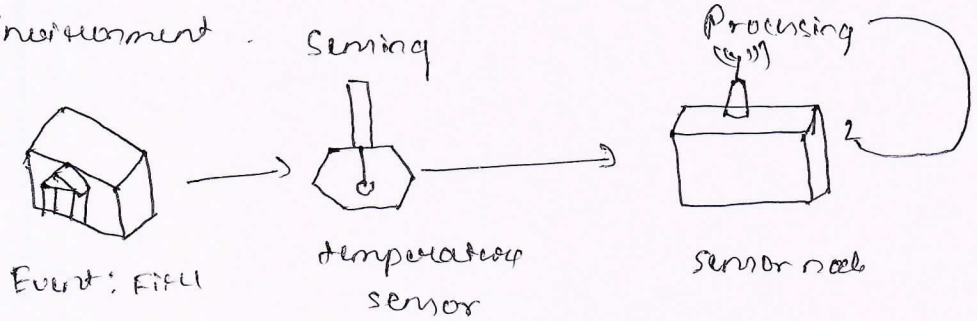
6) a). with neat diagram, explain onsite processing topology.

1) on-site processing topologies.

In this topology, the data is processed at the source itself. It is used in applications that have a very low tolerance for latencies, these latencies may result from the processing hardware or the network. applications such as healthcare & flight control systems. the processing infrastructure is fast & robust enough to handle such data.



– 2M

Fig: Event detection using an on-site processing topology.

(6.1)

figure shows the on-site processing topology, where an event is detected utilizing a temperature sensor connected to a sensor node. The sensor node processes the information from the sensed event & generates an alert. the node additionally has the option of forwarding the data to a remote infrastructure for further analysis & storage. -3M → 5M

6)b) Discuss various processing topologies.

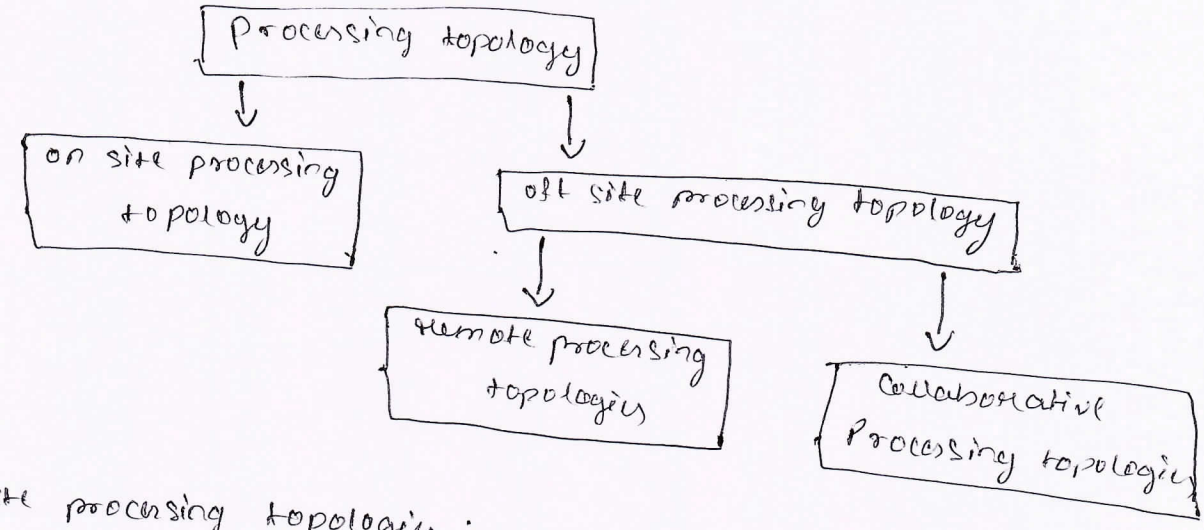
the various processing solutions are divided into 2 large topologies,

1) on-site processing topologies.

2) off-site processing topologies: it further divides into

i) Remote processing topologies.

ii) collaborative processing topologies.



1) on-site processing topologies.: —2M

In this topology, the data is processed at the source itself. It is used in applications that have a very low tolerance for latencies, these latencies may result from the processing hardware or the network, applications such as healthcare & flight control systems. the processing infrastructure is fast & robust enough to handle such data. (refer figure 6.1).

2) off-site processing:

here processing is not done at the source point. It causes for latencies & is significantly cheaper than on-site processing topologies. In this topology, the sensor node is responsible for collection & framing of data to be transmitted to another location for processing

It is divided into 2 types.

i) Remote processing :

It is the most common processing topology used in present-day IoT solution. It encompasses sensing data by various sensor nodes, the data is then forwarded to a remote server or a cloud + based infrastructure for further processing & analytics.

(refer figure 5.1)

ii) Collaborative processing.

here sensors cooperatively process data from multiple source to serve a high-level task. It typically finds use in scenarios with limited or no network connectivity. the fig shows collaborative processing topology for collaboratively processing data locally.

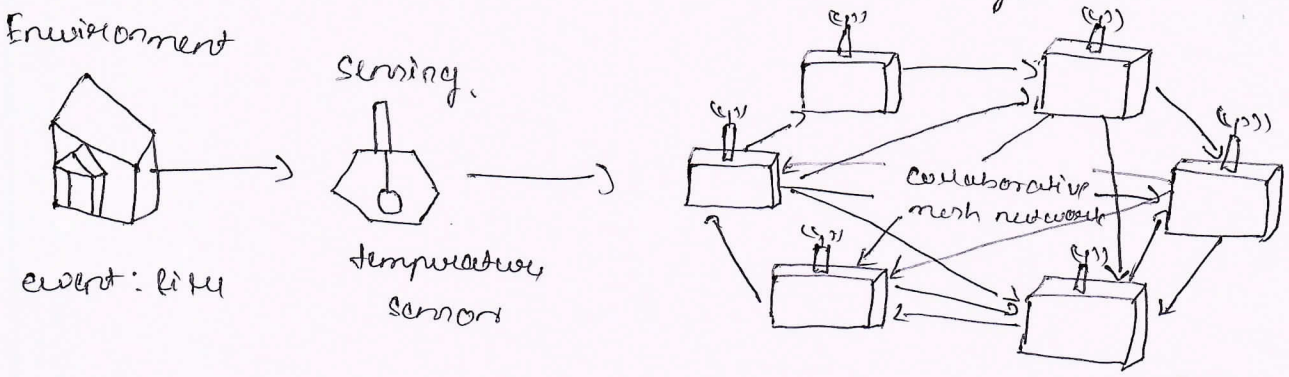


figure: Event detection using a collaborative processing topology.

— 2M

— 3 x 2 = 6M

→ (10 M)

6) c). Discuss the importance of data processing in IoT & offloading decision making approaches.

Data processing is more crucial with the rapid advancements in IoT. Intelligent & resourceful processing techniques are required to process vast amounts & resourceful processing techniques are also important to decide when to process & what to process.

3 types based on the urgency of processing.

1) Very time-critical data

2) Time critical data

3) Normal data.

— 2M

Offload decision making

The choice of where to offload & how much to offload is addressed consid-ered data generation rate, network bandwidth, the criticality of appl-ication, processing resource available at offload site, & other factors main 3 approaches are

a) Naive approach:

this rule based approach, in which the data from IoT devices are off-loaded to nearest location based on achievement of certain offload crit-eria.

b) Bargaining based approach:

to minimize the quality of service by reaching a point where the quali-ties of certain parameters are reduced, while the other are enhanced.

c) Learning based approach.

It relies on past behaviour & trends of data flow through the IoT architecture. the optimization of QoS parameters is done by learning from historical trends & trying to optimize previous solutions further & enhance the collective behaviour of the IoT implementation

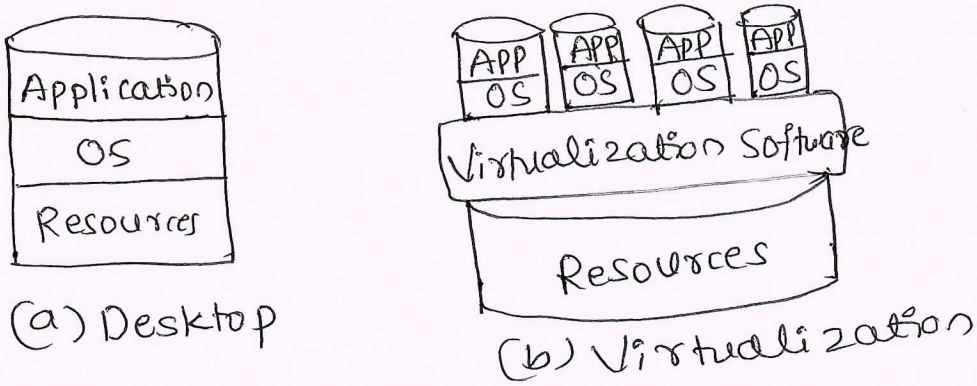
- 3M → (5M)

Module-4

7a) What is virtualization and explain its different types.

→ * The technique of sharing a single resource among multiple end users is known as "Virtualization". It is the key concept of cloud Computing.

* In the visualization process, a physical resource is logically distributed among multiple users. However, a user realizes that the resources is unlimited and is dedicatedly provided to him/her.



(a) Desktop (b) Virtualization

fig. Traditional desktop versus Virtualization.

* Fig above (a) represents a traditional desktop, where an application (APP) is running on top of an OS, and resources are utilized only for that particular application.

* Fig b Virtualization software separates the resources logically so that there is no conflict among the users during resource utilization

– 3M

Types of Virtualization

① Hardware Virtualization:

Sharing of hardware resource among multiple users. For example, a single processor appears as many different processes in a Cloud Computing architechre. Different operating Systems can be installed in these processors and each of them can work as a stand-alone machine. It uses a virtual machine manager Called a hypervisor to provide abstracted hardware to multiple guest operating systems, which can then share the physical hardware resources more efficiency.

(ii) Storage Virtualization:

In this virtualization, the storage space from different devices is accumulated virtually, and seems like single location. Through storage virtualization, a users documents or files exist in diff locations in distributed fashion.

(iii) Application Virtualization:-

Application Virtualization Software allows users to access and use an application from a separate Computer from the one on which the application is installed.

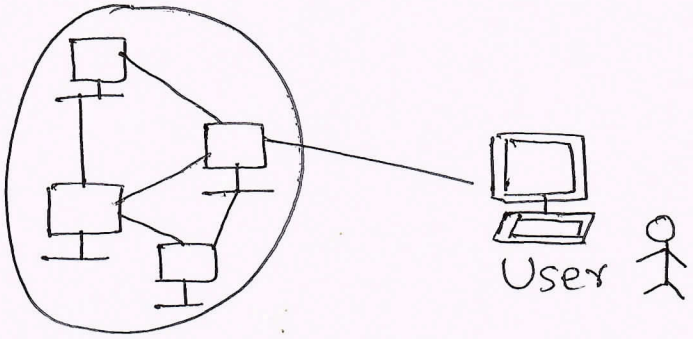
(iv) Desktop Virtualization:-

This type of virtualization allows a user to access and utilize the services of a desktop that resides in the Cloud. The users can use the desktop from their local desktop

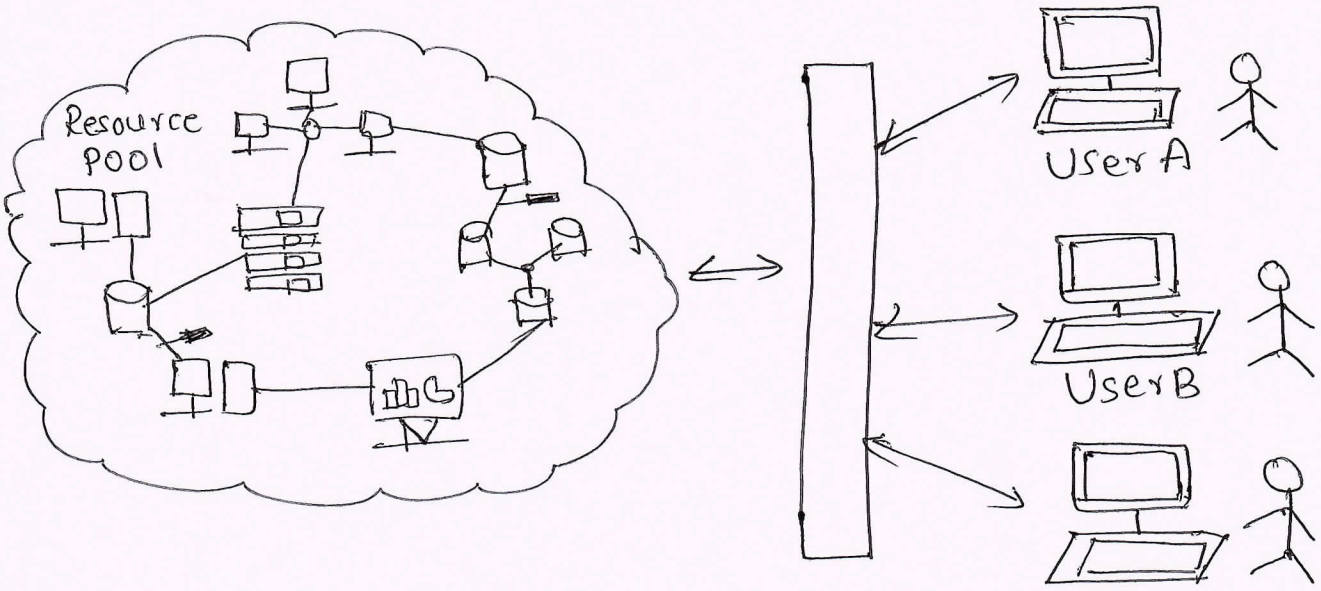
-3M
→EM

7b) Differentiate between Network based computing and cloud computing

→



(a). Network Computing



-2M

* Cloud computing comprises a pool of multiple resource such as server, storage and network from single / multiple organization.

* These resources are allocated to the end users as per requirement, on a payment basis.

* In cloud computing architechure, an end users can request customized resources from cloud Service Provided (CSP)

* Cloud computing comprises, an end user can request.

* These resources are accessible by multiple users through a regular command-line terminal at the same or different time instants.

* Cloud service are accessible by multiple users through from anywhere & at any time by an authorized user through internet connectivity.

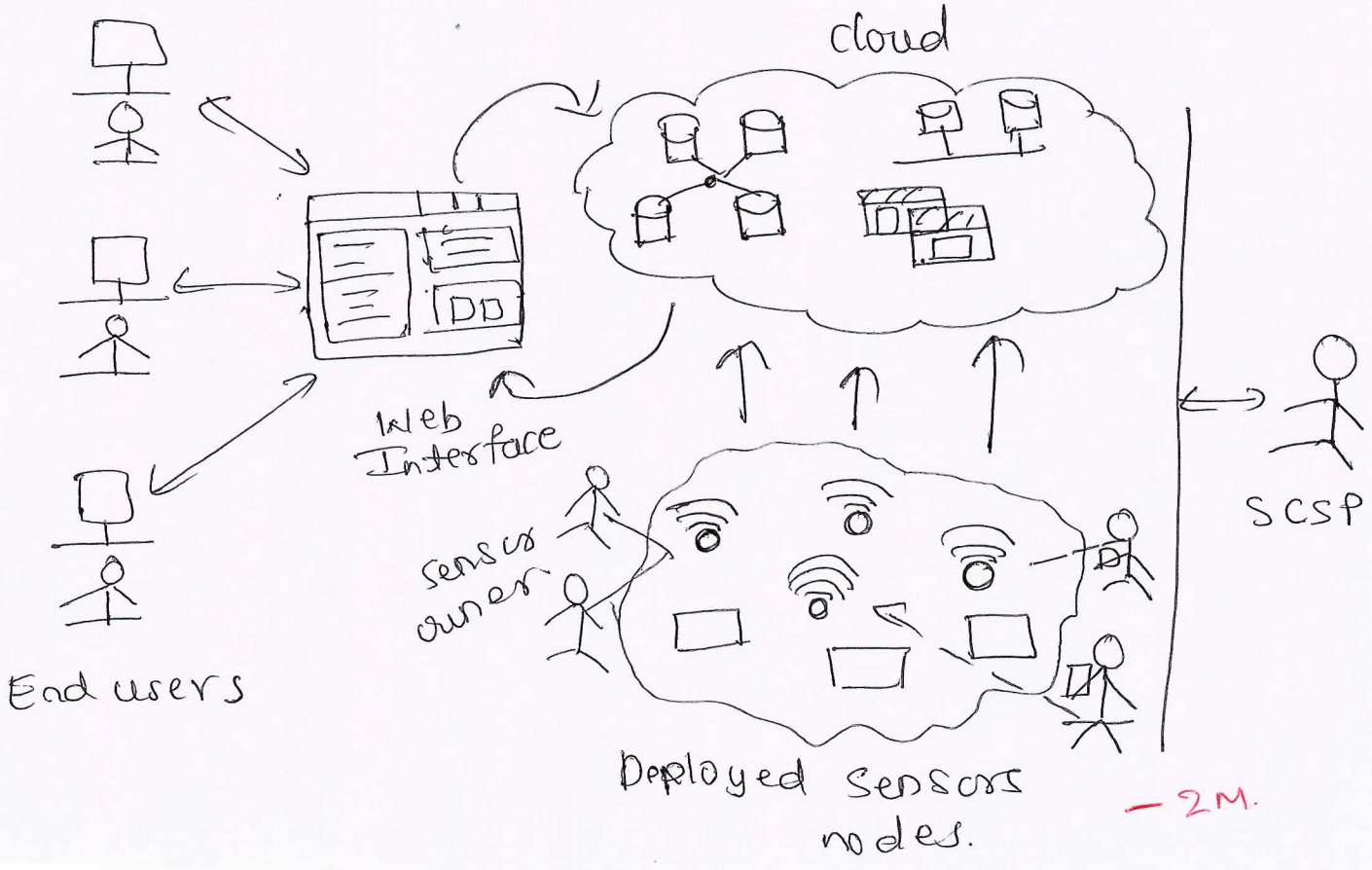
* the services of cloud computing are based on the pay-per-use model.

* The concept is the same as paying utility bills based on consumption.

* Gmail, Facebook, & twitter are some examples of cloud computing application. — 3M → 6M

7c) Explain the architecture of sensor cloud platform

→



— 2M.

End-User

* The end user is also knownas customer of the sensor-cloud services.

* An end user registers him/herself with the infrastructure through web portal.

* Through the web portal, the end user receives the service, as shown in Fig. Above. Based on the type & usage duration of service, the end user pays the charges to the SCSP

Sensor owner

* A particular sensor owner can own multiple homogeneous or heterogeneous Sensorer nodes.

* The sensors owner receives rent depending upon the duration & usage of his/her sensor node(s).

Sensor-Cloud Service Provider (SCSP):-

* An SCSP is responsible for managing the entire sensor-cloud infrastructure.

* The SCSP receives rent from end users with the help of a pre-defined pricing model.

* The pricing scheme may include the infrastructure cost, Sensor owner's rent, & the revenue of the SCSP.

- 3X2=6M

→ (8M)

8a) *Explain components of Agricultural IOT

(1) Cloud Computing

It processes & analyze huge amounts of agriculture data like soil moisture, humidity

Soil, pH level, & plant images produced by sensors. Based on the data analysis, action needs to be taken, such as switching on the water pump for irrigation.

(ii) Sensors

* Important backbone of IoT application & indispensable components.

* used to soil moisture, humidity, water level & temperature

(iii) Cameras :

* Imaging is one of the main components of argiculture used for crop security. Multispectral Thermal, & RGB Cameras are commanly used for scientific agricultural IoT.

(iv) Satellites :-

Satellites images are used in agricultural application to monitor different aspects of the crops such as crop health monitoring & dry zone assessment over a large area

(v) Analytics :->

Analytics is the systematic computational analysis of data or statistics

(vi) Wireless connectivity

wireless connectivity enables the trasmission of agricultural sensor data from the field to the cloud server.

(VII) Handheld devices

* One of the fundamental components of e-agriculture is a handheld device such as a smartphone

* Farmers can access different agricultural information, such as soil & crop conditions of their field & market tendency, over their smartphones.

(VIII) Drones

* Drones imaging is an alternative to satellite imaging in agriculture.

* used in agriculture for crop monitoring, pesticide spraying & irrigation

1 X 6 = 6M

8b) What is service level Agrement (SLA), explain it's importance & metrics while defining SLA

→ * A service-level agrement (SLA) is a contract between a service provider and it's customers that documents what services the provider will furnish & defines the service standards the provider is obligated to meet.

* An SLA provides a detailed description of the services that will be received by the customer.

* An SLA may include multiple organization for making the legal contract with the customer.

— RM

Importance of SLA.

* Customer point of View :- Eeach CSP has it's SLA, the customer can compare the SLAs of different organization & choose a prefered CSP based on the SLAs

* CSP point of View :- In many cases, certain performance issues for a particular service CSP may be able to provide efficiency.

Merits of SLA — 2M

(i) Availability : This metric signifies the amount of time the service will be accessible for the customer.

(ii) Response time :- It is the maximum time that will be taken for responding to a customer request.

(iii) Portability :- This metric indicates the flexibility of transforming the datea to another service.

(iv) Problem Reporting :- How to report a problem whom, & how to be contracted, is explained in this metric.

(v) Penalty :- The penalty for not meeting the promises mentioned in the SLA

— 3M → (6M)

8) Explain how agricultural IoT help in efficiency distribution of water in agricultural field

→ Smart irrigation management System

It monitoring & control different agricultural parameters, such as water level, soil moisture, fertilizers, soil temperature, weather, evaporation & plant water use to automatically adjust the watering schedule to the actual conditions of the site, It is an affordable solution for farmers to access agriculture field data easily & remotely. — 2M

* The architecture of the Smart irrigation management System.

three layers

@ Sensing and actuating layer:-

* this layer deals with different physical devices, such as sensor nodes, actuators & Communication modules

* The cluster head in the system collects data from other sensor nodes, which are deployed on the agricultural field.

* The cluster heads use GPRS to transmit data to the remote server.

(b) Processing and Service layer

* This layer acts as an intermediate layer b/w the sensing & actuating layer & the applicatio layer
* The sensed & processed data is stored in the server for future use. These data are accessed at my from any remote location by authorized users.
* Depending on the sensed values from the deployed sensors nodes, the pump actuates to irrigate the field

(c) Application layer

* This layer interfaces the farmer with the smart irrigation management system
* The farmer can access the status of the pump, whether it is in switch on/off, and the values of different soil parameters from his/her cell phone.
* This information is accessible with the help of the integrated mobile technology facility of the farmer's cell phone
* Additionally, an LED indicator & LCD system are installed in the farmer's house.

- 3 x 2 = 6M → (8M)

9) a) Explain fog framework for intelligence public safety in vehicular environment FISVER with block diagram.

* Fog-FISVER framework is designed for low-latency fog computing architecture needed for the connected vehicle.

* Fog-FISVER consists of different IoT components & it developed based on a 3 tiered architecture.

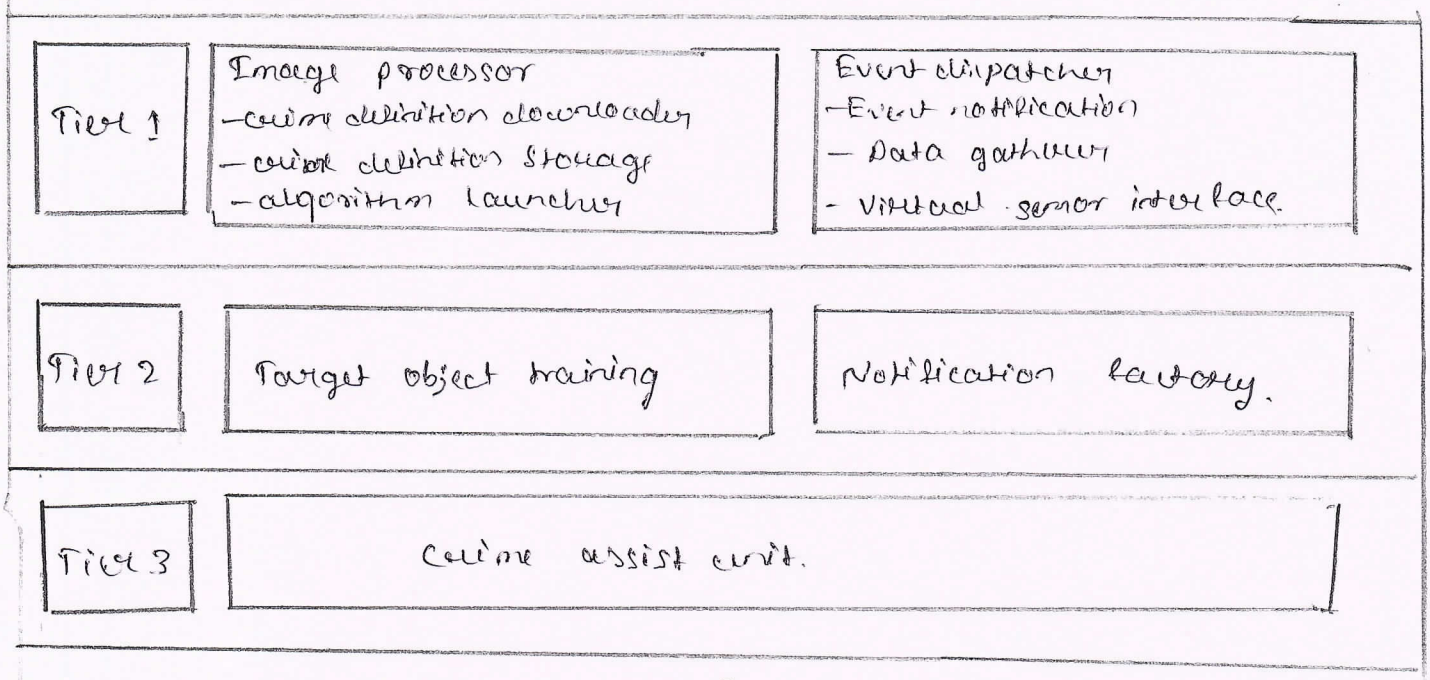


Fig 9.1 Architecture of Fog-FISVER. — GM.

* Tier 1 : In-vehicle FISVER Smart transportation safety (STS) Fog:

→ This tier accumulates the real sensed data from within the vehicle and processes it to detect possible criminal activities inside the vehicle.

→ This tier is responsible for creating crime-level metadata & transferring the required information to the next tier.

→ For performing all the activities, Tier 1 consists 2 subsystems.

1) Image processor

It is a potent component, which has the capability of detecting criminal activities. The processor system used a deep-learning based approach for enabling image processing techniques, to implement the fog computing architecture in the vehicle. A Raspberry-Pi-3 processor board is used, which is equipped with a high-quality camera.

2) Event dispatcher:

It is responsible for accumulating the data sensed from vehicles & the image processor. After the successful execution of criminal activity information is sent to fog. FISUER STS fog infrastructure.

#Tier-2: FISUER STS Fog Infrastructure:

Primarily, this tier has 3 responsibilities — keep updating the new object template definitions, classifying events & finding the most suitable police vehicle to notify the event. it is divided into 2 sub-components:

1) target object training.

2) Notification ~~training~~, latency.

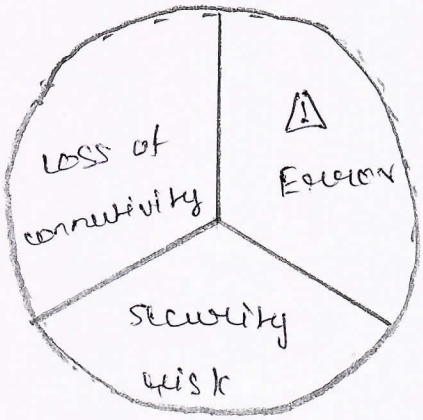
#Tier 3: It consists of mobile applications that are executed on the users devices. the application helps a user, who witnesses a crime, to notify the police.

→ 3 X 2 = 6M

→ (10M)

9) b) Discuss the advantages & risks associated with healthcare IoT

9.2 (a) Advantages of healthcare IoT



(b) Risk in Healthcare IoT.

— 1M

Advantages of healthcare IoT

a) Real-time

* a healthcare IoT system enables users, such as doctors, and users at the patient side, & staff in a healthcare unit.
* it enables a doctor to observe a patient's health condition in real time even from a remote location & can suggest the type of care to be provided to the patient.

b) Low cost.

* Healthcare IoT systems facilitate users with different services at low cost.
* for ex, an authorized user can easily find the availability of beds in a hospital with simple internet connectivity.

c) easy management:

* Healthcare IoT is an infrastructure that brings all its end users under the same umbrella to provide healthcare services,
* however, healthcare IoT facilitates easy & robust management of all entities.

d) automatic processing.

* Healthcare IoT enables end-to-end automatic processing in diff-erent units & also consolidates the information across the whole chain: from a patient's registration to discharge.

e) Easy record-keeping

* a healthcare IoT enables the user to keep these records in a safe environment & deliver them to authorized users as per requirement

f) Easy diagnosis:

* In a healthcare IoT system, the diagnosis of the disease becomes easier with the help of certain learning mechanisms along with the availability of prior datasets.

— 2M

Risk in healthcare IoT:

a) Loss of connectivity.

* Intent connectivity may result in data loss, which may result in a life-threatening situation for patient. proper & continuous connectivity is essential in a healthcare IoT system.

b) Security.

* the healthcare system must keep data confidential. this data should not be accessible to any unauthorized person.

c) Errors:

In the healthcare system, errors in data may lead to misinterpretation of symptoms & lead to wrong diagnosis of patient.

- 2M → (5M)

9) c) with a neat diagram explain types of machine learning.

4 categories-

i) Supervised learning; classification & Regression.

ii) unsupervised learning: clustering & association

iii) Semi-supervised learning.

iv) Reinforcement learning.

- 1M

i) Supervised learning.

* type of machine learning in which machines are trained using well "labelled" training data & on basis of that data, machines predict the o/p.

* It is used for 2 types problems.

classification &

Regression.

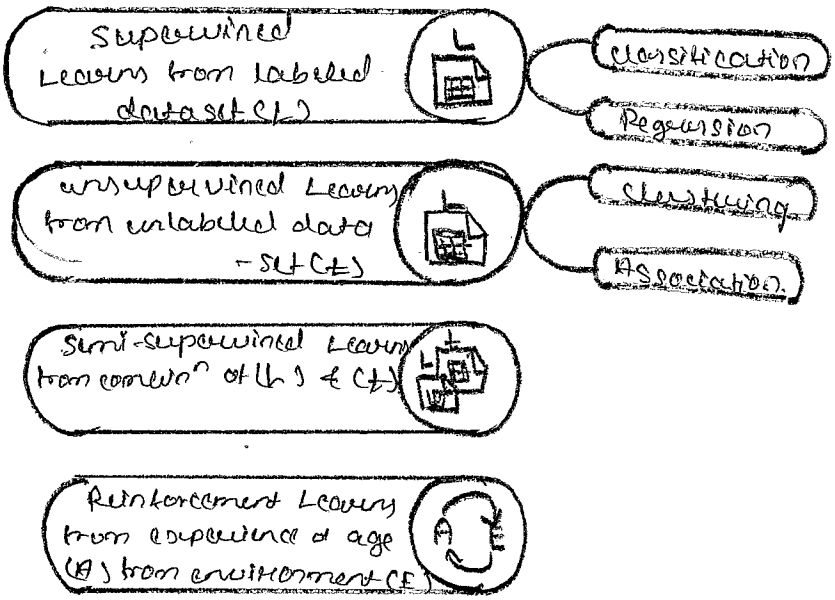


Fig : Types of ML

ii) unsupervised learning.

* It doesn't use any labels in its operations.

* It is another machine learning method in which patterns are inferred from unlabelled I/P data.

* It can be used for 2 types of problems:
  clustering &
  Association

iii) Semi-supervised learning.

* It belongs to a category b/w supervised & unsupervised learning.

* algorithms under this category are a combination of both labelled & unlabelled datasets for training.

* labelled data are typically expensive & are relatively difficult to label correctly.

* unlabelled data is less expensive than labelled data, therefore, semi-supervised learning includes both labelled & unlabelled datasets to design the learning model.

iv) Reinforcement learning.

* It is a type of machine learning method where an intelligent agent interacts with environment & learns to act within that.

It establishes a pattern with the help of its experiences by interacting with environment.

* It aims to achieve a particular goal in an uncertain environment.

- 4x1=4
- STM

10) a) Explain the hardware components & front end design features of Ambisense system).

* the hardware of Ambisense system: In the Ambisense sys^m, a variety of hardware components are used such as.

i) Sensors:

the sensors used in the Ambisens sys^m are non-invasive. The descriptions of sensors used for forming WBAN in Ambisens sys^m are as follows:

* Optical Pulse sensing probe: It senses the photoplethysmograph (PPG) signal.

* Electrocardiogram (ECG) unit and sensor: It is a kit that contains ECG electrodes, alcohol swabs, & a wrist strap.

* Electromyogram (EMG) sensor: the EMG sensor is used to measure the client electrical activities.

* Temperature sensor:

* Galvanic skin response (GSR) sensor: the GSR sensor is used for measuring the change in electrical characteristics of the skin.

ii) Communication Module: each sensor node consists of a Bluetooth module. the communication b/w the sensor nodes & the LDPU takes place with the help of Bluetooth.

- SM

iii) Local data processing unit (LDPU):

an LDPU is a small processing board with limited computation capabilities. — 2M

iv) Front End of Ambulance System.

* In this, the doctor, paramedic/nurse, & patient can participate & use the services.
* the web interface is designed as per the requirements of the users of the system.
* each user has the option to log in & access the system. — 3M
* In Ambulance, the database is designed in an efficient way such that it can deliver customized data to respective user

→ 10M

10) b) Explain the challenges in using machine learning.

i) Data discription.

the data acquired from different sensors are required to be informative & meaningful. the discription of data is a challenging part of ML.

ii) Amount of data

to provide an accurate o/p, a model must have a sufficient amount of data. the availability of a huge amount of data is challenge in ML

iii) Erroneous data.

a dataset may contain noisy or erroneous data. the learning of a model is heavily dependent on quality of data.

iv) Selection of model.

multiple models may be suitable for solving a particular purpose, however, one model may perform better than others.

v) Quality of model.

after the selection of model, it is difficult to determine the quality of selected model, however, the quality of the model is essential in an ML-based system. — 1X5 = 5M.

→ 5M

10) c) why privacy & security are important in healthcare IoT ? explain.

a) Loss of connectivity.

Intermittent connectivity may result in data loss, which may result in a life-threatening situation for the patient. proper & continuous connectivity is essential in a healthcare IoT system.

b) Security -1M

the healthcare sys^{n} must keep the data confidential. this data should not be accessible to any unauthorized persons. on the other hand, different persons & devices are associated with a healthcare IoT sys^{n}.

-2M

c) Errors

In the healthcare sys^{n}, errors in data may lead to misinterpretation of symptoms & lead to the wrong diagnosis of patients. It is a challenging task to construct an error-free healthcare IoT architecture.

-2M

→ 5M