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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

University / Model Question Paper

Scheme & Solution

Faculty Name	:	Prof. Vijayalaxmi K. / Prof. Raghavendra N.
Course Name	:	Introduction to Interent of Things (IOT)
Course Code	:	BETCK205H
Year of Question Paper	:	June / July - 2024
Date of Submission	:	23-01-2025

Faculty Member   HoD   Dean (Acad.)

CBCS SCHEME

USN 2VD23EC112

BETCK205H/BETCKH205

Second Semester B.E./B.Tech. Degree Examination, June/July 2024
Introduction to 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.	Classify the network types based on physical topologies and connection types with schematic diagram.	10	L2	CO1
	b.	With a neat diagram, explain the interdependency technology for IOT planes.	10	L2	CO1
		OR			
Q.2	a.	With neat diagram, explain the network communication between two hosts following OSI model.	10	L2	CO1
	b.	Explain the interdependencies and reach of IoT over various application domains and networking paradigms.	10	L2	CO1
		Module – 2			
Q.3	a.	Outline the basic differences between transducers, sensors and actuators.	6	L2	CO2
	b.	Explain the major factors influence the choice of sensors in IoT based sensing applications.	8	L2	CO2
	c.	Define Sensor and explain the characteristics of sensor.	6	L1	CO1
		OR			
Q.4	a.	Classify the sensor based on : i) Power requirements ii) Sensor output iii) Power to be measured.	10	L2	CO2
	b.	Classify Sensing types on the nature of the environment and the physical sensors.	10	L2	CO2
		Module – 3			
Q.5	a.	Explain IoT device design and selection considerations.	10	L2	CO2
	b.	What are the parameters considered for off loading the data and identify typical data offload locations available in context of IoT.	10	L2	CO2
		OR			
Q.6	a.	Explain event detection using onsite , offsite remote processing topology and collaborative processing technology.	10	L2	CO2
	b.	Classify the data based on how they can be accessed and stored and the importance of processing of IoT.	10	L2	CO2

		Module – 4			
Q.7	a.	Explain the classification of virtualization based on the requirements of the user.	6	L2	CO2
	b.	Explain different types of cloud model.	10	L2	CO1
	c.	What is SLA and mention its metrics.	4	L2	CO2
		OR			
Q.8	a.	What are the advantages of virtualization?	10	L2	CO1
	b.	Explain different types of cloud simulators with its features.	10	L2	CO1
		Module – 5			
Q.9	a.	Explain the different components of health care IoT.	10	L2	CO1
	b.	Explain the architecture and advantages of vehicular IoT.	10	L2	CO2
		OR			
Q.10	a.	What is Machine Learning? What are the advantages and challenges of Machine Learning?	10	L2	CO2
	b.	What are the advantages and risk of health care IoT?	10	L2	CO2

*****

1a. Classify the network types based on physical topologies & connections types with schematic diagram.

Ans. Depending on the way a host communicates with other hosts, computer networks are of two types:

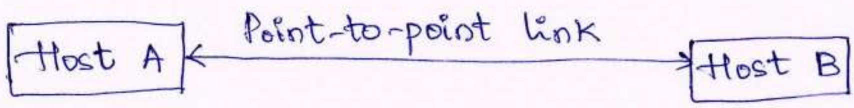
1. Point-to-point
2. Point-to-multipoint

Point-to-point:

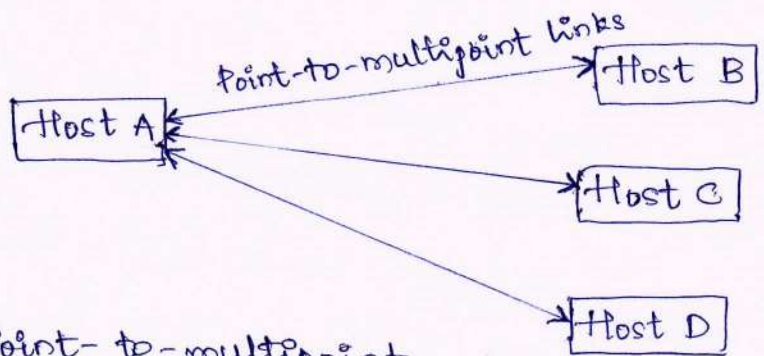
- These connections are used to establish direct connections between two hosts.
- Ex – a remote control for an air conditioner or TV is a point-to-point connection.
- These networks were designed to work over duplex links & are functional for both synchronous as well as asynchronous systems.

Point-to-multipoint:

- In this connection, more than two hosts share the same link.
- It is similar to one-to-many connection type.
- Ex – Used in wireless networks & IP telephony
- The channel is shared between the various hosts, either spatially or temporally



(a) Point-to-point link



(b) Point-to-multipoint

2M

Depending on the physical manner in which communication paths between the hosts are connected, computer networks can have the following four broad topologies: Star, Mesh, Bus, & Ring.

Star Topology:

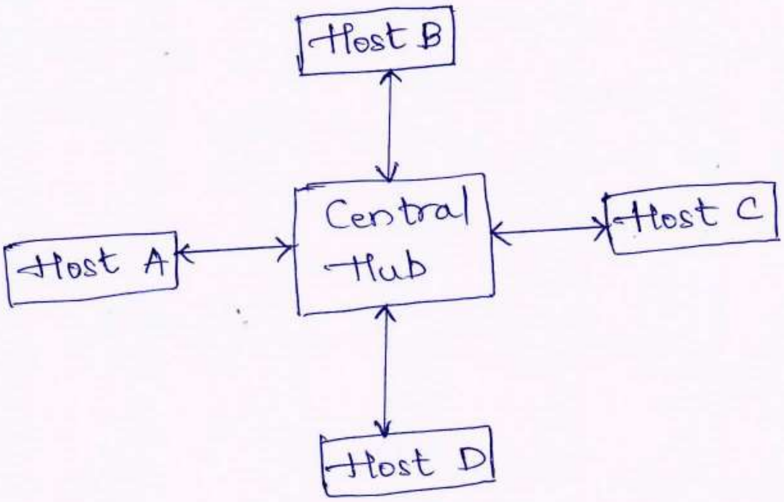
- In star topology, every host has a point-to-point to a central controller or hub.
- The hosts cannot communicate with one another directly; they can only do so through the central hub.
- The hub acts as the network traffic exchange.

Advantage of star topology.–

- Easy installation
- Ease of fault identification. within the network.

Disadvantage of star topology–

The danger of a single point of failure. If the hub fails, the whole network fails.



2M

(a) Star topology

Mesh Topology:

- In a mesh topology, every host is connected to every other host using a dedicated link (in a point-to-point manner).
- This implies that for 'n' hosts in a mesh, there are a total of $n(n-1)/2$ dedicated full duplex links between hosts.

- This massive number of links makes the mesh topology expensive.

Advantages of mesh topology -

- Even if a link is down or broken, the networks is still fully functional as there remain other pathways for the traffic to flow through.
- The security & privacy of the traffic as the data is only seen by the intended recipients & not by all members of the network.
- The reduced data load on a single host, as every host in this network takes care of its traffic load.

Mesh ~~Bus~~ Topology:

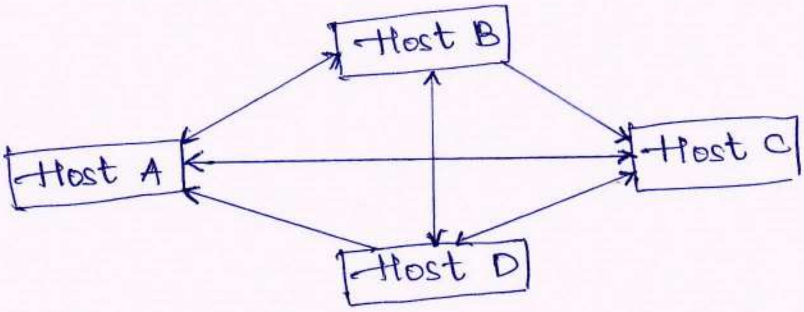


Fig: Mesh topology

1M

Bus Topology:

- A bus topology follows the point-to-multipoint connection.
- A backbone cable or bus serves as the primary traffic pathways between the hosts.
- The hosts are connected to the main bus employing drop lines or taps.

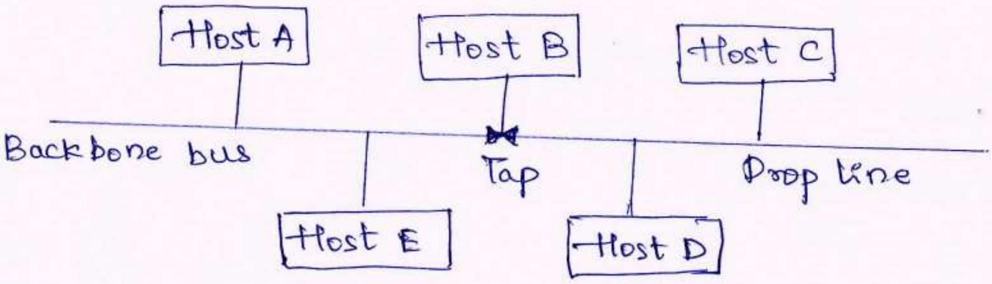
Advantages of bus topology -

- The ease of installation. However, there is a restriction on the length of the bus & the number of hosts that can be simultaneously connected to the bus due to signal loss over the extended bus.

• Multiple drop lines & taps can be used to connect various hosts to the bus, making installation very easy & cheap.

Drawback of bus topology-

• Difficulty in fault localization within the network.



2 M

Fig: Bus topology

Ring Topology:

• It works on the principle of a point-to-point connection.
• Here, each host is configured to have a dedicated point-to-point connection with its two immediate neighboring hosts on either side of it through repeaters at each host.
• The repetition of this system forms a ring.
• The repeaters at each host capture the incoming signal intended for other hosts, regenerates the bit stream, & passes it onto the next repeater.

Advantage of ring topology-

• Fault identification & set up of the ring topology is quite simple & straightforward.

Disadvantage of ring topology-

• The high probability of a single point of failure. If even one repeater fails, the whole network goes down.

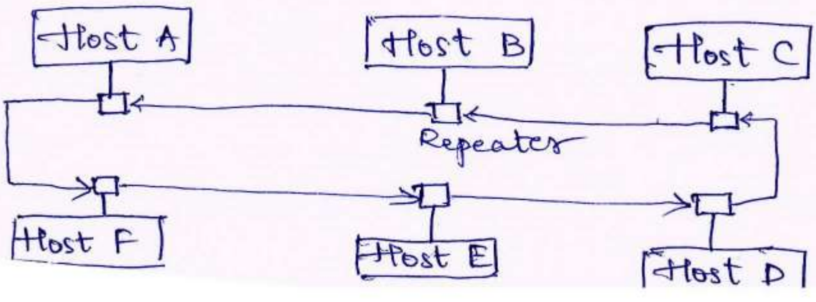


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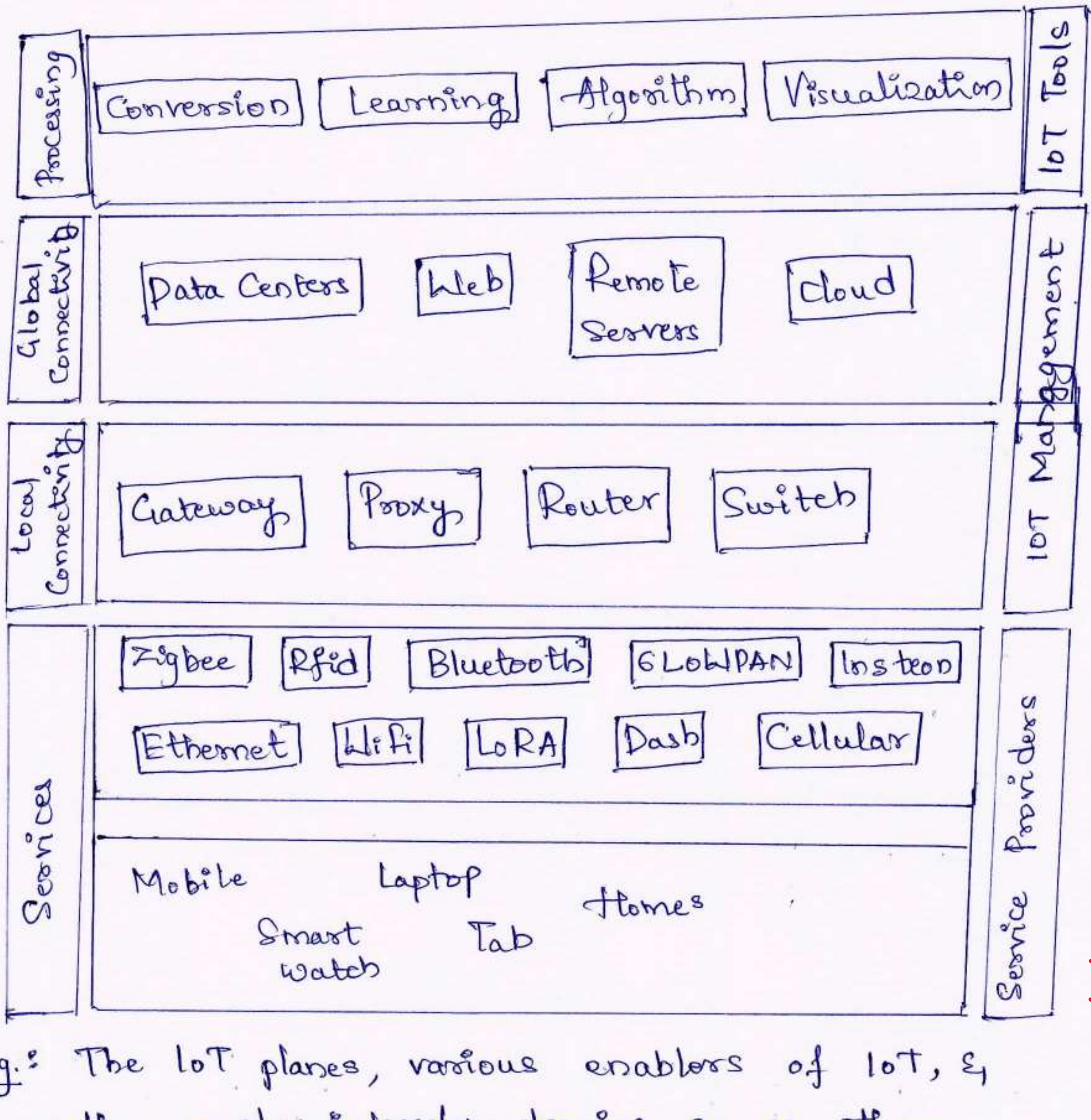
Fig: Bus Topology

1b. With a neat diagram explain the interdependency technology for IOT planes.

Ans IoT is a paradigm built upon complex interdependencies of technologies, which occur at various planes. The IoT paradigm is divided into four planes:

a. Service plane
b. Local ~~plane~~ connectivity plane
c. Global connectivity plane
d. Processing plane.



3M

Fig.: The IoT planes, various enablers of IoT, & the complex interdependencies among them.

By considering bottom-up view, the services offered fall under the control & purview of service providers. The service plane is composed of two parts :-
a). things or devices & b). low-power connectivity

Typically, the services offered in this layer are a combinatio of things & low-power connectivity. The things may be wearables, computers, smartphones, household appliances, UAVs, robots, & other such contraptions. The immediate low-powe connectivity, which is responsible for connecting the things in local implementation, may be legacy protocols such as WiFi, Ethernet, or cellular; modern-day technologies are mainly wireless & often programmable such as Zigbee, RFID, Bluetooth, & others. The range of these connectivity technologies is severely restricted; they are responsible for the connectivity between the things of IoT & the nearest hub or gateway to access the Internet.

The local connectivity is responsible for distributing Internet access to multiple local IoT deployments. This distri-bution may be on the basis of the physical placement of the things, on the basis of the application domains, or even on the basis of providers of services. Services such as address management, device management, security, sleep scheduling, & others fall within the scope of this plan. The local connectivity plane falls under the purview of IoT management as it directly deals with strategies to use/reuse addresses based on things & applications.

Global connectivity plane enables IoT management - IoT in the real sense by allowing for worldwide imple-mentations & connectivity between things, users, contro-llers, & applications. This plane also falls under the purview of IoT management as it decides how & when to store data, when to process it, when to forward it, & in which form to forward it. The web, data-centers, clouds, & others make up this plane.

The paradigm of fog computing lies between the planes of local connectivity & global connectivity.

The final plane of processing is topup of the basic IoT networking framework. The members of this plane are termed as IoT tools, because they wiring-out useful & human-readable information from all the raw data that flows from various IoT devices & deployments. The various sub-domains of this plane include intelligence, conversion, learning, cognition, algorithms, visualization, & analysis. Computing paradigms such as "big data", "mach-ine learning", & others, fall within this domain. 7M

2a. With a neat diagram explain the network communication between two hosts following the OSI model.

Ans: The Open System Interconnection (OSI) model is a stand-ard "reference model" created by ISO to describe how software & hardware components involved in network communication divide efforts & intearct with each other.

The communication process in the OSI/ISO model:

1. In higher layers, each layer of the sender adds its information to the message received from above that layer & moves the entire package just below the layer as shown in figure.
2. Each layer added its information in the form of headers. Headers are added at the level of messages (6, 5, 4, 3, & 2). A header is added at the Data Link layer (layer 2).
3. At the physical layer, the sender sends a stream of bits to the receiver. At thes layer the entire package is converted into a form that can be transferred to the receiver. On the receiver side, each process is accompanied

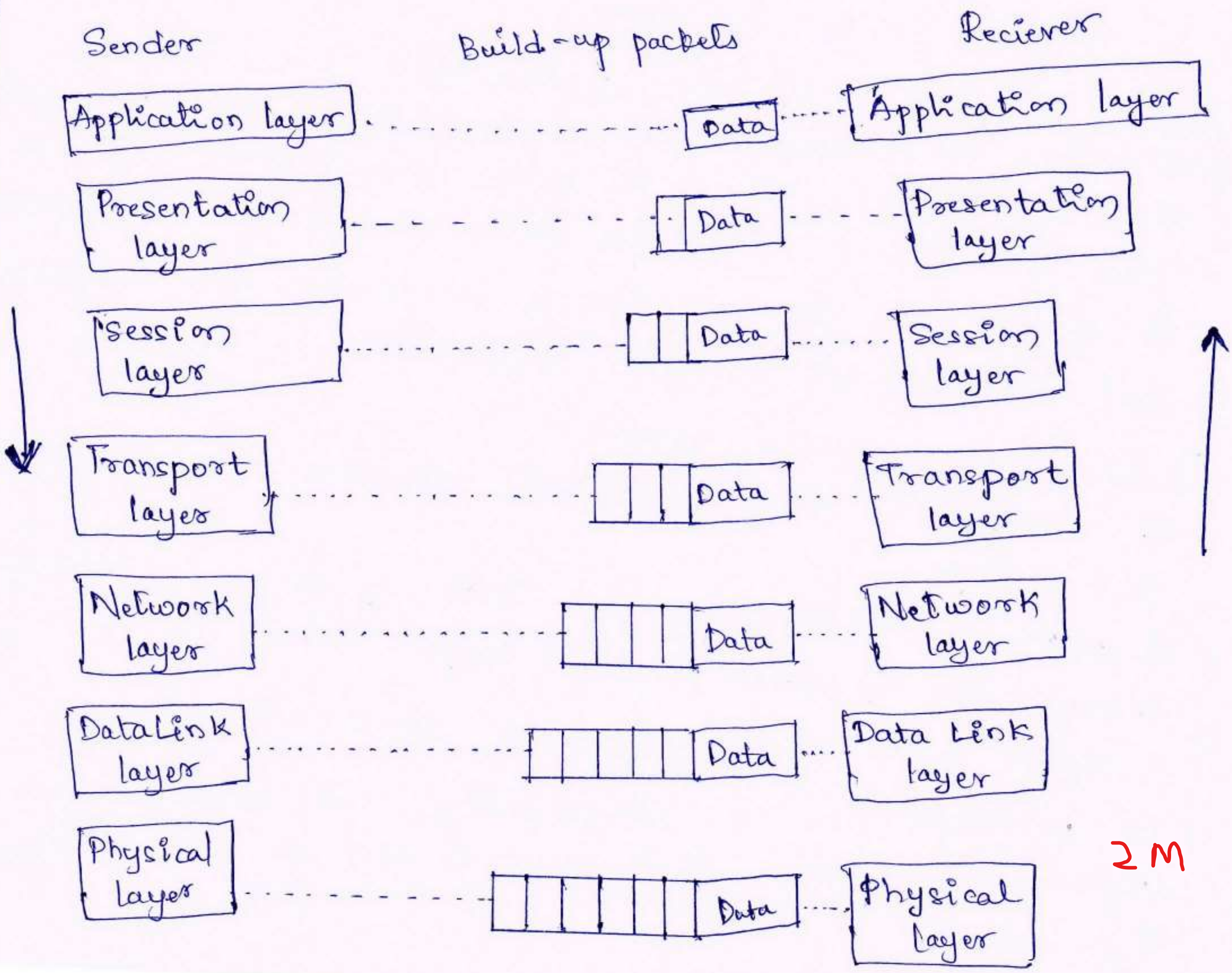
layer-by-layer to receive & delete message data.

4. Always the upper OSI layers (7, 6, 5, 4) are implemented in the software, ~~layers (4, 5)~~ & the lower layers are a combination of hardware & software (layer 2, 3) ~~expe~~ except for layer 1 which is mostly hardware.
Layers 1, 2, & 3 are network support layers. They deal with physical ascepts of moving data such as electrical specifications, physical connections, physical address, & transport time & reliability from one device to another.
Layer 4 ensures reliable data transmission.

5. Each layer is assumed to handle messages or data from the layers that are above or below it.

6. Thus, each layer takes data from the adjacent layer, Handles it according to these rules, & then sends the processed data to the next layer on the other side.

8 m



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2b. Explain the interdependencies & reach of IoT over various application domains & networking paradigms.

Ans: Technological interdependencies of IoT with other domains & networking paradigms

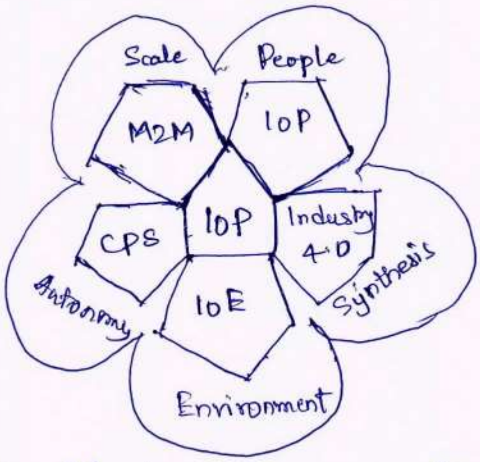
a). M2M : Machine-to-Machine paradigm.

b). CPS : Cyber Physical System Paradigm

c). IoE : Internet of Environment Paradigm

d). Industry 4.0 : 4th Industrial revolution

e). IoP : Internet of People



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a). M2M : Machine-to-Machine communications:

- It refers to communications & interactions between machines & devices. via one or more communication networks.
- These interactions occurs in cloud computing infrastructure
- It collects data from machinery & sensors, also enabling device management & device interactions.

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b). CPS : Cyber Physical System :

- It encompasses sensing, control, actuation & feedback as a package.
- It helps in maintaining the state of an environment through the feedback control loop.
- A digital twin is attached to a CPS-based system.
- IoT paradigm does not compulsorily need feedback or a digital twin systems. It is more focused on networking than controls.

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c). IoE : Internet of Environment :

- The IoE paradigm is mainly concerned with minimizing & even reversing the ill effects of the permeation of Internet-based technologies on the environment.
- The major focus areas of this paradigm include smart & sustainable farming, sustainable & energy-efficient habitats, enhancing the energy efficiency of systems & processes, & others.
- Any aspect of IoT that concerns & affects the environment falls under the purview of IoE.

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d). IoP : Internet of People :

- IoP is a new technological movement on the Internet which aims to decentralize online social interactions, payments, transactions, & others tasks while maintain -ing the confidentiality & privacy of its user's data.
- A famous site for IoP states that as the introd -uction of Bitcoin has severely limited the power of banks & governments, the acceptance of IoP will limit the power of corporations, governments, & their spy agencies.

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e). Industry 4.0 :

- Industry 4.0 is commonly referred to as fourth industrial revolution of digitization in the manuf -acturing industry
- This paradigm strongly puts forward the concept of smart factories, where machines talk to one another without human interventions.

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- The digitization & connectedness in Industry 4.0 translate to better resource & workforce management, optimization of production time & resources, & better upkeep & lifetimes of industrial systems.

Q.3c Define Sensor & explain the characteristics of sensor.

Ans: Sensors are device that can measure, quantify, or respond to ambient changes in their env-ironment. For example, a temperature sensor converts heat into electrical signals. 1M

Characteristics of sensors:-

Sensors are characterized by their ability to sense the phenomenon based on the following 3 fundamental properties.

1). Sensor Resolution
2). Sensor Accuracy
3). Sensor Precision

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1). Sensor Resolution:

- The smallest possible change that a sensor can detect is referred to as the resolution of a sensor.
- Ex, sensor A can detect 0.5 degree Celsius changes in temperature; whereas another sensor B can detect upto 0.25°C in temperature. Therefore, the resolution of sensor B is higher than the resolution of sensor A.
- The more the resolution of a sensor, the more accurate the precision. 2M
- A sensor's accuracy does not depend upon its resolution.

2). 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.

- Ex, a weight sensor detects the weight of a 100kg mass as 99.98kg. We say this sensor is 99.98% accurate, with an error rate of 0.02%.

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3) Sensor Precision:

- The principle of repeatability of a measurement defines the precision of a sensor.
- Ex- the temperature sensor measures 25.8°C in repetitive measurements (10 times), & the actual value is 25°C the sensor is precise but not accurate.
- On the other hand, each time, if the sensor measures different values (25.1, 24.9, 25.2, 24.8, etc). The sensor is accurate but not precise.

1M

3a. Outline the basic differences between Sensors, Actuators & Transducers.

Ans:

Parameters	Transducers	Sensors	Actuators
1. Definition	Converts energy from one form to another	Converts various forms of energy into electrical signals	Converts electrical signals into various forms of energy, typically mechanical energy.
2. Domain	Can be used to represent a sensor as well as an actuator	It is an input transducer.	It is an output transducer.
3. Function	Can work as a sensor or an actuator but not simultaneously	Used for quantifying environmental stimuli into signals	Used for converting signals into proportional mechanical or electrical output.
4. Examples	Any sensor or actuator	Humidity sensors, temperature sensors, Anemometers, Manometers, Accelerometers & others	Motors, Force heads, pumps, & others.

6 M

3b. Explain the Major factors that influence the choice of sensors in IoT based sensing applications.

Ans: The choice of sensors in an IoT sensor node is critical & can either make or break the feasibility of an IoT deployment. The following major factors influence the choice of sensors in IoT-based sensing solutions:

1. Sensing range
2. Accuracy & Precision
3. Energy
4. Device size

1M

1. Sensing Range :

- The sensing range of a sensor node defines the detection fidelity of that node
- Typical approaches to optimize the sensing range in deployments include fixed K-coverage & dynamic K-coverage.
- The sensing range of a sensor may also be used to signify the upper & lower bounds of a sensor's measurement range.
- Ex, a proximity sensor has a typical sensing range of a couple of meters.
- In contrast, a camera has a sensing range varying between tens of meters to hundreds of meters.
- As the complexity of the sensor & its sensing range goes up, its cost significantly increases.

2M

2. Accuracy & Precision :

- The accuracy & precision of measurements provided by a sensor are critical in deciding the operations of specific functional processes.
- For ex- a standard / regular temperature sensors have a very low temperature sensing range, as well as relatively low accuracy & precision.
  - The use of these sensors in industrial applications, where a precision of up to 3-4 decimal places is required, cannot be facilitated by these sensors.
- Industrial sensors are typically very sophisticated, & as a result, very costly.
  - However, these industrial sensors have very high accuracy & precision score, even under harsh operating conditions.

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3. Energy:

- The energy consumed by a sensing solution is crucial to determine the lifetime of that solution & the estimated cost of its deployment.
- If the sensor or the sensor node is so energy ine-fficient that it requires replenishment of its energy sources quite frequently, the effort in maintaining the solution & its cost goes up; whereas its deployment feas-ibility goes down.
- Consider a scenario where sensor nodes are deployed on the top of glaciers.
  - Once deployed, access to these nodes is not possible.
  - If the energy requirements of the sensor nodes are too high, such a deployment will not last long, & the solution will be highly infeasible as charging or changing of the energy sources of these sensor nodes is not an option.

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4. Device size:

- Most of the applications of IoT require sensing solutions which are so small that they do not hinder any of the regular activities that were possible before the sensor node deployment was carried out.
- Larger the size of a sensor node, larger is the obst-ruction caused by it, higher is the cost & energy requirements, & lesser is its demand for the bulk of the IoT applications.
- Consider a simple human activity detector.
  - If the detection unit is too large to be carried or too bulky to cause hindrance to regular normal move-ments, the demand for this solution would be low.
- The wearable sensors are highly energy-efficient, small in size, & almost part of the wearer's regular wardrobe.

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4a. Classify sensors based on :
1. Power requirement 3. ~~Power~~ Property to be measured.
2. Sensor output

Ans: 1. Based upon the power requirement sensors are of two kinds :
a. Passive sensor b. Active sensor

a. Passive Sensor :

- It does not need any additional energy source & directly generates an electric signals in response to an external stimulus.
- That is, the input stimulus energy is converted by the sensor into the output signal.
- Most of passive sensors are direct sensors.
- Ex- a thermocouple, a photodiode, & a piezoelectric sensor.

b. Active Sensor :

- It requires external power for its operation, which is called an excitation signal.
- That signal is modified by the sensor to produce the output signal.
- Ex- a thermistor is a temperature sensitive resistor. It does not generate any electric signal, but by passing an electric current through it its resistance can be measured by detecting variations in current &/or voltage across the thermistor.

4M

2. Based upon the sensor outputs sensors are of two kinds:
a. Analog sensors b. Digital sensors.

a. Analog Sensors :

- It produce an output signal which is usually in the form of voltage, current, or resistance, proportional to the measured quantity.

b. Digital Sensors :

- It provide discrete or digital data as output.

3. Based upon the property to be measured sensors may classified as :

a. Scalar sensor b. Vector sensor 3M

a. Scalar Sensor :

- Scalar sensors produce an output proportional to the magnitude of the quantity being measured.
- Ex :- temperature sensor, color sensor, pressure sensor, strain sensor, etc.
- Factors such as changes in sensor orientation or direction do not affect these sensors.

b. Vector Sensor :

- The sensor which produces an output signal/voltage which is proportional to the magnitude, direction, as well as orientation of the quantity being measured, is known as a vector sensor.
- Ex – sound sensor, image sensor, velocity sensor, etc.
- Factors such as changes in sensor orientation or direction affect these sensors. 3M

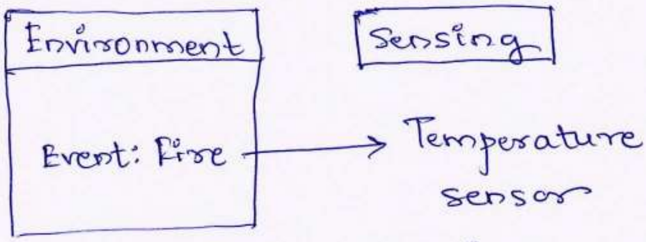
4b. Classify sensing types on the nature of the environment & the physical sensors.

Ans: Sensing can be divided into 4 different categories based on the nature of the environment being sensed & the physical sensors being used.

1. Scalar sensing
2. Multimedia sensing
3. Hybrid sensing
4. Virtual sensing 2M

1. Scalar sensing:

- The sensors used for measuring scalar quantities such as temperature, current, atmospheric pressure, rainfall, humidity, light, etc are referred to as scalar 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 below -

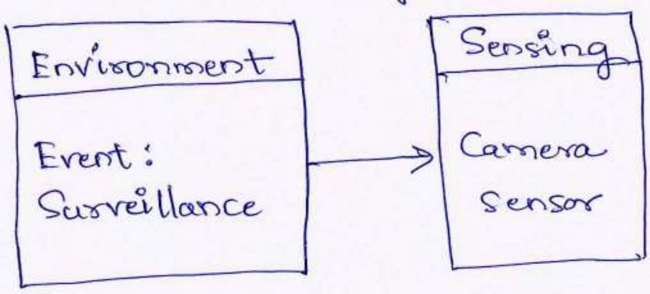


2M

Fig.: Scalar sensing

2. Multimedia sensing:

- The sensors used for measuring quantities such as images, direction, flow, speed, acceleration, sound, force, mass, & energy are known as multimedia sensors.
- These quantities have both directions as well as magnitude, hence these sensors are also called "vector sensors".
- A simple camera-based multimedia sensing using surveillance as an example is shown below.

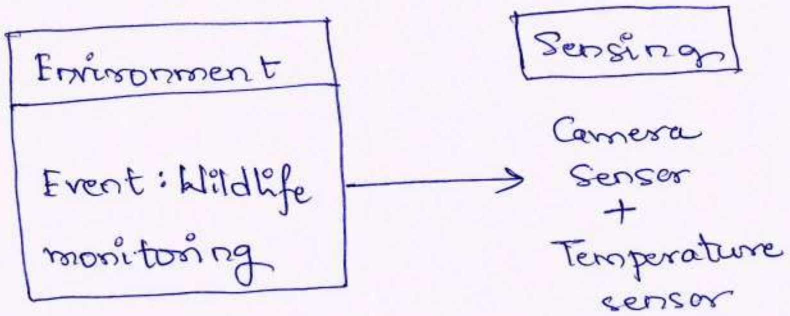


2M

3. Hybrid sensing:

- The sensors are used to measure both scalars as well as multimedia quantities at the same time & are referred to as hybrid sensing.

- Ex: in an agricultural field, measure collectively the soil moisture, soil temperature, & the color of the leaves to decide a plant's health by a camera sensors.
- Fig. below shows an example of hybrid sensing, where a camera & a temperature sensor are collectively used to detect & confirm forest fires during wildlife monitoring.



2 M

Fig: Hybrid sensing

4. Virtual sensing:

- They are also called soft sensing or proxy sensing.
- A virtual sensing system uses information available from other measurements & process parameters to calculate an estimate of the quantity of interest.
- Ex— A's sensors are being used for the actual measurement of parameters; whereas virtual data is being used for advising B. This is virtual sensing

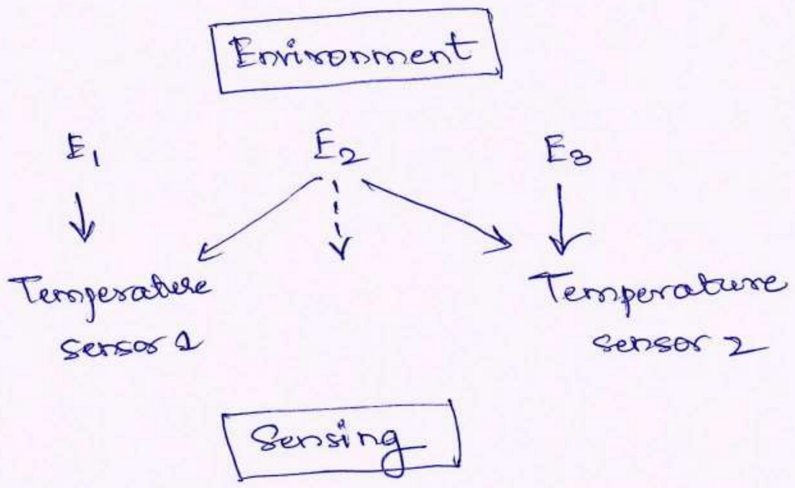


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Fig: Virtual sensing

5a. Explain IOT device design & selection consideration.

Ans: The processor is the main factor for IOT device design & selection for various applications. Other important considerations to design an IoT device are -

1. Size
2. Energy
3. Cost
4. Memory
5. Processing power
6. I/O rating
7. Add-ons

2 m

1. Size:

- Size & energy consumption are crucial factors of a sensor node.
- The larger the size factor consumes more energy.
- Additionally, large-size factors are not suitable for many IoT applications.

2. Energy:

- Energy efficient processor is the most important factor in designing IoT-based sensing solutions.
- The higher the energy requirements, the higher the battery replacement frequency
- This principle is not a good option for IoT-based applications.

3. Cost:

- Cheaper cost of the hardware enables a much higher density of hardware deployment.
- Ex- cheaper gas & fire detection solutions would enable users to include much more sensing hardware for a lesser cost.

4. Memory:

- Devices with higher memory tend to be costlier.
- But features such as local data processing, data storage, data filtering, data formatting, & other features rely heavily on the memory capabilities of devices

5. Processing Power:

- In deciding what type of sensors can be accommod-ated with the IoT device/node, & what processing features can integrate on-site.
- The processing power also decides the type of applications the device can be associated with.
- Ex- if the application involves video or audio needs more processing power than other simple sensing IoT appli-cations.

6. Input/output (I/O) rating:

- Primarily the processor, is the deciding factor in determining the circuit complexity, energy usage, & requirements for support of various sensing solutions & sensor types.
- Some processors have a meager I/O voltage rating of 3.3V, as compared to 5V for older processors.
- This needs additional voltage & logic conversion circuitry & increases the cost & complexity of the node.

7. Add-ons:

- IoT device provides, such ADC units connections to USB & ethernet, & inbuilt wireless access capabilities for various IoT applications.
- These add-ons also decide how fast a solution can be developed others helps in defining the robustness & usability of a processor or IoT device in various application scenarios.

2m- each

P.T.O

5b. What are the parameters considered for offloading the data & identify typical data offload locations available in the context of IoT.

Ans: Offload location :

The choice of offload location decides the applicability, cost, & sustainability of the IoT application & deployment. The offload location are classified into 4 types:

a. Edge c. Remote server

b. Fog d. Cloud

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:

- Fog 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 & network bandwith use.

c. Remote Server:

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

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.

5m

P.T.O

Offloading Considerations:

Offloading parameters need to be considered while deciding upon the offloading type to chose arising from the nature of the IoT application & the hard-ware being used to interact with the application. These parameters are as follows:

a. Bandwidth
b. Latency
c. Criticality
d. Resources
e. Data volume

a. Bandwidth:

- The maximum amount of data that can be simultaneously transmitted over the network between two points.
- The bandwidth of a wired or wireless network is also considered to be its data-carrying capacity & often used to describe the data rate of that network.

b. Latency:

- It is the time delay between the start & completion of an operation, which is due to physical limitations of the infrastructure in the network or the processor which is associated with an operation.

c. Criticality:

- It defines importance of a task being pursued by an IoT application.
- The more critical a task is, the lesser latency is expected.
- Ex- detection of fires using an IoT solution has higher criticality than detection of agricultural field parameters.

d. Resources:

- It signifies the actual capabilities of an offload location.

e. Data volume:

- The amount of data generated by a source or sources that can be simultaneously handled by the offload location.
- Typically, for large & dense IoT deployments, the offload location should be robust enough to address the processing issues related to massive data volumes.

5m

6. a) Explain event detection using onsite, offsite remote processing topology and collaborative processing technology.

Ans – In the offsite processing topology, the sensor node is responsible for the collection and framing of data that is eventually to be transmitted to another location for processing. The fire detection event using an offsite remote processing topology is shown below.

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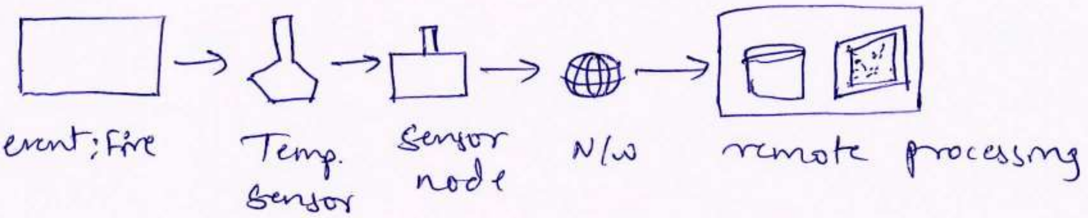
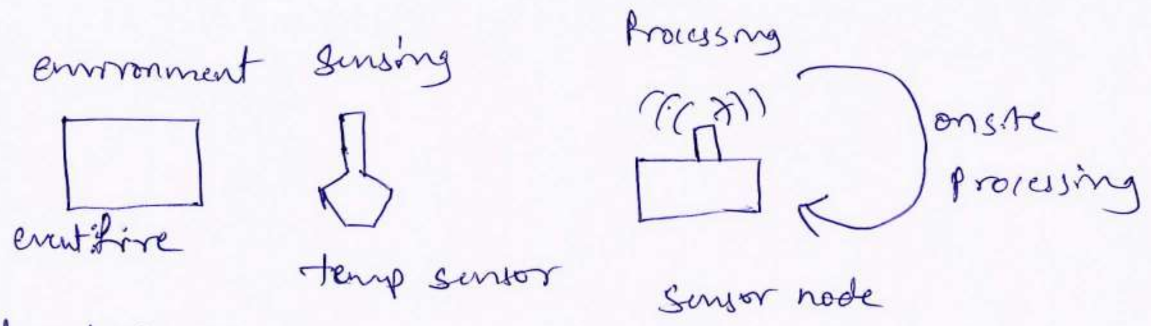


Here the sensing of an event is performed locally, and the decision making is outsourced to a remote processor. However this paradigm tends to use up a lot of N/w bandwidth and relies heavily on the presence of network connectivity between the sensor nodes and the remote processing infrastructure.

Onsite processing

- As evident from the name, the on-site processing topology signifies that the data is processed at the source itself.
- This is crucial in applications that have a very low tolerance for latencies. These latencies may result from the processing hardware or the network.
- Applications such as those associated with healthcare and flight control systems have a breakneck data generation rate.
- figure below shows the onsite processing topology, where an event is detected utilizing a temp. sensor connected to a sensor node. The sensor node processes the info. from the sensed event and generates an alert. The node additionally has the option of forwarding the data to a remote infra. for further analysis and storage

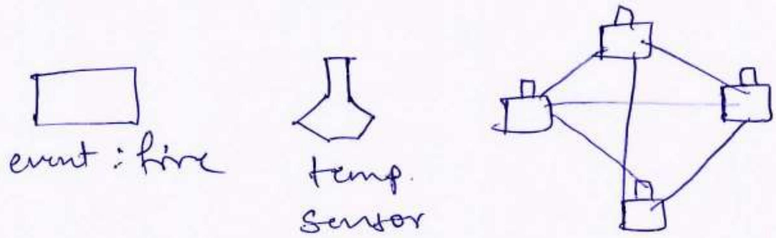
4M



Collaborative processing

- This processing topology typically finds use in scenarios with limited or no network connectivity, especially systems lacking a backbone network.
- Additionally, this topology can be quite economical for large scale deployments spread over vast areas, where providing networked access to a remote infra. is not viable.

3M



Collaborative n/w /mesh.

6. b). Classify the data based on how they can be accessed and stored and the importance of processing of IoT.

Ans. The huge data volume generated in Internet is composed ~~of~~ a variety of data such as e-mails, text documents, social media, videos, audios & images.

These data can be broadly grouped into 2 types based on how they can be accessed and stored i) structured data and 2) unstructured data

2M

Structured data

- They are typically text data that have a pre-defined structure.
- Structured data are associated with relational database management systems.
- These are primarily created by using length-limited data

fields such as phone numbers, social security numbers, and other such info.

- Even if the data is human or machine generated, these data are easily seachable by querying algorithms as well as human generated queries.
- Established languages such as SQL are used for accessing these data in RDBMS. 4M

Unstructured data

- In simple words, all the data on the Internet, which is not structured is categorized as unstructured.
- These data types have no pre-defined structure and can vary according to applications and data generating sources.
- Some of the common examples of human-generated unstructured data include text, emails, videos, images, audio, chats. 2M
- Querying languages such as NoSQL are generally used for this data type.

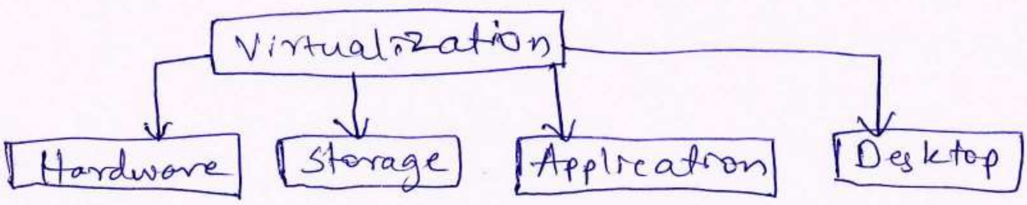
Importance of Processing in IoT

- The necessity of intelligent and resourceful data processing technique has become even more crucial with the rapid advancements in IoT, which is laying enormous pressure on the existing network infra globally. 2M
- The data to be processed into 3 types based on the urgency of processing - 1) very time critical 2) Time critical, 3) Normal.

Module-4

Q.7. a) Explain the classification of Virtualization based on the requirements of the user.

Ans - Virtualization is categorized into 4 types



1) Hardware virtualization : sharing of hardware resources among multiple users. A single processor appears as many different processors in a cloud computing architecture. Different OS can be installed in these processors and each of them can work as a stand-alone machine. **2 M**
It uses VMM called a hypervisor to provide abstracted hardware to multiple guest OS.

2) Storage virtualization : The storage space from different devices is accumulated virtually, and seems like a single storage location. Through this virtualization, user's files can exist in different locations in a distributed fashion. **2 M**

3) 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. A user can use the application on local computer without ever actually installing the application.

4) Desktop ~~ap~~ virtualization : This type of virtualization allows a user to access and utilize the services of a desktop that resides in the cloud. Users can use the desktop from their local desktop. **2 M**

7.b) Explain different types of cloud model.

Ans The cloud model can be divided into 2 parts.

1) Service model
- Software as a service (Saas)
- Platform as a service (Paas)
- Infrastructure as a service (Iaas)

2) Deployment model :

- Private cloud
- Community cloud
- Public cloud
- Hybrid cloud.

2 m

i) SaaS : This service provides access to different software applications to an end user through internet connectivity.

- User does not need to purchase & install software on local desktop. Software is located in a cloud server
- SaaS offers scalability
- software can be accessible from any location
- User need not to worry about the updation of software

eg :- Office 365, Salesforce, Netflix

ii) PaaS : It provides a user can develop and run different applications.

- The cloud user need not go through the burden of installing & managing the platform such as OS, etc.

· eg :- Google App Engine & Microsoft Azure.

iii) IaaS : IaaS provides infrastructure such as storage, networks, and computing resources.

- User uses the Infrastructure without purchasing the software and other network components.

eg :- Google Compute Engine.

4 M

a) Private cloud : This type of cloud is owned explicitly by an end-user organization. The internal resources of the organization maintain the private cloud.

b) Community cloud : This cloud forms with the collaborations of a set of organizations. for a specific community. Each organization has some shared interests.

c) Public cloud : The public cloud is owned by a third-party organization, which provides services to the common public. The service of this cloud is available for any user, on a payment basis.

d) Hybrid cloud : This type of cloud comprises two or more clouds.

4M

7. c) What is SLA and mention its metrics.

Ans - SLA - service level agreement is a contract between a service provider and its customers that documents what services the provider will furnish and defines the service standards the provider is obligated to meet. 1M

Metrics for SLA

Some of the common metrics used to construct SLA are

1) Availability - Amount of time service will be accessible for the customers
2) Response time - maximum time for responding to request
3) Portability - flexibility of transferring data
4) Problem Reporting - How to report a problem
5) Penalty - Penalty for not meeting the promises 3M

8. a) What are the advantages of virtualization

Ans Two main entities in a cloud computing are 1) End users and 2) Cloud service providers. Both are benefited in several aspects.

Advantages of virtualization for End users.

1) Variety : It enables various types of applications based on the requirements.

- It enables end users to access applications, hardware, or software virtually from a variety of devices & networks

2) Availability : virtualization creates a logical separation of the resources of multiple entities without any intervention from end users.

- It makes available a considerable amount of resources a per user requirements.
- The end user feel that there are unlimited resources present dedicatedly for him/her.

3) Portability : Ability to transfer applications and data between cloud computing environments.

- It enables migration between public and private clouds.
- Portability signifies the availability of cloud computing service from anywhere in the world, at any instant in time.

4) Elasticity : Elasticity refers to automatically increasing or decreasing cloud resources.

- It automatically adapts to match resources with demand as closely as possible, in real time.
- An end user can scale-up or scale-down resources like processing, memory and storage resources to meet changing demands. 6M

Advantages of virtualization for cloud service providers

1) Resource utilization : Here use the resources on their own or get them from third parties

- Resources are distributed among different users dynamically as per their requirements
- Resources can be re-utilized for multiple users.

2) Effective Revenue Generation : A CSP generates revenue from the end users based on resource utilization.

- The resource dynamic reallocation and re-utilizing features of cloud computing enable more revenue generation. 4M

8 b). Explain different types of cloud simulators with its features.

Ans Cloud simulation is required because

- Real deployment of the cloud is a complex and costly procedure

- It is challenging to estimate the performance of an IoT system with the cloud before real implementation.

- cloud simulator provides

1) Pre deployment test before real implementation
2) System testing at no cost
3) Repeatable evaluation of the system
4) Pre-detection of issues that may affect system

1M

Some of the popular cloud simulators are

1) Cloud Sim.

- It provides various cloud computing data centers along with different data center network topologies in a simulation environment.
- Virtualization of server hosts can be done in a simulation
- A user can allocate VM dynamically.
- A user can stop and resume the simulation at any instant in time.

3m

2) Cloud Analyst

- This simulator is easy to use due to the presence of GUI
- It allows a user to add components and provides a flexible and high level configuration.
- A user can perform repeated experiments
- It can provide a graphical output.

3M

c) Green cloud

- It is an open-source simulator with a user-friendly GUI
- It provides the facility for monitoring the energy consumption of the network & components.
- It supports the simulation of cloud network components
- It allows a user to manage and configure devices,

3M

Module-5

9. a) Explain the different components of health care IoT.

Ans Some of the components of health-care IoT are

1) Sensors - physiological sensors collect the physiological parameters of the patient.

2) Wireless Connectivity - used to communicate between the wearable sensors and the LPU with the help of bluetooth and Zigbee.
- Communication between LPU and the cloud or server is done using WiFi and WLAN.

3) Privacy and security - To increase the security of health care data, different heathcare service providers and organizations are implementing health care data encryption and protection schemes.

2M.each

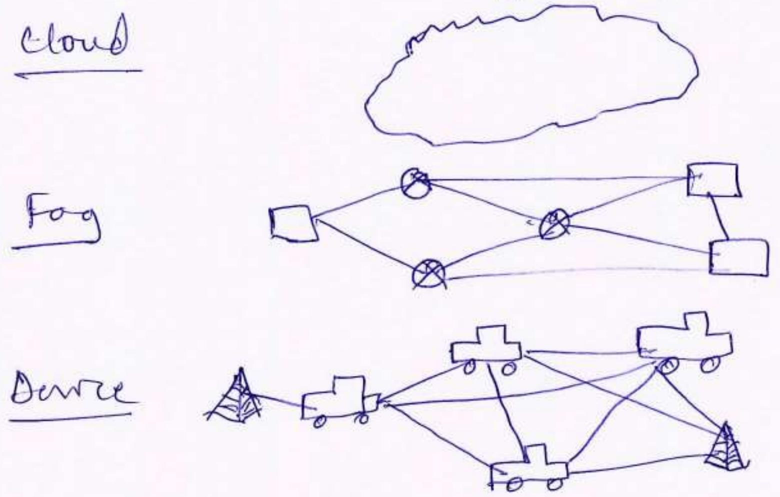
4) Analytics - It converts raw data into meaningful information.

5) Cloud and fog computing - It plays a vital role in the storage of massive volumes of health data. The major challenges in storage are security and delay in accessing the data.

6) Interface - The user interface must be designed in such a way that it can depict all the required information clearly and should be easy to understand.

9.b) Explain the architecture and advantages of vehicular IoT.

Ans The architecture of vehicular IoT is divided into 3 sub layers. 1) Device layer 2) Fog layer 3) Cloud layer.



Architecture of vehicular IoT

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1) Device layer - This layer consists of the basic infrastructure of the connected vehicle.
- This layer includes the vehicles and RSU
- These vehicles contain certain sensors which gather info
- RSU works as a local centralized unit.

2) Fog layer - It provides fast decisions in real time, much near to the devices.
- In vehicular IoT systems, fast decision making is important to avoid accidents

4M

3) Cloud layer - Processing of huge data, fog computing is not enough, in such a situation, cloud computing is used.

Advantages of vehicular IoT
1) Easy tracking
2) Fast-decision making
3) Connected vehicles
4) Easy management

5) Safety
6) Record.

4M

10 a) What is Machine Learning? What are the advantages and challenges of Machine Learning.

Ans. - Machine learning is a field of study that gives computers the ability to learn without being explicitly programmed.

- ML is a powerful tool that allows a computer to learn from past experiences and its mistakes and improve itself without user intervention.
- The main components of ML are statistics, mathematics and computer science for drawing inferences, construction ML models and implementation respectively.

3M

Advantages of ML

- Self learner
- Time efficient
- Self guided
- Minimum Human interaction required
- Diverse Data handling
- Diverse applications

4M

Challenges in ML

- Data Description
- Amount of data required
- Erroneous Data
- Selection of Model - proper selection of model depends on various parameters like amount of data, quality, type of results
- Quality of Model. - Difficult to determine quality of selected model.

3M

10 b) What are the advantages and risk of health care IoT?

Ans Advantages

1) Real time - Healthcare IoT system helps users, such as doctors, end users at the patient side and staff in a healthcare unit, to receive real time updates about the healthcare IoT components.
- It enables a doctor to observe a patient's health condition in real time even from a remote location.

2) Low cost - It facilitate users with different services at low cost

3) Easy Management - Healthcare IoT is an infrastructure that brings all its end users under the same umbrella to provide heathcare services
- However, healthcare IoT facilitates easy and robust management of all entities.

4) Automatic processing - Healthcare IoT enables end to end automatic processing in different units and also consolidates the information across the whole chain

5) Easy record-keeping - A healthcare IoT enables user to keep these records in a safe environment and deliver them to the authorized user as per requirement

6) Easy diagnosis - In a healthcare IoT system, the diagnosis of the disease becomes easier and the help of certain learning mechanisms along with the availability of prior datasets.

6 M

Risks in healthcare IoT

1) Loss of connectivity - Intermittent connectivity may result in data loss, which may result in a life-threatening situat for the patient.

2) Security - The healthcare system must keep the data confidential. This data should not be accessible to any unauthorized person.

3) Error - In a healthcare system, errors in data may lead to misinterpretation.

4M