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1) Memorize the goals of IOT ? List out different Challenges of IOT

→ Goals of IOT:

① The basic premise & goals of IOT is to "connect the unconnected." This means that basic that are not currently joind to a computer network, namely the internet, will be connected sot that thy can communicate and interact with people and other objects.

② when objects and machine can be sensed and controlled across a network a tighter integration between the physical world and computer is enabled.

③ This allow for improvment in the areas of efficing, accuracy, automation and enablment of advanament.

Challenges of IOT:

① Scale: While the scale of IT networks can be large, the scale of IOT can be several orders of magnitude larger. The scale of the network the utility is managing has increased by more than 1000 fold.

② Security: with more "things" becoming connecting with other things and people security is an increasingly complex issues for IOT threat surface is now greatly expanded and if a device gets hacked its connectivity is a major concern. IOT security is also pervasive across just about every fact of IOT.

③ Privacy: As sensors become more prolific in our everyday lives, much of data gather will be specific to individuals and their activities. This data can range from health information to shopping patterns and transactions at a retail establishment for business, this data has monetary values.

④ Big data & data Analytics : IOT and its large number of sensors is going to trigger a deluge of data that must be handled. This data will provide critical information and insights if it can be processed evaluating massive amount of data arriving from different sources in various forms and doing so in a timely manner.

⑤ Interoperability : variable protocols and architectures are jockeying for market share and standardization within IOT. Some of these protocols and architectures are based on propriatory elements and others are open. Recent IOT standards are helping minimize this problem, but there are often various protocols and implementations available for IOT networks

3) Define Information Technology and operational Technology. Distinguish various difference between IT and OT networks.

→ Information Technology supports connections to the internet along with related data and technology systems and is focused on the secure flow of data across an organization.

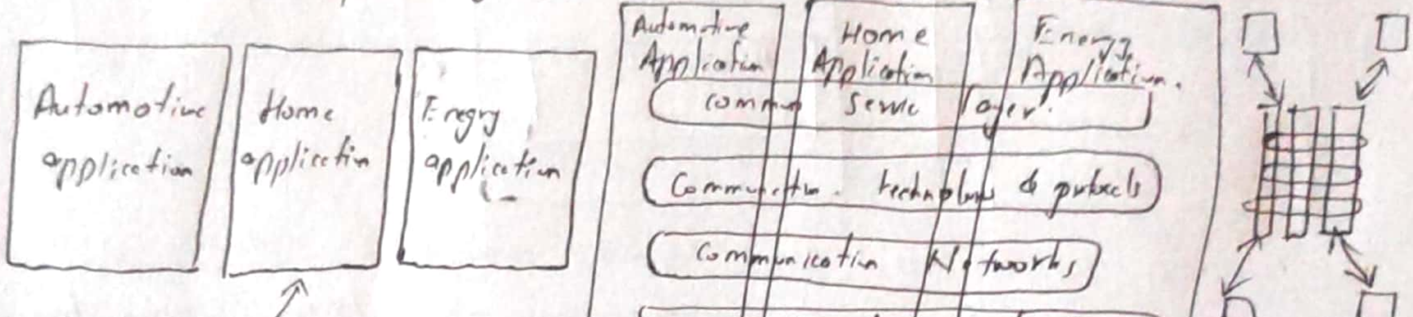
Operational Technology monitors and controls devices and process or physical operational systems.

Difference :

criterion	OT Network	IT Network
① operational focus	Keep the business operating 24x7	Manage the computer, data and employee communicating system in a secure way.
② priorities	① Availability ② Integrity ③ Security	① Security ② Integrity ③ Availability.
③ Types of data	Monitoring, control and Supervisory data.	Voice, videos, transactional & bulk data.
④ Security	controlled physical access to device	Devices and users authenticated to the network.
⑤ Implication of failure.	OT Network disruption directly impacts business	can be business impacting, depending on Industry, but work around may be possible.
⑥ Network upgrades	Only during operational maintenance windows	often requires an outage window when workers are not on site, impact can be mitigated.
⑦ Security vulnerability	Low: OT network are isolated and often use proprietary protocols	High:- Continual patching of hosts is required. and the network is connected to internet & required vigilant protection.

3) Illustrate the one-machine to IOT architecture with diagram and also examine how the application, Service and Network layers providing functions to one M2M architecture.

→ One of the greatest challenges in desigining an IOT architecture is dealing with the heterogeneity of devices, software and access methods, by developing a horizontal platform architecture, one M2M is developing standards that allow interoperability at all levels of the IOT Stack.



Application layer:
- Smart energy
- Asset tracking
- Fleet management

Services layer: one M2M includes a common service horizontal framework supporting Results APIs

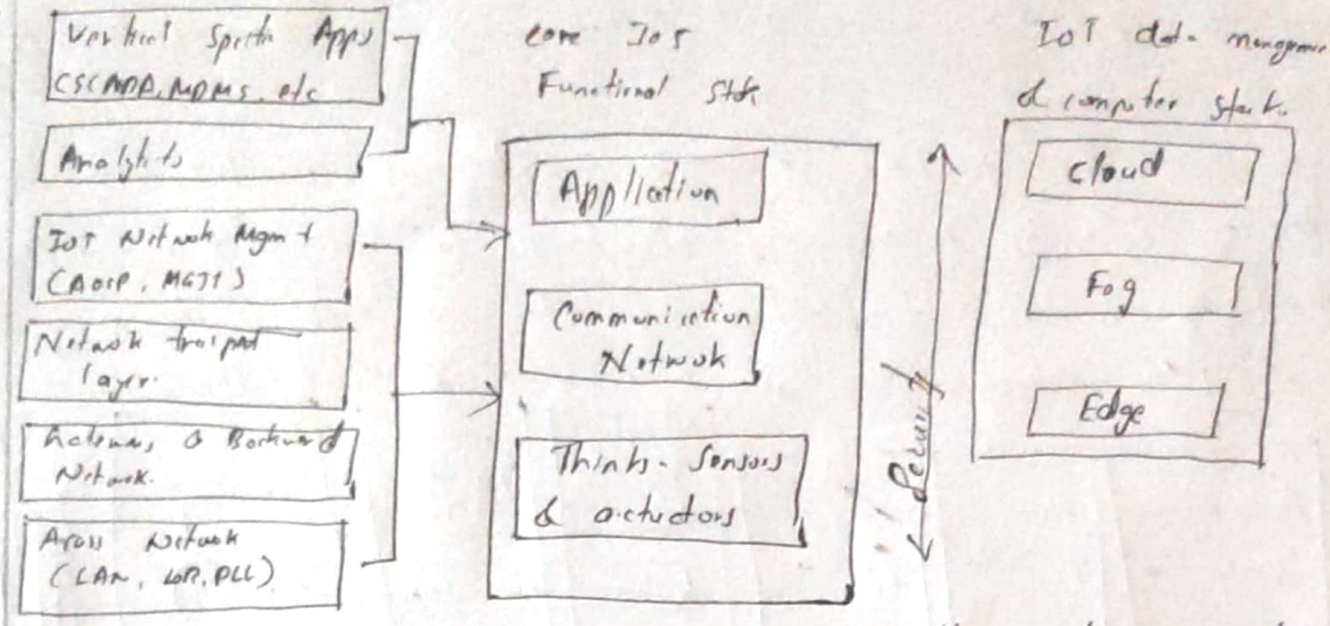
Network layer: Application talk to APIs to communicate to Sensors.

- The Application layer: The one M2M architecture gives major attention to application between devices and their applications. This domain includes, the definition for interactions with business Intelligence Systems. Applications tend to be industry-specific and have their own sets of data models and they are shown as vertical entities.

- Service layer: This layer is shown as a horizontal framework across the vertical industry application. At this layer horizontal module include the physical network that the IOT application run on, the underlying management protocol and the hardware.

- Network layer:- This is the communication domain for the IOT devices and end points. It includes devices themselves and the communication network that links them. Embodiments of this communication infrastructure include wireless mesh technologies, such as IEEE 802.15.4 and wireless point-to-multipoint systems such as IEEE 801.11 ab.

4) Sketch the expanded view of the simplified IOT architecture.

-> 

The core IOT Functional stack expanded into sublayer containing greater detail & specific network functions. For ex: the communications layer is broken down into 4 separate sublayer. The access network, gateway & backhaul. IP transport & operations & management sublayers. The application layer of IOT network is quite different from the application layer of a typical enterprise network. Instead of simply using business applications IOT often involves a strong big data analytics the IoT is not just about the control of IoT device but rather the useful insights gained from the data generated by the device. Thus the application layer typically has both analytic and industry-specific.

5) Illustrate the characteristics of smart objects:

-> ① processing unit: Smart object has the some type of processing unit for acquiring data, process & analyse sensing information received by the sensor, coordinating control signal to any actuators, and controlling a variety of functions on the smart object, including the communication and power systems. The specific type of processing unit that is used can vary greatly, depending on the specific processing needs of different applications.

② Sensors or actuators: A smart object is capable of interacting with physical world the physical world through sensors and actuators. A sensor learns and measures its environment, where as an actuator is able to produce some change in the physical world. A smart object doesnot need to contain both sensors and actuators

③ Communication device: The communication unit is responsible for connecting a smart object with other smart objects and the outside world. Communication device for smart objects are either wired or wireless. In IoT networks smart object are wirelessly interconnected for a number of reasons, including a cost limited infrastructure availability etc

④ Power Source: Smart objects have components that need to be powered the most significant power consumption usually comes from the communication unit. As with the other these smart objects building blocks the power requirements also vary greatly from application to application. Typically smart objects are limited in power are deployed from a very long time, & are not easily accessible.

6) Illustrate how sensors are grouped & clustered into different categories & explain the different types of sensors with example.

- ①Active or passive: Sensors can be categorized whether they produce an energy output and typically requires an external power supply or whether they simply receive energy and typically require no external power supply.

② Invasive or non-invasive: Sensors can be categorized based on whether a sensor is part of environment it is measuring or external to it

③ Contact or noncontact: Sensors can be categorized based on whether they require physical contact with what they are measuring or not.

④ Absolute or relative: Sensors can be categorized based on whether they measure on an absolute scale or based on a difference with a fixed reference value.

⑤ Area of application: sensors can be categorized based on the specific industry or vertical where they are being used.

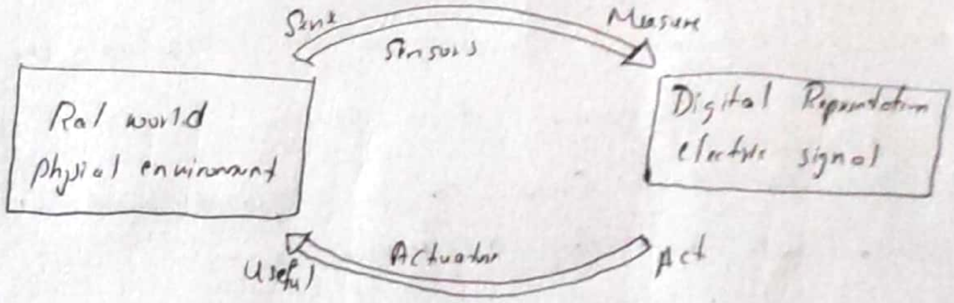
⑥ How sensors measures: Sensors can be categorized based on the physical mechanism used to measure sensory input.

⑦ What sensors measures: Sensors can be categorized based on their application on which physical variables they measures.

Different types of Sensors:

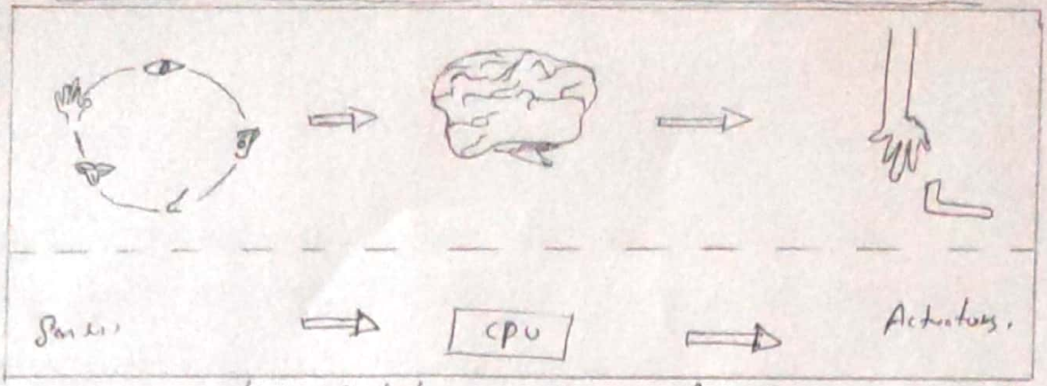
Sensor types.	Description	Examples.
① position	A position sensor measures the position of object	potentiometer, inclinometer
② Occupancy & motion	occupancy sensors detect the presence of people & animals in surveillance area.	Electric eye, radar
③ Velocity & acceleration	Velocity sensors may be linear or angular, indicating how fast an object moves along a straight line. Acceleration sensors measure changes in velocity	Accelerometer, gyroscope.
④ Force	Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond threshold	Force gauge, viscometer, tactile Sensor
⑤ Pressure	Pressure sensors are related to force sensors, measuring force applied by liquid or gas pressure is measured in terms of force per unit area.	Barometer
⑥ Flow	Flow sensors detect the rate of fluid flow	Anemometer, mass flow sensor.

7) Highlight how sensors and actuators interact in physical world and compare sensors & actuators functionality with humans.



Humans use their five senses to sense and measure their environment the sensory organs convert this sensory information into electrical impulses that the nervous system sends to the brain for processing. The human brain signals motor function and movements & the nervous system carries that information to the appropriate part of the muscular system corresponding a processor can send an electric signal to an actuator that translates the signal into some type of movement or useful work that has measurable impact on the physical world.

Comparision of sensors & Actuator functionality with human:



1) Type of motion: Actuator can be classified based on the type of motion they produce. Ex: linear, rotatory etc.

2) Power: Actuator can be classified based on their power output Ex: low power, high power

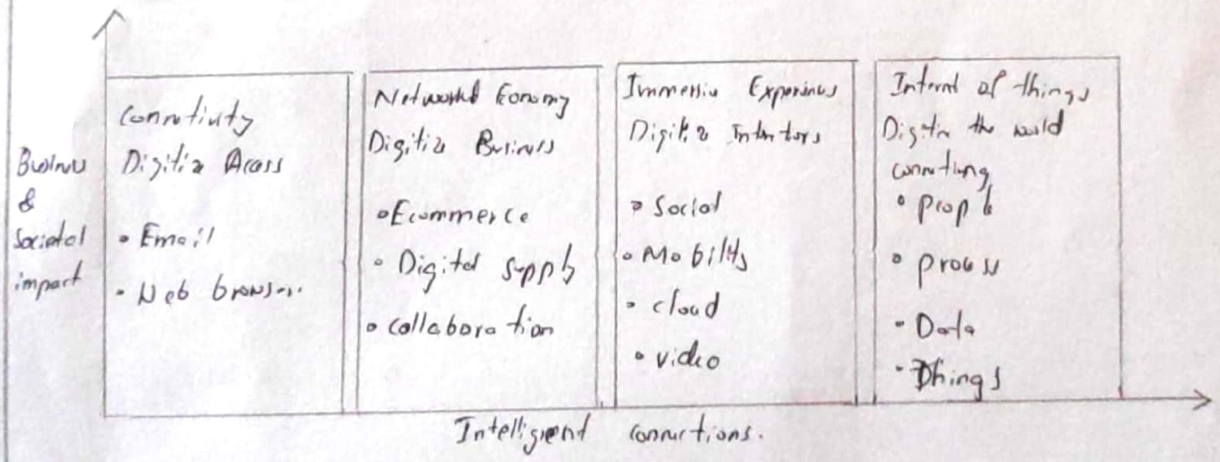
3) Binary or continious: Actuator can be classified based on the number of stable-state outputs

4) Area of application: Actuator can be classified based on the specific industry or vertical where they are used.

5) Type of energy: Actuators can be classified based on their energy type.

8) Illustrate the evolutionary phase of Internet along with the current challenges addressed by connected roadways

- The evolution of the internet can be categorised into four phase.



Connectivity
Digitize Access
- Email
- Web browser.

Networked Economy
Digitize Business
- E-commerce
- Digital supply
- Collaboration

Immersive Experiences
Digitize Interactions
- Social
- Mobility
- cloud
- video

Internet of things
Digitize the world connecting
- people
- process
- Data
- Things

Internet phase.	Definition.
• Connectivity	This phase connected people to email, web services & search so that information is easily accessed.
• Networked Economy	This phase enabled e-commerce and supply chain enhancement along with collaborative engagement to drive increased efficiency in business application.
• Immersive experiences	This phase extended the internet experience to encompass through mobility
• Internet of things	This phase is adding connectivity to objects & machines in the world around us to enable new services & experiences. It is connecting the unconnected.

Current challenges addressed by connected roadways.

Challenge.	Supporting data.
Safety:	According to the US department of Transpottition 5.6 milion cashs were 2012 alone.
mobility:	More than a billion cars are on roads worldwide connected vehicle mobility applications can enable system operators and drivers to make more informed decision.
Environment:	According to American public transportation association each year transit systems can collectively reduce dioxide emission.

9) List and briefly explain how the core IoT functional stack is being operated.

① "Things" layer: At this layer, physical devices need to fit the constraints of the environment in which they are deployed while still being able to provide information needed.

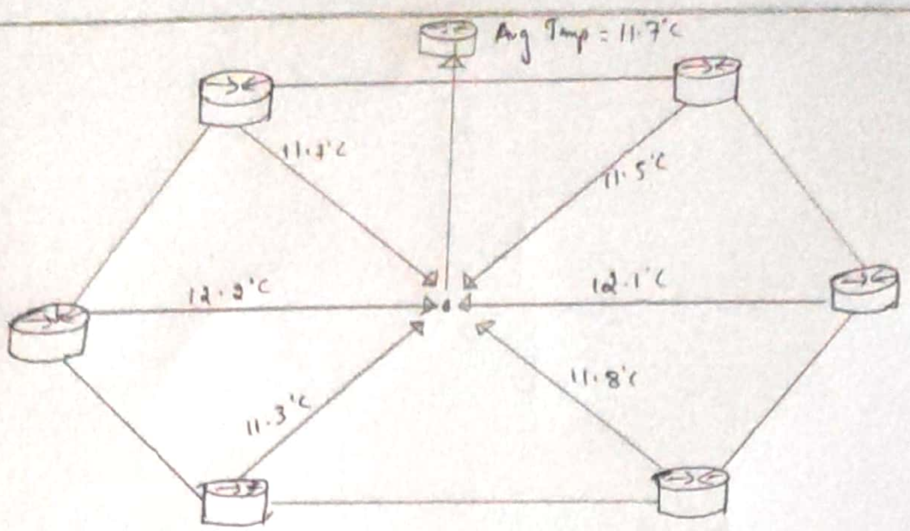
② Communications network layer: When smart objects are not self contained they need to communicate with an external system. ~~#~~ In many cases this communication uses a wireless technology. This layer has four sublayers

- Access network sublayer: The last mile of the IoT network is the access network this is typically made up of wireless technologies such as 802.11ah.
- gateways & backhaul network sublayer: A common communication system organizes multiple smart objects in a given area around a common gateway. The gateway communicates directly with smart objects.
- Network transport sublayer: For communication to be successful network & transport layer protocols such as IP & UDP must be implemented to support the variety of devices to connected media to use.
- IoT network management sublayer: Additional protocols must be in place to allow the headend application to exchange data with the sensors.

③ Application & analytics layer: At the upper layer an application needs to process the collected data, not only to control the smart objects when necessary but to make intelligent decisions based on information collected.

10) Illustrate the data aggregation function in wireless sensors networks & explain how smart objects are wirelessly connected.

→ In data aggregation for the the temperature readings from a logical grouping of temperature sensors are aggregated as an average temperature reading.



→ The data aggregation function are helpful in reducing the amount of overall traffic in WSNs. with very large numbers of deployed small objects.

→ This data aggregation at the network edges is where fog and mist computing are critical IOT architectural element needed to deliver the scale and performance required by so many IOT use cases.

I) Event driven: Transmission of sensory information is triggered only when smart object detects a particular event or predetermined threshold.

II) Periodic: Transmission of sensory information occurs only at a periodic intervals.