Unit - 2

2.1> Internet of Things: Concepts Introduction

2.1.1> Defn, Characteristics of IOT, Vision,

2.1.2> Trends in adoption of IOT

2.1.3> IOT Devices, IOT devices vs Computers,

2.1.4> Societal Benefits of IoT

2.1.5> Technical Building Blocks -

2.1.6> Physical Design of IOT :-

2.6.1> Things in IoT

2.6.2> Interoperability of IoT Devices

2.6.3> Sensors and Actuators

2.6.4> Need of Analog/Digital conversion

2.7> Logical Design of IoT :-

2.7.1> IoT functional blocks

2.7.2> IoT enabling technologies

2.7.3> IoT levels and deployment templates

2.7.4> Appns in IOT

2.1) Introduction to Internet of Things (IoT)

- The Internet of Things is the n/w of physical objs or "things" embedded with electronics, s/w, sensors, and n/w connectivity, which enables these objs to collect and exchange data.
- IoT allows objs to be sensed & controlled remotely across existing n/w infrastructure, creating opportunities for more direct integration bet^n the physical world.

2.1.1) Defn of IoT :-

Formal defn of IoT is "A dynamic global n/w infrastructure with self-configuring capabilities based on standard and interoperable comm^n protocols, where physical and virtual "things" have identities, physical attributes, and use intelligent interfaces, and are seamlessly integrated into information n/w that communicate data with users and environments".

2.1.2) Characteristics of IoT :-

Characteristics of IoT are :-

1) Dynamic & self-Adapting :-

- IoT devices should dynamically adapt themselves to the changing

contexts and scenarios.
- For example assume a camera for the surveillance.

2) Self configuring:-
- This is one of the most imp. characteristics of IoT. As per the requirement IoT devices can be capable of to upgrade the s/w with minimal intervent^n of use.

3) Interoperable communicat^n Protocols:
- IoT allows diff. devices to communicate with each other in diff. n/w. The IoT devices are connected to the n/w to share some info^m with other connected devices.

4) Unique Identity:-
- In IoT based system multiple "things" of same functionality are deployed.

5) Integrated into Informat^n n/w:-
- IoT devices are typically configured in such way that they can communicate with other devices in the IoT environment to create an info^m n/w

2.1.1.4) Internet of Things : VISION :-

- IoT describes a new world of billions of obj's that intelligently communicate & interact with each other.
- A following diff. examples describes the vision of IoT :-

1) Home Security :-

- The Internet of Things is the key driver behind a completely smart & secure home.
- IoT connects a variety of sensors alarms, cameras, lights, and microphones to provide 24/7/365 security.

2) Activity Trackers :-

- These sensor devices are designed to be worn during the day to monitor and transmit key health indicators in real time.

3) Digital twins :-

- In the manufacturing world, a digital twin is essentially an identical digital copy of a physical obj.

4) AR Glasses :-

- Google Glass is essentially a small, lightweight computer that worn like a pair of eyeglasses hands-free work.

Q.1.1.) Trends in adoption of IOT.

- Internet of Things is the next stage of the info^m revolut^n & refrenced the inter-connectivity of everything from urban transport to medical devices to household appliances.
- Integrat^n with the Internet implies that devices will use an IP address as a unique identifier.
- Objects in the IoT will not only be devices with sensory capabilities, but also probe actuation capabilities.
- on the other hand, IoT systems could also be responsible for performing actions, not just sensing things.
- Intelligent shopping systems, for example, could monitor specific user's purchasing habits in a store by tracking their specific mobile phones.
- Some of the emerging trend in development and deployment of IoT based appl^n's are mentioned below:-

1) Comm^n & co-operat^n
2) Addressability
3) Identificat^n

4) Embedded internet processing
5) Localization
6) User interfaces.

2.13) IOT Devices: -

IoT devices are the nonstandard computing devices that connect wirelessly to a nlw & have the ability to transmit data.

- Examples of IOT Device: -

1) Sensors: -

- IoT devices perform an i/p fun are commonly called sensors. They "sense" a physical change in some characteristic that changes in response to some excitation.
- A sensor is basically an electrical device. A sensor can be very small and itself can be a treatable device however.

- 2) Actuators: -

- Devices that perform an o/p fun are generally called actuators. Actuators are used to control some external device.
- Both sensors and actuators are collectively known as transducers b'coz they are used to convert

energy of one kind into energy of another kind.

- IoT devices vs Computers: —
- An IoT device and a comp. they are substantially different. The big difference betn IoT device & general purpose computer is that IoT device is a special purpose & they do a particular thing.
- Another diff. is that IoT devices the main fun of an IoT device is not to compute.
- A comp. is there to be a comp., to comp. fun, to run programs. But An IoT device, that is not its main point.
- Now, computational intelligence can help you, nlw connectivity can improve its ability, but that is not its main fun, to talk on the nlw.
- So computers are general purpose, they can do whatever you want. You grab something onto them; they can do what you want.

2.1.4) Social benifits of IOT:—

- IoT is currently turning into another revolution after the internet has hit the IT space.
- The general effect that IoT can have on social media is huge. In the context of social media, IoT will be able to distribute some of the most imp. benfits like,

1) Smart homes & cities can save the energy costs by controlling the electricity or temp. when one is away from home or work.
2) Smart health devices can improve health care by monitoring patients and remotely administering medicines to them.
3) Smart automobiles can require assistance if required or assist in monitoring vehicle speed based on traffic.
4) Tracking the behavior of consumers in real-time & increasing awareness on the citizens.

2.1.5) Internet of things - Technical Building Blocks -

- Now that we understand what the IoT is, IoT allows things in

the physical word to interact with the virtual world through a communication network.
- These devices or objects exchange & sharing of content awareness info with each other.

1) Sensors:-
- Sensors are the front end of the IoT devices. Sensors also called "Things" of the system.
- The main of sensor is task to get necessary data from surroundings & pass it further to database or processing systems.

2) Processors:-
- As computer and other electronic systems, processor are the brain of the IoT system.
- The main fun. of processor is to process raw data collected by the sensors & transforms them to some meaningful info & knowledge.
- Microcontroller, embedded h/w devices, etc can process the data using processor attached within the devices.

3) Gateways :-
- Main role of gateways is to route the processed data & transfer it to proper databases or new storage for proper utilizatn.
- For every IoT system commn & nlw connectivity are essentials.
- Examples of gateways are LAN, WLAN, PAN, etc.

4) Applns :-
- Applns are another end of an IoT system. Applns provide interface to users to interact with that data.
- Examples of appln are: smart home apps, security system control applns, etc.

If we summarize the elements of IoT then we can say that, the sensor collects the raw data & transfered to embedded processors.

2.1.6) Physical design of IoT :-

- The physical design of an IoT system is focus on the Things Devices & protocols that used to build an IoT system.
- Every device has a unique identity that performs remote sensing, actuating, and monitoring work
- The protocols that are used in IoT device to established comm' betn the Node devices and server over the internet.
- So the physical design of IoT is categorized into parts.
  (a) Things in IoT
  (b) IoT protocols

2.6.1) Things in IoT :-

- As we discussed earlier. that IoT devices which have unique identities that can perform sensing, actuating & monitoring capabilities.
- The process is done on collected data is either locally or send the data to centralized servers or cloud.

a) Sensor :-

- sensor is any physical

device that converts one form of energy into another. There are diff. types of sensors are available in market for example temp. sensor, humidity sensor, presence detector sensor etc so on.

b) Actuator:
- An actuator works in the reverse direction of a sensor. It takes an electrical i/p & turns it into physical action.
- For example, an electric motor, a hydraulic system, and a pneumatic system are all diff. types of actuators.

c) Controller or control center:-
- In this example, a sensor may collect info & sends info to a control center.
- The control center where a decision is made and a corresponding command is sent back to an actuator in response to that sensed i/p.

2.1.7) Interoperability of IoT Devices:-
- Oxford dictionary meaning of "Interoperability" is able to operate in conjuct". It means that two

Inter operable systems can understand one another and use the functionality of each other.
- IoT consist of a variety of devices, even more than the traditional Internet.
- The characteristics of IoT devices such as processor speed, RAM, comm^n technology, and battery capacity differ broadly between diff. brands and models.
- In some cases, the devices such as Smart TV, printers, air conditioners support traditional ubiquitous Wi-Fi technologies & 3G/4G cellular communications.
- Device interoperability refers to enabling the integration of interoperability of such heterogeneous devices with various comm^n protocols & standards supported by heterogeneous comm^n protocols.
Inter operability is the biggest challenged in IoT. As of now there is no common protocol or standard available that can accomplish the level of interoperability.

2.63) Sensors and Actuators :-

In previous sessn we already discussed about IoT devices that it sensor & actuator.

- Sensors :-
  - The ability to efficiently collect data start with the use of sensors.
  - Sensors are devices that collect i/p from the physical world & then transmit them for addl processing, or use them with artificial intelligence to make decisions.
  - For example if we consider Industrial Internet of Things, data collected from sensors is used to help business owners & managers make intelligent decisions.

Sensor Type (examples)	Sensor (Examples)
1) Environment, weather, moisture	Actinometer, bed wetting alarm, dew warning, fish counter, gas detector, rain sensor, tide gauge, snow gauge

Sensor Type (Examples)	Sensors (Examples)
2) Pressure	Barograph, barometer, boost gauge, bourdon gauge, pressure gauge, time-pressure gauge, McLeod gauge, ionizer gauge
3) Thermal, heat, temp.	Bolometer, bimetallic strip, calorimeter, exhaust gas temp. gauge, gardon gauge, golay cell, microwave

- Actuators :-
- An IoT device is made up of a physical obj. + controller + sensors + Actuator + N/ws.
- An actuator is a mic component or system that moves or controls the mechanism of the system.
- In simple terms, an actuator operates in the reverse direction of a sensor.
- It takes an electrical i/p & turns it into physical action.
- For example : an electric motor,

a hydrawic system, and a pneumatic system are all diff. types of actuators.
- The following fig. shows when actuator do; the controller directs the actuator based on the sensor data.

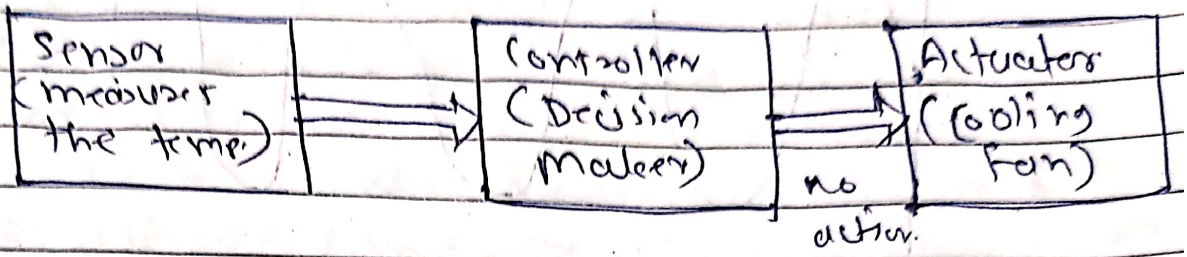


Fig. Working of IoT devices & use of Actuators.

2.6.4) Need of Analog/Digital Conversion:-
When we build IoT proj's using an Arduino or a Raspberry Pi, we use diff. sensors to obtain info regarding the physical world and based on that info we do some processing.
So, there are 2 types of sig. are used for comm^n.
1) Analog Signals
2) Digital Signals.

1. Analog Signals:-
- Analog signals are continuous signals which are time-varying.
- Analog signals represent in the form of sine waves and they can be defined by amplitude, frequency, and phase.

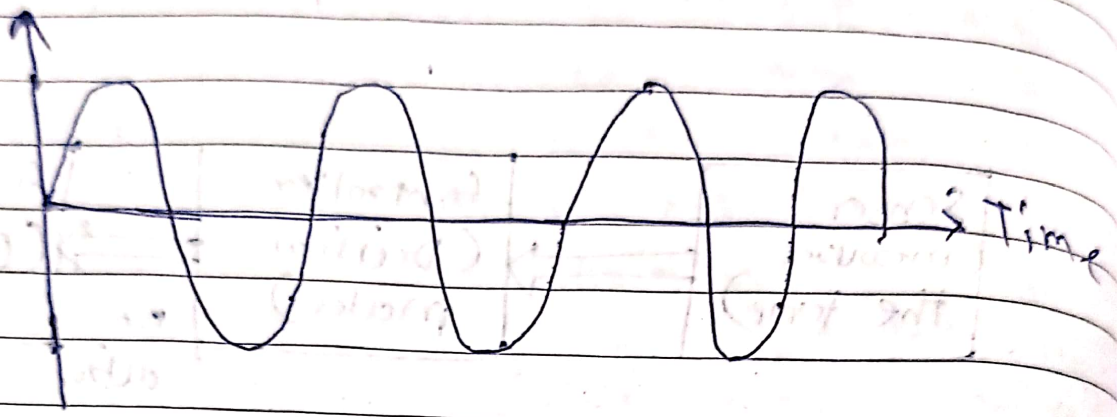


Fig. Analog Signals

- Amplitude represents the highest height of the signals, frequency represents the varying rate of the analog signals & phase represents the posⁿ of the signal in time.

2) Digital Signals:-
- Digital signals are a type of discrete signals which are time-varying. In digital signal the data is carried in the form

of binary number.
- Binary number can either carry a "0" or a "1".
- For example suppose we want turn on/off the switch, it sends out digital signals when pressing it to turn on while transmitting as a "1" and when pressed again to turn off while transmitting as a "0".
- Digital signals are normally defined by bit interval and bitrates. Bit interval is the required time to transmit one bit and bitrate is the frequency of the bit interval.
- Following fig. shows represented digital signal.

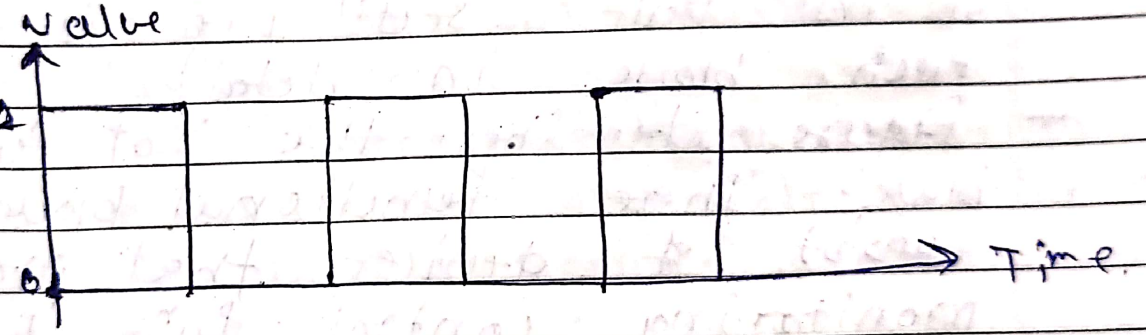


Fig. Digital signal

- We use analog sensors and communicate with a microcontroller. it is not possible for the microcontroller to directly understand these analog signals.

2.7> Logical design of IoT:-

Logical design of IoT system is abstract representation of the entities without going into details.

It consist of functional blocks that provide the system with capabilities identification, sensing, actuation, comm^n & mgmt.

2.7.1> IoT functional Blocks:-

- An IoT system consist number of functional blocks like devices, services, comm^n, security & appl^n. These blocks describe the functionality in IoT system so in this sect^n we will see each block in detail.
- Figure describes the IoT functional block. There functional blocks consist of devices that provide monitoring control fun^s, handle comm^n betn host & server, manage the transfer of data, secure the system using authentication & other fun^s, & interface to control & monitor various terms.

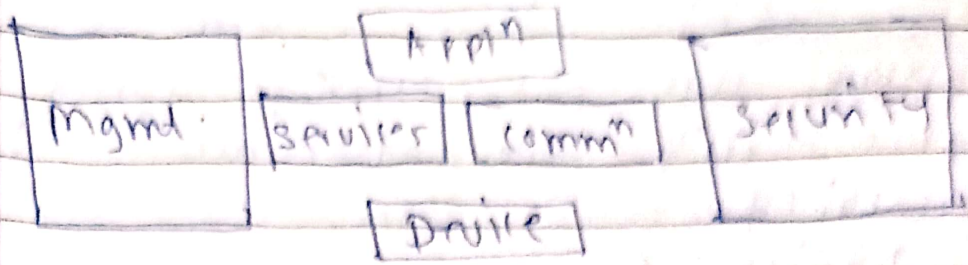


Fig. IoT functional blocks

1) Appln :-
This functional block is an interface to the IoT system. Appln provides a control system that use by users to view the states & analyze of system.

2) Mgmt :-
This functional block provide various fun's that are used to manage an IoT system.

3) Services :-
This functional block provid. some services like device monitoring, Device control services, Device discovery.

4) Commn :-
This block handler the commn betn the client and cloud based server using various protocol.

5) Security:-
This block is used to secure an IoT system using some fun like authorizn, data security.
6) Device:-
These devices are used to provide functionalities sensing, Actuatn, Monitoring.

2.7.2) IoT Enabling Technologies:-
- IoT is enabled by several technologies including wireless sensor n/ws, cloud computing, big data analytics.
- The following sectn. -
1) Wireless sensor n/w:-
- A wireless sensor n/w is a distributed device with sensors which are used to monitor the environmental & physical condn's.
- A wireless sensor n/w consists of end nodes, routers and co-ordinators.
- example:-
1) Weather monitoring system
2) Surveillance system
3) Health monitoring system
4) Soil moisture monitoring system.

2) Cloud computing :-
- Cloud computing means delivering appln & services over internet.
- Cloud computing makes provision of computing, networking.
- Characteristics :-
1) Broad nlw access
2) On demand self-services
3) Measured service.
4) Pay- per- use.

3) Big Data Analytics :-
- Big data is defined as coll^n of data sets whose volume, velocity, or variety, is so large that it is difficult to store, manage, process & analyze the data.
- eg. Sensor data generated by IoT systems such as weather monitoring stations, MIC sensor data collected from sensors embedded in industrial and energy systems for monitoring their health & detecting faults.

4) Embedded Systems :-
- An Embedded system is a comp. system that has comp. hlw & slw embedded to perform specific tasks.

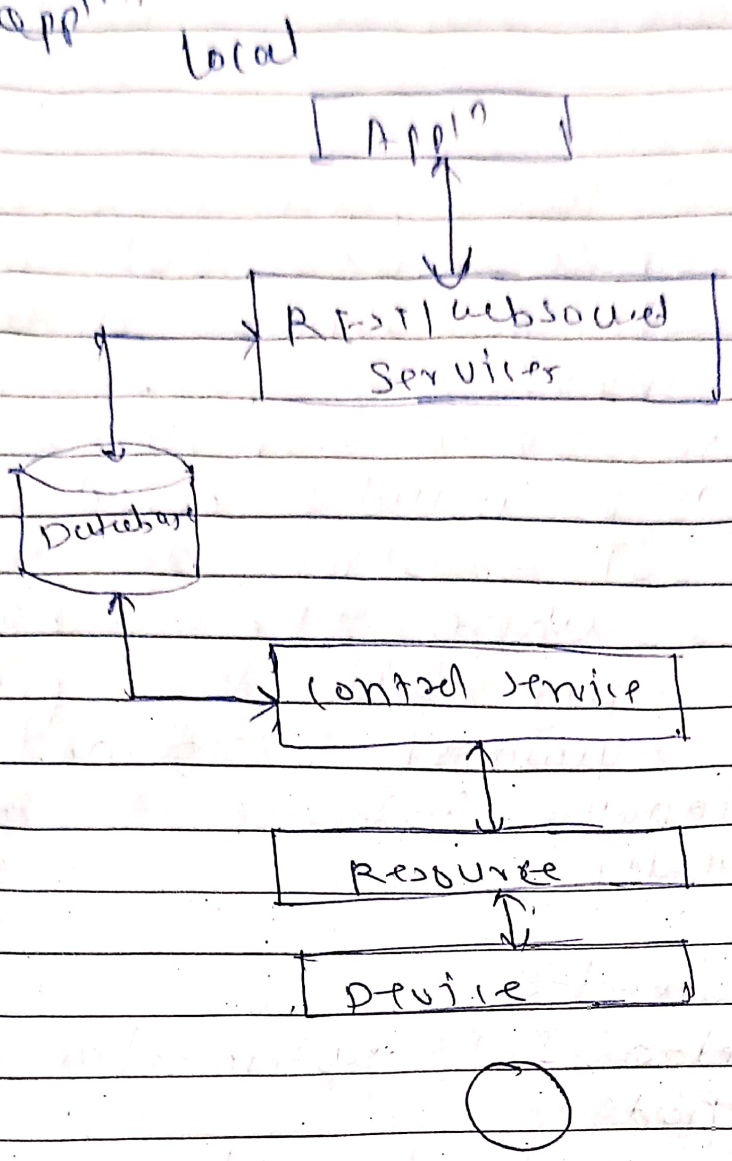
- Embedded system has specific processors such as digital signal processors, graphics processors & appln specific proc.
- Embedded systems run embedded operating system such as real-time operating systems.

5) Comm^n Protocol: -
- Comm^n protocol is main building of IoT system & enables the n/w connectivity.
- The sending & receiving of data is done through diff. levels of networking.

7.3) IoT levels & Deployment Templates: -
- There are basically 6 levels of IoT describes the scope of IoT appln.
- Some terms which are used for representation of IoT levels: - Device, controller service, Resource, Database, Web service, Appln.

4) IoT level-1: -
- level-1 IoT system consist of a single node/ device.
- Node/ Device performs sensing

and/or actuation, stores data, performs analysis & hosts the appln.



Monitoring Node.

Fig. IoT level-1.

- level-1 IoT systems are suitable for modeling low-cost and low-complexity solns.

- As shown in fig. a single node is used for sensing the data, storage & analysis.

2) IoT level-2 :-
- like IoT level 1, level-2 IoT system has a single node that also performs sensing and/or actuation & local analysis.
- Data is stored in the cloud & the appln is usually cloud-based.
- Level-2 IoT systems are suitable for solns where the data involved is big but the primary analysis requirement is not computationally intensive & can be done locally.

3) IoT level-3 :-
- A level-3 IoT system has a single node.
- Data is stored and analyzed in the cloud & the appln is cloud-based.
- level-3 IoT systems are suitable for solns where the data involved is big & the analysis requirements are computationally intensive.

4) IoT level-4:-

- A level-4 IoT system has multiple nodes. Nodes will perform local analysis.
- Application & cloud based data is stored in the cloud.
- Level-4 contains one additional node that is observer node.
- Observer node is local & cloud-based node which can subscribe to and receive information collected in the cloud from IoT devices.
- Level-4 IoT systems are suitable for solns where multiple nodes are required, the data involved is big and the analysis requirements are computationally intensive.

5) IoT level-6:-

- A level-6 IoT system has multiple independent end nodes that perform sensing and/or actuation and send data to the cloud.
- Data is stored in the cloud and the application is cloud-based.
- The centralized controller is aware of the status of all the end nodes and sends control commands to the nodes.

2.7.4 Appln in IoT:-

- IoT appln can be used in many ways to help business simplify, improve, automate, and control processes.

Applns:-

1) Smart Home is one of the most and the most practical appln of IoT. In smart home system different levels at which IoT is applied.

2) Agriculture:-

- Farming is one sector that will benefit the most from the Internet of Things. There so many development happening on how farmers can use IoT in agriculture.

3) Healthcare:-

- The use IoT sensors connected to patients, allows doctors to monitor a patients condition outside the hospital and in real-time.
- IoT helps to improve the care for patients and the prevention of dangerous events in high-risk patients.

4) Traffic Monitoring:-

- The Internet of things can be very useful in the mgmt.

of vehicular traffic in large cities, contributing to the concept of smart cities.

⇒ Environmental Mgmt: -

- The weather monitoring & environment monitoring are very imp. in agricultural sector.