Introduction of IOT :-

The IOT is the network of Physical objects. i.e; the devices, vehicles, building and other items embedded with electronics, software, sensors and network connectivity that enables these object the exchange data.

→ Taking everyday things embedded them with electronics, networks and sensors and then connecting to the internet and exchange data without human interpretation is called as the IOT.

History of IOT :-

→ IOT term was coined by Kevin Ashton (1999).
→ Carnegie mellon researcher connected a vending machine to internet to remotely check for
– cold soda in 1982.
→ In 1990, the first toaster was operated over net.
→ In 2000, LG introduced first smart fridge.
→ In 2004, First smart watch introduced.
→ In 2007, Apple smart i-Phone and Wearable Fibit was released.
→ In 2009, Google started testing self driven car.
→ In 2011, Sony introduced smart TV
→ In 2013, Google car was released.

Basic of IOT :-

The internet of things refers to the capability of everyday devices to connect the other devices and people through the existing internet infrastructure.

Characteritics of IOT

(i) Inter connectivity :-
Everything can be connected to the global information and communication infrastructure through IOT.

(ii) Heterogeneity :-
IOT have different hardware and use different network but they can still interact.

(iii) Things related service :-
IOT provides things the related services with in constraints of things, such as privacy and consistency b/w physical and virtual things.

(iv) Dynamic changes :-
The state of a device can change dynamically. thus the number of device can vary.

(v) Integrated into information network :-
IOT devices are integrated with network for communication purpose.

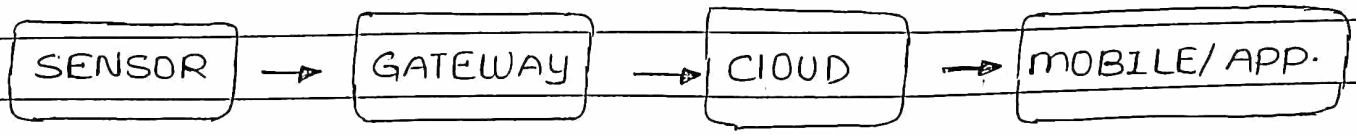
(vi) self adapting :- automatically modified.

(vii) self configuration

COMPONENTS OF IOT

(i) control units :-
A small computer single integrated circuit containing processor, memory and programmable input and output peripheral.

(ii) Sensor :-
Device that can measure a physical quantity and convert it into a signal, which can be read and interpreted by microcontroller unit.



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✳ NOTES :-

(i) Gateway take care of various wireless standard infrance.

↳ one gateway can control / handle multiple technology and multiple sensor.

(ii) cloud computing has the almost unlimited capacity of storage and processing power which is more mature.

WORKING OF IOT

ENVIRONMENT → INFORMATION → RECEIVER

(i) collect and transmit data :-
The device can sense the environment and collect information related to it and transmit it to a different device to the internet.

(ii) Actuate device based on trigger :-
it can be program for run the device based on condition.

(iii) Receive information

(iv) communication assistance.

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Advantages of IOT :-

(i) Improved customer engagement and communication.
(ii) support for technology optimization
(iii) Support wide range of data collection
(iv) Reduce waste.

Disadvantages :-

(i) loss of privacy and security
(ii) Flexibility :- many devices are attached at same time in one device.
(iii) complexity :- The IOT is diverse and complex network
(iv) compatibility.

How does IOT influence ?

a) People :-
more things can be monitored and controlled so people can become more capable.

b) Process :-
many complex task can be done in lesser time by colliborating more users and machine in real time.

c) Data :-
collection of data frequently and reliably which results in more precise decision making.

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Basic IOT system and its building block :-

↳ The four things from basic building blocks of the IOT system.

1. SENSOR :-

sensors are the front end of the IOT devices. These are so-called "things" of the system. Their main purpose is to collect data from its surroundings and give data to its surrounding.

↳ These have to be uniquely identifiable devi with unique IP address. so, that they can be easily identifiable over a large network.

↳ These have to be active in nature which means that they should be able to collect real time data.

2. PROCESSOR :-

Processors are the brain of the IOT system. Thier main function is to process the data captured by sensor.

↳ we can say that it gives intelligence to the data.

↳ Processors mostly work on real time basis and can be easily controlled by application.

↳ These are also responsible for securing the data.

↳ Embedded hardware devices, multicontroller etc.. are the ones that process the data because they have sensors attached to it.

3. GATEWAY :-

Gateway are responsible for routing the processed data and send it to proper location for its proper utilization.

↳ In other words, we can say that gateway helps into communication of data.

↳ It provides network connectivity to the data. Network is essential for any IOT system to communicate.

4. APPLICATION :-

Application are the another end of the IOT system.

↳ Application are essential for proper utilization of all the data collected.

↳ Applications are controlled by users and are a delivery point of particular services.

ENABLING TECHNOLOGIES

1. Cloud computing :-

↳ Cloud computing has almost unlimited capaci of storage and processing power which is a more mature technology.

↳ Cloud computing is a Pay per use model for enabling available conveineint on netwo access to a shared pool of configurable resources.

* Cloud computing services are offered to users in different forms.

a) Iaas :- Infrastructure as a service.

b) Pass:- Platform as a service.

c) Saas :- Software as a service.

2. Big data analytic :-

↳ A category of technology and service where the capabilities provided to collec store, search, share and analyze data which have the characteritics of high volume, velocity and variety.

Environment → Data collection → Data analysis → Data execution

3. Wireless sensor Network :-

↳ A wireless sensor is a network formed by a large number of sensor-nodes where each nodes is occupied with a sensor to detect physical phenomena such as light, heat, pressure etc.

4. communication Protocols :-

↳ Communication protocols are used as backbone of IOT system.

↳ it enables network connectivity and coupling to application.

↳ it also performs error correction and detection flow, data encoding etc.

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Q. what are the best solutions for IOT in python?

↳ some of best solutions for IOT in the python programming language are as follo

1. Python on Raspberry Pi :-
The primary objective of running Python on an IOT device that pops up in mind is grabbing the Raspberry Pi from the table.

↳ Python is pre-installed in the operating system, and the only objective left for us is to write the coding script. In this scenario, we can control the input/output ports on the expansion bar of the Raspberry Pi.

↳ There are controllers available in large variety of computing power and budgets we can choose these controllers for the IOT systems.

2. Python on pyboard :-
Another great solution for python in IOT devices is the Pyboard with STm32F405F micro controller.

↳ The pyboard is considered a compact as well as powerful electronics development board. it works on micro python. The pyboard connects to the pc through USB.

Actuators :-

↳ Actuators are the device which is capable for performing a physical action.

↳ Actuators interact with the world.

↳ Actuators are the interface between micro controller and the sensors.

↳ An actuators requires a control signal and a source of energy.

Q. What is Python ?
Python is a popular programming language. it was created by Guido van Rossum and released in 1991 at Netherlands.

↳ Python general purpose, high level programming.

* Why Python ?
i) simple and easy to learn.
ii) platform independent.
iii) Free and open source embedded support.

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Q. Why use python in the IOT?

↳ For many developers, python is considered as the language of preference in the market. it is simple to learn and has clean syntax and has large online community supporting it.

python becomes a great choice when it comes to IOT. we can either use it for the backend side of software development of devices.

ESP8266, ESP32 with micopython :-

↳ Another option could be using ESP8266 and ESP32 to run python. we have to create device based on the IOT with low power consumption, great capabilities, and integration with wireless WI-FI networks. more precisely, we can use micropython.

IOT SOFTWARE :-

↳ The software and the programming language on which IOT works uses very common programming language that Programmers use and already know.

↳ Embedded system have less storage and Processing Power, their language needs are different.

↳ IoT software encompasses a wide range of software and programming languages from general purpose languages like C and C++, Java and Python.

↳ C and C++ :- The C programming language has its roots in embedded system - it even got its start for programming telephone switches.

Structure of C Program.

Header :- # include <stdio.h>
main() :- int main()
variable decleration :- int a = 10;
Body :- Print F ("%d", a);
return :- return 0;

↳ C++ is the object - oriented version of C, which is a popular language for both linux os and Arduino embedded IoT software systems.

↳ Java - C and C++ are hardware specific, the code in JAVA is more portable.

↳ it is like write once and read anywhere language.

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PYTHON

↳ Python is an interpreted language, which is easy to read, quick to learn and quick to write.

↳ its use is slowly spreading to the embedded control and IOT world.

↳ Python is a power house of serving data heavy applications.

Q. what is an IOT platform?

A multi layer technology which is used to manage and automate the connected devices is known as the IOT platform.

↳ it is a service which helps you in bringing the Physical object online.

Types of IOT platform :-

1. IOT connectivity management platform :-

↳ IOT connectivity management platforms are name suggestion, centred around the networking component of IOT system.

↳ They provide users with the software, hardware and data directing necessary for keeping their device online.

2. IOT Device management Platforms :-
IOT Device management Platforms specialize in the grunt work involved with IOT devices. They ensure that everything is connected and secure, and keep your updated status.

3. IOT Cloud Platform :-
IOT Cloud Platforms provide users with the infrastructure required to create a IOT system.

4. IOT Application Enablement Platforms :-
IOT Application enablement Platforms are a one-size-fit that offers to users everything they need to get a IOT system off the ground.

5. IOT Advanced Analytic Platforms :-
IOT advanced analytic Platforms are a great solution for data driven IOT system.

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UNIT :- 02

IOT COMMUNICATION PROTOCOL

communications protocols are set of rules established between nodes to exchange information in safe manner.

main aspects of a communication protocol :-

1. speed or data rate :-
   The amount of information to be transmitted within a time duration.

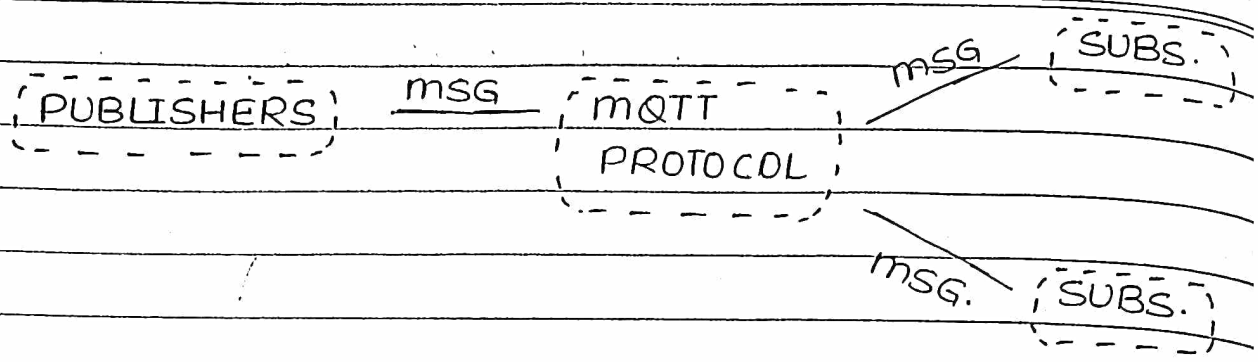
   ↳ it is usually expressed in bPS, kbPS, mbPS etc.

2. Range :-
   maximum distance between two intercommunicating nodes.

3. Power consumption :-
   The amount of energy that a nodes needs to work within its life time.

4. Interoperability :-
   The capability of exchange information between one device to another device, even if they are of different types.

5. scalability :-
   The challenge of deloying a higher numbers of nodes, increasing the number of end users etc.



MQTT :-

↳ message queing telemetry transport (MQTT) is a machine to machine protocols, that helps IOT devices communicate with each other, with minimal code requirement and network footprint.

↳ MQTT support messaging between one cloud device to other cloud device.

Q. Why MQTT protocol is important?

1. Lightweight and efficient :-
MQTT implementation on the IOT device requires minimal resources, so it can even be used on small micro controllers.

2. Scalable :-
MQTT implementation requires a minimal amount of codes that consumes very little power, in operations.

3. Reliable :-
many IOT devices connect over a unreliable cellular network at same time then MQTT built feature that reduce the time and IOT device takes to reconnect with the cloud.

4. secure :-
MQTT makes it easy for developers to encrypt messages and authenticate devices and user.

MQTT COMPONENTS :-

1. MQTT client :-
An MQTT client sends data to one device to another device from MQTT library.

↳ if the client is sending messages, it acts as a Publisher and if client is receiving messages it acts as a receiver.

2. MQTT broker :-
The MQTT broker is the backened system which co-ordinates / sends message between different clients.

↳ it is also responsible for other task authorizing and authenticating MQTT clients to Passing messages to other system.

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IOT LAW ENFORCEMENT APPLICATIONS

↳ To improve human existance, regulations enforcement applications securing people and make sure that they are in under protection.

some of important applications are :-

i) Traffic signals sensor / lesser congestions
ii) wearable for government officers.
iii) Drones for boarder Patrolling.
iv) IOT in courts.
v) Policing
vi) Detection of crime.

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↳ Define yourself.

BLUETOOTH LOW ENERGY (BLE)

Bluetooth low Energy is a family of short wireless range connectivity protocols.

↳ BLE is a technology that allows mobile devices and computers to establish Peer-to-Peer (जोड़ना) communication without requirement a Physical connection.

↳ BLE relies heavily on the Time Division multiple Access (TDMA) technique, which means that bluetooth device communicating by accessing a channel for fixed amount of time.

↳ BLE can communicate over few metres of distance (generally 10 metres).

BLUETOOTH LOW ENERGY APPLICATIONS :-

↳ BLE can used to connect IOT device to mobile devices.
↳ The BLE uses IOT device that do not have a Power source, such as sensor.
↳ BLE is suited to connecting low power devices.
↳ BLE has a range about 10 metres.
↳ The communication protocols is not suitable for wide ranges.

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Advantages of BLE :-

i) Low power consumption even we compared to other low power technologies.
ii) BLE achieves optimized and low power consumption by keeping the radio off.
iii) Quickly connected over short range.
iv) Available in chipest price compared to other similar technologies.

Limitations of BLE :-

a) Data throughput :-
The data throughout of BLE is limited by the physical radio data rate.

b) Range BLE :-
it was designed for short range application hence, its range of operation is limited.

c) Gateway requirement for internet connectivity
To transfer data from BLE, one device to another device through the internet by generating IP address.

ZIGBEE PROTOCOL

↳ The zigbee protocol is a wireless technology that is basically available in global standard to address the unique needs of low power, low cost wireless machine to machine networks.

↳ zigbee is personal network area group with low network group 4.

↳ it is a technology of home networking.
↳ zigbee is technological standard created for controlling and sensing the network.

↳ zigbee is personal area network of task group 4. so it is based on IEEE 802.15.4.

Types of zigbee Devices:-

i) zigbee coordinator device :-
it communicates with routers, the device is used for connecting the devices.

ii) zigbee router :-
it is used for passing the data between devices.

iii) zigbee End device :-
it is the device that is going to be controlled.

Characteritics of zigbee :-

- Low power consumption.
- Low data rate (20-250 Kbps)
- Short range (75-100 m)
- Network join time (30 usec)
- Support small and large networks.
- Low cost of product and cheap implementation.

Advantages :-

i) Design for low power consumption.
ii) Provide network security and application support.
iii) zigbee makes possible for home networks where all devices are able to communicate.

Disadvantages :-

i) Limited ranges :- zigbee is short ranged network compared to other wireless communication protocols.

ii) Limited data rate :- zigbee designed for low data rate application.

iii) Interoperability :- zigbee is not as widely adopted as other IOT protocols.

iv) Security :- powerful security.

LORA (Long Range)

↳ LORA is a Physical proprietary radio communication technique.

↳ it is based on spread spectrum modulations technique derived from chirp spread spectrum technology.

↳ it was developed by cycleo (Patent 9647718-B2) a company of Grenoble, France.

↳ LORA technology was designed for specifically for long range, low power communicate developed by a company called semtech and it is new wireless technology.

↳ LORA is mainly targeted for machine to machine and IOT NETWORKS.

↳ This technology is enable to connect a number of applications runnings on the same network.

↳ LORA was formed to standardize LPWAN (low power wide area network)

Features of LORA :-

Battery :- long battery life.
Frequency :- ISM 868/ 915 MHZ
modulation :- spread spectrum modulation
capacity :- 1 lora gateway takes thousands of nodes.

WI-FI (Wireless Frequencies / Fidelity)

↳ Wi-Fi stands for wireless Fidelity / Frequencies which enable the interconnectivity of many computers or Laptops.

↳ In other words, A way to connect internet from the access point to the computer or laptop.

↳ Wi-Fi is based on the IEEE 802.11 family of standards and is suitable for local area networking technology designed to provide in building broadband coverage.

Features of Wi-Fi :-

Network type :- LAN Technology
Standard :- IEEE 802.11
Communication direction :- Bi-directional
Frequency :- 2.4 GHz to 5 GHz
Power usage :- medium
Range :- up to 50m
Data rate :- 0.1 to 54 mbps
Topology :- Star, Tree, P2P
Connecting devices :- 4 to 8 devices at a time.

Advantages :-

i) cost effective
ii) convenient EXplanadibility
iii) Easy to use.
iv) Hassle - Free.

Disadvantages :-

i) micro / more Power consumption
ii) inconsistant and instable
iii) low level security
iv) low range Network.

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UNIT :- 03

SENSOR IN INTERNET OF THINGS.

↳ sensors are used for sensing things and devices etc.

↳ A device which provides a usuable output to response a specified measurement.

↳ The sensor attains a physical parameter that converts it into signal which is suitable for processing the characteritics of any devic

Characteritics of sensor :-

(i) Static characteritics :-

it is about how the output of a sensor changes response to an input changes after steady state condition.

(ii) Accuracy :-

Accuracy is the capability of measuring the instrument to give a result of close to the value of measured quantity.

(iii) Range :-

Range gives the highest and lowest value of physical quantity which the sensor can actually sense.

(iv) Resolution :-
Resolution is important characteritics towards selection of sensor.
The higher the resolution, better the Precision.

Dynamic characteritics :-

(i) zero-order system :-
In this system, the output signals show a response to the input signal with no delay. it does not include energy storing elements.

(ii) First-order system :-
In this system, the output signals show a response to the input signal with some delay and include some energy storing elements.

(iii) second-order system :-
complex output response.
The output response of the sensor oscillates before steady state.

Classification of sensor :-

- **Passive sensor :-**
  The sensor which can not independently sense the signals.
  Ex :- soil moisture, water level.

- **Active sensor :-**
  The sensor which can independently sense the signals.
  Ex :- Radar, sounder etc.

- **Analog sensor :-**
  The sensor which response the continous function of signals.
  Ex :- Temperature sensor, LDR etc.

- **Digital sensor :-**
  The sensor which response in binary. and design to overcome the disadvantages of analog sensor.

- **Scalar sensor :-**
  Detect the signals based on their magnitude only.
  Ex :- Temp, Gas.

- **Vector sensor :-**
  Detect the signals based on their magnitude as well as direction.
  Ex :- Accelorometer.

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TYPES OF SENSOR.

1. Electrical Sensor :-
Electrical sensor may be contact or non-cont
This sensor operate by making the sensor complete an electrical circuit.

2. Non-contact Electrical ~~signal~~ sensor :-
This sensors rely on the electrical Princip of induction for detecting motals and as well as non-metals signals.

3. Light sensor :-
Light sensor is also known as Photo sensor and one of the important sensor.

→ LDR is a simple light sensor available today.
→ The property of LDR is that its resistance is inversly proportional to the intensity of the ambient light.

4. Touch sensor :-
The detection of something by touch of finger known as touch sensor.

5. Range sensor :-
The sensor which detects the how signals near or far from the sensing position.

NODE MCU (micro controller unit)

The node mcu is an open source software and hardware development environment that is built around a very inexpensive system-on-chip (soc) called the ESP8266.

The ESP8266, designed and manufactured by espressif system that contains all crucial elements, of the modern computer.

↳ The ESP8266 is also hard to access and use, you must solder wires with the analog voltage, and its pins has simplest task such as Powering.

Specific-ation:-

↳ The most common modals of the node mcu are "the Amica."

Amica node mcu measures 49mm x 26mm with a standard pin space of "0.1 to 0.9 pins between rows."

↳ lolin node mcu measures 58mm x 32mm with a pin spacing of between "0.1 to 1.1" in rows.

lolin node mcu has wider pin spacing and larger board.

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Pins and Functions of Node mcu :-

a) Power pins :- There are four power pins. 1 VIN pin three 3.3 V pins.

NOTE :-

→ VIN can be used to directly supply of Node mcu and its peripherals. VIN pin is used for power delivered on the Node mcu module.

→ 3.3 pins are used for voltage regulators and used to power supply to the external components.

b) GND :-

GND are the ground pins of Node mcu.

c) I2C pins :-

I2C pins are used to connect I2C sensors and peripherals. Both I2C master and I2C slave are supported.

→ I2C pins is realized functionally and maximum at clock frequency 100KHz.

d) GPIO pins :-

Node mcu has 17 GPIO pins which can be assigned to function such as I2S, I2C, PWM, LED light etc.

Each GPIO pins enables to configurate the internal pull-up or pull-down impedence.

e) UART Pins :-

Node mcu has 2 UART pins which provide communication (RS232 and RS485) and can communicate up to 4.5 mbps.

F) SPI pins :-

Node mcu has 2 SPIs pins (SPI or HSPI) in slave and master modes. which has following Features :-

i) 4 times modes of SPI Format transfer up to 80 MH2 and the divided clocks of 80 MH2.

g) PWM pins :-

The board has 4 PWM (Pulse width modulation) pins, which is used for driving digital motors and LEDs.

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IOT DEVELOPMENT BOARD

A development board is printed circuit board containing circuitry and hardware for experimenting with micro controllers, micro-processors or other complex integrated circuits.

→ Development board contains buttons, switches, output components such as LEDS, various input / output pins etc.

Catogory of Development Board :-

① Micro-controller based board :-
These boards are comprised of small compute These are premarily used in office machine, Power tools, automotive control sys etc

② System-on-chip (SOC) boards :-
It have more system components integrated into chip and have memory, audio recelverg and USB communication abilities etc.

③ Single Board computers :-
It contains the all features of a computer on a single device, including I/O ports, microprocessors and Memory.

Important Features of development board:-

① connectivity support
② processing power
③ memory
④ peripheral capabilities.

WIRELESS NETWORK.

Wireless Technology is a method of connection within an IOT system that includes sensors, platforms, routers, applications and other systems Each options has trade off between power consumption, bandwidth and Range.

Types of wireless Network:-

① Cellular → best reliable broadband communication that support everything from streaming application to voice calls.

② Bluetooth
③ WiFi } Define yourself.

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UNIT :- 04

API (Application Programming Interface)

↳ API is an interfacing software platform that allows the exchange of any information or data, the interaction among different applications

↳ Google map, twitter, Facebook are new example of APIs which is used in our day to day life.

* Open APIs :-
Open APIs are also known as Public APIs. it is available to general Public and has noany restrictions to access.

* Partner APIs :-
Partner APIs are similar to Open APIs but there is some license or right are required to access the API.
These are controlled by third party gateway APIs.

* Internal APIs :-
↳ Internal APIs are also known as Private APIs.
↳ These are designed for internal use within an organization or the company.
↳ This has better security and is not available for Public use, only a internal system can access them.

* Composite APIs :-

↳ composite APIs are used for provide different services APIs in one place.

↳ it helps the speed up the process and improve the performance of everything which is available at single place.

ROLE OF API IN IOT

↳ API is the set of protocols, routines, and tools to create software application, and it specifies how software component must interact.

↳ in API, developers can create context-base apps that intract with the real world.

@ For achieving IOT, multiple type of APIs are needed for all devices. This allows data flow over the internet protocol for managing authorization.

↳ API help the developers to create applicatio that can integrate with web services and mobile applications.

↳ APIs are time saver and offer convenien to end users for logging in or out to the devices.

TYPES OF APIs

1. SOAP (Simple Object Access Protocol) :-

↳ It is much complex API but also well defined in term of security.

↳ Banking transaction or any other application that needs higher security then SOAP API is used.

↳ it can allow any style of programming which is based on wide range of protocols such as HTTP, SMTP, XML etc.

↳ it is a protocol that defined a communication protocol between server and client.

2. REST (Representation state transfer) :-

↳ REST is type of API which helps in communication of your electronic device with the world.

↳ it is one of the most popular web used APIs. The interface has nothing to do with storage of Backend.

↳ certain features are required for using this API such as resources identification, services interface and also manipulate the specific interface.

↳ it is the client - servor communication based on URL and HTTP protocols.

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3. JSON-RPC (Javascript Object Notation - Remote Procedure calls)

↳ It has one of the best request efficeincy. thus it uses JSON formatting

↳ it is much reliable and simple to use and has popular programming language such as JAVA, script, PHP, ruby etc.

↳ it ~~has~~ is human readable as well as machine readle and they are designed as such way that they are called methods.

↳ JSON is ~~the~~ older method compared to SOAP.

4. XML-RPC (Extensible markup Language - Remote Procedure calls)

↳ This is much similar to JSON-RPC, but ~~has~~ here xml is used for formatting of data.

↳ it is much simpler and uses minimum bandwidth. while REST performs basis on resources but it depend on the actions.