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Connecting everday things embedded with electronics, software, and sensors to internet enabling to collect and exchange data without human interaction is called as IOT.

The term things refers to anything and everything in day to day life which is accessed or connected through the internet.

The system created by IOT has greater transparency, control and performance

IOT means accessing and controlling daily usable equipments and devices using Internet

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What is IOT?

The Internet of things describes the network of physical objects (things) ~~For example~~ that are embedded with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

The term IOT ~~was~~ were coined by computer scientists Kevin Ashton in 1999. At that time Ashton proposed RFID chips products to track them through a supply change and the project was funded by company. procter & Gamble P&G. With more than 7 billion connected IOT devices today experts are expecting this number to grow by 22 billion in 2025.

Advantages of IOT

1) Increasing productivity and efficiency of business operations.

2) Easily connecting the physical business world to the digital world to drive quick time to value.

IOT interact and communicate with each other and do lot of task for us, then they maximize the human effort as well as it saves alot time.

3) Driving data driven insids from IOT data to help better manage the business.

4) Creating new bussiness models and revenue streams

Enhance data collection

Reasons of IOT acceptance

1) Connectivity: Connectivity is required between sensors to the cloud and to the other things for efficient data transfer

2) Access to low cost and lower power sensor technology

3) Cloud computing platform

4) Machine learning and Analytics

5) Use of AI in sensor generated data

Disadvantages

As IOT systems are interconnected and communicate over networks, it can be lead by the various kinds of network attacks.

IOT system provides substantial personal data in maximum detail.

The designing, developing and maintaining and enabling the large technology to IOT system is quite complicated.

Historical development of IOT

ARPANET was the first connected network granddad of the Internet. The history of IOT starts with ARPANET

In 1982, a graduate student in Carnegie Mellon University's computer science department, David Nichols, wanted to know if the department's coke vending machine had cold soda bottles. He was tired of going to the machine only to find there was no cold bottle available; the vending machine was quite some distance from his classrooms so, he wanted to have information beforehand.

He was helped by his two fellow friends (students), a research engineer at the university. The code they wrote could check if coke was available in the vending machine, and if yes,

whether it was cold or not. Anyone on the university ARPANET could monitor the status of the coke vending machine

In 1989 Tim Berners Lee proposed the framework of world wide web, which laid the foundation of the Internet.

In 1990 John Romkey developed a toaster that could be turned on and off over the Internet. This toaster is considered to be the first IOT device - the first "thing" that began Internet of things.

In 1993 the Trojan Room Coffee Pot was built.

In 1999 Kelvin Ashton coined the term of IOT in his presentation of P&G

In 2008 first IOT conference was held in Zurich.

10 remarkable IOT projects

Managing traffic
The highway agency measures traffic flow on Britain's roads by tapping into driver's phone GPS. If traffic stalls, the agency instantly knows there's a problem. Relying on traffic updates on the radio now seems positively prehistoric.

Fixing Lifts
ThyssenKrupp worked with Microsoft and CGI to create an IOT monitoring system for each lift shaft. Technicians now use real-time data to determine repair needs, examine diagnostics and move elevators using an app. In case of malfunction, an error message is transmitted automatically, cutting repair time.

Catching Burglars
The app includes motion detection, which sends an alert msg to ur personal phone. You can then watch the video and see what is happening.
- Manything app - home security camera
- woman Arizona caught a thief by supplying footage to the police

Caring for your dog
A device is a lightweight device which attaches to the dog's collar and works like a fitbit device. Measuring activity, location and sleeping patterns.

Winning Gold at Rio 2016
Jeo Pavey, European 10,000m champion uses SHS BioSport heart-rate earphones combined with the Runkeeper app.
It can forgo the usual chest strap, compiles speed & route via GPS then reports back to a web-accessible analytics interface

Weather Reporting Systems
It gives weather forecasts in the surrounding areas. The system collects information from the temperature, humidity, and rain sensors and reports statistics online with the help of the Internet.

Facial Recognition Bot
It can recognize different faces of the people and voices to identify unique voices.

Smart Agriculture System
It helps in performing and monitoring lots of farming tasks. With sensors we can automatically irrigate a chunck of land.

Health monitoring System
It allows the user to track all the vitals of the body.

Smart Cradle System
With its help, parents can keep a check on the infant from far.

Applications of IOT
It has a wide range of domain including homes, cities, environment development, retail, logistics, agriculture and health and many more.

Health and safety - (IOMT)
Agriculture - smart irrigation, farming, greenhouse control
Smart cities - smart traffic lights.
smart parking
Environment -
Energy - electricity
Retail - inventory management, smart vending machine

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Logistics - route generation & scheduling, fleet tracking, shipment monitoring and remote vehicle diagnosis.

Smart home industry - Indoor air quality monitoring

Physical Design of IOT

The physical design of an IOT system is referred to as the things / devices and protocols that are used to build an IoT system all these things / devices are called Node devices and every device has a unique identity that performs remote sensing, actuating and monitoring work and the protocols that are used to establish communication between the Node devices and servers over the internet.

Things | Protocols

Things / Devices

Things / Devices that are used to build a connection, process data, provide interfaces, provide storage and provide graphics interface in an IOT system all these generates data in a form that can be analyzed by an analytical system and program to perform operations and used to improve the system.

Connectivity	Processors	Audio/Video Interfaces	I/O Interfaces (for sensors actuators etc)
USB Host RJ45 / Ethernet	CPU	HDMI 3.5mm Audio RCA Video	UART

Memory Interfaces	Graphics	Storage Interfaces	SPI
NAND/NOR DDR1/DDR2/DDR3	GPU	SD MMC SNO	I2C CAN

Connectivity

Devices like USB hosts and Ethernet are used for connectivity b/w the devices and the servers.

Processor

A processor like CPU and other units are used to process the data then data are further used to improve the decision quality of an IoT system

Audio / Video Interfaces

An interface like HDMI and RCA devices is used to record audio and videos in a system

Input / Output Interfaces

To give input and output signals to sensors, and actuators we use things like UART, SPI, CAN, etc

Storage Interfaces

Things like SD, MMC and SDIO are used to store the data generated from an IoT devices.

Other things like DDR and GPU are used to control the activity of an IoT system.

(4) IoT Protocols

These protocols are used to establish communication between a node device and a server over the internet, it helps to send commands to an IoT devices and receive data from an IoT device over the internet. We ~~can~~ use different types of protocol that are present on both the server and client-side and these protocols are managed by network layers like application, transport, network, and link layers

Application Layer			
HTTP	CoAP	WebSockets	
MQTT	XMPP	DDS	AMQP

Transport Layer	
TCP	UDP

Network Layer		
IPV4	IPV6	6LOWPAN

Link Layer		
802.3 (Ethernet)	802.16 (WiMax)	2G/3G/LTE (Cellular)
802.11 (WiFi)	802.15.4 (LR-WPAN)	

(1) Application Layer Protocol

In this layer, protocols define how data can be sent over the network with the lower layer protocols using the application interface. These protocols include HTTP, WebSocket, XMPP MQTT, DDS and AMQP protocols.

- HTTP

HyperText Transfer Protocol that presents in an application layer for transmitting media documents. It is used to communicate between web browsers and servers. It makes a request to a server and then waits till it receives a response and in between

the request server does not keep any data between two requests.

- WebSocket
This protocol enables two way communication between a client and a host that can be run on an untrusted code in a controlled environment this protocol is commonly used by web browsers.

- MQTT
It is a machine to machine connectivity protocol that was designed as a publish subscribe messaging transport and it is used for remote locations where a small code footprint is required.

② Transport Layer
This layer is used to control the flow of data segments and handle the error control also these layer protocols provide end to end message transfer capability independent of the underlying network.

- TCP
The transmission control protocol that

defines how to establish and maintain a network that can exchange data in a proper manner using the internet protocol

- UDP
a user datagram protocol is a part of an internet protocol called the connectionless protocol. This protocol is not required to establish the connection to transfer data.

③ Network Layer
This layer is used to send datagrams from the source network to the destination network. We use IPv4 and IPv6 protocols as host identification that transfers data in packets.

- IPv4
This a protocol address that is unique and numerical label assigned to each device connected to the network. An IP address performs two main functions host and location addressing. IPv4 is an IP address that is 32-bit long.

- IPv6
It is a successor of IPv4 that uses 128bit

for an IP address. It is developed by the IETF task force to deal with long-anticipated problems.

(4) Link Layer
Link layer protocol are used to send data over the network's physical layer. It also determines how the packets are coded and signaled by the devices.

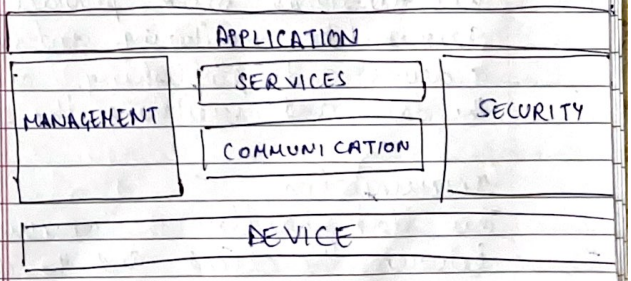
Ethernet
It is a set of technologies and protocols that are used primarily in LANs. It defines the physical layer and the medium access control for wired ethernet networks.

Wifi
It is a set of LAN protocols and specifies the set of media access control and physical layer protocols for implementing wireless local area networks.

Logical Design of IoT
The logical design of an IoT system refers of an abstract representation of entities and processes without going into the low-level specifics of implementation. It uses functional blocks, communication models, and communication APIs to implement a system.

The logical design constitutes of
- IoT functional blocks
- IoT communication Model
- IoT communication APIs

(2) IoT Functional blocks
An IoT system consists of a number of functional blocks like Devices, services, communication, security, and application that provide the capability for sensing, actuation, identification, communication, and management.



These functional blocks consist of devices that provide monitoring control functions, handle communication between host and servers, manage the transfer of data, secure the system using authentication and other functions and interfaces to control and monitor various terms.

Application
It is an interface that provides a control system that use by users to view the status and analyze of system.

Management
This functional block provides various functions that are used to manage an IoT system.

Services
This functional block provides some services like - monitoring and controlling a device and publishing and delting the data and restoring the system.

Communication
This block handles the communication between the client and the cloud-based servers and sends/receives the data using protocols.

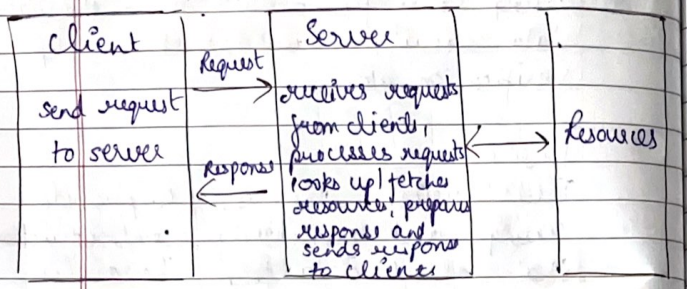
Security
This block is used to secure an IoT system using some functions like authorization data security, authentication, 2-step verification, etc.

Device
These devices are used to provide sensing and monitoring control functions that collect data from the outer environment.

(4) IoT Communication Models
There are several different types of models available in an IoT system that is used to communicate between the system and server like the request-response model publish-subscribe model, push-pull model, exclusive pair model, etc.

- Request-Response Model
This model is a communication model in which a client sends the request for data to the server and the server responds according to the request

When a server receives a request it fetches the data, retrieves the resources and prepares the response, and then sends the data back to the client

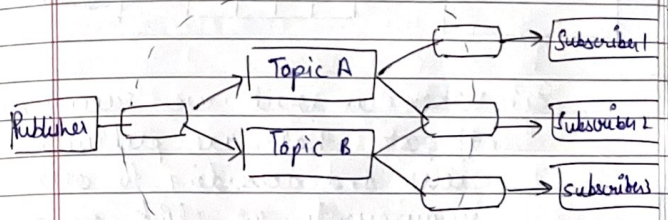


In simple terms, we can say that in the request-response model server send the response of equivalent do the request of the client in the model, HTTP works as a request-response protocol between a client and server.

Eg: When we search query on a browser then the browser submits an HTTP request to the server and then the server returns a response to the browser (client)

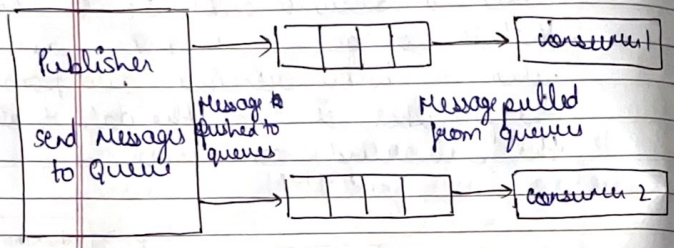
- Publish-Subscribe Communication Model

In this communication model, we have a broker between publisher and consumer. Here publishers are the source of data but they are not aware of consumers. They send the data managed by the brokers and when a consumer subscribes to a topic that is managed by the broker and when the broker receives data from the publishers it sends the data to all the subscribed consumers.



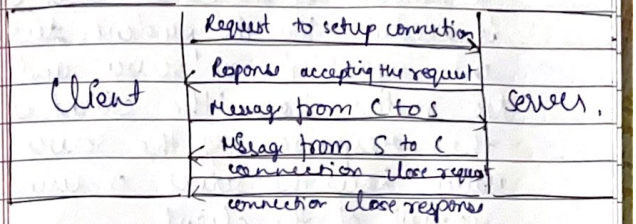
Eg: On the website many times we subscribed to their newsletters using our email address. These email addresses are managed by some third-party services and when a new article is published on the website it is directly sent to the broker and then the broker sends these new data or posts to all the subscribers.

- Push-Pull communication Model
It is a communication model in which the data push by the producers in a queue and the consumers pull the data from the queues. Here also procedures are not aware of the consumers



Eg: when we visit we saw a number of posts that are published in a queue and according to our requirements, we click on a post and start reading it.

- Exclusive Pair communication Model
It is a bidirectional fully duplex communication model that uses a persistent connection between the client and server. Here first set up a connection between the client and the server and remain open until the client sends a close connection request to the server.



(AE) IOT communication APIs
These APIs like REST and WebSocket are used to communicate between the servers and system in IoT.

REST-based communication APIs
Representational state trasfer (REST) API uses a ~~tot~~ set of architectural principles that used to design web services. These APIs focus on the systems' resources that how resource states are transfered using the request-response communication model. This API uses some architectural constraints.

- Client-server
Here the client is not aware of the storage of data because it is concerned about the server and similarly

the server should not be concerned about the user interface because it is a concern of the client. This separation is needed for independent development and updating of server and client No matter how the client is using the response of the server and no matter how the server is using the request of the client.

- Stateless
It means each request from the client to the server must contain all the necessary information to understood by the server because if the server can't understand the request of the client then it can't fetch the request data in a proper manner.

- Cacheable
In response, if the cache constraints are given then a client can reuse that response in a later request It improve the efficiency and scalability of the system without loading the extra data.

A RESTful web APIs is implemented using HTTP and REST principles.

WebSocket based communication API
This type of API allows bi-directional full-duplex communication between server and client using the exclusive pair communication model. This API uses full-duplex communication so it does not require a new connection setup every time when it requests a new data. WebSocket API begins with a connection setup between the server and client and if the WebSocket is supported by the server then the client can send data to each other in full duplex mode.

This type of API reduces the traffic and latency of data and makes sure that each time when we request new data it cannot terminate the request.