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Internet of Things: A survey on Architecture, Gateways, Communication models and Careers

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Abstract

The Internet of Things (IoT) is having a significant impact on our daily lives across a wide range of areas, from small wearable devices to big industrial systems. As a result, various IoT frameworks have been used to design and deploy a wide range of IoT applications. The goal of this paper is to present an overview of the Internet of Things, architectures, and critical technologies, as well as their applications in our daily lives.

Keywords : Sensor, IOT devices, gateways

1.IoT as a paradigm

With the internet as its backbone, the Internet of Things (IoT) has become one of the most powerful technologies of the modern era. The Internet of Things, or IoT, is a technology that allows actual items to connect with one another. In layman's terms, the "Internet of Things" is a technology that uses the internet to communicate between humans and machines or machines to machines.
Because the term "things" refers to these devices or physical objects, it's crucial to know what kinds of objects can be connected via the Internet. We can categorise these things into categories, as indicated in Fig 1.

1. Intelligent objects, also known as Smart Objects
2. Non-Smart Objects are objects that lack intelligence**.**

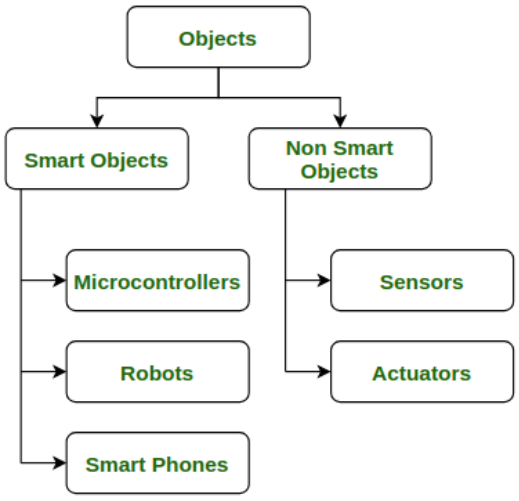

Fig1- IOT Objects

1.1 Smart Objects

Smart objects, as the name implies, are objects that have some intelligence. Now that the world has altered enough, our ordinary items can communicate, react, and identify other objects in response to their surroundings.In any framework, the primary principle of IoT is to eliminate human contact, and smart things meet this criterion to a large extent..As a result, Smart Objects are referred to as IoT building

blocks.Smart items and the Internet of Things (IoT) are like two wheels on a car that work together to accelerate our modern infrastructure's vehicle (JeffinGracewell, J, Pavalarajan, S ,2019).

Features of Smart Object
As shown in Fig 2, smart objects have some specific characteristics that are required to classify a physical thing as a smart object.These characteristics will be discussed further down.

Physical Shape
Because the term "object" refers to something with a physical shape or size, each Smart Object must have these physical characteristics in order to be deployed in the infrastructure.

1. **Unique Identifier**
   Smart Objects should have a distinct identity that allows them to be recognised in the infrastructure.It's something that distinguishes one object from others. Humans employ this form of physical identity to help them reason.
2. **Communication Capabilities**
   It must be able to communicate in order to send and receive data over the internet or other networking technologies.
3. **Unique Name and Address**
   The terms name and address refer to the object's networking address, such as an IP address, which is used for communication.In the entire internet infrastructure, the address should be unique.Humans, on the other hand, utilise the name for logical objectives.
4. **Processing Powers**
   Smart Objects have some basic computing and processing capabilities that allow them to make decisions in response to their surroundings.
5. **Sensing Capabilities**
   It must have certain sense capacities in order to be aware of its surroundings (Pressure, toxic gasses, temp. etc).

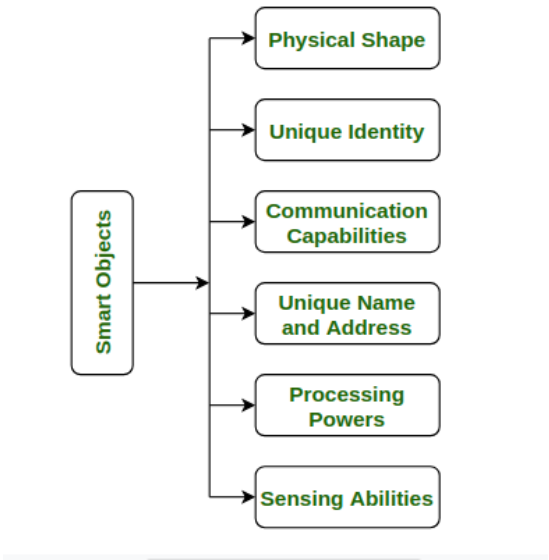

Fig 2 -Features of Smart Objects

Examples :
In our daily lives, we are surrounded by smart objects. We all have our smartphones in our pockets, for example.Smart refrigerators, smart TVs, and Alexa voice assistants are examples of modern smart items that we utilise in our daily lives.Microcontrollers, such as Arduino, are widely used (Prasanth.A, .Pavalarajan.S ,2019)

1.2 Non-Smart Objects :
The term "non-smart object" refers to objects that lack intellect and processing skills. Non-smart devices include sensors and actuators.

1. **Sensors :**
   Sensors are electronic devices made up of sensitive cells that may detect or sense a physical or scientific quantity such as temperature, pressure, or the concentration of a poisonous chemical, among other things.
   - **Actuators :**
     Actuators are electrical devices that collect data from sensors or similar sensors through the internet to accomplish a certain activity.Actuator can be divided into two sections.
   - **Mechanic Actuators –**
     These are actuators that carry out a task on themselves or on another item
   - **Actions –**
     An object carries out actions.Vibrations are similar to sending e-mails.

We can simply classify the objects in the Internet of Things using this approach.We can now see how smart things and the Internet of Things can be used to create complex applications since they allow us to communicate without the need for human intervention (Pavalarajan.S and Vincent Antony Kumar.A ,2013).This is especially significant in situations where human presence is not always available.

2. Communication Models in IoT

IoT devices are omnipresent, and in the future, they will enable circulatory intelligence.Understanding how multiple IoT devices communicate with one another is vital and valuable for operational perception.IoT communication models are quite valuable (SinghD, TripathiG, JaraAJ, 2014).People and things can be connected at any time, in any place, with anything and anybody, via any network and service, thanks to the Internet of Things.

Types of Communication Model :

2.1. Request & Response Model

A client-server architecture is used in this paradigm.

- When necessary, the client requests information from the server.This type of request is frequently encoded.
- Because the data between requests is not kept and each request is processed independently, this paradigm is stateless.
- The server classifies the request and retrieves the requested information from the database and its resource representation.
- In the Request-Response communication model, on the other hand, the client submits a request to the server, and the server responds. When the server receives the request, it determines how to react, retrieves data and resources, and prepares and sends the response to the client.

2.2. Publisher-Subscriber Model

Publishers, Brokers, and Consumers are the three entities that make up this model..

- Data is gathered from publishers. It transmits the information to the broker-managed topics.
- Consumers subscribe to the topics that the broker manages.
- As a result, brokers must receive data from publishers and distribute it to the relevant customers.The broker only possesses knowledge about the customer to whom a specific issue pertains that the publisher is ignorant of.

2.3. Push-Pull Model

Data publishers, data consumers, and data queues make up the push-pull model.

- Consumers and Publishers are completely unaware of each other
- The message/data is published and pushed into the queue by the publishers.
- On the other hand, the data is pulled from the queue by the consumers.
- When there is a discrepancy in the rate of data push or pull on the publisher and consumer sides, the queue works as a buffer for the message.
- Queues aid in the separation of producer and consumer messages. Queues also serve as a buffer in cases where the rate at which the producers push data and the rate at which the consumers pulldata differs.

2.4. Exclusive Pair Model

- The bi-directional Exclusive Pair paradigm includes full-duplex communication between client and server.
- The connection is continuous and remains open until the client sends a request to close it..
- The server keeps track of all the connections that have been established.
- The server is aware of all open connections because this is a state-full connection architecture.
- This paradigm underpins the Web Socket-based communication API.

3.Internet of Things Architecture

The Internet of Things (IoT) technology has a wide range of applications, and its use is rapidly increasing (U J, Kim M, Bang HC, Bae SH, Kim SJ ,2016).It functions according to how it was designed/developed, depending on the many Internet of Things application areas. However, it lacks a well-defined working architecture that is universally followed (Gubbi J, Buyya R, Marusic S, Palaniswami M, 2013). The architecture of the Internet of Things is determined by its usefulness and application in various industries. Even yet, the Internet of Things is constructed on a basic procedural flow. So, in this essay, we'll go through the core architecture of the Internet of Things, as depicted in the .Fig 3.

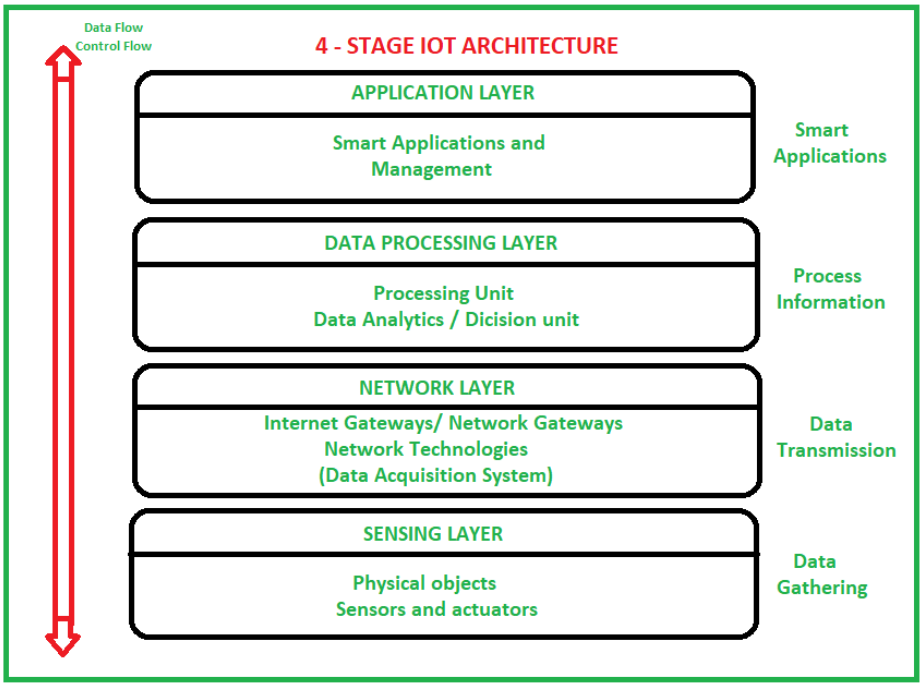

Fig 3 - Architecture of IOT

So, as shown in Fig. 3, there are four levels present, which may be split into four categories: sensing layer, network layer, data processing layer, and application layer (A. Prasanth, M.Karthihadevi, Pavalarajan.S, G.Sasi ,2019).These are explained in the next paragraphs..

1. **Sensing Layer –**
   This Sensing layer contains sensors, actuators, and devices.These sensors or actuators take in data (physical/environmental characteristics), process it, and then send it out via the network..
2. **Network Layer –**
   This layer contains Internet/Network gateways and Data Acquisition Systems (DAS).DAS is in charge of data aggregation and conversion (Collecting data and aggregating data then converting analogue data of sensors to digital data etc).Advanced gateways, in addition to providing a connection between sensor networks and the Internet, also provide numerous fundamental gateway functions such as virus protection and a firewall.
3. **Data processing Layer –**
   This is the IoT ecosystem's processing unit.Data is evaluated and pre-processed here before being sent to a data centre, where it is accessed by software applications, also known as business apps, which monitor and manage data and prepare subsequent actions (Ray PP ,2016).As a result, edge IT, or edge analytics, enters the picture.
4. **Application Layer –**
   This is the final stage of the IoT architecture's four stages.Data centres, also known as cloud computing, are data management centres where data is handled and used by end-user applications such as agribusiness, health care, aerospace, farming, and defence..

4.Gateways for the Internet of Things (IoT)

Gateways operate as a channel to connect cloud and controllers (sensors and devices) in the Internet of Things (IoT). It is possible to establish device to device or device to cloud communication with the help of gateways (Mohammed FH, Esmail R ,2015).

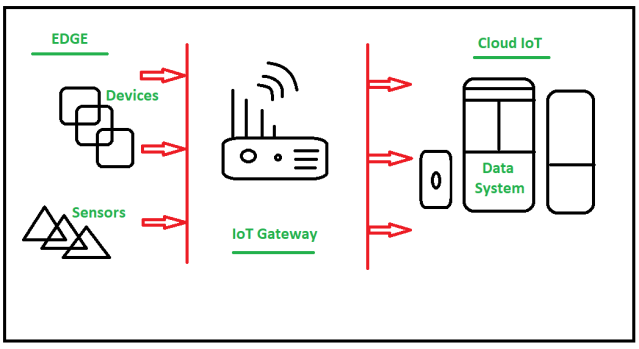

Fig 4- IOT Gateways

It connects sensor networks to the Internet and enables IoT communication, among other things. This IoT gateway performs protocol translation, aggregates all data, performs local processing and filtering of data before sending it to the cloud, stores data locally, and autonomously controls devices based on some inputted data, providing additional device security. (A. Prasanth , Pavalarajan.S , 2019).IoT Gateways establish connectivity between sensors and the cloud (Data System) as seen in Fig. 4: Because IoT devices have minimal power consumption (battery power), they are energy constrained, so communicating directly with the cloud/internet will be ineffective in terms of power.

As a result, they communicate with the Gateway first via short-range wireless transmission modes/networks such as ZigBee, Bluetooth, and others, which consume less power, or they can be connected via long-range wireless transmission modes/networks such as Wi-Fi. (Amroun H, Ouarti N, Ammi M ,2016).

Then, via an ethernet, WiFi/cellular, or satellite connection, the Gateway connects them to the Internet/cloud by translating data into a standard protocol like MQTT. And, unlike sensor nodes, which are battery-operated, most gateways are powered by the mains. Multiple Gateway devices are used in practise. (Thirumurugan.P ,Pavalarajan.S ,2016).

Let's consider a simple IoT gateway. When we utilise numerous radio technologies like WiFi, Bluetooth, and the cellular network of a smartphone to work on any IoT project in delivering and receiving data, this also works as a basic IoT gateway. (Pavalarajan.S and Krishnamoorthy,2014),.

IoT Gateways are a critical component of IoT infrastructure since they create communication connections and perform other functions as detailed above. As a result, when considering an IoT ecosystem, an IoT Gateway is one of the most important components.

5. IoT Careers

The Internet of Things (IoT) is made up of two basic components: the Internet, which serves as the backbone of connectivity, and Things, which refers to physical things or devices. The internet of things (IoT) is a network in which all physical items, such as mechanical and digital machinery, interconnected computing devices, animals, and people, are connected to the internet and exchange data through network devices or routers.

Applications:
Many IoT applications are available on the market in many fields-

5.1. Home Automation System:

It comprises lighting control, gardening, safety, and security, in which lights, air conditioning, TVs, computers, and cameras, among other things, may communicate with one another and be controlled remotely via a phone, mobile device, or the internet. Installing smart gadgets allows you to save time, money, and energy (DerhamyH, EliassonJ, DelsingJ, PrillerP ,2015).For example-

- **Smart Refrigerator**
  It not only alerts you to products that have been consumed, such as empty bottles in the fridge, but also allows you to order them online before they run out.
- **Smart thermostats**
  It allows you to regulate the temperature of your home from anywhere in the world by simply touching your phone or tablet.
- **Hue bulbs**
  Your fingertips can alter the brightness of the bulbs' illumination.At night, the lights dim and change dynamically in response to the environment.When an intruder is detected, they can also go into blinking mode.

5.2. Enterprise:

IoT is important in retail, manufacturing, and other industries.

- **Manufacturing**
  From production flow monitoring and remote equipment management to condition-based alerts and more, the Internet of Things has an impact on every element of manufacturing. Product flow management powered by IoT helps optimise material usage and reduce waste. In addition, IoT devices give managers with additional information that they can use to make more productive decisions. The information gathered is utilised to improve both the product and the process.
- **Retail**
  RFID tags ensure that things are in stock and available to customers both online and in person.Digital price labelling of items is provided by retail shelving, which also alerts merchandizers when the shelves are empty.

5.3. Medical and Health Care:

The Internet of Things (IoT) has a wide range of applications in healthcare.

It enables patients to receive better care and medical facilities to operate more efficiently. IoT in healthcare also allows for machine-to-machine connection, data exchange, and interoperability, all of which help to improve healthcare delivery. IoT can gather, report, and analyse data in real time, reducing the need for human intervention.

- **CGM** (continuous glucose monitoring) and insulin pens-CGM is a gadget that takes many readings to continuously monitor

blood sugar levels for several days.Smart insulin pens may keep track of the time, volume, and type of insulin delivered in a dose, as well as suggest the best type of insulin to use (Sasikala.N, Prasanth.A, Pavalarajan.S ,Karuppathal.R ,2018).

- **Connected Contact Lens**
  A connected contact lens could detect diabetes and tear glucose levels.It can also detect changes in the size of the eyeball, which is an indication of glaucoma.It is necessary to conduct research.
- **Hearing Aid –**
  A hearing aid based on the Internet of Things allows you to listen to multiple conversations at once.It is a boon to be able to listen to the sound in a noisy area.
- **Mimo Monitors**
  They gather data such as the baby's location, respiration rate, and body temperature, which is then relayed to mobile phones.This can aid in the implementation of safety measures at a nursery. IoT also aids in the treatment of diseases like as cancer and Parkinson's disease.
- **Connected Inhalers**
  Asthma is a disease that cannot be cured but can be managed with inhalers.A sensor-connected inhaler can notify a patient to a triggering element such as air pollen or temperature, which can help avert an attack.
- **Smart watches for Depression**
  Every year, a large number of people seek help for depression.These watches detect depression levels and suggest what should be done in the event of a depressive episode.This programme assesses and analyses a patient's level of depression and stores data on the cloud, allowing a psychologist to better comprehend the patient's problem by monitoring from afar.

5. 4. Transportation:
The most practical example is the electronic toll collection system. RFID (Radio Frequency Identification System) is a computer-assisted technology that identifies objects and metadata. If RFID scanners are connected to an internet interface, they may automatically identify, track, and monitor things attached in real time.This makes advantage of the Internet of Things.

5.5Careers in IoT:
Some of the career options in IoT are

- **Data Analysts**
  Data analysts analyse and review data acquired from the Internet of Things, which is one of the employment opportunities in IoT.Sensors, network end devices, and other critical components are used to collect IoT data, which is then analysed..
- **Instrumentation Engineer**
  Sensors and Actuators for closed loop systems should be handled by professionals.
- **Software program Engineer**
  The key responsibilities of a software programme engineer include developing backends and interacting with middleware and cloud databases.
- **IoT Security Specialist**
  The primary responsibility of the specialist is to protect personal information from being hacked, gadgets from malfunctioning, and to develop and implement security measures for the firm.
- **Embedded Programs Engineering**
  From pcb design and manufacture through firmware engineering, entire product lifecycle management, and internet gateway interfacing, an embedded programme engineer can programme the electronic components of IoT devices.

6 Conclusion

Smart cities, smart environments, security and emergencies, smart business processes, smart agriculture, domestic and home automation, and healthcare are all examples of where IOT is being implemented today. We outlined the technologies and specifications that can be used to make the Internet of Things a reality in this article.After that, we go over some nice examples of how the Internet of Things might be useful, and finally, we go over some careers that need to be addressed before this technology becomes widely accepted.

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