INTERNET OF THINGS (PART-1)

Abstract

The paper contains information about different aspects of Internet of Things (IoT) mainly concentrating on Embedded systems, sensors, Privacy and Security, Virtual reality and Augmented reality and applications of it. The part-I discusses about embedded systems, sensors and their main applications and brief description of them. The part-II discusses about privacy and security.

Keywords: Internet of Things (IoT), Embedded systems, sensors, Privacy and Security, Virtual reality and Augmented reality.

Authors

Mr. Houston Ivan Moses
Assistant Professor
Department of Computer Science
Bhavan's Vivekananda College
Secunderabad, Telangana, India.

Mr. D.Ganesh Kumar
Assistant Professor
Department of Computer Science
Bhavan's Vivekananda College
Secunderabad, Telangana, India.

Reema Kashmiri
Department of Computer Science
Bhavan's Vivekananda College
Secunderabad, Telangana, India.

C. Pushyaraag
Department of Computer Science
Bhavan's Vivekananda College
Secunderabad, Telangana, India.

I. INTERNET OF THINGS (IOT)

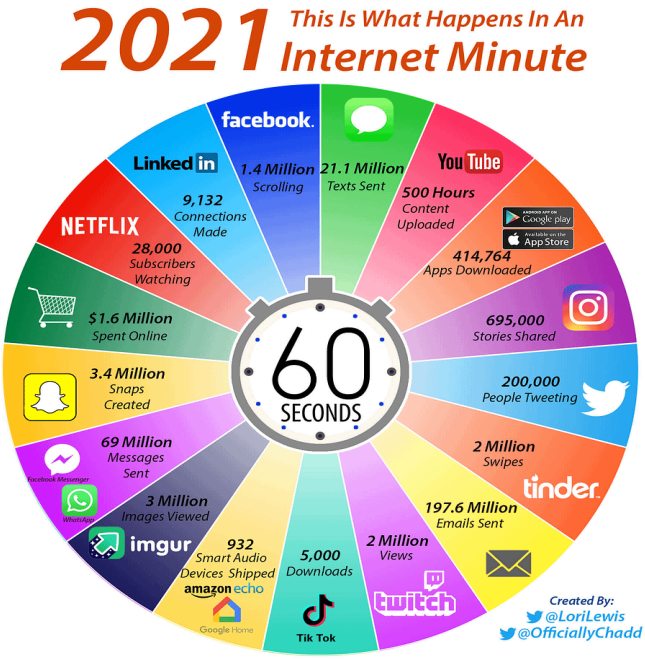
Before we go ahead and know about the Internet of things let me ask you a quick question. Have you ever heard of the following terms?

> IOT
> Smart Things
> Smart Watch
> Smart City

Before we actually start off, let's see how great this topic is, how waste this topic is, how good this topic is. Let's see a few examples. So most of us have seen fitness apps, fitness watches, fitness headbands and so on…. People use their phones or people have smart watches while they are jogging, running, swimming, exercising. So what these things do is track people's activity like how many miles they have jogged or ran, sprinted etc. such activities can be tracked through these devices example let's take Tesla. Tesla is an automated self driving car so what autopilot is advanced self-driving technology so let's say you are going in a particular line on a highway And you have turned autopilot mode and the car automatically steers itself without us doing anything and accelerates itself and based on the traffic it applies brakes to itself. There are also additional features in this car like smart summon so let's say you use the smart summon feature Tesla car automatically comes from the parking and it comes in front of you all features are possible by 4.0 Technologies and IOT that means internet of things is playing major role in the software.

Before going into this topic let me ask you some questions about how exactly you are reading this magazine? How do you talk to a distant friend? How do you watch your favorite movie? Seeing these questions what triggers in your mind? That's right in your computer or smartphone or your Tablet. Now just imagine what all day to day activities you do on your smartphone and also imagine missing out on all of them so some of our activities on smartphones are talking to our friends, browsing articles on google, scrollings reels on instagram etc.

So how exactly is this possible? Because smartphones or computers are the gadgets that are connected to the inter net globally. Let me show you a picture of how big the internet has grown and what happens within a minute on the internet.



If you just pick any of the above things as an example let's say Snap chat 3.4 million snaps are being created, on Instagram 695,000 stories are being created and we can also see lot more activities on huge scale and all these are all happening on internet just in one minute because other smartphones or electronic gadgets are connected to the internet globally.

Now what if every physical thing around us is connected to the internet, for example table, chair, door etc. are connected to the internet? Let me give you an example of what will happen so we all go to shopping malls and finding parking is a hassle over there. So how would you feel as soon as you enter the shopping mall you get a message from your phone that "This lot of parking is free"? Let's take another scenario while you are going out from home and the fridge sends a message that "I don't have this stuff…. bring them to me while you are coming back from work to home". Let's take another common scenario when we are going outside, the most common thing we forget it's either our phone or our wallet instead of checking things in mid of your journey and check your bag only to find out that your wallet is no0t present can be excruciating news to know now what if you crossed your doorstep and you get a message from your wallet saying "Hey you forgot me so come pick me up".

This can be possible when all the things around us are connected and they are taking intelligent actions. This is the core essence of the internet of things. That is connectivity and intelligence for normal things which we see in our day to day life. So how do we achieve connectivity and intelligence of normal things which we see in our day to day life? So that's where the DNA of IoT comes into place **D**evice: To sense to surroundings **N**etwork: To talk to other things **A**pplication: To act intelligently.

II. DEVICES

Let's start with IOT devices components of an IoT device so we have sensors, processor, communication element, power element firmware these are all core elements of what an IoT device is. Sensors are those which help IoT devices to sense their surroundings. Any change in the environment the sensors can detect there is a proximity sensor the work of this proximity sensor is when an object is coming near, proximity sensor can detect that object. And then there is light sensor it detects the intensity of light PIR sensor detects Radiant heat reflected from the objects and so on….When these sensor based IoT devices are embedded into normal things around us that is when normal devices are able to sense their environment. As I said in the above example regarding parking, for that we require 3 sensors: parking sensors: senses occupancy, location sensor: Where exactly the vehicle is and proximity sensor: Ensures you don't hit objects outside parking lot. There are sensors so advanced that they can detect even your brain signals and can be converted into graphs and also produce sound of the brain Signals and that sensor name is electroencephalographic sensor. So let's take a simple example: our smart phone itself is a bundle of sensors: Proximity sensor: Auto turn off screen when mobile is near ear, Ambient light sensor: Your phone auto brightness, Accelerometer + gyroscope: Number of steps walked. Typical smartphone has 13 sensors but did you know that a McLaren Formula 1 racing car has 300 sensors!

How do smart things talk to other things?

III. NETWORK

The following enables smart things to communicate Bluetooth, WI-Fi, 4g/5g, LPWANs, Lora WAN, Li-Fi, etc….

These are things which can be embedded into normal things enabling them to communicate with each other.

IV. APPLICATIONS

We have a sensor like soil moisture sensor which senses the moisture level we have electrochemical sensor. What is the level of nutrients? What is the pH level in the soil? And this information is communicated using network to the application also say for example the farmer has his own preferences the crop should be watered only in the morning for probably sometime in the evening so the farmer with the help of application enter these preferences and how much quantity should be watered so it's in the morning time this is the amount of quantity should be watered if it's evening time this is the amount of water that should be applied to this can be entered by the farmer in the application and based on the analysis of all the things the suggestions can be given to farmers Like for example this area of your families particularly dry and it needs more amount of water Not only providing the instructions but also actions can also be performed so with the information gathered sprinklers automatically sprays water on the dry area and making the farm equally fertile.

V. IOT AND ARTIFICIAL INTELLIGENCE

IOT stands for Internet of Things and AI stands for Artificial Intelligence where in both modern technologies are quite different but when both of them are combined it can transform the industry.

IoT can be understood with real life applications where in things like fridge, car or the watch we wear. Unknowingly these objects communicate with each other and might tell us what is happening through various gestures. In other words IoT helps regular things to work smartly and makes it convenient for usage.

AI is also similar to IoT but it is programmed in such a way that it can do things which humans do it in day to day life. Just like our mind analyzes what is happening in surroundings and helps in giving responses, AI learns the data and uses that learning to perform tasks.

VI. HOW AI ENHANCES THE CAPABILITIES OF IOT DEVICES AND NETWORK?

Consider AI as the brain that gives IoT devices more intelligence. IoT devices are like your eyes and ears in that they constantly gather data from their environment. However, they require AI to interpret all of that data and make wise choices.

Consider your front door with a smart camera. It observes individuals entering and leaving, but AI determines if they are a member of the family, a delivery guy, or a complete stranger. AI therefore aids the camera in comprehending what it is seeing.

AI leverages its intelligence to make judgements using data from IoT devices, such as cameras or sensors. As a result, the technology performs better, comprehends more, and assists you in methods that it couldn't otherwise. To make your life simpler, it's like giving them a super brain!

VII. INDUSTRIAL IOT AND AI AUTOMATION

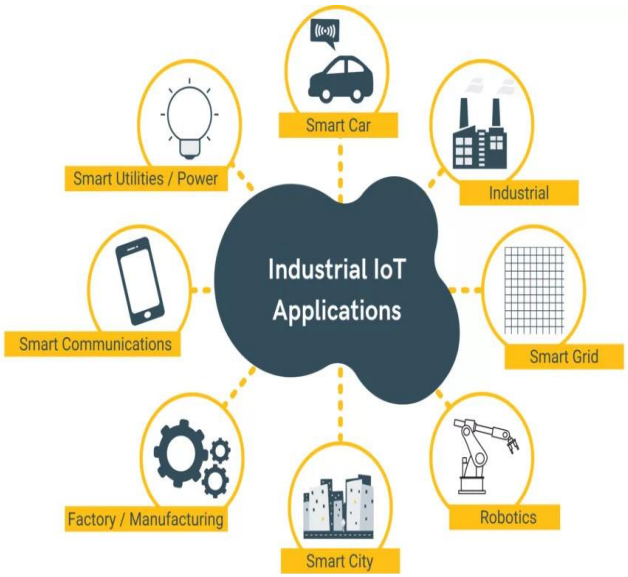
IoT in automation helps in monitoring the processes and combining with AI helps in better decision making, increase in productivity and enhances efficiency.

In this process various devices, machines are connected to internet such that data will be collected and exchanged. The ultimate goal of industrial IoT is to build smart systems where data drivers' thoughts help in producing efficient outcomes.

Examples include Sensors and actuators, cloud computing

AI automation involves in simplifying complex tasks using AI algorithms which helps machines to perform actions that require human intelligence. This type of automation reduces operational time, improves the safety standards and optimizes the operations.

Examples include supply chain management, predictive maintenance



VIII. PREDICTIVE ANALYTICS AND REAL-TIME DECISION MAKING

1. **Predictive Analysis:** In simple words using AI means letting computers to learn from data. When we use AI with data from various devices like sensors and cameras, it helps us to predict what will happen in future using various patterns.

2. **Example:** AI can look at past data where in it finds patterns and common trends occurred which finally brings us to s conclusion like weather changes or when devices need to fixed.

   Apart from this AI and IoT can be used in real time decision making. Examples include smart watches, fitness tracker, traffic lights, energy saving lights, parking availability etc. .

3. **Challenges and Considerations:** Combining both IoT and AI brings tremendous advantages but also increases privacy issues.

   Suppose we use smart devices every day in our life, it might make our life easy but also brings many privacy and security concerns.

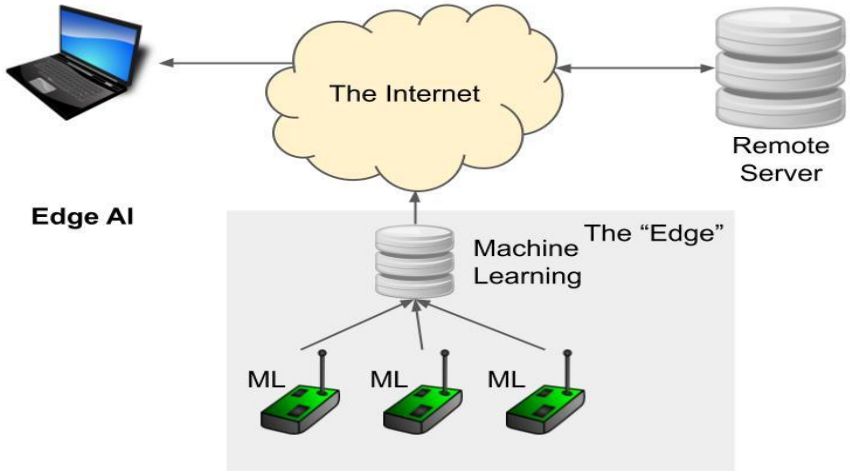
4. **Privacy Issues:** Smart devices track all the activities which we do in our daily life. The concern is the personal information that is gathered by these devices may be visible to others and can be utilized in unexpected ways.

5. **Security Concern:** IoT and AI gadgets require sturdy locks just as you would if you wanted to make your home secure. Hackers could be able to get access to these devices and access your data or take control of them if they aren't adequately protected. Your personal information could be stolen or your devices might be used inappropriately as a result.

IX. FUTURE PROSPECTS AND INNOVATION

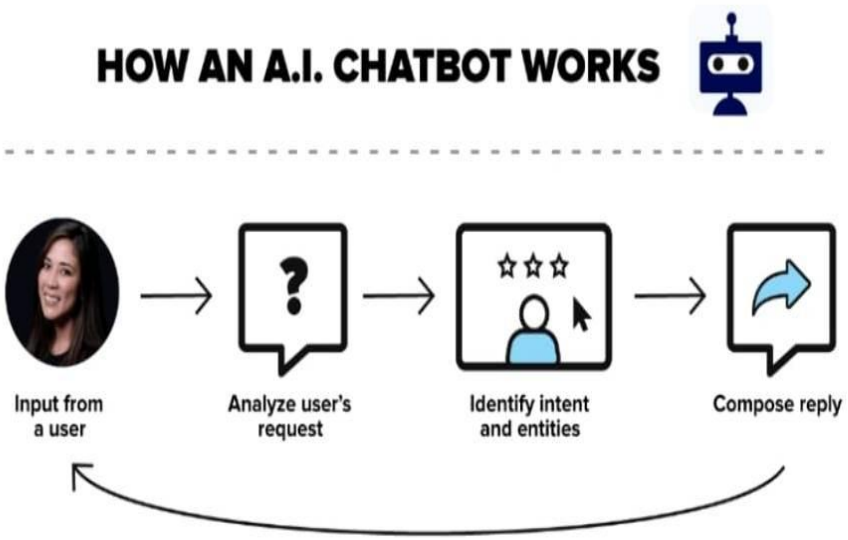
IoT devices are getting smarter day by day by exchanging data and AI is making the computer smarter in such a way it is capable of making its own decisions. The new trends that can be observed are:

1. **Edge AI:** Previously data is sent to big computers for processing. But now devices are trained in such a way that they can do tasks where they are. We can understand this through an example where mobile devices are able to detect faces and unlock itself instead of depending on far away servers.



2. **5G Connectivity:** This is the latest technology that is emerging in market as it provides high speed internet, seamless streaming and has the capacity to connect more devices at same time. With such features it can reshape the digital industry.

3. **AI Chatbots:** These are the powerful tools powered by artificial intelligence which helps in answering questions and solving problems. These chatbots is user friendly and is found in apps, websites and messaging platforms.



4. **Smart Cities:** Smart cities integrate technology which makes cities more organized, clean, and helpful for people who lives there.

5. **Personalized Experiences:** Big tech giants use AI for streaming services which helps in suggesting things or online shops showing us things that we are interested in.

X. IOT ARCHITECTURE

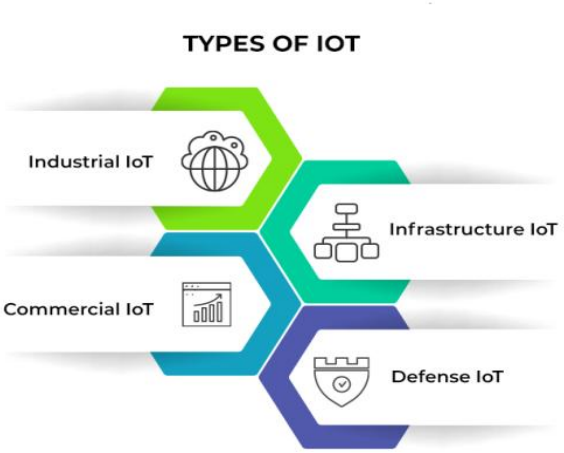
1. What is IOT?

In the digital age we live in, the Internet of Things (IOT) has emerged as a revolutionary force reshaping the way we interact with technology, our environment, and even each other. IOT represents a vast ecosystem of interconnected devices, sensors, and systems that communicate with each other via the internet, facilitating seamless data exchange and automation like never before.

2. **Types of IOT:** IOT can be categorized into several types based on the nature of the connected devices and functions

- **Industrial IOT:** It focuses on improving industrial processes, manufacturing, and infrastructure. It includes connected sensors and devices in factories, supply chain management, and logistics.

- **Consumer IOT:** This is perhaps the most familiar type of IOT for many people. It includes smart home devices such as thermostats, lights security cameras, and voice assistants like Amazon Alexa or Google Assistant.



3. Benefits of IOT

- **Efficiency**: IOT automates tasks, reducing manual intervention.
- **Data Insights**: Generates vast amounts of data for informed decision-making.
- **Cost Savings**: Optimizes resource usage, leading to reduced operational costs
- **Safety and Security**: Enhances safety with real-time monitoring.

XI. ARCHITECTURE

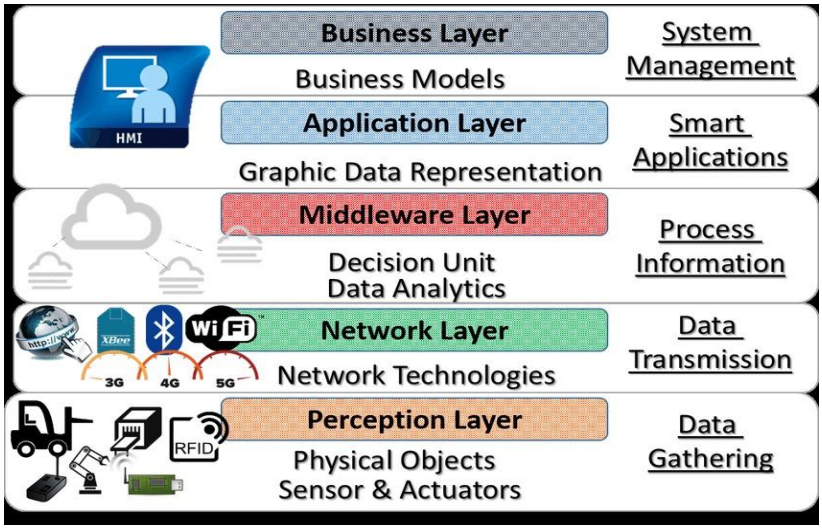
The IOT has been taking a lot of interest in framework and architectural designs to promote their IOT devices and systems .The IOT system are designed as very user friendly and in environment dependent manner.

IOT architecture is used to control the smart IOT devices having sensors and Internet gateway. It is the way by which the system performs all the operations and interacts to complete the set of task. They are the ranged collection of sensors, protocols, cloud services and layers. It is also used to track the consistency of system through protocols.

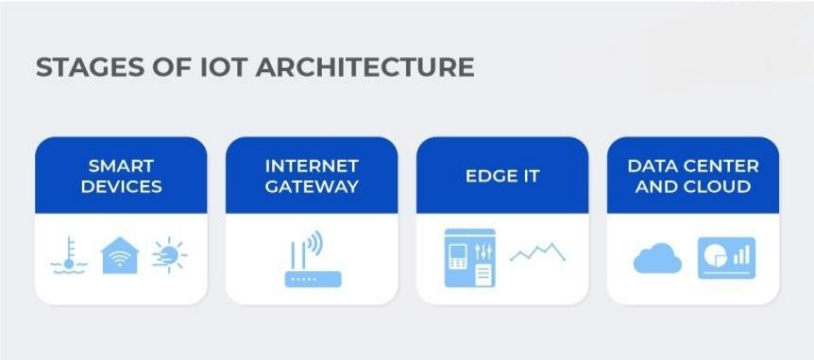
1. Layers of IOT Architecture

IOT Architecture Contain 5 different layers that is:

- **Perception Layer:** It is also known as physical layer, which work with sensors for sensing and gathering details about environment.
- **Network Layer:** It is connecting with smart devices, servers and network devices. It is also used to transfer the sensor collected data.
- **Application Layer:** It is the service provided to the user. Example for application layer is Smart house, smart TV/gadget etc..
- **Business Layer:** It manages the whole IOT models profit and also maintains the devices.
- **Process Layer:** This layer is also known as middleware layer, which store and analyzes the data that has be transported.



XII. IOT ARCHITECTURE STAGES



- Internet Gateways
- Edge IOT
- Datacenter and cloud

1. **Internet Gateways:** It is based on traditional IOT Gateway whose main goal is to act as an intermediate between the world of things and the data center, usually in the cloud-based.

2. **Edge IOT:** The term edge is derived from Edge Computing where data is processed at the network, and is close to the originating data. The key factor which makes edge processing is by turning the data processing and action by taking the closest to real-time applications.

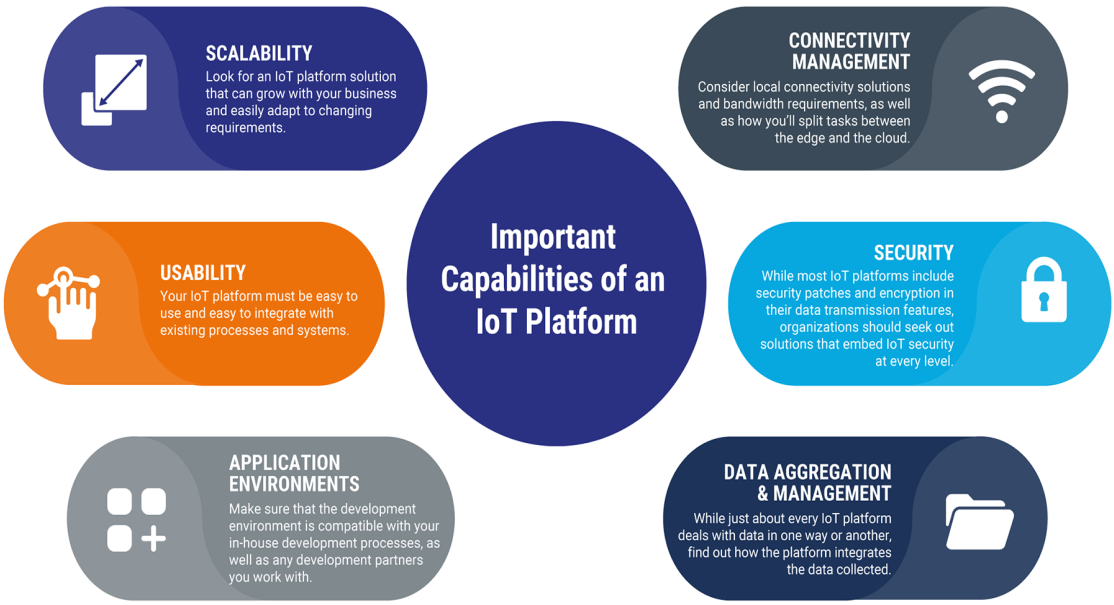
3. **Data Center and Cloud:** Virtualization, hardware resources and IOT devices are used in IOT architecture by which it can be well utilized. For the different cloud service models both HTTP and MQTT servers are used which are also known as the application servers. The HTTP servers implement services for end-users and electronic devices, while the MQTT servers ensure real-time communication among devices.

XIII. IOT PLATFORMS

In the dynamic landscape of the Internet of Things (IOT), the role of IOT platforms stands as a linchpin. These platforms serve as the backbone of IOT, providing the necessary tools and infrastructure to connect, manage, and extract meaningful insights from the myriad of interconnected devices.

1. Key Functions of IOT Platforms

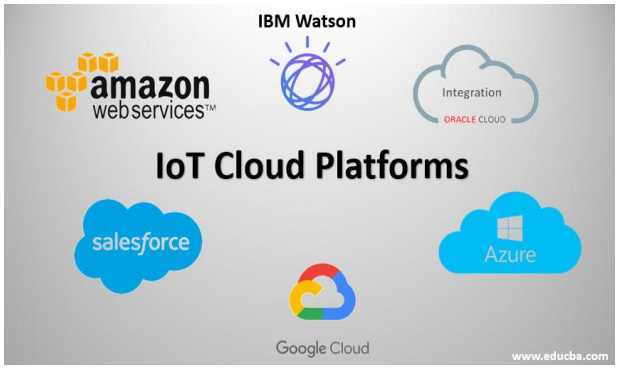
- **Device Management**: IOT platforms streamline device on boarding, configuration, and monitoring. They ensure seamless connectivity, allowing devices to communicate effectively.
- **Data Management**: IOT generates a vast trove of data. Platforms gather, store, and analyze this data, transforming raw information into actionable insights.



- **Security**: Security is paramount in IOT. IOT platforms incorporate robust security measures, including encryption and access control, safeguarding data and devices from threats.
- **Scalability**: As IOT networks grow, platforms scale effortlessly, accommodating new devices and data streams without disruption.
- **Interoperability:** IOT platforms facilitate communication between devices from different manufacturers

2. Leading IOT Platforms

- **AWS IOT**: Amazon Web Services offers a robust IOT platform, with cloud services for device management, data analytics, and machine learning.
- **Azure IOT**: Microsoft's Azure IOT suite provides tools for building, deploying, and managing IOT solutions at scale.



- **Google Cloud IOT**: Google's platform integrates IOT data with Google Cloud services, enabling data analysis and machine learning.
- **IBM Watson IOT**: IBM's platform combines IOT data with AI and block chain for comprehensive insights and security.

3. Benefits of IOT Platforms

- **Accelerated Development**: These platforms provide pre-built frameworks and APIs, expediting IOT solution development.
- **Cost-Efficiency**: By offering reusable components and cloud-based services, platforms reduce development and infrastructure costs.
- **Enhanced Data Insights**: IOT platforms enable advanced data analytics, aiding in trend analysis, predictive maintenance, and informed decision-making.
- **Ecosystem Growth**: They foster collaboration among developers, device manufacturers, and businesses, driving IOT innovation.

XIV. CONCLUSION

In conclusion, IoT communication technologies form the backbone of the interconnected world we are building. They enable devices to seamlessly exchange data, creating a way for innovative applications and solutions that span industries and domains. From the familiar Wi-Fi and Bluetooth for short-range connections to the sophisticated LoRaWAN and NB-IoT for wide-area coverage, the array of communication technologies available offers solutions for diverse use cases.

Undoubtedly both the technologies have the power to transform the future and have the potential to reshape various industries, the way we live, the way we work and the way we interact. This symbiotic relationship expands both technologies' potential, forging an innovative alliance that transforms markets, improves user experiences, and boosts productivity.

As AI has the capability to handle huge data sets i.e. the huge data that is generated during the process, it can give valuable insights which help us to take real time decision making, analyzing the things, predicting the things, automating the tasks. overall this helps us to save the time and increases the performance In the coming years, as IoT becomes more deeply integrated into our daily lives, industries, and infrastructure, the way we communicate, interact with technology, and shape our environments will undoubtedly be transformed, guided by the continued evolution of IoT communication technologies.

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