II. OVERVIEW OF IOT FEATURES

Internet of Things (IoT) is a technology of connected smart devices that has incremental use cases across industries. With the increasing use across various industries, it is becoming a necessity to define a common standard of IoT ecosystems. As a design standard, any IoT device comes with some common set of features like connectivity, analytics, endpoint management, etc. Let's discuss the high-level feature maps of IoT devices.[1]

1. Connectivity

In the case of IoT, the most important feature one can consider is connectivity. Without seamless communication among the interrelated components of the IoT ecosystems (i.e sensors, compute engines, data hubs, etc.) it is not possible to execute any proper business use case. IoT devices can be connected over Radio waves, Bluetooth, Wi-Fi, Li-Fi, etc. We can leverage various protocols of internet connectivity layers in order to maximize efficiency and establish generic connectivity across IoT ecosystems and Industry. There may be special cases where the IoT ecosystem is built on-premises or in an intranet.

2. Sensing

We humans can naturally understand and analyze our circumstances easily based on our past experiences with various things or situations. In the case of IoT in order to get the best of it, we need to read the analog signal, convert it in such a way that we can derive meaningful insights out of it. We use Electrochemical, gyroscope, pressure, light sensors, GPS, Electrochemical, pressure, RFID, etc. to gather data based on a particular problem. For example for automotive use cases, we use Light detection sensors along with pressure, velocity and imagery sensors. To make a use case successful we need to choose the proper sensing paradigm.

3. Active Engagements

IoT device connects various products, cross-platform technologies and services work together by establishing an active engagement between them. In general, we use cloud computing in blockchain to establish active engagements among IoT components. In the case of Industry grade, IoT solutions raw analog data need to be acquired, preprocessed and rescale as per business capacity. As per Google, only 50% of structured and 1% of unstructured data is used to make important business decisions. So while designing the IoT ecosystems carriers need to consider the future needs of manipulating such a huge scale of data to satisfy incremental business needs. One can confuse the need of active engagements with scale, practically it means your systems should be able to handle huge data across various technologies, platforms, products, and industries.

4. Scale

[1] https://www.educba.com/iot-features/

IoT devices should be designed in such a way that they can be scaled up or down easily on demand. In general, IoT is being used from smart home automation to automating large factories and work stations, so the use cases vary in scale. A carrier should design their IoT infrastructure depending upon their current and future engagement scale.

5. Dynamic Nature

For any IoT use case, the first and foremost step is to collecting and converting data in such a way that means business decisions can be made out of it. In this whole process, various components of IoT need to change their state dynamically. For example, the input of a temperature sensor will vary continuously based on weather conditions, locations, etc. IoT devices should be designed this keeping in mind.

6. Intelligence

In almost every IoT use cases in today's world, the data is used to make important business insights and drive important business decisions. We develop machine learning/ deep learning models on top of this massive data to obtain valuable insights. The analog signals are preprocessed and converted to a format on which machine-learning models are trained. We need to keep in mind the proper data infrastructure based on business needs.

7. Energy

From end components to connectivity and analytics layers, the whole ecosystems demand a lot of energy. While designing an IoT ecosystem, we need to consider design methodology such that energy consumption is minimal.

8. Safety

One of the main features of the IoT ecosystem is security. In the whole flow of an IoT ecosystem, sensitive information is passed from endpoints to the analytics layer via connectivity components. While designing an IoT system we need to adhere to proper safety, security measures, and firewalls to keep the data away from misuse and manipulations. Compromising any component of an IoT ecosystem can eventually lead to failure of the whole pipeline.

9. Integration

IoT integrates various cross-domain models to enrich user experience. It also ensures proper trade-off between infrastructure and operational costs.

IoT benefits to organizations

The benefits of the IoT for business depend on the particular implementation; agility and efficiency are usually top considerations. The idea is that enterprises should have access to more data about their own products and their own internal systems, and a greater ability to make changes as a result.

Enterprise use of the IoT can be divided into two segments: industry-specific offerings like sensors in a generating plant or real-time location devices for healthcare; and IoT devices that can be used in all industries, like smart air conditioning or security systems.

Manufacturers are adding sensors to the components of their products so that they can transmit data back about how they are performing. This can help companies spot when a component is likely to fail and to swap it out before it causes damage. Companies can also use the data generated by these sensors to make their systems and their supply chains more efficient, because they will have much more accurate data about what's really going on.

Generally, IoT is most abundant in manufacturing, transportation and utility organizations, making use of sensors and other IoT devices; however, it has also found use cases for organizations within the agriculture, infrastructure and home automation industries, leading some organizations toward digital transformation.

IoT can benefit farmers in agriculture by making their job easier. Sensors can collect data on rainfall, humidity, temperature and soil content, as well as other factors, that would help automate farming techniques.

The ability to monitor operations surrounding infrastructure is also a factor that IoT can help with. Sensors, for example, could be used to monitor events or changes within structural buildings, bridges and other infrastructure. This brings benefits with it, such as cost saving, saved time, quality-of-life workflow changes and paperless workflow.

A home automation business can utilize IoT to monitor and manipulate mechanical and electrical systems in a building. On a broader scale, smart cities can help citizens reduce waste and energy consumption.

IoT touches every industry, including businesses within healthcare, finance, retail and manufacturing.

What are the benefits of the Internet of Things for consumers?

The IoT promises to make our environment -- our homes and offices and vehicles -- smarter, more measurable, and... chattier. Smart speakers like Amazon's Echo and Google Home make it easier to play music, set timers, or get information. Home security systems make it easier to monitor what's going on inside and outside, or to see and talk to visitors. Meanwhile, smart thermostats can help us heat our homes before we arrive back, and smart lightbulbs can make it look like we're home even when we're out.

Looking beyond the home, sensors can help us to understand how noisy or polluted our environment might be. Self-driving cars and smart cities could change how we build and manage our public spaces.

However, many of these innovations could have major implications for our personal privacy.

II.1. IoT tools and technologies

IoT devices are about the internet of things which means things of things are connected via the internet. IoT devices are wireless sensors like Bluetooth, Wi-Fi and computer devices. Devices are attached to the object that can operate through the internet or can communicate with a human without human interaction. It will help people to make their life easy and smart. These devices have sensors which will transmit data to user or object via the internet. Devices can be remotely monitored and controlled. Technology has extended the use of internet connectivity beyond devices like desktop or laptop. IoT devices are embedded in the home, health care, industrial, etc equipment.

4. Sensors

Sensors are the most critical hardware in IoT applications and are used to gather information from the surroundings. These systems are made up of power management modules, RF, energy and sensing modules. Communication from Wi-Fi, Bluetooth, transceiver, BAW, and duplexer is managed by an RF module.

4. Microcontrollers

A microcontroller is a device in a single integrated circuit devoted to executing a single task and running an application. This contains programmable peripherals for contains programmable, memory unit, and a CPU. Microcontrollers are designed primarily for embedded applications and are widely used in remotely operated electronic devices such as mobile phones, washing machines, microwaves, and cameras.

4. Other IoT hardware

Smart wearable devices such as smart memory, glasses, rings, and shoes are examples of IoT hardware. Smart devices allow us to access more of the content and resources that we love and create a new approach to collaboration as part of an IoT network. Desktop, mobile phones, and tablets are standard command center and remains an integral part of IoT application. Other network distribution devices like switches, hubs, and routers act as a key connector in IoT application.

IoT Hardware Providers

In today's market, one can find many IoT hardware providers who will be able to provide the required hardware-based up on the project requirement. Let's take a quick overview of a few of the hardware providers.

Adafruit offers DIY electronic hacking courses online and provides a space to learn. 'Adafruit Feather' is a production line of boards designed for fly prototyping. This production line includes a wide catalog of accessories that speed up IoT application development.

Arduino is the omnipresent name in the space for electronic development. The company offers a range of open-source development kits, billing software, and microcontrollers.

Lantronix is a company that offers Infrastructure, modules and gateway kit to support connectivity between IoT applications. This California based company has recently launched advanced gateways based on XP200 industrial standard.

Espressif is well known for its low energy consuming IoT hardware applications for Wi-Fi and Bluetooth. Espressif is popular for its processors, modules, and production boards series ESP826. Most industry-wide development boards are working on Espressif chipset.

IoT Applications

All IoT apps have certain commonalities or 'building blocks' irrespective of the request. Things, Data Acquisition Module, Data processing module, and communication module together consist of building blocks of IoT application.

4. Thing

The "thing" is fully integrated into the smart device in many IoT products. Think about things such as a smart water pump or an autonomous vehicle.

4. Data Acquisition

The data acquisition module focuses on obtaining physical signals from the "thing" that can be manipulated by a computer and converting them into digital signals. This is the component of hardware that includes all sensors that acquire real-world signals such as temperature, light, vibration, motion, etc

4. Data Processing

The third essential component of IoT hardware is the data processing module. This unit performs a series of operations on the data, performs spatial analysis, internal data storage, and performing any other edge computing operations.

4. Communication

The communication module is the last but very essential part of the device's hardware. This is a unit that allows communication between devices and storage either locally or in the cloud space. This module can include, to name a few, communication ports like USB, Modbus or Ethernet/IP. It may further consist of wireless communication radio technology such as Wireless fidelity.

II.2. IoT in Projects

Consumer and enterprise IoT applications

There are numerous real-world applications of the internet of things, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT (IIoT). IoT applications span numerous verticals, including automotive, telecom and energy.

In the consumer segment, for example, smart homes that are equipped with smart thermostats, smart appliances and connected heating, lighting and electronic devices can be controlled remotely via computers and smartphones.

Wearable devices with sensors and software can collect and analyze user data, sending messages to other technologies about the users with the aim of making users' lives easier and more comfortable. Wearable devices are also used for public safety -- for example, improving first responders' response times during emergencies by providing optimized routes to a location or by tracking construction workers' or firefighters' vital signs at life-threatening sites.

In healthcare, IoT offers many benefits, including the ability to monitor patients more closely using an analysis of the data that's generated. Hospitals often use IoT systems to complete tasks such as inventory management for both pharmaceuticals and medical instruments.

Smart buildings can, for instance, reduce energy costs using sensors that detect how many occupants are in a room. The temperature can adjust automatically -- for example, turning the air conditioner on if sensors detect a conference room is full or turning the heat down if everyone in the office has gone home.

In agriculture, IoT-based smart farming systems can help monitor, for instance, light, temperature, humidity and soil moisture of crop fields using connected sensors. IoT is also instrumental in automating irrigation systems.

In a smart city, IoT sensors and deployments, such as smart streetlights and smart meters, can help alleviate traffic, conserve energy, monitor and address environmental concerns, and improve sanitation.

Now let us see a few of the IoT big-time IoT projects undertaken by the governments and public sector around the world.

IoT-Enhanced Human Experience

Today’s society is progressing towards the age of technology and people are coming across many electronic devices such as mobiles, tablets, smartwatches and various other forms of electronics in day to day life also referred to as the Internet of things. By the end of this decade, more than 40 billion devices are predicted to be deployed in our surroundings. The data generated by these devices will be uploaded to the internet periodically, which can be further used for automation and decision-making purposes.

1. Health services
2. Public safety

Private sector project

Here is the list of following private sector project mention below:

1. Smart home lighting project by Philips Hue

Philips Hue is a revolutionary technology for a modern home that lets you remotely control the lights installed in your home. One can schedule the lights to go and off for a duration of time. Lights are further embedded with sensors to detect human presence and turn on and off accordingly.

The technology can go further beyond, enhancing the movie experience by auto-adjusting brightness based on the kind of movie being watched. For instance, if you're watching a horror movie, the brightness of the room will go down giving the user a better experience.

2. Medication Dispenser

This medication dispenser by Philips is designed for elderly patients who are unable to keep track of their daily medication. This device helps in keeping the track of their medication and dispenses the required dosage in pre-filled cups. This device further notifies the user when it needs to be refilled or serviced.

3. Drowsiness and sleeping pattern detecting system using Brainwaves and IoT technology

A new system will be able to detect brainwave frequency and raise an alarm when it detects drowsiness in the user. According to a study, the adult brain consists of billions of neurons interconnected to each other. These neurons in a fully awake state generate an electrical charge which contributes to generating a small range of electrical charges around our scalp.

This charge can be detected with the help of sensors. If the user is in a drowsy state of mind while driving the automobile, the system can detect inactiveness and sound an alarm on the user's mobile device to awake the user.

After a hard day, people tend to fall asleep. Because of a lot of work pressure, even after working hours, one may have to put extra effort into it. It becomes hard to concentrate in today's world when the brain feels drowsy or sleepy. The Things Internet (IoT) has a wide variety of applications.

IoT includes a wide range of systems, sensors and networking products, advances in computational power, electronic miniaturization and network interconnections to provide many applications that were not available before. Every individual's sleep pattern is different, so all user data is stored in the cloud.

Based on the age group, this data can be analyzed, and sleep pattern graphs can be generated. And users who sleep information can also be used to assess whether a user leaves a healthy life for their health conditions.

It is possible to create an Android application that will keep track of the sleep pattern of the user. The client will have to set a timer, and the device will do its job in that time frame. The sleep pattern information will be stored and used for future reference.

A Drowsiness Detection Module based on the EEG was proposed for people who still have pending work to do after a hectic day and need to stay awake to complete the same. So, it's hard to keep up and complete the work after a tiring day. With the aid of Brain Waves, this device can sense an individual's mental state.

On the mobile application, the user sets a timer and the module is in ON state until the timer is on. The program will also hold the sleep pattern for the users, and this information will be stored in the cloud. The Application will track the pattern and make suggestions as needed.

4. Smart Building Project: Deployment of IoT in commercial and public buildings

This project is based on the Internet of Things coexisting alongside buildings to build a cost-effective energy management system for commercial buildings. Automated energy management in buildings takes advantage of occupancy identification and forecasting since occupancy is directly associated with the use of energy.

Hence there is a possibility of detecting occupancy in a residential building using only commonly available and low-cost sensors, making it possible to integrate occupancy detection and subsequently occupancy prediction service in building's energy management system. Further, this system is capable enough to distinguish occupants' activities and remotely control devices such as cameras.

Occupancy forecasting can help improve automated energy management systems for buildings by improving the estimation of energy consumption for the house. In addition, if the occupancy forecast is realized as a stand-alone microservice, the occupancy data may also be used by other applications, such as building automation. We are therefore working to extend our approach with additional sensors to facilitate a more reliable detection and prediction of the population.

IoT plays a key role in making our buildings and cities smart. Smart buildings are designed to protect the occupants from theft, attack, fire and natural disasters. This can be accomplished by assessment of the building and its surroundings and then deploying the required measures such as detecting unknown presence that is detecting people who are not part of the community and have trespassed.

The safety measures have been categorized into three steps security operations, the system of the building and countermeasures.

The buildings of today are a complex combination of structures and technologies. Every element inside a building has been improved and developed over time, offering building occupants the ability to control heating, ventilation, air conditioning, lighting, entertainment, and security systems by pressing a button or even configure their surroundings to adapt autonomously to their lifestyle and activity. In order to operate, smart building management systems use embedded sensor devices.

Sensors provide information about current occupants in a building, including lighting, heating, ventilation, electrical and other mechanical systems. A single light sensor can be used to detect people's passage through doorways or chokepoints. While certainly more cost-effective than smart doors or motion detectors, none of these methods are useful in-real-time monitoring of room occupancy.

The first approach had us position a sensor at the top of a door frame so that the door could block the sensor when it was opened. The second method was to position sensors at waist height, pointing across the window.

5. IoT Based Smart mobile charger

During the 2018 annual IoT conference, a program was suggested that can simplify the mobile and laptop charging process. This system would only be able to switch on and off when the electronic device is connected and charged when it is necessary and

can be further enhanced to control other devices. Further improvements can be made to the system to improve the performance of the hardware.

A machine capable of tracking and managing power consumption would significantly help to reduce energy waste. This system would only be able to turn on and off when the device is connected and charged when it is needed, and it can be further improved to monitor other devices. There are several modules available that will transform the adapter into an IoT-based device when combined with the charging circuit, such as ESP8266, Particle Photon, and other Arduino-based Wi-Fi modules.

This Project was undertaken to introduce a smart charging system that uses the charged device to automatically monitor its actions through the cloud. In IoT, systems can be designed to reduce power consumption as well as human effort.

The system being used is an ESP8266, the webserver is the IoT network, and the device can be separated from the platform. The system is designed to communicate with the webserver based on IoT and relays commands to the webserver. The device helps to monitor other devices and automatically sends notifications to the phone.

A system is designed to help control the power supply from the charger and monitor the amount of power the device consumes. Using this program, one can help prevent devices such as cell phones and laptops from being disabled or overloaded. Three basic components, namely an IoT device, an IoT platform, and a client device, will be used to design this system.

IoT has enormous potential in almost every field to develop new smart applications. Using techniques that extend the battery life of the IoT device and decrease its power consumption, their efficiency can be increased in energy-based IoT devices. This machine can be then used to manage the charge in mobiles, laptops and other electronic devices.

In this new digital landscape, the IoT plays an ever-important role, offering us ways to make our world more intelligent and interconnected than ever before. That said, there are still major challenges ahead that need to be addressed in order to enable companies to make the most of the IoT. As a key component of the smart revolution, the Internet of Things has great promise. This provides both increased efficiency and new services to improve citizens ‘ lives by allowing easy collection of data from the surrounding. In order to realize this dream, adequate application models and programming abstractions are needed to overcome the complexities of the physical world and help developers build applications faster and in a more efficient way.