Internet of Things: An Overview

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Abstract—Internet of Things is ubiquitous but still unknown because of its ability to fit into the lives of humans in such a way that we are unaware how efficiently IoT functions everywhere in everything. Internet of Things is actually all about the things of the internet. How everything is made with internet connection, to the extent that internet is not only a thing of technology but instead a vital part of the day to day life of all humans in one way or the other. The Internet of things has the power to transform the real-world things into intelligent things, which in turn make automata so easily incorporate into our lives that we don’t even realize its existence. In this research article, we present the history of IoT, the process of IoT and its characteristics. As a further matter this article pays particular attention on definitions, basic requirements, and the research challenges for internet of things. This research paper focuses on providing a general review of Internet of Things and its architecture. Nevertheless, this manuscript will give good cognition for the new researchers, who want to do research in the field of Internet of Things and make knowledge acquisition easy and coherent.

Keywords—Actuators, Barcode, Bluetooth, Cloud computing, Internet of things, Radio frequency Identification, Sensors, Smart Environments, Ubiquitous Sensing, Wireless Sensor Networks, Wi-Fi, ZigBee.

I. INTRODUCTION

A thing can be a device besides a traditional computer. We append to it some computational intelligence and it becomes an intelligent device. Further when we annex a network connection to the intelligent device to enhance its functions it becomes an IoT device.

Internet indicates inter network and network signifies connection. Thus, the internet of things represents the connection of things where things can be anything and everything. Everyday objects like electronic devices, technological products, and even the things that we do not generally think of as electronic things including food, clothing, plants, furniture, establishments, works of art and all the conglomeration of culture, nature and innovation, all can be the thing in the internet of things. That means here things can be both living things like humans, animals, plants or non- living things like watch, chair, refrigerator or all the more the elements like land, air and water. Ergo, things are any objects around us having a physical existence that we convert into intelligent things and adding network connection they are called IoT devices.

Internet of things implies how things are connected with each other and with humans providing a promising opportunity to build powerful systems and applications by transforming many existing systems and use the growing ubiquity of radio-frequency identification (RFID), and wireless, mobile, and sensor devices to maximum advantage.

In the early stages the term IoT was suggested to refer to idiosyncratic detectable connected objects with radio-frequency identification (RFID) technology. Subsequently, researchers relate IoT with more technologies such as sensors, actuators, mobile phones and GPS devices. Now a days, the definition for IoT that is often referred to is:

“where ‘Things’ are a device besides a traditional computer having an identity, physical aspect, and virtual personalities and use some type of computational intelligent and a network connection [1].”

IoT devices are different from standard general-purpose computers as IoT devices have a main function separate from computation. They are efficient in every aspect, considering both the software and the hardware, in the particular task they are designed for and inefficient in all other tasks. Whereas, computers are general purpose and function ordinarily at executing every task but are not particularly efficient for one work.

The main aim of Internet of Things is to make life easier. It enhances features without increasing complexity. Thus, IoT devices must have a very simple interface along with access to external computation and data.

II. HISTORY OF IOT

The convergence of many trends has facilitated the formation and growth of IoT. In earlier days, the size of computational technology hardware was very big and the cost of production was also very high resulting in limited availability of resources. On the contrary, now a days the hardware size has decreased manifold and the IoT devices need significant computation and speed which are readily available specifications in the hardware. Other developments that support the advancement of IoT is the availability of internet almost everywhere in the developed world. Wireless network is less expensive and demands no installation of physical cables and immobile big devices.
The data costs are fairly low and simultaneously the data bandwidth is relatively high. So now as the cost of computational technology has decreased we can add it to things to form the things of the internet alias Internet of Things.

The term “Internet of Things” was coined by Kevin Ashton of Procter & Gamble, later MIT’s Auto-ID Center, in 1999. In 1982, at Carnegie Mellon University a drink machine was modified to become a networked appliance, capable to delineate about itself. The strongly influencing piece of academic writing, “The Computer of the 21st Century”, by Mark Weiser, 1991 provided a vision for IoT around the same time. Other major technological advancements were also seen around 1993 and 1996 [2].

Although, the field started gathering momentum with the advent of Device to Device (D2D) communication. The concept of the Internet of things mainly became popular around 1999, through the Auto-ID Centre at MIT. Kevin Ashton preferred the phrase “Internet for Things.”

Finding its way into the everyday life IoT has come a long way in a very short span of time from 1982 where it was an idea in the making to today in its widespread but hidden stage in which it is facilitating health care, media and marketing, law enforcement, transportation and many manufacturing and consumer applications, to further spread in the future making every object connect and communicate with each other so that most of the objects that surround us will be on the network.

III. THE PROCESS OF IOT FORMATION

The process of formation of IoT can be expressed in numerous ways:

A. Knowledge Hierarchy

![Figure I Knowledge Hierarchy](image)

One is using the “knowledge hierarchy” (Rowley, 2007) or the DIKW Model, in which there are four stages [3]. Starting from the bottom to top is Data, Information, Knowledge and Wisdom. 

1) Data: In IoT data would refer to all the sensory stimuli the sensors gather, be it useful or useless. A sensor capable of hearing would hear everything in its surroundings. Whereas its functioning requires only a certain sound, hearing which it will perform the specific task it is designed for.
2) **Information:** According to the extensively accepted definition of information, information is processed data. For IoT information is the segregated stimuli on which it will function from all the data that it will capture. Considering the example we have taken to explain data, information is the particular sound that when the sensor hears it performs the task it is designed for.

3) **Knowledge:** It stands for the knowing part. To understand the information and know what is to be done with the information that is required by the user and applications, as usually it is not the information that humans need, but high-level understanding and concepts that provide human and machine comprehensible meanings and insights of the elementary data.

4) **Wisdom:** The comprehensible understanding and insight of the data gained by the knowledge can be then modified into intelligence with background knowledge to utilize the full capacity of IoT and create end-to-end solutions. Wisdom for IoT technology would refer to its capability to remember and analyze what is information and how to use it always, it signifies the device’s capability to remember and update its functioning and tackle any situation with intelligence.

**B. Three step process**

Another way in which we can better comprehend IoT is by following the simple steps mentioned below to form an IoT device using a general object.

1) **The Thing:** By referring to a device which is simply any object around us.

2) **Computational Intelligence:** Adding computational intelligence to it.

3) **Network Connection:** Giving it access to network connection.

**IV. IOT HARDWARE AND SOFTWARE**

Any IoT device is made of majority or all of the following elements [4]:

*The thing + Power source + Sensors and Actuators + Memory + Processing + Communication + UI/UX*

**A. The Thing**

The main building block of an IoT device is the device itself, the ‘Thing’. It can be any object around us having a physical existence. This object is then modified by the addition of the elements of the IoT device to form a device having high performance, efficiency, consistency and speed to perform a specific task it is designed for.

**B. Power source**

As any other device, IoT device too requires a power source to function. It is decided based upon the customer usage habits and the portability of the device. Apart from these the other factor that influences the power supply are the product intent and fault protection.

**C. Sensors/Actuators**

On one hand sensors are devices that convert physical properties and quantities to an electrical signal and on the other hand actuators are devices that convert electrical signals to a physical output [1]. And both are required by IoT devices as IoT devices are objects that originally do not have the capability to communicate or compute the data around it, sensors and actuators make it possible for these devices to understand their surroundings, gather the data, convert it into information and after computation present it in the form of a response. For instance hearing a particular sound the device will open the door or tell the daily schedule of the user (perform its task). Here the sensor captures the sound as an input out of all the sounds around it then after the device has processed it the task of opening the door is the output delivered though the actuators.

An IoT device may use any of the following sensors depending upon its requirements:

- Accelerometers, temperature sensors, magnetometers, proximity sensors, gyroscopes, image sensors, acoustic sensors, light sensors, pressure sensors, RFID sensors, humidity sensors, micro flow sensors, etc [5].

**D. Memory**

Memory is mandatory to store database, session data, user settings, etc. It also provides a platform to store any functions and programs required to run the IoT device productively.

**E. Processor**

Electronic circuit that performs the computations and process the basic instructions that run the device using some external source of data.
It is the core where the software is run and the data is processed into information.

**F. Communication**

The device on gathering the required data and getting a stimulus in most cases needs to communicate mainly using wireless communication. The choice of a communication medium depends on the range the device needs to communicate over and what data rates are available and what are required. The designer needs to take into consideration the use case because different communication protocols require different conditions, some require more power, cost and board space whereas some may require less power [6]. Some examples of communication mediums best suited for IoT devices include Wi-Fi, Bluetooth and ZigBee protocols.

**G. UI/UX**

User interface is the most vital part of technology as any device is nearly something that the general public has not seen before and the user interface is the only thing that comforts a user to use any device as if it were already existing around him. For IoT devices, especially the ones that offer control not just in a smart phone but on itself the importance of User Interface and User experience is significant.

V. ADVANTAGES OF IOT DEVICES

**A. Fast**

The IoT devices are made to make the users life easier hence all IoT devices offer swift services as the computational speed of the device is fast.

**B. Efficient**

IoT devices have a basic difference when compared with general purpose computers and that is that IoT devices are efficient. IoT devices are special purpose devices because of which the software and hardware are efficient for the task they are made for, though they are inefficient for other tasks.

**C. Accurate**

The ability of the IoT devices to accurately accomplish a task improves customer engagement. Accuracy achieves richer and more effective engagement with audiences as users find it definitive.

**D. Simple**

IoT enhance the features of a device without increasing the complexity. This feature of IoT makes it very convenient to use as users are comfortable in indulging with minimum possible complexity to make the tasks automated and reliable.

**E. Dedicated**

IoT devices have a dedicated functionality which makes them dependable as they are efficient in the task they are designed to perform. They perform a dedicated task and henceforth, there are less chances of the processing slowing down or going wrong.

**F. Connected**

It has the scope to stay connected to other devices, such as smart phones, etc. As well are capable of staying connected to users in a merging sort of fashion as they are constantly connected to the user in the form of a wrist band, clothing, jewelry, watches, etc.

**G. Always Available**

IoT devices try to provide users human facilities overcoming the limitation of humans as these devices are always available for the users. Unlike humans the devices do not need rest, sleep or food so they are readily available. This is a major advantage of IoT devices mainly in the field of healthcare where some users need constant monitoring for their wellbeing.

VI. DISADVANTAGES OF IOT DEVICES

**A. Security**

Where there is a network there are security issues as not all aspects are known or seen by the user. The IoT devices are constantly connected over the network which keeps the users revealed to attacks [7].

**B. Privacy**

The IoT devices are constantly watching over us and recording information. They observe us for our benefit and are tracking all our activities to fulfil the task they are made for [8]. The basic activity of an IoT device is to be pervasive to collect information. It has privacy as an issue as all the recording is done without the active participation of the user.

**C. Complexity**

IoT is complex for some in terms of design, use and maintenance. Though using a number of devices, each for a different task makes it a tiresome activity whereas the sole purpose of IoT is making life easier. In accordance to network, IoT is a very complicated network that includes the connection between various types of networks through various communication technologies [6].

**D. Flexibility**

It is a concern as to if in the IoT system devices are capable of integrating with other devices or there will be several incompatible and at variance devices [9].
E. Rely on technology

This is a critical risk of IoT. Humans are on the verge of completely depending on technology, the possibility of this happening seems like a major drawback of IoT.

F. Social isolation

Staying dependent on devices for every task users do not move out to fulfil any requirements, it makes users lazy and they stay entangled in technology to the extent that the amount of human interaction is diminishing and users are becoming socially isolated.

VII. CONCLUSION

Internet of things is powerful and pervasive. It has widespread applications as well as the ability to merge into the lives of the users to the extent that they may depend on it so much that they lose the social connect. The first part of the paper constitutes the meaning of IoT, its history and the process of making an IoT device to later going through its hardware and software requirements and the advantages and disadvantages of IoT. The ultimate objective of IoT is to enhance features of any device without increasing the complexity to make the life of the user easier. This paper reviews every aspect related to IoT that is important to understand IoT and its ubiquitous existence in the environment. Different from other IoT research papers, the main contribution of this research paper is that it focuses on providing basic and vital information for the new researchers, who want to do research in the field of Internet of Things. Presented here is the insight to the “Things” of the internet for a better understanding of the Internet of things.

REFERENCES