Internet of Things: Architecture, Applications, Challenges and New Technologies

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Abstract— Internet of Things is an innovation for researchers; it is vital technology for a smart person in life. IoT communicates between human, gadgets, and everyone. It can use different types of associations like wi-fi, Bluetooth. IoT authorized things will divide data about the state of things and surround condition with everyone, by chance of IoT, the universe will end up sharp in each insightful since Internet of Things will give a method for jagged urban communities. The growth for embedded is vast, and it is becoming day to day. In coming to future IoT is going to connect 28 billion till 2020 varying from gadgets like smartwatches and automobiles. In this paper, we will take a different scenario and technology used and thus conclude different summons to glance to a fitter solution which will help the group or community.

Keywords— Internet of Things, IoT Architecture, RFID, Wireless Sensor Network, IoT Applications, Future Technologies.

I. INTRODUCTION

The Internet of Things (IoT), also called the Internet of Objects, it will change everything including ourselves. The effect of the internet is on areas like education, communication, business, science, government[1]. It is the network of physical devices accessed using the Internet. Today, the Internet is one of the most important and powerful creations in all of human history, and now with using the internet of things, the internet becomes more favorable to have a smart life in all aspects [2]. The Internet of Things is not only a concept, but it can prove to be a revolution in new technology to change the lifestyles of humans altogether It links all the items with technology to create a new, different universe for those who interact with and the help each other via internet[3]. The idea of IoT is the extensive existence around us of a variety of things or objects like Radio Frequency Identification tags, mobile phones sensors, actuators, etc. Different addressing schemes can communicate with each other and collaborate with others to attain their common goals. The Internet of Things enables us to link anytime, anything and from any place using network [4].

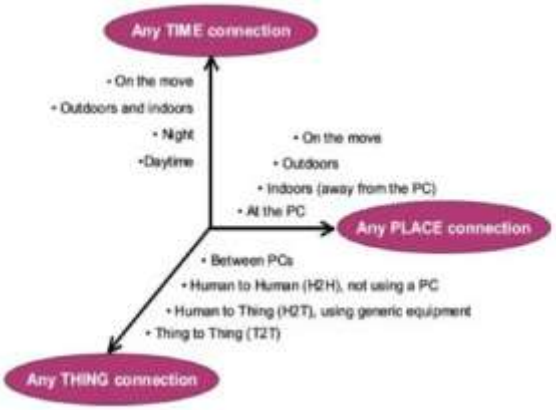

Fig.1. Dimensions of IoT

Fig. 1 shows that with the internet of things, anything will be able to interact to the internet at any time from any place to give facility by any network to everyone so this system will make a new type of application can include such as smart vehicle, smart home also to give various facilities such as notification, security, energy saving automation, communication and entertainment [5,6].

II. GROWTH OF INTERNET OF THINGS OVER PAST YEARS

In 2020 around 50 to 100 billion things will be connected electronically using the internet [7]. The following figure shows the growth of the things related to the internet from 1988 to forecast 2020.

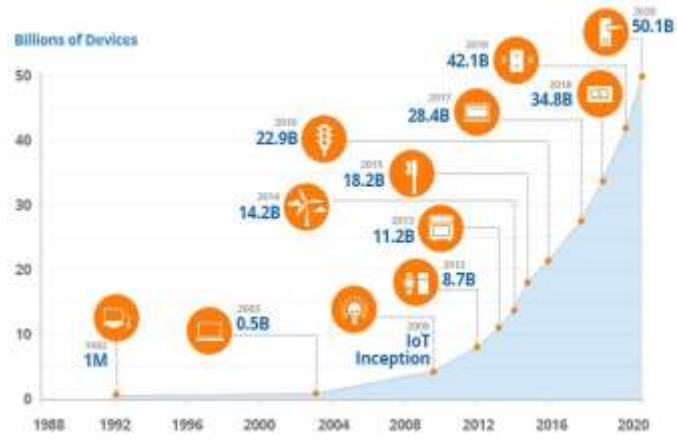

Fig.2. Internet of Things Growth

In the above graph the growth of IoT over the years. In 1992, only 1,00,000 people were using IOT as technology. Till 2003, the number grew to only half a billion people. In 2009 marked the IOT inception, 2012 witnessed a sudden increase in the use of IoT where the people reached 8.7 billion. The number of users has been increasing over the years reaching 28.4 billion in 2017. Now it is expected that the number will broaden to 50.1 billion by 2020. [8] The Internet of Things (IoT) will give technology to creating smart action for machines to communicating another machine with many different types of information [9]. The outcome of IoT depends on standardization, which provides compatibility, interoperability, reliability, and effective operations on a global scale [10].

III. ARCHITECTURE

The Internet of Things is inspected as the third wave of the World Wide Web after static web pages and social networking's based web. It is a worldwide network which connects various type of objects at any time and anywhere via a popular internet protocol called Internet Protocol [11, 12].

A) As stated by IoT forum architecture, it is divided into three layers, i.e., Perception, Network, and Application layer.

Fig.3. IoT forum Architecture

a) **Perception layer**: This is responsible for identifying smart objects in the environment.
b) **Network layer**: For dealing and routing purpose network layer is used.
c) **Application layer**: This layer is used for providing services to users through different applications.

B) According to ITU, IoT architecture is divided into five layers [13]:

- Sensing Layer
- Access Layer
- Network layer
- Middleware Layer
- Application layer

To additionally enhance the security aspect, again new six-layer architecture was proposed [14].

a) **Coding layer**: This is the topmost layer of IoT architecture which has a unique ID allotted to each object which helps in identifying each object uniquely [15].
b) **Perception layer**: It is also named as the physical layer. This consists of data and network sensors which would sense various attributes of objects and collects useful data about the object then converts it into digital signals. So here signals behave like input for the network layer. [16][17].
c) **Network layer**: The output of the perception layer is input for the network layer, and it is transmitted to the middle layer through various transmission media [18].
d) **Application layer**: This layer permits the user to approach various applications IoT provide. IoT found its applications in vast areas such as transportation, health care, government, retail, etc. [19].
e) **Business layer**: It is also called as a management layer, it manages all the applications and services of IoT.

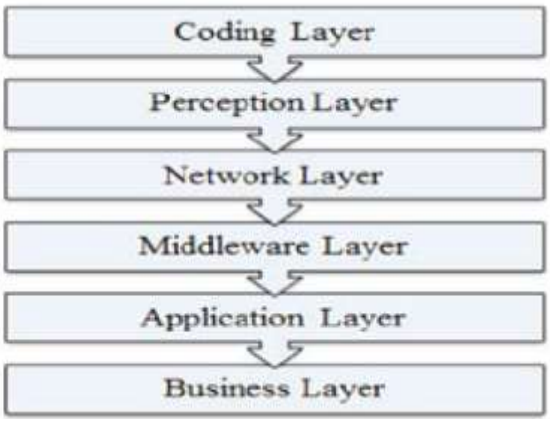

Fig.4. IoT Six Layer Architecture

IV. TECHNOLOGICAL BACKBONE

Following are three elements of IoT that aids seamless connectivity:

(i) Hardware: It consists of various sensors, actuators, embedded devices and communication devices.

(ii) Middleware: It consists of multiple tools used for the storage of data collected by sensor devices, and this is used for data analytics.

(iii) User End Visualization: It consists of data visualization and interpretation tools. This can be retrieved on various tenets which assist the end user to keep a mark of events operated by those data collected by sensible hardware's. The Internet of Things contains several joined smart devices which involve various technologies located such as Radio Frequency Identification (RFID), sensor technology, and intelligent embedded technology. The pillar of IoT is RFID. It also supports some new upcoming technologies like, remote communication technology, remote information transmission technology [20]. There are certain technologies which will provide a clear moral sense for the three components mentioned above.

A) Wireless Sensor Network (WSN):

The advances in wireless communications and low power integrated circuits have made it a possibility of making available efficient, low power miniature, low cost, devices to use in remote sensing applications. The data collected by various sensor nodes are sent to either centralized systems or distributed systems for further processing and analysis that helps in various decision-making processes. Wireless Sensor Network consists of independent devices which have sensing capabilities for monitors physical or environmental conditions like temperature, pressure [21]. It consists of sensor nodes and the base station as depicts in Fig. 5.

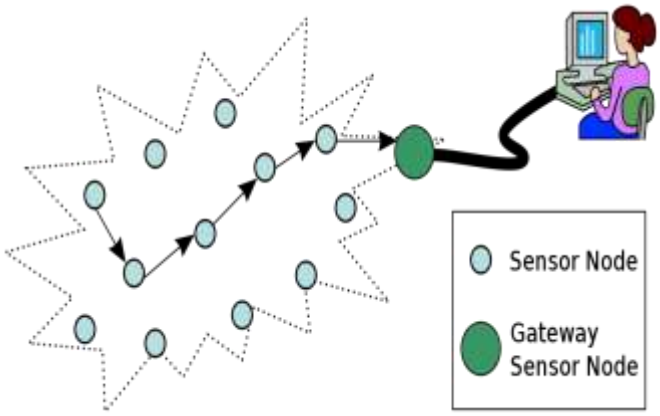

Fig.5. Wireless Sensor Network

The point of exchange information with each other using radio signals. Data is moved from one point to another [20] and a base station behave as a mediator between users and the network [21].

B) Radio Frequency Identification (RFID):

A radio frequency identification system uses tags or labels attached to objects to be identified. These are the types of RFID tags: Active Tags and Passive Tags. Passive tags are not cell powered; they use the power of the reader's inquisition signal for interacting the ID to the RFID reader. Below diagram shows the RFID view:

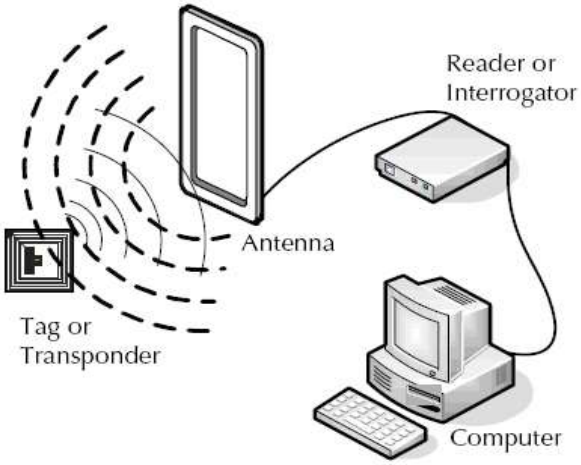

Fig.6. Radio Frequency Identification

V. INTERNET OF THINGS APPLICATIONS

There are many applications like smart homes, smart city, smart energy, and smart grid, smart wearable, smart environment, smart health, shopping, agriculture, smart transportation, and mobility.

a) Smart Homes: Homes and buildings may operate many devices and objects smartly using the Internet of Things. In that application of IoT includes security, smart lighting, smart media, central heating and air controlling, energy management as shown in the following the figure.

Fig.7. Smart home applications

Now a day's Wi-Fi technology in automation home has been used primarily because of networking connected nature of deployed electronics where such devices as TVs, mobile devices. These are usually supported by Wi-Fi [22].

b) Smart City: These cities are where information technology is the principal infrastructure and the basis for providing important services to peoples. Smart cities can be improved in many stages by improving infrastructure facilities, public transportation with reducing traffic congestion, keeping citizens safe and more engaged in the community as depicted in figure 8 [23].

Fig.8. Smart Cities Aspect

c) Smart Energy and Smart Grid: A smart grid is about information, control and developed for smart energy management. It is a system that integrates the information and communications technologies to the network of electricity will make a real-time, two-way communication between suppliers and consumers, it also creating more dynamic interaction to energy flow which helps deliver electricity by more efficiently and sustainably [24]. There are different applications that can be handled using the internet of things for smart grids like industrial, solar power system, nuclear power system, vehicles, hospitals and control of cities power.

Fig.9. Smart Grid Applications

d) Smart Wearable: These are networked devices which collect data, track activities, and customize experiences to people's needs and desires. Wearable's devices mainly cover fitness, health and entertainment requirements. The internet of things technology for wearable applications is to be highly energy efficient which means ultra-low power and small sized.

e) Smart Environment: Smart environment is where located everything comprises of "smart system" like smart buildings, smart utilities, smart government [25]. The smart environment is a dominant system in our day to day life; It provides many facilities for many environmental applications like air and water pollution, weather monitoring, waste management, and natural disaster and other environment indicators shown in the following the figure.

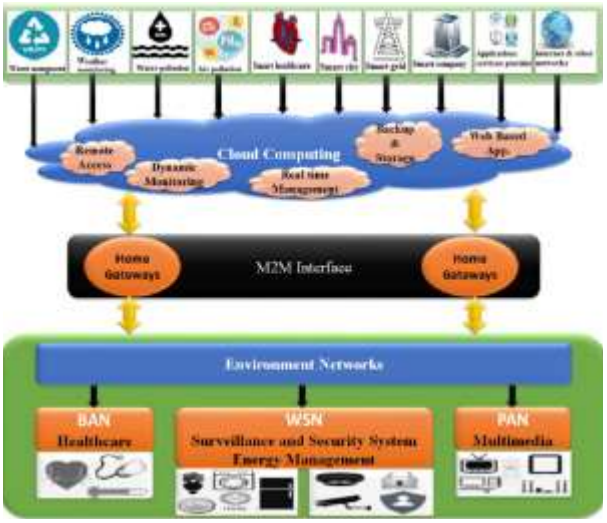

Fig.10. Smart Environment based IoT

Smart environment devices combination with the Internet of Things technology is evolving for tracking, sensing, monitoring objects related to the environment which provide advantages to achieve a sustainable and green world life.

f) Shopping: Now at the time of shopping in a market, the goods will automatically introduce about them and also when you buy it will give the signal to staff to put a new one there. So in this way, it is making the shopping facility very smart.

g) Agriculture: In the field of agriculture IoT helps in improving the production rate of crops. It also assists in monitoring the soil texturing, quality, humidity of soil, with this help it is detecting which area is suitable for a particular crop and which not [26].

VI. INTERNET OF THINGS CHALLENGES

The Internet of Things arise with different new opportunities applications in many fields, but it faces certain challenges as well [27].

a) **Security:** It is one of the biggest challenges, some devices such as sensors, actuators which are directly accessible, so they are prone to different security attacks like spoofing, denial of service, altering attack [28]. So for security, it is needed to deploy against attacks.
b) **Standard and interoperability**: Collection of standards has a huge impact on the Internet of Things. Each object which sort IoT have diverse data, preparing and correspondence abilities. First diverse object likewise subjected to different conditions, for example, the vitality comprehensibility and the correspondences data transfer capacity necessities. To stimulate correspondence and participation of these things, basic benchmarks are required [29].
c) **Self-Organizing**: Smart things should not be handling as computer systems that require their users to the formation and adapt them to specific situations. Mobile things which are often only isolated used, need to establish connections automatically and able to configure themselves to suit their specific environment.
d) **Data Storage:** As the amount of data is become larger with a very high pace, so it is major problem of storage of data. It also affects data protection, if stored data crash then it is hard to backup all the stored data. So it is also an important problem in IoT.
e) **Data Interpretation:** To aid the clients of accurate things, there is a need to convert area setting by sensors as marked under situations. For expert organizations to benefit from the differing information that will be performed should have the capacity to reach some inducible deduction from decoding sensor information.

VII. CONCLUSION

Internet of things is another revolution which provides many applications to connect the things to other things and people to things through the internet. Every interrogation in actual can be differentiated with each other through a network. All system and revolution of correlating are used as a part of making the idea of a network of things such improvement are adaptable indexing, RFID, inserted framework, strategies to get management forms, putting away facts and safety issues. This paper has tried to highlight the IoT in simple through the four sections namely; section I, discussed an overview about the IoT. Section III focuses on the technical backbone for the realization of IoT. Section II discussed about the growth of IoT over past years. Section III and IV reviewed an architecture and technological backboned of IoT. Section V evaluate a set of the popular applications which are provided by IoT such as Smart Homes, Smart Wearable , Smart Environment, Smart Environment. Section VI discussed a set of challenges faced of the Internet of things. Based on this paper, It can be assumed that new research problems creates due to the huge scale of devices, the physical connection and internet worlds and continuing issues of privacy and security.

VIII. REFERENCES

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