

IoT Creating an Ingenious, Collaborative and Congruent World

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Abstract: “When wireless is perfectly applied, the whole earth will be converted into a huge brain, which in fact it is, things being particles of a real and rhythmic whole and the instruments through which we shall be able to do this will be amazingly simple and compact so that it could be carried in the vest pocket.” – Nikola Tesla. The Internet of Things is the smart interconnection of things over the present and future Internet infrastructure. IoT has the ability to revolutionize complete human life in every domain of present life and even beyond imagination. It allows smart human lives allowing communication between objects, machines and everything together with people. With the evolution of the Internet to cover the real-world, many new services will be enabled that will completely ameliorate people’s everyday lives, generate new businesses opportunities, and make cities, buildings and transport smarter. This fantastic opportunity provides some security challenges also. This paper analyzes the basic working and features of Internet of Things. Trends in the Internet of Things with the goal of scrutinizing and inspecting their privacy implications are also discussed. Later, the impact that Internet of Things in our day to day lives is discussed, pointing out the challenges that need to be overcome to ensure that the Internet of Things becomes a benison reality.

Keywords: Applications, Cloud, IoT, Sensors.

I. INTRODUCTION

Internet of Things is a concept which enables communication between interconnected devices and applications, whereby the things communicate through internet. Its working is based on identity communication devices. The internet is a vast global network of connected servers, computers, tablets, and mobiles governed by connected systems. Fundamentally Internet of Things is the physical connection of objects embedded with electronics, software, sensors to achieve greater service by exchange of data.[3] Under this each thing is uniquely identifiable through embedded computer system. The Internet of Things is the interconnection of numerous devices (billions to trillions); smart things around us – uniquely identifiable and addressable everyday things with the ability to collect, store, process and transfer information about them and their surroundings IoT has the capability to provide a new level of high class services based on acquiring data with the help of smart things in a populated environment like our work space. Some of the famous IoT systems are –advanced database management systems, pervasive health-care, public scrutiny, and data acquirement in our day to day life. [1,2]

Physical object+ sensor + internet = Internet of Things

II. COMPONENTS OF IoT

The working of IoT can be basically divided into 4 major components:

2.1 Sensors and devices: Sensor can be defined as an object that is responsible for collection of data from their surroundings. They basically have sensitive collector parts which are capable of gathering information which may be in the form of heat, light, sound, any movement etc. In a particular device one can use multiple sensors performing the job much more than just sensing the environment, for e.g. – a mobile phone i.e. a smart phone has sensors but still a mobile is not just a sensor but it also has several other functions also.[4]

2.2 Connectivity: The sensors can be connected to the cloud through a variety of methods including – cellular satellites, wifi, Bluetooth, low power LAN, or even Ethernet. Choosing which connection is best suitable for the job required to be done or depending on which IoT application one is working upon, since the utmost job is to make the data reach the cloud in an appropriate manner.

2.3 Data processing: Once the data exits from the cloud interface, software come into action and perform some kind of process on the data. The various functions performed here include simple and complex processes like checking temperature readings etc, or complex operations like using computer vision on video to identify objects (used to check any intruders). But what if the data exceeds the limit set by standards like temperature is above the set standards, that’s where the USER INTERFACE comes into action.

2.4 User interface: The next step in the operation of IoT is the interaction between user and machine. This could be via an alert to user, email, text, notifications etc. Also there can be a possibility of interaction that allows users to proactively check and intrude into the operations of the system. E.g. – a user might want to check the video of his or her house via a phone or web. This becomes possible by user interaction principle of IoT. However there can also be cases where the user doesn't want the system to every time ask for command and then function, instead it wants that some crucial decisions be taken by the IoT itself via the predefined rules and standards set up previously.[3,5]

III. WORKING PRINCIPLE OF IoT

The Internet of Things (IoT) is a system in which various computing devices including mechanical and digital machines are interrelated, objects are provided with unique identifiers which performs the task of transferring the data over a network without requiring human to human interaction.

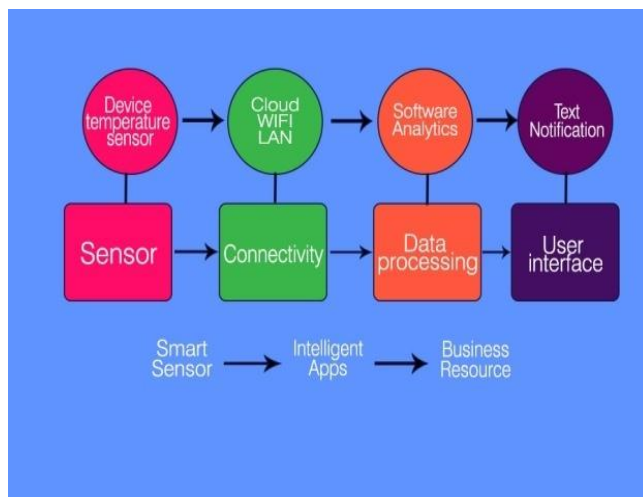


Fig 1. Working of IoT

IV. ROLE OF CLOUD IN IoT

Cloud is a huge interconnected network consisting powerful servers that perform services for business and for people. Cloud works on the principle of pay as needed and hence very cost effective and crucial for businesses since it meets its variable needs. Activities like storage and data processing take place in cloud rather than on device, and this is the main implication of IoT. Using the cloud is highly important for aggregating the data and drawing insights. Companies such as Amazon, Google, Microsoft are one of the largest cloud service providers in the world.

Another dimension of cloud is that it allows for high scalability. Cloud is like the “brain of IoT”. When there are hundreds of sensors putting their input it becomes extremely expensive, time consuming and energy wasting job. Instead, data can be collected together and passed to the cloud from these sensors and processed there collectively. Sensors and devices only collect data but the major task or the smart stuffs

happen in cloud. Cloud solutions give enterprises the ability to consume significant amounts of data, whether it's latent or in real time; store that data; and apply rules and structure to it for consumption. Cloud computing technology and a flexible consumption-based price structure corresponding with off-premises hybrid, private, or public cloud compute models have generated the ability to deliver new offerings to market, which were simply not achievable in the past.

Cloud is not the basic necessity for IoT to perform its task. IoT can also perform its function without cloud by processing and commanding data locally rather than in the cloud via an internet connection. Such technique is called as fog computing or edge computing. However, there are substantial benefits of using clouds for many IoT applications. Not choosing cloud would slow down the process and finally lead to increased cost. [6,7,8]

V. ADVANCEMENTS IN IoT

In the 1990s, Internet connectivity began to proliferate in enterprise and consumer markets but its use was limited due to its poor network connectivity. In 1999 the term Internet of Things was coined by Kevin Ashton, Executive Director of the Auto-ID Center in Massachusetts Institute of Technology (MIT wrote about IoT principles in his book titled “When Things Start to Think”. In the 2000s internet connectivity improved and LG announced its first Internet of refrigerator plans.

By 2002 David Rose created the “The Ambient Orb” which was named by NY magazine as the Idea of Year. In year 2004 RFID was deployed on a massive scale by the US Department of Defense in their Savi program and Wal-Mart in the commercial world. IoT flourished when invisible technology started operating behind the scenes dynamically reacting to how we want ‘things’ to act.

In 2005 The UN's International Telecommunications Union (ITU) published its first report on the Internet of Things topic. By 2008 it had already captured a part of the industrial sector when a group of companies launched the IPSO Alliance to promote the use of IP in networks of “Smart Objects” and to enable the Internet of Things, US National Intelligence Council listed the IoT as one of the 6 “Disruptive Civil Technologies” with potential impacts on US interests out to 2025. Noting the increase in the number of connected devices and the popularity it gained, In 2010 Chinese Premier Wen Jiabao called the IoT a key industry for China and had planned to make major investments in Internet of Things. In 2011 IPv6 was launched (a new protocol) which allowed for various addresses to be used for connecting IoT devices. To date, the world has deployed about billion ‘smart’ connected things. According to the predictions, there will be 50 billion connected devices by 2020 and in our lifetime we will experience life with a trillion-node network. IoT is thought as a billion of connections making life easier and smarter. In a nutshell, from technological perspective the IoT is being defined as smart machines interacting and communicating

with other machines, objects, and infrastructure, resulting in generation and processing of data into useful data than can independently ‘command and control’ things and make life easier for human beings. [9, 10] The following graph is drawn between the increase in the number of devices (millions) over the years.

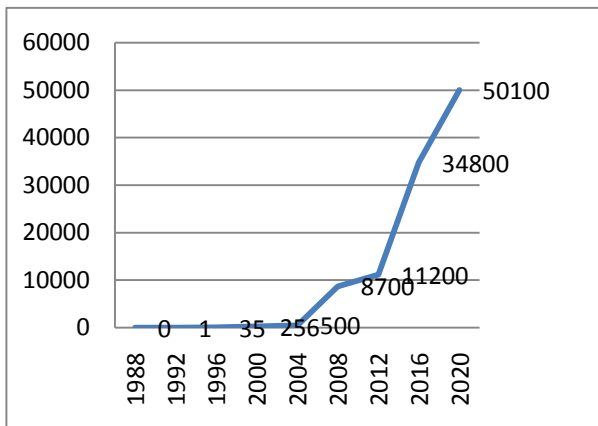


Fig 2. Outburst of IoT

VI. APPLICATIONS OF IoT

IoT is making life easier and also bringing it to next level. It offers huge range of applications for the betterment of life of people and making it more “smart”. There are many fields which include the applications of IoT such as homes, offices, vehicles, industries, medical fields etc. The major advantage of IoT is that its entire application can be completed at extremely low cost and hence it proves to be cost effective even for small scale business.

The *Internet of Things (IoT)* proves to be an asset to human life. Connection of all the things wirelessly through the cloud enables to create “magic” in individual’s life. The most important applications are explained below.

6.1 Smart cities: This includes connection of different parts of the cities to a common database which is easily accessible. It also allows effective monitoring of the availability of parking areas as well as the vibrations and material conditions in buildings, bridges and historical monuments. Intelligent highways with warning messages and diversions according to climatic conditions and unexpected events like accidents or traffic jams could also be implemented.

6.2 Security & Emergencies: IoT has huge scope in this domain. Several hazardous situations can be checked upon and eliminated using this. Detection of gas leakages, generation of leakage alerts in nuclear stations is amongst one of the most important applications. [13]

6.3 Smart Agriculture: With the help of IoT the yield, variety and production of crops could be greatly enhanced. Soil moisture, irrigation, humidity could be checked and controlled for product enhancement. By creating the

“automatic green house” through IoT, micro climate conditions can be created to maximize the production of fruits and vegetables’ quality. Another big application of IoT is setting up of “Meteorological Station” to study weather conditions in fields to prevent the crops from drought, hail etc.

6.4 Domestic & Home Automation: Home automation provides smart homes by which appliances can be controlled remotely so that accidents can be avoided. Also it reduces bills and resource usage. Intruders could be prevented from entering into the home by “intrusion detection system of IoT” providing safe living. The artistic work and heritage goods which are present in the museum can also be preserved by proper monitoring using IoT to prevent them from unfavorable conditions.

6.5 Medical field: There are various domains in medical field where application of IoT is very advantageous. It can be used for monitoring patient’s condition in a hospital and old people at home. e.g. a tiny wearable band can be worn by a patient and a healthcare alert can be sent for medical assistance. Medical fridges with automatic controlling are provided for storing medicines, vaccines and organic elements. When accident occurs, victims medical conditions are readily made available to the doctor through IoT.[13]

6.6 Industrial Control: There are various industrial applications of IoT. It includes “Machine to Machine Applications” to auto-diagnose the problems in various machines and to monitor them. Also, “Indoor Air Quality” can be monitored by IoT by checking oxygen levels and toxic gas inside chemical plants to ensure security of workers and safety of goods. Ozone and temperature can also be controlled in food industries and also to maintain the desirable temperature conditions in other mining industries.



Fig 3. End user applications

VII. PROVOCATION OF IoT

IoT will not be able to reach its complete potential, until the sensors are self-sustaining. It is not possible to change the batteries of millions and trillions of devices across the planet and even in space every time and during every situation. So,

finding a different way for the sensors to get charged such as from environmental elements viz. vibrations, air, light etc. is the need of the day. Internet of things has found its pace and will continue to grow on its way. The possibility and opportunities IoT brings from businesses and consumers is tremendous.

To attain long term sustainability IoT needs to improve upon potential crashes because as soon as the connection interrupts or cloud crashes it would stop working which would mean a major setback for organizations, especially health care and safety sectors will suffer tremendous financial losses.

The future aims at eliminating latency that is to reduce the time taken to send instructions or data to the cloud and the processed data back to the user. For example, in an automated vehicle if a crash is un-avoidable then individual, doesn't have to wait for the instructions from the cloud instead it will be self sufficient to take the appropriate steps. [11]

VIII. DATA RELIABILITY AND SAFEGUARD

21st century embarks the explosion of data in every field. Data is perceived as a paramount collaborative asset that needs to be secured. Loss of information can lead to direct financial losses such as sales, fines etc. One of the main components of IoT i.e. RFID is most vulnerable as it allows person tracking and does not allow any implication of specific intelligence and protection against the internal malicious attacks. Therefore new methods to ensure security are required. For this there are 3 approaches of security control i.e. Preventive, Detective and Responsive. "Proactive not Reactive; Preventive not Remedial".

Within the context of an IoT System, it is important to consider the potential privacy outcomes prior to putting the system into an operational state. At the beginning, analysis will focus on data types collected, to understand which are sensitive and what regulations are needed to be applied to each data type. Then in-depth analysis should be undertaken so as to understand the indirect privacy outcomes for the operation of various IoT components. For instance, while handling applications to track connected automobile, it becomes necessary to interpret whether the tracking would reveal patterns of driving. Any security mechanism must be able to serve the required purpose by preventing a compromise, diagnosing that a compromise is underway or responding to a compromise after it has been discovered is indicated by the principle of defense in depth.[14]

For safeguarding data in IoT digital signature can be used. It uses key infrastructure which has the ability of protection against both loss of confidentiality and integrity. When a fraud tries to intrude into the system encrypted with digital signature it prevents the user for accessing the data, detects the source of intrusion and responds by initiating alerts to the moral user. This way we can enhance the security by associating the IoT system with digital signature.

Authorization protocols in IoT are of major importance to avoid misuse of data since here data flows autonomously and without human knowledge in place. Principles of informed accord, security and data confidentiality must be safeguarded in order to promote more universal adoption of the technologies underlying the IoT. Also, protection of privacy is not only related to technical solutions but also have market based and socio-ethical considerations. The development of IoT will be obstructed until the concerted efforts of government, civil society and private sector are not made. We can seize the future benefits of a fair and user-centric IoT through awareness of these technological advances and the challenges they present. [12, 13]

IX. CONCLUSION

Internet of Things is the new emerging technology which has inter-connected things as well as humans to things. Every object in the world now can easily be identified, connected and is capable of making decisions independently. This has greatly altered the lifestyle of an individual and also the working of an enterprise. Due to its wide distribution and easy connectivity it can be used in enhancing the transport, security, working in different areas. Presently, the main aim is to connect maximum possible devices through IoT so as to make their working easier as well as maintaining the required database on a common platform so that it is reliable, easily accessible without even compromising the security.

Currently IoT is spreading like a wildfire and it is estimated that in less than a decade it would nearly capture the whole world and change every aspect of our lives. The big revolution is yet to occur which would remarkably revolutionize the industrial production because it has the capability to work without the presence of humans which would ultimately result in the overall development of the country. This paper surveyed the evolution of IoT, focused on its working technique, efficiency of cloud and M2M, and brings into view some of the most important applications of IoT in the present world; reveal the upcoming technologies related to it with a belief of transforming the future by its uses.

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