A Study on Internet of Things

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Abstract

One of the fuzz words in the Information Technology is Internet of Things (IoT).In the upcoming era real world things like cars and buses, homes, factories, machine and tools will be connected to the internet in order to make our lives easy and more comfortable. The IoT aims to incorporate everything in our surroundings under a general infrastructure; it gives us control of things around us as well as keeps us informed of the state of the things. The main purpose of this paper is to provide a summarization of Internet of Things, architectures, and fundamental technologies and their usages in our day to day routine. IoT is an apprehensively connected system of smart devices that arrange automatically, share information, data and resources, responding to a situation and changes in the environment.

Keywords: Internet of Things, Network, Cloud Storage, Object, RFID, Sensors, Wi-Fi, Artificial Intelligence

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I. INTRODUCTION

The Internet of Things is a revolutionary invention in the field of Information Technology. The phrase Internet of Things is abbreviated as IoT which is made up of two words i.e. the first word is Internet and the second word is Things. IoT can be defined as the networked interconnection of mundane objects, which are often equipped with ubiquitous intellect. [1] It will lead to rise in the presence of the Internet everywhere by coordinating every object for communication through inbuilt systems, leading to a highly distributed network of objects communicating with human beings as well as other objects. It uses standard network protocol TCP/IP to serve millions of users worldwide.

The upcoming trend in the era of computing will be outside the extent of the traditional desktop. [2] In the Internet of Things (IoT) paradigm, various objects or things that surround us will be present on the network in various forms. [3] Radio Frequency Identification (RFID) and sensor network technologies will progress to encounter this new challenge, in which information and communication system is invisibly enclosed firmly in the environment around us. This will result in the generation of large amounts of data which has to be stockpile, processed and put forward in an even, efficient, and easily enunciable form.

[4] The term Internet of Things was first used by Kevin Ashton, founder of Auto-ID Centre at MIT in his presentation in 1991. Ashton was part of a team that discovered how to connect objects to the Internet through an RFID tag.

The Internet of Things focuses on increased system-to-system communication; it's built on cloud storage and networks of data-assembling sensors; it's changeable, virtual, and momentary connection; and it is believed that it's going to make everything in our lives from streetlamps to airports intelligent. A sensor is not a machine and does not work similar to a machine. It measures, it analyse; in short, it collects data. The Internet of Things realises in the form of connection of sensors and machines. It means that, the real value of the Internet of Things is created at the junction of gathering data and provide with leverage. All the information accumulated by all the sensors in the world isn't worthy unless there isn't an infrastructure in place to evaluate it in real time.

The key to using large amount of data is Cloud-based application. The functioning of internet of things is not possible without cloud-based applications. It is these applications that interpret and transmit the data coming from all the sensors. It is cloud that enables the apps to go to work for us at any place and at any time.

Let's look at one example. In 2015, large devastation was caused due to an earthquake in Nepal and some regions in India. In future the number of deaths due to an earthquake can be reduced with the help of IoT. Intelligent IoT devices embedded with various sensors are installed in building, bridges, lakes, rivers, underground pits, nearby mountains, etc. then the data collected can be used to study the movements of the tectonic plates of earth and predict earthquake or areas that are prone to earthquake in order to reduce loss of life and property.

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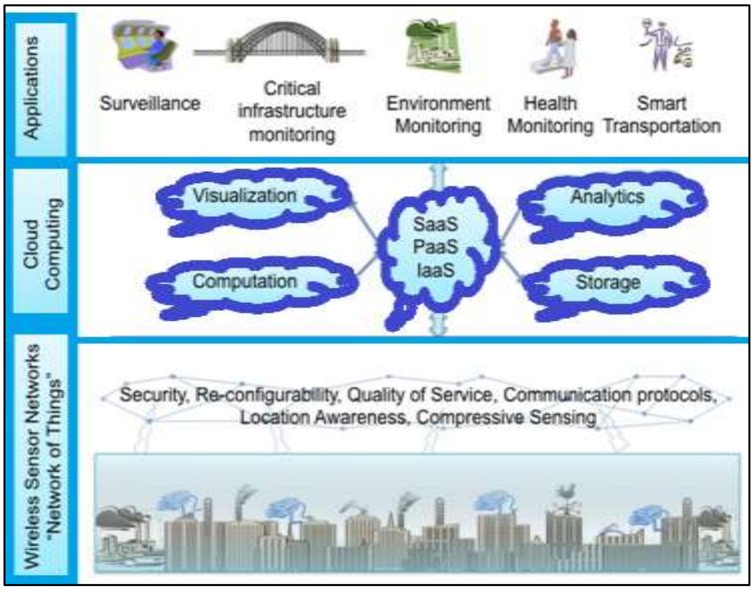

Fig. 1: Internet of things

II. IMPORTANCE OF IOT

In general, the IoT promotes a heightened level of awareness about our world, and a platform from which to monitor the reactions to the changing conditions that said awareness exposes us to. And, like the advent of the Internet itself, the IoT enables a myriad of applications ranging from the micro to the macro, and from the trivial to the critical.

There are two main effects we see in the Internet of Things. First, things are connected to a service that manages them. We can now monitor things, predict when they break, know when they are being used or not, and in general begin to exploit things as managed resources.

The second, bigger effect comes from the Metcalfe effect, or simply the network effect, of connecting things together. Bob Metcalfe once stated that the value of a communications network is proportional to the square of the number of connected compatible communicating devices. Since then it's used to refer to users, but maybe Bob was thinking way ahead. Notice the word compatible. In this context, it means to be able to meaningfully exchange data.

When we connect physical objects to the network, and connect them together in such a way as to manage them as a larger system, we can exploit the Metcalfe effect applied to the resources. We are converting capital assets into managed resources and then applying network management.

Because Internet of Things will be built as a physical graph, it's socialization of everything, from simple everyday devices to industrial devices. Metcalfe states that 10X connections is 100 times the value. Cisco is projecting that the Internet of Everything has the potential to grow global corporate profits by 21 percent in aggregate by 2022. I believe these represent a case for pure information on one end, and an average efficiency gain over all of industry on the other.

III. TRENDS

Internet of Things has been identified as one of the emerging technologies in IT. It has been forecasted that IoT will take more than 10 years for market adoption. The popularity of different paradigms varies with time. The web search popularity, as measured by the Google search trends during the last 12 years for the terms Internet of Things and Big Data are shown in Figure 2. As it can be seen, since IoT has come into existence, search volume is consistently increasing with the falling trend for Wireless Sensor Networks. As per Google's search forecast, this trend is likely to continue as other enabling technologies converge to form a genuine Internet of Things.

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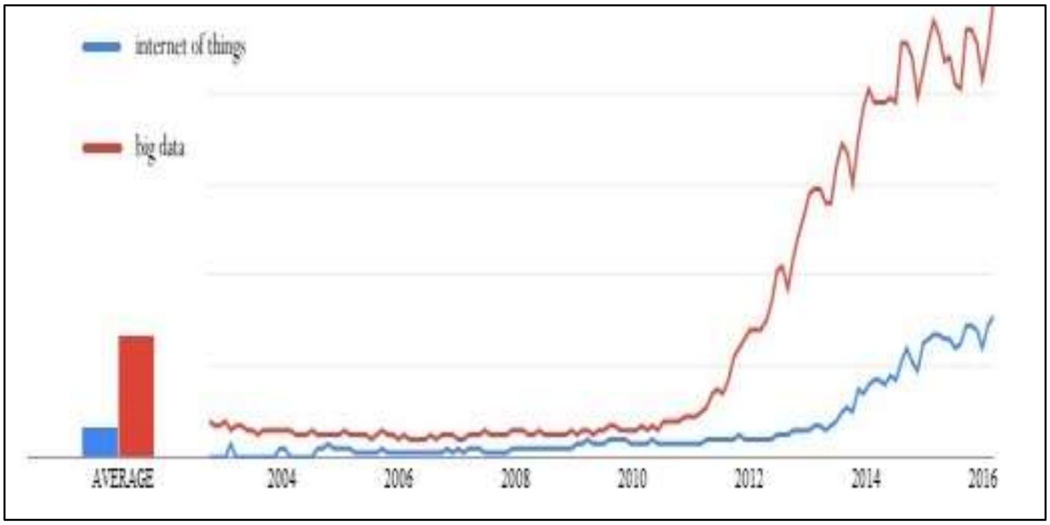

Fig. 2: Google search trends since 2004 for terms Internet of Things and Big Data.

IV. ELEMENTS OF IOT

We represent specific classifications that will help to describe the components requisite for Internet of Things from a high level perspective. Specific classification each unit can be searched anywhere also. There are basically three IoT components which are defined such as:

1) Hardware - which consist of sensors, embedded communication hardware and also actuator.
2) Middle-ware - used for computation related tools for data analytic and on demand storage.
3) Presentation- guide is usually easy for interpretation related tools which can be designed for many applications and can be also widely accessed on different platforms and it can also be used for understanding visualization. In this below section, a few technologies which fall in these categories which will constitute the three components as stated above:

A. *Radio Frequency Identification (RFID):*

RFID technology is a major advancement in the embedded communication areas which allows designing of microchips for wireless data communication. It also aids automatic identification of anything they are attached to use as an electronic bar-code. There are generally two types of RFID tags; these are passive RIFD and active RFID. Firstly, passive RFID tags do not have their own battery power, instead the power of the reader's interrogation signal for communication to the ID to the RFID reader is used. There are various applications particularly in supply chain management and retail sector, this has resulted. Also applications such as transportation (replacement of tickets) and access control applications it can be found. The passive tags are recently being used widely in many bank cards and road toll tags which is the first global deployments. Secondly, Active RFID readers are battery powered and can start the communication. The most important application of active RFID tags is in port containers to monitor cargo.

B. *Wireless Sensor Networks (WSN):*

Advancement in technology in wireless communication and integrated circuits that has low power due to which the small-scale devices that are efficient, low cost, low power has made available for use in remote sensing applications. The sum-up of all these factors has enhanced the viability to utilize a sensor network comprising of a wide range of intelligent sensors, allows the collection, analysis and distribution of valuable information, accumulated in a variety of environments. Active RFID is almost similar to as the lower end WSN nodes with restricted processing capability and storage. Sensor data are allocated among sensor nodes and sent to a centralized system for analyzing the data. The components that compose the WSN monitoring network include:

C. *WSN Hardware:*

In this WSN hardware, a node contains processing units, sensor interfaces, and power supply and transceiver units. Inevitably they consist of multiple A/D converters for sensor interfacing and more modern sensor nodes has one more advantage to communicate using one frequency band making them more flexible.

D. *WSN Communication Stacks:*

Designing a significant topology, routing and MAC layer is critical for scalability and durability of the deployed network. Nodes in a WSN needed to communicate among themselves in order to transmit data in single or multi-hop to a base station. The node degraded network lifetimes and drop outs are recurrent. At the sink node communication stack should be competent to interact with the outside world via the Internet to act as a gateway to the WSN subnet and the Internet.

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E. WSN Middleware:

It is a mechanism for combining cyber infrastructure with a Service Oriented Architecture (SOA) and sensor networks to provide accessibility to varied sensor resources in a deployment independent manner. This is basically based on the idea of isolating resources that can be used by so many applications. A platform independent middleware for developing sensor applications is needed, like an Open Sensor Web Architecture (OSWA). OSWA is created upon a uniform set of operations, standard data representations as elucidate in the Sensor Web Enablement Method (SWE) by the Open Geospatial Consortium (OGC).

F. Secure Data Aggregation:

A secure and efficient data aggregation method is essentially required for extending the longevity of the network as well as assuring reliable data collected from sensors. As node failures are a common characteristic of WSNs, the network topology should have the capability to cure itself. Ensuring security is critical as the system is protecting it from intruders and system is automatically linked to actuators becomes very essential.

G. Addressing Schemes:

Addressing schemas is the capability to uniquely identify Things 'is critical for the growth of IoT. This will not only enable us to uniquely identify billions of devices but also used to control remote devices with the help of the Internet. The few most essential features of designing a unique address are: reliability, uniqueness, persistence and scalability. Every component that is already connected and those which not yet connected must be identified by their unique location identification, and functionalities.

The currently used IPv4 may support to an extent where a group of cohabiting sensor devices cannot be identified individually but geographically. The Internet Mobility attributes in the IPV6 may reduce some of the device identification problems; however, the diverse nature of wireless nodes, concurrent operations, variable data types, and confluence of data from devices aggravate the problem further.

Another aspect of IoT is the tenacious network functioning to channel the data traffic is lasting and omnipresent. Although, the TCP/IP taking good care of this mechanism by routing in a more efficient and reliable way, from source to destination, but the IoT confront a bottleneck at the interface between wireless sensor devices and the gateway. Moreover, the scalability of the device address of the existing network must be sustainable. The addition of networks and devices must not confine the reliability of the data over the network, performance of the network, the functioning of the devices or the effective use of the devices from the user interface.

In order to meet these issues, the Uniform Resource Name (URN) system is fundamental for the development of IoT. URN has created copies of the resources that can be accessed through the URL. Spatial data being gathered in very large amount, it is often quite essential to take advantage of the benefits of metadata in order to transfer the information from a database to the user through the Internet. IPv6 also gives suitable alternative to access the resources in a unique way. Another critical aspect of development in addressing is the development of a light-weight IPv6 that will allows addressing home appliances distinctively.

Wireless sensor networks, which run on a various stack compared to the Internet, IPv6 stack cannot possess to address each individual, and hence a subnet with a gateway having a URN will be prerequisite. A layer for addressing sensor devices by the relevant gateway is much needed. At the subnet level, the URN for the sensor devices could be the unique IDs not like human-friendly names as in the lookup table at the gateway to address this device. Also, at the node level every sensor will have a URN (as numbers) for sensors to be addressed by the gateway. The entire network now forms a web of connectivity from users to sensors i.e. high-level to low-level that is accessible (through URL), addressable (through URN), and controllable (through URC).

H. Data Storage and Analytics:

Analytically, one of the most important outcomes of this emanating field is the creation of an unprecedented amount of data. The internet consumes up to 5% of the total energy generated up to date and with these types of demands, it is sure to go up even further. On concluding, data centres that run on harvested energy and are centralized will ensure reliability as well as energy efficiency. Storage, expiry and ownership of the data become major issues. For smart monitoring and actuation the data have to be stored and used intelligently. It is very important to develop artificial intelligence algorithms which could be distributed or centralized based on the requirement. In Order the sense of the data collected Novel fusion algorithms need to be developed. Learning method based on evolutionary algorithms temporal machine, State-of the-art non-linear, genetic neural networks, and other artificial intelligence techniques are necessary to achieve automated decision making.

These systems show characteristics such as, integration, interoperability and adaptive communications. They also have a modular architecture both in terms of hardware/ software system design development and are very well-`suited for IoT applications. Further, a centralised infrastructure for support storage and analytics is required. IoT middleware layer is formed in this way and there are numerous challenges involved as discussed. As of now, Cloud based storage solutions are becoming rapidly popular and in the years ahead, Cloud based analytics and visualization platforms are envisage.

I. Visualization:

Visualization is an important for an IoT application as this enables interaction of the user with the environment. With advancement in touch screen technologies, use of phones and smart tablets has become very intuitive. For beneficial of a person

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from the IoT revolution, fascinating and user friendly visualization has to be created. As transition from 2D to 3D animation more information are provided in useful ways for consumers. Due to which policy makers can convert data into knowledge, which is difficult in fast decision making. Meaningful information from raw data is extracted which is non-trivial. This encloses both visualization of the associated raw and event detection and modelled data along with information represented according to the requirement of the end-user.

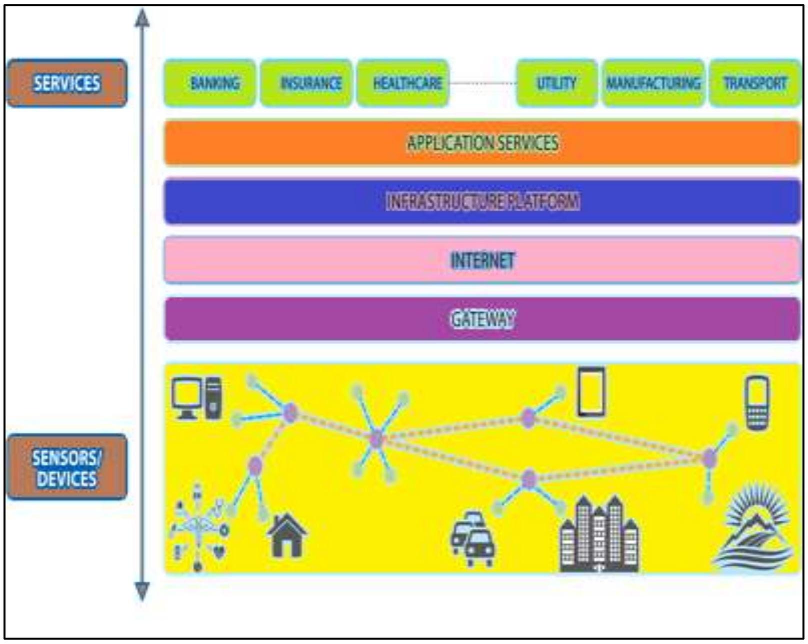

Fig. 3: Architecture of IOT

V. APPLICATION OF IOT

We do not have to wait that long to see Internet of Things in action. Many current IoT applications present promising clues as to what a fully wired future would be looking like, including-

A. *Smart Cities:*

Smart cities are cities that are fully wired. But, architects, government officials, companies, urban planners like Microsoft, Intel, IBM, Cisco and Siemens and futurists would love to see the day when all of a city's disparate infrastructure systems could be connected to each other, work in tandem and centrally controlled. Centralized systems might include water purification, traffic systems, sewers, and conservation, and more. If we imagine a day when a municipal official could share water in an area where a flood occurs, as well as divert the flow of traffic away from the occurrence by changing the area's traffic signals. Other option if a smart city might optimize individual power consumption with its overall consumption of hydroelectric, solar electric and other forms of energy. The important components of urban development for a smart city should include, smart industry, smart technology, smart services, smart management and a smart life.

B. *Medical Monitoring Devices:*

In this medical field, monitoring devices uses for medical purposes these days are wireless which permits doctors to monitor the vital signs of patients that are at distant. This is enormously beneficial in rural areas and faraway places where hospitals and healthcare facilities are insufficient. Other types of medical monitoring devices are designed in order to provide emergency notifications, in case a person is in need of a medical emergency. These technologies are integrated along with one's electronic medical record and wireless technologies in other hospitals can not only enhance hospital/healthcare efficiency but also it saves lives of a person.

C. *Smart Homes:*

Smart homes control all electrical devices, wirelessly connected objects, appliances, in a residence, enabling users with a single input device to automate their functions. Smart homes integrates all these applications ,such as a system might allow user to use laptop for scheduling specific episode to record at a specified hour; thermostat, turn on your security system, and washer, dim your lighting, and turn off ACs. Presently, smart homes are designed either from expensive or less expensive custom installed packages and, wireless hubs respectively for the do-by-your-own. As there is limitation also such as full connectivity is an ideal hard o achieve because of varied technical standards for disparate household implements. As now, the market is rapidly growing and, as per market research firm it will reach $77 billion by 2020.

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D. Other:

- Various other applications Internet of things uses in many aspect of life these include- environmental monitoring systems - deployed specifically in disaster prone areas;
- Infrastructure management systems which can be used for examining the stability of structures;
- Energy management systems – created to monitor energy consumption and save energy and also;
- Intelligent transportation systems – it give a brief about a systems with functions that ranges from fleet management to traffic control.

VI. Drawbacks of IoT

A. Breach of Privacy:

When we put anything on the internet it always stays on the internet. Security measure are being taken to protect our information, but there is always the possibility that hackers may break into the system and steal the data. If all the information of an individual is stored on the internet, people could hack into it to find out everything about his or her life. Also, information store on internet can be misused by companies that they are given access to. This is a catastrophe that commonly occurs in companies at times.

B. Over Reliance on Technology:

With the progress in time, the current generation has grown up with internet and technology that are easily and readily available in general. Yet, mundane reliance on technology and using the information that it provides to make decisions can lead to devastation. No system in this world is robust and fault-free. The circumvention that occur constantly in technology are not hidden, specifically those involving the internet. More is the dependency and entrust on the internet, any catastrophic crash of the internet can cause us potential harm.

C. Lesser Employability of Menial Staff:

Workers and helpers who are unskilled at Iot may end up losing their jobs due to the effect of automation in daily life, that has already been happening like due to ATM machine and automated billing systems.

VII. Challenges faced by IoT

- It is difficult to sense a complex environment.
- To enable different application needs various types of wired and wireless connectivity standards are required.
- Major challenge is to protect manufacturer's IP and user's privacy.
- To deploy IoT applications end-to-end service are required that include cloud service.
- Iot application development is difficult for everyone except the experts.

VIII. Conclusion

This chapter provides the summary of the proposed research work. In this paper we have studied about an evolving IT technology Internet of Things which would help connect objects to objects enabling communication between them without any human interference. Iot although not in much use in today's time but will be the mostly used technology in future thus making our work simple and easy.

IX. Future trends

A. Technological Development

- Development of open framework for IoT.
- Development of Thing DNA identifier.
- Development of wide spectrum and spectrum aware protocol.
- Development of self-learning and self-repairing protocol.
- Development of the invisible Iot.
- Development of things to human collaboration.
- IoT for all.
- Development of smart sensors (bio-chemical).
- Development of security protocols and mechanisms that are self-adaptive.
- Research Work
- Global scale applications and global interoperability of IoT.

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- Object Intelligence.
- IoT services that implement whole processes.
- Iot services in multi or cross domain.

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