Internet of Things (IoT): A Literature Review

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Abstract— The Internet of Things is a transformative development. Technologies that could allow literally billions of everyday objects to communicate with each other over the Internet have enormous potential to change all of our lives. IoT has many applications in all domains such as industrial wireless sensor network, smart homes, agriculture, etc. IoT uses standard protocols and predefined architecture for deployment using Smart technologies such as Radio Frequency Identification, Wireless Sensors etc. However, this manuscript will give good comprehension for the new researchers, who want to do research in this field of Internet of Things (Technological GOD) and facilitate knowledge accumulation in efficiently.

Key words: Internet of Things, IoT, RFID, IPv6, EPC, Barcode, Wi-Fi, Bluetooth, NFC, ZigBee, Sensors

I. INTRODUCTION

Today's internet is changing day by day as its application getting increases and new developments in its architecture. Internet of Things (IoT) is a new revolution of the Internet. Internet of Things (IoT) is can be said the expansion of internet services. It provides a platform for communication between objects where objects can organize and manage themselves. It makes objects themselves recognizable. The internet of things allows everyone to be connected anytime and anywhere [1]. This is becoming well-known concept across many horizontal and vertical markets including a common man's everyday life in the society, as it has several applica- tions. The development of the Internet of Things [IoT] has been primarily driven by needs of large corporations that stand to benefit greatly from the foresight and predictability afforded by the ability to follow all objects through the commodity chains in which they are embedded [2]. The ability to code and track objects has allowed companies to become more efficient, speed up processes, reduce error, prevent theft, and incorporate complex and flexible organizational systems through IoT [3]. The IoT is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology. They are going tag the each object for identifying, automating, monitoring and controlling.

II. INTERNET OF THINGS

The Internet of Things describes a world in which everyday objects are connected to a network so that data can be shared. But it is really as much about people as the inanimate objects. Many millions of us already carry 'smart' phones in the INDIA but a phone is not smart. It helps its user to make smarter decisions.

Smart phones are only the beginning. In the future we will carry sensors that measure our health and how we move around the environment in which we live. These will help us to socialize and navigate the world in ways that we can barely imagine.

There is a danger of trivializing the importance of the Internet of Things through examples that are used to stereotype it - for example, the 'fridge that orders fresh milk'. The Internet of Things has the potential to have a greater impact on society than the first digital revolution.

There are more connected objects than people on the planet. The networks and data that flow from them will support an extraordinary range of applications and economic opportunities. However, as with any new technology, there is the potential for significant challenges too. In the case of the Internet of Things, breaches of security and privacy have the greatest potential for causing harm.

A. Definitions

There is no unique definition available for Internet of Things that is acceptable by the world community of users.

In simple words, when the objects or things connected with each other using standard protocols and standard infrastructure so that they can communicate between each other and all these objects/things can be monitored and controlled by anywhere and anytime using internet then it can be called as Internet-of-Things (IoT). In system architecture (a) all the things such as objects in smart homes, vehicle, electronic gadgets, etc. are connected to internet Internet of Things is maturing and continues to be the latest, most hyped concept in the IT world. Over the last decade the term Internet of Things (IoT) has attracted attention by projecting the vision of a global infra- structure of networked physical objects, enabling anytime, anyplace connectivity for anything and not only for any one [4]. The Internet of Things can also be considered as a global network which allows the communication between human-to-human, human-to-things and things-to-things, which is anything in the world by providing unique identity to each and every object [5]. IoT describes a world where just about anything can be connected and communicates in an intelligent fashion that ever before. Most of us think about "being connected" in terms of electronic devices such as servers, computers, tablets, telephones and smart phones. In what's called the In- ternet of Things, sensors and actuators embedded in physical objects—from roadways to pacemakers—are linked through wired and wireless networks, often using the same Internet IP that connects the Internet.

III. TECHNOLOGIES

The Internet of Things [6] was initially inspired by members of the RFID community, who referred to the possibility of discovering information about a tagged object by browsing an internet address or database entry that corresponds to a particular RFID or Near Field Communication [7] technologies. In the research paper "Research and application on the smart home based on component technologies and Internet of Things", the included key

technologies of IoT are RFID, the sensor technology, nano technology and intelligence embedded technology. Among them, RFID is the foundation and networking core of the construction of Internet of Things [8]. The Internet of Things (IoT) enabled users to bring physical objects into the sphere of cyber world. This was made possible by different tagging technologies like NFC, RFID and 2D barcode which allowed physical objects to be identified and referred over the internet [9]. IoT, which is integrated with Sensor Technology and Radio Frequency Technology, is the ubiquitous network based on the omnipresent hardware resources of Internet, is the Internet contents objects together. It is also a new wave of IT industry since the application of computing fields, communication network and global roaming technology had been applied. It involves in addition to sophisticated technologies of computer and communication network outside, still including many new supporting technologies of Internet of Things, such as collecting Information Technology, Remote Communication Technology, Remote Information Transmission Technology, Sea Measures Information Intelligence Analyzes and Controlling Technology etc. [10].

A. Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is a system that transmits the identity of an object or person wirelessly using radio waves in the form of a serial number [11]. First use of RFID device was happened in 2nd world war in Brittan and it is used for Identify of Friend or Foe in 1948. Later RFID technology is founded at Auto-ID center in MIT in the year 1999. RFID technology plays an important role in IoT for solving identification issues of objects around us in a cost effective manner [5]. The technology is classified into three categories based on the method of power supply provision in Tags: Active RFID, Passive RFID and Semi Passive RFID. The main components of RFID are tag, reader, antenna, access controller, software and server. It is more reliable, efficient, secured, inexpensive and accurate. RFID has an extensive range of wireless applications such as distribution, tracing, patient monitoring, military apps etc. [12].

B. Internet Protocol (IP)

Internet Protocol (IP) is the primary network protocol used on the Internet, developed in 1970s. IP is the principal communications protocol in the Internet protocol suite for relaying datagram across network boundaries. The two versions of Internet Protocol (IP) are in use: IPv4 and IPv6. Each version defines an IP address differently. Because of its prevalence, the generic term IP address typically still refers to the addresses defined by IPv4. There are five classes of available IP ranges in IPv4: Class A, Class B, Class C, Class D and Class E, while only A, B, and C are commonly used. The actual protocol provides for 4.3 billion IPv4 addresses while the IPv6 will significantly augment the availability to 85,000 trillion addresses [13]. IPv6 is the 21st century Internet Protocol. This supports around for 2128 addresses.

C. Electronic Product Code (EPC)

Electronic Product Code (EPC) is a 64 bit or 98 bit code electronically recorded on an RFID tag and intended to design an improvement in the EPC barcode system. EPC code can store information about the type of EPC, unique

serial number of product, its specifications, manufacturer information etc. EPC was developed by Auto-ID centre in MIT in 1999. EPC global Organization [Wikipedia, "EPCglobal", 2010] which is responsible for standardization of Electronic Product Code (EPC) technology, created EPCglobal Network [Wikipedia, "EPCglobal Network", 2010] for sharing RFID information. It has four components namely Object Naming Service (ONS), EPC Discovery Service (EPCDS), EPC Information Services (EPCIS) and EPC Security Ser- vices (EPCSS).

D. Barcode

Barcode is just a different way of encoding numbers and letters by using combination of bars and spaces of varying width. Behind Bars [14] serves its original intent to be descriptive but is not critical. In The Bar Code Book, Palmer (1995) acknowledges that there are alternative methods of data entry techniques. Quick Response (QR) Codes the trademark for a type of matrix barcode first designed for the automotive industry in Japan. Bar codes are optical machine-readable labels attached to items that record information related to the item. Recently, the QR Code system has become popular outside the automotive industry due to its fast readability and greater storage capacity compared to standard. There are 3 types of barcodes of Alpha Numeric, Numeric and 2 Dimensional. Barcodes are designed to be machine readable. Usually they are read by laser scanners, they can also be read using a camera.

E. Wireless Fidelity (Wi-Fi)

Wireless Fidelity (Wi-Fi) is a networking technology that allows computers and other devices to communicate over a wireless signal. Vic Hayes has been named as father of Wireless Fidelity. The precursor to Wi-Fi was in- vented in 1991 by NCR Corporation in Nieuwege in the Netherland. The first wireless products were brought on the market under the name WaveLAN with speeds of 1 Mbps to 2 Mbps. Today, there are nearly pervasive Wi-Fi that delivers the high speed Wireless Local Area Network (WLAN) connectivity to millions of offices, homes, and public locations such as hotels, cafes, and airports. The integration of Wi-Fi into notebooks, hand- helds and Consumer Electronics (CE) devices has accelerated the adoption of Wi-Fi to the point where it is nearly a default in these devices [24]. Technology contains any type of WLAN product support any of the IEEE 802.11 together with dual-band, 802.11a, 802.11b, 802.11g and 802.11n. Nowadays entire cities are becoming Wi-Fi corridors through wireless APs.

F. Bluetooth

Bluetooth wireless technology is an inexpensive, short-range radio technology that eliminates the need for proprietary cabling between devices such as notebook PCs, handheld PCs, PDAs, cameras, and printers and effective range of 10 - 100 meters. And generally communicate at less than 1 Mbps and Bluetooth uses specification of IEEE 802.15.1 standard. At first in 1994 Ericson Mobile Communication company started project named "Bluetooth". It is used for creation of Personal Area Networks (PAN). A set of Bluetooth devices sharing a common channel for communication is called Piconet. This Piconet is capable of 2 - 8 devices at a time for data sharing, and that data may be text, picture, video and

sound. The Bluetooth Special Interest Group comprises more than 1000 companies with Intel, Cisco, HP, Aruba, Intel, Ericson, IBM, Motorola and Toshiba.

G. *ZigBee*

ZigBee is one of the protocols developed for enhancing the features of wireless sensor networks. ZigBee technology is created by the ZigBee Alliance which is founded in the year 2001. Characteristics of ZigBee are low cost, low data rate, relatively short transmission range, scalability, reliability, flexible protocol design. It is a low power wireless network protocol based on the IEEE 802.15.4 standard [15]. ZigBee has range of around 100 meters and a bandwidth of 250 kbps and the topologies that it works are star, cluster tree and mesh. It is widely used in home automation, digital agriculture, industrial controls, medical monitoring &power systems.

H. *Near Filed Communication (NFC)*

Near Field Communication (NFC) is a set of short-range wireless technology at 13.56 MHz, typically requiring a distance of 4 cm. NFC technology makes life easier and more convenient for consumers around the world by making it simpler to make transactions, exchange digital content, and connect electronic devices with a touch. Allows intuitive initialization of wireless networks and NFC is complementary to Bluetooth and 802.11 with their long distance capabilities at a distance circa up to 10 cm. It also works in dirty environment, does not require line of sight, easy and simple connection method. It is first developed by Philips and Sony companies. Data exchange rate now days approximately 424 kbps.

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