International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 04, April-2023

The Impact of Internet of Things (IoT) on Healthcare Services, An Overview

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***Abstract*—The Internet of Things (IoT) is the evolutionary of the internet, which create a world-wide infrastructure interconnecting machine to human. Fuelled by the recent adaptation of a variety of enabling wireless technologies and embedded sensor and actuator nodes, the Internet of Things (IoT) has stepped out of its infancy and is the next revolutionary technology in transforming the Internet into a fully integrated Future Internet. The Internet of Things (IoT) has the potential to deliver solutions that dramatically improve energy efficiency, security, health, education and many aspects of daily life. It is the idea of automating the technology via which we can command and control systems. This paper presents the impact of the Internet of Things (IoT) on healthcare services. It briefly describes the building blocks of Internet of Things (IoT) and puts light towards the integration of cloud and IoT. The paper even highlights the technological challenges and future directions in order to make IoT a reality, and it is impact on healthcare services.**

Keywords: Internet of Things (IoT); RFID; WSN; Cloud Computing; Healthcare.

I. INTRODUCTION

Internet of Things can be defined as the collection of two terms: one is Internet, which is defined as networks of networks which can connect billions of users with some standard internet protocols [1]. Internet connects several different sectors and department while using different technologies. Several devices like mobile, personal systems and business organizations are connected to Internet. The second term is Thing; this term is basically mean to these devices or objects which turn into intelligent objects [2]. Internet of Things as the name says is the wireless network of large number of interconnected devices (things) that can communicate with each other without human intervention. This will happen when our environment will be embedded with sensors and technologies such as RFID (Radio Frequency Identification), WSN (Wireless Sensor Network) etc. will help us meet this challenge.

The term Internet of Things was first coined by Kevin Ashton in the year 1999 in the context of supply chain management. Although the definition of things has been changed as technology evolved the main aim of making computer sense information without the aid of human intervention remains same. As per GSMA, Internet of Things (IoT) refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects [3]. The data that will be gathered will require huge amount of storage space resulting in its dependability on cloud computing. A subset of IoT known as Machine to machine (M2M) communication already uses wireless network to connect devices to each other over the internet with minimal human intervention. The idea is to make everything smarter so that we can command and control the objects in our surrounding. The creativity of this new era is boundless with amazing potential to improve our lives.

The medical sector has benefited from the digital transformation and modern communication technologies and is likely to rely more and more on Internet of Intelligent Things technologies in the coming years, thanks to the continuous development of communication systems and artificial intelligence tools that have helped to create innovative features of how health care services are delivered, as well as the spread of mobile phones and wearable devices with easy Internet access and near-real-time information exchange.

The IoT application in the field of medical and healthcare will benefit patient to use the best medical assistance, shortest treatment time, low medical costs and most satisfactory service. Health monitoring is important to be checked regularly in order to make sure our body constantly maintain in healthiness and excellent condition

This paper is organized as follows. The structure of IoT is summarized in section II. The technologies that compose cloud the IoT has been specified in section III. The future applications of IoT in healthcare have been described in section IV. Section V contains conclusion.

II. IoT STRUCTURE

In this section, the IoT structure is briefly described. Figure 1 presents, the structure of the IoT, which is consists of six layers: coding layer, perception layer, network layer, middleware layer, application layer, and business layer. For further development of IoT [4], a number of multi-layered security architectures are proposed. A three key level architecture of IoT, are described in [5], while [6] described a four key level architecture. A five layered architecture are proposed at [7] using the best features of the architectures of Internet and Telecommunication management networks based on TCP/IP and TMN models respectively. Similarly a six-layered architecture was also proposed based on the network hierarchical structure [8].

The six layers of IoT are described below:

- Coding Layer

Coding layer is the foundation of IoT which provides identification to the objects of interest. In this layer, each object is assigned a unique ID which makes it easy to discern the objects [8].

- Perception Layer

This is the device layer of IoT which gives a physical meaning to each object. It consists of data sensors in different forms like RFID tags, IR sensors or other sensor networks [9] which could sense the temperature, humidity, speed and location etc. of the objects. This layer gathers the useful information of the objects from the sensor devices linked with them and converts the information into digital signals which is then passed onto the Network Layer for further action.

- Network Layer

The purpose of this layer is receive the useful information in the form of digital signals from the Perception Layer and transmit it to the processing systems in the Middleware Layer through the transmission mediums like Wi-Fi, Bluetooth, WiMaX, Zigbee, GSM, 3G, etc. with protocols like IPv4, IPv6, MQTT, DDS etc. [10].

- Middleware Layer

This layer processes the information received from the sensor devices [11]. It includes the technologies like Cloud computing, Ubiquitous computing which ensures a direct access to the database to store all the necessary information in it. Using some Intelligent Processing Equipment, the information is processed and a fully automated action is taken based on the processed results of the information.

- Application Layer

This layer realizes the applications of IoT for all kinds of industry, based on the processed data. Because applications promote the development of IoT so this layer is very helpful in the large scale development of IoT network [7]. The IoT related applications could be smart homes, smart transportation, smart planet etc.

- Business Layer

This layer manages the applications and services of IoT and is responsible for all the research related to IoT. It generates different business models for effective business strategies [12].

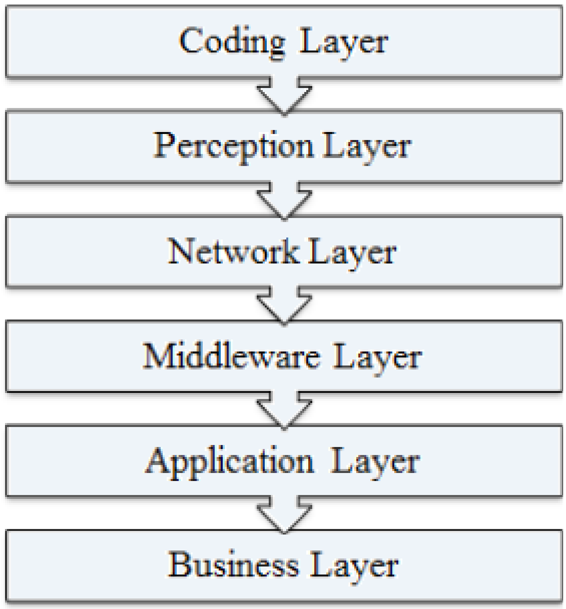

Fig. 1: The structure of Internet of Things

III. TECHNOLOGIES of (IOT)

The Internet of Things encompasses many aspects of our life from connected homes and cities to connected cars and roads, roads to devices that track individual behavior and use the data collected to push services [13]. The Internet of things in the near future will be used to refer to the general idea of things, especially everyday objects that are readable, recognizable, locatable, addressable, controlled via internet irrespective of the communication means. In this section, we discuss some enabling technologies that will aid IoT become a reality.

A. RFID (Radio Frequency Identification)

RFID is a wireless technology of transferring data by using electromagnetic fields in order to automatically identify and track tags attached to objects that contain electronically stored information as shown in figure 2. They aid in automatic identification of anything they are attached to acting as an electronic barcode. RFID is used to identify objects from a distance of few meters with a stationary reader typically communicating wirelessly with small battery free transponders attached to objects. It provides two basic and quintessential functions for an IoT i.e. identification and communication. The passive RFID tags are not battery powered and use the power of reader's interrogation signal to communicate the ID to the RFID reader. The passive cards are being used in many bank cards and road roll tags [13]. A typical RFID microchip merely consists of hundred thousand transistors, contains no microcontroller and has minimal storage capacity usually just a few bytes. Instead of using a battery, passive RFID microchips are supplied with power from a reading device. Active RFID readers have their own battery supply and can instantiate communication as shown in figure 3. The RFID technology has not only contributed towards technical progress but also towards cost reduction and standardization and hence it is widely used.

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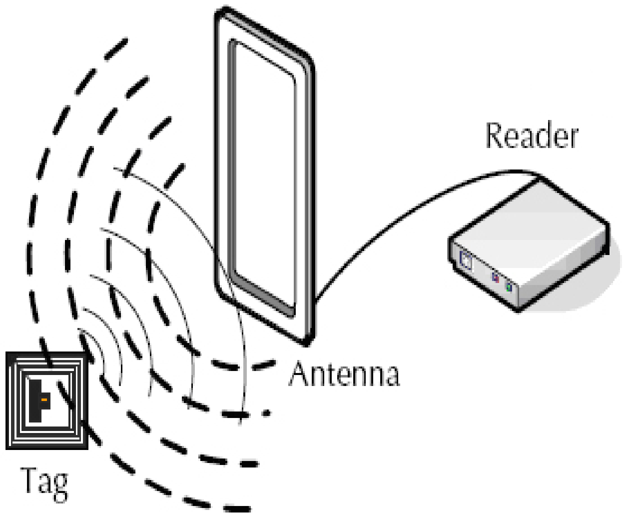

Fig. 2: RFID Scenario

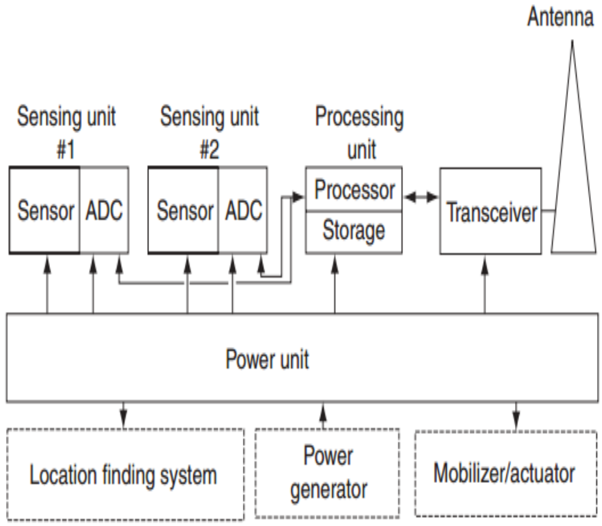

Fig.3: WSN sensing node

B. WSN (Wireless Sensor Networks)

The advancement and convergence of micro electromechanical systems (MEMS) technology, wireless communications and digital electronics has led to the development of miniature devices having the ability to sense, compute and communicate wirelessly over short distances [14]. These miniature devices called nodes interconnect to form wireless sensor networks as shown in figure 3, and find wide ranging applications in environmental monitoring, infrastructure monitoring, and traffic monitoring etc. the components that make up the WSN monitoring network include:

- WSN hardware: It contains sensor interfaces, processing units, transceiver units and power supply.
- WSN communication stack: Nodes in WSN need to communicate among themselves in order to transmit data in single or multi-hop to a base station. The communication stack at the sink node must be able to interact to the outside world through the internet to act as a gateway to WSN subnet and internet.
- WSN Middleware: It is a mechanism to combine cyber infrastructure with Service Oriented Architecture (SOA) and sensor networks to provide access to heterogeneous sensor resources in a deployment independent manner. It is based on isolating resources that can be used by several applications.
- Secure Data Aggregation: In order to extend the lifetime of networks as well as reliable data collected from sensors, an efficient and secure data aggregation method is required. Ensuring security is critical as the system is linked to actuators and protecting systems from intruders is very important.

C. Cloud Computing

The two worlds of cloud and IoT have seen an independent evolution. On one hand, IoT can benefit from the virtually unlimited capabilities and resources of Cloud to compensate its technological constraints (e.g., storage, processing, and energy). Specifically, the Cloud can offer an effective solution to implement IoT service management and composition as well as applications that exploit the things or the data produced by them [15]. On the other hand, the Cloud can benefit from IoT by extending its scope to deal with real world things in a more distributed and dynamic manner, and for delivering new services in a large number of real life scenarios. IoT involves a large amount of information sources that includes non-structured or semi-structured data having three typical characteristics of big data i.e. volume, variety and velocity. Hence it implies collecting, accessing, storing, sharing, archiving and searching large amount of data making cloud the most convenient and cost effective solution, offering virtually unlimited, low cost and on demand storage capacity to deal with data produced by IOT. Secondly, IoT devices have limited processing resources that do not allow on-site data processing. Data collected is usually transmitted to more powerful nodes where aggregation and processing is possible, but scalability is challenging to achieve without a proper infrastructure. The unlimited processing capabilities of Cloud and its on-demand model allow IoT processing needs to be properly satisfied and enable analyses of unprecedented complexity. Thus a novel IT paradigm in which cloud and IoT are two complementary technologies merged together is expected to disrupt both current and future internet. Figure 4, shows the cloud computing scenario.

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Fig.4: cloud computing scenario

D. Networking Technologies

These technologies have an important role in the success of IoT since they are responsible for the connection between the objects, so we need a fast and an effective network to handle a large number of potential devices. For wide-range transmission network we commonly use 3G, 4G etc. but it has been known, mobile traffic is so much predictable since it only has to perform the usual tasks like making a call, sending a text message etc. so as we step into this modern era of ubiquitous computing, it will not be predictable anymore which calls for a need of a super-fast, super-efficient fifth generation wireless system which could offer a lot more bandwidth [16]. Similarly for a short-range communication network we use technologies like, Bluetooth, Wi-Fi etc.

E. Nano Technologies

This technology realizes smaller and improved version of the things that are interconnected. It can decrease the consumption of a system by enabling the development of devices in Nano meters scale which can be used as a sensor and an actuator just like a normal device. Such a Nano device is made from Nano components and the resulting network defines a new networking paradigm which is Internet of Nano-Things [17].

F. Micro-Electro-Mechanical Systems (MEMS)

MEMS are a combination of electric and mechanical components working together to provide several applications including sensing and actuating which are already being commercially used in many field in the form of transducers and accelerometers etc. MEMS combined with Nano technologies are a cost-effective solution for improvising the communication system of IoT and other advantages like size reduction of sensors and actuators, integrated ubiquitous computing devices and higher range of frequencies etc. [18].

IV.APPLICATIONS of (IOT) in HEALTHCARE

Smart devices, mobile internet and cloud services contribute to the continuous and systematic innovation of healthcare and enable cost effective, efficient, timely and high quality ubiquitous medical services. The services provided include chronic disease management, elderly care, wellness and fitness programs etc. Medical care or health care is one of the major challenges of this world, it is estimated that approx. 20-30 billion [19] population of this world suffer from different disease such as arthritis, asthma, cancer, COPD, diabetes [20], care for elderly people such as Heart Attack [21] detection, Activity and Movement Recognition of elderly people[22] and many more. The past few years have witnessed that Internet of Things (IoT) [23] has evolved a lot and continues to evolve in medical care or health care is one of the major challenges of this world, as the internet of things is a new idea for physical objects or things, called “smart devices” and is a very challenging area in the field of information technology and computer science. one of a state-of-the-art IIoT project in today’s healthcare environments the personal healthcare robot called Baymax[24] , which is a robot with a soft synthetic skin that can detect medical conditions (this was an initiative based on a fictional Disney character in *Big Hero 6* but it may not be far from becoming reality). Early versions of a robot teddy bear, developed by MIT Media Lab, are now being put through their paces in a children’s hospital in the United States. An updated version of the bear has been fitted with pressure sensors on two of its paws and several touch sensors throughout its body parts. The screen of the smartphone device in the robot’s head shows animated eyes. The robot can use the phone’s internal speaker, microphone, and camera for sensing changes in a child’s well-being.

For scholars, the main challenges while deploying internet of things are to prepare and process data for classification because of an unprecedented increase in the amount and complexity of data collected by different types of sensors

V.CONCLUSION

The Internet of Things promises to deliver a quality change in an individual’s life in the near future through widely distributed and locally intelligent network of smart devices. This paper presents a brief introduction of Internet of Things describing its elements such as RFID and WSN that would aid in making it a reality, and it is application in healthcare services. Moreover the need for integration of cloud and IoT has been explained in this paper. The paper also presents the main components of IoT, as well as the technological challenges and the future directions of IoT. Just as the internet phenomenon happened not so long ago and caught a wildfire, Internet of Things will soon unlock and deliver value to healthcare industry. Researches in this field can help the competent authorities to care for the patient by using the Internet of Things. By adopting this technology, the patient’s care can be done in fast and smart way, and cost for caring will accordingly reduce.

REFERENCES

[1] Somayya Madakam, R. Ramaswamy, Siddharth Tripathi, "Internet of Things (IoT): A Literature Review," *Journal of Computer and Communications, 3, 164-173, 2015.*

[2] Shashank Agrawal, Dario Vieira, "A survey on Internet of Things," Abakós, Belo Horizonte,v. 1, n.2, p. 78 – 95, ISSN:2316–9451, 2013.

[3] JayavardhanaGubbi, RajkumarBuyya, SlavenMarusic, Marimuthu Paliniswami, Internet of Things: A vision, architectural elements and future directions, Future Generation Computer Systems 29, Elsevier 1645–1660, 2013.

[4] M.U. Farooq, Muhammad Waseem, Sadia Mazhar, Anjum Khairi, and Talha Kamal, "A Review on Internet of Things (IoT), International Journal of Computer Applications" (0975 8887), Volume 113-No. 1, March 2015

[5] Wang Chen, "An Ibe Based Security Scheme Of Internet Of Things," in Cloud Computing and Intelligent Systems (CCIS), pp. 1046, 1049, 2012.

[6] Hui Suo, Jiafu Wan, Caifeng Zou, Jianqi Liu,"Security in the Internet of Things: A Review," in Computer Science and Electronics Engineering (ICCSEE), pp. 648-651, 2012.

[7] MiaoWu, Ting-lie Lu, Fei-Yang Ling, ling Sun, Hui-Ying Du, "Research on the architecture of Internet of things," in Advanced Computer Theory and Engineering (ICACTE), pp. 484-487, 2010.

[8] Xu Cheng, Minghui Zhang, Fuquan Sun,"Architecture of internet of things and its key technology integration based-on RFID," in Fifth International Symposium on Computational Intelligence and Design, pp. 294-297, 2012.

[9] Debasis Bandyopadhyay, Jaydip Sen, "Internet of Things - Applications and Challenges in Technology and Standardization" inWireless Personal Communications, Volume 58, Issue1, pp. 49-69.

[10] Ying Zhang,"Technology Framework of the Internet of THings and Its Application," in Electrical and Control Engineering (ICECE), pp. 4109-4112, 2011.

[11] Guicheng Shen and Bingwu Liu,"The visions, technologies, applications and security issues of Internet of Things," in E -Business and E -Government (ICEE), , pp. 1-4, 2011.

[12] Rafiullah Khan, Sarmad Ullah Khan, Rifaqat Zaheer and Shahid Khan, "Future Internet: The Internet of Things Architecture, Possible Applications and Key Challenges," in Proceedings of Frontiers of Information Technology (FIT), pp. 257-260, 2012.

[13] Benjamin Khoo,"RFID as an Enabler of the Internet of Things: Issues of Security and Privacy," in Internet of Things (iThings/CPSCom), pp. 709-712, 2011.

[14] Sohraby, K., Minoli, D., Znati, T."Wireless sensor networks: technology, protocols, and applications", John Wiley and Sons, ISBN 978-0-471-74300-2, pp. 15-18, 2007.

[15] B.B.P. Rao, P.Saluia, N.Sharma, A.Mittal, S.V.Sharma,"Cloud computing for Internet of Things & sensing based applications," in Sensing Technology (ICST), Sixth International Conference, IEEE, 2012.

[16] O.Vermesan, P.Friess,"Internet of Things From Research and Innovation to Market Deployment," River Publishers, pp. 74-75, 2014.

[17] I.Akyildiz and J.Jornet,"THE INTERNET OF NANOTHINGS," IEEE Wireless Communications, Volume: 17 Issue: 6, pp. 58-63, 2010.

[18] V.M. Lubecke, Jung-Chih Chiao,"MEMS technologies for enabling high frequency communications circuits," in Telecommunications in Modern Satellite, Cable and Broadcasting Services, Volume: 2, pp. 382-389, 1999.

[19] Zubair Rahman A.M.J. Jayapandian N., "Secure and efficient online data storage and sharing over cloud environment using probabilistic with holomorphic encryption", Cluster Computing, vol. 20, no. 2, pp. 1561-1573, 2017.

[20] M Anoopkumar, AMJ Md Zubair Rahman, "A Review on Data Mining techniques and factors used in Educational Data Mining to predict student amelioration" 2016 International Conference on Data Mining and Advanced Computing (SAPIENCE), pp. 122-133, 2016.

[21] N Jayapandian, AMJ Md Zubair Rahman, M Koushikaa, S Radhikadevi, "A novel approach to enhance multi-level security system using encryption with fingerprint in cloud", Futuristic Trends in Research and Innovation for Social Welfare (Startup Conclave), World Conference on IEEE, pp. 1-5, 2016.

[22] Gerald, Josef,Christian and Josef Scharinger, "NFC Devices: Security and Privacy", ARES 08 proceedings of the 2008 Third International Conference on Availability, Reliability and Security, IEEE Computing Society, Washington, DC, USA,2008.

[23] M. Anoopkumar, A. M. J. Md. Zubair Rahman, (2015), "A comprehensive survey on educational data mining and use of data mining techniques for improving teaching and predicting student", International Journal of Advanced Science and Engineering Research www.ijaser.in Volume: 4, Issue: 1, ISSN: 2455-9288, 2019.

[24] Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.