A Survey on IOT: An Architecture, Protocols and its Applications

Karishma Gandhi[1] , Snehi Patel[2]
Department of Computer Engineering
[1] Assistant Professor, Silver oak college of Engineering & Technology
[2] Lecturer, Silver oak college of Engineering & Technology

Abstract- *The Internet of Things (IOT) also known as Internet of everything. Internet of things is a research area due to its importance in various areas like commerce, industry, and education applications. Internet of things will connect not only mobile devices and computers, but it will also interconnect homes, smart buildings, and cities, as well as water networks, automobiles, airplanes and electrical grids, gas, etc. In the upcoming years IoT is expected to be one of the main medium between various technologies by connecting smart physical objects together and allowing different applications in support of smart decision making. In this paper, we will discuss about the history of IOT, Various architechture of IOT, protocols, its application in numerous areas.*

Keywords- internet of things (IoT), IoT Architecture, IoT Protocols, IoT Applications, Security, Privacy, Future Trends

I. INTRODUCTION

Recently, the concept of the Internet as a set of connected computer devices is changed to a set of connected surrounding things of human's living space, such as home appliances, machines, transportation, business storage, and goods etc[1]. The number of things in the living space is larger than the number of world population. Research is going on how to make these things to communicate with each other like computer devices communicate through Internet [1]. The communication between such things is referred as Internet of Things (IoT). Till now, there is no specific definition or standard architecture of IoT. Some researchers define the IoT as a new model that consists all of communication technologies such as wireless sensor networks, mobile networks, and actuators. Each element of IoT is called a thing and that should have a unique address. Things communicate using the Radio-Frequency Identification (RFID) technology and work in euphony to reach a common goal. There are various technologies similar to RFID, Machine to Machine, Near Field communications (NFC), (M2M) and vehicular to vehicular communications (V2V), which can be used to implement the modern idea of IoT [2] In addition, the IoT should contain a strategy to determine its users and their privileges and restrictions. The US National Intelligence council has stated that by 2025 the IoT will connect everything in our life [3]. For this target new architectures are proposed and more research challenges are opened. Authors in [3] highlight some research challenges. Considering the research challenges and future vision of IoT, in this paper we present a detail survey.

II. EVOLUTION OF IOT

The Internet of Things, as a concept, wasn't officially named until 1999. One of the first examples of an Internet of Things is from the early 1980s, and was a Coca Cola machine, located at the Carnegie Melon University. Local programmers would connect by Internet to the refrigerated appliance, and check to see if there was a drink available, and if it was cold, before making the trip [4].

By the year 2013, the Internet of Things had evolved into to a system using multiple technologies, ranging from the Internet to wireless communication and from micro-electromechanical systems (MEMS) to embedded systems. The traditional fields of automation (including the automation of buildings and homes), wireless sensor networks, GPS, control systems, and others, all support the IoT.

Simply stated, the Internet of Things consists of any device with an on/off switch connected to the Internet. This includes almost anything you can think of, ranging from cellphones to building maintenance to the jet engine of an airplane [4]. Medical devices, such as a heart monitor implant or a biochip transponder in a farm animal, can transfer data over a network and are members the IoT. If it has an off/on switch, then it can, theoretically, be part of the system. The IoT consists of a gigantic network of internet connected "things" and devices. Ring, a doorbell that links to your smart phone, provides an excellent example of a recent addition to the Internet of Things. Ring signals you when the doorbell is pressed, and lets you see who it is and to speak with them [4].

III. ARCHITECHTURES OF IOT

The TCP/IP protocol stack plays an important role in digital communication which was defined long ago. As IOT connects number of objects which will create a vast traffic and large amount of data capacity is required. Therefore, the new

standard architecture and protocols for IoT needs to address many essential factors (i.e. sustainability, reliability, Quality of Service, confidentiality, integrity, etc.). Due to the IoT procedures are mainly to connect between everything and everyone to exchange information with each other that not only exponentially increasing the network traffic but also storage capacity as well. Thus, IoT improvement relies on the advances in technology and applies to different types of useful applications and business models. The basic architecture and protocols of IoT proposed in [6] and [7] respectively.

3.1. Generic Architecture

The typical IoT architecture can be divided into five layers as shown in Figure 2. Each layer is briefly described below:

Perception Layer: The perception layer is similar to physical layer in OSI model which consists of the different types of sensor (i.e. RFID, Zigbee, QR code, Infrared, etc.) devices and environmental elements. This layer generally copes with the overall device management viz; identification and collection of specific information by each type of sensor devices. The gathered information can be location, wind speed, vibration, pH level, humidity, amount of dust in the air, etc. This gathered information transmits through the Network layer for its secure communication toward central information processing system.

Figure 1. The IoT generic scenarios[5].

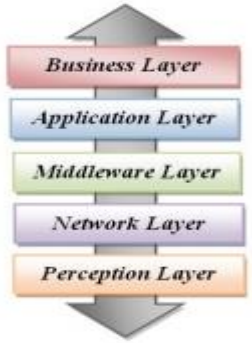

Figure 2. The IoT generic architecture[5].

Network Layer: The Network layer plays an important role in securely transfers and keeps the sensitive information confidential from sensor devices to the central information processing system through 3G, 4G, UMTS, WiFi, WiMAX, RFID, Infrared, Satellite, etc. dependent upon the type of sensors devices. Hence, this layer is mainly responsible for transfer the information from Perception layer to upper layer.[13]

Middleware Layer: The devices in the IoT system may generate various types of services when they are connected and communicated with others. Middleware layer has two essential functions, including service management and store the lower layer information into the database. Moreover, this layer has capability to retrieve, process, compute information, and then automatically decide based on the computational results.[13]

Application Layer: Application layer is responsible for inclusive applications management based on the processed information in the Middleware layer. The IoT applications can be smart postal, smart heath, smart car, smart glasses, smart home, smart independent living, smart transportation, etc. Business Layer: This layer functions cover the whole IoT applications and services management. It can create practically graphs, business models, flow chart, executive report, etc. based on the amount of accurate data received from lower layer and effective data analysis process. Based on the good analysis results, it will help the functional managers or executives to make more accurate decisions about the business strategies and roadmaps.[13]

3.2 IoT Protocols

Protocol is the special set of rules and regulations that end point in a telecommunication connectionuse when they need to communicate to other end point which connected to the same/different network. In this subsection will briefly describe about the most frequently used protocols for Machine-to-Machine (M2M) communication. MQTT (Message Queue Telemetry Transport): MQTT is a Client Server publishes or subscribes messaging transport protocol. It is light weight, open, simple and designed so as to be easy to implement. The protocol runs over TCP/IP or over other network protocol that provided ordered, lossless, bi-directional connections. The MQTT features include: use of the publish/subscribe message pattern which provides one-to-many message distribution, a messaging transport that is agnostic to the content of the payload, and this protocol also has three qualities of service for message delivery viz; “At most once”, where messages are delivered according to the best efforts of operating environment. The message loss can occur and this level could be used, Secondly, “At least once”, where message are assured to arrive but duplicate massages can occur. Finally, “Exactly

once", where message are assured to arrive exactly once. This level could be used [8]. This that cause to drastically reduce network traffic. Furthermore, the MQTT protocol is not only minimized transport overhead and protocol exchange to reduce network traffic but also has an extraordinary mechanism to notify interested parties when an abnormal disconnection occur as well. CoAP (Constraint Application Protocol): CoAP is a specialized web transfer protocol for use with constrained nodes and constrained networks (e.g. low-power, lossy). The nodes often have 8-bit microcontroller with small amounts of ROM and RAM, while constrained network often have high packet error rate and typical throughput is 10 kbps [9]. This protocol designed for Machine-toMachine (M2M) application such as smart city and building automation. CoAP provides a request and response interaction model between application end points, support build-in discovery services and resources, and includes key concepts of the Web [10] such as URIs and Internet media types. CoAP is designed to friendly interface with HTTP for integration with the Web while meeting specialized requirements such as multicast support, very low overhead and simplicity for constrained environments.[13]

IV. APPLICATIONS

Applications of IOT are in various areas such as Transportation, Smart home, Smart city, Lifestyle, Retail, Agriculture, Smart factory, Supply chain, User Interaction, Healthcare, Culture and tourism, Environment and Energy.

In this paper, the focus will be briefly on the IoT's Applications in Smart Homes, Healthcare, Transportation and Social Networking.

1. Smart Homes

Deployment of Sensors in houses and offices could make our life easier in several aspects such as room heating can be adapted as predefined preferences and the weather; the room lighting can automatically change according to the time of day; Prevention of hazardous incidents with appropriate alarm and monitoring system and reducing the energy cost by automatically switching off the electrical equipments such as television, air condition, kettle, fridge, light bulb and so on, when not used.[13]

2. Healthcare

IoT-driven, noninvasive monitoring systems are used for hospitalized patients whose physiological status requires constant close attention. These monitoring systems employ sensors to collect physiological information which is analyzed and stored using gateways and the cloud. This information is then sent wirelessly to caregivers for further analysis and review hence, rendering a health professional having to check the patients' vital signs after regular intervals unnecessary. Instead, it provides a continuous automated flow of information. Thus, the quality of care is improved through constant attention which in turn lowers the cost of care and eliminates the need for a caregiver to actively engage in data collection and analysis. [11]

3. Transportation

Today's different type of transportation such as cars, train and buses along with the road and the rails equipped with sensors, actuators and powerful processors may provide beneficial information to the driver and/or passengers to provide better navigation and safety [12]. Numbers of profit and non-profit organizations would benefit from gathered road traffic patterns information such as governmental authorities used for construction/ planning purpose, freight companies used these information to perform more route optimization which allows energy saving, and so on.[13]

4. Social Networking

Social networking: This application is involved to the automatically update of information and location about our social activities in social networking websites. We probably think of RFIDs which generate events about people and places to assist users real-time updates in their social networks [12]. The mobile/web application user interfaces would display a feed of events that their friends have preliminary defined and the users not only manage their friend lists but also grant permission for each friend who has privileged to reach the information or events.[13]

V. CONCLUSION

The Internet of Things, things that communicates with each other via Internet, access, store and retrieve data on the Internet with users. This paper describes the importanance of IoT in daily Life with the generic architecture, its most widely used protocols and various applications. IOT can also be used with other applications such as Security and privacy maintanence.

REFERENCES

[1] Said, Omar, and Mehedi Masud. "Towards internet of things: Survey and future vision." International Journal of Computer Networks 5.1 (2013): 1-17.

[2] Azori, luigi; iera, antonio; morabito, giacomo. The internet of things: a sur- vey. Computer networks, v. 54, doi.10.1016/ comnet.2010.05.010.
[3] Luigi A., Antonio I., Giacomo M. 2010.The Internet of Things: A survey. Science Direct journal of Computer Networks, Volume 54, Pages: 2787–2805.
[4] http://www.dataversity.net/brief-history-internet-things/
[5] Kraijak, Surapon, and Panwit Tuwanut. "A survey on IoT architectures, protocols, applications, security, privacy, real-world implementation and future trends." (2015): 6-6.
[6] Tan, N. and Wang, N. (2010) Future Internet: The Internet of Things. 3rd International Conference on Advanced Computer Theory and Engineering, August 2010.
[7] Wu, M., Lu, T., Ling, F., Sun, J. and Du, H. (2010) Research on the Architecture of Internet of Things. 3rd International Conference on Advanced Computer Theory and Engineering (ICACTE), August 2010.
[8] http://www.mqtt.org/documentation
[9] Palattell, M., Accettura, N., Vilajonasa, X., Watteyne, T., Grieco, L., Boggia, G. and Dolher M. (2013) Standardized Protocol Stack for the Internet of (Important) Things. IEEE Communication Surveys & Tutorials, 1389-1430
[10] Birmann, C., Castellani, A.P. and Shelby, Z. (2012) CoAP: An Application Protocol for Billions of Tiny Internet Nodes. IEEE Internet Computing. http://dx.doi.org/10.1109/MIC.2012.29
[11] Kulkarni, Alok, and Sampada Sathe. "Healthcare applications of the Internet of Things: A Review." International Journal of Computer Science and Information Technologies 5.5 (2014): 6229-32.
[12] Atzori, L., Iera, A. and Morabito, G. (2010) The Internet of Things: A Survey. Computer Networks Journal, June 2010, 27872805.http://dx.doi.org/10.1016/j.comnet.2010.05.010
[13] Kraijak, Surapon, and Panwit Tuwanut. "A survey on IoT architectures, protocols, applications, security, privacy, real-world implementation and future trends." (2015): 6-6.