Volume 8, No. 2, March 2017 (Special Issue)
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
REVIEW ARTICLE
Available Online at www.ijarcs.info

Internet of Things: Future of Cloud Computing

Hirra Sultan
Department of CSE, SEST
Jamia Hamdard, New Delhi, India
prlhirr@gmail.com

Abstract: Information Communication Technologies (ICT) practices are growing exponentially resulting in abundant availability of computation, resources and processing are available abundantly at a specific cost. Over the last decade, cloud computing has been changed from connecting devices over internet to Internet of Things (IoT). IoT is commonly known as '*things*' connected over internet for achieving a common goal such as processing, computation or information sharing. IoTs are connected devices such as RFID tags, sensors, mobile phones etc. having unique addressing schemes and coordinating computation to achieve a desired result. According to a study, it is expected that there will be 50 billion devices considered to be connected as IoT devices in distributed environment. Its applications are imminent in developing smart cities, smart retail markets, automated vehicles, real time traffic navigation, drone surveillance, environmental monitoring etc. Though there will be specific tradeoffs and costs implied over abundant availability of the computationally equipped devices. These tradeoffs may be resolved or become challenges in the growth and widespread adaptability of IoTs devices. Few of the issues include implementing framework, security, privacy, trust negotiation etc. In this paper, we discuss about IoT, its evolution, issues, concerns and challenges currently faced while implementing IoTs in distributed environment over the cloud.

Keywords: Cloud Computing, Internet of Things, Ubiquitous Computing

I. INTRODUCTION

In today's world, technology is growing exponentially and resources are available abundantly at a certain cost and thus the ICT practices are going towards a new pathway. Big Data [10] and Ubiquitous computing is the talk of the technological communities nowadays. IoT is a term commonly related to 'Ubiquitous Computing' where everything is connected to the Internet. The term "Internet of Things" was first coined by Kevin Ashton in MIT in 1999 during a presentation. In the same year, Neil Garshenfeld spoke about IoT principles in his book "When Things Start to Think" [1]. In 2005, the idea was widely accepted in industry and new systems and devices started to roll out in the technological market and community. The concept of IoT involves presence of devices or things in a pervasive environment. IoT are connected devices such as RFID tags, sensors, mobile phones etc. having unique addressing schemes and coordinating computation to achieve a desired result. The power of being connected to internet and of machine-to-machine communication makes IoT pervasive in nature.

Networking and M2M communications play an important role in technologies used in IoT applications[2]. Figure 1 shows most commonly used IoT applications.

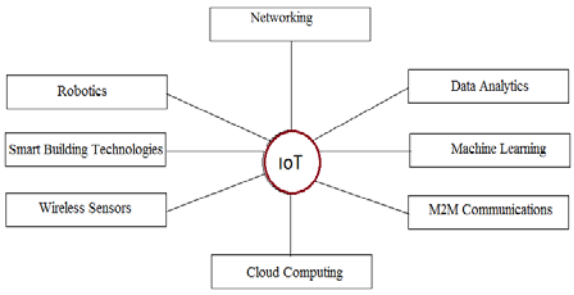

Figure 1: Technologies most commonly used for IoT

Evolution of IoT

The idea of IoT has been around for 18 years and recent advancement in the technologies made the IoT more popular. Table 1 below shows the important activities and events related to IoT in chronological order [3].

1999	• The term Internet of Things is coined by Kevin Ashton, Executive Director of the Auto-ID Centre in Massachute Institute of Technology (MIT) • Neil Gershenfeld first time spoken about IoT principles in his book titled "When Things Start to Think" • MIT Auto-ID Lab, originally founded by Kevin Ashton, David Brock and Sanjay Sarma in this year. They helped to develop the Electronic Product Code
2000	• LG announced its first Internet of refrigerator plans
2002	• The Ambient Orb created by David Rose and others in a spin-off from the MIT Media Lab is released into wild with NY Times Magazine naming IoT

	as one of the Ideas of Year
2005	• The UN's International Telecommunications Union (ITU) published its first report on the Internet of Things topic
2008	• Recognition by the EU and the First European IoT conference is held • 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

II. IoT: Future of Cloud Computing

IoT has a huge number of devices interconnected to each other. These devices send and receive data amongst each other continuously. The data can be real-time such as temperatures, weather conditions, traffic, pollution levels, noise etc. Figure 2 shows services provided by IoT devices.

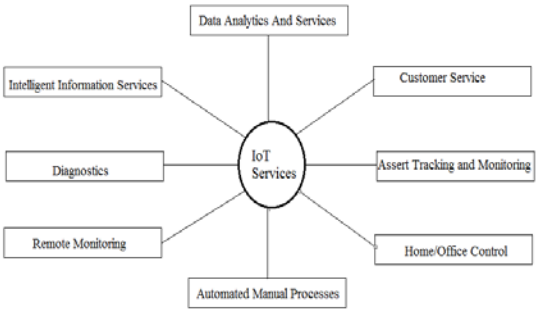

Figure 2: Services Provided by IoT Devices

Cloud is a distributed computing system which provides virtual memory. As such cloud remains private. It is either being used for personal use, or within a group. With IoT, cloud becomes public. IoT leverages Cloud from being personal to a public domain where life without cloud would be difficult to imagine.

The backbone of IoT consists of cloud. The connection over geographically separated devices are governed by high speed cloud connectivity enabling high and fast streaming of data.

IoT utilizes cloud storage by providing unlimited storage space. Recommendation based services; data mining etc. may become more efficient and goal-oriented with the help of IoT [4].

III. Current and Future Trends in IoT

IoT is being used in many ways more than merely connecting devices together. The current implementations of future trends of IoT are:

- ***Effective Electricity Generation***:

NYPA (New York Power Association) has introduced and used IIoT (Industrial IoT) in its systems. They have connected energy producing machines like turbines to analytical software via sensors. This helps them predict the amount of energy that would be produced and any fall or failure in production. Hence any power cuts can be predicted as early as a week or even earlier. Also, as data is recorded, it helps in making better analysis and taking decisions.

NYPA are planning on connecting all the buildings via sensors so that building temperatures can be controlled hence reducing power consumption based on request. This would also give the association a better estimate of power requirements and hence any changes in production may be implemented [5].

- ***Revolutionizing Retail Market:***

Retail stores are often faced with the challenge of maintaining inventory. This can be changed by the use of smart shelves. They automatically send alerts once the no. of items is below threshold ensuring nothing is out of stock.

Also, sensors are being used in stores that monitor the quality of perishables. If the quality of products is not worth consuming, store manager or in-charge is notified to change the stock.

RFID tags are used to locate inventory down the supply chain. Hence the retailers know exactly where the products are in the supply chain. This helps in estimating exactly when the products would be delivered. This knowledge proves crucial when decisions need to be made on fly when faced with high demand from customers [6].

- ***Smart Cities:***

One of the biggest changes that IoT would bring in our society would be converting our cities into smart cities. Smart cities encompass a broad spectrum. This includes smart homes, smart offices, smart parking, smart cars, everything smart.

As smart homes, we would have all the devices interconnected, and communicating with each other. Also, the devices can be remotely accessed via a middleware (mobile apps). This would lead to better experience, better energy saving and an overall better life. This can be visualized as setting the temperature to optimum before reaching home, turning the geyser on so you can have a hot bath immediately on reaching home without having to wait for the water to heat up, voice based actions like a passkey to turn on all lights or turn on a favorite piece of music. This also encompasses

automatic turning on/off of lights and other accessories once a room is detected empty.

Smart offices can again be visualized as everything connected. Everyone's schedule is entered in the computers. So which room is free and which is available is known in advance, and optimizing the usage of meetings and office space. Also, this helps in reducing energy consumption as the temperatures can be reduced or increased as required.

Smart parking spaces help find parking space easily. Also, they optimize the space by using multi-level parking [7].

IV. CHALLENGES AROUND IOT

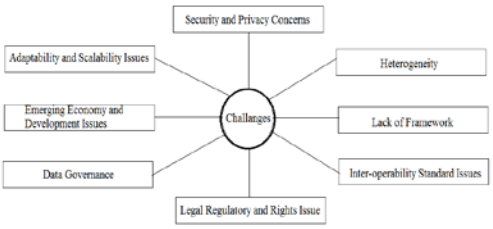

Fig 3: Challenges in Implementation of IoT

IoT is an emerging technology which has challenges in its implementation. Data transmitted among IoT devices can be easily sniffed, modified or lost. Devices can be remotely controlled to generate bogus data and may be accessed by a third party from cloud storage. Several issues which are prevalent in the implementation of IoT are identified and discussed below [8]:

- ***Security and Privacy:*** IoT generates big data, which is sensitive and in huge volumes. Data can be misused and cause a person or organisation huge damage. It may lead to character assassination, identity theft, ransom demands etc. The issue also increases due to use of over the counter solutions or no security at all.
- ***Heterogeneity:***IoT consists of all kinds of things or devices leading to heterogeneity in the network. This heterogeneity poses a difficulty in implementing security mechanisms or framework for devices which are not compatible. IoT largely comprises of sensors with low memory space hence they cannot use advance encipherment mechanisms.
- ***Lack of Framework:*** IoT lacks a standard framework because of different protocols by different governing and regulatory bodies. The disparity in the framework results in difficulty of unified architectural integration of multiple devices.
- ***Inter-operability Standard Issues:*** Lack of a standard and defined protocol poses challenges for devices to exchange data. This causes delays in deployment of devices as interoperability of devices is difficult to achieve.
- ***Data Governance, Legal Regulatory and Rights Issue:***IoT exposes a lot of data to other devices and to governing organisation. There are no regulations defined about the usage policy of data and their distribution. Further, there are no legal laws or regulatory policies defined by any governing body over data handling and exposure.
- ***Emerging Economy and Development Issues:*** The affordability of sensors and devices makes sure IoT can be implemented easily in every aspect of our daily lives. However, this requires availability of high speed internet connectivity. High speed internet connectivity is a bottleneck in several geographies of the world.
- ***Adaptability and Scalability Issues:***

Deployment leads to adaptability of the multiple devices in a heterogeneous environment. However, adaptability is possible to achieve once there is defined set of architectural framework to govern the deployment of IoT among diversified devices. Scalability is open to usage discretion by the public and the outcome of the deployment leads to dynamic growth of IoT technologies.

As per a survey done by Semantic on current IoT security scenarios, following issues were published [9]. Several of them are listed below:

- 19% of all tested mobile applications used to control IoT devices didn't use SSL.
- None of analyzed devices provided mutual authentication between client and server.
- Some devices offered no enforcement and often no possibility of strong passwords.
- Some IoT cloud interfaces didn't support two-factor authentication.
- Many IoT devices didn't have mechanisms to protect user account from brute force attack.
- Some devices didn't implement protections against account harvesting.
- Most IoT services didn't provide signed or encrypted firmware updates if updates were provided at all.
- Many IoT cloud platforms had common web application vulnerabilities.

V. CONCLUSION

IoT is the next big thing we would see in the world. It has the potential of changing our world altogether, making it something unrecognizable and unimaginable. It is a disruptive technology that would change everything around us. Implementation of IoT is facing many challenges and issues. These pertain to heterogeneity and lack of any standards. As a disruptive technology this will gradually emerge and take over everything. The other issue in IoT is acceptance of the technology by the people. The response of people accepting IoT devices doing their activities, handling their details may determine the growth curve of IoT. Another issue is of decision making capability. Humans work on fuzzy logic but machine decisions are binary. This argument remains open to discuss among people who want to implement IoT and people who do not. One such common example of argument is asking about the decision an automated car would make if a person comes in front

of the car unexpectedly. Humanity and machine computation can converge if IoT will be a glowing future of technological world in coming years.

VI. REFERENCES

[1] Neil Garshenfeld, "*When Things Start to Think*",ISBN-13: 978-0805058741

[2] Rinju Ravindran, Jerrin Yomas, Jubin Sebastian E, "*IoT: A Review on Security Issues and Measures*" IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498 Vol.5, No.6, December 2015

[3] http://postscapes.com/internet-of-things-history

[4] Wikibooks contributors, "*I Dream of IoT/Chapter 4: IoT and Cloud Computing*," Wikibooks, The Free Textbook Project.

[5] http://www.cio.com/article/3129410/internet-of-things/how-iot-makes-electricity-generation-more-efficient.html

[6] http://www.cio.com/article/3090123/internet-of-things/how-the-internet-of-things-is-revolutionizing-retail.html

[7] http://www.cio.com/article/3137047/internet-of-things/internet-of-things-poised-to-transform-cities.html

[8] https://www.toptal.com/it/are-we-creating-an-insecure-internet-of-things

[9] Mario Ballano Barcena, Candid Wueest, "*Insecurity in the Internet of Things*", Semantic White Paper, Version 1.0, March 12, 2015

[10] Farheen Siddiqui "Applications for Big Data in of Intelligent Distributed Processing "IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 18, Issue 6, Ver. I (Nov. - Dec. 2016), PP 61-64 DOI: 10.9790/0661-1806016164