IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
IJARSCT
Impact Factor: 7.301
Volume 3, Issue 3, January 2023

Internet of Things (IoT): Definitions, Challenges, and Recent Research Directions

Mr. Abhishek Jangam[1] and Mrs. Vijaya Bhosale[2]
Student, M.Sc. I.T., I. C. S. College, Khed, Ratnagiri, Maharashtra, India[1]
Asst. Prof., Department of I.T., I. C. S. College, Khed, Ratnagiri, Maharashtra, India[2]

Abstract: *We want to showcase the Internet of Things (IoT) idea as a whole and examine the primary challenges the IoT environment is experiencing by concentrating on the most recent research directions in this area. A new technology called the Internet of Things (IoT) intends to actualize the idea of connectedness so that anything can be accessed from anywhere at any time. It can be characterized as a connected intelligent and interoperable node in a dynamic global infrastructure network. In actuality, the IoT environment faces a variety of difficulties that materially affect their performance. These difficulties can be divided into two groups: I Overarching issues including virtualization, connectivity, heterogeneity, and security;ii) Distinctive barriers: Examples include the wireless sensor network (WSN), radio frequency identification (RFID), and quality of service (QoS), which is viewed as a factor that is shared by both special challenges and general challenges. This paper also highlights the key IoT applications.*

Keywords: IoT; heterogeneity; virtualization; WSN; RFID; QoS

I. INTRODUCTION

The "ubiquitous computing" or "web 0.3" age, which is currently in effect, is defined by intelligent technology. For this type of cutting-edge technology, the Internet of Things (IoT) has established itself as a more lucrative sector. Not only is cloud computing not the first technology in this area, but it has also been used to illustrate the world of ubiquitous computing. Kevin Ashton used the phrase "Internet of things" for the first time in the RFID magazine in 1999 [2], and it was also used for the first time in the seventh ITU Internet Report from 1997, which was titled "Challenges to the Network." The goal of Kevin's Internet of Things vision was to enable networked objects to communicate data about real-world objects over the internet. The majority of IoT-related architectures proposed in recent years have been implemented, including semantic web publishing through social networks; For instance, Nike + iPod, an innovative service for the iPhone, allows users to record information and publish it to social networks and friends [3].with a well-thought-out behavior and taking into account the fact that autonomy and privacy exist. In the meantime, there are many different objects and things in the IoT environment, which can be separated into two types:i) Items requiring rechargeable batteries: The majority of them are mobile devices, such as laptops, tablets, and mobile phones; ii) Items are not rechargeable: From a mobility standpoint, these things are static [4].IoT typically has three main requirements: the first, a common understanding of its users' circumstances and applications. Next, the IoT's analytics tools, which aim for autonomous and intelligent behavior [5], software architecture and ubiquitous communication networks to cover and process contextual information

II. RELATED WORK

The drive of this unit of the paper is to deliver a brief impression of the Internet of Things, including its definition, history, and origins. It also aims to highlight the "IoT infrastructure" architecture design, which is based on three dimensions; The final section of this section discusses IoT and traditional Internet similarities and differences.

2.1 Definitions and History

Mark Weiser published in 1991 about his ideas for the future of the Internet under the heading "Ubiquitous Computing." He was concentrating on how to activate the intelligent, sustainable world in the existence of mobile phones, which acts as a potent multimedia system [6] through this concept. Kevin Ashton is regarded as a pioneer in the IoT space [2]. Three paradigms—internet-oriented (Middleware), things-oriented (Sensors), and semantic-oriented—

were used by Atzori A.lera et al. [7] to categorise the Internet of Things (Knowledge). Similar subjects from the Massachusetts Institute of Technology's MIT Media Lab were covered by Neil Gershenfeld in his 1999 book "When Things Start to Think."

2.2 Architecture and Design

A privileged IoT system can be built on top of the best architecture design, which solved many problems with the IoT environment, including scalability, routing, networking, etc. The three key dimensions on which the IoT architectural strategy is often based are:

2.3 Differences between IoT and Traditional Network

The Internet of Things (IoT) technology started a new era of telecommunications technology by breaking many of the old ideas about networks can be thought of as an Internet-based extension and expansion network;Despite being regarded as the foundation upon which to construct any IoT block, it is distinct from either the traditional network or the so-called Internet of People.

The most common declaration used to define the Internet of Things (IoT) atmosphere is "IoT atmosphere= Internet + WSN." This is the utmost significant equation for describing the IoT environment. According to table 1, the similarities and differences between IoT, the Internet, and WSN must be determined in order to analyze and determine the accuracy of this declaration.

This viewpoint, based on prior knowledge of the IoT environment, is incorrect; because this view should be rejected for two main reasons. First; The nature of the Internet of Things necessitates lightweight communication protocols, and the complexity of the TCP/IP protocol is particularly unsuitable when working with smart little things, so IP may not always be used for addressing things. Second, in contrast to conventional networks, the IoT environment is primarily based on connected smart objects. Because of this, they have moved beyond being merely an extension of the Internet. Additionally, the behavior of the Internet of Things is dependent on the development of interoperable systems [10]. Based on these arguments, the previous statement can be corrected:

IoT= Internet + WSN+ Smart Items surrounded by Intelligent environment.

III. CHALLENGES AND RECENT RESEARCH DIRECTIONS

The majority of the most common or general IoT environment challenges are discussed in this section; It also shows the most recent directions for research on each subject. Lastly, Table 3 examines the most recent research directions and the solutions proposed for each of them. Table 4 also examines the summary of the IoT research topics for the future.

3.1 Networking

In general, the issue of networking is very important to the Internet because it includes some of the crucial factors that are used to manage networks. First and foremost, D. Giusto et al. mentions traffic and protocols that have a significant impact on the network's behavior in [11].used a mobile Ad-Hoc Network to address networking issues. The authors have made use of mobile ad hoc networks (MANET), which are connected to fixed networks through various gateways. In IoT, the location of an object's movement cannot be predicted, and the object may be required to transmit data from one network to another. The most significant issue is the fluctuation of dynamic gateways and the difficulty in locating objects. The MANET, which is made up of a number of autonomously organized mobile nodes or objects, is thought to be a way to keep a connection. Multi-homed ad-hoc is also thought to be an extension of the IoT's existing infrastructure.

3.2 Routing

To successfully complete the communication process, the routing process entails choosing the most advantageous route between the source and the destination. Based on the type of communication protocol, the number of hops, costs, and bandwidth can be used to determine the best route. Routing protocols can be broken down into two main categories: i) Protocols that react: Following the transmission request, the path is established. ii) Proactive protocols: initial path prior to making the request. Sudip Misra et al., in [12], proposed the "fault-tolerant routing protocol" for the Internet of

Things, which was developed with the help of the cross-layer concept and learning automate (LA).LA deals with optimization problems to select the best solutions. Cross-layering is needed to save energy for IoT devices (FRID, for example).

3.3 Heterogeneity

The most well-known illustration of the problem of heterogeneity is the Internet of Things (IoT) environment, which is comprised of numerous distinct devices by nature. The Internet of Things (IoT)'s main goal is to find a common way to abstract these devices' differences and make the most of their capabilities. In this way, the researchers always try to find a good way to deal with these devices, no matter what they are made of. In [13], C. G. Garcia et al. aimed to introduce solutions to IoT issues like interconnection and heterogeneity and create an application that lets people connect services over the Internet, these solutions are shown in: developing software for an IoT platform, a graphic editor, and a domain-specific language (DSL).For instance, a number of applications that are used to solve the problem of heterogeneous objects over the Internet, such as WhatsApp, Skype, and so on, have emerged in recent years. These applications are regarded as a straightforward example of how to solve this issue. The authors have looked at Midgar software for managing heterogeneous smart devices in an IoT environment, and DSL package is intended precisely for this persistence. The main goal of this software is to establish a domain where it is simple for objects of any kind to communicate with one another.

3.4 Middleware Layer

A software layer or group of sublayers that sits between the technology and application layers and offers a uniform method of representation and communication is known as the middleware layer.
There are three main layers that make up the middleware layer:

- ***Service Composition Layer:*** A standard layer that sits on top of SOA middleware that offers capability for composing single services and creating customized applications. This layer is only concerned with offering services. Each participating service's individual architecture makes up the service composition architecture, which also publishes SLA [14].
- ***Service Management Layer:*** The layer enables IoT administration. There are two categories in which service management can be divided: Runtime services are those that depend on time as a key component in their direct implementation. ii) Design period: services are a component of maintaining a lifestyle and developing services [15]. A number of services, including object dynamic discovery, status monitoring, service policy enforcement, service Meta model updates, and service configuration are included in the service management layer. Some middleware also includes additional features related to QoS management and lock management. It is noteworthy that new services can be developed during run-time through the service management layer [7].
- ***Object Abstraction:*** the need to object abstraction layer is summarized in vast and heterogeneous objects which scattered through IoT, layer organized harmonizing accessto different devices with common language and procedure. Object abstraction includes wrapping layer consists of two sub-layers, interface sub-layer that management, incoming/outcoming messages and it provides an interface exposing the available method through a standard web service interface. Second sub-layer is a communication sub-layer that implements logic at web service methods and translate these methods at devices to communicate with real-world objects [7].

The middleware layer, which sits between the technology and application levels and may be a software layer or a group of sub-layers, offers a uniform means of representation and communication.
The middleware layer is composed of three main layers:

1. The common layer of SOA middleware is the layer of service composition; it constructs a particular application and offers capability for service composition. This layer was primarily concerned with the supply of services. The service composition architecture, which is thoroughly detailed in SLA [14], is made up of the separate architectures of the participating services.
2. Layer of Service Management: The layer in the IoT allows for management. There are two subcategories of service management: runtime: services whose direct implementation relies on time as a crucial factor.

3. Design time: Creating services and maintaining a way of life go hand in hand [15]. Its managed services layer is comprised of a variety of services, including item dynamically detection, status monitoring, business application control, services para modeling modifications, and able to create an environment. Some middleware additionally has additional functionality related to locking control and QoS management. Notably, its managed services layer permits the creation of new service while existing ones are still in use [7].
4. Abstraction of objects: The need to complain to the deliberation layer is mentioned in several, disparate articles that were dispersed across the Internet of Things. The layer coordinated suitable access to different devices with standard language and system. The object abstraction layer's interface sublayer offers an interface for managing both inbound and outbound messages as well as presenting the accessible methods using a standard web service interface. The wrapping layer is composed of two sublayers. The responsibility for converting the logic of web service method calls into the capacity of devices to interact with actual objects falls on the second sub-communication layer's sub-layer [7].

3.5 Interoperability

The ability to create systems or devices that work together effectively is one way to define the interoperability concept. In [16] Jussi et al. aimed to make use of the semantic level interoperability architecture for IoT and ubiquitous computing; The semantic information sharing solutions known as "smart-M3" are the foundation of the architecture.

3.6 Quality of Service(QoS)

The ideal definition of quality of service (QoS) is "the amount of time that is taken to deliver the message from the sender and the receiver." If this time is equal to or less than a predetermined time requirement, QoS is achieved.The QoS concept was re-defined by the ITU as a degree of conformance in the provider's delivery of service to the user in accordance with their agreement [17].To ensure QoS, service models must be used to determine the level of QoS provided by each Internet service.

IV. THE HOT TOPICS AND RELATED CHALLENGES

The Internet of Things (IoT) is made up of a slew of additional components that can be described as "unique challenges" or as an extension of the IoT's general difficulties. The purpose of this section is to briefly explain some of these aspects.

4.1 Radio frequency Identification (RFID)

RFID is a forward leap in implanted correspondence and WSN, RFID is utilized to produce a remarkable ID for the item in WSN. There are two parts to it: passive RFID: which was used to power the interrogation signal sent by the reader to send the ID to the RFID and the access control application. RFID in use: Readers initiate communication and have their own battery supply. In order to enhance RFID performance in a specific IoT application field, Ultrawide Bandwidth (UWB) technology is utilized.UWB is an innovation permits the up-and-coming age of RFID to beat a significant number of the ongoing limitations in current RFID like low security, lessen region, and aversion to obstructions. The RFID consists of three essential components: the object-carrying RFID tag or transponder, the RFID tag reader or transceiver, and the back-end database.

4.2 Wireless Sensor Networks(WSN)

WSN is a crucial component of the Internet of Things. It is regarded as the building block of the IoT and consists of a collection of specialized sensor data shared among sensor nodes with communication infrastructure for monitoring various events or states of objects, such as temperature, sound, pressure, and so on.These sensor nodes operate on their own and can be connected to one another through self-organization.Notably, WSN support the distribution idea between sensor nodes, and each sensor network includes a radio transceiver with an internal or external antenna, a microcontroller, an electronic circuit for the sensors, and an energy source [30].

V. APPLICATIONS

Because it touches a lot of important aspects, such as healthcare, smart water, transportation, surveillance, and so on, the Internet of Things (IoT) technology has recently emerged as one of the fundamentals of our lives.In addition, numerous applications have emerged to support this idea. The IoT applications can be divided into four categories according to [5], which can be summarized as follows: The healthcare industry is regarded as the most common example of this category; i) Personal and home uses Wi-Fi as a backbone, providing a higher sampling rate and a higher bandwidth for data transfer; ii) Enterprise uses information that may be collected from networks; environment monitoring, such as video surveillance, is the most common example of this category; iii) Mobile uses sensor information that can be obtained from large-scale WSN for online travel time monitoring; transportation is the most common example of this category. Lastly, iv) Utilities: Information about service optimization and power consumption can be gleaned from networks to reduce costs and increase profits for businesses that use these kinds of applications. The smart grid, smart metering, and smart water and water quality are the best examples of this kind. The most common examples of each of these categories will be discussed in this section, and table 5 provides a summary of the IoT application categories.

5.1 Healthcare

The IoT Cloud paradigm [33] has been extensively utilized in the healthcare industry for remote diagnosis, treatment, and patient status tracking. The paradigm needs to serve four pivots, which are as follows is a function that identifies the patient while they are moving, and ii) authentication and identification: identification with the intention of reducing diagnostic and authentication errors in order to meet security requirements; iii) data collection: Usually aims to speed up processing, and it has to do with combining RFID technology with other types of health data. Finally, iv) sensing: used to provide the patient with information in real time [32].The following are the issues in this area: interoperability, streaming QoS, security, heterogeneity, and control

VI. CONCLUSION AND FUTURE

IoT is a one the principal procedures that is utilized to communicate the universal registering approach, yet it still not famous like the distributed computing innovation. Through its three sections, this paper aimed to highlight the IoT concept as a whole: section I provided an overview of the Internet of Things (IoT) concept by focusing on its history and the year 1999, when Kevin Ashton, who is regarded as one of the pioneers who talked about IoT and even the Cisco company now, started it.The following is a review of the fundamental concept for designing an IoT structure based on the integration of three dimensions: intelligent applications, independent networks, and information items As a result, the integration of the social, digital, and real worlds is essential to the IoT structure's future. Last but not least, the differences between the Internet of Things and the conventional network are discussed in this section. Communication, networking, quality of service (QoS), scalability, virtualization, big data, heterogeneity, and security were examined in Section II as the primary general obstacles that significantly impacted IoT performance. The purpose of this section was to demonstrate and offer the most recent solutions to each aspect of these difficulties. Under the heading "The Hot Topics and Related Challenges," this section also covered an additional type of challenge known as "unique challenges."

REFERENCES

[1]. M. H. Miraz, M. Ali, P. S. Excell, and R.Picking,“A Review on Internet of Things (IoT), Internet of Everything (IoE) and Internet ofNano Things (IoNT)”, in 2015 Internet Technologies and Applications(ITA),pp.219–224,Sep.2015,DOI:10.1109/ITechA.2015.7317398.

[2]. P. J. Ryan and R. B. Watson, “Research Challenges for the Internet of Things: What Role Can OR Play?,” Systems, vol. 5, no. 1, pp. 1–34,2017.

[3]. M. Miraz, M. Ali, P. Excell, and R. Picking, “Internet of Nano-Things, Things and Everything: Future Growth Trends”, Future Internet, vol. 10,no.8,p.68,2018,DOI:10.3390/fi10080068.

[4]. Mahmud, S. H., Assan, L. and Islam, R. 2018. “Potentials of Internet of Things (IoT) in Malaysian Construction Industry”, Annals of Emerging Technologies in Computing (AETiC), Print ISSN: 2516-0281, Online ISSN: 2516-029X, pp. 44-52, Vol. 2, No. 1, International Association of Educators and Researchers (IAER), DOI:10.33166/AETiC.2018.04.004.

[5]. Mano, Y., Faical B. S., Nakamura L., Gomes, P. G. Libralon, R. Meneguete, G. Filho, G. Giancristofaro, G. Pessin, B. Krishnamachari, and Jo Ueyama. 2015. Exploiting IoT technologies for enhancing Health Smart Homes through patient identification and emotion recognition. Computer Communications,89.90,(178-190).DOI:10.1016/j.comcom.2016.03.010.

[6]. I. E. Paromtchik and C. Laugier, “Motion generation and control for parking an autonomous vehicle,” in Proceedings of IEEE International Conference on Robotics and Automation, 1996, vol. 4, pp. 3117–3122.

[7]. R. Cabrera-Cosetl, M. Z. Mora-Alvarez and R. Alejos-Palomares, "Self-Parking System Based in a Fuzzy Logic Approach," 2009 International Conference on Electrical, Communications, and Computers, Cholula, Puebla, 2009, pp. 119-124.

[8]. E. Eckermann, World history of the automobile. Society of Automotive Engineers, 2001. SAE Press. p. 14. ISBN 9780768008005.

[9]. G. N. Georgano and EBSCO Publishing (Firm), From the early years to the golden era of coach building. London: Mason Crest Publishers, 2002. ISBN 1-59084-491-2.

[10]. I. E. Paromtchik and C. Laugier, “Motion generation and control for parking an autonomous vehicle,” in Proceedings of IEEE International Conference on Robotics and Automation, 1996, vol. 4, pp. 3117–3122.