International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

IoT - Challenges and Future Applications

[1]Mr.B.Nagaraju, [2]Dr.Maniganda P, [3]Mr.M.Devsingh
[1]Assistant Professor [2]Professor [3]Associate Professor
Balaji Institute of Technology & Science

Abstract—With the Internet of Things (IoT) gradually evolving as the subsequent phase of the evolution of the Internet, it becomes crucial to recognize the various potential domains for application of IoT, and the research challenges that are associated with these applications. Ranging from smart cities, to health care, smart agriculture, logistics and retail, to even smart living and smart environments IoT is expected to infiltrate into virtually all aspects of daily life. Even though the current IoT enabling technologies have greatly improved in the recent years, there are still numerous problems that require attention. Since the IoT concept ensues from heterogeneous technologies, many research challenges are bound to arise. The fact that IoT is so expansive and affects practically all areas of our lives, makes it a significant research topic for studies in various related fields such as information technology and computer science. Thus, IoT is paving the way for new dimensions of research to be carried out. This paper presents the recent development of IoT technologies and discusses future applications and research challenges.

Keywords—Internet of Things; IoT applications; IoT challenges; future technologies; smart cities; smart environment; smart agriculture; smart living

I. INTRODUCTION

The Internet can be described as the communication network that connects individuals to information while The Internet of Things (IoT) is an interconnected system of distinctively address able physical items with various degrees of processing, sensing, and actuation capabilities that share the capability to interoperate and communicate through the Internet as their joint platform [1]. Thus, the main objective of the Internet of Things is to make it possible for objects to be connected with other objects, individuals, at any time or anywhere using any network, path or service. The Internet of Things (IoT) is gradually being regarded as the subsequent phase in the Internet evolution. IoT will make it possible for ordinary devices to be linked to the internet in order to achieve countless disparate goals. Currently, an estimated number of only 0.6% of devices that can be part of IoT has been connected so far [2]. However, by the year 2020, it is likely that over 50 billion devices will have an internet connection. As the internet continues to evolve, it has become more than a simple network of computers, but rather a network of various devices, while IoT serves as a network of various "connected" devices a network of networks [3], as shown in Fig. 1. Nowadays, devices like smartphones, vehicles, industrial systems, cameras, toys, buildings, home

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

appliances, industrial systems and countless others can all share information over the Internet. Regardless of their sizes and functions, these devices can accomplish smart reorganizations, tracing, positioning, control, real-time monitoring and process control. In the past years, there has been an important propagation of Internet capable devices. Even though its most significant commercial effect has been observed in the consumer electronics field; i.e. particularly the revolution of smartphones and the interest in wearable devices (watches, headsets, etc.), connecting people has become merely a fragment of a bigger movement towards the association of the digital and physical worlds. With all this in mind, the Internet of Things (IoT) is expected to continue expanding its reach as pertains the number of devices and functions, which it can run. This is evident from the ambiguity in the expression of "Things" which makes it difficult to outline the ever-growing limits of the IoT [4]. While commercial success continues to materialize, the IoT constantly offers a virtually limitless supply of opportunities, not just in businesses but also in research. Accordingly, the understudy addresses the various potential areas for application of IoT domains and the research challenges that are associated with these applications.

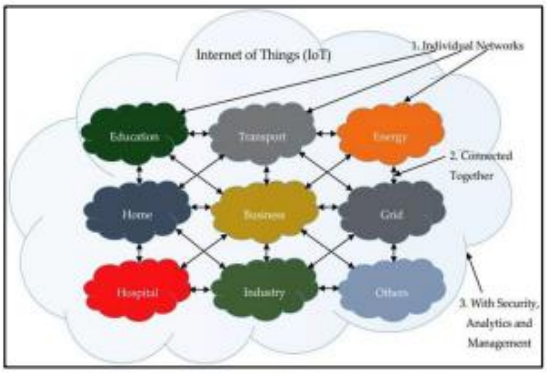

Fig. 1. IoT can be viewed as a Network of Networks [3].

II. POTENTIAL APPLICATION DOMAINS OF IOT

Potential applications of the internet of Things are not only numerous but also quite diverse as they permeate into virtually all aspects of daily life of individuals, institutions, and society. According to [5], the applications of IoT cover broad areas including manufacturing or the industrial sector, health sector, agriculture, smart cities, security and emergencies among many others.

A. Smart Cities

According to [6], the IoT plays a crucial role in improving the smartness of cities and enhancing general infrastructure. Some of IoT application areas in creating smart cities include; intelligent transportation systems [7], smart building, traffic congestion [7, 8] waste management [9], smart lighting, smart parking, and urban maps. This may include different functionalities such as; monitoring available parking spaces within the city, monitoring vibrations as well as material conditions of bridges and buildings, putting in place sound monitoring devices in sensitive parts of cities, as well as monitoring the levels of pedestrians and vehicles. Artificial Intelligence (AI) enabled

IoT can be utilized to monitor, control and reduce traffic congestions in Smart Cities [6]. Moreover, IoT allows installation of intelligent and weather adaptive street lighting and detection waste and waste containers by keeping tabs of trash collection schedules. Intelligent highways can provide warning messages and important information, such as access to diversions depending on the climatic conditions or unexpected occurrences like traffic jams and accidents. Application of IoT to achieve smart cities would require using radio frequency identification and sensors. Some of the already developed applications in this area are the Aware home and the Smart Santander functionalities. In the United States, some major cities like Boston have plans on how to implement the Internet of Things in most of their systems ranging from their parking meters, streetlights, sprinkler systems, and sewage grates are all scheduled to be interlinked and connected to the internet. Such applications will offer significant break throughs in terms of saving money and energy.

B. Healthcare

Most healthcare systems in many countries are inefficient, slow and inevitably prone to error. This can easily be changed since the healthcare sector relies on numerous activities and devices that can be automated and enhanced through technology. Additional technology that can facilitate various operations like report sharing to multiple individuals and locations, record keeping and dispensing medications would go a long way in changing the healthcare sector [10]. A lot of benefits that IoT application offers in the healthcare sector is most categorized into tracking of patients, staff, and objects, identifying, as well as authenticating, individuals, and the automatic gathering of data and sensing. Hospital workflow can be significantly improved once patients flow is tracked. Additionally, authentication and identification reduce incidents that may be harmful to patients, record maintenance and fewer cases of mismatching infants. In addition, automatic data collection and transmission is vital in process automation, reduction of form processing timelines, automated procedure auditing as well as medical inventory management. Sensor devices allow functions centered on patients, particularly, in diagnosing conditions and availing real-time information about patients' health indicators [6]. Application domains in this sector include; being able to monitor a patient's compliance with prescriptions, telemedicine solutions, and alerts for patients' well-being. Thereby, sensors can be applied to outpatient and inpatient patients, dental Bluetooth devices and toothbrushes that can give information after they are used and patient's surveillance. Other elements of IoT in this capacity include; RFID, Bluetooth, and Wi-Fi among others. These will greatly enhance measurement and monitoring techniques of critical functions like blood pressure, temperature, heart rate, blood glucose, cholesterol levels, and many others. The applications of Internet of Things (IoT) and Internet of Everything (IoE) are further being extended through the materialization of the Internet of Nano-things (IoNT) [3].

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

The notion of IoNT, as the name implies, is being engineered by integrating Nano-sensors in diverse objects (things) using Nano networks. Medical application, as shown in Fig. 2, is one of the major focuses of IoNT implementations. Application of IoNT in human body, for treatment purposes, facilitates access to data from in situ parts of the body which were hitherto in accessible to sense from or by using those medical instruments incorporated with bulky sensor size. Thus, IoNT will enable new medical data to be collected, leading to new discoveries and better diagnostics.

C. Smart Agriculture and Water Management According to [11], the IoT has the capacity to strengthen and enhance the agriculture sector through examining soil moisture and in the case of vineyards, monitoring the trunk diameter. IoT would allow to control and preserve the quantity of vitamins found in agricultural products, and regulate microclimate conditions in order to make the most of the production of vegetables and fruits and their quality. Furthermore, studying weather conditions allows forecasting of ice information, drought, wind changes, rain or snow, thus controlling temperature and humidity levels to prevent fungus as well as other microbial contaminants. When it comes to cattle, IoT can assist in identifying animals that graze in open locations, detecting detrimental gases from animal excrements in farms, as well as controlling growth conditions in offspring to enhance chances of health and survival and so on. Moreover, through IoT application in agriculture, a lot of wastage and spoilage can be avoided through proper monitoring techniques and management of the entire agriculture field. It also leads to better electricity and water control.

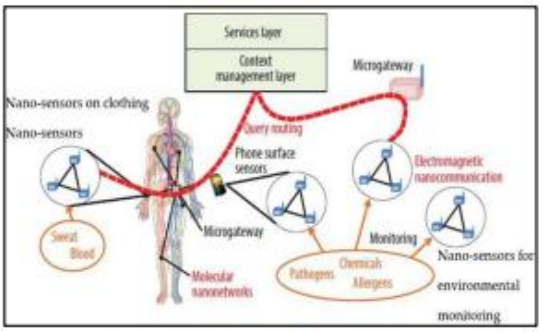

Fig. 2. The Internet of Nano-Things [3].

III. RESEARCH CHALLENGES

For all the above potential applications of IoT, there has to be proper feasibility into the different domains to ascertain the success of some applications and their functionality. As with any other form of technology or innovation, IoT has its challenges and implications that must be sorted out to enable mass adoption. Even though the current IoT enabling technologies have greatly improved in the recent years, there are still numerous problems that require attention, hence paving the way for new dimensions of research to be carried out. Since the IoT concept ensues from heterogeneous technologies that are used in sensing, collecting, action, processing, inferring, transmitting, notifying, managing, and storing of data, a lot of research challenges are bound to arise. These research challenges that require attention have consequently spanned different research areas [14].

A. Privacy and Security Owing to the fact that IoT has become a vital element as regards the future of the internet with its

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

increased usage, it necessitates a need to adequately address security and trust functions. Researchers are aware of the weaknesses which presently exist in many IoT devices. Furthermore, the foundation of IoT is laid on the existing wireless sensor networks (WSN), IoT thus architecturally inherits the same privacy and security issues WSN possesses [3, 15]. Various attacks and weaknesses on IoT systems prove that there is indeed a need for wide ranging security designs which will protect data and systems from end to end. Many attacks generally exploit weaknesses in specific devices thereby gaining access into their systems and consequently making secure devices vulnerable [16, 17] . This security gap further motivates comprehensive security solutions that consist of research that is efficient in applied cryptography for data and system security, non-cryptographic security techniques as well as frameworks that assist developers to come up with safe systems on devices that are heterogeneous. There is a need for more research to be conducted on cryptographic security services that have the capability to operate on resource constrained IoT devices. This would enable different skilled users to securely use and deploy IoT systems regardless of the inadequate user interfaces that are available with almost all IoT devices. In addition to the protection and security aspects of the IoT, additional areas like confidentiality in communication, trustworthiness, and authenticity of communication parties, and message integrity, and supplementary safety requirements should also be incorporated. These may include features like being able to prevent communication of various parties. As an example, in business transactions, smart objects must be prevented from facilitating competitors' access to confidential information in the devices and thus using this information maliciously.

B. Processing, Analysis and Management of Data The procedure for processing, analysis and data management is tremendously challenging because of the heterogeneous nature of IoT, and the large scale of data collected, particularly in this era of Big Data [18]. Currently, most systems utilize centralized systems in offloading data and carrying out computationally intensive tasks on an international cloud platform. Nevertheless, there is a constant concern about conventional cloud architectures not being effective in terms of transferring the massive volumes of data that are produced and consumed by IoT enabled devices and to be able further support the accompanying computational load and simultaneously meet timing constraints [19]. Most systems are therefore relying on current solutions such as mobile cloud computing and fog computing which are both based on edge processing, to mitigate this challenge. Another research direction as regards data management is applying Information Centric Networking (ICN) in the IoT. Since these information centric systems offer support in the efficient content retrieval and access to services, they appear to be quite valuable not just in accessing but also transferring as well as managing generated content and its transmission. This solution, however, brings about various challenges such as; how to

extend the ICN paradigm competently over the fixed network edge, how to take in IoTs static and mobile devices as well as how to apportion the functionality of ICN on resource constrained devices [19]. Data analysis and its context not only plays a crucial role in the success of IoT, it also poses major challenges. Once data has been collected it has to be used intelligently in order to achieve smart IoT functions. Accordingly, the development of machine learning methods and artificial intelligence algorithms, resultant from neural works, genetic algorithms, evolutionary algorithms, and many other artificial intelligence systems are essential in achieving automated decision making.

C. Monitoring and Sensing Even if technologies concerned with monitoring and sensing have made tremendous progress, they are constantly evolving particularly focusing on the energy efficiency and form aspect. Sensors and tags are normally expected to be active constantly in order to obtain instantaneous data, this aspect makes it essential for energy efficiency especially in lifetime extension. Simultaneously, new advances in nanotechnology/biotechnology and miniaturization have allowed the development of actuators and sensors at the Nanoscale.

D. M2M (Machine to Machine) Communication and Communication Protocols While there are already existing IoT oriented communication protocols like Constrained Application Protocol (CoAP) and Message Queuing Telemetry Transport (MQTT), there is still no standard for an open IoT. Although all objects require connectivity, it is not necessary for every object to be made internet capable since they only need to have a certain capability to place their data on a particular gateway. Additionally, there are a lot of options in terms of suitable wireless technologies such as LoRa, IEEE 802.15.4, and Bluetooth even though it is not clear whether these available wireless technologies have the needed capacity to continue covering the extensive range of IoT connectivity henceforth. The communication protocols for devices are the driving force in actualizing IoT applications, and they form the main support of data flow between sensors and the physical objects or outer world. While various MAC protocols have been projected for several domains with Frequency Division Multiple Access, Time Division Multiple Access and Carrier Sense Multiple Access (FDMA, TDMA and CSMA) for low traffic efficiency that is collision free, more circuitry in nodes are required respectively. The main objectives of the transport layer include guaranteeing an end-to-end reliability as well as performing end-to-end control of congestion. In this aspect, most protocols are unable to cooperate appropriate end to end reliability [20].

IV. CONCLUSION

The IoT can best be described as a CAS (Complex Adaptive System) that will continue to evolve hence requiring new and innovative forms of software engineering, systems engineering, project management, as well as numerous other disciplines to develop it further and manage it the coming years. The application areas of IoT are quite diverse to enable it to serve different users,

who in turn have different needs. The technology serves three categories of users, individuals, the society or communities and institutions. As discussed in the application section of this research paper, the IoT has without a doubt a massive capability to be a tremendously transformative force, which will, and to some extent does already, positively impact millions of lives worldwide. According to [25], this has become even more evident, as different governments around the world have shown an interest in the IoT concept by providing more funding in the field that is meant to facilitate further research. A good example is the Chinese Government. Countless research groups have been, and continue to be, initiated from different parts of the world, and their main objective is to follow through IoT related researches. As more and more research studies are conducted, new dimensions to the IoT processes, technologies involved and the objects that can be connected, continue to emerge, further paving way for much more application functionalities of IoT. The fact that IoT is so expansive and affects practically all areas of our lives, makes it a significant research topic for studies in various related fields such as information technology and computer science. The paper highlights various potential application domains of the internet of things and the related research 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 of Nano 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] E. Borgia, D. G. Gomes, B. Lagesse, R. Lea, and D. Puccinelli, "Special issue on" Internet of Things: Research challenges and Solutions".," Computer Communications, vol. 89, no. 90, pp. 1–4, 2016.

[5] K. K. Patel, S. M. Patel, et al., "Internet of things IOT: definition, characteristics, architecture, enabling technologies, application future challenges," International journal of engineering science and computing, vol. 6, no. 5, pp. 6122–6131, 2016.

[6] S. V. Zanjal and G. R. Talmale, "Medicine reminder and monitoring system for secure health using IOT," Procedia Computer Science, vol. 78, pp. 471–476, 2016.

[7] R. Jain, "A Congestion Control System Based on VANET for Small Length Roads", Annals of Emerging Technologies in Computing (AETiC), vol. 2, no. 1, pp. 17–21, 2018, DOI: 10.33166/AETiC.2018.01.003.

[8] S. Soomro, M. H. Miraz, A. Prasanth, M. Abdullah, "Artificial Intelligence Enabled IoT: Traffic Congestion Reduction in Smart Cities," IET 2018 Smart Cities Symposium,

pp. 81–86, 2018, DOI: 10.1049/cp.2018.1381.

[9] 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.

[10] 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.

[11] V. Sundareswaran and M. S. null, "Survey on Smart Agriculture Using IoT," International Journal of Innovative Research in Engineering & Management (IJIREM), vol. 5, no. 2, pp. 62–66, 2018.

[12] P. Tadejko, "Application of Internet of Things in logistics-current challenges," Ekonomia i Zarz{a˛}dzanie, vol. 7, no. 4, pp. 54–64, 2015. [13] S. Rajguru, S. Kinhekar, and S. Pati, "Analysis of internet of things in a smart environment," International Journal of Enhanced Research in Man-agement and Computer Applications,vol. 4, no. 4, pp. 40–43, 2015.