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IOT: Challenge and Recent Research Directions

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Abstract

Recently, IOT has emerged as a new technology that is used to express a modern wireless telecommunication network, and it can be defined as an intelligent and interoperability node interconnected in a dynamic global infrastructure network, also it seeks to implement the connectivity concept of anything from anywhere at anytime Indeed, the IOT environment possesses a large spectrum of challenges has a broad impact on their performance, which can be divided into two categories, I) General challenges: such as communication, heterogeneity, virtualization and security. II) Unique challenges: such as wireless sensor network (WSN), Radio Frequency Identification (RFID), and finally Quality of service (QOS) that is considered as a common factor between both general and special challenges. In addition, this paper highlights the main applications of the IOT.

Keywords: IOT, WSN, RFID, QOS, Heterogeneity, Virtualization.

Introduction

The Internet of Things (IOT) is an emerging paradigm that enables the communication between electronic devices and sensors through the internet in order to facilitate our lives. Internet of

Things (IOT) has emerged strongly as a more prosperous area to express this kind of a new technology. Today, we are living in the era of smart technologies which represents a "ubiquitous computing" or “web 0.3”.It is not the first technology in this field, but also the cloud computing technology has been used to represent the ubiquitous computing world. In the seventh in the series of ITU Internet Reports originally it was launched in 1997 under the title “Challenges to the Network”, and it was first coined by Kevin Ashton in the RFID journal 1999 , In 2005 this name was changed to “Internet of things“. Actually, the definition of IOT varies based on who you talk, but formally, it can be defined as a dynamic global network infrastructure with self-configuration and interoperable communication. Simply, IOT means the ability to make everything around us starting from (i.e. Machine, Devices, Mobile phone and Cars) even (Cities and Roads) are expected to be connected to the Internet with an intelligent behavior and taking into account the existence of the kind of autonomy and privacy.

2. Related Work

Its definition, its history and its inception also highlight the architecture design of IOT that is relied on three dimensions called “IOT infrastructure”; and the final part in this section discusses the similarities and differences between both IOT and traditional Internet.

3. Definitions and History

The main concept of a network of smart devices was discussed as early as 1982, with a modified Coca-Cola vending machine at Carnegie Mellon University becoming the first ARPANET-connected appliance, able to report its inventory and whether newly loaded drinks were cold or not. Mark Weiser's 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of the IOT. In 1994, Reza Raji described the concept in IEEE Spectrum as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories". Between 1993 and 1997, several companies proposed solutions like Microsoft's at Work or Novell's NEST.

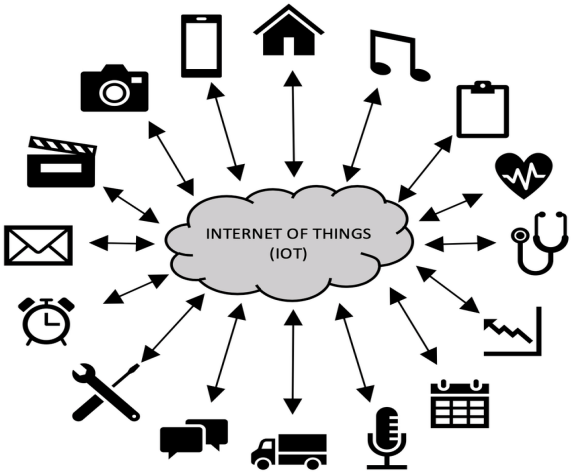

Figure.1. Internet of things(IOT) technology

4. Architecture and Design

The best design of the architecture is a foundation stone to build a privileged IOT system; this architecture helped to address a lot of issues in the IOT environment such as scalability, routing, networking, etc.. Typically, the IOT architecture approach base don't here main dimension are:

Information items: it includes all items connected to IOT environment may be sensing items, identifying items and control items;

ii) Independent network: which includes several features such as self-configuration, self-protection, self-adaptation, and self-optimization; and

iii) Intelligent applications: which have intelligent behavior over the Internet generally; the intelligent behavior may be intelligent control, exchange data methods through network items, data processing, all the applications which are related to the IOT can be classified according to these dimensions

5. Differences between IOT and Traditional Network

In the beginning, the IOT technology has broken a lot of the traditional ideas of network and started a new era of telecommunication technology. Can be considered IOT as an extension and expansion network based on the Internet; but it is different from either traditional network or the so- called Internet of people and WSN although considered as backbone to build any IOT

block. The major equation to represent the IOT environment is "IOT environment= Internet + WSN", it is a common statement that uses to express the IOT environment. To analyze and judge the correctness of this statement, must be determined the similarities and differences between IOT, Internet, and WSN according to table 1. From the previous knowledge about the IOT environment can be judged on this view, it's a wrong; because there are two basic reasons for rejecting this view. First; IOT may not necessarily use IP in all cases for addressing things, because nature of IOT needs lightweight communication protocols, the complexity of the TCP/IP protocol is not suitable in particular, when works with the smart little things. Second, the IOT environment is mainly based on the connected smart objects unlike traditional network.

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

Table 1. The similarities and differences between IOT, Internet, and WSN

Characteristics	IOT	Internet	WSN
Comm. Protocol	Lightweight Comm. protocols.	(TCP/IP)	Lightweight Comm. protocols.
Scale degree of Area	Cover wide area	Cover wide area	Cover local area
Networking Approach	Determine backbone	Determine backbone	Self-organization
Identify objects	Must	Can not	Can
Type of nodes	Active and passive	Active	Active
Network design	WSN+ dynamic smart things+ Internet surrounded by intelligent environment	Set of networks contains set of Fixed objects	Dynamic smart objects
Behavior	Dynamically	Fixed	Dynamically
Networking Time	Timing synchronization	Unlimited	Unlimited

6. Challenges and Recent Research Directions

In this section, the paper discusses the bulk of popular challenges or general challenges of the IOT environment; it also displays the recent research directions for each topic. Finally, Table 3 reviews the recent research directions and the proposed solutions for each one of them, in addition to table 4 which reviews the summary for the future research topics in the IOT.

6.1. Types of IOT

There are four types of IOT

1) Low Power Wide Area Network (LPWAN)
2) Cellular
3) Mesh Networks
4) Local and Personal Area Network (LAN/PAN)

6.2. Networking

Generally, the Networking issue has a great relevance in the Internet because of it includes some of the important factors which uses to manage networks. First of all, traffic and protocols that have a significant impact on the behavior of the network, these points are mentioned in [11] D. Giusto et al. Sought to deal with networking challenges via mobile Ad-Hoc Network.

6.3. Routing

Routing process means selecting the best path between the source and the destination to complete the communication process successfully. Can be classified routing protocols into two main categories are: i) Reactive protocols: the path is established after transmission request is made, ii) Proactive protocols: initial path before the request is made. In Sudip Mishra et al. proposed the protocol under the name of "fault-tolerant routing protocol" for IoT.

6.4. Heterogeneity

The IoT environment is the best-known example to represent the heterogeneity issue because it contains a plethora of the different devices in their nature; the main objective of IoT is creating a common way to abstract the heterogeneity of these devices and achieving the optimal exploitation of their functionality.

6.5. Middleware Layer

The middleware layer is a software layer or a set of sub- layers interposed between the technological and the application layer, it provides a standard way for representation and communication.

i) Service composition layer: the common layer on top of SOA middleware; it provides the functionality for composition of single service and builds specific application.

ii)Service Management layer: the layer allows management in IOT. Service management can be classified into two areas are

Runtime: services that based on time as a critical factor to implement them directly

Design time: services a part of maintenance lifestyle and service development .

iii)Object abstraction: the need to object abstraction layer is summarized in vast and heterogeneous objects which scattered through IOT, layer organized harmonizing access to different devices with common language and procedure

6.6. Interoperability

Interoperability concept can be defined as the ability to create systems or devices cooperating with each other in an efficient way. In the Internet of thingswe use the semantic level interoperability architecture for pervasive the computing and IOT; the architecture is relied on the semantic information sharing solutions called “smart-M3”.

6.7. Quality of Service (QOS)

Ideally, QOS is defined as “the amount of time that is taken to deliver the message from the sender and the receiver” if this time is equal or less than pre-specified time requirement the QOS is achieved. ITU re-defined QOS concept as a degree of conformance of delivering service to the user by the provider with agreement between them . For QOS assurance, must cope with service models to determine which degree of QOS for each Internet service.

6.8. Virtualization

Virtualization is known as the ability to share hardware resources among multiple operating systems. The virtualization technology allows for the multiple operating systems and software like applications or services to run upon the same server through creating more than virtual machine inside the physical machine.

6.9. Big Data

Big Data is a new expression to describe massive data whether structure or unstructured, which is difficult to deal with traditional database methods and software techniques. Simply, Big Data defined as a large volume of data . Dataset considered as a Big Data when it meets 4 V's- value, volume, velocity, and variety. Big Data attracts almost a new industrial field such as online social networks (Twitter, Facebook, and Insta); the collection of data through the social network is very huge, for example twitter in 2010 producing up 120 terabytes of data of the day .The coupling between IOT and Big Data was very strong.

6.10. Cloud Computing

Cloud computing is a way to access large amount of computational resources and supports a large number of users in a reliable and decentralized manner; it's also provide software cheaply. Cloud Computing consists of the three main layers are: Infrastructure as a Service (IAAS), Platform as a Service (PAAS) and Service as a Service (SAAS) each one provide significant features through the cloud data Centre. Recently, a lot of researches are mentioned integration between cloud computing concept and IOT; for example not as a limitation in [24], Alessio et al. sought to review the existing integration between IO T and cloud computing in the Cloud IOT paradigm and illustrate the benefits from them.

6.11. Power Consumption

The power consumption issue is a critical point in wireless networks. Typically, the efficiency of the work of sensors depends on the lifetime of the battery. Nowadays the most of devices are equipped with sensors such as smart mobile phone, tablet and laptop to deal with the modern applications.

6.12. Security and privacy

The security rule aims to protect it from threats; these threats classify into two kinds are: the external threats such as attacks on system form attackers and the internal threats represented in misuse of the system or information In the IOT environment the security and the privacy are important to guarantee a reliable interaction between the physical world and the cyber world.

6.13. Advantages of IOT

1) Electric Devices are directly connected and communicate with a controller computer, such as a cell phone, resulting in efficient electricity use. As a result, there will be no unnecessary use of electricity equipment.

2) Personal assistance can be provided by IOT apps, which can alert you to your regular plans.

3) It can assist in the smarter control of homes and cities via mobile phones. It enhances security and offers personal protection.

7. Conclusions and Future Directions

This paper has sought to highlight the IOT concept in general through the three sections namely; section I, reviewed an overview about the IOT concept via highlighting its history and its inception since 1999 at the hand of Kevin Ashton who considered as one of the pioneers who talked about IOT and even Cisco company now. Accordingly, the future of the IOT structure relies on the integration among real or physical worlds, cyber-world and social world. Lastly, Section II, reviewed the main general challenges which had a significant impact on the performance of IOT such as communication, networking, QOs, scalability, virtualization, big data, heterogeneity and security; this section sought to illustrate and provide the recent solutions for each element of these challenges.

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