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Survey on the Internet of Things Definitions and Applications

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الملخص:

يشير إنترنت الأشياء (IoT) إلى الأجهزة المجهزة بأجهزة استشعار وقدرة حاسوبية وبرامج وتقنيات أخرى تقوم بتوصيل البيانات ومشاركتها مع الأجهزة والأنظمة الأخرى عبر الإنترنت. يربط إنترنت الأشياء الأشخاص والأشياء بسلاسة لتكوين علاقة تكافلية. في ظل الوجود الواسع النطاق لإنترنت الأشياء، يتم تقديم الخدمات كمنتج. لقد أضافت التطورات في الإنترنت والأشياء قيمة إلى إنترنت الأشياء وتسببت في التطور الذي نراه اليوم. ولذلك، فإن أي تقدم كبير في إنترنت الأشياء يجب أن يأتي حتمًا من الجهود التعاونية عبر مختلف التخصصات، بما في ذلك العلوم الاجتماعية والمعلوماتية والإلكترونيات والاتصالات. وقد استلزم هذا التطور مراجعات دورية لتعريف إنترنت الأشياء. دراستنا مخصصة للأشخاص الذين يرغبون في المشاركة في هذا المجال المعقد ومساعدته على النمو في مثل هذا الوضع الصعب. تتم مراجعة التقنيات التمكينية ويتم تقديم العديد من وجهات النظر حول نموذج إنترنت الأشياء هذا.

الكلمات الدالة: الجودة المرغوبة، المستقبلية، إنترنت الأشياء، مجالات إنترنت الأشياء، RFID

Abstract

The Internet of Things (IoT) refers to devices equipped with sensors, computing power, software, and other technologies that communicate and share data with other devices and systems via the Internet. The Internet of Things seamlessly connects people and things to form a symbiotic relationship. In the widespread presence of the Internet of Things, services are offered as a product. Developments in the Internet and things have added value to the Internet of Things and caused the evolution we see today. Therefore, any significant advancement in the Internet of Things must inevitably come from collaborative efforts across various disciplines, including the social sciences, informatics, electronics, and telecommunications. This evolution has necessitated periodic revisions to the definition of IoT. Our study is intended for people who wish to get involved in this complicated field and help it grow in such a challenging setting. The enabling technologies are reviewed and several perspectives on this IoT paradigm are provided.

Keywords: Desired Quality, Futuristic, Internet of Things, IoT domains, RFID

1. Introduction

The network of heterogeneously connected devices will shape the Internet of the future, significantly expanding the boundaries of the world with real and virtual elements. The phrase "Internet of Things" (IoT), which was recently used to represent anything having digital capabilities that may communicate via the Internet, is regarded as a component of the Internet of the future.[11][17]

In 1999, Kevin Ashton made the initial proposal for the Internet of Things (IoT), which he defined as a network of radio-frequency identification (RFID)-enabled, interoperable, connected things. The Internet of Things may encompass billions of smart devices, communicative items enabling connections between people and things at anytime, anywhere, with anything, and preferably using any device. IoT will give, [10]. Linked item's new capabilities because it aims to use any network and any service.

To realize the Internet of Things vision, a variety of information and communication technologies are coming together. These technologies can offer our society boundless advantages and services, as well as generate value of their own as services become more generally available, the Internet of Things is emerging as an exciting innovation that is having significant effects on numerous aspects of daily life and future consumer habits, [12]. Internet of Things is now a worldwide network and service infrastructure. The uses of the Internet of Things are varied and in great numbers. The effects of the technologies and how they interact employed in IoT are so extensive that it serves as the foundation for the fourth industrial revolution. The Internet of Things, in principle, will allow items to be linked to anything and anyone at anytime, anywhere, and through any connection, network, or operation. The IoT heralds the start of an innovative Internet revolution. The fundamental concept is the diffuse existence surrounding us of many kinds of objects or things – including RFID identifiers, detectors, motors, and smartphones – that can communicate with one another, and interact with their neighbours to achieve shared objectives via distinct addressing methods,[2]. Because they can transmit information about themselves, objects can make themselves identifiable and acquire intelligence through the making of decisions or the facilitation of decisions connected to context. They can be parts of intricate services or have access to data that has been compiled by other entities. This shift occurs simultaneously with cloud computing capabilities develop, and the Internet switches to IPv6, which has nearly infinite addressing capacity.

The main benefit of IoT is the profound impact it will have on many aspects of everyday life and the behaviour of prospective customers. From the perspective of the average user, the domains of work and home are where the advent of IoT will most obviously have an impact.

Novel application categories may encompass electric vehicles and smart homes, wherein devices and services offering alerts, safety, energy conservation, automation, communication, computing, as well as amusement that combined with a single, integrated system and a shared Interface. Not everything will be ready to go at once. Individuals, intelligent items, devices, systems, and the nearby environment such as wireless and M2M gadgets, RFID tags, and wired sensors will combine to form a highly decentralized common resource pool linked by a dynamic network of networks. Computing, storage, and communication services will be highly pervasive and distributed in the future. The "communication language" will function in a variety of platforms and environments and be built on interoperable protocols. In this context, IoT refers to a general idea in which anything connected to the Internet can have an active role. By developing smart settings, where the Internet now plays a different role. This effective instrument for interaction offers wired and wireless internet connections for gaining access to data, materials, and applications. [5].

IoT benefits from the convergence of the Internet for consumer, business and industrial Internet. Convergence results in an open global network that connects people, data, and things. This convergence uses the cloud to connect smart devices that perceive and send a wide range of data, helping to create services that would be impossible to create without this degree of interdependence and analytical intelligence. Transformational technologies such as cloud, IoT, and mobile are driving platform adoption. By enabling a global infrastructure to generate new services, the cloud enables anyone to create content and apps for global clients. [8].

This worldwide infrastructure is accessible via mobile at any time and from any location. As a result, there is a global network of things, users, and customers who can establish businesses, contribute content, and create and buy new services.

2. The History and Definition of IoT

As a result of using IoT, many devices that may be identified via wireless connectivity form a dynamic network. Many services are provided due to the connection between the digital worlds and the physical. To create such services, several concepts and technical components are combined. Different applications from various domains are being merged into a single ecosystem with a common operator. The term "Internet of Things" combines two words: Internet and Things. The initial term "Internet" was coined in 1969, with its origins in the ARPANET

project. The goal was to connect computers in the United States Defence Department. Nowadays, the Internet is more than just a computer network; It has grown into a network of all sizes and forms, including transportation, smartphones, household devices, games, imaging devices, healthcare equipment, and manufacturing equipment. (collectively stated to as "Things"), the Internet has grown to become a worldwide network [15]. While the term, "things" might refer to either a physical or digital item. These items exist and move in space [9]. J. Gubbi observes that as technology advances, the concept of "Things" alters as well. The field in which objects will be used determines their perception, and "things" can be realized in several ways. Originally, "Things" were limited to RFID, sensors, actuators, and intelligent objects. However, modern technology has enabled the connection of persons, information, methods, and things, resulting in the "Internet of Everything". The incorporation of nano-sensors in various items via nano networks creates an "Internet of Nano Things" [13]. Various interpretations of the Internet of Things emerge from different views. These definitions include the two most important aspects of IoT: "Internet" and "Things." The evolution of the Internet has an impact on the evolution of IoT. Sir Robert Alexander Watson-Watt, a Scottish physicist, invented radar in 1935. Radar works based on Radio Frequency IDentification (RFID). During WWII, its use in detecting enemy planes originated the concept of using RFID tags to identify objects. The progress continued into the 1950s and 1960s. In 1973, the first RFID tag was patented [14]. Tags with RFID technology was widely used. The Massachusetts Institute of Technology (MIT) founded The Auto-ID Centre in 1999 to locate and identify a wide range of innovations required to facilitate, minimize faults, and increase performance in a manufacturing environment. Among the technologies featured were smart cards, bar codes, various sensors, voice recognition techniques, and biometrics. AutoID Centre received support from the Uniform Code Council, EAN International, Procter & Gamble, and Gillette in the same year. David Brock and Sanjay Sarma, two distinguished professors at Auto-ID Centre, were hard at work on RFID research. Their primary goal was to trace all the supplier's products using RFID technologies. Producing RFID tags containing serial numbers that can be used to provide information about the object. This information is stored in a storage system that will be available online. Sarma and Brock's research transformed how people considered employing RFID in the supply chain [19]. Radio Frequency IDentification was the most desired technique for connecting and identifying an Internet-connected object. The Internet of Things was not properly defined. The availability of always-on services that provide consumers with pertinent content and information regardless of their location was made possible by technological improvements. [14]. The IoT concept started

to gain traction in 2003–2004 with the launch of initiatives like Cool Town, the internet , and the Disappearing Computer initiative. For the first time, the term "Internet of Things" appeared in book titles. When the International Telecommunication Union (ITU) produced a report on the Internet of Things, it took it to a new level. ITU proposed connecting sensorial things from all over the world and intellectual ways. ITU divided things into four categories: "tagging things" (using embedded systems), "feeling things" (using sensors and wireless sensor networks), "shrinking things" (using nanotechnology), and "tagging things" (using identification technology) [7]. Cluster of European Research Project (CERP) considers that the Internet of Things (IoT) will bring together the digital and physical worlds by combining many ideas and technological elements from ambient intelligence, widespread computing, and universal computing. According to ITU and (IERC), IoT is defined as: "A dynamic infrastructure that can self-configure, utilizing standard and interoperable communication protocols, in which virtual and physical objects are seamlessly integrated into the information network and have virtual personalities, traits, and identities". According to an Internet of Things report, new sensor and communication technologies and networks, together with additional automatic identification and data collection technologies, should be employed to expand the application of IoT beyond radio frequency identification. Therefore, the IoT is a: "A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. This infrastructure includes existing and evolving Internet and network developments. It will offer specific object identification, sensor, and connection capabilities as the basis for the development of independent cooperative services and applications. These will be characterized by a high degree of autonomous data capture, event transfer, network connectivity and compatibility". [3] Because of advancements in sensor technologies and device capabilities, business logic can now be executed at network edges. This aided in the decentralization of business processes, which benefited performance, capability, and local decision-making. Taking into account the improvements stated in [16].

IEEE recognized the diversity of IoT research as well as the ambiguity created by its description. To address these concerns and raise awareness about the topic, the IEEE IoT Initiative published a report on its online portal in 2015. The published report contains a comprehensive definition of IoT. The IEEE IoT Initiative presented two distinct definitions based on system size and complexity, one is for local systems, while the other is for massive worldwide systems. In a local environment system, things can be recognized individually while connected to the Internet. In this case, the suggested description of Internet of Things is:

"IoT is a network which links specific "Things" to the Internet. The "things" have sensing capabilities as well as prospective programming abilities. Information about the object may be collected and the status of the object can be modified from anywhere, at any time, with anything by utilising unique identification and sensing. [19].

Complex services must be offered in large system settings. The system must enable the execution of complex activities. Many items must be connected to provide this functionality, increasing system complexity. According to [15] the Internet of Things is defined as "a self-configuring, adaptive, complex network that connects 'things' to the Internet using standard communication protocols." The networked things have a physical or virtual representation in the digital realm, sensing/actuation capabilities, and programmability. The representation includes information such as the object's identity, status, and location, as well as any additional business, social, or private information. Things deliver services with or without human assistance by leveraging their distinctive identification, data-gathering connectivity, and operational capability. The service is accessed via sophisticated interfaces and is available anywhere, at any time, and for everything involving security. [19]

The various definitions of the Internet of Things attempt to address core challenges that involve the compatibility of devices that are connected, and a higher level of intelligence of devices enabling adaptability and independent behavior, ensuring confidence, privacy, and security. [9].

The Internet of Things is a collection of networked things, also referred to as smart devices, that communicate via the Internet. It may be a remote control, a heart monitor, or an automobile with built-in sensors. These items with an IP address can gather and transport data over an internet connection. The items interact with their surroundings using embedded technology, which allows them to make decisions.

More precisely, “Globally ruling technology acts as one key to shrinking this entire universe into a globally connected small village, while the Internet of Things incorporates, only two words to depict its definition accurately.”

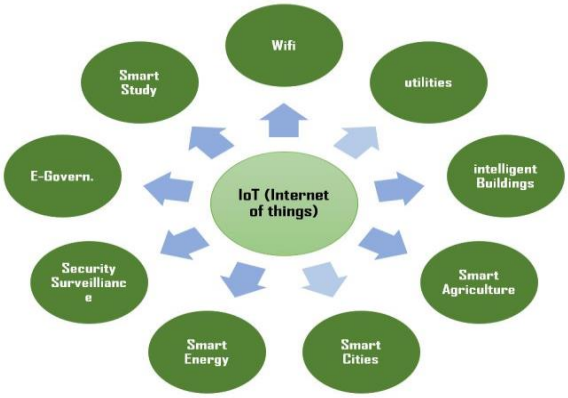

Figure. 1 IoT as Globally Connected Village[6].

3. Internet of Things Applications

It is impossible to foresee every future Internet of Things application while keeping in mind both the wide range of customer needs and technological advancements. We highlight several noteworthy applications in the sections that follow. The research problems are outlined and these applications are described. Many areas and environments in which new applications are likely to improve our quality of life: at home, while traveling, when sick, at work, when jogging, and in the gym.

Nowadays, these spaces are furnished with things that possess minimal intelligence, frequently lacking the ability to communicate. Allowing these objects to interact with one another and to expound on the data they observe from their surroundings implies having various contexts in which a vast array of applications can be implemented. We examine a variety of future applications as well as short- to medium-term uses for each of these categories in the ensuing subsections [5].

IoT is presently found in four well-known domains:

3.1 Healthcare domain

- The Internet of Things (IoT) has several advantages for the healthcare industry, and the applications that result can be broadly categorized as follows [1]:
- Identification and authentication.
- Data collection.
- Sensing.
- Tracking.

3.2 Smart Environments Domain

A smart environment makes life easier and more comfortable by utilizing the intelligence of the objects. The main applications in the smart environments' domain are:

- Comfortable homes and offices.
- Industrial plants.
- Smart museum and gym.

3.3 Transportation and Logistics Domain

Modern automobiles, railroads, buses, bicycles, and streets are all growing more and more equipped with computer control, motors, and sensing devices. Which are capable of transmitting important data to vehicles and traffic monitoring sites to optimize traffic routing, depot management assistance, and provision of pertinent transportation information to tourists. The most common uses in transportation and logistics are:

- Logistics.
- Assisted driving.
- Mobile ticketing.
- Monitoring environmental parameters.
- Augmented maps.

3.4 Personal and Social Domain

Applications that allow users to engage with others to establish and maintain social interactions are included in this category. Certain events, such as moving to or from our home or business, traveling, running into some pals, or playing football, we may naturally contact other people to inform them of what we are currently doing or what we have done in earlier days [4]. The primary uses in the social and personal areas include:

- Historical queries.
- Losses.
- Thefts.
- Social networking.

3.5 Futuristic Applications Domain

Since the necessary technologies are currently available, the applications covered in the preceding sections can be implemented quickly or easily, making them plausible. In addition to these, we may imagine a plethora of other uses, which we will refer to as futuristic as they depend on technology that is either not yet developed or whose use is currently too challenging [18]. The principal applications are:

- Robot taxi.
- City information model.
- Enhanced game room.

3.6 Desired Quality of any IoT Application

1- Interconnectivity

It is the fundamental prerequisite for any Internet of Things system. All devices on a network should have guaranteed connectivity because only devices within a network can communicate with one another.

2- Heterogeneity

IoT-enabled devices may differ in terms of hardware and software setup, network topologies, and connections, but even with this diversity, they should be able to communicate and function together.

3- Dynamic in Nature

IoT devices ought to be able to dynamically adjust to their ever-changing environment, including shifting scenarios and intros.

4- Self-adapting and self-configuring technology

Take a security camera, for instance. It should be adaptable enough to function in a variety of weather and lighting scenarios (morning, afternoon, or night).

5- Intelligence

In the Internet of Things, gathering data alone is insufficient; knowledge extraction from the created data is crucial. For instance, data from sensors must be correctly analysed to be useful. Therefore, one of the essential elements of IoT is intelligence. Since we cannot derive any insights from data without data processing, data interpretation plays a crucial role in all Internet of Things applications. Big data is therefore one of the IoT field's most enabling technologies.

6- Scalability

Every day, more and more elements (devices) are being connected to IoT zones. An IoT setup should therefore be able to accommodate the growth. It can be expanded horizontally by multiplying with simple cloning, or vertically by increasing processing power, and storage capacity.

7- Identity

Every IoT item has a distinct identification. This identification is useful for tracking, communicating, and knowing the status of objects. Any system's security and safety will be immediately impacted by the lack of identification as we are unable to determine who is

connected to a certain network or with whom we must speak in the absence of discrimination. Therefore, it should be possible to distinguish between IoT networks and devices using technology that is both transparent and acceptable.

8- Safety

Users' private information may be compromised if their devices are linked to the Internet. Data security is therefore quite difficult. The user can suffer a loss as a result. The massive IoT network's equipment might also be in danger. As a result, equipment safety is equally important.

9- Architecture

It ought to be hybrid, enabling many manufacturers' devices to work with the Internet of Things.

4.Conclusion

Things from a wide range of domains, including smart items, gadgets, products, processes, and living things, are included in the Internet of Things. The Internet of Things is utilized to deliver application services across several domains by using the computing and communication capabilities of such devices. Services are occasionally offered across multiple domains, in a single domain, or in a collection of domains. The process of defining IoT involves several parties, scientific communities, corporations, and government bodies, putting out different definitions. The Internet has dramatically altered our way of life by facilitating virtual relationships in a variety of environments, involving social and business interactions. The Internet of Things (IoT) has the potential to bring a new dimension to this process and achieve the ideal form of communication by enabling connections with and among smart devices. We have examined the most essential features of the IoT in this study, with a particular focus on what is being achieved and which challenges deserve additional study.

We conclude that the different definitions of IoT that are now being suggested by different groups describe IoT instead of defining it. IoT-enabling technologies are also continuously being developed at the same time. IoT is becoming more dynamic as a result of these quick changes that are upending the entire situation. Fuzziness is being caused by the IoT's dynamic nature. However, everyone's perspective on IoT is unique. On the other hand, In the coming years, IoT applications will play a significant role in driving networking and communication research in educational and industrial labs.

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