Big Data and Computing Visions

www.bidacv.com

Big. Data. Comp. Vis. Vol. 3, No. 2 (2023) 39–44.

Paper Type: Original Article

Green IoT: How Wireless Sensor Networks are Paving the Way for Sustainable Smart Environments

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Citation:

Alqahtani, H. (2023). Green IoT: how wireless sensor networks are paving the way for sustainable smart environments. *Big data and computing visions, 3*(2), 39-44.

Received: 23/11/2022 Reviewed: 25/12/2022 Revised: 18/01/2023 Accepted: 13/02/2023

Abstract

The Internet of Things (IoTs) enables the incorporation and connecting of physical devices to the internet with little human intervention and human-to-human or human-to-PC communication. It discusses the future pattern and the next major upheaval unfolding in the realm of information technology. Individuals and objects are linked to everything and anybody, anytime, wherever, and via the use of organization or administration. It also focuses on how IoT can promote a greener and cleaner environment through Green Internet of Things (G-IoT). This article provides an overview of IoT and G-IoT. It also covers various advancements and problems in G-IoT and how it might reduce energy use. This article clarifies the concept of the IoT, including its features, security concerns, and technology adoption trends.

Keywords: Environment, IoT, G-IoT, Network, Revolution.

1 | Introduction

The internet is a constantly changing phenomenon that undergoes significant changes on a daily basis. Data is easily obtainable because of the low-cost and widely accessible broadband connections and internet gadgets. The number of internet-connected gadgets is increasing, which benefits the Internet of Things (IoTs) [1]. The IoTs is propelled by the extension of the internet through the incorporation of physical items, as well as the capacity to give smarter services to the environment as more data becomes accessible. The term "things" refers to embedded equipment equipped with sensors that can collect, store, and analyze data. Because they are connected to the internet, data can be transferred for processing, new software can be uploaded, and they can even be operated from afar [2].

The terminology "IoT" refers to a set of technologies and research fields that enable global connectivity over physical things worldwide. Objects in the IoTs can detect their surroundings, convey data, and interact with one another. They become effective instruments for understanding the physical environment and responding quickly to emerging occurrences and abnormalities [3]. As a result, many people regard the IoTs as the ultimate answer for gaining insights into real-world physical activities in real [4]. Technologies like Radio Frequency Identification (RFID), biometrics,

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https://doi.org/10.22105/bdcv.2022.371380.1083

sensor networks, Quick Response (QR) codes, and nanotechnologies will form the foundation of the upcoming IoTs, in which information and communication systems are invisibly integrated in the environment around us, with real implementations addressing a variety of applications such as smart grid, e-health, intelligent transportation, and so on.

2 | Literature Review

Environmental concerns are gaining prominence as the general population is becoming more aware of the devastating implications of environmental degradation. Recent technological advancements have increased the carbon footprint [5]. This development is clearing the way for an emerging industry known as Green Internet of Things (G-IoT). Within a few years, it would give green assistance to a wide range of users in managing their responsibilities. The G-IoT is expected to bring about substantial changes in our everyday lives and contribute to the realization of the goal of green ambient intelligence, which interconnects our physical environment through green networks. Green networks in IoT will help to reduce emissions and pollutants, maximize environmental conservation and monitoring, and cut operating expenses and power usage. G-IoT may be characterized as follows, with energy efficiency being the primary consideration during the design and development of IoT. The energy-efficient techniques (hardware or software) are implemented by IoT to either allow decreasing the greenhouse effect of existing apps and services or to lessen the impact of IoT itself. In the first situation, the usage of IoT will aid in the reduction of the greenhouse impact, however, in the second case, additional optimization of the IoT greenhouse footprint will be undertaken. The whole life cycle of G-IoT would focus on green design, green manufacture, green use, and lastly green disposal/recycling to have no or very little environmental effect. According to worldwide consultants Gartner, Inc. (the world's largest information technology research and consulting firm), Information and Communications Technology (ICT) now accounts for around 0.86 metric gigatonnes of carbon emissions per year (almost 2% of global carbon emissions). And the same ICT, including IoT technologies, has a direct impact on reducing CO2 emissions.

3 | Proposed Work

Summary of study

IoT is made up of six components: identity, sensing, communication technology, computing, services, and semantics.

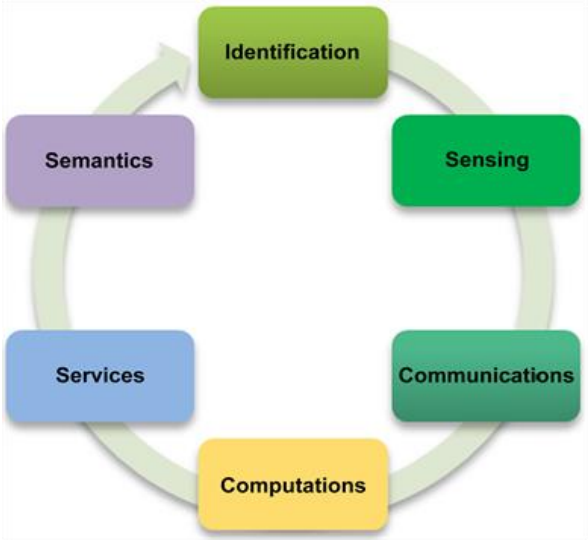

Fig. 2. Components of IoT.

Identification is the process of naming and connecting services with their demand, i.e., acquiring data at a point of action. This might be data collected by an appliance, a wearable gadget, a wall-mounted control, or any number of other regularly encountered devices [6].

Sensing is the process of gathering data from linked things and transferring it to a database, data warehouse, data center, or other location. The collected data is then processed in order to conduct appropriate actions based on the services that are required. Humidity sensors, temperature sensors, wearable sensing devices, mobile phones, and other types of sensors can be used. Biometric, biological, environmental, optical, or aural sensing can all be used (or all of the above). Sensing technology serves a specific function. This approach works best in the guidance of fellow researchers [7]. In this, the authors continuously receive or ask input from their fellows. It enriches the information pool of your paper with expert comments or upgrades. And the researcher feels confident about their work and takes a jump to start the paper writing [8].

Communication technologies link disparate items to provide specialized services. This necessitates the use of either Wi-Fi (wireless LAN) or Wide Area Network (WAN) communications. Wi-Fi, bluetooth, IEEE 802.15.4, Z-wave, LTE-Advanced, Near Field Communication (NFC), UltraWide Bandwidth (UWB), and other IoT communication protocols are available [9].

Computation, which is carried out by hardware processing units (e.g., microcontrollers, microprocessors, System on Chips (SoCs), Field Programmable Gate Arrays (FPGAs)), and software applications. Many hardware platforms (e.g., Arduino, UDOO, Friendly ARM, Intel galileo, Raspberry PI, Gadgeteer) and software platforms (e.g., TinyOS, LiteOS, Riot OS) are created and used. The cloud platform is a particularly significant computational component of IoT since it is extremely powerful at processing diverse data in real-time and extracting various types of valuable information from the collected data [10].

Services are classified into four types:

- *Services pertaining to identity.*
- *Services for gathering information.*
- *Services with a focus on collaboration.*
- *Services that are available to everyone.*

Because every application mapping real-world items into the virtual world must first identify the objects, identity-related services serve as a foundation for other types of services. Services that collect and aggregate raw data that must be processed and reported are known as information aggregation services. The data collected is then used by the collaborative aware services to make judgments and respond appropriately. Ubiquitous services are those that are available to anybody, at any time and from any location, on demand [11].

Semantic refers to the capacity to intelligently extract knowledge in order to give essential services. This procedure typically consists of the following steps: locating resources, utilizing resources, modeling information, and identifying and evaluating data [12]. Semantic technologies that are often utilized include Resource Description Framework (RDF), Web Ontology Language (OWL), Efficient XML Interchange (EXI), and others.

Advantages

I. Reduction in waste.
II. More efficient recycling.
III. Less starvation.
IV. Reduction of plastic pollution.

Disadvantages

I. Some companies may go out of business.
II. Job losses.
III. High product costs.
IV. Lack of awareness of the general public.

Real-timeline applications

Automation in industry (machine-to-machine communications): with the use of RFID tags, automation is feasible, and the RFID reader interacts directly with the robot without the need for human interaction [13].

Healthcare (real-time tracking): tracks and monitors patients and medical equipment in real time. In terms of assets, tracking aids in maintenance, availability, monitoring of usage, and material tracking to avoid any instrument from being accidentally left behind in a patient's body during surgery [6].

Monitoring of the environment: it is used to identify geographical and temporal changes, environmental physical changes, organism changes, and changes produced by human activities or natural occurrences.

Agriculture: it can detect water levels and produce the appropriate crop as a result. Assisting agriculture while also assisting in the prevention of forest fires.

Pollution control: The Internet of Things Academy (IoTA) is spearheading the effort to improve air quality in London. The IoTA has been experimenting with sensors and other technology to try to enhance London's air quality. The IoTA offered the buggy air project as one alternative. The IoTA envisions sensors on buggies (strollers) that measure and record pollution at street level. The GPS in the stroller would pinpoint the exact location of the pollution levels [14].

Intelligent buildings: homeowners may monitor all of their systems to determine which are malfunctioning. Users may save both money and energy if they know which gadgets waste the most energy. The IoT is being integrated with technologies such as solar panels. Many IoT solutions provide feedback on energy use and point users in the right direction for appropriately allocating energy while avoiding waste.

Water sensors: using these sensors, officials could learn which restaurants were illegally discharging trash into sewers and which taps were left open without being utilized.

3.1 | Recycling

Public awareness about the changing paradigm of energy supplies, consumption, and infrastructure is increasing. Rather than being based on fossil resources or nuclear energy, the future energy supply needs to be based largely on various renewable resources. The future electrical grid must be flexible enough to react to power fluctuations by controlling energy sources and consumption by consumers. Such a grid will be based on networked smart devices (appliances, generation equipment, infrastructure, and consumer products) based on IoT concepts [15]. Overall, IoT can dramatically increase the quality of life for citizens. There are countless examples of companies like this trying to make the world greener using IoT. IoT is something that everyone can get behind as it not only saves money, but is good for the environment and the sustainability of the planet for future generations [15].

3.2 | G-IoT-Related Projects and Standardization Green

Governments and various organizations are taking initiatives and are playing a laudable role in up-upliftment of society with the inclusion of governments across the world have put forth initiatives to force corporations to reduce carbon emissions, become more energy efficient, and use greener techniques [17].

The trend project collects power consumption data and assesses the energy-saving potential of technologies, protocols, architectures, and experiments with new approaches. It also includes training programs to spread green network awareness, i.e., GreenNet. Project earth investigates the energy efficiency of wireless communication systems. It focuses on the theoretical and practical energy efficiency limitations of current networks to develop a new generation of energy-efficient equipment, deployment strategies, and network management solutions to ensure the Quality of Service (QoS) [18]. The IEEE communication society has also established a Technical Subcommittee on Green Communications and Computing (TSCGCC). TSCGCC works to develop and standardize energy-efficient communications and computing. It also provides opportunities to interact and exchange technical ideas, identify R&D challenges, and collaborate on solutions for the development of energy-sustainable, resource-saving, and environmentally friendly green communications and computing technologies [19].

3.3 | Challenges for G-IoT

Green technologies will play an important role in enabling energy-efficient IoT. There are many challenging issues that need to be addressed. Here, key issues been summarized that need further consideration. G-IoT architectures for IoT, a standard architecture, such as the ISO OSI model or the TCP/IP model, is needed to enable communication across various applications and heterogeneous networks that have a wide variety of devices. Moreover, it is important to understand how to integrate energy efficiency across the whole architecture to make it energy efficient [20]. Green infrastructure providing energy-efficient infrastructure for IoT can be achieved through a redesign approach. Green spectrum management. The cognitive radio approach brings many benefits to green mobile services, which are currently restricted to RF systems. Outside the world, the IoT has brought about a digital revolution. It has helped a lot in decision-making with the use of analytics and thereby improving transparency. This has led to huge investments in sensors and which is likely to increase in the years to come. It is expected that the IoTs will be omnipresent in the coming years, improving the quality of our lives and the way we live and work. In the years to come, we foresee having smart cars, smoke detectors, door locks, industrial robots, streetlights, heart monitors, trains, and wind turbines connected to sensors.

4 | Conclusion

Environmental concerns are gaining prominence as the general population becomes more aware of the implications of environmental deterioration. Many things need to be prioritized in the areas of standardization, security, and governance to ensure the seamless operation of the IoTs, which may benefit society as a whole. This study also focuses on several related technologies and concerns about G-IoT for a smarter future. The IoT represents a significant paradigm change in ICT that will accelerate the development of smart cities throughout the world. The G-IoT is projected to usher in significant changes in our daily lives and help us understand the vision of green ambient intelligence. Within a few years, we will be surrounded by a large number of sensors, gadgets, and objects that can connect through IP, behave intelligently, and give green help to people in managing their duties. Finally, prospective research objectives and outstanding issues in G-IoT have been outlined. The green perspective of the IoTs has been reviewed in this work. Recent advancements in the field of G-IoT have been highlighted and addressed, as well as the future scope of G-IoT. A lot of intriguing research is likely to be published in this area.

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