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Green IOT: Energy Saving Practices

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ABSTRACT

This research paper provides the users with an overview of Green IOT and their energy saving practices in the present year and also in coming years. The Internet of Things (IoT) is a relatively new concept that intends to connect billions of objects. IoT devices detect, gather, and transmit critical data. from their immediate surroundings This huge quantity of money was exchanged. billions of gadgets create a vast amount of data a requirement for energy Green IoT is based on the idea of minimising carbon emissions. IoT device energy usage and environmental impact safe. Motivated by the goal of creating a long-term IoT environment, we begin by providing an outline of green IoT and the problems that it faces. Are being faced as a result of the increased use of energy hungry IoT devices.Then we analyse and assess techniques for reducing energy usage on the Internet of Things, such as constructing energy-efficient datacentre's, transmitting data from sensors in an energy-efficient manner, and designing energy-efficient rules, among other things. Furthermore, we examine green IoT initiatives critically and offer five guidelines for achieving green IoT. Finally, we look at a case study of a critical part of the Internet of Things, namely smart phones, and offer a simple and succinct vision of how to improve present practises in order to make the Internet of Things greener for the world in 2020 and beyond.

INTRODUCTION

The Internet of Things (IoT) is a concept that envisions the connectivity of everyday objects through the use of various types of sensors, such as radio-frequency identification (RFID), and actuators that work together to sense, collect, and transmit important information from their surroundings to the Internet. IoT is a word that refers to the use of appropriate technologies to connect the physical and digital worlds. For the past several years, the Internet of Things has been one of the hottest subjects in the technological industry, and it is expected to alter the world in the same way that the Internet did.

According to Frost & Sullivan (2011), RFID sales have been steadily increasing over the years and will continue to do so dramatically in the next years. If the projections are even close to being correct, energy consumption worries will develop since Active RFIDs require battery-powered energy, and to address this issue, we must use a variety of techniques to make IoT technology green.It has been observed that the number of Internet-connected gadgets is rapidly increasing. Identification, sensing, connectivity, computing, services, and semantics are all components of the Internet of Things' mechanism. The most critical step is identification, which guarantees that the required data or service is delivered to the correct destination.Sensing is the process of gathering information from various sources and sending it to datacentres. This information is then examined for various services utilising various conditions and criteria. Humidity, temperature, and other data can be collected using the sensors. In the Internet of Things, communication is the process of combining diverse items to provide specialised services. Wi-Fi, Bluetooth, and other similar technologies are commonly used for communication.Microcontrollers, microprocessors, Field Programmable Gate Arrays, and a variety of software applications all conduct computation. Identity, information aggregation, collaborative, and omnipresent services are all examples of services. Finally, semantics is concerned with the intelligent collecting of information in order to make decisions. In order to make the Internet of Things green, new cutting-edge approaches and tactics that can meet the energy demands of billions of devices must be researched. I hope to present a complete review of energy-saving methods and initiatives for the green IoT in this post.

IOT TRENDS

The contemporary period is thought to be entirely reliant on the Internet. Our reliance on the Internet and smartphones is growing at a rapid rate. What role does the Internet of Things play in everyday life? This is the fundamental question that will be addressed in the following section.

APPLICATIONS OF IOT

The Internet of Things is transforming our daily lives by tracking many events and making intelligent judgments to improve our lifestyles and protect the environment. IoT has a wide range of applications in everyday life.

1) Smart Cities: Smart Cities, which has gained popularity in recent years, is one of the most fascinating and growing IoT applications. A smart city is a collection of smart domains such as Smart Transportation, Smart Energy Saving Mechanisms, Smart Security, and others that give people with the most up-to-date technology services all under one roof.

2) IoT in Garments: A New Type of E-Thread anticipates data collection from clothing. This can aid in the collection of real-time data to track a patient's activity without the need for an additional equipment.

3) Smart Homes: As mentioned in by equipping our home or workplace with IoT technologies such as RFIDs, we can follow the actions of building occupants and make decisions that save energy, money, and the environment. For example, every item within a smart fridge may contain RFIDs, and we could use the information provided by the sensors on the goods to decide when to go shopping and what we need to buy.

4) Wearable technology

Even now, wearables are a popular topic in the market. These gadgets are used for a variety of applications, including medical, health, and exercise. Jawbone, a wearables company, is the most well-funded of all the IoT businesses.

IV.GREEN INTERNET OF THINGS

The term "green Internet of Things" refers to a concept that emphasises energy saving in Internet of Things principles. Green IoT is described as energy-efficient methods in IoT that either decrease or eliminate the greenhouse effect generated by existing applications The Internet of Things will aid in the elimination of the greenhouse effect and the Internet of Things will be further optimised to prevent the greenhouse effect. From concept to execution, every step in the IoT should be green.

A variety of tactics should be implemented in order to deploy the Green IoT proposes a number of technological alternatives for Green IoT. In order to deploy Green IoT, a framework for energy efficient optimization of IoT items was proposed in. Green IoT can also be achieved through the use of green RFIDs, green datacenters, green sensor networks, and green cloud computing. The specifics of these will be detailed in the next sections. The Internet of Things (IoT) is a new technology that is altering our perceptions of the IT business.We must address the IoT's large-scale consumption of energy resources, and the sooner we address this issue, the more efficient the IoT will be.

V.CHANGING BEHAVIOURS TO SUPPORT GREEN IOT

Another technique for improving energy efficiency and reducing carbon footprints is to develop certain basic habits that reduce energy use in our regular activities. Although this is a modest scale approach, when the small savings are added together on a global scale, it can make a significant difference. One method is to use automation systems presented in to detect energy consumption habits in offices, residences, and factories, and subsequently limit energy losses in our everyday routine tasks. Though we can't rely on this strategy very much, it can nevertheless save us a lot of Challenges Energy-efficient technology will rely heavily on green IoT technologies. There are a slew of serious issues that must be addressed. The author summarises them here and highlights the important issues that need to be addressed further.

1) Green Infrastructure: Providing energy-efficient infrastructure is seen as a critical issue on the road to greening. However, because establishing large new infrastructure is difficult, this area of research is less focused and requires additional attention.

2)Green Security and QoS: Algorithm execution places an extra stress on IoT devices, causing excessive energy and power usage. When it comes to green IoT,the importance of safety and security cannot be overstated. Along with security, we must look for excellent procedures that take into account both power usage and the essential QoS.

3) Green IoT Architectures for IoT: IoT architecture is still a work in progress. The standards committees are attempting to provide connections between heterogeneous networks and other devices with a wide range of capabilities. The goal is to think of protocols as a way to save energy while performing other duties.

4) Green Communication: One of the most important aspects of the Green IoT is communication, which has a number of concerns and challenges.

VI.DIFFRENT WAYS TO MAKE IOT GREEN IOT

1) Software-Based Green IoT Techniques

Data Centre’s can be pivotal to an energy efficient IoT network, but energy efficiency needs to be introduced in data centre’s to make them viable for IoT. e-CAB, a policy-based architecture, proposed in makes use of an Orchestration Agent (OA) in a Client-Server Model, that is responsible for context evaluation of Servers with respect to their efficiency in consumption of resources, for management of Data Centre’s. The intelligently selected servers then send the processed information back to client devices. However, this architecture requires to install OA on each device at the Client-side and backup servers to ensure reliability should be used which may result in high energy consumption. C-MOSDEN, a context aware sensing platform makes use of Selective Sensing to achieve energy efficiency. The results prove to decrease the energy consumption but generates some small overheads, which, if minimized, can make this model a very efficient one.

Sensors consume unnecessary energy when they are idle but are powered on, so, to conserve unnecessary usage of energy, an energy efficient scheduling algorithm is proposed which changes states of sensors to on-duty, pre-off-duty and off-duty according to the requirements of the situations in order to prevent unnecessary energy usage .M.Etelapera *et al.*, proposed an energy efficiency model by reconfiguring Virtual Objects (VO) at runtime on three different operating modes. To estimate the energy consumption on these modes, an analytical model was introduced which resulted in 47.9% less energy consumed in one mode than the other.

Virtualization can decrease the amount of hardware resources consumed within architecture and hence decrease the energy consumption. A virtualization framework using Mixed Integer Linear Programming (MILP) proposed in having a four layer architecture in which IoT devices are placed in upper layers and networking elements in lower layer. Results show that 36% less energy is consumed by applying this framework.
Cloud Computing is necessary to provide the Quality of Service and reliability to the customers but it results in excessive energy and bandwidth consumption which can be reduced by using the method in . It reduces the communication delays, achieved by replicating data closer on the cloud applications that are close to the consumers.

2) Hardware-Based Green IoT Techniques
RFID plays a central role in the IoT. advancement in passive RFID, Wireless Identification and Sensing Platform (WISP) can lead to a more efficient and low power computation in the IoT. Passive RFIDs take energy from the Radio Frequency signals around them, and capacitors are used to store energy for performing tasks that require more power. Apart from this, some energy-expensive commands in series could cause communication delays between sensors nodes and interrogators which could lead to serious energy overheads.
Design of Integrated Circuit (IC) in an IoT network is vital in energy conservation. A concept of Green Sensors on Chip (SoC) improves the design of IoT networks by combining sensors, processing power on a single chip to reduce the traffic, e-waste, carbon footprint and the energy consumption of the overall infrastructure. Although, Sleepwalker example depicts the conservation of the energy by using Green SoC, but more energy can be conserved using recyclable material for this model.
The usual method to save energy in a sensor-based network is to schedule the power on and off according to the usage of the sensors. Apart from this, reducing the hardware by introducing Sensor-on-Chips in healthcare systems has produced impressive results for energy conservation in IoT. The network traffic and communication overheads are minimized hence decreasing the energy consumption. Discontinuous Reception/Transmission (DRX/TX) is a mechanism that allows devices in IoT like sensors to switch them off when they are idle to conserve energy.

3) Policy-Based Techniques
Policies and strategies based on the real time data from IoT devices can help saving energy on a large scale. There are different stages of devising policies for achieving energy efficiency such as monitoring (different situations of energy consumption), information management, user feedback, and automation system. We can use data collected from different parts of a building where occupants' behaviour differs, and energy consumption varies and then we can devise policies and strategies for different parts of the same building. Automation Systems can help identify location of residents of a building and environmental changes with which we can make decisions to save energy. *City Explorer,* a home automation solution, used by to make strategies consists of 3 layers having data collection, data processing and services such as energy efficiency as their respective duties. The above Policy based system when applied to real-life scenario minimized energy consumption by 20%.

4) Awareness Based Techniques
Awareness campaigns are a vital factor in decreasing the energy consumptions, but this varies from culture to culture and country to country because you cannot predict or estimate how many people will listen and follow your campaigns. So, Smart Metering Technology can be used to provide homeowners with a real time feedback of their energy consumption from various sources of their homes, offices, buildings and then we can advise them on how to control and minimize their energy consumption based on that real-time data. This can save the energy from 3-6%.

5) Changing Behaviours to Support Green IoT
Another strategy that can be adopted to achieve energy efficiency and to extenuate carbon footprints is to adopt some basic habits by which we can decrease energy consumption in our daily life activities. Although, this is a small-scale measure but if we add up the small savings on a worldwide scale, it can make a huge difference. One way is to track the habits of energy consumption in offices, homes, industries through automation systems proposed in and then mitigate the energy losses in our daily routine tasks. Though, we cannot rely much on this technique, but it can still save some decent amount of energy.

6) Recycling for Green IoT
Use of recyclable material for the production of devices in an IoT network can help make it an environment friendly one. For example, Mobile phones are made from the some of the scarcest natural resources like copper, plastic and consist of some elements that are non-biodegradable and can increase greenhouse effect if not properly dealt with when the phones are no longer in use.
90% of the material in the phones is recyclable so the need for recycling is ever increasing if we are to tackle the problem of greenhouse effect and huge energy consumption. Although, it is an unrealistic assumption to recover 90% material, but it still can make a considerable difference to save energy.

VII.GREEN IOT PRINCIPLES

On the basis of above literature and evaluation, we propose five principles (depicted in Figure 5), to achieve Green IoT and reduce carbon footprints.

1. Reduced Network Size: Reduce the network size by efficient placement of nodes and by using ingenious routing mechanisms. This will result in high-end energy savings.
2. Use Selective Sensing: Collect only the data that is required in that particular situation. Eliminating extra data sensing, a lot of energy can be saved.
3. Use Hybrid Architecture: Use of Passive and Active sensors for different types of tasks in an IoT network can reduce the energy consumption.

4. Policy Making: Devise efficient policies to reduce energy consumption in smart buildings. Policies can have a direct impact on the consumption of energy and as a result, a considerable amount of energy can be saved.

5. Intelligent Trade Offs: We have to do trade-offs everywhere, so we can intelligently prioritize cost and in some situations processing or communication to save energy like compressive sensing and data fusion. Trade-Offs must be chosen according to a particular scenario.

VIII.IMPACT OF SMART PHONES ON THE ENVIRONMENT IN PRESENT AND FUTURE TRENDS

The main purpose of green computing is to see the impact of mobile devices such as PDA (personal digital assistance) laptops and mobile phones or smart phones on environment. Since we are facing the problem of pollution in the environment, environment friendly products should be invented, promoted and used. Smart phones are one of the main causes of emissions and here considers the impact of these smart phones in both present and future. In this section, we consider the case study of smart phones which are a very important component of the IoT. We investigate and foresee its usage, impact and the recycling.

A) Reduce the environmental impact

Smart phones play a vital role nowadays. Alongside using smart phones, we also need to consider achieving green environment. Green IT focuses on the energy- efficient equipment and eco-friendly hardware in terms of using, designing, manufacturing, and disposing. Technology is causing environmental encumbrance as a result of the desired resources. To reduce the smart phone emissions impact on environment, the researchers in suggested to choose green material, change contract length, cut down on packaging and accessories, and design for disassembly and energy saving batteries.

1) Toxic Material

In a smart phones charger can be the cause of the environmental damage because its main component is print wiring boards, the main problem was the electronic components. The CO2 emissions generated from the incineration of plastics were almost the same as they were by metals. Metals are harmful for the environment. The mobile phones are the more toxic substances, a number of standing and are bio accumulative chemicals "waste minimization of the US EPA is bio accumulative and toxic chemical substances". PCBs from the mobile phone are made up of 13% polymers, 63% metals and 24% ceramics. The eco toxicity in the water is due to cell phones material that is cu(copper).

2) Recycling

Recycling is the process of applying some techniques on existing equipment, usually faulty, and to make same material or some other useful material. In, china collection rate of the mobile phones for recycling is less because many of them are reused in the second-hand market; this reuse does not affect the environment. In china, the mobile phone waste recycling examples are the green card recycling activity and the green box environmental program. E-waste is the cause of environmental damage and green IT is achieving by managing e-waste and this analysis also gives a solution like print both sides of the paper in the organizational level.

*3)*Green Metrics:

The research carried out in improved the energy efficiency of mobile system networks and some special devices were extended, so many energy efficient metrics (called green metrics) were proposed. There are mainly two types of metrics, the facility metrics and the equipment metrics. Equipment level metrics report for lower efficient rating of a single piece of the equipment of mobile network with particular functionalities in micro aspects. The green rate can be estimated by the energy consumption of the network or by total power consumption. By using clusters of green metrics, we can find what amount of energy consumes at the run time in an application.

4)Design for disassembly and repair:

Many phones are intentionally glued within a case that stops customers from opening them. Designing smart telephones which are less complicated to take apart, to restore or exchange components would make a massive change. And it will make it more price-effective to extract and reuse components and metals.

5) Choose greener materials:

Similar to polylactic acid plastic (PLA), which is made completely from corn starch or glucose and is renewable and biodegradable; recycled plastic and ordinary substances like bamboo or use fewer substances.

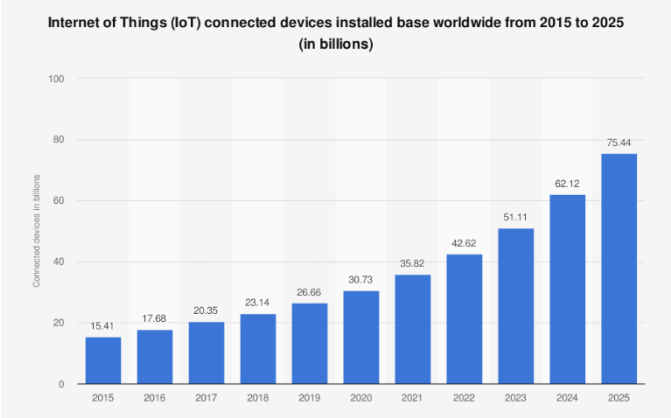
6) Energy-saving batteries:

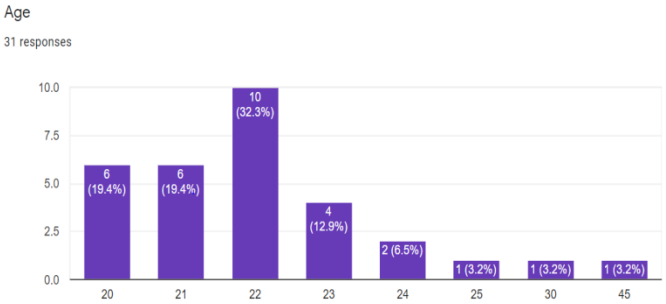
The natural and organic radical battery (ORB) uses no heavy metals that may be detrimental to humans and charges in just 30 seconds.

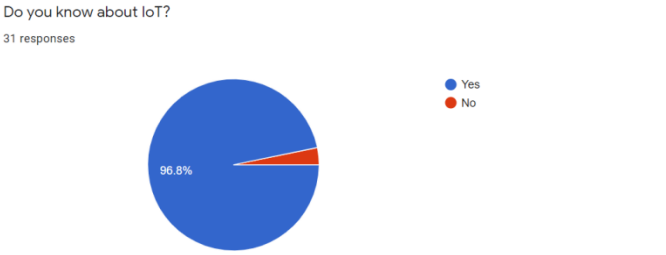
7) Cut down on packaging and accessories:

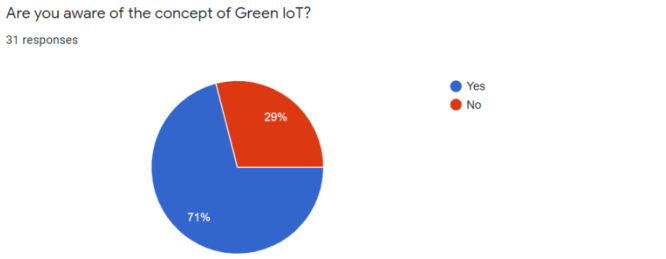
Are all these manuals, chargers and packaging substances relatively needed? 70% of purchasers have already got suitable chargers for the 30 million new phones offered annually. HTC, Nokia and Sony now promote some units with simply USB leads alternatively of needless chargers, as part of O2 Chargers out of the field campaign.

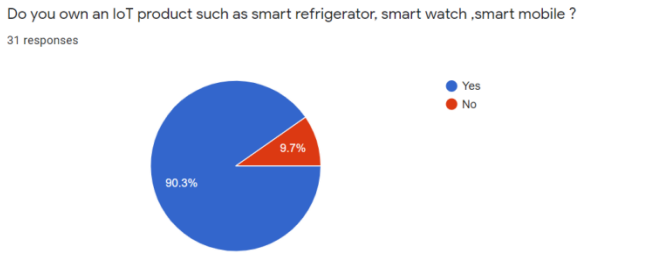
IX.FIGURES AND SURVEY RESULTS

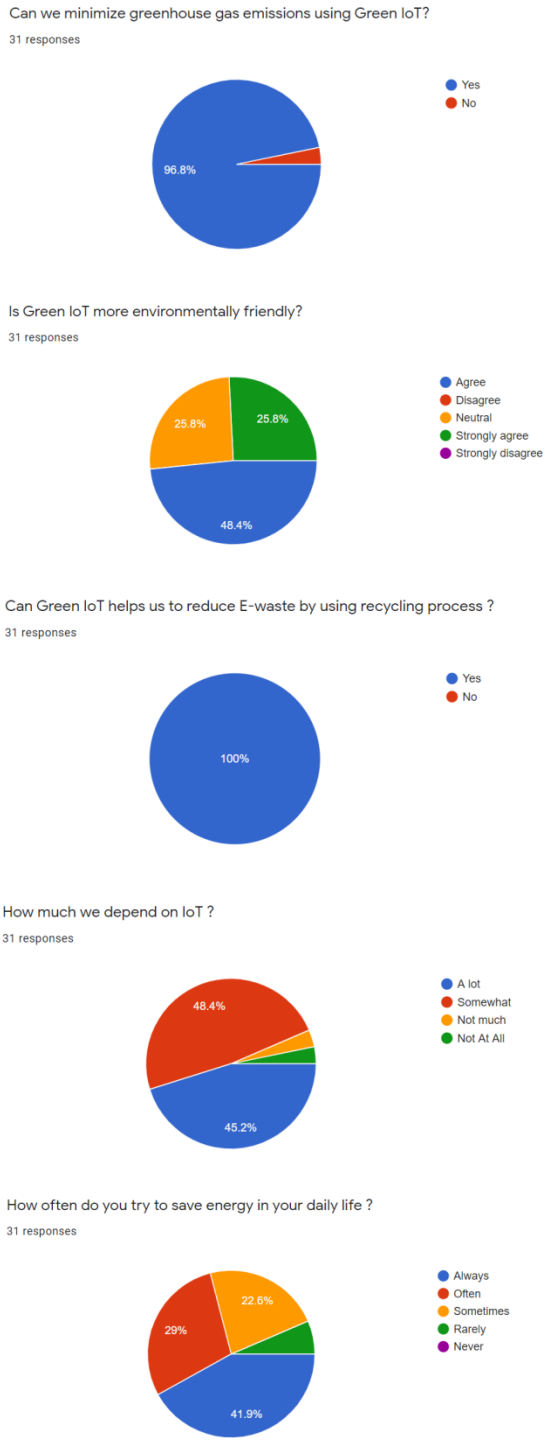












X.CONCLUSION

In this paper, the major challenges of energy efficiency and carbon footprints in the IoT network have been discussed and different solutions to solve these problems have been critically evaluated. Furthermore, a detailed taxonomy of methods to achieve Green IoT has been provided in this paper. Five principles have been proposed to realize the concept of Green IoT. The impact of IoT on economy is going to be paramount and it is predicted to revolutionize the entire ICT industry. The need of research for a generic architecture, recyclable material and policy making to achieve Green IoT has been highlighted. IoT can undoubtedly change the course of technological advancements in the world if focused and dedicated work is put in the right direction. The world awaits the wonders it can unfold.

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