International Journal For Technological Research In Engineering
Volume 10, Issue 11, July-2023 ISSN (Online): 2347 - 4718

ANALYSIS ON IMPROVING ENERGY EFFICIENCY THROUGH GREEN CLOUD COMPUTING IN IOT NETWORKS

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Abstract— This paper presents a review study on Green Cloud Computing. Green computing is the combination of two words that is green and computing. Here the meaning of green means environment and the meaning of computing is processing. It means that in green computing everything which is getting processed must be environment friendly. We can also define green computing as the study or the practice of manufacturing and designing using disposing of computing devices or resources without any impact on the environment. In green computing we mostly use environment friendly devices. Green Computing brings the fact that how important it is to save the environment as there are many ways to produce goods and services but the most important thing is to not harming the nature at the same time. By using green cloud computing, the resources and equipments that are used in cloud computing are used in a very efficient manner. It is very important to implement green cloud computing everywhere. we can implement green computing by using the cloud computing as we know that cloud computing is a type of computing that relies on sharing computer resources rather than having local servers. The future is for sure that one day green cloud computing will take place in every cloud field giving benefits to us as well as nature.

Keywords—Green Computing, Cloud Computing, Green Servers, IoT

I. INTRODUCTION

Green cloud computing gives the another way to the IT sector in terms of energy consumption, loads on data centers and virtual machines. In the green cloud computing all of the computing devices are being used in an efficient and in a very eco-friendly manner including all the designing and manufacturing of device. The aim of green cloud computing is to recycle and reuse the device. Green cloud computing helps in providing an environment which is less costly, easily usable and which also consumes less power. Green Cloud computing is about lessening the environmental footprint of computers. This is most easily achieved by making data centers and computing devices more energy efficient using more renewable energy sources, using less hazardous materials in computing devices, promoting device longevity, and making devices and other IT equipment better recyclable[1]. Lower energy costs longer lasting computing devices reduced health risk for computer workers and recyclers. Green Cloud Computing is the future technology that supports environment, reuse consumed power and energy, and optimize the resources efficiently. Green Cloud computing focuses on reduction of CO2 emission in environment and thus makes IT industry environment friendly. As we are moving towards cloud and using its application in every field such as disaster management, service provisioning, online data storage, data retrieval from any place at any time etc we must ensure it to be environment friendly otherwise the day will not be far when pros of cloud becomes cons for environment. Green computing improves the way computing devices are used by accomplishing economic feasibility, environmentally sustainable production practices, disposal and recycling procedures and energy-efficient resources. The primary objective of green computing is power management and energy efficiency, but it also includes the selection of environment friendly hardware and software by recycling material to increase the product's life. Green computing refers to the technique of utilizing computing resources as effectively as possible. In order to achieve these objectives, hazardous materials should be minimized, energy efficiency should be maximized throughout the product's lifetime, and recyclability or biodegradability of obsolete products and factory waste should be promoted. Implementing energy-efficient central processing units (CPUs), servers, and peripherals, as well as reducing resource usage and properly disposing of electronic waste, are examples of such approaches (e-waste) [2]. The Environmental Protection Agency of the United States developed the Energy Star programme in 1992, which is a voluntary labeling programme aimed to encourage and recognize energy-efficient monitors, temperature control devices, and other technologies. It was as a result of this that the sleep mode became widely used in consumer electronic devices. In fact, there are multiple USENET messages dating back to 1992 that use the term "green computing" in this sense, indicating that it was coined shortly after the Energy Star programme was launched. Not only because of rising energy costs and the possible savings that may be realized, but also because of the impact on the environment, green computing is a very popular issue these

days. The amount of energy required to create, store, operate, and cool computing systems has increased dramatically in recent years, partly as a result of the large number of systems and computing resources that businesses have come to rely on[3]. The amount of computing power consumed by businesses has reached a critical point. Consider the following scenario: an e- commerce company with 100,000 servers can easily spend upwards of $20 million per year on server electricity. Add another $10 million for air conditioning cooling, and the total cost of electricity alone exceeds $30 million each year. Clearly, there is a significant amount of money to be saved in their infrastructure.

II. BACKGROUND

A. Cloud Computing

Cloud computing is a type of computing that relies on sharing computer resources rather than having local servers. The main users of cloud computing are end user, business management user and cloud service providers. Cloud computing has resulted in the emission of CO2 due to the energy consumption from the data centres. Various practices have been adopted to lower the energy consumption by data centre machines by using hardware virtualization and energy Conversant strap in software applications. The energy consumption is predicted to rise with the continuous usage of cloud computing services and the data centres which host them. It is for this energy concern that there is a need to rethink how data centres adopt green computing, and the equipment been used[4].

B. Green Computing

The goal of green computing is to attain economic viability and improve the way computing devices are used and also reduces the power usage of computers and its peripherals by using it in eco-friendly manner. Green Cloud Computing Considers both performance and energy efficiency and it is a new thinking which is based on cloud architecture and services [5]. Green computing for IoT remains the best consideration in building a sustainable ecosystem. Embracing green computing practices will contribute to making recyclable devices and reduce energy consumption across computing infrastructure. Green computing will, therefore, be an excellent solution for supporting the growth of IoT being eco-friendly. Basically the goals of green computing are similar to green chemistry: reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote recyclability and biodegradability of defunct product and factory waste. Adopting Green Computing Strategies make sense not only from an ethical, or moral stand-point, but from a commercial stand-point. There are many business benefits achievable through the implementation of a green computing strategy such as cost savings, resilience, disaster recovery, business continuity planning and of course public relations[6]. We can implement green computing by using such devices which are environment friendly as well as bio-degradable. We have to reduce the use of paper or using the electronic mail instead of using the paper or using the paper on both the side to effectively use the green computing. We must have to use LCD/LED monitor instead of CRT monitor and must start using notebook computer instead of desktop computer. The best way to start implementing the green computing is to start replacing the old machine which used large amount of power and produces large amount of heat with new and modern technology machine which uses less power to run and also produce very less amount of heat. Green computing also recommends shutting down the machines and turning off the computer screens when we are not using it. The roads to achieve the green computing are to use only the green components as well as using the green disposable technique.

C. Internet of Things

The IoT stands for Internet of Things and it is the Extension of internet connectivity into physical devices. IoT presents a world where all the smart things are connected and can communicate with each other. Kevin Ashton coined the term IoT. Things in IoT are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet. IoT comprises each and every object connected to the Internet and may communicate with each other. IOT products can't function without communication technologies that include network protocols (Zwave, ZigBee, and Thread) and connectivity options (Bluetooth, Cellular, and Wi-Fi). In addition, IoT systems leverage advanced technologies such as cloud computing, machine learning (ML) and artificial intelligence (AI). Thread is the emerging networking protocol used in IoT Devices [7]. IoT has improved our day today quality lives by major technical changes. IoT makes our life easy by use of multiple technologies and different kinds of applications. IoT provides augmentation and automation. IoT saves time, improves decision making, find usage in variety of applications and also saves money. IoT different application domains are healthcare, home automation, smart city, smart grid, smart vehicles, transportation, smart parking, smart infrastructure, industrial, manufacturing, business, governance, supply chain, logistics, education, agriculture and mining[8].

D. Next generation heterogeneous IoT Network

The next-generation networks (NGNs) are made up of millions of heterogeneous physical entities, multiple operational domains, nodes, technologies and complex protocols, different gateways. Additionally, with the development of 5G networking technologies, the networking market also continues to develop, enabling IoT networks in numerous sectors to provide flexible IoT applications such as airports connected to epassports, digital facial data to check

identity, many innovative smart city projects and critical infrastructure, Agriculture 5.0, the automotive industry, and so on. This shows that the IoT eco system has become an extremely important and integral part of our everyday lives. Hence the demand for IoT is growing everywhere and even more with the integration of IoT with 5G. Unfortunately, IoT devices have poor security settings, which opportunistically allow cyber-criminals to access IoT nodes and thus sensitive personal data to perform malicious activities. Furthermore, 5G-IoT networks are composed of millions of heterogeneous physical entities, nodes, and more, which increases the threat landscape to a greater extent. Certainly, there are potential threats in such a large-scale heterogeneous communication environment. The key considerations in NGNs' infrastructure are the critical demands of high data flow rates, massive connectivity, low latency (e.g., in autonomous vehicles and remote surgery) as well as the coexistence of multiple technologies. The extreme heterogeneity in Internet of Things (IoT) networks impacts the network performance, application service quality, and user experience, and has opened many vistas for adversaries to compromise and eventually knock down the networks [9].

E. Blockchain platform for Industrial IoT

The word "blockchain" is first found in the white paper of Bitcoin, but its concept originates from the research area of distributed computing. As given in Fig. 1, the IIoT block chain is a network of nodes in which each node corresponds to an IIoT device. The blockchain can be regarded as a state machine that records the states of all the nodes. For example, in Bitcoin, the state of a node is the Bitcoin balance of the node, and the Bitcoin blockchain is a global ledger that stores the balances of all the nodes. Each blockchain node keeps a replica of the global state, and all the nodes maintain the state machine in a decentralized manner, thus removing the need for a central server.

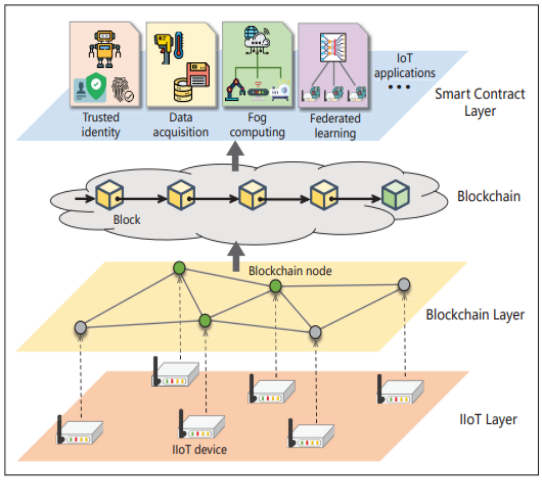

Figure 1. Architecture of blockchain for IIoT

As a disruptive technology that originates from cryptocurrency, blockchain provides a trusted platform to facilitate Industrial IoT (IIoT) appli cations. However, implementing a blockchain platform in IIoT scenarios faces various security challenges due to the rigorous deployment conditions. Recent years have witnessed the wide application of the Internet of Things (IoT) technology in the industrial context by connecting massive numbers of smart IoT devices. The rapid development of Industry 4.0 brings both opportunities and challenges to Industrial IoT (IIoT) scenarios such as automat ic manufacturing, smart logistics, industrial sensor networks, and fog computing . To facilitate these IIoT applications, a trusted platform is needed to provide trusted data acquisition, identity management, and decentralized computing. Block chain, the disruptive technology underpinning cryptocurrency, provides a promising solution to the above issues. Blockchain is a tamper-proof decentralized ledger maintained by a group of nodes through a consensus algorithm. Furthermore, the blockchain supports the execution of generic computer programs as smart contracts, resulting in the proliferation of various decentralized applications. We run the blockchain software on the IIoT devices and connect them to form the IIoT blockchain via IoT communication technologies [10].

F. Digitalization for adopting green computing

Digitalization is defined as the process of converting paper based information into the digital format so that it can be used on computers. In the past decade we have seen massive digitalization. All our information's, which were previously stored in files and notebooks, are now available in digital format where we can instantly access it from our devices. People can use their phones, tablets and laptops to do things like grocery shopping and banking. The total time spent on these electronic devices has risen dramatically in recent years, as all the work and social lives are moving online. Customers who previously used to interact with companies physically or through calls now use digital devices and social media for the communication. Organizations are rapidly adopting these technologies to automate their processes and provide a better user experience to all their customers. For example, banks and retailers, have websites and mobile apps that allow customers to bank and shop without leaving their homes. COVID-19 has further increased the deployment of digital technology. Digitalization is more than just converting paper documents to digital formats. Our household items are now becoming digital as they are linked to the internet. We can now control these devices remotely with the help of internet.

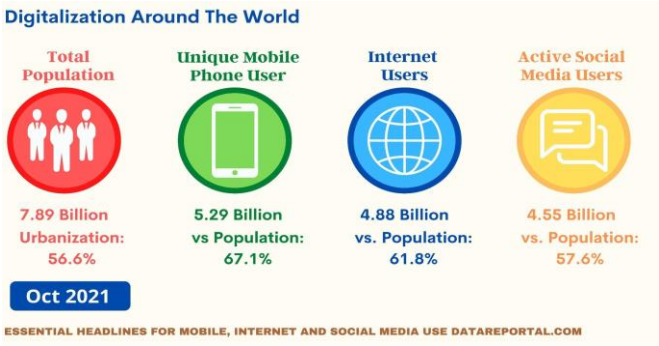

Figure 2. Data about the world mobile phone, internet and social media user

There are connected devices all around us—phones, vehicles, and household items. These connected devices are often referred to as IoT—the Internet of Things. With the introduction of 5G, our devices are more connected than ever before. 5G is defined as the fifth generation of cellular networks. It is Up to 100 times faster than 4G, 5G is creating never-before-seen opportunities for people and businesses [11].

III. DEPLOYMENT MODELS OF GREEN CLOUD

Green Cloud deployment models represent a specific type of Green Cloud environment distinguished primarily by ownership, size, and access. Each deployment model has varying degrees of data security, risk, and investment. Each deployment models have its benefits [12].

Private Green Cloud or on-premises Green Cloud: The private Green Cloud infrastructure provides a dedicated network and equipment that are operated solely for the customer's business and are managed internally or externally. In a private Green Cloud arrangement, the customer maintains all components of the associated technology, which includes any servers or software required to deploy Green Cloud resources. Private Green Clouds give customers a greater degree of flexibility and control over data security and storage but are also more expensive given the physical space, hardware, and environmental controls required.

Public Green Cloud: The public Green Cloud is made available to the general public by a supplier who owns, operates, and hosts the Green Cloud infrastructure and offers access to users over the Internet. Because users share the public Green Cloud, this model offers the greatest flexibility (on demand scalability) and cost savings (pay as you go model). However, the public Green Cloud has increased security risks as customers have no visibility or control over where the infrastructure is located, and it offers limited configuration and availability variance.

Community Green Cloud: The community Green Cloud infrastructure is a multi-tenant Green Cloud service model that is shared among several organizations and is governed, managed, and secured commonly by all the participating organizations or a third-party managed service supplier. Community Green Clouds are a hybrid form of private Green Clouds built and operated specifically for a group that shares common goals [13]. With the community Green Cloud, the costs of deployment and access are spread over fewer users than the public Green Cloud, but there are more users than the private Green Cloud.

Hybrid Green Cloud: The hybrid Green Cloud is composed of two or more Green Clouds (private, public, and/or community Green Clouds) that remain separate but are bound together, offering the advantages of multiple deployment models. A hybrid Green Cloud increases the flexibility of Green Cloud computing as customers can leverage suppliers in either a full or partial manner. There are, however, increased potential risks with accessing multiple Green Cloud platforms. Hybrid green clouds have more benefits as compared to public and private green cloud.

IV. NEED OF GREEN CLOUD COMPUTING

Green Cloud computing is now becoming a business standard. It simplifies the user's accessibility. It provides a virtual storage space to the user which could be used without bothering about the details of the entire mechanism. Here are some other reasons why every enterprise might need Green Cloud computing for their business. Green Cloud computing removes the requirement of a company to invest in storage hardware and servers and it comes under cost savings. Since all the services will execute over the internet, a company does not have to bother about technical issues and other problems associated with physical storage and backup [14]. A company can thus focus more on their core business. It delivers reliable performance irrespective to the geographical location of the user. Another key feature could be the automatic updating of services and applications.

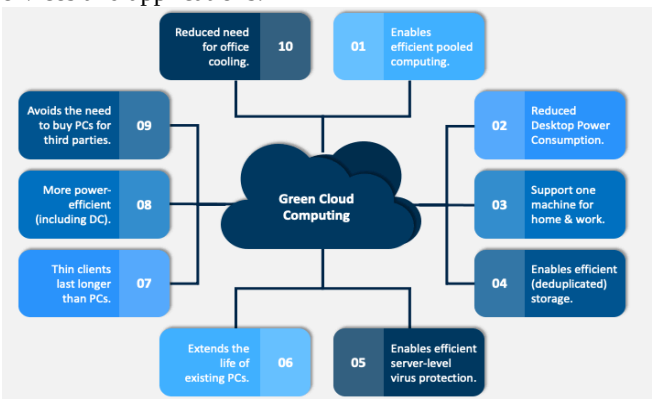

Figure 3. Objectives of Green Cloud Computing

Green Cloud Computing offers optimum security which protects you against any unauthorized access, modification and loss of data and it comes under security. Even if part of the Green Cloud environment fails or stops working, the other resources continue to work until the problem is fixed. The release of carbon emission is increasing day by day due to installation of servers and increasing data centers for futuristic load of IoT devices data in cloud computing. Due to the release of carbon emission Environment is getting impaired on hourly basis. Due to the de-duplicated data more and more data centres are required for storing it [15]. Ecological balance is getting disturbed. Power Consumption is increasing due to large amount of data storage in data centers.Obstruction in sustainable development and inclusive growth. The cost in implementing green cloud is less as compared to normal cloud. Cost is claimed to be reduced and in a public Green Cloud delivery model capital expenditure is converted to operational expenditure [16]. This is purported to lower barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks [17]. There are many key characteristics of green cloud computing. First one is agility which improves with user's ability to re-provision technological infrastructure resources. The second one is the cost which is claimed to be reduced and in a public green cloud delivery model, capital expenditure is converted to operational expenditure. The third one is virtualization and it is a technology that allows servers and storage devices to be shared. Applications can be very easily migrated from one physical server to another with the help of virtualization. The fourth one is multitenancy which enables sharing of resources and cost across a large pool of users. The fifth one is reliability and it is improved if multiple redundant sites are used, which makes well-designed Green Cloud computing suitable for business continuity and disaster recovery. The sixth one is performance and it is monitored and consistent and loosely coupled architecture is constructed using web service as the system interface. The seventh one is security and it is the most important of all because if the data in the green cloud computing is not secured then why people will move to green cloud. This is the reason green cloud is more secure and reliable from the old ones. The last one is the maintenance as green Cloud computing applications is easier, because they do not need to be installed on each user's computer and can be accessed from different places.

V.CONCLUSION

Green computing for IoT remains the best consideration in building a sustainable ecosystem. Embracing green computing practices will contribute to making recyclable devices and reduce energy consumption across computing infrastructure. Green computing will; therefore be an excellent solution for supporting the growth of IoT being eco-friendly. To promote green cloud computing for IoT devices by allocating the cloud resource effectively such that no cloud resource should be over or under loaded and task should be assigned in balanced fashion. Energy efficient solutions and design of IoT devices are required to minimize the impact of Cloud computing on environment by creating awareness among people. Adopting green computing strategies makes sense from both an ethical and commercial standpoint. Green computing has various corporate benefits including cost savings, resilience, disaster recovery, business continuity planning, and of course public relations. Given the prevalence of IT in today's information economy, IT executives can dramatically affect the battle against global warming while improving company efficiency. Green Cloud computing is a paradigm for supplying and consuming IT resources as needed. This helps transfer costs from capital to operational expenditures and makes IT systems more nimble. This new way of procuring IT services has forced enterprises to rethink their infrastructure and platform services strategies, reducing costs and increasing overall agility.

Green Cloud computing changes the way businesses pay for and use IT services. It has opened new doors for IT service providers and outsourcing companies. For outsourcing providers to stay up with the rapid changes in the IT services sector, they will need to adapt new strategies to incorporate Green Cloud services in their offers. They should test Green Cloud services and see which models work best for their customers. This will help them uncover new Green Cloud business prospects.

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