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Green Cloud Computing and its future

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Abstract

Cloud computing makes computer resources and processing power available to anybody, wherever in the world. Compared to specialized high-performance computing equipment, this plan offers great performance at a lower cost for customers throughout the world. For this provision to work, massive data centres must be tightly linked to the system, which means that when they are used more, they use more energy and produce more CO_2. In recent years, energy has become a major issue. As a result, the relevance of green cloud computing has grown. This type of cloud computing uses techniques and algorithms to help decrease energy waste. In this survey, we talk about some of the most effective ways to cut back on energy use and CO_2 emissions, both of which have the potential to have serious health consequences. Initially, we'll talk about data centers' green matrices and then examine green scheduling methods that can help reduce energy usage and CO_2 emissions in current infrastructure. At the same time, this article also discusses the various existing green cloud designs and their benefits and drawbacks.

Keywords: Computer, Cloud Computing, Green Matrices

Introduction

When it comes to Cloud computing, the internet and many experts agree that it's a collection of diverse computing principles involving thousands of computers communicating in real-time so that users have the impression that they're accessing one massive resource. Web data storage, enormous computer resources, data processing servers, and other features are all provided by this system. It's not a new idea; in fact, cloud computing has been around since the 1950s. Back then, the solution was to implement time sharing systems. Many experts hinted about the age of cloud computing in their publications or statements between 1960 and 1990. Dumb terminals linked to mainframes were more well-known than cloud computing during this time period. VPNs (Virtual Private Networks) began to replace dedicated connections in the early 1990s, even though they were inferior in terms of Quality of Service (QoS). Salesforce.com was one of the first companies to offer business applications through the internet, back in 1999. AWS (Amazon Web Services) and Elastic Compute Cloud (ECC) were two of Amazon's early ventures into cloud computing, which helped pave the way for the arrival of cloud computing in approximately 2002. (EC2). Other online industry giants such as Google, Yahoo, and others have joined the group since 2009, with the launch of web 2.0.

The notion of cloud computing may be viewed as a hierarchical structure made up of many models. There are three models included in the Service Model (B. Priya 2013): software as a service, a platform as a service, and infrastructure as a service. This is the first model to be discussed. Deployment models include public cloud, private cloud, community cloud, and a mix of all of these. This is the second model. When it comes to cloud computing, the main goal is to optimize shared resources, but there are drawbacks, including high infrastructure costs and excessive power consumption, according to NIST. (Liu 2007)When it comes to cloud computing, the main goal is to optimize shared resources, but there are drawbacks, including high infrastructure costs and excessive power consumption, according to NIST.

High electricity usage and CO2 emissions have recently been a major source of worry due to the threat of global warming. With the help of organisations like Greenpeace, the United States Environmental Protection Agency (EPA), and the Climate Savers Computing Initiative, the world has grown extremely environmentally conscientious. As cloud computing becomes increasingly popular and widely used, and as people around the world become more environmentally conscious, researchers have been forced to develop concepts for a more environmentally friendly and energy efficient version of cloud computing, which they call green cloud computing. Earlier studies have shown that green cloud computing may help reduce power usage and CO2 emissions while also repurposing energy efficiently.

To process user requests, the cloud makes use of hundreds of data centres, and to keep these data centres up and running, a large amount of electricity is consumed for cooling and other operations. Green cloud computing strives to minimize this power usage every year, which helps to alleviate some of these problems. To keep costs down, a variety of strategies and algorithms are employed. (Singh 2013) Research is underway to find ways to reduce the amount of energy we consume.

While one focuses on static cluster server setup, (B. Priya 2013) the other stresses dynamic cluster server configuration (Liu 2007) (E. Pinheiro 2003)to minimize overall power consumption by balancing load and effectively using just a portion of the resources available. CPU frequency scaling that considers load balancing can also help conserve energy by adjusting the clock frequency dynamically as the workload changes. (Fan 2007) Data-center power usage may be measured with a variety of other methods as well. The Green Grid created the Power Usage Effectiveness (PUE) metric to gauge data centre efficiency. PUE shows you how much extra electricity is needed to keep IT equipment cool. IT giants like Google, Microsoft, Yahoo!, and others have adopted green clouds because they save electricity waste.

The Article is divided into 5 parts wherein the second part focuses on prior study on green cloud computing. Part three provides a brief overview of the strategy employed to resolve the issue. Part Four compares the new approach to the old one. Part five of the paper summarizes the findings and looks forward to the newer approaches in the same topic.

Existing Projects

Recent years have seen a significant growth in the use of Green Cloud Computing. Green Cloud's applicability in real-world settings has been extensively researched using a variety of factors. Data centers' energy consumption has skyrocketed. Green grid proposes various criteria as Power Usage Effectiveness (PUE) and Data Center Efficiency (DCE) metrics [10], TDP (Thermal Design Power), (Alagoz 2021) etc. to improve the energy efficiency of operational data centres (A. Jain 2013). PUE is a widely used criterion.

PUE has a value range of 1.0 to infinity. If the PUE number is close to 1, it implies that IT equipment is using all of its available power. With Google PUE at 1.13 (T. Kgil 2006), several firms have attained low PUE levels in recent years. If PUE is 1.5, then IT equipment uses 1kWh of energy, the data centre uses 1.5kWh, and 0.5WH of energy is spent on pointless tasks like cooling and CPU dissipation. Table I provides an overview of various data centre parameters. When employing the optimal architecture, PUE levels of 1.6 should be feasible in many data centres with PUE values as high as 3.0. This estimate was done in

Lawrence Berkley National Labs and shows that 22 datacenters measured had PUE levels ranging from 1.3 to 3.0.

Some professionals have used a green scheduling method in conjunction with a neural network prediction to cut down on the amount of energy consumed by clouds. (T. Vinh T. Duy 2010) When using this technique, the server anticipates the load and calculates the peak load from time t until restart time. The number of servers is decided on based on their peak load. When there are N_0 servers in ON state, then N_n servers are required.

$N_n > N_0$ means restart the server if it's in an off state, whereas Nn > No means shutdown the server when it's in a on state. If Nn > No, then restart the server.

Similarly, in an attempt aim to reduce data centre energy use F. Satoh et al (F Satoh 2013), they are creating a sensor-driven energy management system that integrates a better VM allocation tool with an energy management system. As a consequence, this technology will assist save 30% of the energy used by numerous data centres by reducing power usage. Using this technique, carbon emissions may be reduced while at the same time saving electricity.

Another big problem with data centres is cooling, which uses a significant amount of energy. Previously, IT equipment was kept cool with the help of a mechanical refrigerator. Pre cooling, also known as free cooling, is now widely employed. Mechanical cooling is reduced to a minimum with free cooling. In the same way that Facebook places its data centre in the cold and dry country of Sweden. Microsoft allows servers to be exposed to natural ventilation in order to keep them cool. In addition, Google's data centre is cooled using river water [1]. To reduce energy usage, several hardware and software solutions like as virtualization and software efficiency algorithms are being employed.

Rasoul Beik et al. [6] present a software-architecture energy-aware layer that calculates data centre energy consumption and offers services to customers that do so in a cost-effective manner. In this work, several energy models have been addressed to minimise power consumption and CO2 emission in order to make the cloud more green. In the paper published by Bhanu Priya, (B. Priya 2013) it provided cloud computing metrics for this purpose. There are three major factors considered in this survey; any cloud can be green by following these factors, the first of which is virtualization, followed by workload distribution and then software automation. Other factors such as pay-per-use and self-service are also discussed and proven to be crucial for reducing energy consumption are also taken into consideration.

Expenses for cloud data center maintenance and operation are rising, according to Kliazovich and Bouvry. (Bouvry 2010)The author of this research focuses on the distribution of workloads between data centres in order to quantify energy usage at the packet level. This method allows for communication at the packet level. The simulator has been used to do energy packet level simulations, such as the NS2 simulator for green clouds and the lone "cloudsim" simulator for clouds. At each degree of complexity, the simulation is carried out in a different way to see how it affects the final outcome. In the realm of energy in cloud computing, Kaur stated the completion of several obstacles. (Singh 2013) The author proposes a methodology to quantify the energy spent by creating various gases in the environment. The suggested model includes a number of data, analysis, and recording areas. Remain vigilant and restrained when using the green cloud virtualization idea to maximize energy efficiency and promote environmental health. Data centres consume a lot of energy and energy is accessible all the time, thus the author discusses solar energy in his work because of the new issue in cloud computing presented in Hosman et. Baikie. (Baikie 2013)

Data centers’ energy usage is a prominent topic since energy may play a significant role in those facilities. A "less power consumption platform, energy efficient cloud computing, and DC power distribution" is presented by the author in this study as a small-scale public cloud data centre. A survey was carried out to see where cloud computing stands in terms of efficiency in terms of energy use. (Pattinson 2012) They eloquently address energy efficiency as a contentious topic in relation to cloud computing in their article. An aspect of cloud computing's energy efficiency is addressed in this study. Yamini and colleagues Green cloud computing's core methods such as virtualization, Power Management, material recycling, and telecommuting are elegantly introduced. The main goal of this article is to decrease the excessive energy consumption by consolidating or scheduling the use of tasks and resources in green cloud computing. The good results in the article are not for a direct drastic reduction in energy but apply prospective electricity savings in massive cloud data centres in the cloud. The reduction in energy. The demand for cloud services is growing at an alarming rate, as is the amount of energy consumed and toxic gases emitted, both of which are detrimental to human health and are major factors in the rising cost of cloud operations. On the conduct of a thorough literature review of the many cloud members who contribute to overall energy usage, and the results were impressive. This paper discusses the cloud's structure and how it may be used for green cloud computing.

Carbon green cloud architecture contributes to the third-party idea, consisting of two types of directories referred to as green offer and emission of carbon. These directories assist us in making available and making use of Green services from both consumers and suppliers. Green brokers use a list of green offerings and pre-scheduled services to find services with the lowest carbon footprint. To reduce energy usage, it is necessary look to virtual machines. In the real Cloud Computing data centres, an author offers a dynamic reallocation approach for VMs that turns off the unneeded servers and saves a lot of energy. (Buyya 2010)

In order to establish a green cloud environment through the use of virtualization, AR Nimje and his colleagues focused on the security of cloud data centres. (AR Nimje n.d.) The study utilizes a variety of ways to solve security concerns while also reducing power usage. Because it minimizes the burden on data centres and makes resource deployment, administration, and delivery simple, virtualization entered the picture. By including a hypervisor environment, Nimje was able to achieve a high level of security while still providing virtualization.

Approaches Currently in Use

According to Buyya and colleagues, There are two sorts of directories: green offer and carbon emission. (Buyya 2010) The carbon green cloud architecture alludes to the third-party idea. These directories assist us in making available and making use of Green services from both consumers and suppliers.

There is a "Green offer Directory" where the suppliers' services are listed. In order to reduce CO2 emissions, the Green Broker used these services and grouped them based on price, time, and service. In the Carbon Emission Directory, data on cloud service and data centre energy and cooling efficiency is kept and archived for future reference. The green broker made advantage of the most recent service information available.

When a user requests services, the Green Broker is contacted. In this way, the Green Broker selects the green offer and energy efficiency data, then distributes the services to a private cloud on the basis of that information Then, provide the completed product to the customers.

MN Hulkury and MR Doomun, in their paper utilize this directory idea brilliantly and offer a new architecture known as an integrated green Cloud architecture (IGCA). (Doomun 2012) A sample ICGA structure is depicted in the image below. (Fig. 1)

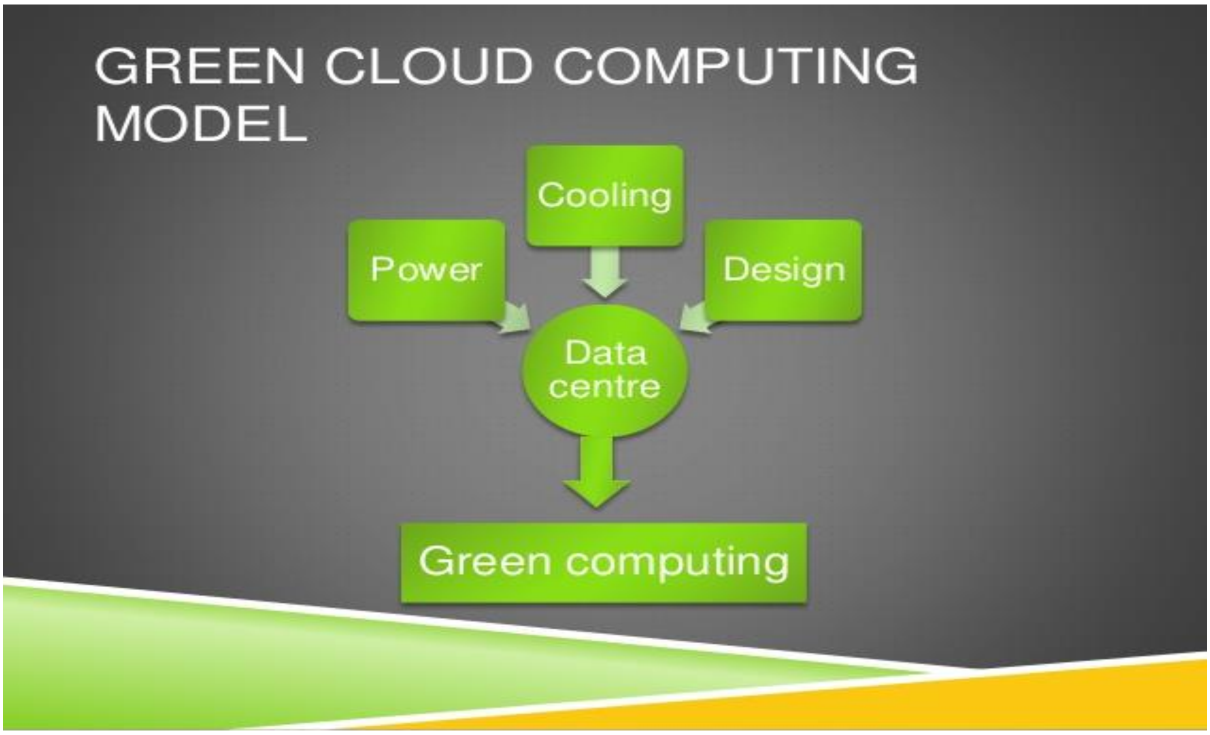

Fig. 1: Green cloud computing model

There are two parts to this architecture: the client and the server. When it comes to the server side, there are the green cloud middleware, green broker, and sub-servers like processing servers and storage servers. These are all present on the client side. In IGCA's green broker layer, the directory idea is utilised to organise all of the public cloud's information and deliver the best green service to users.

Both of the green cloud middleware's components may be found in one place. In the middleware, the manager is the main point of contact for all of the data. All of the information is stored on private clouds on PCs belonging to the users. The amplitude of each sever's frequency range. The component of middleware keeps track of things like energy use, storage capacity, and more.

When the client made a request, the manager responded. The request is divided into jobs and distributed among the users, and information about each task is stored in the component. When a work is run on a private cloud server, a green broker on the public cloud, or a client

PC, the carbon emissions and energy consumption are computed and displayed to the users. The manager chooses the best green offer while also considering the job's level of security. When a management makes a decision, the XML file stores that information for later use. All users have access to the second component in order to view the XML file. This file contains all of the job-related data. The places where the employment are located are listed in the file, they will run the program using said file if the addresses are correct. If the job entry is missing from the file, the task will be run on the client's PC or in a private cloud instead. Three locations are involved in the job's execution. This information is kept in client-side memory, thus the next time a similar request comes in, it won't be intercepted by middleware since it was performed LOCALLY (on the requester's end). The location and server name are retrieved from the file if the task is run in the private cloud. Alternatively, if it's on the public cloud, we'll enlist the aid of a green broker to figure out the best green option for conducting the project. The middleware is well-versed in all three locations' specifics. The middleware calculates the energy consumed by the company's employees in order to make future decisions. There are a number of variables that influence where a work should be conducted, including processing speed, energy usage, bandwidth, and others. The middleware will compute and evaluate the location based on the three options by taking them all into account. The IGCA maintains a healthy work-life balance while ensuring the safety and satisfaction of its clients. Considering all possible locations, the manager splits up the work and finds a high-quality environmentally friendly solution (public, private, local host). Managers perform important coordinator roles in this design, allocating tasks to users and making all of the final decisions. Managers are the weakest link in this system because they are the single point of failure. If the manager fails, the entire system will come crashing down.

Benefits and Drawbacks

Everything that has ever been built has some positive and negative aspects, as we've seen. This directory evaluates the most suited service that emits less carbon dioxide, thus it immediately shows that energy consumption will drop as well since CO_2 emission and energy consumption are both directly proportional. Buyya provided the architecture for green cloud. An further drawback is that other important factors like quality provisioning, security, and so on are ignored in favour of CO_2 emissions and energy. (S. K. Garg and R. Buyya 2012) Hulkary take these variables into account by using additional components that search for services first on the private cloud and then on the public cloud, which saves time and yields better results than Buya Architecture. (Doomun 2012) This system's biggest flaw is that the manager is the hub of communication, therefore if the manager fails, the entire system will come to a standstill. In addition, decision-making is done by the management, and everything needs to be done by hand. Some of the benefits and drawbacks of the present architectures are listed below, along with suggestions for how they could be improved for the future.

Conclusions and Prospects for the Future

Using this article, we tackled the issue of traditional cloud computing against the usage of green cloud computing while also shedding light on new research in the area of green cloud computing for a healthier and greener environment. As a result, we conducted research on green cloud computing. Future research can go in a lot of different areas. Our research in the study focuses on finding an effective approach to retrieve cloud-based data so that all of the features discussed may be implemented. We can also automate the green cloud manager, who is in charge of all service-related choices.

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