IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1205184 |

A Survey on Green Cloud Computing

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ABSTRACT: The future of the IT industry is at the crossroads, and unless there is no sustainable solution formulated within the industry, it would potentially be the end of the planet. Data centers within the industry consume most of the energy, and there is an immediate need for these power centers to switch towards green and clean energy. This study investigates the dynamics of Green Cloud Computing services and performs a literature review to examine the need, barriers, and trends of green cloud computing. By investigating the characteristics, barriers, and trends, the study proposes that the future of IT is deeply entrenched with green energy. The results of the study note that green cloud computing can be highly effective in enhancing the benefits of cloud computing further and mitigating its effects on the environment.

KEYWORDS: Green cloud computing, energy conservation, power conservation, quality of service, task allocation.

I. INTRODUCTION

The question of sustainability is at the helm of the 21st century.[3] This is because sustainable development is a strategy for survival for not only humanity but also the planet. That one of the biggest challenges to the environment lies in the computing field. This is due to the fact that the modern world cannot function without reliance on computing technology. Almost all of the large businesses are moving towards the use of cloud computing for daily operations, without which their activities would be put in serious jeopardy. In doing so, the energy consumed by cloud computing is putting the environment at great risk. [3] Has further discussed this point by stating that one of the key fields which utilize energy resources is cloud computing. Sustainable development cannot be achieved unless and until the field of cloud computing is switched towards green energy. Green cloud computing denotes cloud computing operations that rely on renewable energy. Because it is among the key fields in local and international business, formulating a green cloud computing technique is at the heart of sustainable development and mitigating the impact of climate change. However, this is a very radical field as many businesses still have cloud computing technology that consumes energy that is not clean.[2] Therefore, any attempt towards saving the environment needs to start with "Green Cloud Computing' whereby all of the businesses around the world switch from the non-renewable source of energy towards sustainable and green energy.[1] This paper is set out to investigate the dynamics of Green Cloud Computing. It tends to build on the circular economy and improve the energy efficiency of the entire cloud computing industry which is deemed one of the major contributors to global carbon emissions. one of the prominent technologies widely spread over the whole world is cloud computing. It provides various services to its beneficiaries such as scalability, adaptability, flexibility, data storage and data access etc, in return of paying an optimized amount of sum or charges. The main supremacy of cloud computing is that the user can approach any kind of service on request like computing, data storage without any obstacle through internet. The increasing demand of cloud services by the customer allows the cloud service provider to install large number of data centers at different locations. These data centers require vast quantity of energy for operations such as monitors, network peripherals, cooling fans of processors, light and cooling systems. As per observation the power consumption and energy consumption in data centers are gradually increasing from the year 2011.[1] As a result, energy consumption of manufacture industry is gradually increasing. Though there are lots of nonconventional source of energy like wind, water, sun but still large portion of energy is created from conventional source of energy like fossil which are in limited amount. To build energy efficient cloud service along with data center is a major concern. Energy efficient and sustainable cloud computing is required to decrease the negative impact on environment by reducing CO2 emission.[1] To eradicate aforesaid issue, Green cloud computing came into consideration. GCC (Green Cloud Computing) the name itself defines low consumption of energy with less negative impact on environment. GCC itself provides energy efficient model that minimizes the CO2 emission and cost. In general energy consumption is directly proportion to performance but by using the energy conservation algorithm, energy consumption can be minimized with better performance. Various techniques like virtualization; server consolidation, load balancing, and storage management are being used for energy conservation in GCC. Cloud services have three important parts like Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS). These services are managed by virtualization, which decreases the cost of data center and energy

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consumption by data center. However, Green cloud computing is at its developing stage that ensures the quality of services, performance with energy efficiency and sustainable structure. A revolutionary change in data industry will be encountered due to Green cloud computing in coming years to come.

II. GREEN CLOUD COMPUTING ARCHITECTURE

Green Computing is the study and practice of using computing resources efficiently. It is a criterion for measuring organizational success using the triple bottom line (TBL) which simply means economic, ecological & social. [2]

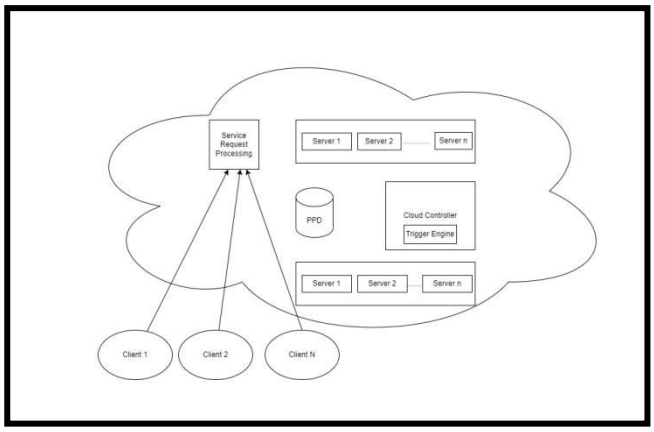

Fig .1. Green Cloud Architecture

Goals of Green Computing:

1. Reduce the use of hazardous material.
2. Maximize energy efficiency during products lifetime.
3. Promote Recyclability.
4. There are many ways to optimize a client's environment to save energy and reduce environmental barriers. The architecture of optimizing O.S. towards green computing has three layers namely:
5. Physical Hardware Service Layer
6. Operating System Service Layer
7. Application Service layer

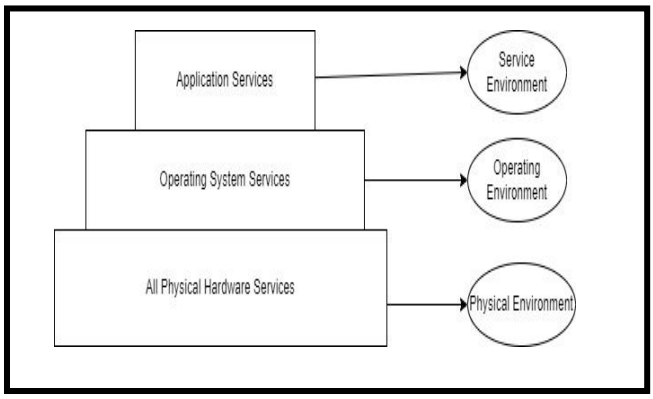

Fig 2. Layers of Green Cloud Computing

Each layer has its own services and provider services to the above layer. Each layer has to work coordinately with other layers. Although green computing can be applied to both operating system services and application services. [2]

A. Physical Hardware Services Environment

Acquiring an energy star 40 system that recognized Advanced Configuration and Power Interface (ACPI) 3.0 power management compatibility from Window vista allows the O.S. to manage power for the processor, attached devices,

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and allows advanced compatibility for hibernation and sleep. Also administrated can use group policies throughout the bag, the maximum CPU load to reduce energy consumption when needed. It was ahead distribution from a wireless sensor network to optimize in order to avoid overcooling the entire data center. It focuses on green computing by optimizing O.S and scheduling Hardware resources. The green computing architecture for optimized OS enables computer's power management features in OS for various techniques like Virtualization, Terminal servers, shared memory, etc.[2]

B. Operating System Services Environment

The operating execution environment is the configuration and standardization of the O.S. and the supporting utilities. It is crucial to leverage the most power-saving capabilities possible while accomplishing the computing goals of the organization. When setting up a standardization configuration minimize the number of running system services to reduce energy consumption. O.S. also provides services for both the upper and lower layer. Resource allocation and efficient energy saving are the key resources. Hardware resource allocation happens in the worst-case scenario, with low frequency. Due to this, they are the same as farms that are 90% percent underutilized. So, optimizing it becomes more necessary.[2]

C. Application Services Environment

Client application virtualization such as Microsoft Application virtualization can be used to reduce the number of resources used by clients in order to run a fully installed application and architect. However, this takes careful planning and work in a focused set of scenarios. Based on the power state of the client, the experience of a less power-intensive presentation can be seen using the Power-aware Windows Presentation Foundation (WPF). Also, some are aggregating application development best practices to minimize energy resources consumption in the client environment.[2]

III. LITERATURE WORKS

Given the importance of the field, many researchers and scientists have taken up the field and produced relevant technologies and solutions. This paper is an attempt to bring those creative solutions to light and open a debate around the new discipline of Green Cloud Computing. The related work is discussed below. [3]

Power Usage Effectiveness (PUE)

PUE is a measure of how effectively and efficiently a data center uses its energy. It evaluates the performance of energy by calculating the ratio of energy used as a whole against the energy utilized by the IT resources alone. It was developed by the scientists working at Green Grid, which aims at a swift movement of data centers towards green energy. PUE is among the most important metric for denoting the energy used and wasted at the data centers.

Green Cloud Architecture (GCA)

GCA as a way of redesigning the architecture of data centers compatible with environmental sustainability. GCA is mindful of both the energy consumed and wasted during the day-to-day process of cloud computing. It tends to provide a long-term solution to both private and public cloud-based services by removing the unsustainable part in the cloud architecture and making the services more ecologically friendly.

IV. CLOUD SERVICE MODELS

There is the existence of different service models that include Software as a Service (SaaS), Storage as a Service (SaaS) and, Processing as a Service (PaaS). All these models fall within the ambit of cloud computing, and their compatibility with the environment is critical for the future of these services. The basic function of cloud computing is to provide these three types of services, and for the development of Green Cloud Computing, these services have to be made compliant with energy efficiency and conservation. [1]

V. WORK FLOW

To understand the dynamics of Green Cloud Computing, the study will perform a pre-determined methodology. This entails studying different academic papers, carving out different themes relevant to the topic, and then bringing into perspective the author's own analysis. A detailed methodology is given below.[1]

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Research Approach

This research is approached through a qualitative framework. This means that non-numerical data will be collected in order to make sense of the research topic. A qualitative research approach is also focused on collecting experiences, opinions, and ideas related to the topic.

Data Collection

The primary source of data collection for this study is secondary. This means that the published literature on the topic will be studied. This published literature will be academic work that has been conducted all over the world by different academics and scholars.

Data Analysis

The data will be a thematic analysis allows the researcher to carve out different and most important themes for the stated topic. It brings out important criteria related to Green Cloud Computing. The selection of these themes will be based on their importance in the cloud computing field. As stated, the researcher plan to review different academic material, and hence, the themes that are overlapping in these published papers will be brought into the light.

VI. RESULT AND DISCUSSION

Characteristics of Green Cloud Computing

Green Cloud Computing is a field that is still largely undeveloped, and this is the reason why there is a need for the development of a model. This model should emphasize the key themes of cloud computing and how it can be made viable with environmental sustainability. [3]

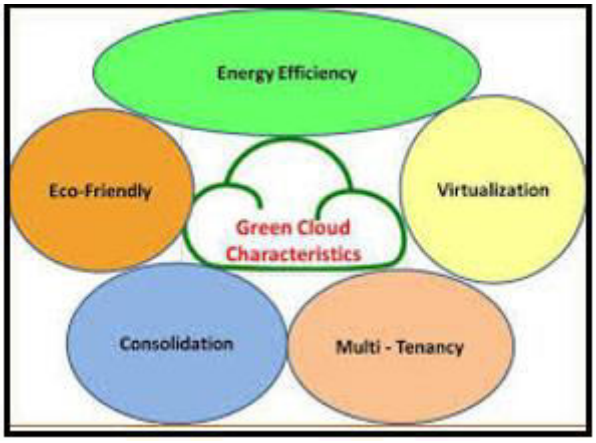

Fig 3. Characteristics of Green Cloud Computing

As per the above model, there are certain characteristics of the evolving field of Green Cloud Computing. These characteristics include energy efficiency, virtualization, multi-tenancy, consolidation, and eco-friendly. Among the most important of these characteristics, which are also not discussed in this paper yet, are virtualization and multi-tenancy. Virtualization is a concept whereby several virtual computers use the same abstraction process. Within the framework of Green Cloud Computing, this would mean that multiple computers would rely on the shared tasks procession, which would then ultimately reduce the energy consumption per computer and increase efficiency. [3] Similarly, multi-tenancy is a phenomenon that is akin to providing cloud servicing to multiple tenants of the same category in order to avoid additional or marginal investment and energy utilized by a distinct tenant. Although this technique can have many benefits especially linked to energy conservation, there is an immediate threat of risk of privacy between the tenants. Therefore, there is room for further development of multi-tenancy characteristics of Green Cloud Computing. Broadly speaking, it means the process involved in Green Cloud Computing and making it compatible with the sustainable development of the environment. These processes mostly relate to the Application, Network, and Security on which the logic of cloud computing is built.[3]

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VII. NEED FOR GREEN CLOUD COMPUTING

IT generates around 2% of total global emissions. It is also without doubt that the need for cloud computing would rise in the future, given the switch of analog business models into digital arenas. As a result, the global emissions in the IT sector would also rise, which would be contradictory to the health and safety of the planet. This might also cause the IT industry to become one of the key polluters of carbon dioxide emissions. [1]Hence, it is quite apparent that if the IT sector is to develop in the future, it needs to be more sustainable and be made compliant with the environment. The need for Green Cloud Computing is thus essential for the industry. Data centers are among the most consumed energy centers in the IT solution, and hence, no solution of IT sustainability can be developed without forming a sustainable solution for these data centers. The study also highlights the importance of power management and energy efficiency in the current data centers. However, there are certain barriers to the field of Green Cloud Computing which are discussed subsequently. [2]

VIII. GREEN CLOUD FUTURE CHALLENGES

Energy Efficiency: As the today clouds are designing with the multi-core CPU's, there is a need of designing the power optimization and management techniques to support the power management with multi-core CPU's. [3]. Another huge power consuming part of cloud is the data center, which is a collection of data storage components and data management software. An efficient power consumption monitoring system, dynamic power management system and intelligent power supply decision making systems are the research challenges in this area. By considering the today pace of IT, we need a comprehensive and intelligent mechanism to tackle with the entire cloud architecture level energy optimization issues.

Virtualization: Many former researches were widely concentrated on designing of the efficient cloud virtualization process, but the virtualization is still suffering from some high-end optimization relevant limitations.[2] Designing the novel methodologies with the state-of-the-art technologies to optimize the entire lifecycle of virtualization process is an important research. Automated optimal VM's creation with substantial resources and dynamic resource allocation & sharing facilities without affecting the cloud performance are the other considerable research challenges in virtualization.

Multi- Tenancy: Although this an essential character of green cloud, at present multi tenancy is suffering from the privacy and security concerns. Designing the secured multi-tenant architectures and privacy-preserved secured access to multi-tenant modules are the considerable future research challenges.[2]

Consolidation: Design of intelligence support in VM's consolidation, Multi aspect based threshold value calculation, leveraging the key resources and server downtime management became the future research challenges in this area.

Eco-Friendliness: This area mainly concentrates on environment based tools design i.e. carbon emission calculator tools to measure the effect of the cloud on nature. Need to design of a comprehensive framework to certify the clouds with ranking, based on multiple aspects of Green Cloud Computing.

IX. CONCLUSION

The point of departure of this study was to highlight the need for Green Cloud Computing as a way forward for sustainable development. This is quite a novice theme in the IT industry, and it must be admitted that the modern discourse in the sector does not highlight the need to make the transition from non-renewable sources of energy towards more sustainable forms.[1] This is quite alarming because data centers use a tremendous amount of energy which puts the lives of millions at risk. There is a clear need for Green Cloud Computing, a terminology that emphasizes the processes and practices to make computing and other IT resources in accordance with climate safety. The study then dwells on important jargon prevalent in the Green Cloud Computing sector, such as PUE or GCA. [1]Most often than not, these criteria do not serve as the basis of evaluation, and this is one of the problems that the industry is facing. The clientele of cloud computing is in ignorance when it comes to energy efficiency or carbon dioxide emissions which serve as an incentive for the producers to continue with the practices that promise to bring large-scale destruction to the planet. Therefore, the study then proceeds to highlight the core characteristic of Green Cloud Computing which include energy usage metrics, virtualization, multi-tenancy, and consolidation. [2]These are also among the prevalent trends in the industry. Lastly, barriers towards large-scale adoption of Green Cloud Computing such as cost and resources are highlighted. It is clear that the entire responsibility of adoption of Green Cloud Computing rests on the industry, and it is indeed the big and small companies that should make a swift transition towards sustainable development. [3]

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