**Abstract:**

Cloud Computing has become an essential part in this virtualized era for its easy accessibility & on demand services. The growth in cloud computing has led to huge amounts of energy consumption for data processing, storing & communications which isn’t economical for our environment as it releases vast amounts of C02 . So in the recent years green cloud computing has come into the discussion & became a significant area of research. The aim is to reduce the energy consumption & optimize the resources properly for an efficient green cloud environment. The main challenges that are often faced, while working on the optimization of energy & resources are, we need different task scheduling algorithms. Traditional task scheduling algorithms cannot satisfy the cloud’s needs. Improper scheduling of tasks causes a vast amount of energy, time & cost. So the researchers have been trying to modify the traditional algorithms that can fulfill the requirements. In this paper we have explored different approaches, algorithms that have been done in our mentioned topics. Summarization of the reviewed papers & comparison has been done based on the various scheduling parameters to understand in which areas that we need further research on & areas that need improvement.

Keywords: Cloud Computing, Green Clouds, Scheduling of tasks, Energy Consumption, Resource Allocation.

**Introduction:**

Cloud computing is broadly utilized in business and data innovation. It empowers payment-based facilitating of uses from customers, researchers, and different domains. In any case, data centers that host distributed computing applications consume enormous measures of energy, adding to high functional expenses and the evolution of carbon to the climate. The environmental factors Data centers, otherwise called CLOUDS, have a huge limit with regards to data storage and processing. As per The features provided require a monstrous measure of power supply and resources. The recent concern is a dangerous atmospheric destruction. which everybody is defied with Energy scarcity and worldwide environmental change are additionally central issues nowadays. The power consumption of data centers has emerged as a main issue. Green computing is also acquiring fame. In an energy-constrained world, this is turning out to be progressively significant.

Cloud computing offers foundation, stage, and software programs as contributions, which are made to be needed to buyers as membership essentially based absolutely on contributions underneath the compensation pay-as-you-go model. Cloud's objective to drive the format of the accompanying technology data focuses with the guide of utilizing architecting them as organizations of advanced contributions. So clients can get right of passage to and set up programs from wherever withinside the worldwide available for potential emergencies at aggressive costs depending on their necessities. Cloud computing gives incredible blessings to IT sectors with the guide of utilization freeing them from the low-level test of placing in major equipment and programming program frameworks and thus permitting discernment on development and developing business venture cost for their contributions. As laptop devices develop, so the amount of power conservation and the carbon emission are filling the environment. Measures being taken to decrease the problem hastily called “inexperienced computing”. Green Computing is exercise of

designing manufacturing, the use of and discarding laptop server and related sub gadget including screens, printer's carport contraptions systems administration and discussion gadget effectively and proficiently and not utilizing an impact on environmental factors Green Computing is characterized on the grounds that the look at and exercise of the utilization of registering resources effectively through a strategy that consolidates bringing down hazardous materials, amplifying power execution all through the item's lifetime, and reusing more seasoned innovation and ancient items. Green Computing permits gatherings to fulfill business venture needs for practical, power-effective, adaptable, secure areas of strength for and simultaneously as being naturally capable. Each data center exchange calls for strength. Proficiency, framework removal and reusing, and power utilization,comprehensive solidarity and cooling costs, have ended up being priority for people who control the datacenters that make partnerships run.

The figuring system power consumption, alluded to as dynamic power consumption, comprises the larger part of energy utilization of data centers without relating to cool systems. [44] Notwithstanding, most existing explorations of asset assignment focus on planning virtual machines (VMs) across actual servers with the target of adjusting the responsibility of server farm to work on general execution. [45] Such approaches don't for the most part

take into full thought how to diminish energy utilization of server farms. [44]Additionally, distributed computing should guarantee Service Level Agreements (SLAs). SLAs are laid out by exchange between clients and suppliers, which indicate rigid execution necessities, for example, reaction time, throughput, etc. Therefore operating server farm in an energy effective way while ensuring indicated execution presents tremendous difficulties. In this paper, we plan the energy proficiency virtual asset distribution for distributed computing as a multi-objective advancement issue which is then tackled by astute streamlining calculation.

[40] The purpose of this paper is to survey the existing literature on optimized energy consumption and resource allocation for green cloud and to identify the key issues that have been researched and applied and the main contributions of cloud computing to environmental protection are recognized in the following areas.

* Featured recent work, give a more extensive point of view of the area and propose future areas of likely examination, too illustrating open inquiries.
* Different algorithms and methodologies on optimization of energy consumption and resource allocation for green cloud have been provided.
* It features the interest and efforts of researchers and society in a vital region: sustainable technological advancement.
* Academic literature is worried about advancement and consistently presents the most recent revelations and achievements in the researched field.

[40] The rest of the survey is organized as follows. Section 1 covers the introduction and in Section 2 we present a brief overview of Related Works. In Section 3, we provide two tables describing Summary of Findings. In Sections 4 and 5, we present summary and A comparison between different algorithms used in reviewed paper basis on scheduling parameter. In Section 6, we explore the Challenges, Opportunities and Future Scopes. Finally, conclusions are formed in Section 7.

**2.Related Works:**

In this paper[1] the authors have constructed a workflow scheduling model using Green Cloud Scheduling algorithm. This refers to the process of planning cloud service requests in the best way possible in order to complete the task in time allocated with minimal use of energy resources & also minimizing C02 emission rate . Their algorithm also applies Dynamic Voltage and Frequency Scaling(DVFS) to find the optimal frequency to run each task without affecting the performance. Similar (DVFS) method is used in paper [2] to reduce power consumption of the server;the authors have also proposed a Green Energy-Efficient scheduling algorithm to schedule the task based on their SLA priority given by the user. A variant of (DVFS) method (DVS) has been used by the authors of [5] for similar reason.However they have considered a job to be a bag full of tasks.Each PE( Processing Elements) tests the schedubility of the new task and returns the estimated energy consumption incase of being schedulable. The resource controller selects the lowest-energy PE which can run each task. A task should be completed before their deadline, the authors have considered this as a QoS parameter.

To reduce the energy consumption the authors of this paper [3] proposed two algorithms Energy-aware Scheduling algorithm using Workload-aware Consolidation Technique (ESWCT) & Energy-aware Live Migration algorithm using Workload-aware Consolidation Technique (ELMWCT).The ESWCT algorithm shows where to place the VM. & this ELMWCT algorithm is responsible for VM migration dynamically.The resource scheduling center uses the algorithm (ELMWCT) to migrate running VMs from underused physical servers to those which are fully used.The authors in the paper [4] have also worked with VMs. Aggressive VM consolidation may degrade the performance so they have used a total of 4 algorithms to resolve the problem & to optimize resource utilization and reduce energy consumption.Another VM allocation related work has been done in paper[14] the authors have proposed a task scheduling scheme.Each task has to be defined by the amount of resources. Their corresponding VM is then assigned to available servers until the saturation point (Where the performance delays significantly) The scheduler sorts the servers according to their energy efficiency. Most efficient servers will be sorted first & so on until the servers queue are full or no task remains.

In this paper [13] the authors have sorted the computing resource in four categories: CPU, memory, storage, and network. Then they have proposed a Dynamic ResourceScheduling Algorithm.This algorithm is characterized by reserving the simplicityand efficiency of a round-robin scheduling algorithm. The algorithm requires that all nodes must have the same hardware configuration.

This paper[6] working on two types of resources: processing capability and bandwidth in order to make processing capability and storage space facility, preserving network bandwidth and synchronize resources and services divided into 2 groups: non-delay system and waiting scheme

In this paper[8] it's been discussed about the economic issues of hardware cost, power consumption cost,maintenance cost and minimizing computer power, optimum architecture and optimum algorithm.

This paper [10] working on Markov decision Model( MDP) by initializing system information includes the observation period that's 24 hours, the maximum number of levels for workloads, green energy and battery capacity,finding reachable states and possible actions based on the probabilities of all states.

In this paper [9], the problem of energy efficient management of a homogeneous resource’s energy consumption of heterogeneous cluster computing nodes,actual load balancing is not handled by the system, and diverse software configurations have been discussed.

This paper [7] working on resource allocation program and server consolidation program is dead for mapping all requests and unleashing VM respectively, various power-on once drivers not utilized, prime energy consumption by means of client, server and network computational devices and power required to cool the IT load.

In this paper [11], they are working on both virtual and physical machines,by taking the maximum absolute deviation during the VM placement along with the power consumption as well as the service level agreement (SLA) deviation.

This paper [12] is working on communication fabric in data center energy consumption by scheduling approach combining energy efficiency and network awareness, labeled as DENS.

In this paper, [48] presented an approach to select VM for migration and a host selection policy to reassign this VM. They rely on the fact that it is better to migrate VMs on hosts that have low CPU usage so as to not overload and block the host. As a result, energy consumption is reduced compared to other approaches. Not only meet energy efficiency requirement but would also ensure quality of service to the user by minimizing the Service Level Agreement violation. In this paper, purpose a technique to reduce the energy consumption and CO2 emission that can cause severe health issues.

This paper [49] presented the constraint Programming which consider the VM placement problem to minimize total energy consumption in a decision time while maintaining all VMs in the cloud. Multiple copies of VMs are generated by the approach. The algorithm is designed using dynamic programming (DP) and local search to evaluate the number of copies of a VM and then place those copies on the servers in order to minimize the cost of total energy in the cloud system.

This paper [50] Consolidate VMs using: in the under loaded host decision step, the IUD method that is based on the overload threshold of hosts and the average utilization of all active hosts. And in the step of selecting the target host that can accept the VM migration, the algorithm MAUD is adopted (that is based on the average utilization of the datacenter. Improved underloaded decision (IUD) algorithm and minimum average utilization difference (MAUD)algorithm.

In this paper [51] Dynamic Resources Allocation (DRA) method and Energy Saving method. With a power distribution unit (PDU) connected to the system to monitor its status and record energy consumption. By the DRA algorithm, the waste of the idle resources on the VMs can be decreased. Also, the Energy saving method reduces the energy consumption of the cloud cluster.

In this paper, [52] [53] developed an architecture for managing VMs in a data center to optimize energy consumption by using consolidation (running as many VMs as possible in a single physical server with avoiding the lack of resources). This solution considers only the CPU as energy parameter.

In this paper [39] the goal is to save energy consumption without compromising much on the performance. Reducing the carbon footprint but would also cutting down the costs least compromising on SLA violations thereby benefiting the cloud service providers. Simulated Annealing Optimizing Technique has been used for the purpose of continuously optimizing the placement of the VMs (Virtual Machines) over the hosts in order to minimize the power consumption.

In this paper [42] the authors are discussing key techniques to reduce the energy consumption and CO2 emission that can cause severe health issues. Throwing lights on green scheduling algorithms that facilitate reduction in energy consumption and CO2 emission levels in the existing systems. Implementing the green scheduling algorithm combines with neural network predictor for reducing the energy consumption in cloud computing and for the future energy management they developed an energy management System for cloud by the use of sensor management function with an optimized VM allocation tool.

This paper [43] focuses on energy saving of computing procedure, i.e., CPU energy saving, which is the most part of energy consumption of data center without relating cool system. Thus understanding energy model of CPU is a critical premise of the work. The power consumption in CMOS circuits is organized with two parts: dynamic and static power. Static power is the inherent energy consumption. Therefore how to reduce dynamic power with performance guarantee is the most important for it. This section is devoted the description to it’s solution. In general, the objectives of multi-objective optimization problem collide with each other. It is impossible to achieve multiple objectives optimal simultaneously. To tackle the problem faced, they introduce NSGA-II, which is one of the most outstanding evolutionary multi-objective optimization algorithm.

In this paper [44] they have allocated multiple virtual machines to different number of hosts. Efficient allocation of resources to given number of VM (virtual machine) is a quite complex task in cloud computing. This is a NP hard problem which can‟t be solved mathematically. Here they solve this problem with the firefly optimization algorithm and compare the results with Particle swarm optimization. The optimal resource allocation is NP hard problem so the algorithm should run to minimize the Euclidean distance. This work is based on utilizing the maximum resources for a particular number of VM within the available capacity of each resource. Euclidean distance between hosts and VMs is considered as deciding factor since minimum is the distance, less is the energy consumption. Firefly optimization algorithm is used for this purpose since this is not the linear problem which can be solved mathematically, this is a problem bounded with many constraints and parameters.

This paper [45] optimized energy efficient resource management model for cloud computing architectures uses certain algorithms for load balancing that help reduce the energy con- sumption effectively while balancing the loads among the servers . The central aim of the system is to perform load balancing by the load transfer from overloaded servers to under loaded servers as well as perform task scheduling efficiently that helps in mini- mizing the energy consumption in a cloud environment.

This paper [47] effective approach to maximize resource utilization while minimizing energy consumption in a cloud computing environment. MapReduce is a software framework introduced byGoogle to support distributed computing on large data sets on clusters of computers. It reduces the network traffic on the main backbone.

This paper [46] focuses on high-level architecture for supporting energy-efficient service allocation in a Green Cloud computing infrastructure. The MM algorithm sort the list VMs in the decreasing order of the CPU utilization. Then, it repeatedly looks through the list of VMs and finds a VM that is the best to migrate from the host.

.

**Summary of Findings:**

| References | Strategy | Focused On | Description |
| --- | --- | --- | --- |
| *[1]* | *-DVFS*  *-Green Cloud Scheduling Algorithm* | *-Energy Consumption*  *-Resource Utilization* | *-* Find the optimal frequency to run each task |
| ***[2]*** | *-DVFS*  *-Energy Efficient Green Scheduling Algorithm* | *-Power Consumption*  *-SLA* | *-* Schedule the task on the basis of priorities and the minimum order of resources |
| ***[3]*** | *-* ESWCT  - ELMWCT | *-Energy Consumption*  *-Resource Utilization* | *-*Load balancing of physical resources in VMs placement.  -Migrates the VMs from lightly loaded servers to heavy loaded servers. |
| ***[4]*** | *-*Host Detection  -VM Migration | *-Energy Consumption*  *-Performance Efficiency* | -Overloading & underloading host will be detected  -VM will be migrated in selected hosts |
| ***[5]*** | *-*DVS | *-power Consumption* | -Provides a balance between power consumption and tasks deadline. |
| ***[6]*** | proposed Optimal resource allocation technique (ORAT)for green cloud computing is implemented in Java using cloudsim software | working on two types of resources: processing capability and bandwidth. | processing capability, storage space facility, synchronize resources storage capacity, bandwidth |
| ***[7]*** | Energy Saving Algorithm | can solve very complex issues such as finding the resource allocation in the cloud computing system. | minimize power consumption, concentrating workload to the minimum of physical resources. |
| ***[8]*** | Optimum architecture,Designing optimum Algorithm | Minimizing wastages, computing power,, electricity wastages, energy source by using Green Computing Techniques | Green use,Green disposal, Green manufacturing, Green design |
| ***[9]*** | Modified Best Fit Decreasing (MBFD), Migration | the admission of new requests for VM provisioning and placing the VMs on hosts, whereas the second part is the optimization of the current VM allocation. | minimize the number of VMs to lower the CPU utilization and allocate each VM to least power consumption. |
| ***[10]*** | Schematic view of the system, MDP-based green-aware algorithm, optimal expected reward value for all the states | green-aware microservices management problem, reducing brown energy usage while deploying more microservices compared with baselines. | stochastic nature of workloads, maximizes the number of executed microservices, minimizing brown energy |
| ***[11]*** | Utilizes MCC method to provide a balance between power consumption and SLA. | To reduce the power consumption, the number of active PMs is reduced and a trade-off is achieved between the power consumption and the violation from SLA. | an extension of the BFD using the LA, which is called Extended BFD (EBFD). |
| ***[12]*** | DENS ( data center energy-efficient network-aware scheduling. ) | Focusing on server load and traffic load | to achieve the balance between individual job performances, job QoS requirements, traffic demands, energy consumed by the data center |
| *[13]* | -Resource Scheduling Algorithms | -Resource Utilization  -Energy Consumption | -VM allocated to each template(made by tasks required resources  -The algorithm will execute the task based on their energy efficiency template. |
| **[14]** | -most-efficient server first scheme(MEFS) | -Energy Consumption  -Minimize task response time | -Servers are sorted according to their energy profile  -Tasks are assigned from sorted list of servers top to bottom  -When the most saturated servers they are removed from the list |
| **[39]** | -Simulated Annealing | -Resource Allocation Optimisation  -CPU utilization | -optimize the VM allocation in order to reduce the energy consumption & Perform the migration of that VM from the overloaded hosts that have the maximum CPU utilization. |
| **[42]** | green scheduling algorithms | - reduction in energy consumption  -reduction in CO2 emission levels | -implementing the green scheduling algorithm combines with neural network predictor for reducing the energy consumption in cloud computing. |
| **[43]** | -NSGA-II | -energy utilization  -resource allocation | - To achieve multiple objectives optimal simultaneously. they introduce NSGA-II, which is one of the most outstanding evolutionary multi-objective optimization algorithm.. |
| **[44]** | -Firefly optimisation algorithm | -resource allocation  --CPU utilization | - Firefly optimisation algorithm is used for this purpose since this is not the linear problem which can be solved mathematically, this is a problem bounded with many constraints and parameters. |
| **[45]** | -Whale Optimisation Algorithm | -Framework optimization  -Resource Allocation | -Whales can find out the location of their prey and then encompass them. |
| *[47]* | -MapReduce  Algorithm | --Framework optimization  --CPU utilization | -effective approach to maximize resource utilization while minimizing energy consumption in a cloud computing environment. |
| *[46]* | -MM algorithm | -energy utilization  -resource allocation | -high-level architecture for supporting energy-efficient service allocation in a Green Cloud computing infrastructure |
| *[49]* | -DP & local search algorithm | -minimize the cost of total energy. | -The algorithm based on DP: determine the number of copies of each VM and assign these VMs to the servers. In the local search method, servers are disabled depending on their use, and VMs are placed on the rest of the servers to minimize power consumption as much as possible. |
| *[50]* | -IUD, MAUD algorithm | -energy efficient framework  -Improving energy efficiency | -The experimental result shows that the proposed algorithm can reduce the energy consumption and SLA violation of data centers compared with existing algorithms, improving the energy efficiency of data centers. |

**A comparison between different algorithms used in reviewed paper basis on scheduling parameter:**

|  | *Energy Consumption* | *Resource Utilization* | *Quality of Service* | *Cost* | *Load Balancing* | *Performance* |
| --- | --- | --- | --- | --- | --- | --- |
| *Green Cloud Scheduling Algorithm* | ü | ü | *-* | *-* | *-* | *-* |
| Green Energy-Efficient Scheduling Algorithm | ü | ü | *-* | *-* | *-* | *-* |
| ESWCT& ELMWCT | *-* | ü | ü | ü | ü | *-* |
| VM Allocation,  Host  Detection | ü | *-* | ü | *-* | ü | ü |
| Optimal resource allocation technique (ORAT) | - | ü | ü | *-* | - | ü |
| Energy Saving Algorithm | ü | ü | - | ü | - | ü |
| Optimum architecture,Designing optimum Algorithm | ü | - | ü | - | - | - |
| Modified Best Fit Decreasing (MBFD), Migration | ü | ü | - | - | ü | ü |
| *MDP-based green-aware algorithm, optimal expected reward value* | ü | - | - | - | ü | ü |
| MCC method | ü | - | - | - | - | ü |
| DENS | ☑️ | ☑️ | - | - | ☑️ | ☑️ |
| *Resource Scheduling Algorithm* | - | ü | - | - | - | ü |
| *MEFS* | ü | ü | - | - | - | ü |
| *Simulated Annealing* | - | ü | ü | - | - | ü |
| *green scheduling algorithms* | ü | - | - | - | ü | - |
| *NSGA-II* | ü | ü | ü | - | - | ü |
| *Firefly optimisation algorithm* | - | ü | ü | - | ü | ü |
| -Whale Optimisation Algorithm | - | ü | ü | - | ü | ü |
| -MapReduce Algorithm | - | - | ü | - | ü | - |
| -MM Algorithm | ü | ü | ü | - | - | - |
| -IUD, MAUD algorithm | ü | ü | - | ü | - | - |
| -DP & local search algorithm | ü | - | - | ü | - | ü |

**Challenges, Opportunities, Future Scopes:**

**Challenges:**

Green cloud computing has great significance in the present world for making the world green. Green cloud computing also plays a huge role in order to minimize energy usage. But there are some challenges which include both external and internal in HPCs( High Performance Computer system) in case of resource allocation[15].

1. There are some internal challenges which include: Data locality, Internal DC network reliability and SDN design challenges, and also there are some external challenges which include: Geographical constraints, Charging models and Virtual network pricing [15 ].
2. Internal resources include data locality which is the combination of computing power and data management; internal DC Network reliability is the reliability of network resources in the data center and software defined networking design which is a networking paradigm helps in software controlling and plane forwarding in different layers. [17].[16]
3. External resources include the regulative and geographical constraints comprise the issues of system distribution in the geographical location along with regulative, security purposes and charging models comprise the subscription of customers to the Cloud server.[18]
4. To focus on infrastructure which is becoming the bottleneck of the IT environment and system. [33]
5. Experimentally it was found that about 70% is consumed by ideal server of the power utilized [37]
6. To focus on the cooling system, power supply and data center space [25].
7. To minimize power consumption without violating VM-based SLAs workload.[21]
8. In the case of virtual network pricing, resource applicants and owners having their own pricing strategies submit their requirements to allocation agents during resource allocation in order to achieve the target of economic and performance Qos for maximum social benefits. [19]
9. An adverse negative impact is caused by the energy use of data centers for data processing, storing and communication. [ 20].
10. Carbon emission is caused by a data center that is 170 million metric tons of carbon produced per year by a single data center which shows the ultimate negative impact on the environment. [21 ].
11. In 2020, it was anticipated that 670 million metric carbon emissions would be found annually worldwide.[22 ].
12. To focus on QoS-based resource selection and provisioning data Center resources to provide different levels of performance .[37]
13. In 2013, 91 billion kilo-watt hours of electricity usage was estimated which shows the high operational cost.[20].
14. Usually, energy consumption of the model data center equals the consumption of energy of 25,000 households per year which results in a harmful effect on the environment. [23]
15. To focus on reducing on architecture and design of system in order to optimize resource allocation and energy consumption [37]
16. In data center management, power consumption and quality of application services are important [30]
17. The need for mature models for IT equipment, organization, and IT engineering is an issue that has been of interest to some researchers but is limited to specific areas.[24]
18. Data centers require a lot of power and cooling systems in a cloud environment which consume a lot of electricity and energy and release a lot of heat and gas [29]
19. Timekeeping problem is found because physical machines' timing behavior can not be traced by virtual machines. [37]
20. The fast boom in computing may be very quick growing the intake of resources like oil and coal which may impact in power shortage.[26]
21. Activate the server architecture Slow down the CPU clock speed (clock gating) or turn it on Turns off some of the chips when they are idle (power gating).[37]
22. The application server and other components support the same common application logic as before with on-demand capabilities or flexible management, so the system does not deadlock the components. [28].
23. Lifecycle management of devices from the cradle to the graveyard and disposal of e-waste have become issues.[25]
24. High performance parallel and distributed systems which include data centers, supercomputers, real time systems and so on, requires high amount of power supplies and also needs air conditioning to keep them cool.[26]
25. It is very difficult to increase the energy efficiency of large data centers.[27]
26. Increased energy demand in data centers and rising energy costs.[25]
27. Global environmental problems caused by IT-related products are serious problems for energy consumption, cost as well and need to be resolved. [24][25]
28. Frequent system failures increase the need for immediate response to potential threats to data center availability.[26]
29. To focus on Adaptive Link Rate to Create an interface, reduce capacity and reduce capacity Consumption of connection load.[37]
30. Controlling the increasing demand for radiators, which is increasing due to the increase in the overall power consumption of IT equipment.[25]
31. To find a new generation of IC chips that have high performance and provide higher performance without consuming too much power[31]
32. In the digital world of the 21st century, threats to the data center can take many forms; this can range from an intruder trying to physically gain access to the data center facilities/servers, to a hacking attack on a porous network[32]
33. To focus on mechanism that enables movement of each device Idle for a while and be as transparent as possible from the rest Of network devices[37]
34. The need to manage multiple Applications in the data center create on-demand resource provisioning and allocation challenges accordingly Time-varying workload [37]
35. The reliability of using green materials in computers is perhaps the biggest challenge facing the electronics industry.[31]
36. The biggest challenge with virtualization as a technology is that there are many security issues and limited security features that need to be addressed before it impacts cloud technology. [24]
37. Device power density or power and cooling capacity was another challenge for the future. [25]
38. According to the Department of Environmental Protection about 30% to 40% of the computers are always on for weekends and even after and around office hours 90% of these computers are not working. [31]
39. Finding the service portfolio offering that maximizes the revenue weight of excess resources in the DC.[34]
40. To work for reducing voltage scaling for CPU power state as a function of system load [37]
41. Security architecture must be proactive and applications must be able to deal with active behaviors [33]
42. Extend the product’s life and recycling them is another challenge which can be tough[36]
43. Find the best way to incorporate virtual network usage into cost analysis [34]
44. The loss of visibility of the network traffic, making troubleshooting impossible by Extensive scalability .[34]
45. Another main issue of Energy utilization is that datacenters face in which energy devours over 20% of the vast data centers. [35]
46. To reduces Brown's energy consumption while providing more microservices compared to baseline.[10]
47. Active servers need to minimize by maximum resource utilization [38]
48. Large amount of requests per hour can cause huge workloads which is another challenge.[10]
49. To operate the Virtualized data centers with 1000 racks need 10 Megawatt of power [37]
50. To focus on better PUE values to run multiple datacenter.[37]

Therefore it can be said that the effect of resource allocation and energy consumption is immense in order to maintain the greenness of the environment by green cloud computing and above discussed challenges need to be overcomed.

**Opportunities:**

Cloud computing is among the important technologies of the present time. It is modeled to provide services to users such as computing, software, data access and storage without any prior knowledge of the physical location and configuration of the server providing these services. Large and virtualized data centers contain multiple elements as servers,networking equipment, cooling systems that consume high energy to provide efficient and reliable services to their clients. An effective and efficient use of computing resources in the cloud can help in achieving Green Cloud Computing. We have discussed various approaches proposed in previous research works in this field.

* Optimizing resource allocation as well as reducing the operational cost is a key concept. This can be implemented in the platform as a service segment.
* The services or resources are either allocated or de allocated. The major benefit of incorporating into cloud is that it removes the pressure of upfront investment and hence lowers the cost of operation and maintenance.
* Resources allocation is the task of allocating the resources while maintaining the proper balance in the environment. To maintain a proper balance, resource scheduling algorithms are applied to get an efficient performance.
* A lot of work has already been done on cloud systems using various optimization algorithms.
* Maximizing the resource utilization of a cloud computing system achieved different design approaches.
* Many methods [50, 51] have been developed that enhance resource utilization such as memory compression, request discrimination, defining threshold for resource usage and task allocation among VMs.
* The migration of VMs, which aims to focus on the processing of cloud.
* The Dynamic Reconﬁguration of VMs, which aims to relocate dynamically the resources used by the VMs.
* The allocation strategy in private clouds, compared to a normal cloud, demonstrated a 87% reduction in energy consumption.
* Efficiency was achieved by minimizing the packet loss and efficiently using the residual server capacity with respect to traffic patterns.
* The objective of allocation algorithm is to achieve minimum power consumption and it used bin packing problem approach and it was compared with best fit algorithm.
* Moving data using shorter paths and flow optimization cause significant savings.
* Most approaches in the literature propose [48] using resources at the optimal utilization rate since over- and underutilization cause energy inefficiency.

**Future Scope**

1. With green computing, the computing process can be made more eco- friendly as well as making the energy consumption efficient.
2. Travel requirements will be reduced remarkably and we will be able to recycle computing wastage products.
3. More money will be saved due to reducing the utility cost by enabling green cloud data centers.
4. We will understand and analyze the existing data center power and cooling designs, power consumption by the servers and their cooling requirements to achieve maximum efficiency.
5. For designing the holistic solutions we will consider such as number of servers, each type of switches , number of users and total links in a data center to minimize the overall power usage of a data center aiming to improve the efficiency of the equipment used in the cloud computing.
6. The green cloud computing addresses operational cost and environmental impact and optimizes the environment.
7. Further optimization of factors such as virtualization, tenancy and consolidation are to be considered in future work.
8. It is essential to enhance the complete lifespan of virtualization procedures. Privacy and security concerns of tenancy are to be addressed.
9. Calculation of threshold value based on multiple aspects, virtual machine consolidation with intelligent support systems and management of server downtime are also major challenges where the virtualization techniques might be improved by the migration of workload between machines, alongside VM migration, between geographically distributed data centers.
10. The workloads might be concentrated in green cloud data centers. To solve this issue, the capacity schedule has to be performed to support thermal aspects, and therefore the heat recirculation has to be improved.
11. The use of renewable energy may be a non-technical issue. The intermittency of this energy may be a problem aimed at cloud computing suppliers and interrupts the traditional methods for planning operations within the cloud. To certify that SLAs’ requirements are respected, the utilization of a mixture of energy sources that complement each other is important.

Conclusion:

The field of resources management and energy consumption is an important and interesting topic in cloud computing nowadays. In fact, the data centers consume an enormous amount of electrical energy which causes the reduction of performances and the emission of a large amount of carbon dioxide. In order to improve the use of resources and reduce energy consumption, several technologies are used, such as server virtualization, migration and consolidation. In this paper, we presented an analytical study of the researches adopted in the literature in the field of the green cloud to reduce energy consumption of datacenter and achieve application performance.

|  | **References:**  1.F. Cao and M. M. Zhu, "Energy Efficient Workflow Job Scheduling for Green Cloud," 2013 IEEE International Symposium on Parallel & Distributed Processing, Workshops and Phd Forum, 2013, pp. 2218-2221, doi: 10.1109/IPDPSW.2013.19.  2.Chia-Ming Wu, Ruay-Shiung Chang, Hsin-Yu Chan, A green energy-efficient scheduling algorithm using the DVFS technique for cloud datacenters,Future Generation Computer Systems,Volume 37,2014  3.L. Hongyou, W. Jiangyong, P. Jian, W. Junfeng and L. Tang, "Energy-aware scheduling scheme using workload-aware consolidation technique in cloud data centres," in China Communications, vol. 10, no. 12, pp. 114-124, Dec. 2013, doi: 10.1109/CC.2013.6723884.  4.M. A. Khoshkholghi, M. N. Derahman, A. Abdullah, S. Subramaniam and M. Othman, "Energy-Efficient Algorithms for Dynamic Virtual Machine Consolidation in Cloud Data Centers," in IEEE Access, vol. 5, pp. 10709-10722, 2017, doi: 10.1109/ACCESS.2017.2711043.  5.K. H. Kim, R. Buyya and J. Kim, "Power Aware Scheduling of Bag-of-Tasks Applications with Deadline Constraints on DVS-enabled Clusters," Seventh IEEE International Symposium on Cluster Computing and the Grid (CCGrid '07), 2007, pp. 541-548, doi: 10.1109/CCGRID.2007.85.  6.Optimal Resource Allocation Technique (ORAT) for Green Cloud Computing, S[hajin Nargunam](https://independent.academia.edu/SNargunam?swp=tc-au-49395365), 2012, International Journal of Computer Applications  7. Energy Saving from Cloud Resources for a Sustainable Green Cloud Computing Environment Karuppasamy M. and Balakannan S. P. Kalasalingam University, Tamil Nadu, India, River Publishers, Publication 20 April 2018  8. Minimization of Energy Consumption in Cloud Using Green Computing, Insha Qayoom, Volume 8, No. 2, March 2017 (Special Issue), International Journal of Advanced Research in Computer Science.  9. Energy Aware Resource Allocation in Cloud Datacenter Manasa H.B, Anirban Basu, International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-5, June 2013  10. Xu, Minxian & Toosi, Adel & Bahrani, Behrooz & Razzaghi, Reza & Singh, Martin. (2019). Optimized Renewable Energy Use in Green Cloud Data Centers. 10.1007/978-3-030-33702-5\_24.  11. Ghobaei-Arani, Mostafa; Shamsi, Mahboubeh; Rahmanian, Ali A. (2017). An efficient approach for improving virtual machine placement in cloud computing environment. Journal of Experimental & Theoretical Artificial Intelligence*, (), 1–23.* doi:10.1080/0952813X.2017.1310308  12. Kliazovich, Dzmitry; Bouvry, Pascal; Khan, Samee Ullah (2010). [IEEE Int'l Conference on Cyber, Physical and Social Computing (CPSCom) - Hangzhou, China (2010.12.18-2010.12.20)] 2010 IEEE/ACM Int'l Conference on Green Computing and Communications & Int'l Conference on Cyber, Physical and Social Computing - DENS: Data Center Energy-Efficient Network-Aware Scheduling. , (), 69–75. doi:10.1109/GreenCom-CPSCom.2010.31  13.Liang Luo, Wenjun Wu, Dichen Di, Fei Zhang, Yizhou Yan and Yaokuan Mao, "A resource scheduling algorithm of cloud computing based on energy efficient optimization methods," 2012 International Green Computing Conference (IGCC), 2012, pp. 1-6, doi: 10.1109/IGCC.2012.6322251.  14.Dong, Z., Liu, N. & Rojas-Cessa, R. Greedy scheduling of tasks with time constraints for energy-efficient cloud-computing data centers. *J Cloud Comp* 4, 5 (2015).  15. Sharkh, M.A., Jammal, M., Shami, A., Ouda, A.: Resource Allocation in a Network-Based Cloud Computing Environment: Design Challenges. IEEE Communications Magazine (November 2013).  16. Hussain, H., et al.: A survey on resource allocation in high performance distributed computing systems. Parallel Computing 39, 709–736 2013. <http://dx.doi.org/10.1016/j.parco.2013.09.009>  17. Nosrati, Masoud & Karimi, Ronak. (2016). Investigating a Benchmark Cloud Media Resource Allocation and Optimization. World Applied Programming. 6. 5-9. 10.21828/wap0601.002.  18. Sharkh, M.A., Jammal, M., Shami, A., Ouda, A.: Resource Allocation in a Network-Based Cloud Computing Environment: Design Challenges. IEEE Communications Magazine (November 2013)  19. [Zhang, B, Zhao, Y, Wang, R, 2013. A resource allocation algorithm based on media task QoS in cloud computing. In: Proceedings of the 4th IEEE Internation-al Conference on Software Engineering and Service Science (ICSESS), Beijing, p. 841–4  20. G. S. Akula and A. Potluri, “Heuristics for migration with consolidation of ensembles of virtual machines,” Proc. Communication Systems and Networks (COMSNETS), 2014 6th Int. Conf., pp. 1, 4, 6–10.  21. M., Shaden & Kurdi, Heba. (2016). Review of Energy Reduction Techniques for Green Cloud Computing. International Journal of Advanced Computer Science and Applications. 7. 10.14569/IJACSA.2016.070127.  22. S. F. Smith, “Is scheduling a solved problem?” in Multidisciplinary Scheduling: Theory and Applications, G. Kendall, E. K. Burke, S. Petrovic and M. Gendreau, Eds. Nottingham, UK: Springer, 2005, pp. 3–17.  23. A. Beloglazov, J. Abawajy and R. Buyya, “Energy-aware resource allocation heuristics for efficient management of data centers for cloud computing,” Future Generation Computer Systems, vol. 28, no. 5, pp.755–768, 2012  24. Green Computing: Techniques and Challenges in Creating Friendly Computing Environments in Developing Economies Kadima Victor Chitechi Masinde Muliro University of Science & Technology, Kenya,International Journal of Research and Scientific Innovation (IJRSI) | Volume VII, Issue IX, September 2020 | ISSN 2321–2705  25. Kaur, A. K. (2019). Green Computing Emerging Issues in IT. international Journal of Trend in Scientific Research and Development (IJTSRD) International Journal of Trend in Scientific Research and Development, 3(5), 438-440  26. GREEN CLOUD COMPUTING RESEARCH CHALLENGES: A SURVEY Mithun D’Souza1 , Jassim Ibrahim2 , Mohammed Rizwan3 and Dr.S Sathyanarayana,International Journal of Latest Trends in Engineering and Technology Special Issue SACAIM 2016, pp. 297-303 e-ISSN:2278-621X  27.Aditya et al., International Journal of Advanced Research in Computer Science and Software Engineering 3(10), October – 2013  28.L. Qian, Z. Luo, Y. Du, L. Guo, Cloud computing: An overview, in Proceedings of 1st International Conference on Cloud Computing (Beijing, China, 2009), pp. 626–631  29. Masood Anwar, Syed FurqanQadri and AhsanRazaSattar, “Green Computing and Energy Consumption Issues in the Modern Age”, IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, pISSN: 2278-8727Volume 12, Issue 6 (Jul. - Aug. 2013), PP 91-98 www.iosrjournals.org www.iosrjournals.org 91.  30. Zhiwu Liu, Ruhui Ma, Fanfu Zhou, Yindong Yang, Zhengwei Qi, Haibing Guan” Power-aware I/OIntensive and CPU-Intensive Applications Hybrid Deployment within Virtualization Environments” IEEE 2010.  31. Green Computing – Trends and Challenges Kumar Gourav Arora1, Garima Kohli2, Pranav Ratta3 13Assistant Professor, IMS, Jammu, Jammu & Kashmir, India 2 Research Scholar, The Business School University of Jammu, Jammu & Kashmir, India  32. Sari, A. and Rahnama, B. (2013) Simulation of 802.11 Physical Layer Attacks in MANET. Proceedings of the Fifth International Conference on Computational Intelligence, Communication Systems and Networks (CICSyN), Madrid, 5-7 June 2013, 334-337. h[ttp://dx.doi.org/10.1109/cicsyn.2013.79](http://dx.doi.org/10.1109/cicsyn.2013.79)  33. GREEN DATA CENTRE OPTIMIZATION AND SECURITY ISSUES: A SURVEY PAPER,International Journal of Technical Research and Applications e-ISSN: 2320-8163, Special Issue 42 (AMBALIKA) (March 2017), PP. 12-15  34.Resource Allocation in a Network-Based Cloud Computing Environment: Design Challenges, M. Abu Sharkh, M. Jammal, A. Shami\*, and A. Ouda,in IEEE Communications Magazine, November 2013 Issue  35. A. Berl, E. Gelenbe, M. Di Girolamo, G. Giuliani, H. De Meer, M. Dang, and K. Pentikousis, Energy-efficient cloud computing,” The Computer Journal, vol. 53, no. 7, pp. 1045-1051, 2010  36. Kontagora, Ibrahim. (2017). GREEN COMPUTING: TECHNOLOGIES, APPLICATIONS AND CHALLENGES.  37.Assistant Professor, Gayathri.B. (2015). EFFECT OF GREEN CLOUD COMPUTING AND ENVIRONMENTAL SUSTAINABILITY APPROACHES. 12. 270-278.  38.E. Feller, L. Rilling and C. Morin, “Energy-aware ant colony based workload placement in clouds,” Proc. 2011 IEEE/ACM 12th Int. Conf. on Grid Computing, pp. 26–33.  39. Green Cloud: Smart Resource Allocation and Optimization using Simulated Annealing Technique, AkshatDhingra, Sanchita Paul, Indian Journal of Computer Science and Engineering (IJCSE)-2014  [*http://ijcse.com/docs/INDJCSE14-05-02-036.pdf*](http://ijcse.com/docs/INDJCSE14-05-02-036.pdf)  *40. Green Cloud Computing: A Literature Survey, Laura-Diana Radu, ResearchGate, November 2017DOI: 10.3390/sym9120295*  *41. Preeti Chahal et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 3,Issue 3,September 2016,pp. 20-24© 2016 IJRRA All Rights Reserved page-20-Energy Efficient ResourceAllocationbyFirefly Optimization inCloud Computing*  *42.* ***A Study on Green Cloud Computing,*** *December 2013 International Journal of Grid and Distributed Computing 6(6):93-102*  *43. Multi-objective optimization based virtual resource allocation strategy for cloud computing , Li Xu, Zhibin Zeng, Xiucai Ye, 2012 IEEE/ACIS 11th International Conference on Computer and Information Science, 56-61, 2012*  *44. Energy Efficient Resource Allocation by Firefly Optimization in Cloud Computing, Preeti Chahal, Vinod Saroha, IJRRA September 2016*  *45. An Optimized Framework for Energy-Resource Allocation in a Cloud Environment based on the Whale Optimisation Algorithm Authors: Shanky Goyal , Shashi Bhushan , Yogesh Kumar , Abu ul Hassan S. Rana , Muhammad Raheel Bhutta , Muhammad Fazal Ijaz and Youngdoo Son*  *46. Energy-aware resource allocation heuristics for efficient management of data centers for Cloud computing, Anton Beloglazov, Jemal Abawajy , Rajkumar Buyya, Future Generation Computer SystemsVolume 28, Issue 5, May 2012, Pages 755-768*  *47. Cloud computing: state-of-the-art and research challenges, Zhang Lu, Cheng Raouf, Boutaba, Published online: 20 April 2010© The Brazilian Computer Society 2010*  *48. Y. Goyal, M. S. Arya, and S. Nagpal, “Energy efficient hybrid policy in green cloud computing,” in 2015 International Conference onGreen Computing and Internet of Things (ICGCIoT), 2015, pp. 1065 – 1069*  *49. H. Goudarzi and M. Pedram, “Energy -Efficient Virtual Machine Replication and Placement in a Cloud Computing System,” in 2012 IEEE 5th International Conference on Cloud Computing (CLOUD),2012, pp. 750 – 757*  *50. K. He, Z. Li, D. Deng, and Y. Chen, “Energy-efficient framework for virtual machine consolidation in cloud data centers,” China Commun. ,vol. 14, no. 10, pp. 192 – 201, Oct. 2017*  *51. C. C. Chen, P. L. Sun, C. T. Yang, J. C. Liu, S. T. Chen, and Z. Y. Wan, “Implementation of a Cloud Energy Saving System with Virtual Machine Dynamic Resource Allocation Method Based onOpenStack,” in 2015 Seventh International Symposium on Parallel Architectures, Algorithms and Programming (PAAP), 2015, pp. 190 – 196*  *52. N. Madani, A. Lebbat, S. Tallal, and H. Medromi, “New cloud consolidation architecture for electrical energy consumption management,” in AFRICON, 2013, 2013, pp. 1–3*  *53. N. Madani, A. Lebbat, S. Tallal, and H. Medromi, “Power-awareVirtual Machines consolidation architecture based on CPU load scheduling,” in 2014 IEEE/ACS 11th International Conference onComputer Systems and Applications (AICCSA), 2014, pp. 361 – 365* |  |
| --- | --- | --- |