Efficient Load Balancing and Energy Aware Scheduling Algorithm in Heterogeneous Cloud Environment

Sneha Singh, Abhinav Pandey, Chhatrapani Gautam
Department in Computer Science & Engineering
Vindhya Institute of Technology & Science Satna, MP, India
snehaas2804@gmail.com, abhinav221085@gmail.com, acpg.77@gmail.com

Abstract- Cloud computing is a network access model that facilitates an omnipresent and opportune shared pool of configurable computing resources on on-demand network access. The resources are storage, applications, services, networks and servers quickly prerequisite and unhindered with insignificant management effort or interaction from service providers. The internet allows users to communicate with one another. All consumers can utilise the cloud services of any firm, such as Google, Amazon, and others. Small-scale companies are ecstatic about using cloud services. The number of users who use the resources and fulfil the communication request, the more users are also enhancing the load on the cloud. The serves are playing an essential role for in between cloud and customers. The congestion in the network degrades the performance of services, and the user is not receiving the response timely. This paper presents the Scheduling Algorithm in Hybrid Cloud for Efficient load Balancing (HCLB) and Energy-Aware to reduce energy consumption and proper load balancing. The proper scheduling and load balancing schemes reduce the load on servers and improve network performance. The proposed HCLB approach is a hybrid approach that works to estimate the load on servers continuously, and if the load on the server is enhanced, then the load switches to other servers to balance the extra traffic. The proposed approach improves energy utilisation or reduces energy consumption on servers. The proposed HCLB scheme performs better than Rand DENS and HEROS scheduling algorithm.

Keywords: Cloud, Load balancing, Scheduling, Energy, Users, HCLB, Rend, Hero's.

I. INTRODUCTION

These cloud computing environments provide cloud customers with the appearance of unlimited computing resources, allowing them to adjust their resource consumption rate according to demand. There are two types of actors in cloud computing environments: cloud providers and cloud users [1]. On the one hand, providers store vast computer resources in big data centres and rent them out to consumers peruse. On the other hand, some users have apps with varying loads and lease resources from providers. In most situations, the relationship between providers and users is depicted in Figure 1.1. A user first submits a resource request to a supplier. When the provider gets the request, it searches for resources to fulfil it and allocates them to the asking user, usually virtual machines (VMs). The user then runs programmers on the allotted resources and pays for the resources utilised. The resources are returned to the provider once the user has finished utilising them.

These participants are different parties with diverse interests, an intriguing element of the cloud computing ecosystem. The objective of most providers is to earn as much income as possible with the least amount of investment. They may wish to make the most of their computer resources, such as hosting as many virtual machines as feasible on one system. In other words, providers seek to make the most of their resources. However, putting too many virtual machines on a single computer might lead them to interact with one another, resulting in poor and unpredictable performance, which annoys users.

On the other hand, users want their jobs done for the least amount of money or, in other words, want to maximise their cost performance. As a result, providers may evict existing VMs or reject resource requests to maintain service quality, making the environment even more unpredictable. It entails having adequate resources tailored to the workload characteristics of users' apps and efficiently utilising resources. When they seek resources and schedule applications, they must also account for unexpected resources.

II. RELATED WORK

This section describes various existing cloud scheduling techniques to improve load balancing and minimise energy consumption. Cloud computing is helpful to efficient storage and other services provided to users.

Weiwei Lin & Gaofeng Peng et.al.[1] "Scheduling Algorithms for Heterogeneous Cloud Environment: Main Resource Load Balancing Algorithm and Time Balancing Algorithm" is published in the journal "Scheduling Algorithms for Heterogeneous Cloud Environment." This title presents two IoT-aware multi-resource task scheduling methods for heterogeneous cloud settings: primary resource load balancing and time balancing. The methods are designed to improve load balancing, Service-Level Agreement (SLA), and IoT task response time while reducing energy usage to the greatest extent practicable. They're both designed to give a particular job to a specific Virtual Machine (VM) each time. Each time a job is placed in a preprocessed queue, it is allocated sequentially. And the VM selection rule is based on newly invented concepts such as relative load or relative time cost. In addition, users or administrators can alter the behaviour of the algorithms using two customisable parameters that impact the output of preprocessing activities.

Abdulaziz Alarifi, Kalka Dubey et al. [2] Green Cloud Computing: An Energy-Efficient Hybrid Framework An energy-efficient hybrid (EEH) framework is suggested and assessed in this book to enhance the efficiency of using electrical energy in data centres. The proposed framework is built on both request scheduling, and server consolidation approaches rather than relying on only one technique as in previous relevant studies. Before scheduling, the EEH framework organises the customers' requests (tasks) according to their time and power requirements. It uses a scheduling algorithm that considers power usage when making scheduling decisions. It also features a consolidation mechanism that decides which servers should be napped or hibernated, which servers should be overloaded, which virtual machines should be transferred, and which servers are receive migrated virtual machines. A migration method for moving migrated virtual machines to new servers is also included in the EEH framework.

P. Geetha · C. R. Rene Robin,[3] "A green cloud computing power-saving resource allocation system with enhanced QoS" even though cloud computing has piqued the interest of several business leaders and educators, the main problem with cloud computing is the unregulated growth of cloud data centres. Inefficient use of cloud resources leads to inefficiency and environmental risk. Recognising the gravity of the situation, several researchers are working to promote green cloud computing in various ways. Green Cloud Computing is the practice of using methods and strategies to enhance the efficiency of computing assets to reduce energy consumption and the natural consequences of their use. The data centre's power usage allows for web-based monitoring, real-time virtual machine mobility, and virtual machine placement advancement. This research focuses on a resource allocation method for cloud users that does not compromise QoS by utilising two layers, the Cloud Manager Layer (CMLs) and the Green Manager Layer (GML) (GML).

Mayanka Katyal, Atul Mishra [4] "A Comparative Study of Load Balancing Algorithms in a Cloud Computing Environment" is a study that compares several loads balancing algorithms. Various load balancing techniques are shown in this book in a distinct cloud environment, based on criteria provided in the Service Level Agreement (SLA). Cloud computing is a new trend in the IT world that necessitates a lot of infrastructure and resources. The importance of load balancing in the cloud computing environment cannot be overstated. An effective load balancing system assures optimal resource usage by supplying resources to cloud users on-demand in a pay-as-you-say manner. By using suitable scheduling criteria, load balancing may even assist in prioritising users.

Gopalakrishnan Natesan et al. [5] "Using the mean grey wolf optimisation method to schedule tasks in a diverse cloud environment" We suggested a mean grey wolf optimisation method in this work to improve system performance and eliminate scheduling problems. The primary goal of this approach is to reduce the time it takes to manufacture something and the amount of energy it uses. The suggested algorithms' objectives were assessed using the Cloud Sim toolbox for a typical workload. The simulation results demonstrate that the suggested Mean GWO method produces more results than the other algorithms currently in use.

D. Chitra Devi and V. Rhymend Uthariaraj [6] This title is "Load Balancing in Cloud Computing Environment Using Improved Weighted Round Robin Algorithm for Non-preemptive Dependent Tasks." To efficiently share resources, cloud computing employs the ideas of scheduling and load balancing to move workloads to underused VMs. The scheduling of non-preemptive tasks in a cloud computing environment is an irreversible constraint; therefore, it must be given to the most appropriate VMs from the beginning. In practice, their new careers are multi-faceted. Interdependent tasks may be executed in several VMs or across many cores in the same VM. Furthermore, the jobs occur at variable random intervals during the server's operation time under diverse load situations to make cloud computing more effective and enhance user satisfaction. The participating heterogeneous resources are managed by distributing workloads to appropriate resources via static or dynamic scheduling.

T. Kokilavani et. al.[7] "Load Balanced Min-Min Algorithm for Static Meta-Task Scheduling in Grid Computing" is published in Grid Computing. A Load-Balanced Min-Min (LBMM) method is proposed in this title, which decreases the makespan while increasing resource usage. The suggested technique is divided into two stages. The conventional Min-Min method is used in the first phase, and the jobs are rescheduled in the second phase to make efficient use of the underutilised resources.

Shafi'i Muhammad Abdulhamid et. al.[8] "Using the Global League Championship Algorithm, Secure Scientific Applications Scheduling Technique for Cloud Computing Environment" The Global League Championship Algorithm (GBLCA) optimisation approach is initially described in this title for global task scheduling in the cloud environment, followed by scientific application scheduling strategies employing the Global League Championship Algorithm (GBLCA). The experiment is run using the Cloud-Sim simulator. The testing findings reveal that the suggested GBLCA approach improved the makespan performance by 14.44 % to 46.41%. It also demonstrates a considerable decrease in the time it takes to schedule applications, as assessed by response time securely.

Pooja Samal, Pranati Mishra [9] "Analysis of Round Robin Algorithm Variants in Cloud Computing Load Balancing" Using an analytical tool called cloud analyst, several policies concerning the algorithms produced are evaluated in this title. Variants of Round Robin (RR) algorithms are also compared.

Mahfooz Alam et al. [10] "Load Balancing Algorithm Issues and Challenges in a Cloud Computing Environment", This research aids in identifying efficient LBA for resource optimisation, shortest reaction time, maximum throughput, and overload avoidance.

Findings: In most cases, the load balancer is allowed to maintain support continuity while also coping with increased traffic. As a result, effective load balancing techniques are necessary to supply resources to cloud users to discover the most cost-effective resource utilisation. The suggested technique enhances the system's overhead and load imbalance factor.

Application: Load balancing (LB) is a critical component in cloud computing. The cost-effective LB algorithm ensures cost-effective resource consumption by providing resources to cloud users on-demand schedules in a pay-as-you-say manner.

Shilpa Kodli et al.[11] "Load Balancing and Task Scheduling in a Cloud Environment Using a Hybrid Max-Min Genetic Algorithm", to evaluate the usefulness of HMMGA, the suggested method is compared to Max-Min algorithm, Low time complexity and low-cost binary Particle Swarm Optimizer (IBPSO-LBS), and PSO with Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) algorithm. For five VMs, the experimental simulation indicates that HMMGA offers 1.63 and 3.88 seconds less makespan than the Max-Min and TOPSIS-PSO algorithms, respectively. Furthermore, compared to the Max-Min and TOPSIS-PSO algorithms, HMMGA improves resource usage by 10% to 40% on average.

Vignesh Joshi et al. [12] this title, "Load Balancing Algorithms in Cloud Computing," discusses that Cloud computing is critical for improving the efficient sharing of virtual machine resources. Cloud computing depends on two fundamental principles to ensure that a given job is assigned to the most appropriate virtual machine: scheduling and load balancing. In addition, cloud computing should be able to manage several independent tasks coming at the same time and perform them on the same or multiple nodes. Static and dynamic scheduling play an essential role in a heterogeneous environment by improving work allocation to the right resources to meet internet users' demands and making cloud computing technologies more efficient. This research examines and explains effective methods that improve cloud load balancing performance.

Navpreet Kaur Walia et al. [13] The primary objective is to offer a Cost-Aware Load Balancing Framework for Cloud Computing utilising Optimised Scheduling Algorithms for several existing optimised scheduling algorithms, including GA, PBO, and ACO, as well as the new EPC Scheduling algorithm. EPC is an improved PBO algorithm that combines PBO and GA algorithms to improve performance. This combination aids in the selection of appropriate resources for task execution and improved resource allocation. Tasks are split into groups in this framework, and resources are allocated accordingly, increasing utilisation and lowering costs. Homogeneous and heterogeneous cloud environments are created using a local cloud environment, and analysis is performed based on load balancing factor and computing cost, with a minimum of 50 tasks and a maximum of 500 jobs allotted to 100 resources.

Pooja Arora et al. [14] "In Cloud Computing, An Optimised Load Balancing Algorithm" The matrices that impact the load balancing process in the cloud are discussed in this title. It also includes examining several load balancing techniques and related work by other writers. This title suggests a method for an efficient load balancing algorithm in cloud computing based on a study.

Aarti Singh et al. [15] cover "Autonomous Agent-Based Load Balancing Algorithm in Cloud Computing," which focuses on internet-based purchase and release of resources from a data centre being an internet-based dynamic computing system, Cloud computing is susceptible to request overloading. Load balancing is a key component that involves distributing resources so that no system is overloaded and resources are used to their full potential. However, this element of cloud computing has received little attention thus far. Although load balancing is an essential element of various internet-based computing systems such as distributed and parallel computing, it is often overlooked. Several methods for solving the load balancing problem have been presented in these domains. However, just a few algorithms have been suggested for cloud computing. Because cloud computing is so unlike these other settings, a unique load-balancing method must be developed to meet its needs.

III. PROPOSED RESEARCH

This dissertation aims to develop a scheduling algorithm to balance the data centres or other edge server load and minimise the power consumption of all respective devices in the cloud environment. Existing scheduling techniques such as rand dense, heroes, and round-robin provide the way to develop a new algorithm for load balancing of cloud devices. The problem is that they proposed many schemes to offload workload from user devices to cloud servers, but the issues of how the workload should be balanced while requests send to cloud servers from user devices while all data centres and edge servers are busy. In proposed heterogeneous cloud computing with load balancing (HCLB) algorithm data centre architecture adopted as three tiers where the user interfaces with core switch, in this architecture first layer connection between core to aggregator switch, the second layer is aggregator to access switch and third layer connection between access to the edge server. The architecture of the cloud system is a hierarchical tree-like structure that provides all possible ways to go from user to every edge server. In this architecture, while the user sends the request for access to the service from the server, the request comes to all connected core switches, which provides the connection to the next level of aggregator switch. Aggregator switch decides the next connection level to access switch for forwarding the user service request. The access switch sends a request about the current connected server's current load before transferring the user service request. Every server responds to the current load to access switch by reply message, and the access switch stores the load information of each server device and forwards the user service request to lower the loaded device. The HCLB mechanism balances servers' load concerning the current number of tasks run per server. While user service requests come into the server, it goes under the process queue, HCLB assigns a priority of the particular task, and the processor executes the priority-based task. The proposed HCLB scheduling energy consumption reduces using the method of dynamic voltage and frequency scaling (DVFS) technology, which adjust the hardware power consumption according to the applied computing load and manage the dynamic power (DPM). The computing server plays a major role in providing cloud service to end-users due to data centre energy consumption computation in the cloud environment. The power consumption of a computing server is proportional to the CPU utilisation, and an idle server consumes around two-thirds of its peak load consumption to keep the memory, disk and I/O resource running. The remaining one-third changes almost linearly with the increase in the level of CPU load to another area where power consumption is switching uses in between user device to server device, switches form the basis of the interconnection fabric that delivers jobs requests to the computing servers for execution. In the proposed architecture of cloud system, three types of the switch are used, i.e., core, aggregate, access, the energy consumption of a switch depends on the (a) type of switch (b) number of ports (c) port transmission rate and (d) employed cabling solution. The energy consumption by switches can be generalised by the equation:

$$P_{switch} = P_{chassis} + n_{linecards} + \sum_{i=0}^{R} n_{ports}.P_r \quad (1)$$

Where $P_{chassis}$ is the power consumed by the switch base hardware, $P_{linecard}$ is the power consumed by an active line card, n_{ports} number of port and P_r corresponds to the power consumed by an active port running at the rate r. In this equation, P_r is scalable, a switch transmission rate so that minimisation of power consumption control by P_r parameter. In this dissertation, cloud network architecture deployed under green cloud environment and compare our proposed HCLB with existing Rand DENS and HEROS scheduling algorithm, for the analysis input metric taken, i.e., data centre architecture, type of switches (core, aggregate, access), server, users, power mode (server, switch), task size, energy. The analysis output is measured through the energy utilise parameter, data centre and server load. With the help of the result, the result chapter concludes that the proposed HCLB is better than the existing scheduling algorithm in terms of load balancing and energy consumption, which is well adapted for future cloud computing systems in a three-tier architecture.

IV. PROPOSED ALGORITHM

Cloud system is helpful for a low-cost service provider to user, in recent time, cloud environment very much use due to the number of user demand is increasing, so that load of cloud devices, i.e., switch and server, increases propositionally. This dissertation proposed a heterogeneous cloud load balancing technique developed that helps balance the load of servers or switches and decreases the energy consumption of edge servers and all switches in cloud systems. The formal description in the below section is step-by-step by the procedure. Based on the HCLB mechanism, achieve a better outcome in terms of load balancing and energy consumption compared to the existing scheduling mechanism.

Algorithm: Efficient Load Balancing and Energy Aware Scheduling Algorithm (HCLB)

Input: U_n: Number of users
- S_i: Number of servers
- Q_n: Queue in server
- P_t: Task Priority
- S_{wi_c}: Core Switches
- S_{wi_agr}: Aggregator Switches
- S_{wi_a}: Access Switches
- n_{ports}: Number of Port in switch
- P_r: Power consumed by active port
- $P_{chassis}$: Power consumed by the switch hardware
- $n_{linecards}$: Power consumed by an active line card
- L_S: Server Load
- T_{h_l}: Load Threshold

Output: Energy Consume (core, agg, access) switch, server energy consumption, the average load of the server, data centre load.

Procedure:

While U_n request to S_i
    Request come in S_{wi_c}
    S_{wi_c} forward S_{wi_agr}
    S_{wi_agr} forward Request to S_{wi_a}
S_{wi_a} use n_{ports} to broadcast request all connected S_i
$P_{switch} = P_{chassis} + n_{linecards} + \sum_{i=0}^{R} n_{ports}.P_r$
    S_i Calculate $T_{h\_l} = \frac{\sum_{i=1}^{n} s_i}{i}$
If S_i load < T_{h_l} **than**
Select one S_i Load is lower and application handle
    S_{wi_a} forward U_n request for service to S_i
    S_i take the task in Q_n for service

International Journal of Current Trends in Engineering & Technology
www.ijctet.org, ISSN: 2395-3152
Volume: 08, Issue: 02 (March -April, 2022)

S_i assign priority P_t to U_n task
S_i Execute U_n request and send a reply to U_n
Calculate L_S = Total Service / second
Else
Wait for the response from the server
End if
End Procedure

Table 1: Performance Comparison of Rand DENS, HEROS and Proposed HCLB

Metrics	Rand DENS	HEROS	HCLB
Simulation duration (sec.)	51.5	51.5	51.5
Data Centre architecture	three-tier heterogeneous debug	three-tier heterogeneous debug	three-tier heterogeneous debug
Switches (core)	1	1	1
Switches (agg.)	2	2	2
Switches (access)	3	3	3
Servers	12	12	12
Users	1	1	1
Power mode (servers)	DVFS DNS	DVFS DNS	DVFS DNS
Power mode (switches)	DVFS	DVFS	DVFS
Task MIPS	300000	300000	300000
Task memory	1000000	1000000	1000000
Task size	8500	8500	8500
Task output size	250000	250000	250000
Average Load/Server	0.6	0.6	0.5
Data centre Load	55.40%	55.90%	48.40%
Total energy	153.6 W*h	148.4 W*h	145.2 W*h
Switch energy (core)	40.4 W*h	40.4 W*h	40.4 W*h
Switch energy (agg.)	80.8 W*h	80.8 W*h	80.8 W*h
Switch energy (access)	6.4 W*h	6.4 W*h	6.4 W*h
Server energy	26.0 W*h	20.8 W*h	17.6 W*h

V. Performance Analysis of Rand DENS, HEROS and HCLB

There are various metrics considered to evaluate the performance of Rand DENS, HEROS and HCLB algorithms. Based on these metrics, we can determine the performance of the protocols on the cloud. Now that the table entries reflect the energy consumption of nodes, we can see that the nodes in the suggested scenario have more incredible end energy, which suggests that they can work for a more extended period in the network than the prior scheme.

VI. SIMULATION ENVIRONMENT

To validate the simulation described in this project is designed on the ns-2 test-bed, which allows users to construct any network topologies. In this figure, the hierarchical structure is designed for communication. Users of ns-2 may run testing on a network physically located the serves and the load distribution authority to switches by altering the network's logical topology. The test scenarios are designed in ns-2 via a wireless interface, whilst the nodes interact by the wireless interface.

A. Energy Analysis in Scheduling Algorithm

The load performance parameter measures the number of packets poured into the network for connection formation and confirmation between sender and recipient nodes. Server energy, switch energy and core energy are the three sources of energy consumption in the network. The server energy consumption is minimum in the proposed HCLB scheme in cloud computing. The suggested strategy decreases the network load because the server handles the proper scheduling of user requests. They reduce the link expiry time values, reducing unnecessary delay in the network. The proper duration of the link expiry time during transmission shows users' better-scheduling tacks.

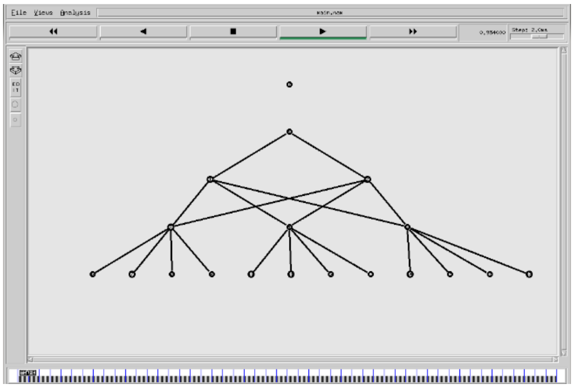

Figure 1: Network Animator Scenario

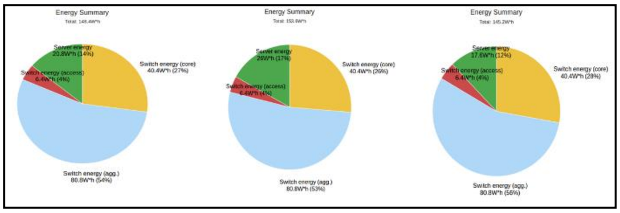

Figure 2: Energy Analysis

B. Analysis of Data Center Load in Cloud

The data centres provide the storage space, processing capability and other resources to the number of cloud users. The communication of cloud users starts with the standard link, and it is capable of handling large loads because of switching the load on the next server if the current server has sufficient load and has low energy for communication. The performance of the previous Rand DENS and HEROS scheme

International Journal of Current Trends in Engineering & Technology
www.ijctet.org, ISSN: 2395-3152
Volume: 08, Issue: 02 (March -April, 2022)

is good, but the HCLB shows the smooth load balancing in the cloud. The proper switching between the serves provides better performance and reduces the network's long time resources consumption issue.

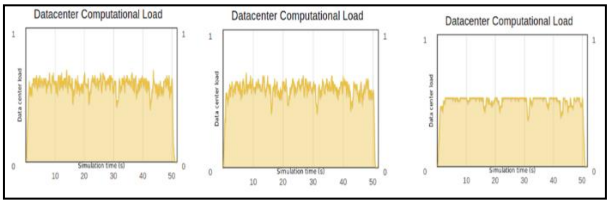

Figure 3: Load Analysis on Data Centers

C. Analysis Virtual Machine Load

The network is many entire types of devices and without these devices are not possible to communicate appropriately with the destination. Here, the load on Virtual Machine balanced adequately in the case of the HCLB approach, but the performance of the rest of the two schemes shows degradation in performance. The monitoring system is also helpful for maintaining the balance among the available servers. The new method makes less energy use and extends the network's life. The entire user in the network is getting the proper response from the server. The more numbers of user's presence have created the problem of load in the network, but efficient scheme handled it appropriately.

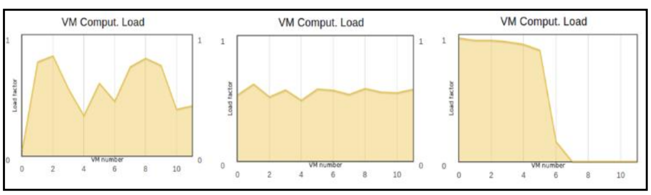

Figure 4: Load Analysis on Virtual Machine

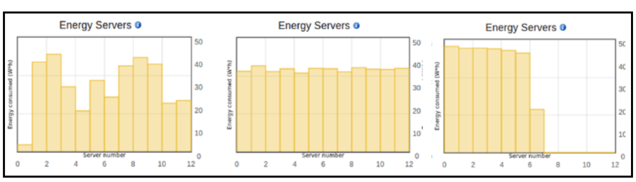

Figure 5: Energy Consumption Analysis

D. Energy Analysis of Server

The transmission and receiving are carried out continuously without any interruptions of heavy load in the network. If the server consumes extra energy, extra efforts are applied because of the absence of proper load balancing schemes. When using conventional schemes like Rand DENS and HEROS, proper load balancing is the main problem in the cloud network. The proposed HCLB scheme improves the cloud response because of handle the load efficiently. The given figure clearly shows no load on servers 8, 10 and 12 in the case of the proposed HCLB scheme. The suggested method also eliminates the potential of unnecessary load and provides an approach to reduce the energy consumption of servers in the network.

VII. CONCLUSION AND FUTURE WORK

Cloud computing provides a virtual environment for users, and users can pay for the resources, services and computing power. The storage space and database are instantly available on request. The cloud concept also improves access time because it is available between the user and server. The serves are handled many loads and because of that also consumes the more energy. The proper scheduling and load balancing for the user requests have reduced the load on servers, and because of that, the information is instantly received to users within the time limit. It has several advantages, indicating that you should only implement cloud computing services by reviewing all the huge load problems in cloud computing. If the users use all available resources, others cannot use those resources, and one more thing is to utilise resources to improve efficiency. Many companies feel more comfortable placing essential data on their platform than on the cloud. Consumers do not know the location of records, the transition of dates, cloud operations. In this paper, the survey of attacks and security schemes are mentioned. This paper presents the Scheduling Algorithm in Hybrid Cloud for Efficient load Balancing (HCLB) and Energy-Aware to reduce the energy consumption and proper load balancing. The proper scheduling and load balancing schemes reduce the load on servers and improve network performance. The performance of the proposed HCLB scheme is also compared with Rand Dens and HEROS. The scheduling approach controls the incoming packets and balances the existing load on the network. The previous work mentions the effective security scheme for congestion control. The basic knowledge of cloud computing is also mentioned in different sections. The reliable security scheme improves the performance and reduces the conditions of extra load in the network.

There is much scope for security in cloud computing. So, in the future, design the security scheme for flooding attacks and measure the load and flooding by attackers separately.

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