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A SYSTEMATIC WAY FOR ENERGY EFFICIENCY ON CLOUD COMPUTING ENVIRONMENT USING EELBVM MODEL

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ABSTRACT

The popularity of cloud computing is increasing day by day so individuals, companies and research centers have started outsourcing their information technology and computational needs to on demand cloud services. Cloud computing is a thriving area in research and industry today, which comprises internet, virtualization and web services. Gradually more remote host machines are built for cloud services causing more energy consumption and power dissipation. The rising energy consumption of computing systems has started to limit further performance growth due to overwhelming electricity bills and CO_2 footprints. Therefore, the goal of the computing system design has been shifted to power and energy efficiency. This can be achieved by Load balancing.

Load balancing is one of the main challenges in cloud computing which is required to distribute the dynamic workload across multiple nodes to ensure that no single node is overwhelmed. It helps in finest utilization of resources and hence in enhancing the performance of the system. The objective of load balancing is to reduce the resource consumption which will further reduce energy consumption and carbon emission rate that is the dire need of cloud computing.

In this research work, we have studied and implemented three dynamic load balancing techniques using Java Programming and simulate through CloudSim. The Main contribution of CloudSim is to provide a holistic software framework for modeling Cloud computing environments and performance testing application services.

And, we have proved that proposed EELBVM Model gives the better results than join idle queue and throttled load balancer. The simulation results show that our model has immense potential as it offers significant in the aspects of response time, execution time, throughput and energy consumption, which leads high improvement in energy efficiency of the data center.

Index Term: Cloud Computing, Load Balancing Algorithms, Energy Efficiency, Energy Efficiency Model, Cloudsim.

I. INTRODUCTION

1.1 Cloud Computing

Cloud computing is the access to computers and their functionality via the Internet or a LAN. Users of a cloud request this access from a set of web services that manage a pool of computing resources (i.e. machines, operating systems, network, application programs, storage, and application development environments). When allowed, a fraction of the resources in the pool is dedicated to the requesting user until he or she relinquish them [37].

It is called "cloud computing" because the user cannot actually see or specify the physical location and organization of the equipment hosting the resources they are ultimately granted to use. That is, the resources are described from a "cloud" of resources when they are allow to a user and returned to the cloud when they are released [38].

A "cloud" is a set of machines and web services that implement cloud computing.

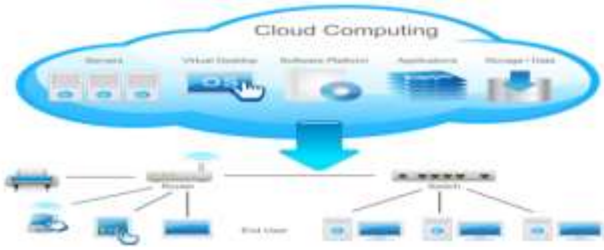

Fig. 1 Overview Of Cloud Computing

1.2 Energy Efficiency on Cloud Architecture

Cloud computing is a new technology which is offering IT services based on pay-as-you-go model to consumers from everywhere in the world. The rising demand of Cloud infrastructure and modern computational requests like business, scientific and web applications outcome in large-scale data centers and lead to extra electrical energy consumption. [5]

As Cloud computing becomes more scattered, the increasing data storage and computation needs raise the energy consumption of their large infrastructures. Energy consumption mainly aims at minimizing the processing and cooling costs of datacenters. High energy consumption causes high operational cost and also led to high carbon emission which is harmful for atmosphere. Hence, to minimize the negative effects of cloud computing on the environment, energy-efficient techniques are required. [6]

Thus energy consumption has become a considerable factor in designing modern Cloud environment.

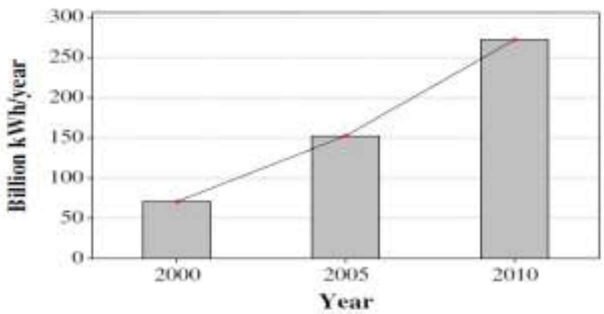

Fig. 2 The Worldwide Data Center Energy Consumption 2000-2010

1.3 Load Balancing on Cloud

Load Balancing is a process of allocating the total load to the individual nodes of the collective system to make resource utilization effective and to improve the response time of the job, at the same time removing a condition in which some of the nodes are over loaded while some others are under loaded.

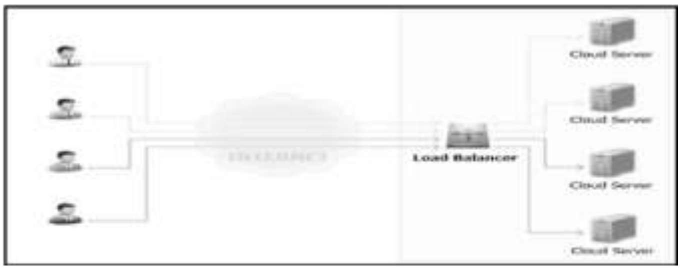

Fig. 3 Load Balancing

Load balancing in cloud computing systems is really a challenge now. Always a disseminated Solution is required, because it is not always practically feasible or cost efficient to maintain one or more idle services just as to fulfill the required demands. A load balancing algorithm which is dynamic in nature does not consider the previous state or behavior of the system.

The important things to consider while developing such algorithm are: evaluation of load, performance of system, stability of different system, comparison of load, interaction between the nodes, selecting of nodes and many other ones, nature of work to be transferred. This load considered can be in terms of amount of memory used, CPU load, delay or Network load.[13]

II. LITERATURE REVIEW

Wei Deng *et al.* [41] proposed the Harnessing Renewable Energy in Cloud Datacenters. They provided taxonomy of the state-of-the-art research in applying renewable energy in cloud computing datacenters from five key aspects, including capacity planning of green datacenters, intra-datacenter workload scheduling, generation models and prediction methods of renewable energy and load balancing across geographically distributed datacenters.

Ching-Hsien Hsu *et al.* [7] discussed Optimizing energy consumption with task consolidation in clouds. They presented Energy aware Task Consolidation (ETC) technique to minimize energy consumption. Taking into consideration the architecture of most cloud systems, a default CPU utilization threshold of 70% is used to demonstrate task consolidation management amongst virtual clusters. The simulation results show that Energy aware Task Consolidation can significantly reduce power consumption when managing task consolidation for cloud systems. ETC has up to 17% improvement over a recent work that reduces energy consumption by maximizing resource utilization.

Moreno, Ismael Solis *et al.* [25] introduced a novel approach to workload allocation that improves energy-efficiency in Cloud datacenters by taking into account their workload heterogeneity. They analyzed the impact of performance interference on energy-efficiency using workload characteristics identified from a real Cloud environment, and developed a model that implements various decision-making techniques intelligently to select the best workload host according to its internal interference level. The experimental results show reductions in interference by 27.5% and increased energy-efficiency up to 15% in contrast to current mechanisms for workload allocation.

Young Choon Lee *et al.* [42] discussed Energy efficient utilization of resources in cloud computing systems. Based on the fact that resource utilization directly relates to energy consumption, they have successfully modeled their relationship and developed two energy-conscious task consolidation heuristics. The cost functions integrated into these heuristics effectively capture energy-saving possibilities and their capability has been verified by their evaluation study. In this study should the results not have only a direct impact on the reduction of electricity bills of cloud infrastructure providers, but also imply possible savings (with better resource provisioning) in other operational costs (e.g., rent for floor space) and the reduction in the carbon footprint of clouds is another important spinoff.

III. PROBLEM FORMULATION

Cloud computing is an evolving paradigm that has redefined the way Information Technology based services can be presented. It has altered the model of storing and managing data for real time, scalable, internet based applications and resources satisfying end users' needs. More and more remote host machines are built for cloud services causing more power dissipation and energy consumption.

To overcome this problem the energy efficient metric is used to compute power consumption and utilization. The proposing work is an Energy Efficiency Load Balancing Virtual Machine (EELBVM) Model that confirms to reduction of energy consumptions and helps to improve quality of service.

EELBVM Model includes the load balancing algorithm which ensure that all the processors in this system as well as in the network does approximately the equal amount of work at any instant of time.

Load balancing is a methodology to distribute work load across multiple computers, or other resources over the network links to achieve the optimal resource utilization, minimum data processing, minimum average response time and avoid overhead.

In the past number of load balancing algorithms have been developed specifically to suit the dynamic cloud computing environments such as WLC (Weighted Least Connection) algorithm, LBMM (Load Balancing Min-Min) algorithm, Bee-MMT (Artificial Bee Colony algorithm Minimal Migration Time), active Clustering algorithm, Honeybee Foraging Algorithm.

EELBVM model is to be built by using the Improved Cartron Dynamic load balancing algorithm which will be compared by Join-Idle Queue and Throttled dynamic Load balancer to meet the objective for systematically energy efficiency on cloud computing environment.

IV. EXISTING WORK

Existing Load Balancing Algorithms for Cloud Computing:

Allocate workload of multiple network links to achieve maximum throughput, minimize response time, low energy consumption and to avoid overloading.

We use three algorithms to distribute the load.

- **Throttled load balancer**

Throttled load balancer is a dynamic load balancing algorithm. In throttled load balancer algorithm, the client first requests the load balancer to search a suitable Virtual machine to perform the required procedure. In Cloud computing, there may be multiple instances of virtual machine (VM). These VMs can be grouped based on the type of requests they can hold. Whenever a client sends a request, the load balancer will first await for that group, which can handle this request and distribute the process to the lightly loaded instance of that group.

- **Join-Idle Queue**

Join-Idle Queue technique is basically used for large-scale systems. This algorithm uses distributed dispatchers by first load balancing the idle processors across dispatchers and then allotting jobs to processors to decrease average queue length at each processor. It effectively keeps down the system load, receives no communication overhead at job arrivals and does not increase actual response time. It can perform close to best possible when used for web services.

- **Round Robin Algorithm (RR)**

It is the simplest algorithm that uses the concept of time quantum or slices. Here the time is divided into several slices and each node is given a particular time quantum or time interval and in this quantum the node will perform its operations.

V. PROPOSED WORK

Earlier for enhancing energy efficiency in cloud environment some algorithms or techniques has been used. But now we will use:

- **Throttled load balancer**
- **Join-Idle Queue**

I have also create a technique i.e. EELBVM which would reduce the overall energy consumption in data center. EELBVM is Energy Efficient Load Balancing Virtual Machine (EELBVM) Model**.** EELBVM Model is based on Improved Cartron dynamic load balancing algorithm. Cartron dynamic load balancing algorithm integrates the use of LB and DRL. LB (Load Balancing) is used to equally distribute the jobs to different servers so that the associated costs can be minimized and DRL (Distributed Rate Limiting) is used to make sure that the resources are distributed in a way to keep a fair resource allocation. Distributed Rate Limiting also adapts to server capacities for the dynamic workloads so that performance levels at all servers are equal.

VI. EXPERIMENTAL SETUP

CloudSim using Java 1.6: CloudSim is a self-contained platform which can be used to model data centers, host, service brokers, scheduling and allocation policies of a large scaled Cloud platform. It is a framework developed by the GRIDS laboratory of University of Melbourne which enables seamless modeling, simulation and experimenting on Designing Cloud computing infrastructures.

VII. OBJECTIVES OF THE STUDY

The Objectives of the research work are:

1. To implement proposed EELBVM model using java programming and simulate on cloud computing environment using CloudSim toolkit.

2. To Analyze the behavior of EELBVM model using following parameters-

- Energy Efficient Metric
- Execution time

- Response time
- Resource utilization
- Throughput

3. To Evaluate the performance and behavior of Improved Cartron dynamic load balancing technique by comparing it with existing load balancing methods such as Join-Idle queue and Throttled Load balancer.

VIII. METHODOLOGY

The complete flow chart of the methodology is shown as below:

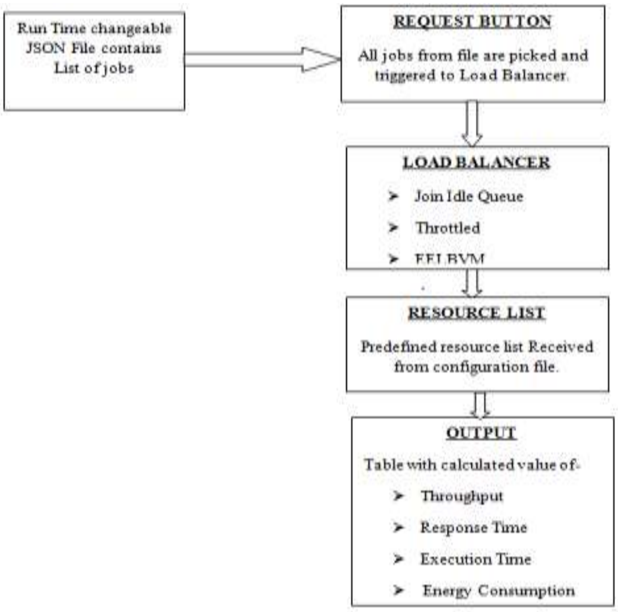

Fig. 4 Step by Step approach of research methodology

IX. RESULTS

In this we shall discuss the result of the experimental results done on the CloudSim with the existing and proposed optimization methods. However, here is a table showing the simulation results for Join_Idle_Queue technique for different number of jobs.

Table 1

Sr.No.	No. of Jobs	Parameters Name			
		Throughput	Response Time	Execution Time	Energy Consumption
1.	1	100	0	5.999	539.99
2.	9	100	0.0555	4.2944	386.5
3.	10	100	0.05	4.765	428.85
4.	12	100	0.0416	4.265	383.87
5.	14	100	0.0357	4.048	364.32

This table shows simulation results for Throttled Load balancer for different number of jobs.

Table 2

Sr.No.	Number of Jobs	Parameters Name			
		Throughput	Response Time	Execution Time	Energy Consumption
1.	1	100	0	5.999	539.99
2.	9	100	0.0370	4.8962	440.66
3.	14	100	0.0238	3.935	354.19
4.	18	100	0.0185	4.127	371.47
5.	19	100	0.0175	4.552	409.73
6.	21	100	0.0158	4.948	445.32

This table shows simulation results for EELBVM Model for different number of jobs.

Table 3

Sr.No.	No. of Jobs	Parameters Name			
		Throughput	Response Time	Execution Time	Energy Consumption
1.	1	100	0	0.5	45
2.	5	100	0	2.55	229.5
3.	7	100	0	3.6310	326.7899
4.	9	100	0	3.954	355.91
5.	10	100	0	4.317	388.55
6.	12	100	0	3.7995	341.95
7.	14	100	0	3.554	319.94
8.	18	100	0	3.332	299.88
9.	19	100	0	3.384	304.56

9.1 Comparison Tables

This table shows different algorithms are compared for 5 Jobs.

Table 4

Algorithms	Number of jobs/Tasks	Response Time	Execution Time	Energy Consumption
Join_Idle_Queue	**For #5**	0	2.8099	252.9
Throttled	**For #5**	0	4.1299	371.7
EELBVM	**For #5**	0	**2.55**	**229.5**

The table depicts the result of different parameters for twelve jobs.

Table 5

Algorithms	Number of jobs/Tasks	Response Time	Execution Time	Energy Consumption
Join_Idle_Queue	For #12	0.0416	4.265	383.87
Throttled	For #12	0.0277	4.1637	374.73
EELBVM	For #12	0	3.7995	341.95

The table depicts the result of different parameters for twenty one jobs.

Table 6

Algorithms	Number of jobs/Tasks	Response Time	Execution Time	Energy Consumption
Join_Idle_Queue	For #21	0.0238	4.514	406.32
Throttled	For #21	0.0158	4.948	445.32
EELBVM	For #21	0	3.598	323.85

9.2 Graphical Charts

Graphical charts shows the comparison between different techniques based on distinct number of jobs considering discrete parameters like energy consumption, response time and execution time.

Figure reveals the information about the energy consumption of datacenter and the results show that EELBVM model consumed less energy as compared to Join_Idle_Queue and Throttled load balancer. Therfore our proposed model is best in case of energy efficient.

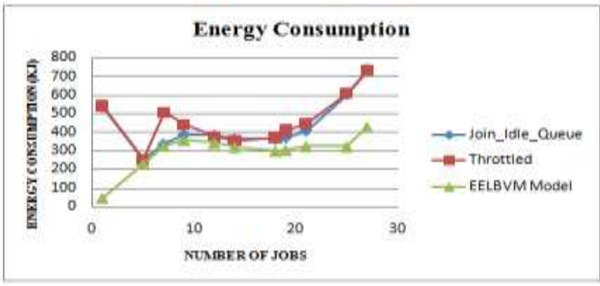

Fig. 5 Energy Consumption Comparison Based On Distinct Number Of Jobs

Response time is the time taken to respond by a particular load balancing algorithm in a distributed system. The response time is calculated by varying the number of jobs. Figure depicts that the response time is minimum in case of EELBVM model.

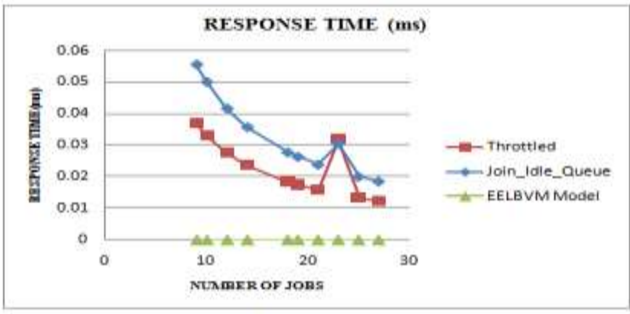

Fig. 6 Response Time Comparison Based On Distinct Number Of Jobs

Execution time is estimated by calculating the total number of jobs executed within a fixed span of time. Figure shows the execution time taken by three techniques for distinct number of jobs. After implementation results show that the execution time of EELBVM model is less as compared to throttled load balancer and Join_Idle_Queue.

Fig. 7 Execution Time Comparison Based On Distinct Number Of Jobs

Figure depicts the comparison between three techniques Join_Idle_Queue, Throttled load balancer and EELBVM model based on minimum, average and maximum execution time. The results show that our proposed model takes less execution time which further results in high performance of the system.

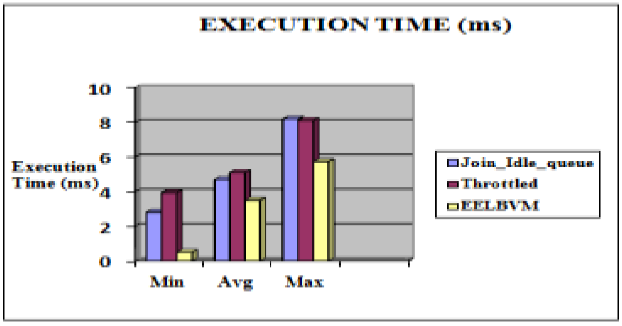

Fig. 8 Min, Max And Avg Execution Time Comparison

Figure reveals the information about the minimum, average and maximum energy consumption by three different techniques.

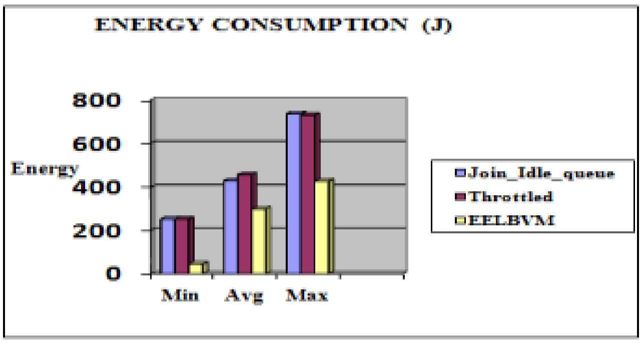

Fig. 9 Min, Max And Avg Energy Consumption Comparison

X. CONCLUSION

In the research work we have proposed and implemented an energy efficient load balancing virtual machine (EELBVM) model on cloud environment using CloudSim Toolkit. And compared it with the Join_Idle_Queue and throttled dynamic load balancing methods. The results show that proposed model are much better than the existing load balancing methods in terms of response time, execution time, and throughput. We also concluded that EELBVM model consumes less energy than Join_Idle_Queue and Throttled load balancer.

XI. FUTURE SCOPE

Cloud Computing is a vast concept and energy efficiency plays a very important role in case of Clouds. There is an epic scope of improvement in this area. We have implemented only 3 dynamic load balancing algorithms. But still there are additional approaches that can be applied to balance the load and energy consumption in clouds. The performance of the given algorithms can also be increased by varying different parameters. We can also migrate our research work on any Private Cloud for the Security and further enhancements.

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