iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** XI **Month of publication:** November 2015

DOI:

An Energy Efficient Model For Green Computing

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Abstract—Cloud computing has emerged as a key component in the field of computer and internet. Cloud has a service model and deployment model, the service model incorporates SaaS, PaaS and IaaS whereas the deployment model includes public cloud, private cloud, hybrid cloud and cloud for community. Despite of so many features possessed by the cloud it also has other side which incorporates two things firstly security and second of all energy efficiency of the hardware infrastructure. Our focus is on energy efficiency in cloud computing. The energy consumed by the server is quite high. In this work we have efficiently calculated the energy consumption using different power models. The traditional linear model and power blade model with two algorithms are evaluated with two different scenarios. The consumption of energy varies largely and moreover we saw abnormalities as task rejection by data centre and task failed on servers which is an issue.
Keywords—Cloud Computing, Linear Model, Power blade Model, Green Cloud Computing

I. INTRODUCTION

Cloud computing is a network model for enabling easy, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, computing applications, and other services) that can be rapidly provisioned and released with minimum management effort or interaction with service provider. Cloud computing achieve multi-level virtualization and abstraction through effective combine usage of variety of computing, storage, data, applications and other resources, users can conveniently use powerful computing and Storage capacity of cloud computing only need to connect to the network. With cloud computing virtual network, the capability of handling millions of users becomes easy. These qualities have attracted many IT giants like Amazon, Microsoft, Google, Intel, VMware etc. Amazon is now a provider of two services first Amazon S3 a Simple Storage Service and Amazon EC2 Elastic Cloud Computing.

Virtualization technology enhances power efficiency of data centers by enabling the assignments of multiple virtual machines (VM_s) to single server. The deployment of multiple VM_s helps in consolidating the task and shutting off other physical machines in order to maintain high energy efficiency. Alternate way for green computing is through service level agreement SLA_s which is established between the consumer and the service provider before allocation of infrastructure. The SLA could be related to storage space, bandwidth requirement and power consumption. On basis of performance SLA could be related to service time and Quality of Service. VM Migration (VMM) technique is another green computing technique for efficient usage of resources. The VMM technique shifts virtual machines from one machine to another will help in distributing load from one physical machine to another. As CPU utilization drops it will migrate the VM back to the machine and turn off the second machine. It lowers the electricity consumption by physical machines. Since the machine will consume energy only when required otherwise it is turned off. VMM could be achieved by using algorithms like monte carlo, round robin etc.

A. Cloud Computing Architecture

The cloud computing architecture has two blocks the front end and back end. Both the ends are connected via network. The front end includes the user computer and the application needed to access the cloud computing system. All cloud computing systems don't have the same user interface. Services like Web-based e-mail programs use existing Web browsers like Internet Explorer or Firefox. On the back end of the system are the different computers, servers and data storage handling systems that create the "cloud" of computing services. A central server ensures that everything runs smoothly. It follows certain protocols and makes use of a software application called middleware. Middleware allows networking of computers for communication. If a cloud computing firm has a lot of clients, there's a possibility of a high demand for a lot of storage space. Some companies need hundreds of digital storage devices. These systems require a minimum of twice the number of storage devices it requires to keep all its clients' information stored. A cloud computing system must have backup of all its clients' information on other devices. The copies enable

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

the central server to retrieve data from backup machines. Making copies of data as a backup is called redundancy.

B. Service Models

Cloud computing has three service models on which whole cloud computing relies. First service model is (IaaS) Infrastructure as a Service, second one is (PaaS) Platform as a Service, and third one is (SaaS) Software as a Service.

1) Infrastructure As A Service (IaaS): IaaS provides infrastructure that could be in form of data storage space or consumer computing services which can be used by user to run or install any software. The infrastructure comprised of operating system, storage system and other softwares installed on user system. It can be managed by consumer. Example: Amazon S3. The S3 provides the storage infrastructure at a very affordable price. The Amazon S3 provides storage from 1Tb to over 5000Tb. The storage cost varies with amount and category of storage [5, 27].

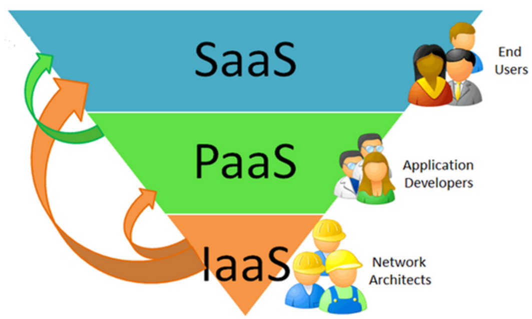


Figure 1 Service Models

2) Platform As A Service (PaaS): By using paas deployment of user is done onto cloud. The platform may be some particular operating system or it may be some driver. These are custom applications which are developed in some programming language or it may be tools from service providers. The user does not control cloud infrastructure but he can customize applications.

3) Software As A Service (SaaS): SaaS enables user to get access to some of the applications on cloud. The client will search for the best service deployed on internet by service providers. The consumer will be able to access the software only when connected to internet. The user will be able to modify application according to the requirement. Services are paid also. Paid services are much secured than free services due to SLA which is signed between the client and the service provider. The client needs not to control the cloud infrastructure. The user applications can be accessed either by interface or with the help of clients like browsers (Gmail, Hotmail etc.) or MicrosoftOffice365 [5].

II. RELATED WORK

A. Different Architecture In Cloud Computing

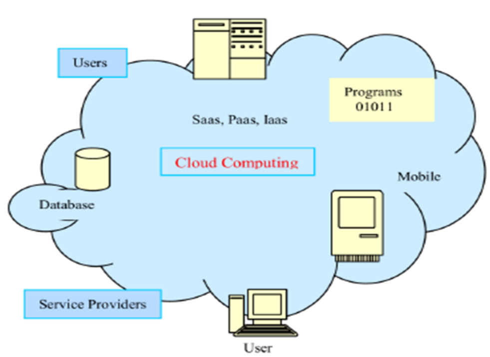


Figure 2 Cloud Computing

The author Kejiang Ye et al. had given energy efficient datacenter architecture. The architecture consisted of four main modules.

Out of four the author had focused on energy management module and monitoring module. The monitoring module examines both virtual machines and physical machines including the power consumption, resource utilization etc. Management module is responsible for all management issues in datacenter cloud, which includes energy management sub module, security management sub module etc. [14]. Anton Beloglazov et al. had given architectural framework of cloud computing in which the cloud environment has consumer, green service allocator, virtual machines and physical machines. The green service allocator includes VM manager accounting and modified best fit decreasing algorithm for allocation of VMs. This allows leveraging heterogeneity of resources by choosing most power efficient node first. The minimization migration policy minimizes number of migrations. This has the upper threshold and lower threshold limit [4].

B. Different Techniques For Saving Energy

Yclee et al. had defined models like cloud model application model and energy model for its task consolidation problem which focus on resource management. Cloud model comprises of PMs, resources and clients, which can be heterogeneous for inter-process communication. Application model has three services SaaS, PaaS, IaaS. While IaaS tied on request of user with time as pay per hour model for SaaS and PaaS based on historical data supplied to service information. The energy model is devised on the basis of processor utilization has a linear relationship with power consumption. The two task consolidation algorithms are ECTC and Maxutil. The algorithm focuses on energy consumption. The maxutil makes task consolidation decision based on resource utilization. The cost function of ECTC computes consumption based on energy consumed energy consumed by current task subtracting the minimum energy required to run the task [25].

Anne-cecileorgerieet. al the focus of the paper is on consumption of energy by different servers like IBM e server 326, sunfire v 20z and HP proliant. The paper has shown various results on the basis of the consumption of energy by machines. Various criteria have been adopted in the paper like consumption of energy by six servers running typical application, energy consumption in idle state etc. It also provide some information on power management using components like CPUs, Hard drive, fans, Ethernet adapters. Consumption of power of disk is composed of fixed proportions, whereas dynamic portions include input and output workload, data transfer, which is about one third of consumption. The author had also discussed about ON/OFF technique with which we could turn OFF/ON our datacentre upon requirement, [2].

KyongHoon Kim, they had proposed about real time service model which is related to real time application such as image processing, financial analysis. In real time service mode task must meet all their dead lines in order to accomplish QoS. Also it had explained periodicity $p_{i,}$ in case of non-periodic application the periodicity p_i for a task in set to 0. When the user request for real time services, it allocate VMs accordingly to those executing services. Real time virtual machine model supports in finding the virtual machines requested by user. It is based on three parameters utilization, MIPS rate and duration awarded. The MIPS rate is based on virtual machine specification. The real time cloud service framework shows various type of real time services as requesting for platform, creating virtual machines, requesting for virtual machines, mapping and executing real time applications. In the paper they had used proportional sharing scheduling which guarantees real time service for multiple virtual machines if total MIPS rate is less than or equal to capacity. The algorithm is dynamic voltage scaling (DVS) enabled RT-VM provisioning. The algorithm is based on scheduling of virtual machines with some processing element PE with certain MIPS rate [15].

C. Green Computing Using SLA

Jian-Sheng Liao et al. converges the attention to energy efficient resource provisioning with guaranteed SLAs. In the paper the author proposed an architecture which considers user's SLA requirement. The SLA will contain duration for customer, in order to minimize energy consumption. The architecture will have four layers internet, application layer, resource management layer and data centre layer. The workflow of system will have an application request from customer, it will be forwarded to cloud provider and finally to datacenter. The studies focus on computational and non-computational jobs such as web servers, storage servers and so on. Whenever the SLA is violated the P penalty will be charged according to algorithm. It had compared two different approaches round robin and SLA based resource constraint VM consolidation. Some data shows different energy consumption by different resources which include the major components like CPU which consumes 58% of power, RAM consumes 28% and 14% by disk [12].

III. PROPOSED WORK & IMPLEMENTATION

We have used the greencloud simulator which is extended from the network simulator. The simulator compile two languages c++

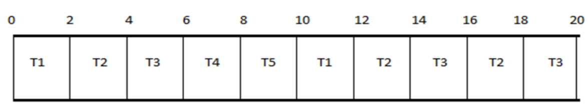
and tcl with core code written in C++. The tool command language supports the frontend and moreover it creates simulation environment which include the parameters involved in it. The evaluation is done on the basis of the two models, greencloud had used in for energy calculation, the Linear power model and Power blade model. Green scheduler and Green scheduler using virtual machines scheduling algorithms are used in these power models. Round-Robin scheduling using host and Round Robin using virtual machines scheduling algorithms are also used. The greencloud is based on three tier architecture which uses L3/L2 switches in its layers. We have used one switch in core network layer two in aggregation layer and 144 physical machines in its last layer. The PMs are arranged in TOR topology which uses switches either L2 or L3.Using simulator we can choose which algorithm we have to use at a particular instance and can choose the appropriate power model. The number of servers and switches can be customized and the number of users can also be fixed.

TABLE I
SHOWING FIVE TASKS TO BE ALLOCATED USING ROUND ROBIN ALGORITHM

Tasks	Burst Time
T1	4
T2	6
T3	6
T4	2
T5	2

Robin-Robin is one of the algorithms of Greencloud simulator that employs process and network schedulers. Round Robin scheduling uses time slices to complete the task, it is easy to implement tasks in it and it provides equal

GANTT CHART



priority to each task in the queue, to show how the algorithm works we have taken simple example to show the working of it.

TABLE II
NUMBER OF CYCLES PERFORMED BY EACH TASK BEFORE IT GETS COMPLETE

Tasks	Burst Time
T1	4, 2
T2	6, 4, 2
T3	6, 4, 2
T4	2
T5	2

In table I we have taken 5 tasks T1, T2, T3, T4 and T5 each having its burst time. The round robin works in identical way as first come first serve, so initially T1 is submitted then T2 and so on. The time shared policy tends to divide the time in fixed slots here a slot is of 2 time-stamps. In the gantt chart the allocation of tasks is done, for the first run each task gets time slot and at time equals to 10 the initial cycle is completed. During the run some task were performed completely and some partially, for the tasks which are not complete yet will move to second cycle here T1, T2 and T3 will occupy time slots. The unfinished tasks will move out of the Queue and the task which are not finished yet get involve in next iteration and so on.
In table 2 all the tasks are given with number the in the burst time it provides information that the task will run for the number of times. Task T1 will run for two times similarly T2 and T3 will run three cycles and task T4 and T5 will run single time In cloud

computing the maximum capacity of server is in MIPS (million instructions per seconds) so the task will be processed in instruction cycles. Suppose a task is of 2000 MIPS and we have to complete the task and the capacity of our server is say 250 MIPS so the earliest finish time for task would be 8 seconds. In this way the algorithm works in the field of cloud computing

Truong Vinh Truong Duy et al. had defines about green scheduling algorithm the algorithm manages load by tuning ON/OFF the physical machines. The purpose of the scheduler is to make the server available at the time when the existing machines are getting overloaded. The availability before the machines reaches saturation level helps in distributing load with ease. This helps in maintaining quality of service (QoS) since it will not allow service level agreement to violate. There are four actions performed on servers using green cloud scheduling algorithm ON/OFF, shutting and restarting. Example initially there is no ON server i.e. it is energy saving mode and for instance OFF may represent shutting down RAM on linux OS and standby on another OS.

Power models:

There are two power models which are used:

- Linear power model
  - It uses rack mount server
  - Require power chord & network cable
  - Normally rack configuration is 19 inches wide & 1.75 inches tall and a rack can accommodate 42 discrete computer devices
  - Example 1U Rackmount Server Chassis with 4 HDD mobile racks and it works with 13" x 12" boards
- Low power blade model
  - Many components were removed to save energy and space.
  - A blade enclosure can hold many blade servers provide services such as cooling, power, networking etc.
  - It can accommodate 1440 per rack
  - Example: the server uses Athlon 64X2 3000+ dual-core processor with 2GB DDR2 SODIMM, 80GB SATA drive, and Broadcom 10/100 integrated NIC.

A. Green Cloud Simulator

The green cloud simulator is based on three-tier architecture; the three layers are connected with links of different bandwidth. The servers are at bottom layer called access network layer. Here tasks are allocated and computed either in FLOPS/MIPS, the servers are arranged in racks in TOR (top of rack) switches. These racks contain L2/L3 switches together the servers and racks formulate the access network layer of the architecture. The middle layer is called aggregation network layer which is connected to lower layer 10 GE Ethernet cables. The layer contains L3 switches which are connected to upper layer with 100 GE Ethernet cable. The upper layer also have L3 switches, the topmost layer is called core network layer. The core network layer contains maximum 8 L3 switches whereas aggregation layer could contain more than 10,000 nodes for servers [9]; the three-tier architecture is similar to FAT tree.

The green cloud Ubuntu 12.04 and above version plat-form and is extended from NS2 simulator. The simulator computes energy of physical machines, switches used for data transfer. The simulator had divided the traffic in three categories computing load, data transfer load and combination of computing load and data transfer load. The power consumption is minimum in computing load in data transfer load the power consumed is more since it may user continuous data exchange through the network. The third type of load combines the two loads so it tries to manage load with desired requirement.

B. Steps Involved In Installation of Greencloud

Unpack the downloaded greencloud software comes with integration into NS-2source code.

Go to the extracted directory and Run script ./install.sh to do a full installation

Execute the simulation script by running ./run .

View the dashboard by opening show-dashboard.html .

C. Simulation Steps

The simulation is setup using TCL files located in ./src/scripts/ directory. The mainfilemain.tcl determines the data center topology and simulation time. It also executes a set of the following scripts used for simulation:

setup_params.tcl contains general configuration of servers, switches, tasks, monitoring and migration

topology.tcl creates the data centre network topology

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

dc.tcl creates the data centre servers and VMs
user.tcl defines behaviour of cloud users
record.tcl sets up runtime results that reports procedures
finish.tcl calculates and it outputs simulation statistics.
The simulation is achieved by executing the ./run/ script. It contains the following three simulation parameters:
Data center load defines the number and computing requirements of incoming tasks with regard to the data center capacity. Usually the value of load must lie between 0 and 1. The load close to 0 represents an idle data centre, while the load equal or greater than 1 would saturate data centre.
Simulation time describes the maximum time allocated for task execution, while tasks deadlines effect timesharing behaviour of tasks. Longer deadlines allow more tasks to be executed in parallel on a single host or a VM.
Memory requirement defines the maximum size of the simulated memory resource that can be used in multitasking.

IV. RESULTS & DISCUSSION

Green cloud simulator works with Ubuntu 12.04 and above, we have used 12.04 versions in it. Firstly go into the terminal and write cd greencloud + enter this will move into the green cloud directory. After you entered the directory to compile the code after the changes you have performed use command "make" this will compile all those codes in which the changes you have performed. The make command is executed in the next image. The "make clean" command cleans the previous compilation first and then "make" command is run. The compilation is needed only when the changes are performed in the C++ files, there is no need to compile when the changes are performed in the TCL files. After compiling the code use command "./run" to run the code as in diagram.
The out will be displayed in the firefox browser. The output will contain summary of simulation in the form of pie chart. The details are also shown with duration of simulation, architecture used, task allocation total and average number of task per server, load on datacenter and energy consumed by transmission media and server.
The graphical representation of different power models with different scenarios as scheduling algorithms is shown in graphs the parameters are total energy, energy consumption from switches, tasks rejected and failed by server, server energy and simulation time. From the results the energy saved by power blade model is almost one third of the liner power model. During the simulation it has been observed that some tasks were rejected by the datacenter and some failed to complete. The energy consumption by these schedulers is low but at the same time numbers of tasks submitted were quite less and lot of tasks failed to complete the scenario. This is clear that it will violate service level agreement (SLA) and moreover it hampers the Quality of service (QoS) parameter. In the end there are two tables which gives two scenarios which shows some important parameters for energy efficient cloud computing.

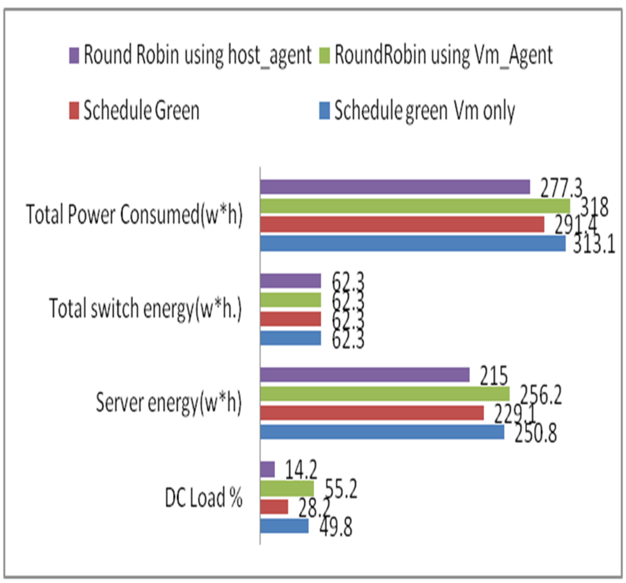


Figure 3 Power Consumption in Linear Power Model

Volume 3 Issue XI, November 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering
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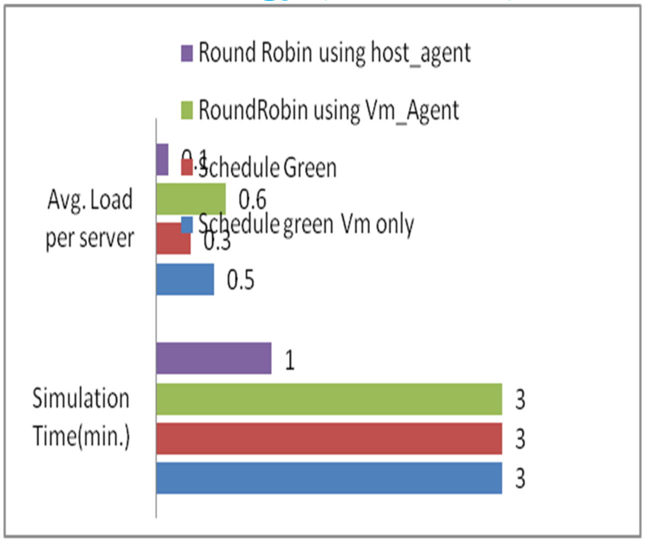

Figure 4 Load and Time Of Linear Power Model

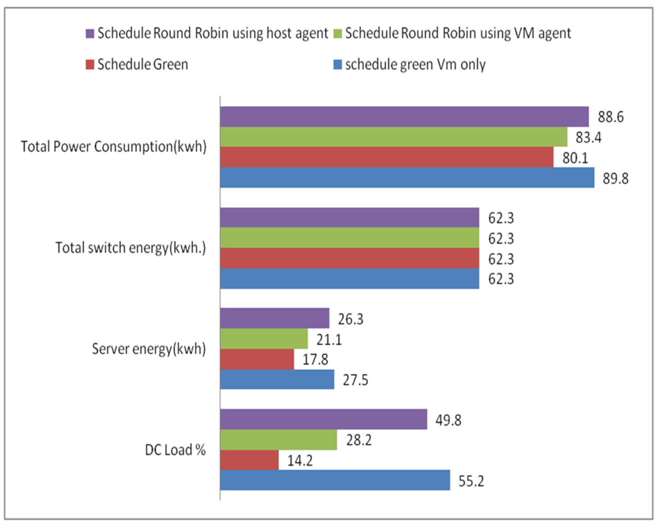

Figure 5 Power Consumption in Power Blade Energy Model

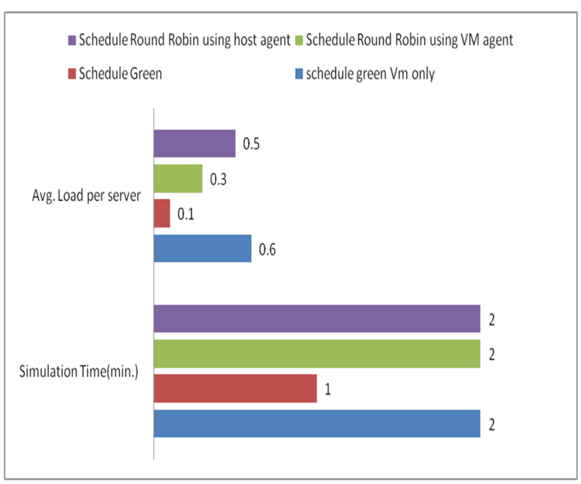

Figure 6 Loads and Time Consumed In Power Blade Model

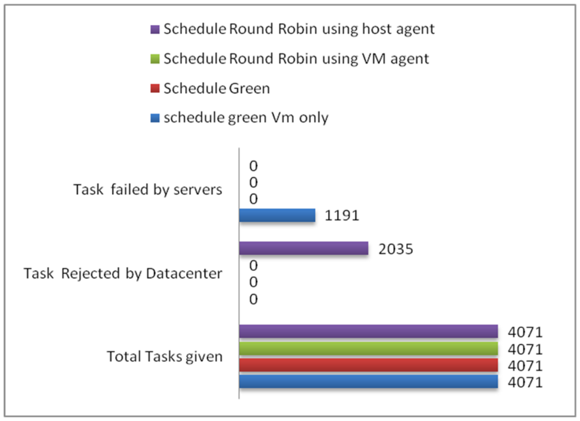

Figure 7 Tasks Failed and Rejected

TABLE III: COMPARISON BETWEEN VARIOUS ALGORITHMS USING LINEAR POWER MODEL SCENARIO 1

Algorithms	Total Tasks Given	Total Tasks Completed	Task rejected	Task failed by server	Total power consumed
RR using VMs	4071	4071	0	0	318
RR using host	4071	2036	2035	0	277.3
Green Scheduler	4071	4071	0	0	291.4
Green Scheduler using VMs	4071	2880	0	1191	313.1

TABLE IV: COMPARISON BETWEEN VARIOUS ALGORITHMS USING POWER BLADE MODEL SCENARIO 2

Algorithms	Total Tasks Given	Total Tasks Completed	Task rejected	Task failed by server	Total power consumed
RR using VMs	4071	4071	0	0	88.6
RR using host	4071	2036	2035	0	83.4
Green Scheduler	4071	4071	0	0	80.1
Green Scheduler using VMs	4071	2880	0	1191	89.8

V. CONCLUSION

Cloud computing has grown so fast that it had made almost every organisation rely on it. Since the time it had developed and now there is vast technological change in the field. It requires huge effort to build a technology that could help consumers as well as service providers. Currently we are facing energy as a challenge in the field because due to steep increase in demand the deployment of hardware infrastructure is being deployed at pace. This infrastructure not only consume electricity by itself it also need auxiliaries which also consumes electricity in order to keep the temperature down for these machines. In our work we have the evaluation of energy consumption using different power models. The traditional linear model and power blade model with two algorithms each with two different scenarios. The consumption of energy varies a lot over two power models. Two abnormalities are observed as task rejection by data centre and task failed on servers which is an issue. In our future work we'll try to rectify these problems and we can formulate strategies for power consumption efficiency and better task allocation policies in future for fine utilization of resources.

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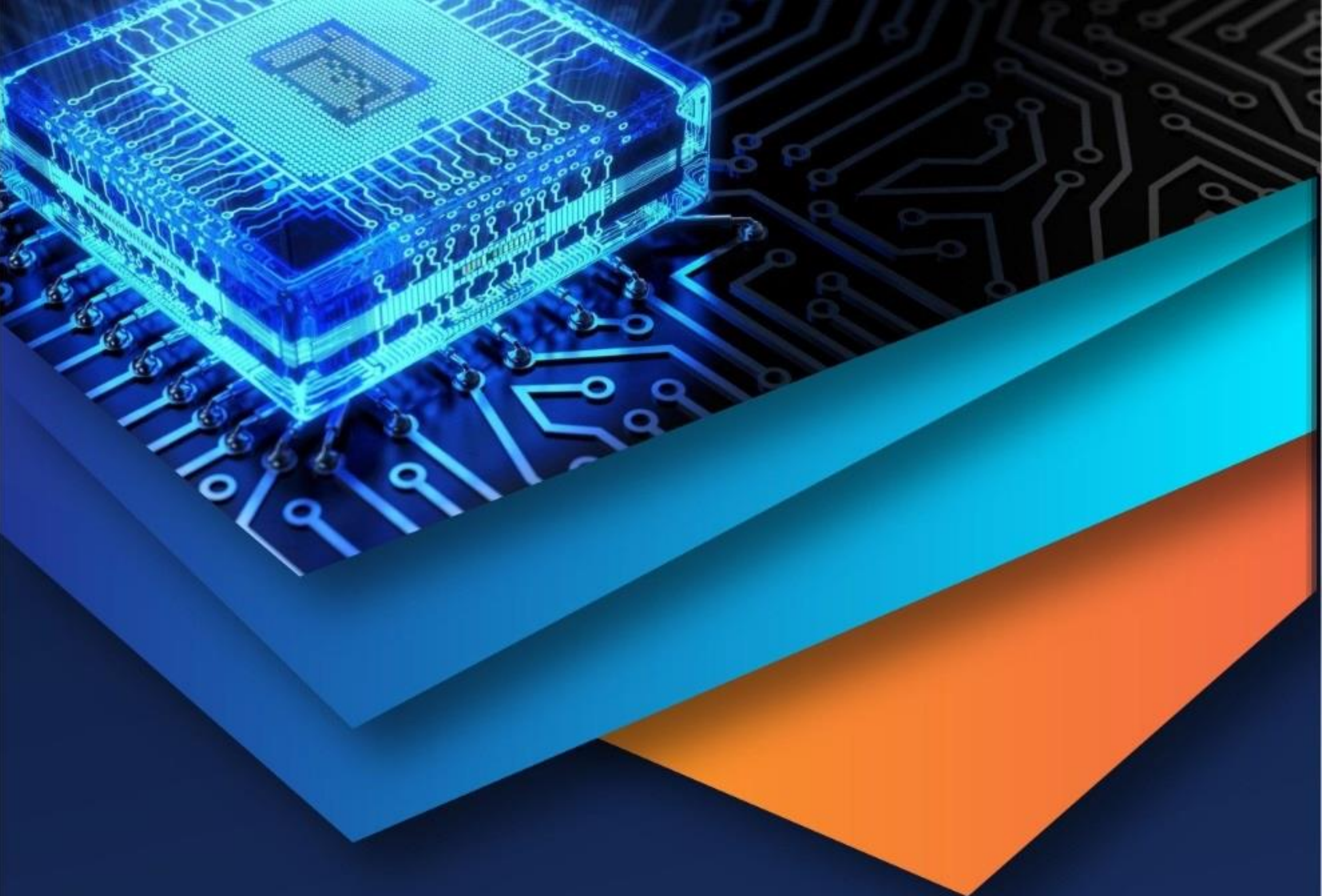

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