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Advance Power Supply Management Through Power Supply Optimization to Significantly Improve the PUE at Multiple Datacenters

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***Abstract:** A complete methodology of running a data center by using various optimization algorithms to reduce energy consumption in data centers by considering the placement of virtual machines onto the servers in the data center intelligently accompanied by a multilevel feedback queue system to efficiently assign (schedule) jobs onto VMs. And finally, presenting a comparative account taking in and ruling out (both cases) various other parameters related to a datacenter. And then ultimately presenting some concluding comparative studies that could really help deciding the components of a datacenter and the algorithms needed for functionality.*
***Keywords:** Cloud computing, PUE, VM, Datacenters, Power Management*

I. INTRODUCTION

Looking back since the concept of datacentres came into existence, they are looked upon as dumping grounds of electricity which are actually all round computing houses that gradually made up their way getting more and more efficient in terms of cost, power and performances. Datacentres have diverse options to procure electricity. There exists no prior work on investigating the trade-off between minimizing datacentre's energy expenditure and maximizing their profit for various datacentres. Here, we shall seek to tackle this shortcoming by proposing a systematic approach to maximize a data centre's profit. This paper takes into account various other factors such as availability of local renewable power generation at data centres. This white paper puts up an optimization-based profit maximization strategy for data centres for both cases, without and with-behind- the-meter renewable generators.

In this paper, our focus is on the cost reduction that data centres may achieve by exploiting the diversity in the price of electricity in day-ahead and real time electricity markets along with minimum resource wastage. This will state a method to deal with calculating the cost, revenue and hence profit for a datacentre in definite time slot taking into account the various parameters. And concluding it with the comparative account of the different options available at each step of implementation as mentioned in the stated methodology.

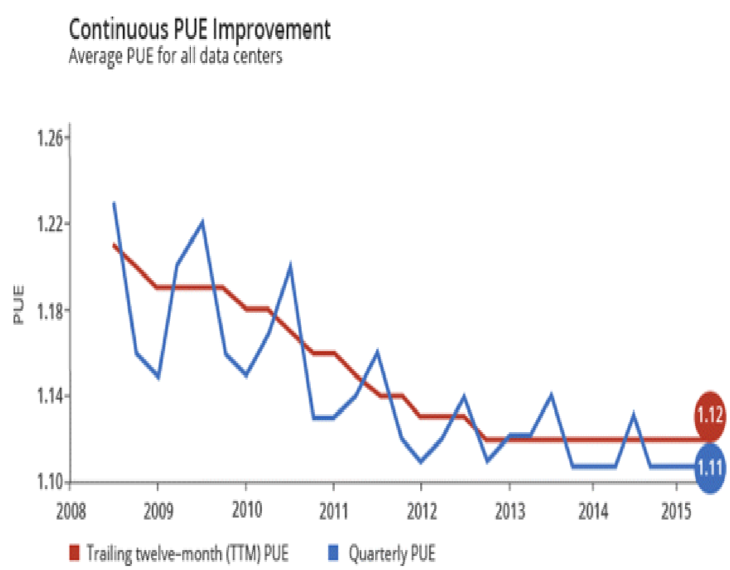

Figure 1: The figure shows the comparison of quarterly PUE and trailing twelve month PUE

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The cost associated with cloud data centres are composed of three factors. Labour cost takes the smallest chunk of total operation cost, nearly 6 % of the total cost, whereas power and cooling cost and computing costs are 20 % and 48 % respectively. Other costs account for remaining 26 %. Cloud data centres add new cost, unlike traditional datacentres. So the prime focus is to cut down on this major proportion (approximately 70%) of cost.

II. LITERATURE REVIEW

A. Hyser (2007) proposed a virtual machine arrangement framework in which an autonomic controller progressively deals with the mapping of virtual machines onto physical has as per strategies specified by the client.

B. Qian (2009) proposed a multi target advancement half and half hereditary reenacted toughening calculation (GASA) to diminish working expenses of SaaS parts.

C. Wang (2010) proposed an option virtual machine position way to deal with limit vitality utilization with a worldwide QoS ensure in cloud server farms. Subhash (2011) did an examination of various existing Virtual Machine's (VM's) booking calculations are done and proposed an Effective Load Balance calculation. Bhaskar (2012) proposed a strategy, dynamic booking and union system that designate assets in light of the heap of Virtual Machines (VMs) on Infrastructure as an administration (IaaS).

D. Kleyman (2012) haslooked at the key considerations of data center optimization, management, and how to better utilize energy resource.

E. Dai (2012) proposed algorithms for the placement of virtual machines onto the servers in the data center.

F. bBobroff(2012), proposed a dynamic server migration and consolidation algorithm which reduces the amount of required capacity and the rate of service level agreement violations.

G. Saini (2013) proposed a parametric analysis is performed to identify the requirement of process migration.

H. Ghamkhari (2013) proposed a ***trade-off*** between minimizing data center’s energy expenditure and maximizing their revenue for various data centers.

I. Prajapati (2013) had done comparative study has been made for different types of VM scheduling and provisioning algorithms.

J. Mandal (2013) adopted energy-efficient methods of operation have to be investigated and adopted.

K. Khan (2014) proposed a load balancing technique. Load balancing in Cloud has become a very interesting and important research area.

L. Pacini (2015) proposed to perform scheduling at three levels. First, datacenters are selected by their network latencies via three policies: Lowest-Latency Time-First, First-Latency-Time-First, and Latency-Time-In Round.

M. Himthani (2015) made a study on cloud computing environment, that requires a suitable algorithm for executing the various jobs provided to the system in a cost effective manner.

N. Saha [2016] proposes a model to optimize the revenue in cloud data center and analyses the model, revenue and different investment or cost commitments of organizations investing in data centers.

O. Sarkar (2016) proposes an algorithmic/analytical approach to address the issues of optimal utilization of the resources towards a feasible and profitable model.

P. Nalawade (2016) proposed a method to put forward an idea to increase the profit of cloud service providers and cloud owners by allocating threshold space.

Q. Mishra (2016) proposed a model for an effective and efficient part way to providing combined source computing resources and services to customers on demand.

R. Sawyer (2016) presents methods for calculating power and cooling requirements and provides guidelines for determining the total electrical power capacity needed to support the data center.

S. Zhou (2016) proposes a redundant VM placement optimization approach to enhancing the reliability of cloud services.

T. Nonde (2016) solved the mixed integer problem, we investigate the effective use of renewable energy and hence resource allocation in core networks with clouds as a means of reducing the carbon footprint.

III.PROBLEM STATEMENT AND FORMULATION

Profit maximization by power management and optimization at multiple datacenters (green and non-green).

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A. Equations

Power (P):

$$P = M[P_{idle} + (E_{usage} - 1)P_{peak} + (P_{peak} - P_{idle})U],$$

$$Revenue = \sum_{i=1}^{N} (1 - q_i(\mu_i))\,\delta_i\lambda_i T - q_i(\mu_i)\gamma_i\lambda_i T,$$

… (1)

where the first term within the summation, i.e., $(1 - qi(\mu))\delta i\lambda iT$ denotes the total payments received by the datacenter within time interval T for the service requests of class i that are handled before the ith SLA-deadline, while the second term,i.e., $qi(\mu)\gamma i\lambda iT$ denotes the total penalty paid by the data centre within time interval T for the service requests of class i that are not handled before the ith SLA-deadline.

$$\underset{\lambda_i \le \mu_i}{\textbf{Maximize}} \quad T\sum_{i=1}^{N}[1 - q_i(\mu_i))\delta_i\lambda_i - q_i(\mu_i)\gamma_i\lambda_i] - T\omega\left[\sum_{i=1}^{N}\frac{a\mu_i + b\lambda_i(1 - q_i(\mu_i))}{\kappa_i} - G\right]^{+}$$

Subject To

$$\sum_{i=1}^{N}\frac{\mu_i}{\kappa_i} \le M_{max},$$

… (2)

IV. PROPOSED METHODOLOGY FOR SOLVING THE PROBLEM

A. Implementation/simulation of a 3-level feedback queue for assignment or scheduling of jobs into a virtual machine in the most efficient possible way.

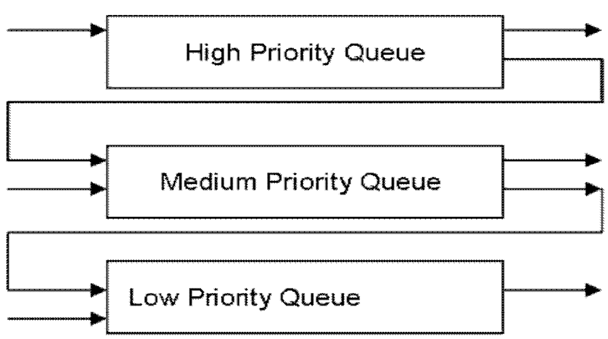

Figure 2: 3-way multilevel feedback queue scheduling.

All the three queues will have different algorithms implementation connection the end of last one to the job and the head of first to the VM.

B. Implementing optimization algorithm to Optimize Virtual Machine Placement in Banker Algorithm for Energy Efficient Cloud Computing for serving the primary and crucial purpose of efficient virtual machine placement over a host ensuring minimum resource wastage and power consumption.

C. Optimize Virtual Machine Placement in Banker Algorithm for Energy Efficient Cloud Computing

In the adopted methodology, Optimized Virtual Machine Placement in Banker Algorithm for energy efficient Cloud Computing is

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named OVMPBA, the technique of Dynamic Threshold used for host overload detection is named as DT and Minimization Migration policy for VM selection is named as MM. Dynamic Threshold (DT) Technique for Host Overload detection. Threshold value is used to decide the time when the migration is to be initiated from a host. When the system load exceeds the threshold value, the system is detected as overloaded. Dynamic threshold (t) value for a host is calculated in following steps-

Firstly CPU utilization for all VMs on the host is calculated as:

Uvm = total Requested MIPS / total MIPS for that VM

Then, allocated RAM and Bandwidth for all virtual machines and host is calculated as:

Bw= ∑ current bandwidth for VMs for host

Ram = ∑ current Ram for VMs for host

Sum=∑ Uvm

Temp= Sum+(Bw/Bw(host)) + (Ram/Ram(host))

t = 1- 0.5*temp

For a host whose utilization value exceeds the threshold value 't' some virtual machine migrations will be performed.

Minimization Migration(MM) Policy for VM Selection:

Once a host is determined as overloaded, some virtual machines requires to be migrated from the current host to lower down the utilization threshold. It is very difficult to decide which VM to migrate because if a large VM is selected, the total migration time will increase and if smallest VM is selected then number of VMs will be migrated. So, the minimization migration policy selects the VM whose size is equal to the difference between the total host utilization and the threshold value.

Following are the steps of Minimization Migration policy which returns the list of VMs that can be migrated:

Input: hostList, vmList

Output: migration List

D. Pseudo Code

1) vmList.sortDecreasingUtilization()
2) for each host in hostList do
3) hUtil _h.util()
4) bestFitUtil _ MAX
5) while hUtil > h.thresh() do
6) for each vm in vmList do
7) if vm.util() > hUtil _ h.thresh() then\
8) t _ vm.util() _ (hUtil _ h.thresh())
9) if t < bestFitUtil the
10) bestFitUtil _
11) bestFitVm _v
12) els
13) if bestFitUtil = MAX the
14) bestFitVm _ vm
15) brea
16) hUtil = hUtil _ bestFitVm.util(
17) migrationList.add(bestFitVm
18) vmList.remove(vm
19) return migrationList

To optimize VM placement in Banker algorithm DT-MM method works together for efficient optimization of the VM placement plan. The method is compared against existing methods Inter Quartile Range (IQR), Local Regression Robust (LRR), Static Threshold (THR) of host overload detection and Maximum Correlation (MC), Minimum Migration Time (MMT) and Minimum Utilization (MU) of VM selection in all possible combinations against the parameters of energy consumption, percentage Service Level Agreement violation and number of migrations which are evaluated as follows in the CloudSim simulator:

% SLA Violation:

Overall SLA violation = (a-b)/a

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% SLA violation= 100 * Overall SLA violation
Where a=Total Requested MIPS
b=Total Allocated MIPS
Energy consumption:
Energy consumption = Total Utilization of CPU/ (3600*1000)
Number of VM Migrations:
Number of VM migrations = Total Migration Count

E. Calculating power and hence the net cost for profit maximization using the formulas stated above (Equation 1 and 2).

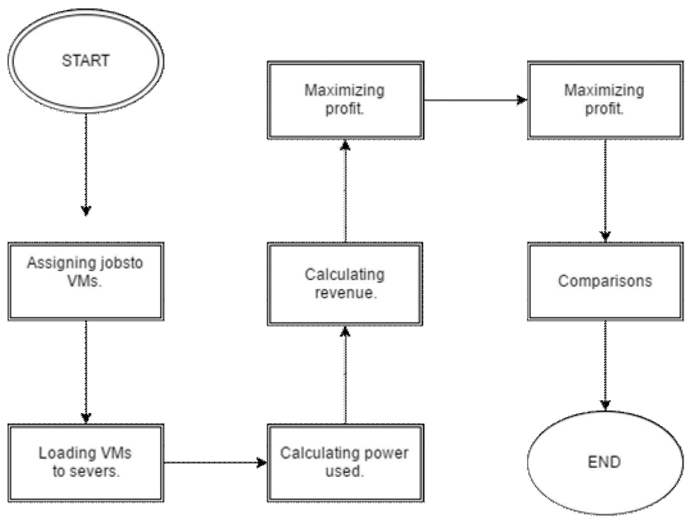

Figure 3: Flowchart for the proposed methodology

V. EXPERIMENTAL SETUP

The whole implementation of datacentres is done over autodesk green building studio. In which, tw different data repositiories one green and another non green was simulated to procure results.
CloudSim test system is utilized to model and test the cloud condition. Planet Lab workload of CloudSim is utilized as a part of the recreation. The cloud framework in PlanetLab workload is sent in a server farm involving two sorts of physical machines and four sorts of virtual machines. The objective cloud model is an IaaS framework with a cloud server farm comprising of aggregate "N" physical machines where N=800. N can be spoken to by N= {pm1, pm2… pm800}. A set "M" of virtual machines keep running on physical machines where M=1024 and M can be spoken to by M= {vm1, vm2… .vm1024}. The virtual machines on a physical machine can be restarted, stopped and relocated to other physical machines in cloud server farm. Diverse Simulation parameters for the PlanetLab workload reproduction are characterized in Table I.

Table 1:

Parameter	Value
Host types	2
Host MIPS	{1860, 2660}
Host RAM	{4096, 4096}
Host Bw	1000000(1Gbit/sec)
VM types	4
VM MIPS	{2500, 2000, 1000, 500}
VM RAM	{870, 1740, 1740, 613}
VM Bw	100000(1Mbit/sec)

VI. RESULTS AND DISCUSSIONS

A complete step by step manual for managing operations and working at a multiple datacenter which includes the optimization algorithm, job scheduling strategy to VMs and further cost- revenue calculation for profit maximization can be expected out of the proposed project.

On simulation of the algorithm and implementation of datacenter, there was a difference of Rs.14,200 in the running costs of a commercial firm datacenter and an educational institution every month over a single unit considering the same prices and rates of electricity and fuel. The net CO_2 emission is expected to be 58.3 tons.

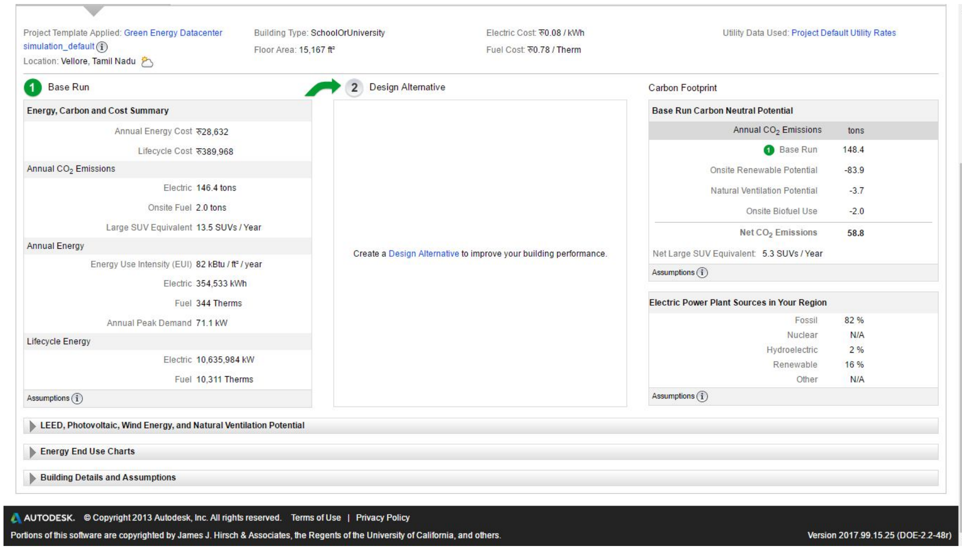

Figure 4: The results of the silated green datacentres

VII. ACKNOWLEDGMENT

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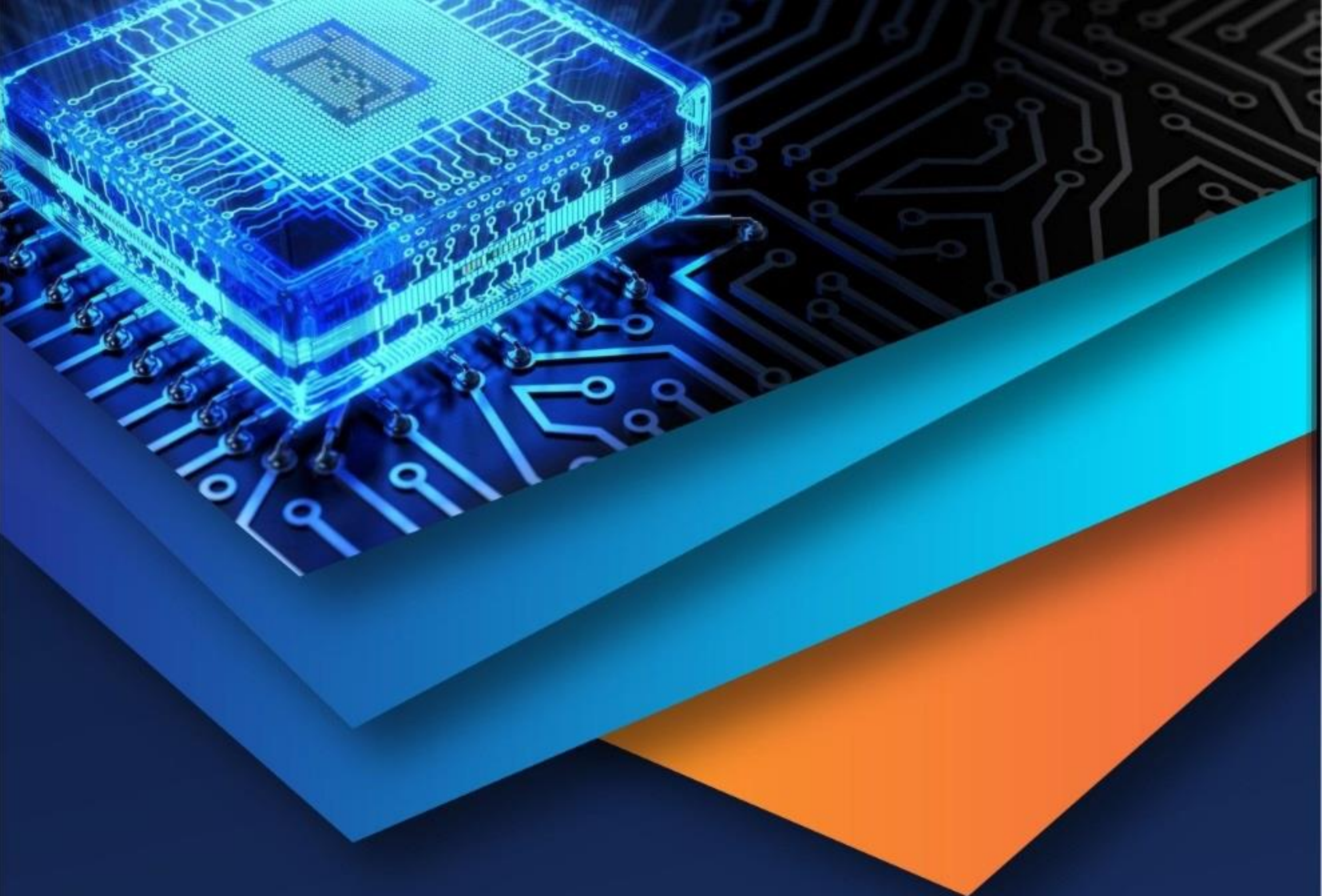

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