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ENERGY EFFICIENT RESOURCE OPTIMIZATION ALGORITHM FOR GREEN CLOUD COMPUTING TO ATTAIN ENVIRONMENT SUSTAINABILITY

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ABSTRACT

High power consumption is one of the major problem for the cloud service providers. Also high power consumption results in maximum amount of carbon-di-oxide emission and this leads to environment pollution. Hence an efficient algorithm is used to optimize the cloud resources in Data Centers (DC). The main objective of this paper is to minimize the total power consumption of DC. Resource consolidation algorithm was used to maximize the resource utilization with minimum cost. Based on our experimental results our proposed algorithm reduces the power consumption, improves the resource utilization and also to reduce the user's cost. Minimum power consumption leads to minimum carbon dioxide emission which leads to attain environment sustainability.

Keywords: power consumption, carbon-di-oxide emission, data centers, resource optimization, energy efficiency.

1. INTRODUCTION

"National Institute of Standards and Technology (NIST)" defined "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction." The cloud computing [9] technology provides cost reduction because the end users engage the necessary infrastructures from a cloud service provider. In past days they owned the resources, but today when needed they hire them. Cloud computing provides dynamic resource sharing methods to utilize the resources efficiently. Different applications need different types of hardware, software and other resources. The fast growing cloud technology effects in adding the data center[10] operational costs. Also increased power usage affect the environment due to the excess emission of carbon-dioxide. Our study uses the cost functions Energy Conscious Task Consolidation. This cost function is used to find the cost effective energy efficient resource for the requested task. In cloud technology power intake and resource usage are joined together. According to recent research, the average resource utilization and the average power consumption of the unused resources are nearly 20% and 60% respectively. To improve the resource utilization, optimization techniques are used.

Cloud computing provides three mandatory services for the end user. These services are Infrastructure-as-a-service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Iaas offers computer hardware such as memory, central processing unit and storage devices as a service, PaaS offers computing platforms such as operating systems, and software frameworks as a service and SaaS offers computer software and application programs as a service.

2. LITERATURE SURVEY

[1][2] developed two algorithms, namely, 'Energy Conscious Task Consolidation', which computes the energy consumption of a given task on a selected resource and 'Maximum Utilization' which finds the most power effect resources based on resource utilization.

Bin Packing[4] methods for task consolidation problem which is a cost effective one but not an energy efficient technique.

Samir Khulher, University of Maryland (US 2011) – considered an elementary scheduling problem which consumes a fixed amount of energy per time slot but it not addresses on reducing the power consumption.

Y.Song (2009) – defined an usability analysis method for World Wide Web – internet based task consolidation.

Srikantaiah (2008) – proposed the job consolidation based on pareto analysis to equalize the power intake and the performance[3].

3. RELATED WORK

Related research on resource scheduling is usually focuses on scheduling performance, response time and completion time. The proposed technique consolidates the task based on pareto analysis to equalize the energy consumption and the performance. The proposed method finds the optimum point and power efficient resource is assigned using the Euclidean distance between the present selection and the optimum point. The proposed algorithm computes the cost of the resource and also used to find the power effective resource with minimum cost.

a) System framework

Figure-1 shows the architecture of Green cloud environment [7]. The following are the components of green cloud.

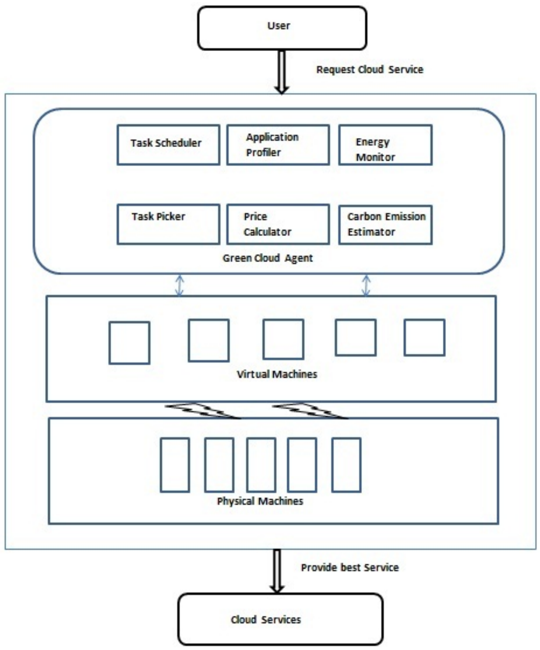

Figure-1. Green cloud architecture.

User: Sends service request to the Green cloud Agent.
Green cloud agent : Acts as a broker between user and service provider. It manages the selection of the greenest cloud provider to serve the request sent by the user.
Task scheduler: Schedules the task, which is executed by the server.
Price calculator: Calculates the cost for the request initiated by the user. Historical data could be used to improve the service levels.
Energy monitor: Monitors and finds, which physical machines that has to be switched- on and switched-off for increased efficiency.
Application profiler: Collects the properties of Users, basis which, the priorities could be granted.
Carbon emission estimator : Calculates the amount of carbon emission for each and every service.
Cloud service : Best service will be furnished by the service providers to the requested users that will result in low carbon emission.

4. RESOURCE CONSOLIDATION PROBLEM

The resource consolidation (formally known as load assignment) problem is the method of assigning a set $J = \{ j_0, j_1, j_2, \ldots j_n \}$ jobs (user request) to a set $S = \{s_0, s_1, s_2, \ldots s_m\}$ of m given number of cloud resources with respect to time constraints. The main aim continues to improve the resource utilization and finally to reduce the power consumption. Time constraints are straightly associated to the resource usage of the jobs. Exactly, in the resource assignment problem, the resources associated to a particular task must adequate to offer the resource usage of the requested task. For example, a task with its resource usage requisite of 80% cannot be allotted to a resource for which the available resource usage [8] at the time of that task's arrival is 70%.

a) Cost model

This model finds the power consumption of a given task on a requested resource. It is used for resource sharing purpose. The cost function of the proposed method is specified as,

$C_{(i,j)}$ = [Total power Consumption of the job] – [Power Consumption of the job running at standalone] + [Power Consumption of the task running in parallel].

b) Power aware resource optimization algorithm

The following algorithm assigns the energy efficient low cost and energy efficient resource to the requested job.

Algorithm 1: Energy Conscious Resource Optimization
Input : $j_i \varepsilon$ $J= \{ j_0, j_1, j_2, \ldots j_n \}$and $S =\{s_0, s_1, s_2 \ldots . s_m\}$
output: $s^* \varepsilon$ S
begin
s* , optimal = ϕ and X= ϕ
for all s ε S do
$a = f_a$
$b = f_b$
$\rho = (a_{max} - |a - b|)$
res = (a,b)
if (res > optimal) then
optimal = res
s* = S
X = ϕ
X = X U (res, s, ρ)
end-if
if (res = = optimal) then
X = X U (res , s, ρ)
for all (f , s, ρ) ε X do
if (($f_a \neq optimal_a$) & if($f_b \neq optimal_b$)) then
if ($\rho > \rho_{optimal}$) then
optimal = f
ρoptimal = ρ
s* = S
else-if (($f_a + f_b$) > ($optimal_a + optimal_b$)) then
optimal = f
$\rho_{optimal} = \rho$
s* = s
end-if
end-if

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```
                    end-for
            end-if
    end-for
end
```

c) Complexity analysis

The time complexity of this algorithm is divided in to two parts. First part finds the selection of optimum resource of the requested task i.e. O(N). The second part to meet the cost constraint..i.e.O(NK).

5. SIMULATION RESULTS

Some simulation experiments were carried out using Cloudsim 3.0.[5][6] The simulation parameters are shown in Table-1.

Table-1. Simulation parameters.

Parameter	VALUE
Processing Unit computation	2860 MIPs
RAM	1 GB
Bandwidth	100 m/s
Storage	8GB

The experiments used four important metrics such as total time, cost of user, make span and resource utilization.

a) Make span

Make span is defined as the total time of all the jobs. 10000 to 15000 jobs were used 15 times repeatedly. The results are shown in Figure-2.

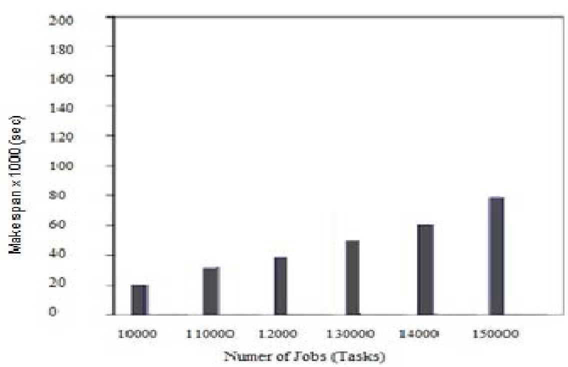

Figure-2. Make span.

b) Cost

The second metric is to save the cost of the user based on selecting the energy efficient resource for the requested task. The cost requirement by the user is shown is Figure-3.

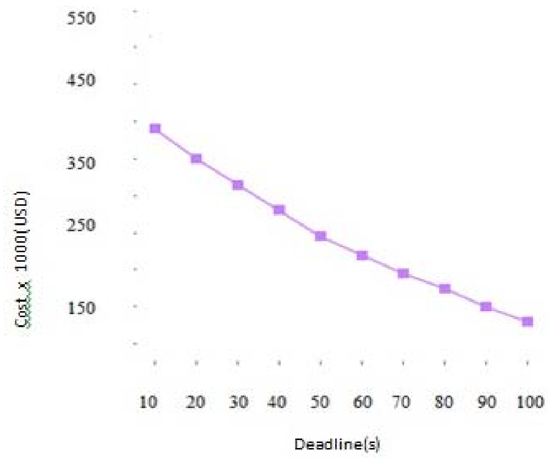

Figure-3. Cost.

c) Energy efficiency

Figure-4 shows the energy efficiency of the proposed algorithm. The sampling rate was performed each task for the selected resource. X axis shows the tasks and the Y axis shows the energy consumption and utilization for the selected resource.

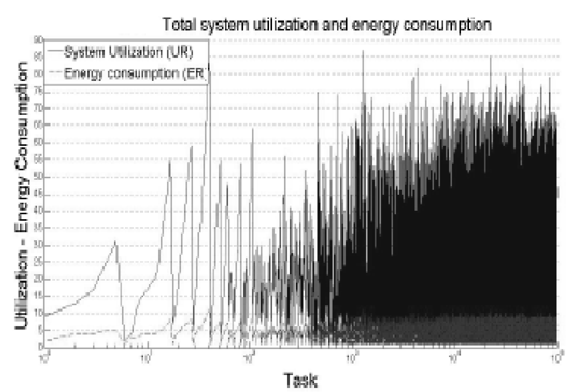

Figure-4. Energy efficiency.

6. CONCLUSIONS

Resource Optimization in cloud computing is an important approach to increase the power efficiency. The efficiency of the proposed method is achieved through the experimental results. The proposed algorithm aims to achieve the metrics such as cost, energy consumption and better utilization of optimal resource to the requested task. Hence this method is better than the existing methods.

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