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ENERGY EFFICIENT VIRTUAL MACHINE ASSIGNMENT BASED ON ENERGY CONSUMPTION AND RESOURCE UTILIZATION IN CLOUD NETWORK

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ABSTRACT

Cloud Computing is an internet based computing which makes and different types of services available to users. For customers based on their required services over the internet virtualized resources are provided. The fast growth of cloud resources with customers demand increases the energy consumption results in carbon dioxide emission. However, energy consumption and carbon dioxide emission in cloud data centre have massive impact on global environment triggering intense research in this area. To minimize the energy consumption in this paper we propose VM Assignment scheduling algorithm, it is based energy consumption and balancing the resource utilization. we consider both the VM and host energy consumption and classify the VMs based the resource usage and schedule them to balance the resources utilization among the hosts in the cloud data centre which leads to better energy efficiency and reduces the heat generation. The effectiveness of the proposed technique has been verified by simulating on CloudSim. Experimental results confirm that the technique proposed here can significantly reduce energy consumption in cloud.

Key words: VMs (Virtual Machines), Green Cloud Computing, VM Classification.

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1. INTRODUCTION

Cloud Computing[1] is dominant computing platform in scientific, engineering and every field due to this energy efficiency in cloud computing is becoming very important. The fast growth of cloud resources increases energy consumption results in carbon dioxide emission which effects the global environment leads to develop innovative energy efficient techniques for Green cloud computing[2][3], it seeks to minimizing energy consumption in a Cloud Computing environment[4][5].

To minimize the energy consumption in cloud the computing resources CPU, memory, disk, bandwidth has to be utilized effectively for this propose Virtualization is used. Virtualization software and Virtual Machine (VM) placement are important aspects in a Cloud Computing environment. Virtualization abstracts lower level server hardware resources for the upper level services which are capsulated in virtual machines. Many VM placement algorithms are being used in cloud computing environment to minimize energy consumption [6][7]. However, most of these techniques have not considered minimizing the energy consumption based on both VM energy consumption and balancing resource utilization which results in performing maximum consolidation of VMs to reduce the number of servers required to allocate them and leads to better energy efficiency and reduce the heat generation[8][9].

They reason why we need to develop this proposed scheduling algorithm based on VM and host energy consumption in the cloud data centre is even though the energy management technique are adopted for monitoring, maintaining and reducing the power and temperature due to several reasons may be the system is ON for several hours or faults in the system or servers are old, the energy consumption in the host sometime may increases or decreases gradually, due to this in the proposed energy efficient algorithm is based on energy consumption, at the time of allocating the VM on the host, we find the energy efficient host[10][11] and resources utilization(CPU, RAM and disk storage) are balanced on the hosts in the cloud data centre results in minimizing energy consumption.

As discussed in the paper[12][13] regarding analysing of workload or tasks type some of the tasks require more CPU and minimum memory for computation and some task require more memory and minimum CPU based on this to balance the resources VMs are classified into VM CPU type, VM memory type. The VM CPU type means more CPU resource and minimum memory resource is utilized, VM memory type means more memory and minimum CPU is utilized. When these VM types are scheduled into the host the CPU and RAM utilization should not violate the maximum host CPU threshold and host memory threshold, The proposed energy efficient algorithm is compared with energy based efficient resource scheduling algorithm EBERSF[14] and energy efficient utilization of resources EEUR[15] techniques which leads further minimization of energy consumption. The effectiveness of the proposed technique has been verified by simulating on CloudSim [19]. Experimental results confirm that the technique proposed here can significantly minimize the energy consumption in cloud.

The paper is organized as follows. Section II we discuss Related Work. Section III is the Proposed Techniques. Section IV is Experimental Results. Section V paper is Concluded.

2. RELATED TECHNIQUES

Anton Beloglazov et al. [7], authors propose an efficient resource management policy for virtualized Cloud data centres. Their aim is to reduce power consumption, The technique is continuously consolidate VMs leveraging live migration and switch off idle nodes to reduce power consumption, while providing required Quality of Service. Their evaluation results showing that dynamic reallocation of VMs brings substantial energy savings.

Hieu Trong Vu et al [8] in their paper author proposed an algorithm for virtual machine placement mechanism that considers both power and traffic among VMs within a cloud data center. The communication performance is improved by reducing virtual machines traffic cost and energy.

Cesar O. Diaz et al. [9] in their paper presents UnaCloud: an opportunistic cloud computing Infrastructure as a Service (IaaS) model implementation, which reduces the cost compared with dedicated cloud infrastructures, They propose an IaaS architecture based on two strategies: virtualization strategy that provides on demand deployment of customized execution environments and opportunistic strategy where idle computing resources are provide to the client. IaaS model provides high efficiency in the deployment of virtual machines in scientific projects.

Stoess et al. [10] who discussed the possibility of energy measurement for Virtual Machines, which cannot be done by connecting hardware measurement devices. They proposed that power usage could be accurately calculated so long as each hardware device reports its power usage in each power mode to its device driver, which in turn would relay the information to the Operating System.

Husain Bohra et al. [11] in their paper describe online monitoring of resource utilization along with the implementation of power-aware policies to reduce the total energy consumption. In their work authors present a novel power modelling technique, VMeter, based on online monitoring of system-resources having high correlation with the total power consumption. The monitored system sub-components include: CPU, cache, disk, and DRAM. This model predicts instantaneous power consumption of an individual VM hosted on a physical node besides the full system power consumption.

James W. Smith et al.[13] in their paper the effect of different workloads on server power consumption in a Private Cloud platform is discussed and display a noticeable difference in energy consumption when servers are given tasks that dominate various resources (CPU, Memory, Hard Disk and Network).

Sukhpal Singh et al[14] In their paper, authors emphasis on the development of energy based resource scheduling framework and present an algorithm that consider the energy between various data centre and Quality of Service. The performance of the proposed algorithm has been evaluated with the existing energy based scheduling algorithms. The experimental results demonstrate that this approach is effective in minimizing the cost and energy consumption of Cloud.

Y. C. Lee *et al.*, [15] authors in their presents two energy task consolidation heuristics, which maximize the resource utilization considering both active and idle energy consumption. The heuristics assign each task to the resource on which the energy consumption is minimized. This energy efficient model is for homogenous cloud workloads.

However, most of these techniques have not considered minimizing the energy consumption based on both VM energy consumption and balancing the resource utilization. The VM Assignment algorithm allocates VM on energy efficient host and balances the resource utilization on the hosts results in minimizes the energy consumption and reduces the heat generation.

3. PROPOSED TECHNIQUE

In this paper to minimize the energy consumption, we propose VM Assignment algorithm. The energy efficient VM Assignment algorithm is based on energy consumption and balancing the resource utilization is illustrated in Figure 1. First we measure the energy consumption of host and VMs using energy equation as discussed below in section 3.1. we consider both the VM and host energy consumption and classify the VMs based on their resource usage CPU, memory and schedule them in such way to balance the resources utilization among the hosts in the cloud data centre and minimize the energy consumption [7] [8][9].

3.1. Measurement of Energy Consumption using Energy Equations

The tasks arrives the data centre, for each task the VM is created. The energy usage of individual VM is measured by monitoring the energy consumption of VM resources on server namely CPU, cache, DRAM, Hard disk. The energy equation is based on OS utilization and performance counters [10]. Because of the lack of measurement of any direct hardware performance counter. The hardware architecture generates the resource utilization per VM about CPU, Cache, DRAM and Disk through the system events such as: CPU-CLOCK-NOT-HALTED, RAM-ACCESSES, INSTRUCTION-CACHE-READ, and DATA-CACHE-READ via performance counters register. These events are used to monitor the power consumption of the VM.

The power equation based on the hardware resources is given in equation 1.

$$P(total)=k_0+(k_1*P_{cpu})+(k_2*P_{cache})+(k_3*P_{dram})+(k_4*P_{storage}) \quad (1)$$

The values for k_0 (constant power during calibration) and k_1 (for CPU), k_2 (for Cache), k_3 (for DRAM), k_4 (for Hard Disk) are obtained by measurement. Where the P_{cpu} - CPU utilization, P_{cache} - Cache memory access count, P_{dram} - DRAM memory access count, $P_{storage}$ - storage hard disk I/O rate.

The total system power is defined as a function of the utilization of CPU, DRAM, Cache, storage hard disk [11]. If Psysmax is the maximum power consumed when the server is fully utilized; k is the fraction of power consumed by the idle server (e.g. 70%); u is the CPU utilized, r is DRAM access count, s is storage hard disk I/O rate, c is the Cache memory access count, then the total system power is as given below:

$$Psys(u+r+c+s) =k.Psysmax+ (1- k).Psysmax.u.r.c.s \quad (2)$$

Psysmax is normally 250 W, which is the normal value for modern servers. The utilization of the CPU, DRAM and storage hard disk, Cache, may change over time due to workload variability. The CPU, DRAM, Cache, storage utilization is a function of time and is represented as u(t), r(t), c(t), s(t). Therefore, the total energy consumption by a physical node (E) can be defined as integral of the power consumption function over a period of time from t_0 to t_1 as shown in equation (3).

$$E = \int_{t0}^{t1} P_{sys}(u(t) + r(t) +)c(t) + s(t))dt \quad (3)$$

3.2. Energy efficient VM placement Scheduling

In the proposed energy efficient VM Assignment algorithm, The resource utilization (CPU, memory) and energy consumption of hosts in the cloud is measured using energy equation as specified in section 3.1, these values are stored into a table in ascending order. The m tasks arrives the cloud data centre, the VM is created for each task, the energy consumption of each VM is measured, and these values are stored into a table in descending order. Next to balance the VM allocation, the resource utilization of the VM (CPU, memory) is measured and the VMs are classified into VM CPU type, VM memory type[12][13]. The VM CPU type means more CPU resources and minimum memory resources is utilized, VM memory type means more memory and minimum CPU is utilized. Schedule the classified VMs such that balancing the resource utilization across the computing nodes in the data centres and while allocating the VM on the host check CPU, memory utilization does not exceeds the maximum host CPU threshold, host memory threshold. Find the maximum power threshold of the host; estimate the total power on host after assigning VM. If the estimated power is less than the maximum power threshold allocate the VM on the host. The VMs is allocated to hosts that provide the least increase in energy consumption. Results in minimizing the energy consumption and reduces the heat generation [14] [15] . The pseudo-code for the algorithm is illustrated in Figure. 1 and the following terms are used [16][17][18].

ecbahostList : Energy consumption on host before allocating VM.

ecbavmList: Energy consumption of each VM.

vmCPUList : The VM List consists of VM where more CPU and minimum memory is utilized.

vmMEMList : The VM List consists of VM where more memory and minimum CPU is utilized.

hostCPUthreshold: The maximum CPU utilization on each host.

hostMEMthreshold: The maximum memory utilization on each host.

Input: hostList,vmList,vmCPUList,vmMEMList,ecbahostList, ecbavmList

Output: Allocating VMs on **Energy Efficient Host** and **balancing** the resource utilization to **minimize energy consumption** and **reduce the heat generation**

1. Update energy consumption of each active host before allocating VMs to ecbahostList
2. Update each VM energy consumption to ecbavmList
3. ecbahostList.sortAscendingenergyconsumption()
4. ecbavmList.sortDescendingenergyconsumption()
5. vmList.classified() and update into vmCPUList,vmMEMList.
6. Power←MAX
7. AssignedHost←NULL
8. hostnum=1;
9. balance = true
10. **foreach** vm in vmCPUList **do**
11. while(host in ecbahostList[hostnum])

```
if (CPUutilizaonhost <= hostCPUthreshold && balancing among the computing nodes)
            powerreq←requiredPower(host, VM)
        if powerreq < Power then
                AssignedHost←host
                Power←powerreq
if AssignedHost≠ NULL then
   Allocate VM to allocated Host
        hostnum=hostnum+1;
         Break;
else
hostnum = hostnum+1;
End while
 if (violated  hostCPUthreshold)
MigrationList.add(VM);
 endfor
  hostnum=1;
foreach vm in vmMEMList do
 while(host in ecbahostList[hostnum])
if (MEMutilizaonhos <=hostMEMthreshold&&balance)
            power←requiredPower(host, vm)
        if powerreq <  Power then
                AssignedHost←host
                minPower←power
if AssignedHost≠ NULL then
   allocate vm to AssignedHost
         hostnum = hostnum+1;
             break;
else
hostnum = hostnum+1;
endwhile
 if  (violated  hostMEMthreshold)
 MigrationList.add(VM);
  endfor
```

Figure 1 Energy Efficient VM Assignment Algorithm

4. EXPERIMENTAL RESULTS

The performance of the proposed method has been evaluated by simulating using CloudSim [19]. The simulated data centre is conducted with specified conditions as tabulated in Table 1.

Table 1 Clouds Simulation Setup

No of Data Centres	1
No of Cloudlets	3000
No of Hosts in Data Centre	100
Resource Configuration of each host	Host have one CPU core with 2000,3000,4000 MIPs, 8GB RAM, 500 GB disk
Resource Configuration of each VM	VM have one CPU core with 200,500,750 or 1000 MIPs, 256MB RAM, 1 GB disk

We simulated proposed energy efficient VM Assignment algorithm to minimizing the energy consumption. The VM is allocated on energy efficient host, it is based on VM energy consumption and balanced resource utilization which leads better energy efficiency. The experimental result of the proposed energy efficient scheduling algorithm is compared with existing approach the energy based efficient resource scheduling algorithm (EBERSF) [14] and energy efficient utilization of resources (EEUR) [15] is illustrated in Figure 2.

The Proposed algorithm the resources are balanced among the hosts which leads further minimization of energy consumption when compared with EBERSF and EEUR algorithm where the resource utilization are not balanced.

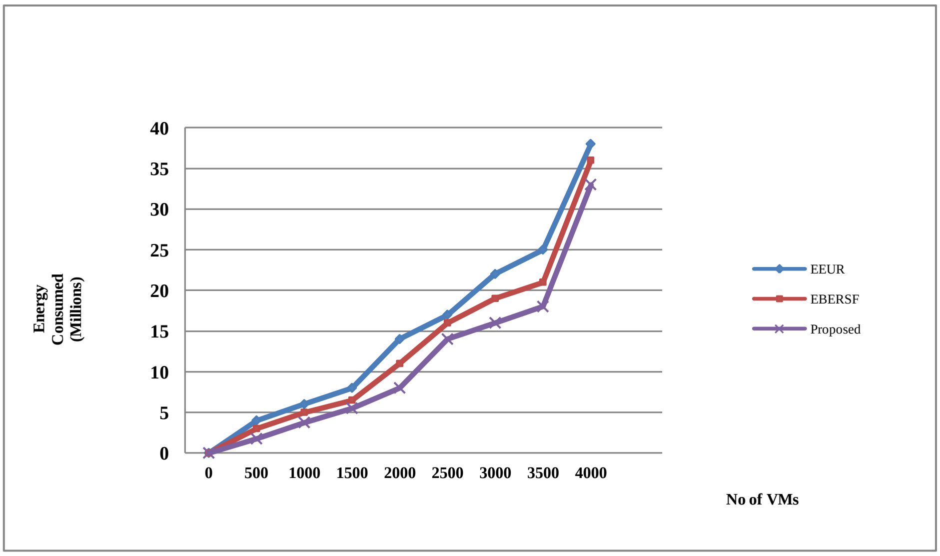

Figure 2 Comparisons between Proposed, EBERSF, EEUR Technique to minimize energy consumption

5. CONCLUSION

In this proposed technique, the energy consumption is minimized and is based on VM energy consumption and balanced resource utilization. We schedule the VMs using the proposed energy efficient algorithm which leads further minimization of energy consumption when compared EBERSF and EEUR techniques. In this algorithm we consider both the VM and host energy consumption and classify the VMs based the resource usage and schedule them in such way to balance the resources utilization among the hosts in the cloud data centre and the VMs are allocated to hosts that provides the least increase in energy consumption. This technique results in minimizing energy consumption and heat dissipation is reduced which leads to green environment.

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