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Effective Approaches for Preserving Energy Consumption in Cloud Computing

Sonya. A[1], Kavitha. G[2]
Department of Information Technology
B. S. Abdur Rahman Crescent Institute of Science and Technology
Chennai, Tamil Nadu, India

***Abstract*:- Cloud Computing offers a dynamic provisioning of worker abilities as an adaptable virtualized administration. Cloud hosting data centers consume a great amount of energy that results in high operational costs. The count of physical machines can be minimized by consolidating heterogeneous workloads by using the proposed algorithms are Workload-aware Consolidation Technique (ESWCT) and the Energy-aware Live Migration algorithm using Workload-aware Consolidation Technique (ELMWCT) and then idle servers are switched off to reduce energy consumption. The execution time for each migrating VM and other physical servers for migrating VM placement has been considered. The resources are utilized effectively and the energy consumed is reduced efficiently. Thus, the performance of the system is improved. Additionally recognize the exhibitions measurements that are expected to assess the proposed work execution.**

Key Words – Cloud Computing, Virtual Machine, Scheduling Algorithm and Energy Consumption.

I. INTRODUCTION

Cloud Computing is a web based processing which gives metering based administrations to consumers. It implies getting to information from a brought together pool of figure assets that can be requested and devoured on request. It additionally gives registering assets through virtualization over internet [1].

Data center is the most prominent in cloud computing which contains assortment of workers on which business data is put away and applications run. Server side which incorporates workers, links, air conditioner, network and so forth devours more force and deliveries enormous measure of Carbon-di-oxide (CO2) to the climate. Perhaps the main challenge looked in cloud computing is the improvement of Energy Utilization.The solution was approached by determining the time to migrate a VM from an oversubscribed host, which is done to achieve a minimized cost with a reduction in energy consumption. Determining the cost of an optimal offline deterministic algorithm along with its competitive ratio have been discussed. Furthermore, proposal of an adaptive method for dynamic consolidation of VMs that utilizes resource usage historical data by VM is discussed. The proposed method ensures reduced energy consumption, while following the SLA. However, it considers only single VM migration and is not applicable for more complex workload problems.

[2][3] Techniques to automate tasks of system resource usage monitoring, determining a new mapping, detecting hotspots and initiating migrations using grey-box and black -box strategies have been discussed. Sandpiper system is utilized to support gray-box, black-box, or combination of both techniques. As the black-box approach is more like an OS and application-agnostic, migration and effective detection of hotspots became an important aspect for the research. But it cannot automatically determine to migrate a VM or spawn a replica in order to garner more resources. An implementation of a prototype system within the state operational cloud infrastructures with real world applications demonstrators is also discussed. The proposed method reduces data centre energy consumption costs. But it increases becoming conscious about the environment.

An experimental approach to solve the complexities performing power optimization consolidation [4]. The results of the experimental studies provide an insight on the variation of performance, resource utilization and energy usage factors when common servers are used to combine multiple workloads with changing resource usage. The proposed method finds a minimal energy allocation of workloads to servers [5]. It resolved the consolidation problem and improves resource utilization and performance. Three new online mechanisms to solve the issues are presented. Initially, a pro-active approach that uses information in a stochastic queuing model to perform control, it also predicts workload behavior for the near future. Secondly, reactive model that achieves the same goals by using feedback control. Third is a hybrid approach that uses predictive information from the pro-active model to provide server and feedback control from the reactive model for DVS. It was able to achieve good savings on energy while adhering to the SLA. Optimization of energy in multiprocessor environments can be achieved using the techniques proposed.

II. METHODOLOGY

ARCHITECTURE DIAGRAM

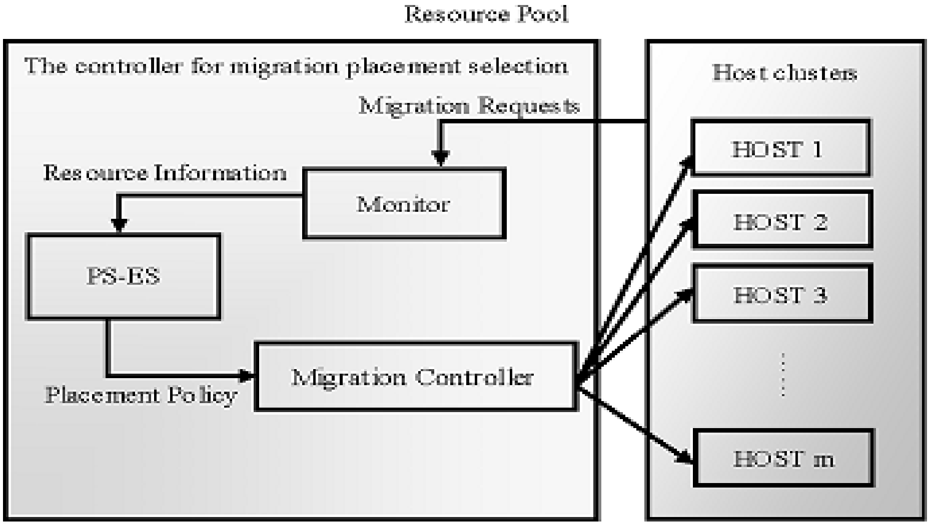

Figure 1 Architecture Diagram

The cloud receives applications from multiple users that need execution. The virtual machines execute every application in the host allocated to them. Each host measures the utilization of resources and the hosts that have a less utilization index is put in switch off mode. Thus, virtual machines that are running on underutilized hosts are migrated to the target host that is optimally utilized and offers same execution speed. The underutilized host is switched off on successful migration of VM to the target host. The architecture diagram of energy aware task scheduling is described in the Figure 1.

SCHEDULING ALGORITHM

On arrival, a VM is rented to the application by a cloud server. In ESWCT algorithm, and considering the resource consumption, the VM is placed to achieve a better equal usage of resources. There are three basic steps for the ESWCT algorithm:

1) Manipulate capability of every component for each physical server
2) Get capability of every component of the VM
3) Assign VM to the server that has the smallest value of IUV

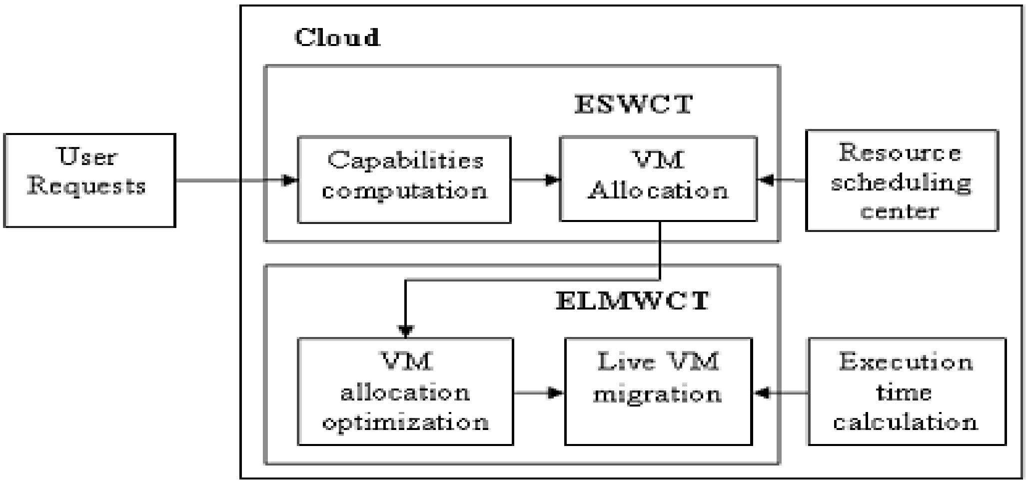

Figure 1.2 Block Diagram of Scheduling Algorithm

VM provisioning by admitting new applications and placement of them on the VM server is done using this algorithm. A minimum number of physical servers with consolidated heterogeneous workloads ensure utilization of all the resources provided in the cloud data centers, which helps in putting the unused servers to sleep mode thus reducing energy usage. The second part of VM allocation includes handling migration of VMs and optimizing the current VM allocation. As mentioned earlier, ELMWCT is the second part of VM allocation, it optimizes the current VM allocation following two steps: First, it selects the VMs that need migration. Node utilization threshold vector is used to determine which VMs need migration. If a single physical machine has lower utilization threshold for CPU, memory and network than the given utilization threshold. The second step again uses the ESWCT algorithm to allocate the selected VMs to other physical machines. Once migration from one physical machine to the other is done, the former is put to sleep mode thus reducing power consumption. The block diagram of scheduling algorithm is described in the figure 1.2.

Algorithms use the following steps for scheduling:

1) Cloud data center receives requests from all the users

2) The required resources are allocated for VMs by the cloud data center. Cloud data centers have a resource scheduling center that allocates the VM to a dedicated physical server using ESWCT algorithm.

3) The arrival of application is unknown by the resource scheduling center. ELMWCT is used to migrate running VMs to fully utilized VM servers and putting in sleep the underutilized physical servers to achieve power saving.

Underutilized physical servers' are located by calculating the average utilization of all CPUs in a cloud data center with the help of the following equation (1)

$$CPU_u^A = \frac{\sum_i^N CPU_i^U NUM_i^{cpu}}{\sum_i^N NUM_i^{cpu}} \qquad ....(1)$$

where,

CPU_u^A is average utilization of all CPUs

N is total number of physical servers in cloud data centre

NUM_i^{cpu} is total number of CPUs of server i

CPU_i^U is current average CPU utilization

Similarly, average memory utilization and average network bandwidth can be calculated using the equation (2)

$$IR_A^U = \frac{CPU_u^A + MEM_u^A + NET_u^A}{3} \qquad ....(2)$$

Where,

IR_A^U is Integrated resource utilization of a cloud data centre

CPU_u^A is average utilization of all CPUs

MEM_u^A is average memory utilization

NET_u^A is average network bandwidth utilization

III. CONTRIBUTION

Execution Time Consideration

Considering the execution time of migrating VM, to reduce the energy usage in cloud server can be achieved, for this the expected execution time to migrate VMs are calculated. If VM having long execution time is migrating to a PM which having its own VM with lesser execution time, the VMs with lesser execution time will be completed early and this newly added longer execution time VM only will run. If that particular server doesn't have this newly added VM means after all of its VM gets completed, it can be switched off earlier. The energy consumed by that server will be reduced. The long execution time of physical server can be reduced by matching the execution times of target PM and migrating VM. The former, being underutilized is then put into sleep mode, thus reducing the energy consumption. Less execution time of migrating VM is placed into the similar execution time of physical server to free the physical server in the early hours.

IV. IMPLEMENTATION

4.1 FUNCTIONAL DESCRIPTION OF MODULES

- Capability Computation
- VM Allocation
- Workload Consolidation
- Optimization of VM allocation
- Execution time calculation

4.1.1 Capability Computation

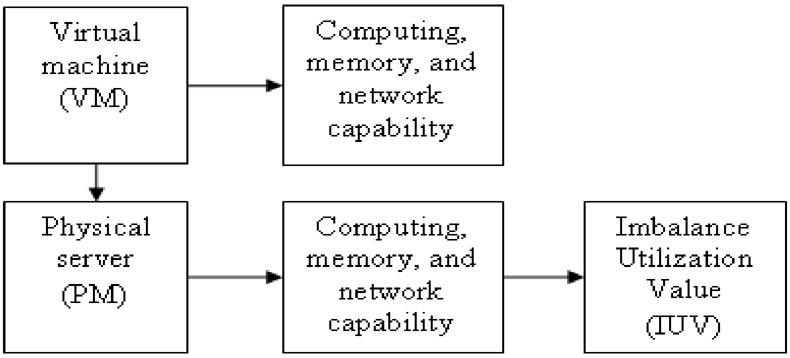

Figure 4.1 Capability Computation

For selecting the physical machine to be allocated to the VM, the various hardware resources are taken into consideration (CPU, network cards and memory). Considering that d denotes a dedicated reference server, rcd is used to indicate its computing potential. Millions of Instructions per Second (MIPS) is used to measure rcd. The difference in the computing potentials of VMs' is measured using a K x L CCM C, i.e. the computing potential of K types of application, executing on L types of physical servers. ESCWCT algorithm individually determines the capability of each and every component available on physical servers, shown in figure 4.1.

4.1.2 VM Allocation

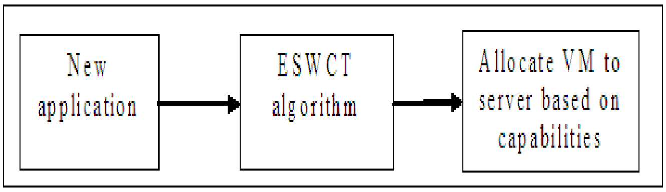

Figure 4.2 VM Allocation

The dedicated reference VM is denoted by dv and the computing capability of the same is indicated using ricdv, and the application that needs allocation of VM is indicated by i. Te computing capability of a server h is denoted by rch that can be measured by MIPS. The remaining computing capability of the VM which is needs placement is computed considering memory and network capability of the same. Provision of resources by the cloud data center in the form of VM is outlined in figure 4.2.

4.1.3 Workload Consolidation

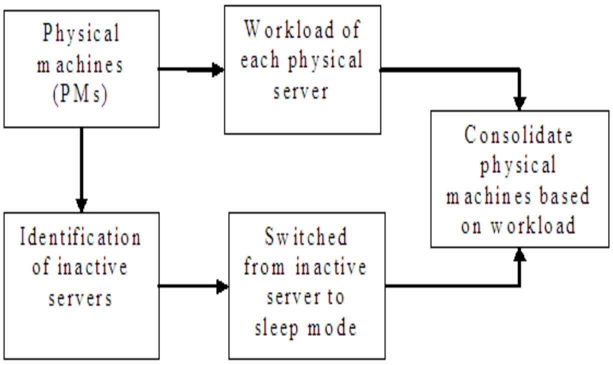

Figure 4.3 Workload Consolidation

Consolidation of heterogenous workloads helps in achieving a minimum number of physical machines that ensures proper utilization of all the resources provided in cloud data centers. This aids in reducing energy consumption as idle servers are put into sleep mode. Figure 4.3 outlines a deterministic way to dictate the workload of each physical machine so as to attain a minimum number of maximum physical machines and inactive server.

4.1.4 Optimization of VM allocation

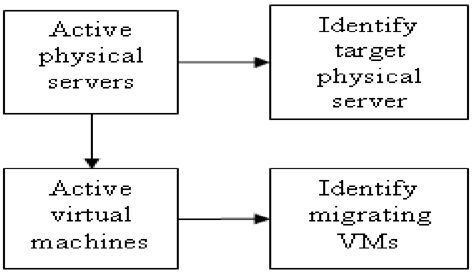

Figure 4.4 Optimization of VM Allocation

The current VM allocation is optimized by using the ELMWCT algorithm which follows two steps. Firstly, the VMs that need migration are selected. A node utilization threshold vector is used to determine the VMs that need migration. The resources are CPU utilization, memory bandwidth and network usage of a physical machine is calculated and compared to the existing node utilization threshold vector. If the utilization value is below the node utilization threshold vector, then all the VMs pertaining to that physical machine need to be migrated to other physical machines. Imbalance Utilization Value (IUV) is obtained while finding migrating VM in cloud data center, that is based on individual average of current memory, CPU and network bandwidth utilization.Figure 4.4 shows the optimization of VM allocation.

4.1.5 Execution time calculation

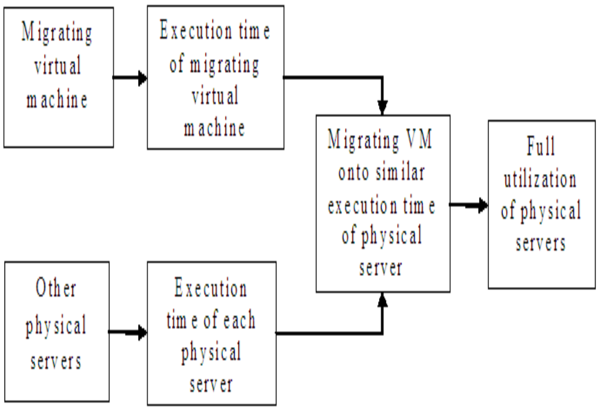

Figure 4.5 Execution Time Calculations

The arrival of applications and the life cycle of VM is completely unknown to the resource sharing center thus making the resource scheduling at the cloud data center a dynamic scheduling problem. ELMWCT algorithm is used by the resource scheduler to migrate the VMs from the underutilized physical servers to physical servers under full usage. The execution time of VMs that need migration are calculated. Target PM is identified by determining a PM that contains a VM whose execution time is closest to the VM that needs migration. This execution time matching between VM and PM helps in reduction of long-time execution time at the physical server. After this the target PM is assigned to the chosen VMs. Once all the VMs finish migration from their former physical machines to the target PM the former physical machines are put to sleep mode, this ensures reduction in power consumption. Execution time calculation is shown in figure 4.5

V. RESULTS

In the proposed framework, the objective of the algorithms was to achieve reduction in energy consumption by considering the heterogeneity of workloads that were characterized by individual resource consumption capacity. Measurement attributes such as imbalance utilization value and average utilization of resources of a cloud data center were introduced for providing space for comparative study of the proposed scheduling algorithms with other existing algorithms. The algorithms were introduced around the objective to achieve reduced power consumption in cloud data centers. They presented ideas to perform live migration of VMs. Sleep mode for underutilized servers are a huge factor that impacts energy consumption. The consideration of execution time while migrating VM and other PM helps in further achieving the objective of energy efficiency.

Before Migration

User ID	Host ID	Utilization	Power
4040	0	0.01	0.7602
4040	1	0.02	0.901
4040	2	0.01	0.626
4040	3	0.01	0.569
4040	0	0.01	0.689

After Migration

User ID	Host ID	Utilization	Power
4040	0	0.01	0.505
4040	1	0.02	0.51
4040	2	0.02	0.51
4040	3	0.01	0.5
4040	0	0.01	0.505

Table 5 Scheduling Results

Calculation of scheduling results considering the resource usage and energy consumption of each host before migration is done. These are results help in determining the hosts that are underutilized and can be put into sleep mode. Once these underutilized hosts are put into sleep mode the VMs that were present in these hosts need to be migrated to another host that offers a similar execution time. After migration, again, the scheduling results for each host are calculated. These results are displayed in table 5.

5.1 PERFORMANCE METRICS

The following parameters have been analyzed

- Resource utilization
- Energy consumption

5.1.1 Resource utilization

Utilization of resources by individual hosts before and after migration are calculated and tabulated in table 5.1 and 5.2 respectively.

S.No.	**Host ID**	**Utilization**
1	0	0.01
2	1	0.02
3	2	0.01
4	3	0.01

Table 5.1 Utilization before Migration

S.No.	**Host ID**	**Utilization**
1	0	0.01
2	1	0.02
3	2	0.02
4	3	0.01

Table 5.2 Utilization after Migration

The resource utilization by each server after migration is maximum when compared to the resource utilization of the same servers before migration, this can be seen in the graph in figure 5.2.

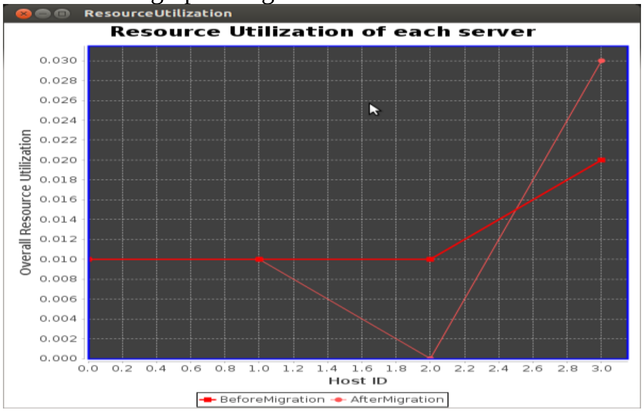

Figure 5.2 Resource Utilization Graph

5.1.2 Energy consumption

The calculations of energy consumptions by individual hosts before and after migrations are tabulated in table 5.3 and 5.4 respectively.

S.No	**Host ID**	**Power**
1	0	0.760
2	1	0.901
3	2	0.626
4	3	0.56933

5.3 Before Migration

S.No.	**Host ID**	**Power**
1	0	0.505
2	1	0.51
3	2	0.51
4	3	0.5

5.4 After Migration

The energy consumption by each server after migration is minimum when compared to the energy consumption of the same servers before migration, this can be seen in the graph in figure 5.3.

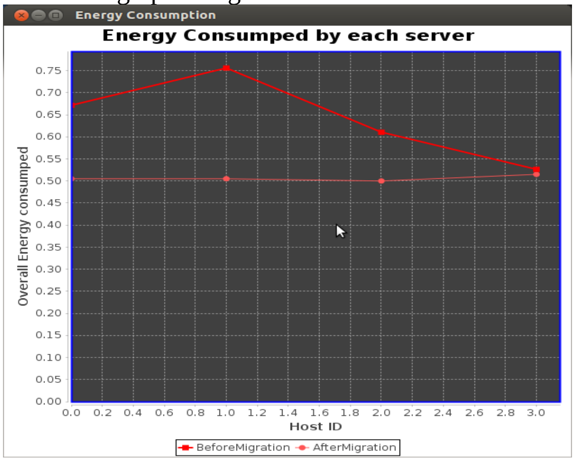

Figure 5.3 Energy Consumption Graph

VI. CONCLUSION

The ESWCT algorithm, considering the resource consumption, aids in determining the physical server where a VM needs to be placed so that it gets a better usage for the utilization of resource components. First part of VM allocation is ESWCT algorithm. Placement of VM on physical server for new applications is determined by ESWCT algorithm. Consolidation of the various workloads to a minimum number of physical machines helps in proper utilization of the resources available at the cloud data center. Putting the underutilized servers to sleep mode further helps in reducing the energy consumption. ELMWCT algorithm is capable to migrating VMs dynamically from underutilized machines to machines that are under full usage, which further reduces power consumption. Thus, the goal of reducing power consumption and increasing resource utilization has been achieved. The cloud data centre will continue to expand and evolve over the years, because of which there is always an urge for optimizing the energy.

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