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A Systematic Review of VM Scheduling Schemes for Energy Optimization in Cloud Environment

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Abstract: ***In Cloud Computing energy consumption is the crucial issue for VM scheduling. In current scenario, lot of companies and institutes wants their own cloud environments such as IaaS, SaaS, and PaaS for their benefits. For efficiently executing cloud environment a scheduler is required for Virtual Machines which schedule VMs as per their requests from consumers. The work of scheduler is to scheduling number of virtual machines available in cloud environment requested by the consumer so that by utilizing less resource using loads balancing to save maximum energy. In this paper, we concentrate on different algorithms and techniques which help to saving energy consumption by virtual machines in cloud environment.***

Keywords: Schedule; Virtual Machine; Load balancing; Ranking algorithm; MBFD; PDABFD.

I. INTRODUCTION

Cloud computing is a computing term which based on utility, consumption and sharing of computer resources. Cloud computing can also be categorized as a new paradigm for the online provisioning of computing software, hardware, data as a service through different pricing models like, reserved or leased, on-demand, spot, pay-as-you-go. Services provided by the Cloud computing is Infrastructure as a Service, Software as a Service, and Platform as a Service. The cloud can be basically deployed as private, public or hybrid.

Basically the cloud computing was evolved by adopting existing technologies and paradigms. The goal of cloud computing paradigm is to give easy access and benefits of cloud without knowing the depth of technology. The cloud consists of servers (Hardware) which consumes power and energy and release carbon dioxide.

The main technology that supports cloud computing is virtualization. Virtualization software splits a physical computing device or physical computer into one or more virtual computers, each of which can be work separately. The benefits for consumer of cloud is that they have to purchase only internet connection and they can use license copy of software. Consumer had no vary about installing operating system or applications or update them or anything. This problem is tackled by the service providers from whom they purchases the services. Cloud computing is available as open source and commercial base for cloud developers. Virtualization can be deployed by different hypervisors namely KVM, VMware, Xen, Virtual box, Eucalyptus etc. The services can be offered by on the bases of energy, power, pay-per use, on-demand models. The hardware of computer system consumes highest energy. Energy consumption is increases when usage for no of computer resources increases.

In previous years there are many variations of scheduling methods called First Come First Serve, Shortest Job First, Priority, Round Robin, Greedy, and Back Filling. These all are used in operating system for scheduling user processes. In this paper we give a review on energy saving scheduling algorithms with respect to maximum load balancing.

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II. Review of Energy Optimization Schemes

In this paper we refer many algorithms, methods, approaches, paradigms, techniques, schemes for how to scheduling virtual machines running on physical hardware and also focus on less energy consumption, resource optimization , load balancing, and no misuse of physical machine's resources.

A. Beloglazov et al., [2] proposed a scheduling scheme where the problem of VM allocation can be divided in two: the first part is the admission of new requests for VM provisioning and placing the VMs on hosts, whereas the second part is the optimization of the current VM allocation. The first part can be seen as a bin packing problem with variable bin sizes and prices. For solve that they use to solve it we apply a modification of the Best Fit Decreasing (MBFD) algorithm. The optimization of the current VM allocation is carried out in two steps: at the first step we select VMs that need to be migrated, at the second step the chosen VMs are placed on the hosts using the MBFD algorithm.This algorithm basically minimize the Migration of VMs.

Pinheiro et al., [6]. In this work the authors have proposed a technique for minimization of power consumption in a heterogeneous cluster of computing nodes serving multiple web-applications. The main technique applied to minimize power consumption is concentrating the workload to the minimum of physical nodes and switching idle nodes off. This approach requires dealing with the power or performance trade-off, as performance of applications can be degraded due to the workload consolidation. Requirements to the throughput and execution time of applications are defined in SLAs to ensure reliable QoS.

T. Thanavanich and P. Uthayopas et al., (2013) proposed an energy aware scheduling for the cloud called EHEFT is proposed. This algorithm trying to achieve more energy reduction while maintaining the same performance as much as possible. The approach of EHEFT is to use performance metric called *RE* to help identify inefficient processor in the system. Then, shutdown these processors and reschedule the task to some other processors. The simulation results show that the proposed method can help reduce the energy consumption without increasing schedule length substantially for many classes of parallel applications. The result of this work can lead to a more energy efficient cloud. In the future, the reduction of time complexity of this algorithm can be explored along with how to make more efficient use of DVS support that is built into the processor. Some extension to maintain the same make span for the task is one of the areas that will be investigated further. [7]

Devare et. al., (2010) implemented the Desktop Cloud system, at the University of Calabria. This system uses the idle resources of the desktops with permission of the owner. The system works on the ―utilization factor and mutual agreement between ―the scheduler strategies, owner and consumer. The various new cloud lease schemes and strategies are under development in Desktop Cloud System. [3]

Li et al., (2011) proposed Hybrid energy efficient scheduling algorithm which is use for private cloud computing. The algorithm which use dynamic migration. The experiment results shows reduce response time, conserve more energy and achieve higher level of load balancing. [5]

A. Beloglazov et al., (2010) proposed the underlying infrastructure is represented by a large-scale Cloud data center comprising *n* heterogeneous physical nodes. Each node has a CPU, which can be multicore, with performance defined in Millions Instructions Per Second (MIPS). The software system architecture is tiered comprising a dispatcher, global and local managers. The local managers reside on each physical node as a part of a Virtual Machine Monitor (VMM). They are responsible for observing current utilization of the node's resources and its thermal state. The local managers choose VMs that have to be migrated to another node. The local managers send to the global managers the information about the utilization of resources and VMs chosen to migrate. The system operation consists of New requests for VM provisioning, Dispatching requests for VM provisioning, VM migration, VM resizing, VM scheduling. [1]

R. Vijindra et al., (2012) proposed a Ranking Algorithm for virtual machines. By using the ranking algorithm, virtual machines are ranked based on the resources. The algorithm accepts the user request based on the job characteristics, it will goes to

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the resource broker, and after that it goes to policy prioritizer. The scheduler is responsible for priority policies, match making services of the user request. Ranking algorithm is used to rank the virtual machines (VMs). [8]

III. METHODS

A. *Modified Best Fit Decreasing (MBFD) algorithm:*

A. Beloglazov et al., [2] proposed Modified Best Fit Decreasing algorithm on reduce excessive power cycling of a server, minimization migration, and Best Fit Decreasing algorithm. Experimental results shows that can minimize energy consumption without compromising the user-specified QoS requirements. This algorithm follows two steps: VM Placement using MBFD algorithm, VM Selection.

1. *VM placement:*

In this VM is allocated into two parts: first is the new VM request and second is the optimization of current VM allocation. The first part is executed by using the Bin Packing algorithm with variable bin sizes and prices. To solve it they apply a modification of the Best Fit Decreasing (BFD) algorithm. In the Modified Best Fit Decreasing (MBFD) algorithms, they sort all VMs by their current CPU utilization in in decreasing. After that each VM is allocated to a host that provides the least increase of power consumption due to this allocation. The complexity of the allocation part of the algorithm is n * m, where n is the number of VMs that have to be allocated and m is the number of hosts.

2. *VM selection:*

The second part of the VM placement is the VM optimization which is again divided into two steps of the current VM allocation: at the first step they finds the list of VMs that need to be migrated, and in the second step they use the MBFD algorithm for the placement of VMs. To determine which VMs can be migrated is a complex task. So, for that they use three policies and decides which VMs should be migrated and when. For the policies they set upper and lower limits of utilization of hosts. The limits for total utilization of CPUs for the all VMs of the each hosts. There are two situations first the CPU utilization of a host crosses below of the lower limit then all VMs of that host have to be migrated to other hosts and this host gone to the sleep mode to achieve idle power consumption. In the second situation the CPU utilization of host crosses the above of the upper limit some of the VMs of this host are to be migrated to other hosts.

The proposed VM selection policies are discussed below:

2.1 The Minimization of Migrations (MM) policy:

This policy decides how to minimize migration of VMs from one host to another so the CPU utilization falls under the lower and upper utilization limits.

2.2 The Highest Potential Growth (HPG) policy:

This policy migrates only those VMs whose CPU usage is lowest relative to the capacity of CPU defined by the VM parameters to minimize migration and maintain SLA rules.

2.3 The Random Choice (RC) policy:

This policy works when the CPU utilization exceeds the upper utilization limits and select random number of VMs for decrease the CPU utilization.

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B. Energy Efficient Scheduling Framework:

R. Vijindra et al., [8] proposed Energy Efficient Scheduling Framework on the energy efficiency of the data centers along with the minimum completion time, fair resource allocation, and load balancing. In this framework Ranking Algorithm is used for Virtual Machine management. In ranking algorithm the virtual machines are ranked by their resources.

Bellow Fig. 1. shows the procedure of Energy Scheduling Framework:

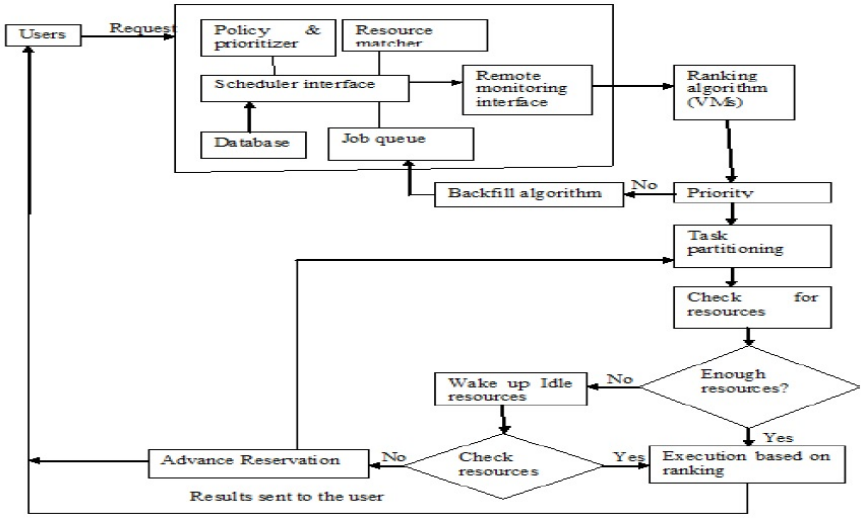

Fig. 1. Energy Efficient Scheduling Framework

Some steps of above figure is elaborated as a text bellow:

1. User sends the requests based upon the job characteristics they required with the performance criteria
2. The resource broker receives the user request. The user request will send to the resource broker
3. The Resource broker has to send user request to policy prioritizer who gives the priority to the user request based on the three policies without violating SLAs norms.
4. The responsibilities of the scheduler interface is responsible for deciding priority policies, find proper services of the user request, and also save the users history in the database.
5. Now the scheduler interface holds the job queue for the low priority jobs
6. The work of remote monitoring interface is to monitor the jobs that are in processing, waiting, or status of available resources and so on.
7. The rank is given to the VM by Ranking Algorithm where ranking is given as per the categories such as CPU resources, Memory resources, bandwidth resources, and online resources for complete the jobs speedily.

Above steps of the procedure gives the idea of accept the use request and its management.

This framework can achieve lower completion time, high efficiency factor, and guaranty of high performance by using Ranking algorithm.

C. Power and Data Aware Best Fit Data (PDABFD) algorithm:

P. Kumar et al., [4] proposed Power and Data Aware Best Fit Data algorithm which is the modification of Best Fit Data algorithm along with the better resource utilization and thus less power consumption. The efficient consolidation of VMs is saving the power. The proposed algorithm sorts the list of VMs available by their CPU utilization and allocates these VMs to proper Host by keep in the knowledge for proper data and allocation of resources.

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Algorithm PDABFD

1. Sort VM (1, 2 …k) in order of their decreasing CPU utilization
2. **For** every V_i in V (1, 2 …k) perform

   minPower := Max

   allocatedhost := elist[ ]
3. **For** every M_j in M (1, 2 ...n) perform

   If M_j has enough resources for V_i **then**

   Power := estimatePower (M_j, V_i)
4. **If** Power < minPower **then**

   Allocatehost := host

   minPower := power
5. **Elseif** allocatehost= NULL **then**

   Add (allocatehost, V_i) to NextVM
6. **return** NextVM

In the proposed methodology needs two managers as local and global. All virtual machine consist Local manager and master node contains global manager which is responsible for collecting information from the local managers for better resource utilization.

IV. Comparison of Energy Optimized Algorithm

Table I list outs the algorithm or framework, approach, and scheduling parameters used in different VM scheduling algorithms and framework. Also compares advantages and disadvantages of various VM scheduling algorithms and framework.

TABLE I

	MBFD ALGORITHM	**PDABFD ALGORITHM**	**RANKING ALGORITHM**
Parameters used	Sort all VMs in decreasing order of their current CPU utilizations.	Power and data constraint together on BFD algorithm.	VMs are ranked based on the classification of resources.
Method/Approach	Using three different migration policies scheduling is made.	Scheduling is done using proper allocation of resources and data awareness.	Scheduling is done based on the job has priority or not. Based on that VM is allocated.
Advantage	Live migration: The images and data of VMs are stored on Network Attached Storage (NAS) so, copying then VM's storage is not required.	Efficient consolidation of VM can increase power saving.	Considers three problems: response time, load balancing, and reduce the energy consumption of the data centers
Disadvantage	Live migration: It creates extra CPU load.	Collecting power and data information of job may reduce response time.	Cannot allocate VMs dynamically.

V. Conclusion

Resource (VMs) allocation and scheduling is a key issue in the cloud computing environment. In this paper we survey and compare three existing VM scheduling algorithm which is mainly based on reduce energy consumption. The comparison and analysis of different existing VM scheduling algorithm or framework in the cloud computing environment has carried out depending upon various parameters used by that algorithm. Currently, we are just compare parameters that are given by the author of that algorithm or framework, no implementation is done to evaluate the performance of algorithm. VM scheduling

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framework / algorithm should include user and service provider's benefits. In the above study of different VM scheduling we found that no paper has specified dynamic VM allocation means no one VM is available for user's request than user has to wait for VM became free in the case of priority request based on reservation or on-demand. Our future work will be based on the above study to develop an auto scheduler which manages VMs as per the users request based on the reservation or on-demand which reduces power consumption and saving energy of data centers in cloud environment.

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