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HM-VM-AM – A HEURISTIC VS META-HEURISTIC APPROACHES FOR VMS ALLOCATION AND MIGRATION IN CLOUD COMPUTING

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ABSTRACT- Cloud computing survives on the basement of virtualization technology. Implementation of efficient load balancing algorithms leads to proper distribution of dynamic workload among multiple nodes in cloud Data Centre (DC). So that proper utilization of resources in DC is assured. VM load balancing is a NP-hard problem. Live migration of VMs, become one of the necessary activities in DC for maintaining Service Level Agreements (SLA) and minimizing the number of servers in running state. Researchers are trying to use hybrid model of algorithms accompanying meta-heuristic vs. heuristic algorithms for VM placement and VM migration respectively to reduce the solution space and time cost. The echolocation activity of Bat can be applied to find optimized results in VM placement. To avoid local minima, it generates Non-Allowed Set of VMs inclusion of under-loaded and overloaded VMs which are analyzed for task allocation. In the centralized system, different metrics and threshold values are maintained to support the number of processes running locally and globally in DC. In distributed systems, these metrics are maintained in their shared storage. These metrics are updated periodically by the VM Manager and Task Scheduler running in the local Host Server (HS). A separate task running in the central system which periodically checks VMs status obtained from local VM Managers which will update number of PMs with under utilization and overloading metrics to select VMs for migration. The proposed Heuristic vs. Meta-heuristic approaches for VMs Allocation and Migration (HM-VM-AM) in cloud computing algorithm considers the Non-Allowed Set generated by the Bat algorithm. The number of VMs belongs to the same PM in this set is compared with that PM's threshold value. If it exceeds, it immediately updates the relevant metrics in the centralized system which initiates the migration process immediately, without waiting for that specific migration process's periodic checking. HM-VM-AM considers the existing efficient heuristic method named, IRIAL (Improved Resource Intensity Aware Load balancing) for selecting the destination PMs for VMs migration. It applies an Improved Multi-Criteria Decision Making (IMCDM) method to find lightly loaded PMs as well as heavily loaded PMs with less completion time of all its tasks. It also considers the resource intensities for selecting destination PMs which reduces the number of VMs migration, communication cost and time, and performance degradation. So the incorporation of job allocation and migration process would reduce the overhead of centralized system and maintains the SLAs.

Keywords: [Cloud Computing, Centralized System, Distributed System, Load balancing, VM Migration, Heuristic and Meta-heuristic algorithms.]

1. INTRODUCTION

Today everyone revives in this world with the provision of unlimited Internet connection in their electronic devices. Cloud computing is the known word to the public and most of them are handsome in utilizing cloud services in their day-to-day life activities. Its familiarity increases the demands to Cloud Service Providers. In today's world, most popular businesses are depending upon cloud computing to provide enormous service to their customers. Apart from their regular online transaction processing, so many analytical processes are going on in the background to analyse the behaviour of their customers to provide customized service to them and lead successfully in the business. CSPs are in demand to meet customers' requirement, maintain satisfaction by sticking on SLAs, and to utilize the resources at the DC optimally to achieve green computing. Virtualization technology lies under the cloud have come across static and dynamic methods of resource allocation. Heterogeneous service requirements demand dynamism in virtualization at DC. Various researches are going on to predict the customers demand in advance. The physical machines' (PMs) resources are allocated to VMs based on the demands.

Different stages of researches are going on from PM level to VM level, from VM's task allocation to VM migration, and when to switch on the PM to shutting it down. The algorithms revive from direct mapping to intelligent mapping techniques. Researches start from heuristic, meta-heuristic, to hybrid techniques for VMs management. Heuristic algorithms is for finding good solution to the VM mapping problem by considering different meta information like cost, SLA, number of migrations, etc., Researchers pond with nature have tried to use their analysed biological model of natural object in this VM management area. The found algorithms named as Meta-heuristic algorithms are inspired with nature and are based on population evolution. Based on the previous researches meta-heuristic algorithms is preferred for VM placement and heuristic algorithms for VM migration to reduce the solution space and time cost [10]. It leads to dynamic solution. Among bees, swarm intelligence, fish and ant colony systems, the biological behaviour of Bat attracts the researchers recently.

The echolocation activity of Bat can be applied to find optimized results in VM placement. Apart from finding appropriate VM for execution of incoming task, it recognizes some of the VMs as Non-Allowed Set which includes under-loaded and overloaded VMs. The under-loaded VMs finding during VM allocation process itself is focused in this proposed work. The existing heuristic method named Improved Resource Intensity Aware Load balancing (IRIAL) method is applied to select PMs for VM migration. IRIAL applies an Improved Multi-Criteria Decision Making (IMCDM) method to find lightly loaded PMs as well as heavily loaded PMs with less completion time of all its tasks. Its testing result shows better performance, reduced computational cost and execution time for load balancing in cloud. The combination of Heuristic vs. Meta-heuristic approaches for VMs Allocation and Migrations in cloud computing leads a hybrid model of HM-VM-AM algorithm which combines both allocation and migration processes and reduces the overhead of centralized system.

2. LITERATURE SURVEY

Research in finding optimal load balancing solution to cloud computing is a never ending interest. In [1], it was proposed with State-Based Load Balancing (SBLB) algorithm which considers cost aware, load aware, and load aware over cost brokering algorithms for selecting DC, and analysing the state of VM for task scheduling. The state of VM is updated to the center controller system in the DC. In [2], the proposed Dynamic Load Balancing with effective Bin Packing and VM configuration (DLBPR) approach processes the jobs within their deadline and balances the load among the resources. The incoming jobs

were classified and stored in a different job queue. It clusters the VMS dynamically and then jobs were mapped into a suitable VM existing on the cluster. TOPSIS algorithm in [3] was proposed for migration of VMs between cluster nodes. It selects the optimal overloaded server for VM migration using the fuzzy decision making system.

A soft computing Genetic Algorithm (GA) based load balancing strategy [4] was proposed to reduce the completion time of a given task. It is composed of three operations are population generation, crossover and mutation. From the generated population, best fitter pair of individuals was selected for crossover process. The mutation probability results the mutation value, the bits of chromosomes were toggled from 0 to 1 or 1 to 0. It eliminates the challenge of inappropriate distribution of the execution time which increases the traffic on the server. The stochastic hill climbing in [5] was simply a loop where over utilized VMs moved in the direction of increasing value which is uphill. It evaluates each element of the set was evaluated according to some criteria designed to move closer to a valid assignment which improves the evaluation score of the state. Honey Bee Behavior inspired Load Balancing (HBB-LB) algorithm [6] was proposed for maximizing the throughput. It considers the tasks priorities which minimized the waiting time of tasks in a queue. A collaborative agent based problem solving technique [7] was proposed with agents with migration heuristics to determine which VMs should be migrated based on the consideration of other facts in the migration process such as destination hosts, migration policies, etc. It monitors and balances different workload types in a distributed manner. The variant intensification and diversification process behaviour of Bat algorithm can be utilized for initialization and updation of parameters was proposed in [8] to achieve more optimized results in load balancing.

An Improved Resource Intensity Aware Load balancing (IRIAL) [9] method was proposed in cloud for load balancing. It considers the different resource intensities of each PM to assign different weights to them which is considered for choosing VMs for migration. It uses IMCDM method for finding the suitable destination PM based on its needed resource's intensity. It maps it to even overloaded PM, if it has such expected level of resource.

Among all sort of researches are going on with their own merits and demerits, the DC is provided with number of schedulers, and managers which are incorporated with direct algorithms or hybrid one. The DC is managed either in a distributed manner or centralized way. The scheduling and management algorithms runs in different stages of resources at DC, updates either centralized manager or in shared storage resources. It depends upon the policies followed in the DCs. The proposed methodology utilizes Bat meta-heuristic algorithm for VM allocation in load balancing as well as the heuristic algorithm IRIAL for VM migration. This hybrid model leads to the proposed HM-VM-AM algorithm to support load balancing and migration processes in Cloud Computing.

3. DESIGN OF BAT ALGORITHM AND IRIAL

3.1 BAT ALGORITHM FOR LOAD BALANCING IN CLOUD COMPUTING

In this algorithm, tasks are considered as artifical bats and VMs are treated as their prey. It avoids the revisitng of same solution again. [11].

Input: Initialization of Bat algorithm parameters: position, loudness and velocity Define set of VMs Define set of tasks Find the resources required for the execution of tasks Utilize the Bat algorithm to select optimal VM which can fulfil the task requirements with the consideration of its available resources Use Tabu search to avoid trapping into local minima. It blocks neighbours of selected VM for current iteration. Under-loaded and overloaded VMs are added into Non-Allowed Set. The process is being repeated to select optimal VM. Bat algorithm is applied to solve

various complex problems by changing its state from exploration to exploitation state very quickly. The supporting, Tabu search algorithm, generates Non-Allowed Set which avoids local minima problem faced by Bat algorithm [11].

3.2 DESIGN OF IRIAL

It is a two-stage approach for finding suitable solution for VMs migration. First one is selection of VMs to migrate and the next stage is selection of PMs for mapping migrating VMs [9].

3.2.1 SELECTION OF VIRTUAL MACHINES TO MIGRATE

1. In IRIAL, the resources of each PM are provided with weight value based on their usage intensities.
2. The weight value of resources are considered to analyse the load of the PM to select its VM for migration and to act as the destination PM for others migration.
3. Every PM periodically checks their utilization of their each type of resources to analyse whether any of the resource is overloaded.
4. Over utilized resources makes the PM as overloaded and trigers migration process by using Multi Criteria Decision Making (MCDM) method.
5. MCDM considers the completion time along with the resource utilization, the most effective VM is selected to migrate.

3.2.2 SELECTION OF DESTINATION PMS BY GLOBALLY MAPPING MIGRATION VM WITH PMS

While selecting destination PMs to migrate the selected VMs, there are different measures such as communication cost of VM, performance degradation and resource intensity are considered.

Along with these measures the expected completion time of both heavily loaded PMs and lightly loaded PMs are also considered.

The weight of jobs represents the priority of migrating the resource out from overloaded PM. Thus, it indicates the priority of considering available resource in selecting destination PMs.

By considering different measures, the Euclidean distance of each candidate PM from the ideal PM.

The PM which has lowest distance is selected as the destination PM. Thus, the IRIAL technique is balancing workload effectively.

IRIAL were evaluated in terms of communication cost reduction, number of migrations and performance degradation [9].

4. THE PROPOSED HM-VM-AM

VM load balancing algorithms have different constraints based on their implementing type of cloud such as public cloud, private cloud, and hybrid cloud. The load schedulers in cloud can be centralized or distributed. Red-Hat Virtualization Suite is the best known example of centralized controller which balances the VMs to hosts.

4.1 CENTRALIZED VS. DISTRIBUTED SYSTEM IN DATA CENTER

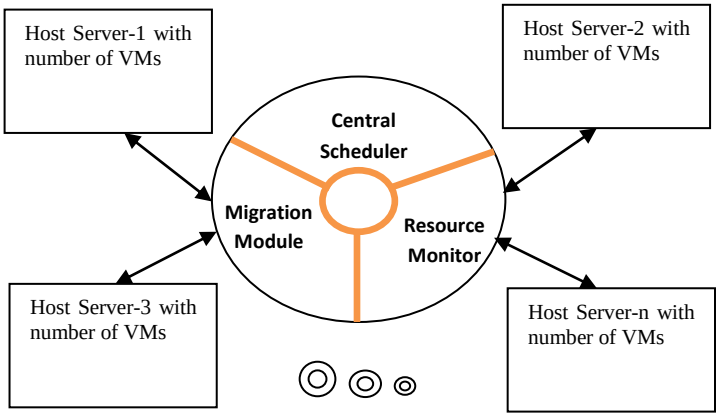

Figure 1. Centralized Scheduler in Cloud Data Center

The benefits of using centralized algorithm are it is easy to implement, attain global information immediately, and easy to maintain. The centralized system periodically checks and maintains the status of global attributes of its connected host servers which are utilized by number of modules running in the system for load balancing [10]. Various metrics maintained at DC includes load variance and standard deviation of utilization,

number of overloaded hosts, makespan, percent of all VMs to be located, throughput, standard deviation of connections, average imbalance level, number of SLA violations, quadratic equilibrium entropy, number of migrations [10]. These metrics are updated periodically by various processes running parallel in the centralized system. The access of these metrics are provided in controlled environment and strictly restricted from unauthorized access. Processes which are running in local PMs and in central system refer the` status of specific metrics to trigger relevant events accordingly. For example, agent system refers the workload status of DC to decide whether to submit its customer job to that specific DC or not.

4.2 DESIGN OF HM-VM-AM

Updation of metrics maintained in the central system or shared storage can be done by the management and monitoring processes running in the control system. When the metrics reach their threshold limit, relevant subsequent tasks may be triggered.

Initialization of Bat algorithm parameters: position, loudness and velocity Define set of VMs Define set of tasks Set threshold value for number of VMs in Non-Allowed Set per PM.

Find the resources required for the execution of tasks Utilize the Bat algorithm to select optimal VM which can fulfil the task requirements with the consideration of its available resources Use Tabu search to void trapping into local minima. It blocks neighbours of selected VM for current iteration.

Under-loaded and overloaded VMs are added into Non-Allowed Set.

Count the number of VMs belongs to same PM in the set.

Check whether the count exceeds its threshold setting value.

If it exceeds, update the metrics maintained in centralized system or in shared storage which will decide the initiation of VMs Migration process, IRIAL.

The process is being repeated to select optimal VM.

HM-VM-AM approach updates the number of overloaded hosts as well as number of under-loaded hosts. These metrics are referred by various processes running locally or global system for knowing the status of DC, PM, and VM and take decisions according. The main focus of these processes are maintaining the SLAs between CSPs and their customers, and reducing the makespan timings of customer tasks running in DC.

CONCLUSION AND FUTURE WORK

Bat algorithm has been used to solve many real world problems like feed forward neural networks, ergonomic work place problems, classification of gene expression data. The echolocation nature of bat makes it to locate and identify its prey in none of the time. It efficiently finds the distance between itself and prey, angular direction and target size. These features of Bat, leads to the development of standard Bat knowledge based algorithm for job scheduling in cloud computing environment by the researchers. It avoids local minima by generating the Non-Allowed Set separately which won't be included in further recent iterations of VM finding for migration. Further HM-VM-AM checks the set values relevant to the same PM are considered and compared with its threshold values of under-load and overload capacity. If it is less than the under-load limit or exceeds its overload limit, to stimulate migration process immediately. It helps to avoid SLA violations. The performance improvement, time and communication cost reduction of IRIAL method also incorporated in this work for selecting suitable PMs to migrate chosen VMs into it. Its IMCDM performs and leads to improvement in performance, reduction in cost of communication and time.

In future, the work can be extended to incorporate neural networks to train the system.

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