BANDWIDTH-AWARE HETEROGENEOUS TASK SCHEDULING IN CLOUD COMPUTING

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Abstract— With the advent of Cloud Computing and its tremendous use, Task scheduling has become an important issue that affect the performance of Cloud. Designing and implementing an effective Task scheduling algorithm for heterogeneous tasks is one of the ultimate goals of Cloud Providers. Focusing on the need of effective allocation of tasks (of different sizes) to the resources, a new scheduling algorithm is proposed for adapting to the heterogeneous size of user tasks. Mostly the task scheduling is done considering the CPU and memory requirements of resource. In this paper, in order to obtain better performance, the Bandwidth and CPU(MIPS) of the resource are considered for binding the tasks with most efficient resources to minimize the total make span. The algorithm is optimized using non-linear programming model. Results of the paper are evaluated using CloudSim toolkit. Results shows that compared to homogeneous Bandwidth-aware tasks scheduling, our proposed algorithm is more efficient.

IndexTerms—Cloud Computing, Bandwidth, MIPS, Task Scheduling.

I. INTRODUCTION

Cloud computing is a very fancy term used every now and then in the companies and within the individuals. Even the ones unaware of the term are using this technology. Gone are the days when one compromised with the cheaper technologies as they could not afford using their services. Pay As Per Use policy has increased it's use vastly.

Cloud Computing provides access to the shared pool of resources on-demand and with least efforts[9][10]. The services of the cloud are easy to use and access as one pays only on basis of usage. The cloud services are limitless, reliable and very cheap.

The various services offered by cloud Infrastructure are [1][2]:

- Infrastructure as a Services (IaaS): In this model, the consumers are provisioned with IT resources like storage, networking and computing.
- Platform as a Service (PaaS): In this model, the consumers are provisioned with the languages, libraries and tools required by users to develop the applications.
- Software as a Service (SaaS) : In this model, the consumers are provisioned with the services of application through browser, no administrative power other than that.

Cloud Computing being the hottest technology[11] in today's world has the massive request and tasks of users. Due to the increased workload, the efficient scheduling of user requests/jobs to the resources is very important[12]. Task Scheduling is the key challenge in Cloud Computing responsible for allocating the most suitable resources of the cloud for the user jobs considering the various factors that restrict the user jobs [3,4].

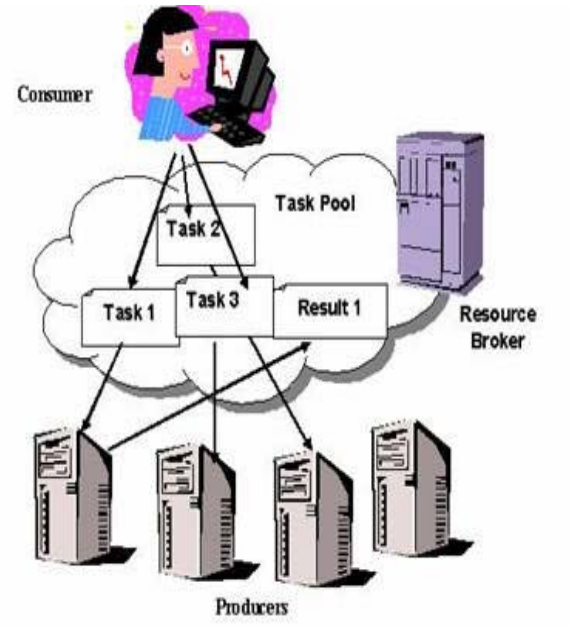

Figure 1. Task Scheduling in Cloud Computing

There are various good Scheduling algorithm that focuses on the CPU and memory requirements of the resource but there are only few that considers bandwidth as one of the factors to scheduling the user tasks on the resource. This paper focuses on efficient utilization of cloud resources with the tasks of variant sizes considering both the computing power and bandwidth of the resource for scheduling tasks.

II. RELATED WORK

Taoshen Li et. al.[5] proposed a scheduling algorithm for adapting to dynamic changes of user tasks. This algorithm considers the association relation between the dependent tasks and schedules the tasks accordingly. However it does not consider the size of tasks and the CPU and bandwidth of VM for scheduling.

Kong et. al. [6] proposed a task scheduling algorithm I virtualized datacenters with fuzzy prediction. This Computation-only task scheduling algorithm only takes into account the computing power and allocates the tasks entirely depending on the CPU power of the resource and does not consider the bandwidth.

Weiwei et. al. [7] proposed a bandwidth aware algorithm for task Scheduling in cloud computing environment. This algorithm takes into account the bandwidth and CPU power of resources for scheduling the tasks of same size. This algorithm however does not account for the tasks of different sizes.

III. SYSTEM ASSUMPTION

To achieve the optimized allocation scheme we formulated a model with various constraints as follows:

1. There are M different sized independent tasks to be scheduled.
2. The number of tasks to be allocated to each node should be less than or equal to M.
3. Bandwidth and computing power of VM is greater than zero.
4. Time spent on each node is less that or equal to total timespan.
5. Sum of bandwidth at each node is less than the upper bound of Bandwidth.

IV. ALGORITHM'S DESCRIPTION

The Algorithm's basic idea can be describes as:

1. At first, get the computing power and bandwidth of the Vms. Also get the information about the tasks which include the size of different tasks and the number of tasks.
2. This information is then passed on to the programming model for decision making of the scheduling.
3. We used Choco to build and solve the programming model and obtained the optimized scheduling scheme. So Choco solves the model based on the information passed and constraints applied.
4. The optimized allocation scheme is then obtained from choco and then tasks are allocated to the Vms according to optimized scheme.

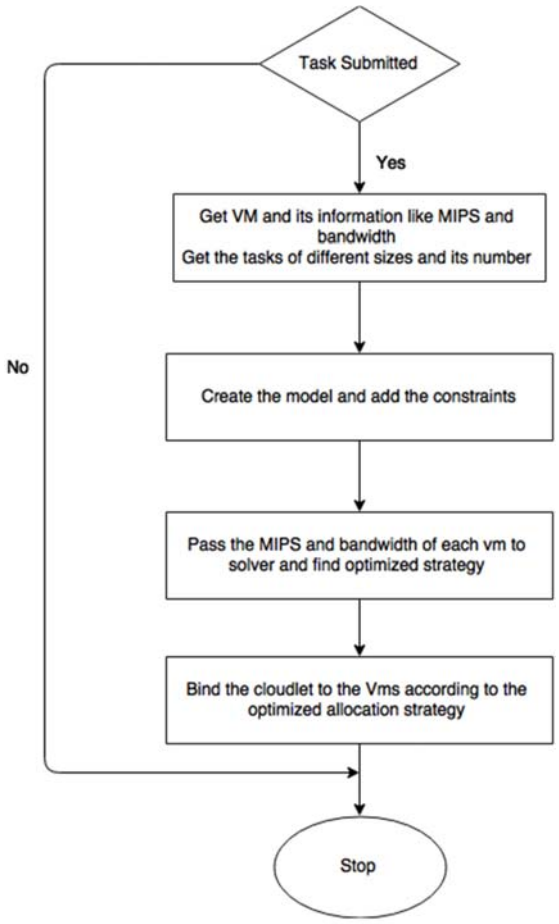

Figure 2. Steps of the Proposed Scheduling Algorithm

The main procedures to the algorithm can be explained by the pseudo code below;

```
Step 1. If (cloudlet_list != empty)
        GetVminfo()
        GetCloudletInfo() // Tasks of different
size

Step 2. for each vm in VmList
                getmips()
                getbw()

Step 3. for each vm in Vmlist and cloudlet in
        Cloudlet_list :
                m =CreateModel()
                m.addconstraints()
                s = chocosolver()
                s.getvm.setbw()

Step 4. getoptmizedsoluton()

Step 5. bindcoudletToVm(cloudlet_id, vm_id)
```

In the main class where the cloudlist and Vms are created the bindAll() function is used to bind optimised number of tasks to the resources. This bindAll() is created in DatacenterBroker class. This function then calls the choco to solve the non-linear programming model created and then find the optimized solution for allocation.

V. EXPERIMENT AND EVALUATION

In order to evaluate the results of proposed model and algorithm, the experiments are performed on CloudSim which is a simulation software for Cloud Computing[8]. To implement the algorithm, the DatacenterBroker class of CloudSim is overwritten by our new broker class. A DatacenterBroker class is created that obtains the computing power and bandwidth of Vms that are passed on to solve the non-linear programming model using Choco. With bandwidth and computing power as input, we get the optimized solution involving the number of different sized tasks to be allocated to each vm. With this allocation scheme we get the minimum completion time for the scheduling.

The implementation of algorithm is done by creating that broker class and passing the computing power and bandwidth as parameter to choco solver that builds and solve the non-linear programming model. The solution is then passed to bindall() function to bind the tasks to the Vms.

To analyze the performance of algorithm, various experiments with different number of tasks are performed and are compared with Bandwidth-aware same sized task scheduling algorithm and and dynamically changing tasks scheduling algorithm.We performed the experiments for the 3 algorithms using the number of tasks respectively, 10, 25, 40, 60. The size of the tasks is randomly selected between [10000, 100000] for our proposed algorithm and dynamic changing task scheduling. However for Bandwidth-aware homogeneous task scheduling the tasks of equal size as 100000 are created. The Vms for all 3 algorithms are created with heterogeneous parameter values of computing power and bandwidth.

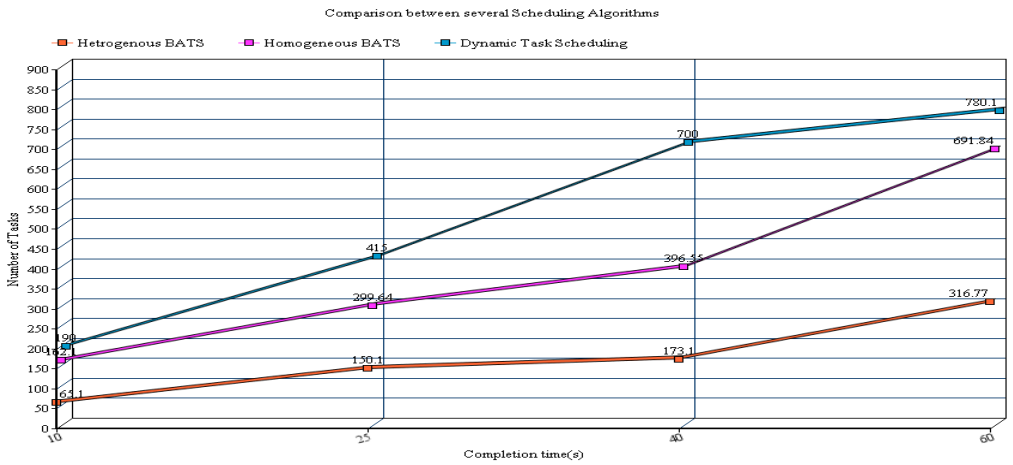

Table 1. VM resource parameters

VM	Computing Power(MIPS)	Bandwidth
0	3000.0	6000.0
1	2000.0	1000.0
2	5000.0	2000.0
3	5000.0	3000.0
4	1000.0	3000.0

VI. RESULTS & DISCUSSION

The experiment results and graph below proves that the proposed algorithm has less completion time than other 3 algorithms. In this algorithm the real life scenario of Cloud Computing is considered in which the user tasks are of different sizes. However the Bandwidth aware task scheduling with same sized tasks does not corresponds to real life scenario.

The use of both the Bandwidth and computing power in the implementation of scheduling algorithm along with the non-linear programming model make the results optimized and we get the best solution out of all the solutions for allocation of tasks with resource.

VII. CONCLUSION

Cloud Computing which is vastly used due to its reliability and scalability has the primary task of scheduling of the resources efficiently. In this paper, the application load of users of different sizes are considered and various number of tasks are efficiently processed on the resources based on their computing power and bandwidth. To get the best solution for scheduling, a non-linear programming model for the problem is built. This model is then solved and optimized task allocation scheme is generated using Choco. This algorithm is implemented on Cloudsim, simulation software for cloud computing. The results generated after implementing the algorithm are then compared with two other task scheduling algorithms. The proposed algorithm has better performance than other two. Also this algorithm consider real life cloud computing tasks scheduling as it considers the tasks of different sizes.

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