Efficient Technique for Allocation of Processing Elements to Virtual Machines in Cloud Environment

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Abstract
Cloud Computing is an efficient way of providing services and resources to the users through Internet. It is an efficient way of sharing computing resources between a number of users simultaneously in an economic way. It is based on pay per use model, i.e., the user will have to pay only for the services or resources consumed by him / her. Now a day, it has been widely used in a number of areas. It can be characterized by the following features like distributed, heterogeneous, flexible, scalable, location independent, on demand self service and ubiquitous network access. The most attractive feature of cloud computing is that it can be accessed through the underlying physical infrastructure. It means that the users need not to build new infrastructure to access the cloud services and resources.
The operation of a cloud environment is totally virtualized, i.e., the user of the cloud system does not have any information about the underlying physical infrastructures, servers where the applications and services are running and the location of the physical resources and the data. In such systems, there is a great need to provision the operation of the system for proper load balancing. For this purpose, the concept of scheduling has been incorporated in cloud systems. Scheduling in cloud systems is performed at two levels, viz. at the host level (Allocation of PE's to VM's, called as VM Scheduling) and another at the user level (Allocation of Cloudlets to VM for execution, commonly called as Cloudlet Scheduling).
In this paper, we are proposing a new algorithm for efficient allocation of PE's to VM's, so that the utilization of the physical resources provided by the cloud service provider can be improved to a certain extent. For this, we are using an optimization algorithm of the operational research domain called as Ant Colony Optimization. Our proposed algorithm can be considered as an improved form of time shared VM scheduling.

Keywords
Cloud Computing, Ant Colony Optimization, Optimal Scheduling, Scheduling Algorithm, etc.

1. Introduction

Cloud Computing can be considered as an extension to Distributed Computing or Parallel Computing or Grid Computing. It is an Internet based Model for providing services and resources to its users through the available network infrastructure. It is an economic way of providing services and resources as the user needs to pay only for the services and resources that he / she had utilized. It is highly scalable and reliable model for accessing resources and services and fails only in the scenario where there is a loss of Internet connectivity. Each cloud infrastructure has been characterized by the type of services and resources it provides to its users and on the basis of the population that utilizes those resources and services [19]. Generally, cloud infrastructures are characterized on two bases, as:

- Cloud Service Models
- Cloud Deployment Models

1.1 Cloud Service Models:

In this category, the cloud infrastructure is classified on the basis of type of service it provides to its user [23]. It can be further classified into three broad

1.2 categories, as:

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

1.3 Cloud Deployment Models:

In this category, the cloud infrastructure is classified on the basis of the population for which the infrastructure has been established [23]. It is further classified into four categories, as:

- Private Cloud
- Community Cloud
- Public Cloud
- Hybrid Cloud

2. VM Scheduling

Virtualization is a technique of abstracting the physical resources of cloud environment in such a way that it leads to improved utilization of those resources beyond their capacity. Virtualization can be implemented with the help of VM's. A VM is a logical instance of a physical computer system that operates in similar manner as a traditional computer system. A single workstation in a cloud environment can execute any number of VM's over it based on its processing power and other specifications. If the scheduling of the VM's is efficient, then the

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resource utilization of the cloud system should be improved as well as proper load balancing will also be accomplished [6].

3. VM SCHEDULING ALGORITHMS

VM Scheduling Algorithms in cloud environments are commonly characterized into two categories, viz. Space Shared VM Scheduling and Time Shared VM Scheduling. Both these algorithms can be applied at the VM level as well as at the Cloudlet level.

3.1 Space Shared VM Scheduling

It is the simplest technique to allocate PE's belonging to a host to the VM's running over it and can be considered as a type of first come first served (FCFS) scheduling. In this technique, PE's are allocated to VM's on fixed basis, i.e., if a PE is allocated to a VM then that PE cannot be allocated to another VM until it cannot be released by the VM to which it has been assigned. It means that sharing of PE's between VM's is not possible [2].

This leads to a scenario where the number of VM's to be created on the available infrastructure totally depends upon the resources present. It can be simply stated that the total demand of the PE's by VM's should not exceed the total availability of PE's in the cloud infrastructure. If a situation arises where the number of PE's demanded by VM's exceeds the number of PE's available to the cloud system, then it results in failure of VM's [1] [12].

3.2 Time Shared VM Scheduling

It can be considered as a type of Round Robin Scheduling technique. In this, a number of VM's can share the same set of PE's to carry out their operations. There will be continuous switching between VM's on the PE's [2].

4. Proposed VM Scheduling Algorithm

In this paper, we are proposing an optimal time shared VM scheduling algorithm based on Ant Colony Optimization principle. Initially ants wander randomly and on finding food, they return to their colony leaving pheromone trails. If other ants find such a path, rather moving randomly, they follow the same path specified by the pheromone trails. By this, the strength for finding the suitable path had been reduced greatly and ultimately this leads to generate an optimal path or shortest path between the Ant Colony and the Food Source [20].

Here, we are proposing an Optimal Time Shared VM Scheduling Technique based on ACO algorithm. First, the cloud environment will be set up and all the entities of the cloud environment like Data Centers and Hosts will be initialized. Once the set up has been initialized, specify the number of VM's to be created. Corresponding to each VM, an Ant has been initialized that can act on behalf of the VM until allocation of PE's.

Each Ant then look for the possible set of PE's that can be assigned to its corresponding VM for its initialization and creates a Cluster of all such PE's through its wandering behaviour for identifying the path from its Ant Colony to Food Location. It then identifies the best possible set of PE's to be allocated to its VM for its initialization using ACO algorithm. Once it gets the optimal set of PE's required, it assigns those PE's to its corresponding VM. Once this has been done, corresponding VM will be created.

For each VM, each corresponding Ant will have to perform the same operation for allocation of PE's. Once all the VM's are created, the tasks are assigned to these VM and VM starts the execution of these tasks. This process continues until all the tasks are executed.

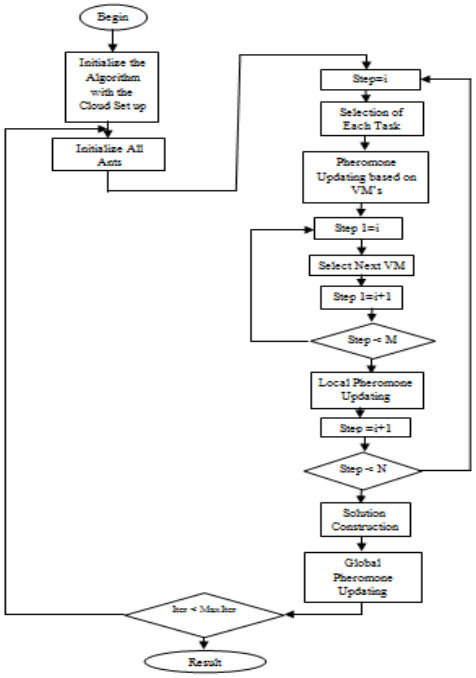

Figure 1: Flow Chart of the Proposed VM Scheduling Algorithm

5. Simulation Environment & Performance Parameters

Cloud Sim is actually a software framework that supports modelling, simulation and experimentation of various cloud computing related phenomena. It was developed by the team of Prof. Raj Kumar Buyya at Cloud Computing and Distributed Systems Laboratory (earlier GRIDS Lab.), Department of Computer Science and Software Engineering, University of Melbourne, Australia [1].

Cloud Sim is an open source free ware software framework that can be downloaded through Internet and can be used to perform different simulations related to cloud. Researchers and scientists can also add the new classes in the basic Cloud Sim package and then the functionality of those classes in their simulations [12].

In order to analyze the performance of the proposed algorithm with respect to the already proposed and implemented algorithms, a number of parameters are computed. By computing these parameters, we can check the efficiency and effectiveness of the proposed algorithm in the cloud computing environments. The parameters taken for this are Cloudlet Response Time, Turn around Time and VM Execution Time.

In our experiments, we have simulated a cloud infrastructure consisting of 3 Data Centers each containing 4 Hosts and all these Hosts are Dual Core Workstations. We have performed simulations based on varying the number of VM's to be created on the proposed infrastructure as well as executing variable number of tasks on specific number of VM's on the proposed cloud infrastructure.

TABLE 1: SIMULATION PARAMETERS

Data Center	Architecture	X86
	OS	Linux
	VM Manager	Xen
Host	MIPS	5000
	RAM	2560 MB
	Storage (MB)	163840
	BW (Kbps)	100000
VM	MIPS	1000
	PE	1
	RAM	512 MB
	Storage (MB)	10,000
	Bandwidth	1000
	Space Shared Cloudlet Scheduler	
	VM Manager	Xen
Cloudlet	Length	1000
	Full Size	300 MB
	Output Size	300 MB
	PE	1

6. RESULTS

We have performed simulations in two different ways, viz. first by varying the load provided to the system and secondly by varying the number of VM's to be created for execution of that load.

In first case, we have kept the load of the system to 100 Cloudlets and varying the number of VM's for execution of those Cloudlets from 20 to 40 with difference of 5 in each simulation.

TABLE 2: VM Running Time (100 Cloudlets)

Algorithm (100 Cloudlets)	20 VM	25 VM	30 VM	35 VM	40 VM
Space Shared	5.12	5.1	5.1	5.1	5.1
Time Shared	5	4.08	4.07	3.06	3.05
Proposed	5	4	4	3	3

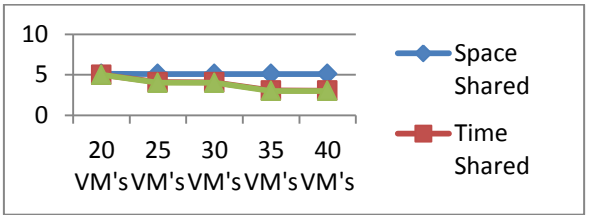

Figure 2: Graph representing Comparison of VM Running Time for 100 Cloudlets

TABLE 3: Cloudlet Turn Around Time (100 Cloudlets)

Algorithm (100 Cloudlets)	20 VM	25 VM	30 VM	35 VM	40 VM
Space Shared	3	2.6	2.6	2.6	2.6
Time Shared	3	2.5	2.2	1.95	1.8
Proposed	3	2.5	2.2	1.95	1.8

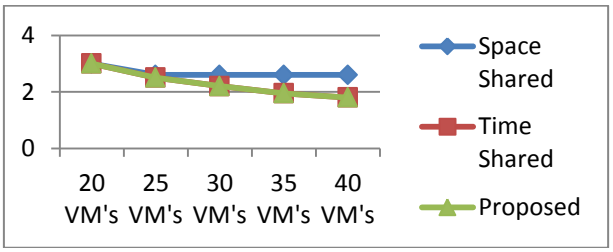

Figure 3: Graph representing Comparison of Cloudlet Turn around Time for 100 Cloudlets

In second case, we have kept the number of available VM's to 30 and we are varying the load provided to the system for execution from 50 to 200 with a difference of 50 at each simulation.

TABLE 4: Cloudlet Turn Around Time (30 VM's)

Algorithm (30 VM's)	50 Jobs	100 Jobs	150 Jobs	200 Jobs
Space Shared	1.56	2.6	3.64	4.68
Time Shared	1.4	2.2	3	3.85
Proposed	1.4	2.2	3	3.85

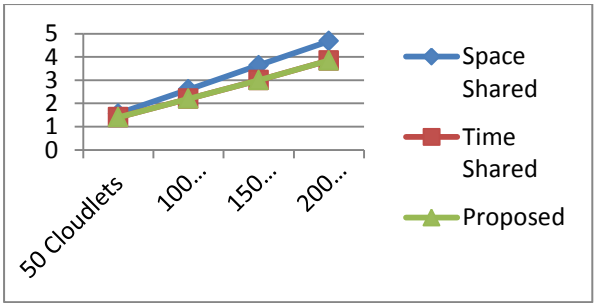

Figure 4: Graph representing Comparison of Cloudlet Turn Around Time for 30 VM's

TABLE 5: VM Execution Time (30 VM's)

Algorithm (30 VM's)	50 Jobs	100 Jobs	150 Jobs	200 Jobs
Space Shared	3.1	5.1	7.1	9.1
Time Shared	2.07	4.07	5.07	7.07
Proposed	2	4	5	7

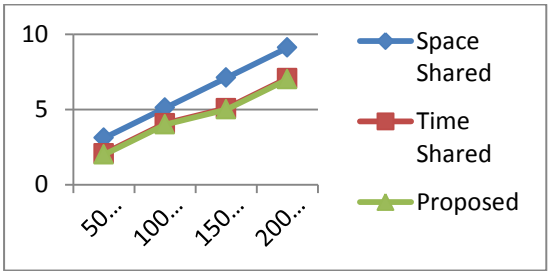

Figure 5: Graph representing Comparison of VM Execution Time for 30 VM's

The following results show that the proposed algorithm is more efficient than the traditional time shared algorithm but the improvement is not on the higher side. But, if we can apply this algorithm at heavy loads and in situations, where on the provided infrastructure, we want to improve the throughput with adding new computational capabilities, this algorithm give better results. The only drawback of this algorithm is that compared to Space Shared and Time Shared approaches, the set up time is on the higher side.

7. Conclusion

For the simulation results, we conclude that the proposed algorithm is better as compared to the time shared algorithm. In large cloud environments, this algorithm proves more efficient as compared to the other built in algorithms. The only problem is in the initialization delay, as due to its complex algorithm, it takes more time for initialization of the cloud environment as compared to the other algorithms.

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