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Cloud Task Scheduling Based on Enhanced Meta Heuristic Optimization Technique

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Abstract: There are number of resources available for the users but user can't afford these resources as these resources are costly. But users can use these resources on a rental basis. Internet access is readily available everywhere and it can be used by user to access the resources. So the best option available is to use the cloud service. With the growing popularity of cloud services, there come certain challenges. The problem of load balancing is its biggest challenge. Load balancing and task scheduling helps in optimizing various resource related parameters. The idea is to reduce the cost from the customer point of view and then improve the resource utilization from service provider point of view. A number of optimization algorithms have already been proposed for load balancing. This paper proposed an enhanced ACO algorithm for cloud task scheduling that helps to improve the imbalance factor of VM;s and also improve the overall Makespan time.

Keywords: Cloud Computing, ACO, VM, Data Center, CI, IAAS, PAAS, SAAS.

I. Introduction

The term "cloud" means network of providing resources over the internet. Cloud just a symbol for the internet. It provides service over a network that is public network or private network.

Task Scheduling is defined as the process which decides which task should be executed on which virtual machine. Depending upon the requirements of the task scheduling, the tasks that arrive in the cloud is executed immediately. To achieve this, an effective scheduling algorithm is required. Scheduling algorithm must reduce the overall operational cost, waiting time of tasks, Makespan, energy consumption, increase the resource utilization etc.[5]

ACO is to simulate the foraging behavior of ant colonies. When an ants group tries to search for the food, they use a special kind of chemical to communicate with each other. That chemical is referred to as pheromone. Initially, ants start searching their foods randomly. Once the ants find a path to food source, they leave pheromone on the path. An ant can follow the trails of the other ants to the food source by sensing pheromone on the ground. As this process continues, most of the ants attract to choose the shortest path as there have been a huge amount of pheromones accumulated on this path.[1]

The organization of paper is as following: Section 2 describes the various method of Cloud Scheduling. Section 3 introduce the related work. Section 4 Methodology . Implementation results are seen in section 5. And section 6 conclusion of this paper.

A. *Service Models*

Service Models are the reference models on which the cloud computing is based . These can be categorized into three basic service models as listed below.

Infrastructure as a Service
Consumers control and manage the systems in terms of the operating systems, applications, storage, and network connectivity, but cannot control the cloud infrastructure.
Platform as a Service

Consumers purchase access to the platforms, enabling them to deploy their own software and applications in the cloud. The operating systems and network access are not managed by the consumer.

Software as a Service
Consumers purchase the ability to access and use an application or service that is hosted in the cloud. A benchmark example of this is Salesforce.com, as discussed previously, where necessary information for the interaction between the consumer and the service is hosted as part of the service in the cloud.

B. Deployment Model

Three main cloud architecture models have developed over time; private, public and hybrid cloud.

Public Cloud

It is a type of cloud hosting in which the cloud services are delivered over a network which is open for public usage. [15]

Private Cloud

It is also known as internal cloud; the platform for cloud computing is implemented on a cloud-based secure environment that is safeguarded by a firewall which is under the governance of the IT department.[13]

Community Cloud

It is a type of cloud hosting in which the setup is mutually shared between many organisations that belong to a particular community, i.e. banks and trading firms.

Hybrid Cloud

It can be an arrangement of two or more cloud servers, i.e. private, public or community cloud that is bound together but remain individual entities.[16]

C. Challenges in Cloud Computing

There are some challenges which are faced by the user. These challenges are discussed as follow: [13]

Table1: Challenges of Cloud Computing

Challenges	Description
1. Data Management and Resource Allocation	Resource allocation is one the most challenging concept of cloud computing. The most challenging issue in data center network A resource is optimizing virtual network provisioning while maximizing the revenue. Furthermore, power consumption is more for data center networks.
2. Load Balancing	It is related to download performance and Storage utilization. This problem mainly occurs in distributed nodes.
3. Availability and Scalability	Performance degradation and oversizing problems occur due to unpredictable in cloud.
4. Compatibility and Migration to Clouds	There are some important concerns during the process of migration such as increasing dependency of enterprises on external third party, departmental downsizing, lack of understanding about cloud features and structure, lack of supporting resources, and uncertainty in new technology.
5. Interoperability and Communication Between Clouds	At each level of communication and interoperability have some shortcomings that make the process of achieving interoperable cloud computing environments more challengeable.

D. Cloud Scheduling

Scheduling problem involves tasks that must be scheduled on resources subject to some constraints to optimize some objective function. Scheduling allows optimal allocation of resources among given tasks in a finite time to achieve desired quality of service The aim is to build a schedule that specifies when and on which resource each task will be executed [17].

Optimization metrics

There are mainly two types of entities involved in cloud: One is cloud service provider and another is cloud consumer.
Consumer-Desired metrics:

Makespan

Makespan indicates the finishing time of the last task. The most popular optimization criterions while scheduling tasks is minimization of Makespan as most of the users desire fastest execution of their application.[18]

$$Makespan = max_{i \in tasks} \{Fi\}, \quad (18)$$

where Fi denotes the finishing time if task i.

Economic cost

It indicates the total amount the user needs to pay to service provider for resource utilization.[18]

$$\text{Economic Cost} = \sum_{i \in \text{resources}} \{Ci * Ti\} \quad (18)$$

where *Ci* denotes the cost of resource i per unit time and Ti denotes the time for which resource i is utilized.

Flowtime

It is the sum of finishing times of all the tasks. To minimize the flowtime, tasks should be executed in ascending order of their processing time.[18]

$$\text{Flow Time} \sum_{i \in tasks} Fi, \quad (18)$$

Where F_i denotes the finishing time of task i.

Tardiness

This defines the time elapsed between the deadline and finishing time of a task i.e. it represents the delay in task execution. Tardiness should be zero for an optimal schedule[18]

$$Tardiness_i = F_i - D_i \quad (18)$$

Waiting time

It is the difference between the execution start time and submission time of the task.

$$\text{Waiting Time}_i = S_i - B_i \quad (18)$$

where Si and Bi are start time and submission time of task i respectively.

Turnaround time- This keeps track of how long it takes for a task to complete execution since its submission. It is the sum of waiting time and execution time of task. [26]

$$\text{Turnaround Time}_i = W_i + E_i \quad (18)$$

where *Wi* and *Ei* are waiting time and execution time of task i respectively.

Fairness

A desirable characteristic of scheduling process is fairness which requires that every task must get equal share of CPU time and no task should be starved.[18]

Provider-Desired

Resource utilization

Another important criterion is maximization of resource utilization i.e. keeping resources as busy as possible. This criterion is gaining significance as service providers want to earn maximum profit by renting limited number of resources.[18]

$$\text{Average Resource Utilization} \sum_{i=1}^{n} \frac{\text{Time taken by resource i to finish all jobs}}{Makespan\ X\ n} \quad (18)$$

where n is no. of resources.

Throughput

It is defined as the total number of jobs completing execution per unit time.[18]

II. RELATED WORK

Srinivasan Selvaraj et al[5] paper applies ACO algorithm for scheduling tasks in cloud. .It aims to compare the performance with the fair scheduling algorithm First Come First Serve (FCFS). Simulation results show that the ACO algorithm outperforms the FCFS algorithm. Mala Karla et al[18] Proposed a three popular metaheuristic techniques: Ant colony optimization (ACO), genetic algorithm (GA) and Particle Swarm optimization (PSO). Metaheuristic techniques are usually slower than deterministic algorithms and the generated solutions may not be optimal, most of the research done is towards improving the convergence speed and quality of the solution. Gurtej Singh et al[7] presents a detailed in of some Bio inspired algorithm, which was used in order to tackle various challenges faced in Cloud Computing Resource management environment. Bio inspired algorithm plays very important role in computer networks, data mining, power system, economics, robotics, information security, control system, image processing etc. There are great opportunities of exploring or enhancing this field algorithm with the help of innovative ideas or thoughts.

Nazmul Siddique et al[8] paper presents an overview of significant advances made in the emerging field of nature-inspired computing (NIC) with a focus on the physics- and biology based approaches and algorithms. It focuses on the physics- and biology-based approaches and algorithms. Pratima Dhuldhule et al[9] proposed a Platform-as-a-Service model to build an HPC cloud setup. The key goals for the architecture design is to include features like on-demand provisioning both for hardware as well as HPC runtime environment for the cloud user and at the same time ensure that the HPC applications do not suffer virtualization overheads. Elaheh Hallaj et al[10] Artificial bee colony is a population-based algorithm inspired by natural behavior of bees which based on cooperation between intelligent bee agents to solve complex optimization problems in a reasonable time. One of these optimization areas is task scheduling in cloud computing environment that aim at allocating numerous requests to limited number of resources to gain maximum profit in terms of time, cost, energy consumption, fault rate and load balancing.

Aarti Singh et al[11] provides a dynamic load balancing for cloud environment. The proposed mechanism has been implemented and found to provide satisfactory results. Mihaela-Andreea Vasile et al[12] proposed a resource-aware hybrid scheduling algorithm for different types of application: batch jobs and workflows. The proposed algorithm considers hierarchical clustering of the available resources into groups in the allocation phase. Faraz Fatemi Moghaddam et al[13] challenges and concerns related to cloud-based environments have been identified and most appropriate current solutions for each challenge have been described. Jyoti Thaman et al[4] paper presents a review of Task and Job Scheduling schemes. A novel taxonomy is proposed in the paper. Schemes falling under Goal Oriented Task Scheduling (GOTS) schemes give service providers a fair chance to apply approach and schedule the tasks and resources that can generate maximum possible economic gains, while using least resource provisioning. Using low resource provision allows providers to use their resources at possible fullest and trading Makespan with marginal increase only. R. Raja et al[3] Cloud computing has the ability to deliver high-end computing capabilities as High Power Computing using data centre with the help of computing infrastructure. Energy efficient algorithms are an effective approach to resolve this complication in a very effective manner.

Luiz André et al[2] paper proposed an algorithm, dynamic and integrated resource scheduling algorithm for Cloud Data Center which balance load between servers in overall run time of request, here they are migrating an application from one data Center to another without interruption. Here they are i-introducing some measurement to ensure load balancing. They have given a mathematical reputation to calculate imbalance load to calculate average utilization to its threshold value to balance load. To implement DAIRS they have used physical server with physical cluster and Virtual servers with virtual cluster. C. Ghribi et al[19] proposed migration is general and goes beyond the current state of the art by minimizing both the number of migrations needed for consolidation and energy consumption in a single algorithm with a set of valid inequalities and conditions. Experimental results show the benefits of combining the allocation and migration algorithms and demonstrate their ability to achieve significant energy savings while maintaining feasible convergence times when compared with the best fit heuristic. Medhat Tawfeek et al[1] cloud task scheduling policy based on Ant Colony Optimization (ACO) algorithm compared with different scheduling algorithms First Come First Served (FCFS) and Round-Robin (RR), has been presented. The main goal of these algorithms is minimizing the Makespan of a given tasks set. Experimental results showed that cloud task scheduling based on ACO outperformed FCFS and RR algorithms.

III. METHODOLOGY
IV.

MAX to MIN MIGRATION:

1. For each VM in the VM List, save the ID's of the cloudlets set with that VM.
2. Compute the length of all cloudlets assigned to each VM in the VM List.
3. Sort of VM's on the basis of length.
4. Migrate cloudlets from heaviest loaded VM to Least loaded VM in the sorted list till the former is greater than average load. Remove the two from the list, i.e. least loaded and heaviest loaded and continue with the same until all VM's are removed from the list.
5. Send all cloudlets for execution.
6. Stop

V. RESULTS AND DISCUSSIONS

Parameters Setting of CloudSim

The experiments are implemented with 10 Data Centers with 40VMs and 800-2400 tasks under the simulation platform. The length of the task is from 20000 Million Instructions (MI) to 40000 MI. The parameters setting of cloud simulator are shown in 2**.**

Table 2: Parameters Setting of Cloudsim

Entity Type	**Parameters**	**Values**
Task(Cloudlet)	Length of Task	20000-400000
	Total Number of Task	800-2400
Virtual Machine	Total Number of VMs	40
	MIPS	256-512
	VM Memory (RAM)	1024
	Bandwidth	500
	Cloudlet Scheduler	Time_shared and Space_shared
	Number of PEs Requirement	1-2
Data Centre	Number of Datacenter	10
	Number of Host	2
	VM Scheduler	Time_shared and Space_shared

Results

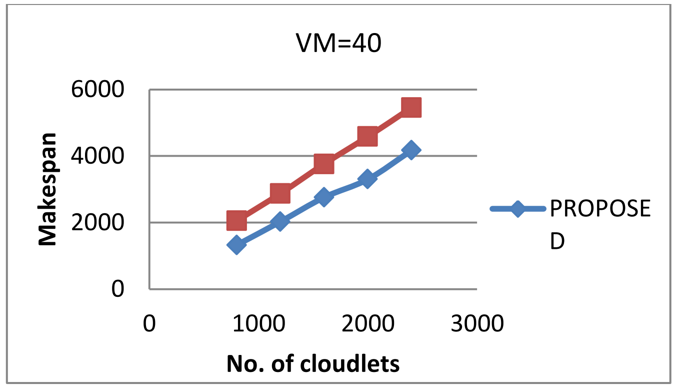

Fig:1 Makespan (fixed VM'S =40)

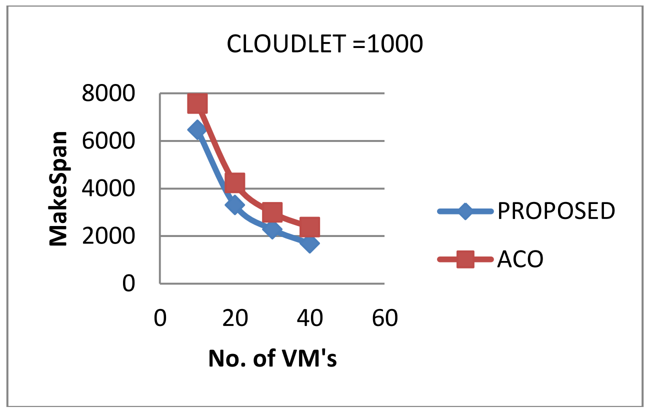

Fig:2 Makespan (Cloudlet's =1000)

It can be observed that there is improvement in Makespan in both cases. Makespan refers to the finish time of last cloudlet. The proposed algorithm clearly outperforms ACO when it comes to Makespan.

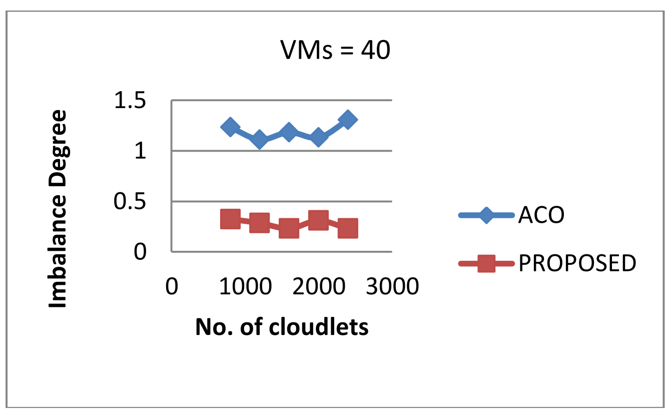

Fig:3 Imbalance factor (VM'S=40)

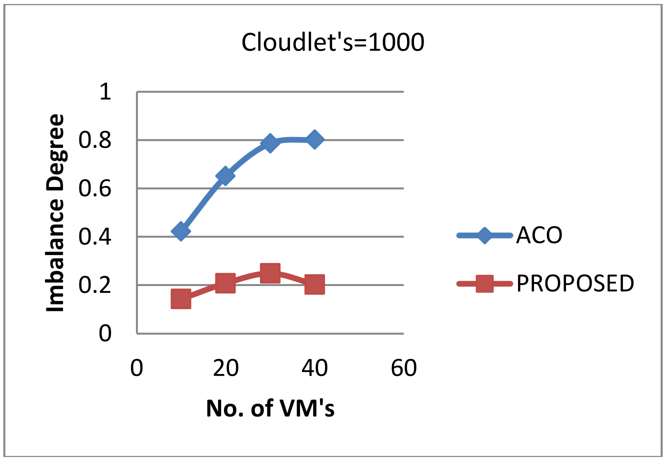

Fig4: Imbalance Factor (Cloudlet's=1000)

The idea of this paper is to improve the Imbalance Degree and the results above shows that the proposed algorithm performs much better than the ACO when it comes to Imbalance Factor.

VI. CONCLUSION AND FUTURE WORK

ACO algorithm basically works on random search mechanism. In this algorithm the positive feedback approach is used and follows the behavior of real ant colony in search of food and to connect. It mainly focuses on minimization of the Makespan to the given task. The ACO random search is mainly used for the allocation of the incoming jobs to virtual machine. ACO does very little to improve the imbalance factor. It can be easily established from the results and discussions that enhanced ACO helps to reduce the degree of imbalance and Makespan as compared with ACO algorithm.

Migration is a very costly task. Identification of tasks with least overhead and right resources for its execution is important. Idea is to minimize the no. of tasks to be migrated and also to migrate the tasks with minimum overhead cost. In future parameters like size of the cloudlet, channel band width can also be considered when migration tasks using Max to Min migration.

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