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Task Scheduling in Cloud Computing using Various Techniques

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Abstract: Cloud computing has become buzzword in computer industry as it provides scalable, reliable and economical services to the users. For better performance of cloud computing it is crucial that an efficient task scheduling algorithm is in place. Scheduling algorithms allocates the resources to the user's task i.e. it provides mapping between resources and tasks. Scheduling in cloud is NP-hard problem because of large solution space available. Meta-heuristic algorithms have become the most famous scheduling approaches as they provide near optimal solution in short span of time. This paper surveys the various approaches for cloudlet scheduling. It also classifies the various approaches based on the objectives considered for optimization.

Keywords: Cloud computing, technologies, scheduling, approaches

I. INTRODUCTION

Cloud computing is the most popular branch of distributed computing that offers on demand computing resources to the users on demand per use basis. It offers easily scalable, reliable and economical IT operations via internet. Virtualization is a one of the key technologies that had made the cloud computing possible. It makes the cloud appear as infinite collection of resources to the users. Users can request as little or as much as they need. Cloud computing is a service model consisting of three layers. These three layers are Infrastructure As A Service(IAAS),Platform as a service(PAAS),Software as a service(SAAS).AS a service model cloud computing offers computing, storage and software as a service rather than product to users.Figure 1 shows the three layers of Cloud computing.

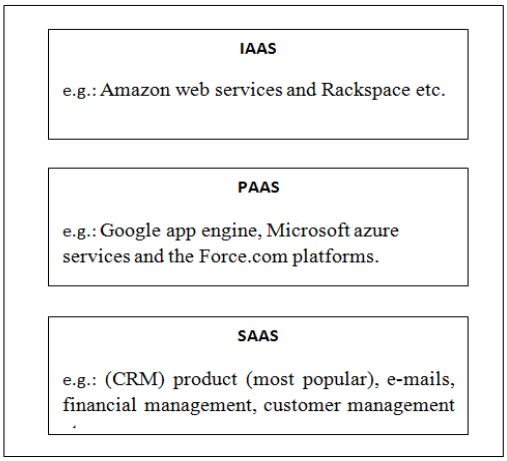

Figure 1 Service Layers of Cloud Computing

In cloud computing the issue of scheduling is very prominent. Scheduling is basically the process of allocating the resources to the user's tasks in an efficient manner. Tasks submitted by users to cloud for execution are referred as Cloudlets. Tasks scheduling in cloud is also known as cloudlet scheduling. A Good Cloudlet scheduling algorithm must be deployed to ensure that available resources are managed in an efficient manner.

The problem of scheduling in cloud computing is a NP-hard problem. It means there is no algorithm available that could find the optimal solution in a polynomial time. That's why the meta-heuristic approached has been proposed by various researches for this problem as they help in finding a near optimal solution in small span of time. These approaches try to schedule the tasks while optimizing the various objectives. Objectives in cloud computing could be classified in two categories as shown in Figure 2.

Consumer Desired	Makespan, Economic Cost, Total execution time, waiting time, Turnaround time
Provider Desired	Average Resource Utilization, Throughput, Priority Constraint, Dependency constraint, Deadline constraint, Budget Constraint

Figure 2 Classification of Objectives

Part II of this paper explains the existing approaches for scheduling of cloud tasks. These approaches could be classified in two categories as shown in Figure 3.Results of various researches have proven that greedy based approaches are more effective and efficient for scheduling in cloud than meta-heuristic approaches.

II. EXISTING APPROACHES FOR TASK SCHEDULING IN CLOUD COMPUTING

Mohit Agarwal et al [1], in their paper proposed the use of genetic algorithm for task scheduling such that overall load could be balanced and overall response time could be minimized. Proposed genetic algorithms were simulated on cloudsim and its performance was compared with existing techniques like First Come First Serve (FCFS) and Greedy based approach. Experiments showed that genetic algorithm outperforms the FCFS and Greedy based approach in terms of better execution time. In the case discussed it has decreased total execution time by approximately 70% than FCFS and 2% than greedy based approaches.

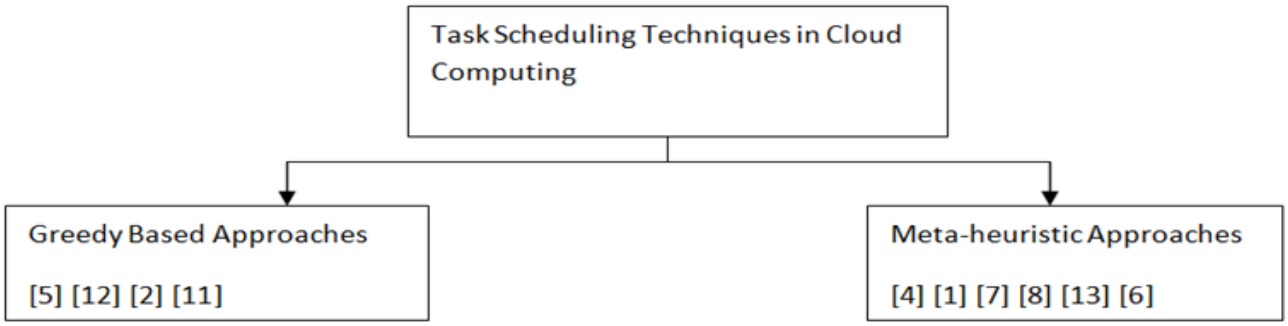

Figure 3 Classification of Scheduling Approaches

In this paper dependency among tasks are not considered i.e. algorithm is not applicable in case of workflow scheduling.

An adaptive algorithm that adapted as per situation was proposed by Shubham Mittal in his paper [2].This adaptive algorithm was designed in such a way that it takes advantage of various other existing techniques. Situation was evaluated and depending on that either RASA or Min-Min approach for scheduling was used. Simulation (done on java7) of this algorithm showed that it produces optimized makespan in comparison to Max-Min, Min-Min, RASA, Improved Max-Min, and Enhanced Max-Min. This algorithm could be further simulated in cloud environment in order to perform various practical evaluations such as scalability, availability and many more.

Various scheduling algorithms were discussed by Arnav Wadhonkar in his survey paper [3].He discussed each algorithm's basic strategy. Comparison of various algorithms on the basis of the performance metric that were considered in that respective paper were made and presented in tabular form that showed which algorithm worked on which performance metric. Another table showed the summarization review of each paper which included proposed strategy, objective of strategy and the future work suggested by that particular paper.

Mohammed Abdullahi et al. [4],proposed the use of newly developed meta-heuristic approach Symbiotic organism search for optimal task scheduling in cloud environment.SOS duplicates the symbiotic relationships that are exhibited by organism in ecosystem like mutualism, commensalism, and parasitism. In order to check efficiency of SOS it was simulated using Cloudsim and simulation showed that SOS outperforms Particle Swarm Optimization (PSO) that is one of the most popular metaheuristic optimization techniques.

Scheduling of workflow in cloud environment with the use of extended parallel cat swarm optimization (PCSO) techniques was proposed by Khadija Bosselmiet et al. [5]. Three components of quality were considered quality of execution, communication and storage. When compared with other existing techniques like PSO, CSO it showed better performance due to significant choice of velocity and position of particle in this algorithm. In the PCSO choice of velocity and position was made using inertia weight function instead of weight function unlike the standard CSO and PSO where random evolution strategy was adopted.

Medhat Tawfeek et al. [6]used the concept of nature based meta-heuristic algorithm Ant colony Optimization (ACO) in scheduling jobs in cloud computing environment. Problem of task scheduling was represented in graph G(V,E) form where V is set of vertices that include tasks and virtual machines, E is set of edges that indicates the allocation of virtual machines to tasks. Metrics considered in this paper for optimization was to minimize makespan. Algorithm was simulated using cloudsim and results were compared with FCFS and round-robin. Experiments conducted showed that ACO outperforms round robin and FCFS. These algorithms could be further extended to incorporate load balancing and precedence among tasks.

A.I.Awad,et al. [7],proposed Load Balancing mutation PSO in order to optimize execution time, round trip time, makespan, costs and load balancing between tasks while considering two important quality of service factors availability and reliability that were not by many other proposed techniques. Simulation of the proposed techniques on cloudsim showed thatit performs better than standard PSO, random algorithm, longest cloudlet to faster resources techniques. It considered only independent techniques, workflow jobs were not considered.

Multi-objective optimization is working upon the optimization of two or more factors in parallel. Use of nested PSO for multi-objective optimization of non preemptive scheduling in cloud environment was proposed by R.K. Jena [8]. The objectives of this algorithm for optimization were energy use and processing time. This algorithm was able to reduce 30% energy consumption and 25 % of makespan when compared with existing techniques Best Resource Selection (BRS).In this technique precedence among tasks was considered and all processing elements were assumed to be homogenous in nature.

[9] Has proposed improved genetic algorithm for scheduling independent tasks in cloud It solves the premature convergence problem of by using the concept of chromosomes matching rate. Convergence speed of proposed improved genetic algorithm has proved to be faster than standard genetic algorithm as proved by research results of the paper.

Yash P. Dave et al. [10],in his survey paper classified the scheduling algorithms in two categories based on the factors they were optimizing, time based and cost based algorithms. Time based algorithms worked upon minimizing the execution time of tasks. Cost based algorithm's main goal was to minimize the total cost incurred in execution of jobs by optimized selection of

resources. Examples of cost based algorithms are Dead line distribution, genetic algorithm, PSO, improved activity cost

Table 1 Comparison of various approaches of Scheduling tasks in cloud

Approach	***Parameters/Objectives***				
	Makespan	Energy	Cost	Load Balancing	QoS
Genetic Algorithms [1]	✓				
Adaptive Algorithm: optimized task scheduling Algorithm [2]				✓	
Symbiotic Organism Search Based Scheduling [4]	✓		✓		
Parallel Cat Swarm Optimization (PCSO) [5]	✓				✓
Ant colony Optimization (ACO) [6]	✓			✓	
Load Balancing Mutation particle swarm optimization (LBMPSO) [7]	✓		✓	✓	✓
Nested PSO [8]	✓	✓			
Improved Genetic Algorithm [9]	✓		✓		✓
Adaptive Min Min Scheduling(AMMS) [11]	✓				
Priority Based Scheduling [12]	✓				
Standard PSO [13]			✓		

etc. Round Robin, Earliest Deadline First and extended min-min are time based algorithms. Brief description of these algorithms was provided in this survey paper.

Two adaptive algorithms,Adaptive min min scheduling(AMMS) and Adaptive List Scheduling (ALS) was proposed in a paper by Li Jiyin et al. [11].These proposed algorithms considered the resource contention in the task scheduling. Proposed scheduling was preemptive in nature. Simulation showed that AMMS outperforms ALS and AMMS provides significant improvement in fierce resource contention situation in comparison to when situation is loose.

Chandershekhar S.Pawar, et al. [12], Paper by proposed a new technique i.e. priority based scheduling algorithm for dynamic scheduling of jobs in cloud environment. This strategy of scheduling considered multiple parameters i.e. network bandwidth and required CPU time so that allocation of resources to jobs could be more effective and efficient. Priority amongst jobs were considered while resource allocation and through simulation it was found out that proposed technique performs better than Min-Min scheduling in resource contention situation.

Particle Swarm Optimization is one of the most efficient meta-heiurstic approach. Use of PSO for scheduling of workflow application in cloud environment was first proposed by Suraj Pandey et al [13]. This proposed technique has taken into account computation cost and Data transmission cost while scheduling. It was simulated using cloud simulator Cloudsim and compared with Best Resource Selection (BRS) technique of scheduling. Results of simulation showed that scheduling using PSO costs 3 times less than BRS for example considered and costs increases linearly in PSO whereas growth of cost in BRS was exponential in nature when no of jobs were increased.

Comparison of various approaches of scheduling cloudlets on the basis of various parameters is shown in Table 1.

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