Task Scheduling Implementations Study by Using Various Algorithms in Cloud Computing

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ABSTRACT: Cloud computing is the fastest growing technology due to its ability of allowing users to pay as they need and which has the highest performance.Cloud computing is capable of holding large amounts of data owing to its heterogeneous nature. For an application, during the process of scheduling or computing critical data, it is necessary to optimize the transferring and processing time, which in-turn is very crucial to the application. Due to the newness of the cloud computing arena, there are not many standard task scheduling algorithms being used in the cloud. The high communication cost in the cloud, does not allows well known task schedulers to be applied in a large distributed computing environments. Today, attempts are being made to build job scheduling algorithms, which are more compatible in nature and is well versed with the cloud environment. The most important task in cloud computing environment is the Job Scheduling, as user's pays for the resources being used and which is time based. So it's mandatory that the resource utilization should be very efficient, and for that the task scheduling plays a very important role in getting maximum benefit from the resources. In this paper, I have carefully measured different types of scheduling algorithms and presented their scheduling factors, parameters etc. Already existing workflow scheduling algorithmdoes not consider availability and reliability. In this paper, a novel heuristic scheduling algorithm, which is called as a hyper-heuristic scheduling algorithm, is presented, and which is used find a better scheduling solutions for the computing systems in the cloud. The final result confirms that the HHSA can drastically reduce the makespan of the task scheduling as compared with other scheduling algorithms.

KEYWORDS: *Cloud computing, Task scheduling, Heuristic Algorithm, Optimization, Particle Swarm*

I. INTRODUCTION

Cloud computing is a new technology for the virtualized resources, which is designed for the end users in a dynamic computing world in order to provide guaranteed and reliable services [1].In this environment, the services of the computing intensive applications can be enhanced as per the user requests on-demand. As the number of users increases rapidly, virtualization is one of the main techniques used to improve the utilization of the physical resources in cloud [2]. It reduces the number of hardware equipment, and also allows isolation and abstraction of physical resources.These virtualization techniques allowsthe operator to create multiple Virtual Machines (VMs), on a single physical server, which also includes network virtualization. More importantly, VMs can be designed by increasing or decreasing the number of CPUs [3]. The effective meta-job scheduling algorithms are required, to efficiently utilize the virtualized resources, in order to execute the computing intensive applications. In the traditional job scheduling, the problem scheduling meta-job of applications among computation resources, so that the jobs completion time is reduced thereby ignoring the shared nature of the network resources [4].

In a datacentre, the scheduling problem is increased by scheduling different users set of applications to the set of computation resources and maximizing the system utilization. Previously research have been conducted in this field, leading to an extensive study of major practical and theoretical results [5].But due to the advancement of the virtualization techniques in the computational cloud systems, it is mandatory to have new scheduling algorithms in order to deal with concerns emerging from the cloud infrastructure. The core function of the job scheduling algorithm, in an cloud computing is to achieve high system throughput, improve the load balancing, and thereby minimizing the total meta-job processing time and thereby matching the meta-job requirements with the available virtualized resources. Job scheduling is a common problem of mapping a set of jobs with a set of virtual machines, so that the user's requests are full-filled in the cloud environment.

The schedulers in cloud environments considers virtualized resources and required constraint of the user's in order to get better match between resources and applications. Job scheduling tends to become more complicated in cloud computing, when the users considers a variety of network resources related to the quality of service. Much of the traditional heuristics scheduling algorithms such as Minimum Completion Time (MCT), min-min Completion Time (Min-Min), Maximum-Minimum Completion Time (Max-Min) etc. A V-heuristic scheduling algorithm is presented which addresses the match of jobs from the applications and the status provided by the virtualized resources, thereby improving the efficiency and utilization of a cloud system. For this service, the cloud service provider (CSP), deploys virtual network from infrastructure provider (InP) with one or more VMs, on a single physical server.

By using, virtualization technologies, which provides efficient data transmission among VMs, the heterogeneous physical networks can be abstracted within the service provider.Hybrid heuristic scheduling algorithmcan be provided for the optimal virtualized resources utilization, maximum throughput, minimizing the job processing time, load balancing among VMs and full-fill on-demand services of user requests.

II. RELATED WORK

Optimization problems are related to the Class NP-hard.These problems are solved by using the enumeration method, heuristic method or approximation method.In enumeration method, a flawless solution can be selected if all the possible solutions are enumerated and compared one by one.When the number of instances are large, enumeration is not feasible for the scheduling problems. In such a case, heuristic is a sub choice algorithm to find a reasonably good solution and is reasonably fast.The approximation algorithms are used when there is a need to find an approximate solution to the optimized solution. These algorithms are used for those problems wherein the exact polynomial time algorithms are known. For the job completion time, enhancing task data locality in large scale data processing systems is very crucial.Much of the approaches which are used to improve data locality ignores global optimization, and suffer from high computation complexity.This problem is addressed by heuristic task scheduling algorithm called Balance-Reduce (BAR) in [6].

Load balancing task scheduler balances the entire systems load and trying to minimize the makespan of the given tasks set.Two different types of load balancing scheduling algorithms which are based on ant colony are proposed in [7] and [8].Another ant colony based algorithm which is aimed at minimizing job completion time and which is based on pheromone is proposed in [9].For the cloud environment, Cloud Loading Balance algorithm [10], adds capacity to the dynamic balance mechanism.In order to decide, which workloads to outsource to which cloud provider, it should maximize the utilization of the internal infrastructure along with minimizing the cost of running the outsourced tasks in the cloud, and also taking into account the applications service constraints quality.A set of heuristics, for the cost-efficiently schedule deadline constrained computational applications, is proposed in [11].Multi-objective meta-heuristics scheduling algorithm to be used in multi-cloud environment is proposed in [12].This algorithm achieves application high availability and fault-tolerance and thereby reducing the application cost and keeps the resource load maximized. Because of the increase in the large Web graph and social networks, cost conscious large graph processing scheduling is important and a heuristic for the same is proposed in [13].

An optimized algorithm which is based on GA and is used to schedule independent and divisible tasks adapting to different computation and memory requirements is proposed in [14]. Multi-agent genetic algorithm (MAGA) [15] is a hybrid algorithm of GA, which solves the load balancing problem. COA (Course of action) involves resource allocation and task scheduling.A robust COA planning involving duration variations which is based on GA is proposed in [16].An important issue in cloud computing, is reducing energy consumption, more importantly during High Performance Computing (HPC).A multi-objective genetic algorithm (MO-GA), which is proposed in [17], optimizes the energy consumption and the generated profit of a distributed cloud computing infrastructure. Another parallel genetic algorithm based resource scheduling which is proposed in [18]. For the global optimization problem,Simulated annealing is nothing but a generic probabilistic meta-heuristic to the global optimum of a given function in a large search space. In cloud computing, an optimized algorithm which is used for the task scheduling based on genetic simulated annealing algorithm is proposed in [19]. The scalability of a computing system is identified mainly by size, geographical distribution area, administrative constraints, heterogeneity, energy consumption and transparency.

A low complexity energy efficient heuristic schedulingalgorithm, which is proposed in [20], performs efficiently demonstrating their applicability and scalability. Tasks are scheduled only at some predefined time and which comes under the batch mode. This enables batch heuristics to sense about the actual execution time of a large number of tasks. Min-min and Max-min are the heuristics and which are used for batch mode scheduling.Heuristics based improved Max-Min algorithm which is proposed in [21] and the QoS Min-Min scheduling algorithm is proposed in [22]. Bag of tasks (BoT) applications are those which executes independent parallel tasks.Heuristics which is proposed in [23] is aimed at maximizing resource utilization while executing BoTs in heterogeneous sets of Cloud resources, which are allocated for different numbers of hours. Another budget constraint scheduler which is proposed in [24] schedules large bags of tasks on to multiple clouds with a different CPU cost and performance, and also minimizing completion time (makespan) while respecting an upper bound for the budget to be consumed. When providers cannot disclose private information such as their load and computing power, the meta-scheduler needs to make scheduling decisions in a blind fashion. Here a deadline-constrained BoT application scheduling approach is required and which is proposed in [25].

For cloud scheduling, Hai Zhong1, Kun Tao1, Xuejie Zhang [26] proposed an optimized scheduling algorithm, which is used to achieve the optimization or sub-optimization.This algorithm uses an Improved Genetic Algorithm (IGA) for the automated scheduling policy. This is used to increase the utilization rate of speed resources. Suraj Pandey, Linlin Wu, Siddeswara Mayura Guru, Rajkumar Buyya [27] presented a particle swarm optimization based heuristic to schedule applications to cloud resources that takes into account both computation cost and the data transmission cost. This is used for workflow application by varying its communication and computation costs.Reference [28] evolved the effectiveness of rescheduling by using cloud resources to increase the reliability of job completion.More importantly, schedules are generated initially, by using grid resources while cloud resources are used only for rescheduling to deal with delays in completion of the job. A job refers to a bag full-of-tasks application that consists of a large number of independent tasks, which is common in many sciences and engineering applications. They have designed a novel rescheduling technique, which is known as, rescheduling using clouds for reliable completion and which is applied to three well-known existing heuristics.

Task assignment are generally found to be NP-complete [29]. Since task assignment is NP-Complete problem, Genetic Algorithm (GA) is used for task assignment [30]. Reference [31] shows that the particle swarm optimization algorithm is able to get the better schedule as compared to the genetic algorithm in grid computing. Reference [32] illustrated that the performance of Particle Swarm Optimization (PSO) algorithm is better as compared to the GA algorithm in a distributed system. Not only PSO algorithm run faster than GA but also the PSO algorithm solution quality is better as compared to GA in most of the test cases. Hence, we use a method called Particle Swarm Optimization, which is used to optimize the task scheduling problem. In this paper, we have focussed on minimizing the total execution time and transfer time.MengXu, Lizhen Cui, Haiyang Wang, Yanbing Bi [33] compiled on multiple work-flows and multiple QoS. They have implemented a strategy for multiple workflow management system with multiple Quality of Service. The access rate for scheduling is increased by using this approach. This approach minimizes the makespan and cost of the workflows. Topcuogluet. al, [34] presented the HEFT algorithm, which is used to find the average execution time of each tasks and also the average communication time between the resources. Then tasks in the workflow are ordered on a rank function. Then the task is given higher priority, which has a higher rank value.

Salehi, M.A. and Buyya, R. [35] suggested a market oriented hierarchical scheduling approach which has both service level scheduling and task level scheduling. The service level scheduling deals with the Task to Service assignment and the task level scheduling deals with the optimization of the Task to Virtual Machine assignment data centres. Yu, J., Buyya, R. and Tham, C.K. [36] suggested a cost based workflow scheduling algorithm by minimizing the execution cost and meeting the deadline for delivering the results.It adapt to the delays of service executions by rescheduling unexecuted tasks.Sakellariou, R., Zhao, H., Tsiakkouri, E. and Dikaiakos, M.D [37] suggested a basic model for workflow applications that modelled as directed acyclic graph (DAGs) and which allows to schedule the nodes of DAG onto resources in a way that convinced a budget constraint and which is optimized for overall time.

Burke et al [38] suggested a hyper-heuristic framework which implements a commonly used graph colouring heuristics coupled with a random ordering heuristics. A follow-up paper [39] weighs up the performance of several meta-heuristics which operates on the search space of heuristics. Iterative techniques like iterated local search and variable neighbourhood search were found to be more effective.The study also implemented hybridisations of the hyper-heuristic framework, which was found to have improved the performance of the overall system. A further study [40] uses the notion of fitness landscapes in order to analyse the search space of graph colouring heuristics.Table 1 shows the implementation study of various scheduling algorithm, the parameters which were focused for optimization and the environment in which the scheduling algorithms were applied. The heuristic algorithms are based on priority and are mainly problem centric.

INFERENCE:

The task scheduling in a cloud environment is a very demanding task because of the following reasons:

- As the resource pool is central t has to caters to the needs of all the jobs. So it is difficult to predict which resources would be available at the time of actual execution of the jobs.
- It is hard to apply access control enforcement mechanism as the workflow is being executed, if the access rights of jobs change dynamically.
- It is hard to handle the dynamic workflow applications wherein the structure of workflow graph varies with time.
- It is hard to reduce the overhead involved during generation of schedules for multiple workflows, as there can be so many users competing for common resources and decisions should be made at the shortest time.
- It is hardto achieve maximum possible utilization of the resources during scheduling levelled workflow applications because of dependencies.
- The virtual instances runs only on physical machines. When physical machine fails due to hardware or any other failures, the entire workflow application has to be restarted. It is then hard to migrate one workflow application running on one virtual machine to another virtual machine.

Table 1 Implementations Study

Method	Objective criteria	Advantages	Disadvantages
Heuristic algorithm for DAG Scheduling	Makespan	It performs better than DLS	Lack of reliability
heuristic based strategy list scheduling	Makespan, Load Balance	Better optimization of makespan and load balance	Need to explore a scheduling algorithm with availability criteria
Improved Critical Path using Descendant Prediction	Makespan and Load Balance	Finds the schedule that results in makespan minimization and improve the utilization of resources.	To increase the energy efficiency, need to Schedule the workflow dynamically.
H-Green heuristic Algorithm	Energy Efficient	reduce the power consumption	The computation cost is high
List Scheduling with Genetic	Makespan, Economic Cost, Energy Consumption, Reliability	conserve more energy and achieve higher level of load balancing	Reschedule the unexecuted tasks is required to minimize

			the computation cost
Improved Cost-Based Algorithm for Task Scheduling	Cost, Performance	Improves the computation /communication ratio	Need to minimize the execution time which is significantly minimize the makespan
A Particle Swarm Optimization based Heuristic for Scheduling	Resource utilization, Time	It is used for good distribution of workload onto resources	Lack of both reliability and availability criteria

III. CONCLUSION

In this paper, we looked over various existing workflow scheduling algorithms and formulated them on the basis of nature of scheduling algorithm, type of algorithm, objective criteria and the environment to which the workflow scheduling algorithm was applied. It is clear that lot of work has already been in the field of workflow scheduling but still there are areas which requires further attention. Also, in this paper, a high-performance hyper-heuristic algorithm was presented and which is used to find better scheduling solutions for cloud computing systems. The suggested algorithm uses two detection operators to automatically determine when to change the low level heuristic algorithm and a perturbation operator to fine tune the solutions to further improve the scheduling results.

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