

Job Scheduling Heuristics and Simulation Tools in Cloud Computing Environment: A Survey

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ABSTRACT

Cloud computing is the extension of distributed computing, grid computing and parallel processing. Cloud Computing Environments provides an efficient way to host, process and analyze large amount of data on remote machines. Apart from this, it also provides various Infrastructure Services (IAAS), Software Services (SAAS) and Platform Services (PAAS) for hosting purpose. Various job scheduling heuristics are proposed over the time for efficient execution of various jobs in Cloud environment. Efficient scheduling of jobs is key factor on performance enhancement of Scheduling Heuristics. Various performance parameters like completion time, waiting time, success rate, resource utilization etc. are used to measure performance of various heuristics. These parameters are also used to measure Quality of Service (QoS) that these heuristics provides to bunch of jobs. Here a detailed survey of various job scheduling heuristics and various simulation tools which are used for simulation of these heuristics is presented. Main objective of this survey paper is to present a detailed survey of various job scheduling heuristics available and different simulation tools available to simulate these heuristics in Cloud environment. A detailed comparative analysis is present for various job scheduling heuristics available and different simulation tools.

Keywords - Cloud Computing, Scheduling Heuristics, Quality of Service (QoS), Cloud Simulators

Date of Submission: May 22, 2018

Date of Acceptance: July 17, 2018

I. INTRODUCTION

Cloud computing is a recent trend in IT which provide various services like Infrastructure Services (IAAS), Software Services (SAAS) and Platform Services (PAAS). A general architecture of Cloud Computing is shown in Fig. 1. With help of Cloud Computing, user can extend computational power and storage capacity of machine. Cloud provides a convenient environment for resources which is used by multiple cloud users. Customers can use any software or hardware without purchasing for it. Client only needs a machine with internet connection that's it. Main idea is to use unutilized infrastructure at nominal cost.

Scheduling jobs in efficient manner is very crucial in Cloud computing environment, because cloud service providers must satisfy various needs of many cloud users. There are various ways to categorize scheduling heuristics. One category is task scheduling, workflow scheduling, resource scheduling, job scheduling etc. It is also categories as Static Scheduling and Dynamic Scheduling. In static scheduling, execution of jobs is fixed before starting, while in dynamic scheduling, jobs are scheduled as it arrives.

Providing Quality of Service(QoS) and satisfy various needs of users is very challenging in cloud environment. Different users are having different QoS requirements.

Various applications also demand varying services. So, with virtualized cloud resources, it becomes very challenging to satisfy requirements of each users and applications as well.

For real use of the unbelievable abilities of the Cloud, effective scheduling heuristics are needed. Main goal of such algorithms is to minimize total execution time by allocating best resource for the job. It is not like that every time reduction in total execution time results in reduction of execution time of each individual job.

The remaining paper is prepared as follows. Part II presents existing scheduling algorithms. Part III presents various simulations tools available for simulations of scheduling heuristics and part IV contains conclusion and contributions of authors.

II. EXISTING SCHEDULING ALGORITHMS

Following scheduling algorithms are currently widespread in clouds.

XiaoShan He, Xianhe Sun and Gergor von Laszewski [3] in 2003 suggested a QoS Guided Min-Min heuristic which focuses on varying bandwidth requirement of various jobs. In this algorithm matching between QoS requirement of users and provided service are based on conventional Min-Min. Main focus is on one-dimensional Quality of Service issue here.

Dong. F, Luo. J, Gao. L and Ge. L. [4] in 2006 proposed a QoS priority grouping algorithm which focuses on deadline and acceptance rate of the job & makespan as key factor of job scheduling in whole system. Results are better than Min-Min and QoS Guided Min-Min as far as completion time and acceptance rates are concerned.

M. Singh and P.K. Suri [5] in 2008 proposed a QoS based predictive Max-Min, Min-Min switcher heuristic. In this heuristic focus is on scheduling of the next job depends on suitable assortment among QoS based min-min or QoS max-min heuristic. Past of task execution is used to forecast performance of resource. This heuristic merge the effectiveness of max-min along with min-min.

Saeed Parsa and Reza Entezari - Maleki [6] in 2009 developed a new task scheduling algorithm called RASA which has the advantage of both Min-Min and Max-Min algorithms. In RASA, completion task of job is estimated on each resource and then both algorithms are applied. RASA use the Min-Min policy to implement the small job first then long job and then applied Max-Min to duck the interruptions in the implementation of large job and support concurrency in the implementation of the big and small jobs.

Huifang Li, Siyuan Ge, Lu Zhang [7] in 2014 established a QDA scheduling heuristic using cloud workflow as a background. It works on instance-intensive workflow scheduling optimization problem. It takes many Quality of Service parameters in to consideration like time, cost, bandwidth, reliability, enumerates them with value and use them in Quality of Service based sub-deadline distribution heuristic to meet whole Quality of Service user satisfaction.

Hilda Lawrance and Dr. Salaja Silas [8] in 2013 suggested a job-based scheduling of resources named potentially all pair-wise rankings of all possible alternatives (PAPRIKA). It counts different Quality of Service parameters in to account and resources are planned according to user requirement and PAPRIKA method.

Mrs. S. Selvarani, Dr. G. Sudha Sadhasivam [9] in 2010 suggested a better cost-based scheduling heuristic to make effective mapping of jobs to accessible resources in Cloud. Heuristic divisions all user jobs depending on importance of each job into 3 different lists. This job scheduling heuristic focus on resource cost and calculation performance both, it also enhances the calculation/communication ratio.

Cui Lin, Shiyong Lu [10] in 2011 suggested an SHEFT workflow scheduling heuristic for scheduling a workflow elastically on a Cloud Computing platform. Main advantage of this heuristic is it allows resources to scale elastically at runtime.

Meng Xu, Lizhen Cui, Haiyang Wang, Yanbing Bi [11] in 2009 suggested a numerous workflows and numerous

Quality of Service. Main working of this heuristic is on multiple workflow management system with multiple Quality of Service. This strategy minimizes the makespan and cost of workflows in Cloud Computing environment.

Comparison of Various Scheduling Heuristics is given in Table 1.

III. CLOUD SIMULATION TOOLS

Cloud resources are costly and cost of setting actual cloud environment is also high. Small scale organizations and researchers may not go with actual cloud implementation for their experiments in cloud environment. They would mostly prefer various simulators available in market for simulation of cloud environment. The use of simulation tools leads to decrease in overall operational cost of the organizations. There are various benefits of using simulators like no capital cost involved, generation of better results, evaluation of various risks on early stage, easy to learn etc. Brief description of few Cloud simulators is given in Table 2.

IV. FIGURES AND TABLES

Cloud Computing Architecture

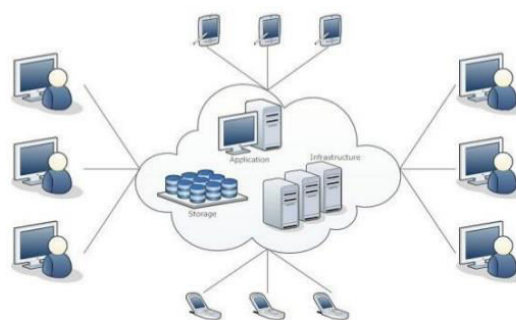


Fig.1. General Architecture of Cloud Computing

Sr. No	Job Scheduling Heuristics	Scheduling (QoS) Parameters	Findings	Tool
1	QDA Scheduling Algorithm [7]	Bandwidth, Time Reliability, Cost	<ol style="list-style-type: none"> Better load balancing. Better Cost. 	CloudSim
2	A Particle Swarm Optimization-based Heuristic for Scheduling [12]	Execution Time, Resource Utilization	<ol style="list-style-type: none"> Better Resource Utilization. Fair workload distribution among resources. 	Amazon Web Services
3	Improved Cost Based Algorithm [9]	Latency, makespan	<ol style="list-style-type: none"> Better makespan with more numbers of VMs. Overall improved latency. 	CloudSim
4	Innovative transaction intensive cost-constraint scheduling algorithm [13]	Execution Time, Cost	<ol style="list-style-type: none"> Lesser cost for few situations Permits the negotiations of completing cost and time 	SwinDeW
5	SHEFT workflow scheduling algorithm [14]	Execution Time, Scalability	<ol style="list-style-type: none"> Optimized Execution Time Runtime Scaling of Resources 	CloudSim
6	Job Scheduling based on Berger Model [15]	Job Completion Time, Fairness	<ol style="list-style-type: none"> Meeting user's expectations Better Job Execution Time 	CloudSim
7	Multiple QoS Constrained Scheduling Strategy of Multi-Workflows [11]	Makespan, success rate of jobs, execution time	<ol style="list-style-type: none"> Improved job execution time Dynamic scheduling of jobs 	CloudSim
8	Task scheduling algorithm based on QoS-driven in cloud computing [16]	Total completion time, Priority	<ol style="list-style-type: none"> Fair Scheduling for balancing load Better performance as far as total completion task is concerned 	CloudSim
9	PAPRIKA [8]	Complication Time, Utility	<ol style="list-style-type: none"> Enhanced resource utility Taking less time for task allocation to resources 	CloudSim
10	Ant Colony Optimization (ACO) [17]	Execution Time, Cost	<ol style="list-style-type: none"> Improved execution time Enhanced cost as far as resource utilization is concerned 	CloudSim
11	Multi QoS Scheduling Algorithm [18]	Execution Time	<ol style="list-style-type: none"> Improved efficiency up to some extent. 	CloudSim

Table 1. Comparison of Various Scheduling Heuristics

Table 2. Comparison of Various Cloud Simulation Tools

Sr. No	Cloud Simulation Tools	Availability	Language	Platform	Findings
1	CloudSim [19]	Open Source	JAVA	Windows, Linux, MaC	Allows simulations of Cloud Environment with very large scale. User can simulate various virtual servers, data centres, clients and also can simulate customized rules.
2	CloudAnalyst [19]	Open Source	JAVA	Windows, Linux, MaC	Almost same feature of CloudSim. GUI based simulator. Capability to describe a simulation with more configurability and elasticity
3	GreenCloud [19]	Open Source	C++	Linux	Much focus on Energy Efficiency. Packet - level simulator for energy - aware Cloud Computing data centres with a emphasis on Cloud communications.
4	Eucalyptus [19]	Open Source	C/JAVA	Windows, Linux	Private cloud and compatible with AWS. is an acronym for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems
5	Open Cloud [19]	Membership Required	Hardware Based	Hardware Based	It is a set of testing tools which simulate network traffic for testing network elements and services. Used for testing of various Cloud applications.
6	iCanCloud [19]	Open Source	C++	Linux	OMNET++ framework is used. Current and non-existing Cloud Computing architectures may be demonstrated and simulated. It offers approaches for gaining the energy consumption of each hardware component in Cloud Computing environment.
7	OpenStack [19]	Open Source	Python	Linux	Compatible with Amazon Web Services. OpenStack software controls large pools of compute, storage, and networking resources throughout a datacentre.
8	Opnet [19]	Paid	C/C++	Windows, Linux	It is a tool to simulate the behaviour and performance of any type of network. Restricted application testing for Cloud
9	MDCSim [20]	Paid	C++/JAVA	Windows, Linux	It helps in modelling unique hardware features of diverse components of a data centre

V. CONCLUSION

In this paper various job scheduling heuristics have been studied and analyzed. Main focus is on heuristics which provides Quality of Service (QoS). Various QoS parameters to measure are completion time, waiting time, success rate, resource utilization, makespan, cost etc. It is observed that each heuristic is compromising in some QoS parameters to achieve other parameters. In this paper, various cloud simulation tools are also studied and mentioned. Various simulation tools are used to simulate different Cloud scenarios and environment. Few of them are open source and few of them are proprietary. Different simulators are using different programming language like C/C++/JAVA and works on different platforms like Windows/Linux/Mac etc.

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Biographies and Photographs



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His preliminary research area focuses on routing in Mobile adhoc network and resource and job scheduling under Cloud environment.