UNIVERSITI PUTRA MALAYSIA

SCHEDULING TIGHT DEADLINES FOR SCIENTIFIC WORKFLOWS IN THE CLOUD

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By

AWADH SALEM SALEH BAJAHER

Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in Fulfillment of the Requirement for the Degree of Master of Computer science

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Abstract of thesis presented to the Senate of University Putra Malaysia in Fulfilment of the Requirement for the Degree of Master of Computer Science

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Abstract

Cloud computing has increasingly become a demand for scientific computations as it provides users with simple access for computation. Commercial clouds are also used for scientific analysis and computation because of their scalability, latest high-quality hardware as well as pay-per-use cost model. Commercial clouds can be easily accessed globally. There have been several studies presenting new algorithms to generate deadline constrained schedules to minimize the execution cost as well as the high failure rate in schedule constructions. However, there are increased failure rates whenever tight deadlines are produced.

The work in this paper focuses on the hurdle of scheduling tight deadline scientific workload. This article will evaluate the performance of the

Proportional Deadline Constrained (PDC) algorithm using Cloudsim and compare it with the Deadline Constrained Critical Path (DCCP) scheduling algorithm. The performance evaluation is done using two different performance metrics, success rate and normalized cost. The results show that the PDC performs better in term of success rate metric while the DCCP algorithm has better performance in term of normalized cost metric. The PDC could be improved on the normalized cost.

Keywords Deadline constrained, scientific workflows scheduling, cloud resources, resource provisions.

APPROVAL FORM

This thesis was submitted to the Senate of University Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Computer science. The members of the Supervisory Committee were as follows:

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DECLARATION

Declaration by a graduate student

I hereby confirm that:

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DEDICATION

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List of Abbreviations

VM	Virtual Machine
C	Cloudlet
DCB	Data Center Broker
PDC	Proportional Deadline Constrained
DCCP	Deadline Constrained Critical Path
SP	Service Provider
MIPS	Million Instruction Per Second
QoS	Quality of Service
VMs	Virtual Machines
MI	Million Instruction
CIS	Cloud Information Service
DC	Data Center
PM	Physical Machine
ECT	Earliest Completion Time

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CHAPTER 1

INTRODUCTION

1.1 Background

Cloud computing is the most modern trend, not only in computer science, but in a variety of sciences and fields. It is used for sharing resources, computations, deployments and experiments of different models. Moreover, cloud computing empowers noteworthy computational leverage to have it connected to numerous real-world issues, be they logical, industrial or therapeutic. When taking a scheduling viewpoint, it is concluded that the most attracting subset is the one related to multi-stage processing operations which might be denoted as workflow(Vahid Arabnejad, Bubendorfer, & Ng, 2017).

More so, commercial clouds are also utilized for analysis of scientific works and computations due to its scalability, latest high-quality hardware as well as pay-as-you-go cost model. Commercial clouds are based on a pay-per-use model. Most of the services of commercial clouds are paid based on duration of use of their resources like storage and network bandwidth. Furthermore, scientific computations have been lately performed on the cloud using the commercial cloud environments such as Amazon EC2, Google. etc. Such scientific computations usually involve fault tolerance, load balancing and accessing certain resources like GPU. Nevertheless, such a flexible cloud model could cause high costs whenever insufficient scheduling are performed (Chard et al., 2015).

This work tends to cover the issue of scheduling deadline-constrained for scientific workflows such as Cybershake, Sight and Epigenomics which are discussed in details in the methodology. Additionally, a number of novel scheduling deadline constrained algorithms were introduced.

The Proportional Deadline Constrained (PDC) algorithm has been presented by Arabnejad, Bubendofer, and Ng to solve the issue of scheduling deadline constrained schedules in commercial clouds which usually results in high failure rate as well as high cost (2017). Besides, the PDC algorithm has four main stages, namely workflow levelling, deadline distribution, task selection and instance selection. Those four stages are elaborated more in the methodology. After implementing all four stages, the PDC algorithm will then be compared to existing algorithms such as IC-PCP. PDC is expected to show higher success rate.

The rest of the work consists of subsections, problem statement, objectives and scope of the work. While the main sections, the literature review, methodology, implementation, results and analysis and conclusion.

1.2 Problem Statement

Commercial clouds can be easily accessed globally due to the rapid development of technology. Furthermore, commercial cloud corporations usually charge their clients on hourly basis as their resources are being used such as network bandwidth, storage, etc. It is also known as pay-per-use model. Moreover, executing scientific workflows on commercial clouds using pay-as-you-go model requires certain algorithms to schedule and complete tasks to pay as less as possible. There have been several studies presenting new algorithms to generate deadline constrained schedules to minimize the execution cost as well as the high failure rate in schedule constructions. However, there are increased failure rates whenever tight deadlines are produced (Vahid Arabnejad et al., 2017).

1.3 Objective of Research

The main objective of this project is the following:

- To evaluate the performance of Proportional Deadline Constrained (PDC) algorithm in scheduling scientific workflow.

1.4 Scope of Research

The focus of the study is the issue of scheduling tight-deadline scientific workflow, studying how the resources are provisioned and utilized for executing certain tasks parallelly. Also, the evaluation of the effectiveness of PDC algorithm in scheduling scientific workflow. Additionally, the evaluation will be performed using discrete event simulation represented in CloudSim framework for modelling and cloud computing simulation.

1.5 Thesis Organization

The thesis is organized as the following:

Chapter 1 Introduction that elaborates the cloud computing environment, commercial clouds and the summary of work.

Chapter 2 The literature review focuses on explaining more about the cloud and commercial clouds. Also, it includes a critically reviewed related work to this study.

Chapter 3 The methodology illustrated more about the definition of the problem, the algorithm, the method used, the parameters and workloads included as well as the simulator used.

Chapter 4 Implementation which shows how algorithms works, how this study simulation is performed and the experimentation executed.

Chapter 5 Results and Discussion illustrates the results of the simulation done in Chapter 4 as well as analyzing it.

In chapter 6 The conclusion includes a summary of the whole work.

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