AN ALTERNATIVE RANKING SCHEME FOR COMPUTATIONAL GRID RESOURCE SELECTION

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ABSTRACT

With widespread use of Internet and other communication technologies, it has become extremely popular to employ idle processing power of computers, which distributed around the world to achieve high performance computing. Grid computing is one the solutions to compute and process large amount of data by using distributed systems. Find suitable resources among numerous resources to execute the submitted job is a critical problem in grid environment. The main idea of proposed algorithm for resource selection is finding reliable resources that can meet job requirements and then based on available resources characteristics and processing power decides about workload of each subtasks. The number and workload of each subtask directly related to the number of available resources and their specifications such as CPU, memory and the status of the network that they are connected. In addition, a ranking mechanism developed to assign a rank to all resources, which join the selection process. It assists reliable resources have more chance to be selected among resources with similar processing performance. Experimental results present that proposed algorithm achieved maximum 95.4% success rate among 1000 submitted job which is 3.3% better than current success rate achieved by Grid Resource Vector (GRV) . The proposed algorithm achieved maximum one second execution time which is showing 2.7s improvement among evaluated methods. In addition, it showed 251.12s completion time among a job with 100K length with 5000 resources where evaluated method achieved 376.45s that shows 125.33s improvement. Proposed algorithm succeeds to increase execution success rate and improve average execution and completion time in comparison of similar algorithms, which shows that alternative ranking scheme is effective for selection reliable resources.

ABSTRAK

Dengan penggunaan internet dan teknologi komunikasi yang semakin meluas, ia menjadi sangat popular untuk kuasa pemprosesan komputer terbiar, dimana ia diedarkan keseluruh dunia untuk mencapat perkomputeran yang berprestasi tinggi. Pengkomputeran grid adalah salah satu penyelesaian untuk mengira dan memproses jumlah data yang besar dengan menggunakan sistem teragih. Masalah utama di dalam perkomputeran grid adalah untuk mencari sumber yang sesuai untuk menjalankan sesuatu kerja. Algoritma yang dicadangkan adalah untuk pemilihan sumber yang boleh dipercayai dan memenuhi keperluan pekerjaan. Seterusnya ciri-ciri dan kuasa daripada sumber yang terhasil digunakan bagi kuasa pemprosesan untuk mengenalpasti beban kerja yang dilakukan untuk setiap subtugasan. Bilangan beban kerja untuk setiap subtugasan berkait secara langsung dengan jumlah sumber yang ada dan juga spesifikasi seperti CPU, memori, dan juga status rangkaian. Tambahan lagi, satu mekanisma berlapis dibangunkan untuk memberi nilai tahap kepada semua sumber ketika proses pemilihan sumber dilakukan. Ia dipercayai dapat membantu sumber yang bernilai supaya mempunyai peluang yang lebih untuk dipilih dalam sumber yang ada didalam prosess pemilihan. Keputusan eksperimen adalah menunjukkan bahawa algoritma yang dicadangkan telah mencapai nilai maksimum sebanyak 95.4% kadar kejayaan dikalangan 1000 kerja yang dikemukakan. Nilai ini dimana adalah 3.3% lebih baik daripada kadar kejayaan yang dicapai semasa menggunakan Grid Sumber Vector (GRV). Tambahan lagi algoritma yang dicadangkan telah mencapai nilai maksimum dalam satu saat perlaksanaan masa dimana ia direkod 2.7 saat dikalangan kaedah penilaian yang digunakan. Selain itu, ia menunjukkan masa akhir adalah 251.12 saat dengan panjang 100k dan 5000 sumber yang mana menggunakan kaedah penilaian adalah 376.45 saat, dan ia menunjukkan peningkatan 125.33 saat. Algoritma yang dicadangkan telah berjaya meningkatkan kadar kejayaan perlaksanaan, purata perlaksanaan dan juga masa akhir. Berbanding penggunaan algoritma yang sama, ia menunjukkan bahawa Skim Lapisan adalah alternatif yang berkesan untuk membuat pemilihan sumber yang dipercayai.

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LIST OF ABBREVIATIONS

API	Application Programming Interface
BP	Back Propagation
CA	Custom Attribute
CFP	Call For Proposal
ELM	Extreme Learning Machine
FCFS	First Come First Serve
GRV	Grid Resource Vector
GIS	Grid Information Service
IBL	Instance Based Learning
JVM	Java Virtual Machine
JS	Job Success
LA	Learning Automata
LSF	Load Sharing Facility
MASK	Multi-Agent System broKer
MI	Million Instructions
MIPS	Million Instructions Per Second
OGSA	Open Grid Service Architecture
OS	Operation System

PBS	Portable Batch Scheduler
PE	Processing Elements
QoS	Quality of Service
RA	Resource Availability
RMS	Resource Management System
RR	Round Robin
SDK	Software Development Kit
SLFN	Single-hidden Layer Feedforward Neural Networks
SLA	Service Level Agreements

CHAPTER 1

INTRODUCTION

1.1 Introduction

In recent decades the computation power of computers grew dramatically and network technologies improved the path that computers connect each other. Although this processing strength is more than most of users' requirement, some of them found that the processing capacity of their workstation is much smaller than their processing demands (Jianzhe *et al.*, 2011). These finding encouraged computer scientists to introduce new utilization of idle power of computers and networks, "Grid Computation".

Grid computing provides a convenient and secure distributed system known as "Grid" for sharing resources which originally belongs to organization such as companies, universities, institutions or personal computers at different locations.

In a distributed system, an application, which called parallel application break into some tasks and each task, assigned to a node that called here resource. Effective resource selection is one of the main problems in resource management (Sarhadi and Meybodi, 2010) which is related several aspects such as resource reliability, completion time, fault management, cost management, job partitioning and so on.

1.2 Background of the Problem

The main problem studied in this thesis is resource selection problem in a computational grid. In a computational grid environment, users dealing with much more resources than they require which they may be spread around the world (Nik *et al.*, 2011). Managing resources in grid environments is an enormous challenge; It is because of resources in grid environments are heterogeneous and furthermore to that, grid resources belong to various organizational domains and employed by different administration policies (Adil Yousif 2011).

Complexity of grid middleware reduced by one of the most significant mechanism of grid systems which called resource brokering and it permits the users of grid to state the specifications and attributes of desired resources and then broker looking for resources that equivalent to the requested condition and selects the suitable resources for task execution (Haji *et al.*, 2005).

Elmroth and Tordsson (2008) categorized resource brokers into two classes based on their behavior: Centralized and Decentralized. Centralized resource broker manages all resources and tasks submitted to grid system while in decentralized resource broker all resources have to join to one or more index servers and also each register server can register in others register servers. All users in grid system have their own broker and when a task submits to grid, brokers discover available resources by index servers. Resources will be selected by resource broker after request extra information from resource providers and user will be informed to concern task submission (Elmroth and Tordsson, 2008).

Matchmaking model which can implement by centralized broker (Elmroth and Tordsson, 2008), collect condition of all resources advertised by resource providers and run a matching application (Wang *et al.*, 2010). It has some problems like information about resources are not always up to date and resource history and reliability ignored (Yu *et al.*, 2005).

Some external factors in scheduling approaches are job completion, resource reliability, and local scheduling which have an important effect in job completion and the grid throughput. Moab (Klusáček *et al.*, 2008) as a meta-scheduler can run distributed job on independent clusters. Greedy approach has been used in GridWay (Team, 2007) as light-weight scheduler which using first come first serve (FIFO) to execute submitted jobs by user. Compute-intensive jobs can be managed by specific workload management systems such as Condor and Condor-G (Frey *et al.*, 2002). The weakness of algorithms and systems above is they do not consider reliability and QoS.

There are different resource selection approaches which have been used in Grids and other distributed systems. Bidding-based or Auction-based approaches assign the submitted job to highest bid received from resources (Garg *et al.*, 2008).

A ranking based approach is ontology-based (Tangmunarunkit *et al.*, 2003) resource selection that assign ranks to resources. This rank calculated by hierarchical process and considers priority groups, location of user (local or remote) and et al. Reputation algorithms such as simple feedback reputation (Sonnek and Weissman, 2005), beta feedback reputation(Ismail and Josang, 2002), weighted feedback reputation(Alunkal *et al.*, 2003) using user feedback to assign rank to resources in order to evaluate user satisfaction and quality of resource performance.

In addition, suitable resources will be selected by agents in agent-based(Manvi and Birje, 2005) resource selection approaches. Attributes and requirements are the base of decision making in all approaches above and none of them considers reliability of resources. Addepallil et al.(2010) presented GRV to overcome reliability problem but the elements that they considered were the duration that a resource was available which means resources that were available longer had more chance to receive jobs than resources that became available recently. Execution failure was another parameter to rate resources in their work. They did not consider resource failure history and assumed all resources are capable to execute the job which is not a valid assumption. JARS (Job history-based Adaptive grid Resource

Selection) (Hur and Kim, 2010) proposed to overcome job execution failure which worked with statistical information and it considers job execution success where resource reliability did not considered.

Job execution and completion time is another important parameter that resource selection approaches should consider. Tao et al (2008) tried to minimize cost and execution time with considering reliability by presenting a Particle Swarm Optimization(PSO) algorithm. Similarly, Liang et al (2008) used frequent workload pattern to speed up execution process and increase reliability of resources. However, the approaches mentioned above only concentrate on processing power and availability. Wu and Sun (2009) presented a memory-CPU partitioning method based on available resources which is more convenient.

1.3 Problem Statement

Recently, numerous questions have been raised up about the performance, efficiency, speed, scheduling, management, throughput, availability and suitability as resource selection issues have become a huge challenge in grid computing. Among these kinds of problems there are enormous researches and studies to cope with them and there is still vast space to deal with these issues. These sorts of architectures are always presented to improve and to expand the mentioned problems for users and those applications waiting for available resources. The main issue is to adapt suitable resources based on user's requirements that lead to the evaluation of the developed algorithms to achieve the existing problems. Thus, the main problem, this research attempts to solve is which parameters should be used to assign rank resources to achieve higher success rate.

As it presented in background of problem, although, these approaches have strengths due to weakness in their assumption and the parameters that they use for ranking resources, they scarify some elements to achieve their goals. A ranking resource selection algorithm should find the most reliable resources by using efficient parameters for ranking that can meet job requirements and try to speed up job execution based on available resources. Ranking resources, based on resources behavior, availability, failure, processing power and network status in long term tracking can assure resource reliability, improve execution success rate and performance efficiency. In addition, assign initial rank to resources based on processing power is not efficient and the proposed method should use an alternative method to assign initial rank.

1.4 Research Questions

This study attempts to answer these questions:

1. What method should be used to study resource selection problem?
2. What parameters should be used for resource ranking to increase execution success rate by finding reliable resources?
3. How to speed up execution procedure as a concern of all resource selection algorithms?
4. How to validate the proposed algorithm to prove it can achieve efficiency?

1.5 Aim of Study

The aim of this study would be to propose a resource selection algorithm which using ranking to find reliable resources based job requirements. Furthermore, it uses ranking procedure to decrease the failure rate and partitioning mechanism to decrease execution and total completion time which will be implemented in GridSim simulator and evaluated by other resource selection algorithms.

1.6 Objectives of Study

1. To study existing resource selection algorithms in computational grid.
2. To design an efficient ranking based resource selection algorithm to increase the success rate and improve average execution and total completion time.
3. To implement proposed algorithm in GridSim simulator.
4. To evaluate proposed resource selection algorithm against existing resource selection algorithms using GridSim simulator.

1.7 Scope of the Study

The scope of this study is in between computational grid and resource selection algorithms. There are some algorithms to find and select most effective resources in computational grids but this study will be focused on propose an efficient matchmaking resource selection algorithm with resource ranking and partitioning mechanism and want to implement and evaluate proposed algorithm in GridSim simulator by using JAVA programming language. Success rate is main evaluation metric which shows the capability of proposed algorithm for selecting reliable resources and its effect on execution time and completion time.

1.8 Motivation

When a parallel job assigned to a grid system several steps should be taken to reach the goal. Resource selection is one of the most important steps in execution of the application, hence, it directly relates to total execution time. Any change and wrong selection among the outsized number of resources can effect on total completion time dramatically or cause to increase rate of resource failure in step of job execution. In other word, it is aimed to propose an effective matchmaking resource selection algorithm to decrease the completion time and rate of resource failure.

1.9 Organization of Research

This dissertation organized as follow:

In chapter 2, previous works by other researchers in same area of this study reviewed and classified. In addition, advantages and weaknesses of them have been recognized and discussed in this chapter.

Research methodology explained in chapter 3 to clarify the method and tools, which used in this research.

In chapter 4, the implementation details of proposed algorithm have been explained which includes design and development procedure.

Chapter 5 discusses about results of this study based on simulation and a comparison between proposed algorithm and similar methods has been done.

Chapter 6 will present the conclusion and illustrate some more suggestion for future studies.

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