# EFFICIENT ALGORITHMS FOR JOB SCHEDULING IN PARALLEL SYSTEMS

By

Ruwanthini Siyambalapitiya

*A thesis submitted in partial fulfilment of the requirements for the degree of*

DOCTOR OF PHILOSOPHY

At the

***Department of Computer Engineering***

***Faculty of Engineering***

UNIVERSITY OF PERADENIYA

SRI LANKA

2012

# ABSTRACT

Title of the Thesis: **Efficient Algorithms for Job Scheduling in Parallel Systems**

Name of the Author: **Ruwanthini Siyambalapitiya**

Department of Study: ***Department of Computer Engineering, Faculty of Engineering,***

**University of Peradeniya, Sri Lanka**

Degree Applied for: **Ph.D.**

In this study, the *job scheduling problem in parallel systems* is addressed. It can be stated as the problem of allocating a set of jobs or tasks to a set of parallel processors or machines to minimize the overall execution time. It has been shown that, it is almost impossible to develop exact optimal algorithms to solve this problem, as it is categorized as a *NP-hard* problem. Therefore, it has been necessary to develop efficient algorithms which will lead to near optimal solutions and that can solve real world problem instances. We consider a mathematical treatment of the *job scheduling problem in parallel systems*.

Several *approximation algorithms* are developed in this study. Minimizing of the *makespan* is the objective function considered in the study. First, more efficient single thread algorithms for the *parallel job scheduling problem* are developed. Then, the concept of multi-threading is used to propose several new more efficient algorithms based on the concepts of *gang scheduling* and *backfilling*, which are applicable to large scale parallel systems.

In order to estimate the quality of solutions obtained, *lower bounds* and *percentage gaps* are derived. Mainly, small and medium scale test problems are used in this study, with a few large scale problems as well. However, it is shown that the results can be applied to large scale problem instances, in general. A method to determine the proximity of solutions to the relevant optimal solutions using statistical techniques is also developed. Performance evaluation of the algorithms is presented in detail. It is shown that our solutions are extremely close to the relevant optimal solutions. All the proposed algorithms are *polynomial time* algorithms.

The random nature of the job completion time is also considered. When the number of jobs and processors are fixed, there can be an infinite number of ways of varying individual job completion times for a given total job execution time for all the jobs. Using more than twenty thousand data sets, performance of algorithms are compared. It is shown that, the performance level of the algorithms does not change even if the random nature of job completion times were considered.