International Journal of Innovative Computing, Information and Control
Volume **7**, Number **2**, February **2011**

ICIC International ©2011 ISSN 1349-4198
pp. **881–896**

SCHEDULING PARALLEL TASKS WITH INTRA-COMMUNICATION OVERHEAD IN A GRID COMPUTING ENVIRONMENT

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Received October 2009; revised April 2010

Abstract. *With the improvements in wide-area network performance and powerful computers, it is possible to integrate a large number of distributed machines belonging to different organizations as a single system, for example, a grid computing environment. A grid computing environment involves cooperation and sharing resources among distributed machines. Users may dispatch their tasks to remote computing resources instead of just computing locally. Hence, task scheduling is an important issue in a grid computing environment. If a task is processed in parallel in a parallel machine, intra-communication overhead is inevitable and is an important factor affecting the task's processing time. Thus, instead of a free communication assumption, this paper takes intra-communication overhead into account. According to the models of parallel task and intra-communication overhead, the problem of scheduling independent parallel tasks with intra-communication overhead in a grid computing environment is investigated. In this paper, a heuristic algorithm for this problem is proposed, and the performance bounds of the heuristic algorithm for scheduling parallel tasks in the environment with message passing machines and in the environment with shared memory machines are derived as 9/2 and 5/2 respectively. Although this problem is mainly about assigning tasks to a grid computing environment, however, by proper transformation it can be applied to the workforce assignment problem.*

Keywords: Parallel task, Intra-communication overhead, NP-hard, Performance bound, Grid computing environment

1. **Introduction.** With a conventional scheduling problem, each task is restricted to being processed on only one processor at a time; however, in a parallel tasks scheduling problem [2,8-10,13,23,24], a task may be processed on more than one processor at a time. The parallel tasks scheduling problem assumes that there are n parallel tasks to be scheduled in a machine with p identical processors, and each task T_i, $1 \leq i \leq n$, has a maximum degree of parallelism Δ_i, $\Delta_i \leq p$, and computation requirement t_i. The maximum degree of parallelism Δ_i means that task T_i may be processed on up to Δ_i processors. Once the degree of parallelism has been decided, it will not be altered during processing. Suppose that task T_i is scheduled to be processed on δ_i processors, δ_i is called the scheduled parallelism of task T_i and the processing time required by T_i, under linear speedup assumption, will be (t_i/δ_i). For this problem type, a schedule is feasible if the scheduled parallelism of each task is not greater than its maximum degree of parallelism, that is, $1 \leq \delta_i \leq \Delta_i$. A feasible schedule is called an optimal schedule if it has the minimum schedule length. Finding an optimal schedule for this problem type in a single machine with at least two processors is NP-hard [2]. Therefore, a polynomial time heuristic scheduling algorithm is one of the ways to obtain an approximate solution for such a problem. A heuristic scheduling algorithm A is said to have a performance bound