Fault-Tolerant Meta-Scheduler for Price-based Job Scheduling by Applying Multi-Reservation Method

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ABSTRACT: In market-like grids, applying an economical method for providing fault-tolerant job scheduling is necessary. Since we have to pay cost for job execution in economic grids, consumers tend to execute their jobs on a grid with minimum cost and acceptable completion time. To do this, many approaches have been proposed, but they unilaterally consider either time/cost or consumer/provider profit. Based on current research, a new approach has been proposed; the approach is an optimized, fault-tolerant method for meta-scheduler that considers bilateral satisfaction for consumer/provider and a tolerable completion time. We suppose that, if one of the provider nodes fails, there would not be enough time to start a task on a new node from the beginning. The experimental results show a promising improvement in job scheduling with less computation cost, better fault-tolerance, and an acceptable completion time.

Categories and Subject Descriptors
C.4 [Performance of Systems]: Fault tolerance; K.6.2 [Installation Management]: Pricing and resource allocation

General Terms: Grid computing, Resource allocation, Fault tolerance

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1. Introduction

At the present time, grid computing [1] is a pervasive and popular infrastructure for high performance and distributed computing. Many researchers believe that the grid, in the near future, will be an acceptable method in real-world applications of parallel and distributed computing. At present, specific organizations, companies, and academic researchers use grid systems in order to achieve some specific goals. For example, the European Community (EU) [2], CERN [3], AustrianGrid2 [4], TeraGrid [5], and Allegro [6] have established studies of e-Science using the grid infrastructure. Allegro benefits from grid computing, which allows a network of distributed computers to work in unison, providing real-time valuation, scheduling, and settlement. The EU is sponsoring a grid project for high-energy physics, earth observation, and biological applications. Grid technology enables sharing of computational resources within and between organizations all over the world. The use of the grid for scheduling computational resources is a very complex process because of the dynamic, heterogeneous resources in a wide area.

In this research, we have considered a hierarchical model for job scheduling based on the meta-scheduler and local schedulers. The goal is to concentrate on the tasks that must be processed, with real-time priority on the economically-based grid. It is obvious that a job owner (consumer or requester) should pay more for a job with real-time priority in the economically-based grid. We assume that there is a time limitation for job execution.

On the other hand, resource allocation has an impact on fault tolerance. Selecting fault-tolerant nodes and assigning them to a real-time job will definitely reduce fault events during the execution of the job. Currently, there is an increasing interest in economic approaches for the allocation of the grid’s resources. In this research, a predictive system for scheduling the grid’s resources has been designed. The system is capable of making dynamic decisions and selecting nodes in the grid in accordance with the conditions of the job and the grid; it also makes decisions concerning the multi-reservation of nodes to increase the fault tolerance. We have considered an option for the consumer (job owner) to increase the priority of her/his job by paying more. In this case, if the consumers tend to receive the results of the job quickly and with high dependability, they must select one of the options that reflect the additional charges, which can change based on grid conditions. When the job is completed, the consumer will be informed about the extent to which her or his selected option increased the price of the job. For economic rescheduling of a failed task, we have used the checkpointing technique by meta-scheduler based on a bidding mechanism. Checkpointing is used in grid computing by known systems, such as Condor [7] and Cactus [8]. Checkpointing is a very general technique that can be applied to any types of parallel applications. It saves the state of the task in stable storage for use in future rescheduling. We saved the checkpointing data that were provided at supporter sites, which are explained in the next sections.

The structure of the paper is as follows. Section 2 provides a formal problem statement. Section 3 contrasts our work with related work. Section 4 presents reviews of the use of rough set theory and the multi-level grid scheduler. In section 5, we propose our method, which is based on a multi-checkpointing technique for scheduling fault tolerance in an economic grid. Section 6 presents our evaluation of experimental results, and section 7 contains our conclusions.

2. Problem Formulation

This section begins with the evolution of economically-based grid computing, and the main function is to achieve a fault-tolerant scheduler, considering cost, time, and efficiency. In the future, due to the increasing requirement for high performance