Multi-agent Negotiation Model for Resource Allocation in Grid Environment*

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Abstract. Due to the resources in the Grid are heterogeneous and geographically distributed, the management of resources and application scheduling in large-scale distributed Grid environment is a complex undertaking. Intelligent agents can play an important role in solving these problems. In this paper we formulated this problem as a multi-agent game with the players being agents purchasing service from a common server. We strive to highlight major challenges in managing resources in a Grid computing environment and present some of our recent works on multi-agent negotiation strategies for resource management and scheduling in grid environment. The proposed approach is to realize multiple negotiation models/protocols/strategies that can be selected by the system automatically to adapt to computation needs as well as changing computing resource environment.

1 Introduction

Grid [2] based computational infrastructure is a promising next generation computing platform for solving large-scale resource intensive problems [1]. However, resource management, application development and usage models in these environments is a complex undertaking. Most of the related work in Grid computing dedicated to resource management and scheduling problems adopt a conventional style where a scheduling component decides which jobs are to be executed at which site based on certain cost functions (Legion [8], condor [9], etc). They treat resource as if they all cost the same price and the results of all application have the same value even though this may not be the case in reality. Due to the complexity in constructing successful Grid environments, it is important to find a novel management mechanism and strategies to solve resource management and scheduling in Grid. In [4] Rajkunar Buyya et.al proposed and explored the usage of an economics based paradigm for managing resource allocation in Grid computing environments. For the market to be competitive and healthy, coordination mechanisms are required that help the market reach an equilibrium price - the price at which the supply of a service equals the quantity demanded [4]. Multi-agent Systems have addressed issues of coordination among autonomous, distributed agents for many years. A wide variety of networked computer systems

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(such as the Grid, the Semantic Web, and peer-to-peer systems) can be viewed as multi-agent systems [3]. Agents with distinct interests or knowledge can benefit by engaging in negotiation whenever their activities potentially affect each other. Through negotiation, agents make joint decisions, involving allocation of resources, adoption of policies, or any issue of mutual concern.

To enhance information coordination, highlight major challenges in resource management and scheduling in Grid environment. In this paper, we proposed and explored models, protocols and strategies for multi-agent negotiation framework to grid computing. The multi-agent approach provided a fair basis in successfully managing decentralization and heterogeneity that is present in human society and human economies. The remainder of the paper is organized as follows. Section 2 introduces multi-agent negotiation framework for resource allocation. Section 3 discusses single issue negotiation model. Section 4 describes multi-issue negotiation. Section 5 gives the conclusion.

2 Multi-agent Negotiation Framework for Resource Allocation

The multi-agent system architecture follows that presented in [5]. See Fig.1. In our project the Grid is viewed as multi-agent systems in which the individual components act in an autonomous and flexible manner in order to achieve their objectives. The multi-agent middleware makes use of agent technology as the main mechanism for grid resource negotiation in the job submission process. It consists of negotiation, migration, and interface modules. In the negotiation module are agents and functions involved in the negotiation process. The migration module completes the negotiation module by matching the Service Level Agreements (SLAs) established by agents, by deciding the place to run the job, and by submitting the job. The OGSA interface module has functions that allow integrating agents into the grid environment. The agent technology has features well fitting for distributed communication, and is particularly robust for the negotiation and migration processes.

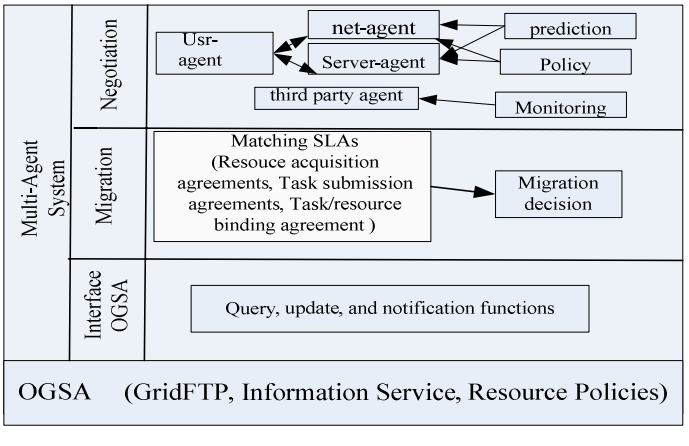

Fig. 1. Multi-Agent System Architecture for Resource Allocation [5]