Balancing Load in a Computational Grid Applying Adaptive, Intelligent Colonies of Ants

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Load balancing is substantial when developing parallel and distributed computing applications. The emergence of computational grids extends the necessity of this problem. Ant colony is a meta-heuristic method that can be instrumental for grid load balancing. This paper presents an echo system of adaptive fuzzy ants. The ants in this environment can create new ones and may also commit suicide depending on existing conditions. A new concept called Ant level load balancing is presented here for improving the performance of the mechanism. A performance evaluation model is also derived. Then theoretical analyses, which are supported with experiment results, prove that this new mechanism surpasses its predecessor.

Povzetek: Za porazdeljevanje obremenitev je predlagana nova metoda s kolonijami mravelj.

1 Introduction

A computational grid is a hardware and software infrastructure which provides consistent, pervasive and inexpensive access to high end computational capacity. An ideal grid environment should provide access to all the available resources seamlessly and fairly. The resource manager is an important infrastructural component of a grid computing environment. Its overall aim is to efficiently schedule applications needing utilization of available resources in the grid environment. A grid resource manager provides a mechanism for grid applications to discover and utilize resources in the grid environment. Resource discovery and advertisement offer complementary functions. The discovery is initiated by a grid application to find suitable resources within the grid. Advertisement is initiated by a resource in search of a suitable application that can utilize it. A matchmaker is a grid middleware component which tries to match applications and resources. A matchmaker may be implemented in centralized or distributed ways. As the grid is inherently dynamic, and has no boundary [1], so the distributed approaches usually show better results [2] and are also more scalable. A good matchmaker (broker) should uniformly distribute the requests, along the grid resources, with the aid of load balancing methods.

As mentioned in [1], the grid is a highly dynamic environment for which there is no unique administration. Therefore, the grid middleware should compensate for the lack of unique administration. ARMS is an agent-based resource manager infrastructure for the grid [3, 4]. In ARMS, each agent can act simultaneously as a resource questioner, resource provider, and the matchmaker. Details of the design and implementation of ARMS can be found in [2]. In this work, we use ARMS as the experimental platform.

Cosy is a job scheduler which supports job scheduling as well as advanced reservations [5]. It is integrated into ARMS agents to perform global grid management [5]; Cosy needs a load balancer to better utilize available resources. This load balancer is introduced in part 3.

The rest of the paper is organized as follows: Section 2 introduces the load balancing approaches for grid resource management. In Section 3, ant colony optimization and self-organizing mechanisms for load balancing are discussed. Section 4 describes the proposed mechanism. Performance metrics and simulation results are included in Section 5. Finally, the conclusion of the article is presented as well as future work related to this research.