Adaptive Scheduling Solution for Grid Meta-brokering

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Since the management and beneficial utilization of highly dynamic grid resources cannot be handled by the users themselves, various grid resource management tools have been developed, supporting different grids. To ease the simultaneous utilization of different middleware systems, researchers need to revise current solutions. User requirements created certain properties that resource managers have learned to support. This development is still continuing, and users already need to stress themselves to distinguish brokers and migrate their applications, when they move to a different grid. Interoperability problems and multi-broker utilization have emerged the need for higher level brokering solutions. The meta-brokering approach means a higher level resource management by enabling automatic and simultaneous utilization of grid brokers. The Grid Meta-Broker [1] is a high-level middleware service that uses meta-data about user request and broker capabilities to find a proper execution environment.

Scheduling at this level requires sophisticated approaches, because high uncertainty presents at all stages of grid resource management. This work presents an adaptive scheduling algorithm that enhances the matchmaking service of the Meta-Broker and enables it to react to unreliable broker properties and load unbalances. The algorithm uses an initial teaching phase to gather reliability information of the interconnected brokers. We keep the first phase of the original matchmaking algorithm of the Meta-Broker: this is used to filter out brokers that are lacking capabilities required by the user. The extension appears in the second phase, where a fitness function is used to calculate the goodness of the brokers. Different environments may require different weights in the fitness function of the algorithm. We developed a method to monitor the behavior of the scheduling algorithm and modify the appropriate weights to find the optimal fitness function. After defining the weights for the actual environment, we are able to calculate the goodness values. This is done with the help of a random generator function [3],[4], which takes into account dynamic historical performance data of the brokers.

We experimented in a simulated grid environment built on top of the GridSim toolkit [2]. It supports modeling and simulation of heterogeneous grid resources, users, applications, brokers and schedulers in a grid computing environment. It provides primitives for the creation of jobs, mapping these jobs to resources and managing them, therefore resource schedulers can be simulated with this tool to study scheduling algorithms. In our general simulation architecture resources can be defined with different grid middleware types. Resources consist of more machines, to which workloads can be set. On top of this simulated grid infrastructure we can set up resource brokers. Brokers are extended GridUser entities: they can be connected to one or more resources, they report to the IS Grid load database (which has a similar purpose as a grid Information System), different properties can be set to these brokers (agreement handling, co-allocation, advance reservation, etc.), properties can be marked as unreliable, different scheduling policies can be set for each broker and resubmission is used, when a job fails due to resource failure. The Simulator is an extended GridSim entity: it can generate a requested number of jobs with different properties, start and run time. It is connected to the Grid Meta-Broker through its web service interface and able to call its matchmaking service. Before the Meta-Broker is used for broker selection, it has to be configured with the capabilities of the interconnected brokers. Our evaluation results show that the Meta-Broker performs better with the enhanced adaptive algorithm: the total makespan of the submitted jobs can be significantly reduced.

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References

[1] A. Kertész, P. Kacsuk: Meta-Broker for Future Generation Grids: A new approach for a high-level interoperable resource management, *CoreGRID Workshop on Grid Middleware in conjunction with ISC'07 conference*, Dresden, Germany, June 25-26, 2007.

[2] R. Buyya and M. Murshed: GridSim: A Toolkit for the Modeling and Simulation of Distributed Resource Management and Scheduling for Grid Computing, *Concurrency & Computation: Prac. & Exp.*, Nov-Dec 2002.

[3] I. Deák: Véletlenszám-generátorok és alkalmazásuk, *Akadémiai Kiadó*, 1986, Budapest.

[4] J.P.C. Kleijnen, B. Annik: Pseudorandom number generators for supercomputers and classical computers? A practical introduction, *European Journal of Operation Research*, 63 (1992) 76-85.