

## EconoGrid: A detailed Simulation Model of a Standards-based Grid Compute Economy

EconoGrid is a detailed simulation model, implemented in SLX<sup>1</sup>, of a grid compute economy that implements selected standard specifications developed by OASIS and the Open Grid Forum. A computing grid is a large-scale collection of distributed computing resources that is available for on-demand access by a large numbers of users. In a grid compute economy, computing resources are sold to users in a market where price is determined by supply and demand. EconoGrid is a tool for investigating global behavior of a grid compute economy over time. EconoGrid models operation of many users and grid service providers communicating over a network with realistic message delays. Users have a set of computing tasks to be executed on the grid together with a budget. Grid service providers manage cluster processors, supercomputers, or other computing resources for executing user tasks. Providers advertise their services for a price designed to cover operating costs. Users discover providers and offer contracts to execute their tasks for a fee. EconoGrid tracks the status of user tasks, the state of service providers, and the evolution of price over time.

The operation of EconoGrid can be parameterized by a large number of variables. These include network topology and the configuration of users and providers, workload characteristics, provider capabilities, and detailed behavior of users and providers. Workload characteristics include task duration and processing requirements, inter-task workflows. Workload level is defined by the number of tasks assigned to clients. Individual tasks are also assigned financial rewards they achieve if completed on time and budgets from which to pay providers. Provider cluster sizes can be varied together with operating costs. Both clients and providers are assigned target profit margins they seek to fulfill. Specific values are chosen from statistical distributions provided as part of the parameter definition. Client and provider behaviors are especially important input parameters. EconoGrid permits selection of defined behaviors for contract negotiation strategy, client selection and prioritization of providers, and provider selection of contract offers. The strategies employed by clients and provider determine allocation of resources during a simulation.

Most recently, EconoGrid has been applied to investigate feasibility of using profit-based resource allocation strategies in moderate-sized computing grids in which workload is varied from 0 to 200% of total provider capacity [1]. The results demonstrated that profit-based strategies worked well at moderate load levels (50-100%) in comparison with traditional resource allocation strategies based on utilization thresholds. At overload, profit-based strategies are decidedly better at allocating resources to the most valuable tasks. The work resulted in the development of a new metric, system welfare, which evaluates performance of compute economies by considering economic benefits to participants together with larger social welfare derived from the operation of a grid.

[1] Mills, K. and Dabrowski, C. "Can Economics-based Resource Allocation Prove Effective in a Computation Marketplace?" submitted for review to the *Journal of Grid Computing*.

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<sup>1</sup> SLX is a commercial simulation system available from Wolverine Software, see: <http://www.wolverinesoftware.com>.