Cloud computing offers businesses a cost-effective alternative to a central computer. The advantages and the flexibility of this computational resource management are the focus of the SORMA and GridEcon projects, as **Dirk Neumann** and **Jörn Altmann** illustrate

Exchanges for Grid and Cloud Computing

Today's business becomes increasingly computation intense. For example, before automobile manufacturers release a new engine, many simulations are executed to validate the properties of the new engine. Through the use of computer simulations, the development time can be shortened and the costs reduced. Since those simulations require a huge amount of computation power, an upfront investment in computers is necessary. However because of the high cost of ownership and the infrequent use of those computers, not all companies can afford it. For those companies, it would be useful to have access to a Computing Resource Exchange where they can buy computing resources at the daily rate. The supply of those computing resources comes from other companies or data centre providers. These kind of exchanges represents a significant advancement in the state-of-the-art of utility computing, where just one large provider of resources offers its resources (e.g. Amazon, Sun, Google, HP).

From the technical perspective, interconnection of computing resources becomes possible through Grid Computing technology. Grid computing denotes a computing model that unifies the processing power of an infrastructure that is dispersed administratively and geographically. Therefore, by using Grid computing, it is possible to set up virtual supercomputers by means of regular servers. The technology assures that adding and removing computers is quite simple, granting extreme flexibility in building up infrastructures quickly.

While the adoption of Grid technology in academia has been prospering, the adoption by commercial companies has been slow, mainly due to the lack of viable business models coupled with chargeable Grid services and commercial transactions on them. What is needed is a set of mechanisms that enables users to discover, negotiate, and pay for the use of Grid services. Since computing resource exchanges address this issue, they are, therefore, one of the crucial success factors for establishing commercial Grids.

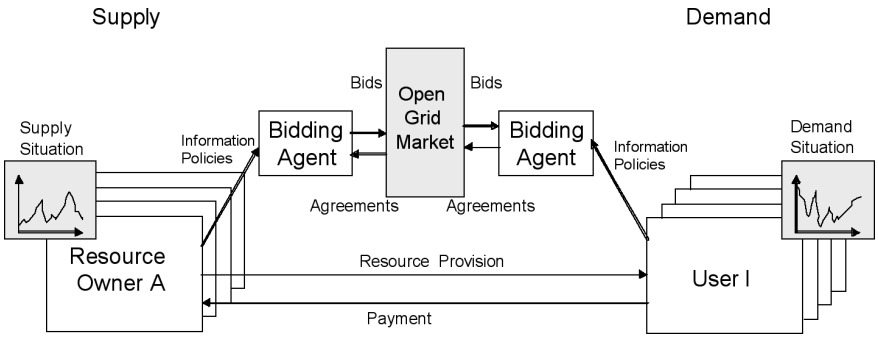

Figure 1: Self-organising Resource Management of SORMA

Computing Resource Exchange

Quite recently, Amazon has floated the idea of Cloud computing with their offerings of Elastic Clouds. Since then, a few other companies started to offer similar services. An exchange for computing resources would have a significant impact on the current oligopoly-structured market, where a few providers (e.g. Amazon, HP, IBM, Google, Sun) can offer computing resources at prices higher than those possible in a competitive market structure. If buyers and sellers accept and trust the computing resource exchange for executing their trades, it will increase the supply of computing resources in the market. Consequently, it will lower the price for buying computing resources and computing resources will become even affordable to enterprises with a low budget.

The EU funded projects, SORMA and GridEcon, focus on the development of computing resource exchanges. While SORMA focuses on the openness of decentralised complex service markets, GridEcon addresses an exchange for basic Computing Cloud resources.

SORMA Exchange

The SORMA market is envisioned to be open with respect to the communication protocols and the local resource managers of computing resources. This openness allows Grid users accessing the Open Grid Market via well-defined interfaces. Furthermore, resource providers with different virtualisation platforms or with different resource managers can easily plug in the Open Grid Market. The idea is to set up a flexible market infrastructure, which can access resources over all existing kind of virtualisation platforms.

The openness is intended to offer the possibility of loosely integrating emerging Grid markets. For example, the Open Grid Market needs to combine platforms like Sun's Network.com or Amazon's Elastic computing cloud, but should also be capable of accessing Beowulf or MOSIX clusters. This approach should attract

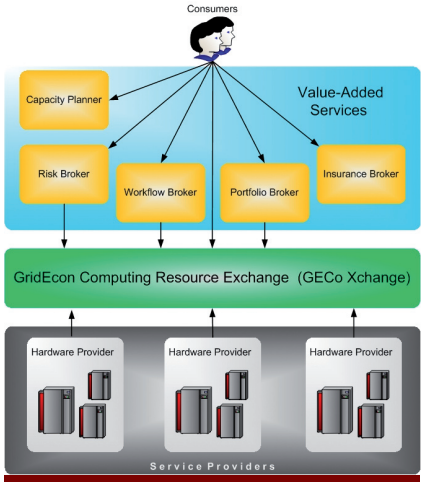

Figure 2: GridEcon Computing Resource Exchange and its value-added services

already existing resource providers such as Sun to plug in the Open Grid Market. Competition on such Open Grid Markets encourages markets to integrate and weed out too complex or inefficient platforms. The resource management for this kind of market is depicted in Figure 1.

Depending on the current demand for resources created by a Grid application, the user delegates the bidding process to an autonomously acting bidding agent. The bids are submitted to the Open Grid Market. Likewise, on the resource owner side, the bidding agents publish automatically available resources based on their predefined policies. The Open Grid Market matches requesting and offering bids and executes them against each other. The matches (i.e. allocations) are formulated in service level agreements (i.e. contracts). The fulfillment of the service level agreements will be automatically executed, while the Grid middleware is responsible for the resource provisioning and the payment system (such as PayPal) for the monetary transfer of funds. The SORMA project has been highly successful with the first prototype of the software soon to be available as a demo on the project website.

The industry partners in SORMA are representing consumers and providers. As a proof-of-concept, the applications from TXT Group and Correlation Systems are implemented on the SORMA Open Grid Market. In cooperation with Sun Microsystems, business models for providers are developed that consider pricing of complex services and pricing strategies.

GridEcon Exchange

In order to attract customers to the GridEcon computing resource exchange for commoditised computing resources and get the computing resource exchange concept accepted by users, the GridEcon exchange offers a set of services that makes the use of the exchange convenient, secure, and safe. The services, which we identified to be necessary for an exchange for commoditised computing resources, can be classified into GridEcon exchange services and value-added services (Figure 2).

Besides the core service of trading commoditised computing resources through a certain market mechanism, the exchange provider needs to offer additional services. They are necessary in order to make the GridEcon exchange work. Those GridEcon exchange services comprise provisioning of resource redundancy (i.e. to achieve service reliability and to improve the probability of a liquid market), monitoring capability for resource offers (i.e. to assure the quality of the goods offered comply with the quality standard set by the GridEcon exchange), simple access (i.e. to enable access to computing resources in a transparent and simple way), anonymity of sellers and buyers (i.e. to ensure that buyers and sellers do not make the transaction without using the exchange), and standardisation of computing resources (i.e. to offer commoditised computing resources).

The value-added services do not have to be offered by the GridEcon exchange provider but can be offered by independent service providers instead. The main value-added services that are developed by GridEcon are the Capacity Planner, the Fixed Price Quotation Broker, and the Insurance Broker. The capacity planning service helps buyers and sellers to make optimised planning decisions about purchases and sales of computing resource. It also supports users to optimally shape their demand and to find the appropriate resources for their applications. The fixed price quotation broker service allows users to sell and buy resources without the uncertainty of fluctuating prices. The insurance broker issues contracts against the failure of resources and compensates the user for the loss of a failed resource.

This set of services, built by GridEcon, will help establishing a market not only for accessing commoditised computing resources but also to sell spare computing resources. It also allows users to adapt their usage strategies of computing resources based on their demand and the supply of the market. This is a valuable alternative to the existing oligopolistic utility computing market. ★

At a glance

Full Project Title
SORMA – Self-Organising ICT Resource Management

Contact details
dirk.neumann@is.uni-freiburg.de

W: www.sorma-project.eu

Project start date: 1 August 2006
Project end date: 31 July 2009

Full Project Title
GridEcon – Grid Economics and Business Models

Contact details
jorn.altmann@acm.org

W: www.gridecon.eu

Project start date: 1 July 2006
Project end date: 30 April 2009

Dirk Neumann Jörn Altmann

Dirk has been assuming the position as Full Professor at the Chair for Information Systems at Albert-Ludwigs-Universität Freiburg. Dirk's research covers market engineering and the management of computing resources and services in the area of Grid Computing, Green IT and service ecosystems.

Jörn Altmann is Associate Professor for Technology Management, Economics, and Policy at Seoul National University, where he heads the group on Internet Economics. Dr. Altmann's current research centres on economics of Internet services and Internet infrastructures, integrating economic models into distributed systems.