Joint Development Project Applies Grid Computing Technology to Financial Risk Management

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This paper briefly describes an ongoing joint research project by NLI Research Institute and IBM to apply grid computing technology in financial risk management. Grid computing has advanced rapidly in the past few years years. However, applications have generally been limited to scientific and technical fields such as geophysics (global weather forecasting), life sciences research (human genome project), and automotive design and development; those by financial institutions have been rare.[1] Our aim is to make breakthroughs in efficiency for the massive computing needs of Monte Carlo simulation, used in the emerging leading-edge field of financial risk management. The project is a cutting-edge endeavor that portends the next generation of computing. In preliminary experiments thus far, we have already reduced computing times from ten hours to 49 minutes—a 12-fold increase in speed—and are striving to establish technologies for further increases in speed and operational stability.

1. Grid Technology

Aside from computer enthusiasts, since most people are unfamiliar with this new technology, we briefly describe grid computing below.

The term "grid computing" derives from its resemblance to the electric power grid. Electric power is distributed over a grid that enables people to use as much power as they need when they need it. Similarly, grid computing is comprised of a set of technologies that enable people to access as much computing power as they need when they need it.

A famous example is SETI@home (Search for Extraterrestrial Intelligence).[2] This project, made famous by astronomer Carl Sagan (author of the science fiction novel *Contact*), attempts to communicate with extraterrestrial life in the universe. Enormous computing power is needed to analyze all the radio signals gathered from the outer reaches of space, and the project does this by sharing the computing load with millions of personal computers

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[1] For information on the project, see *Nihon Keizai Shimbun*, September 25, 2003 morning edition (in Japanese); *Nikkei Computer,* October 6, 2003 special section on grid computing (in Japanese); and IBM's web site (www-1.ibm.com/press/).
[2] See http://setiathome.ssl.berkeley.edu/.

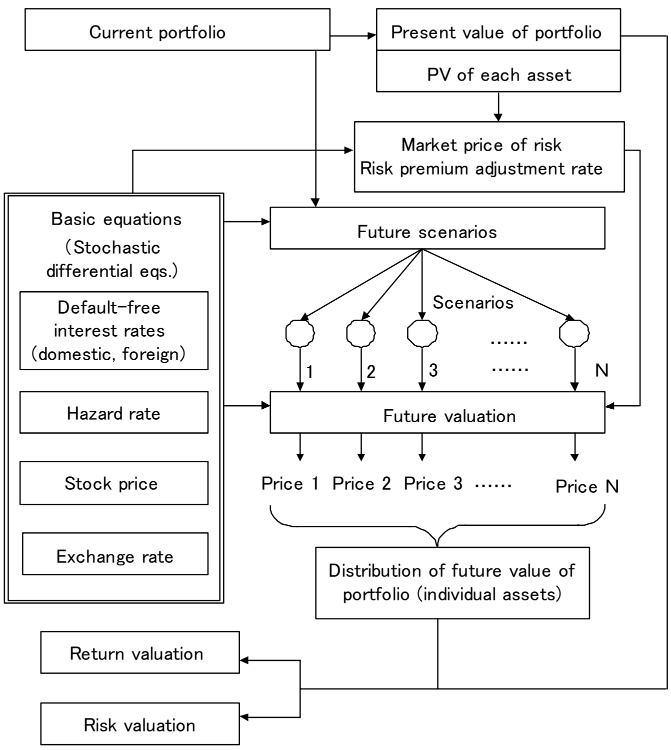
around the world when they are otherwise idle. Approximately three million people have downloaded the necessary software and made their computers available to the project. Simply stated, grid computing thus aims to bundle together many computers and run them as one massive virtual server. Research on grid computing began in the 1990s with academic research applications in geophysics and the life sciences.

Applications in the financial sector are still rare. Examples include Charles Schwab, who reduced the processing time for an existing wealth management application from four hours to 15 seconds, and the Royal Bank of Canada's life assurance system, who reduced run times for policy reserve calculations from 18 hours to 32 minutes.

2. Risk Management, and Monte Carlo Method's Need for Speed

Our project focuses on financial risk management systems. Under the proposed new BIS rules planned for adoption next year (Basel II), innovative banks can measure risk using an internal model. By developing a reliable internal model, banks can thereby reduce their capital requirement. This has prompted innovative banks to develop a good and reliable internal model. However, financial institutions hold large amounts of complex instruments such as derivatives and loans, and conventional risk management methods using simple variance-covariance methods cannot cover all products and transactions.

Figure 1 Integrated Risk Management System



The only way to develop an internal model for integrated risk management that covers complex transactions is to rely on simulations. The integrated risk management system developed by NLI Research Institute offers a framework to integrate market and credit risks for stocks and bonds, and can directly calculate the amount of risk in a fixed period using Monte Carlo simulations (Figure 1). Recently, however, despite improvements in computer performance, calculations have become too large and complex to perform, and the time constraint of simulations has been a major bottleneck. Risk managers would like to see processing times reduced from one day to two to three hours—which is where grid computing comes into play. Reducing processing times with reliable technology is also innovative in how it can change the way business is done.

3. Project Aims and Issues

The integrated risk management system must generate probability distributions of future prices, which requires calculating individual asset prices and portfolio valuations for an enormous number of scenarios (in the neighborhood of 10,000 scenarios), and then tallying results. The basic idea is that rather than performing all calculations on one UNIX workstation, it would be faster to break down repetitive calculations into small parts, allocate them among desktop computers in the office when computing power is available (used as calculation servers), and then collect and aggregate the results on the UNIX workstation (used as a condition setting server, and aggregating server). In preliminary experiments, we connected eight desktop computers with Linux operating systems, and succeeded in reducing the processing time from ten hours to 49 minutes, for a 12-fold increase in speed.

However, this does not mean that a grid of 100 desktop computers can increase speed 100-fold. Adding more computers to the grid would increase speed if computing power were the bottleneck. But other factors (communication capability, for example) gradually tend to limit overall efficiency. Thus the key to maximizing performance while minimizing additional investment is to identify constraining factors, and adopt a balanced approach to speed enhancement.

While results have already been obtained for speed enhancement, in the future development must focus not only on the "gas pedal" (pursuit of speed) but the "brake pedal" (pursuit of safety) to temper the grid. Three key issues to ensure grid safety are integrity, data protection, and scheduling.

Integrity means that the exact same aggregated results are obtained regardless of how the grid configuration is altered (for example, expanding from ten desktop computers to 100). To do this, techniques must be developed to transcend performance differences between UNIX workstations and desktop computers, as well as between desktop computers.

Data protection requires that the grid be able to obtain prescribed calculation results without sharing confidential portfolio data with desktop computers. Even within the relatively secure confines of a company, making portfolio data available to office computers is not an advisable practice. Techniques must be devised so that portfolio data remains anonymous to calculation servers performing risk calculations.

Scheduling methods must be developed so that deadlines can be guaranteed regardless of the use status of computers in daily office operations. Since computer use cannot be controlled by the aggregating side, it is advisable to perform monitoring and rescheduling functions as needed.

While these three considerations may restrain_speed to some extent, they are indispensable for grids to take root in offices of financial institutions.

What can we expect from the basic technologies once they become established? With the addition of security technology and scheduling functions, the technologies can evolve into basic software for financial grid middleware. Simply by installing this software, the computing power of a supercomputer becomes available on demand, in the same way that the electric power grid supplies electricity on demand to homes and factories. The possibilities for the future are mind boggling.

Figure 2 Monte Carlo Simulation Using Grid Computing