Business Grid Computing Project Activities

● Andreas Savva ● Toshiyuki Suzuki ● Hiro Kishimoto

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The recent global diffusion of the Internet has increased the importance of e-business and created new opportunities and challenges. One effect is that the business cycle, from planning to development to operation, is becoming shorter and shorter. Therefore, there is increased pressure on companies and public institutions to construct and manage reliable and flexible application systems at low cost. The Business Grid Computing project is aiming to address these new requirements by developing Grid technology based on virtualization, autonomous control, and unified management of IT resources. The project is based on the Open Grid Services Architecture (OGSA), which is a next-generation standard architecture unifying Grid and Web services technology. To improve the interoperability of Grid systems, the project is also promoting international standardization of the technologies it develops. This paper describes the technologies developed by the Business Grid Computing project and also gives an overview of the standardization activities.

1. Introduction

The recent global diffusion of the Internet and the wider availability of fast network connections have increased the importance of e-business but at the same time have created demanding challenges. In particular, the business cycle, from planning to development to operation, is shorter than ever before. After an e-business starts operation, it often requires changes, including the addition of new functions. Also, performance requirements can change dramatically, often unexpectedly, over the lifetime of the e-business. Therefore, there is a strong demand for technologies that can support flexible construction and operation of a large variety of information systems at low cost and high reliability.

The aim of Business Grid technology is to meet these new e-business needs. The Business Grid is a fusion of Web services technologies developed for application integration and Grid computing technologies initially intended to enable effective use of distributed supercomputers for scientific computation. The Business Grid Computing project was started with the aim of developing Business Grid technology. In this project, Fujitsu is designing and developing Business Grid middleware and aggressively pursuing the standardization of key technologies within various standards bodies, including the Global Grid Forum (GGF).

This paper describes the background of the Business Grid Computing project, the technologies being developed, and the associated standardization activities.

2. Business Grid objectives

The trend towards shorter and shorter business cycles has spurred the demand for technologies that can be used to construct and operate information systems simply and securely

and also change those systems' functions and manage their performance easily. Unfortunately, the application of Information Technology (IT) to business requires an initial investment that can be quite high. Costs may include purchasing computer hardware, developing or customizing software, and operation and management expenditures, which increasingly form a larger proportion of the overall cost. The initial high cost creates a barrier to entry, especially for small or start-up firms. Therefore, Business Grid technology is intended not only to support a secure and reliable IT infrastructure, but also to minimize the cost of entry and thereby facilitate the adoption of IT by businesses. In more detail, the goals of Business Grid technology are as follows:

1) To share IT resources, possibly distributed over a network of collaborating data centers, and support their flexible usage.
2) To reduce the total cost of ownership (TCO) and provide a robust infrastructure for business operation through autonomous configuration control and common management capabilities.
3) To adapt to changes in system load by optimum and dynamic allocation of resources. For example, it should be possible to use IT resources independent of their location so that the load is spread more evenly and the overall utilization is increased.
4) To simplify the construction of highly reliable systems by providing load distribution, fail-over, and disaster recovery functions, so that the reliability and security of systems providing essential social services are increased.

3. Business Grid Computing project

The Business Grid Computing project was started to address the requirements of systems providing essential social services as part of the Focus 21 project of the Ministry of Economy, Trade and Industry.

The Ministry is promoting Focus 21 as a line of research and development projects for stimulating economic activity. The aim is the quick adoption by business of the fruits of research and development in order to directly enhance industrial competitiveness. The implementation of Focus 21 is premised on the commitment of private companies to provide financial and human resources to the projects. It is also premised on the selection of projects that can produce results which can be quickly put to practical use. The projects are chosen from four areas: life sciences, information and communications technology, environmental science, and nano-technology and materials science.

The Business Grid Computing project is scheduled to run for three years from fiscal 2003 to 2005 with the participation of Fujitsu Ltd., Hitachi, Ltd., NEC Corp., and the National Institute of Advanced Industrial Science and Technology. The project has identified a set of critical user-requirements and is developing technologies to address them. The key requirements are described below.

3.1 Increasing the efficiency of in-house IT systems

Conventionally, IT resources have been statically allocated to each in-house IT system of a company based on the expected maximum load of each system. It has not been possible to optimize resource allocation over all the in-house IT systems. Moreover, the costs for system construction and operation have been increasing because systems are becoming more complex in order to support new requirements, for example, increased reliability.

Business Grid middleware optimizes the use of IT resources by dynamically sharing them according to the load of each in-house IT system, standardizes the IT platform and the management of system operations, and increases system reliability. As a result, the middleware makes it possible to use the in-house IT resources more

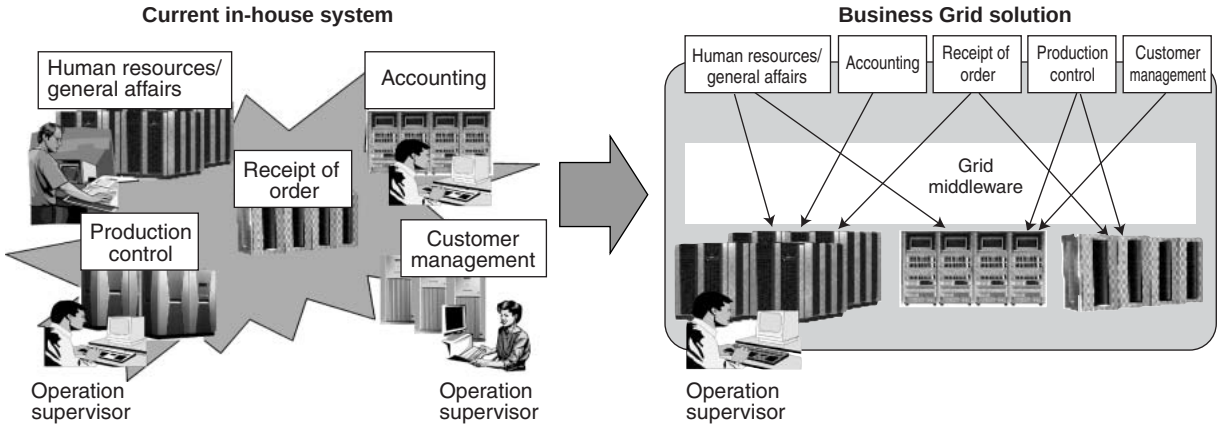

Figure 1
Efficient use of IT resources realized by Business Grid techonology.

efficiently and reduces the costs of system construction and operation (**Figure 1**).

3.2 Managing expected load increases

With the increasing popularity of the Internet, data centers are used more and more for limited-time-offer campaigns and events, for example, reservations for concerts and international conferences, live broadcasts, and electronic conferences. The expected load of such business applications can vary substantially. Therefore it should be possible to add resources flexibly and inexpensively when the system load is expected to temporarily increase.

At the moment, IT resources are allocated statically to individual business applications. Therefore, the initial as well as the operational costs can be quite high because sufficient resources have to be allocated to handle worst-case scenarios. If sufficient resources are not available at a single data center, resources at other data centers can also be used. However, adapting the business application to use resources from multiple data centers would incur extra costs.

Business Grid middleware enables IT resources to be dynamically allocated to business applications. Consequently, a business application can use just the resources it requires at any specific time. If it is forecast that the load will increase, more IT resources, possibly from other data centers, can be allocated. The end result is that the management of the business application can be simplified and more predictable performance achieved (**Figure 2**).

3.3 Enhancing the availability of the e-Japan system[1)]

To realize electronic government, the e-Japan Priority Policy Program is discussing the use of data centers for polling and administrative services, including the issuance of resident cards and the processing of applications. However, if a local data center is seriously damaged by a major disaster, not only the services and operation may be disabled, but also residents' information and other important data may be lost. Therefore, disaster recovery mechanisms are required to guarantee continued operation. Developing such recovery mechanisms is hard, not to mention costly. The cost would be even higher if each data center tried to develop such measures independently. This is a big problem when IT systems are used for critical services.

Business Grid middleware provides standardized fault-recovery mechanisms that enable the construction of fault-tolerant systems at comparatively low cost. For example, data could be backed up to other data centers and if a disaster

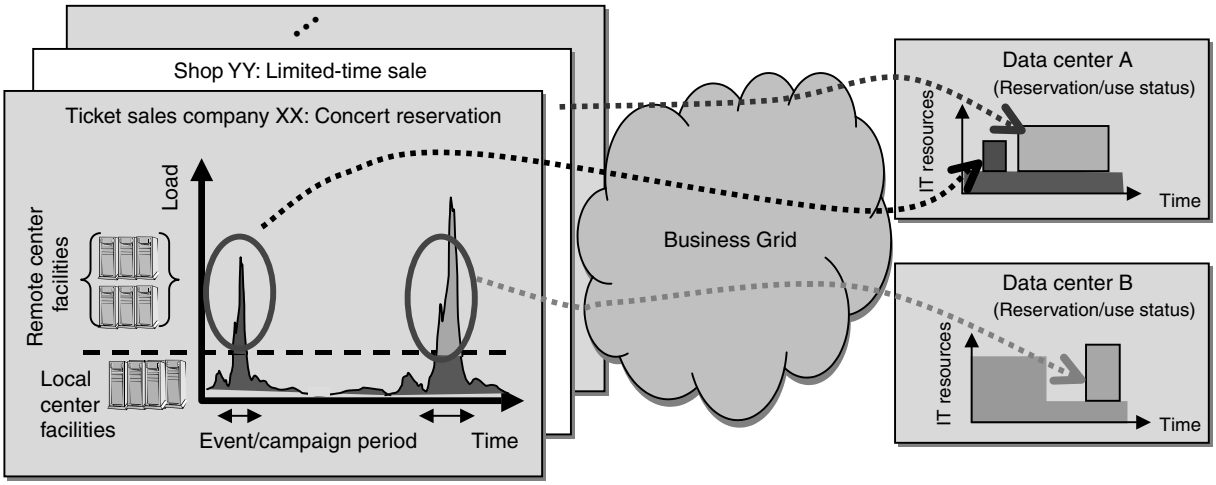

Figure 2
Managing increases in expected load.

occurs, the affected applications could be migrated to those data centers and continue operation. Therefore, Business Grid middleware can make the e-Japan system highly available (① to ④ in **Figure 3**).

4. Business Grid middleware

The following describes the Business Grid middleware being developed in the Business Grid Computing project.

4.1 Open Grid Services Architecture (OGSA)

The Business Grid Computing project is developing the Business Grid middleware based on the Open Grid Services Architecture (OGSA).[2] OGSA is a proposed standard architecture for next-generation Grid systems. It integrates Web services technology used for application integration together with Grid computing technology used for virtualizing and sharing distributed computing resources. OGSA enables Grid computing to be applied to and adapted for business use. A more detailed description of the problems solved by OGSA is given below.

Grid computing has achieved a remarkable success in scientific and technical areas. Many kinds of Grid middleware, for example, the Globus Toolkit[3] and the Uniform Interface to computing Resources (UNICORE),[4),5] can be used to connect supercomputer centers, provide practical security platforms for authentication, authorization, discovery, and monitoring of distributed resources. They also provide functions to execute applications at remote sites and access widely distributed data at high speed.

The problems associated with the construction of business systems, however, are not fully solved by conventional Grid technologies. First, standard protocols must be defined for Grid middleware to ensure the interoperability of Grids. Also, the operation of complex applications that consist of many heterogeneous hardware and software components requires that components support a common level of manageability to simplify overall management. Furthermore, functions for virtualizing IT resources and autonomous control must also be provided to ensure the high reliability and efficiency of business applications.

OGSA defines a uniform infrastructure for Grid systems by using a set of existing or emerging Web services technologies. In particular, OGSA uses the Web Services Resource Framework (WSRF).[6] By basing itself on Web services technologies, OGSA can also benefit from advances in business application management and control.

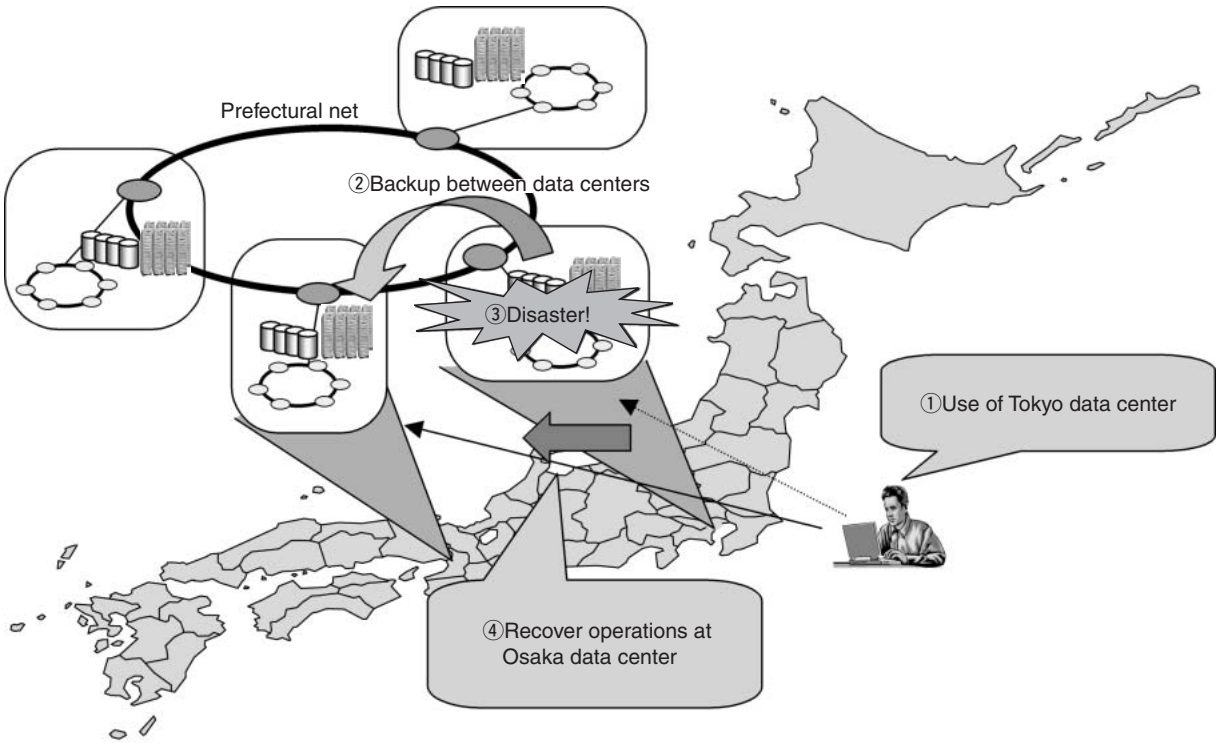

Figure 3
Providing highly available operations in the e-Japan project.

Furthermore, OGSA defines the functional components required for the virtualization of IT resources and autonomous control of the Grid system.

4.2 Features of the Business Grid middleware

The Business Grid middleware based on OGSA has the following features to simplify and make more flexible the operation of complex business applications, and support the use of heterogeneous IT resources:

1) All information relating to a business application can be described and retained in a defined format. Such information includes the description of suitable IT resources as well as the procedure (job control flow) for deploying a business application on such resources.
2) The IT resources used by business applications are virtualized as hosting environments. A hosting environment is a combination of hardware components such as servers, storage, and networks as well as infrastructure software components such as operating systems (OSs), application servers, and DBMSs. Hosting environments support common interfaces that simplify their management.
3) Based on the above features, business applications can be deployed automatically on distributed IT resources. Also, a business application operating on an IT resource can be moved to another resource or more resources can be added to a business application.

The Business Grid middleware also has the following features to support business applications that may be running for long periods, for example, months or years:

1) IT resources can be reserved in advance for specific periods to ensure that a business

application can use the required resources during the specified period.

2) IT resource usage can be optimized based on long-term considerations and by adjusting existing resource reservations when necessary.

4.3 Architecture of the Business Grid middleware

Figure 4 shows the architecture of the Business Grid middleware. The middleware consists of the following functional components:

1) Job execution management function

Business applications are represented as jobs. This function manages jobs for their entire lifetime. In response to a job execution request, it authenticates the user, searches for the IT resources best suited for the job, reserves those resources, and then manages the job execution until its completion.

2) Resource management function

This function manages all available resources. It also deploys the programs and data required for job execution on IT resources.

3) System configuration management function

The system configuration management function provides a common model of the various components of the system and enables their monitoring and management through common manageability interfaces.

4) Autonomous control function

The autonomous control function changes the allocation of IT resources when a system component fails and adjusts IT resource usage when the processing load changes.

5) Other basic functions

Other basic functionalities that enable the above functions include security, user management, and event notification.

5. Standardization contributions

The Business Grid Computing project has been actively working on standardizing the technologies developed in the project by submitting proposals to standards organizations such as

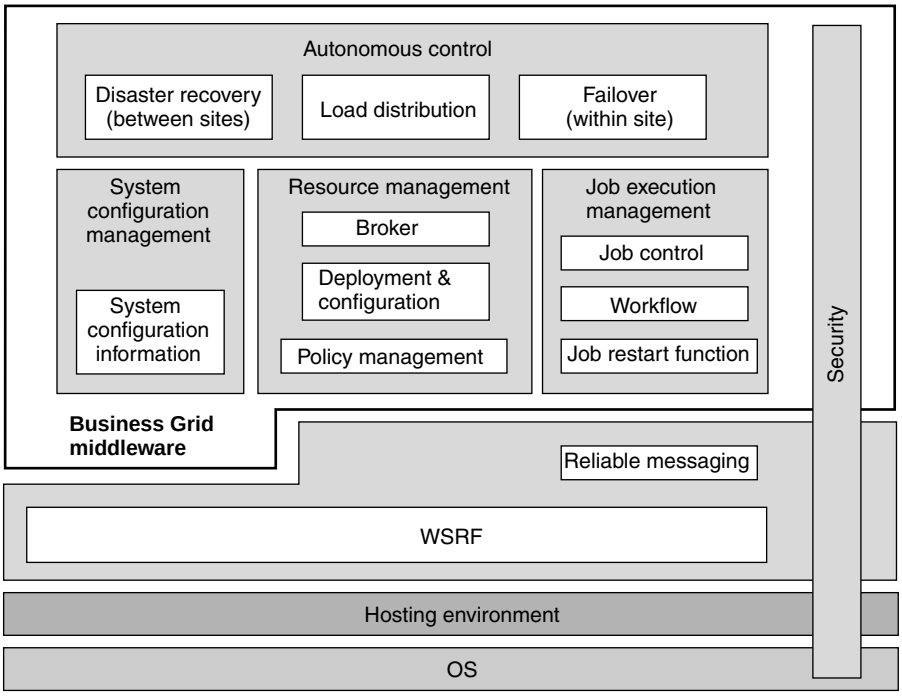

Figure 4
Architecture of Business Grid middleware.

GGF[7] and the Organization for the Advancement of Structured Information Standards (OASIS).[8]

Figure 5 shows the relationship between the functional components of Business Grid and the standardization working groups. The project has already made substantial contributions to the following working groups:

1) Open Grid Services Architecture Working Group (OGSA-WG) (GGF)

This working group defines OGSA, a proposed standard architecture of Grid systems. OGSA specifies the set of functional components required in a Grid system and the relationships and interactions between the components.

2) Web Services Resource Framework Technical Committee (WSRF TC) (OASIS)

The WSRF TC defines a generic and open framework for modeling and accessing stateful resources using Web services. The framework includes mechanisms to describe views on the state, to support management of the state through properties associated with the Web service, and to describe how these mechanisms are extensible to groups of Web services.

3) Job Submission Description Language Working Group (JSDL-WG) (GGF)

The JSDL-WG defines a standard XML language for describing job submissions together with standard translations between JSDL and existing systems.

4) Grid Resource Allocation Agreement Protocol Working Group (GRAAP-WG) (GGF)

This working group is defining WS-Agreement, which is an XML language for specifying an agreement between a resource or service provider and a consumer, and a protocol for creating an agreement using agreement templates. WS-Agreement can be used as the protocol between the scheduler and resources when the Grid system allocates and schedules computing

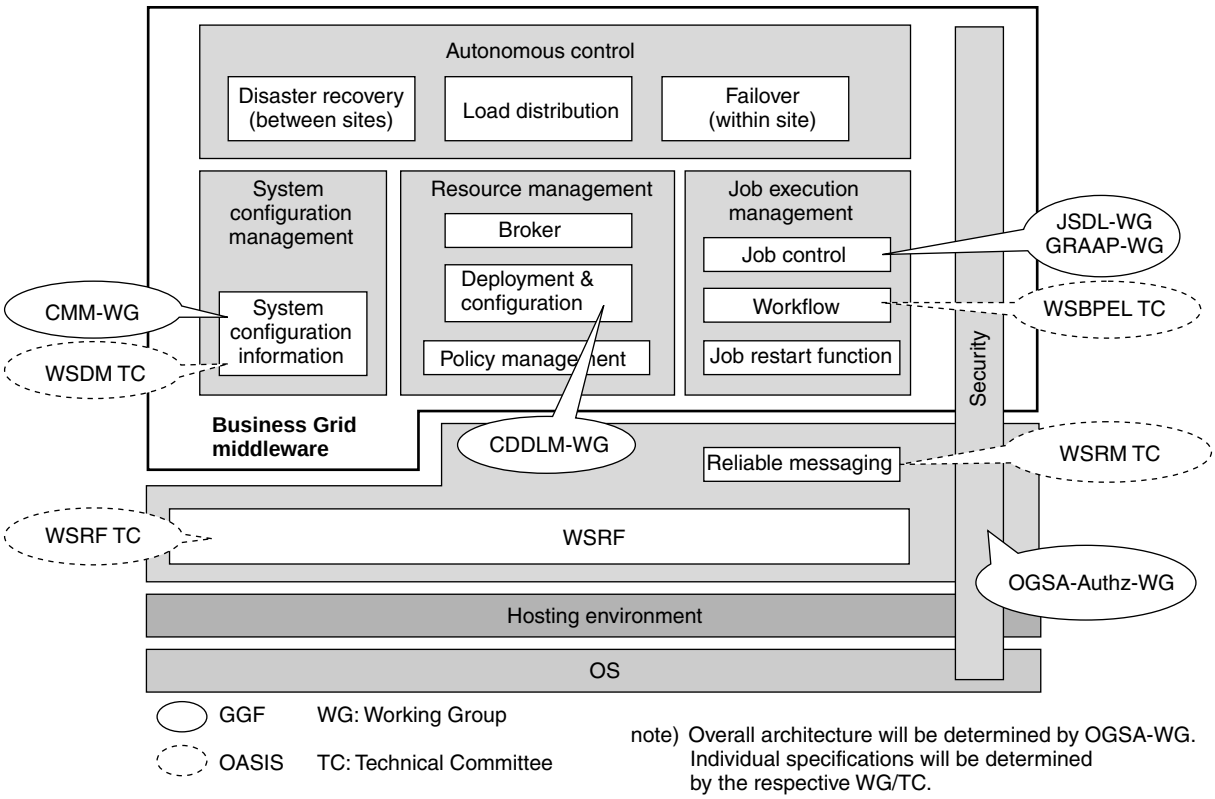

Figure 5
Relationship between Business Grid components and standardization working groups.

resources.

5) Web Services Business Process Execution Language Technical Committee (WSBPEL TC) (OASIS)

This technical committee defines the specification of the Business Process Execution Language (BPEL), which is a language for describing the behavior of a process based on interactions between the process and its partners.

6) Configuration Description, Deployment and Lifecycle Management Working Group (CDDLM-WG) (GGF)

CDDLM-WG standardizes the service configuration description, deployment, and management of the deployment lifecycle. These specifications can be used as a building block to enable autonomous deployment and control of complex applications.

7) Common Management Model Working Group (CMM-WG) (GGF) and Web Services Distributed Management Technical Committee (WSDM TC) (OASIS)

The CMM-WG and WSDM TC are working on standardizing a common set of technologies that can be used to enable the management and control of heterogeneous, distributed computing resources.

The WSDM TC is working on the Web services management technology that will be the foundation for the above management and control technologies. The CMM-WG is working on identifying and analyzing management problems specific to the Grid.

8) Web Services Reliable Messaging Technical Committee (WSRM TC) (OASIS)

This technical committee standardizes the technology for reliable messaging between Web services. The same technology can be used for communication between services on the Grid.

9) OGSA Authorization Working Group (OGSA-Authz-WG) (GGF)

This working group defines specifications needed for basic interoperability and pluggability of authorization components in OGSA.

6. Conclusion

This paper described the activities of the Business Grid Computing project. The project is developing Business Grid technologies for building and operating business-oriented IT systems flexibly and inexpensively with high reliability.

This project is part of the priority policy program under the control of the Ministry of Economy, Trade and Industry.

In addition to developing Business Grid middleware, future activities in the project will include verification and validation of the developed middleware by experimental deployments in cooperation with clients and also releasing developed material as open sources. The companies participating in the project will use the project's results to enhance the competitiveness of their products.

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Andreas Savva received the B.Sc. (Eng) and M.Sc. degrees from the Imperial College of Science, Technology and Medicine, UK in 1990 and 1991 and the Dr. Eng. degree from the Tokyo Institute of Technology, Japan in 1996. He joined Fujitsu Ltd., Kawasaki, Japan in 1997, where he worked on high-performance computing and interconnects, including InfiniBand. He moved to Fujitsu Laboratories Ltd., Kawasaki, Japan in 2001, where he has been working on Grid Computing and standardization of Grid technologies, primarily in the Global Grid Forum (GGF). He is a member of the Association of Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE).

Toshiyuki Suzuki received the B.S. and M.S. degrees in Mathematics from Kanazawa University, Kanazawa, Japan in 1987 and 1989, respectively. He joined Fujitsu Ltd., Shinyokohama, Japan in 1989, where he has been engaged in development of Enterprise Management Software.

Dr. Hiro Kishimoto received the B.E. and M.E. in Communication Engineering and the Ph.D. in Computer Science from Tohoku University, Sendai, Japan in 1981, 1983, and 2000, respectively. He led several software projects that developed high-performance, high-availability distributed systems. He is currently one of the architects of the Business Grid Computing project. He is an active member of GGF and serves the Open Grid Services Architecture working group (OGSA-WG) as one of the co-chairs. He received the IEEE Gordon Bell Award in 1994 and the InfiniBand Contribution Award in 2000.