News Release

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National Institute of Advanced Industrial Science and Technology
National Institute of Information and Communications Technology
KDDI R&D Laboratories Inc.
Nippon Telegraph and Telephone Corporation

World's First Successful Experiment on Interworking Between Grid and Ultra- High-Speed Optical Network

Information processing infrastructure established using adaptive combination of optical paths and computing resources over GMPLS network

FOCUS

1. Interworking between the Grid Resource Scheduler and the Network Resource Management System is achieved over the GMPL-based network.
2. A grid is established through simultaneous reservation of both the number of computers/storage devices and an ultra high-speed optical network, which connects such computing resources.

ABSTRACT

The National Institute of Advanced Industrial Science and Technology's (AIST's) [Hiroyuki Yoshikawa, President] Grid Technology Research Center [Satoshi Sekiguchi, Director], National Institute of Information and Communications Technology (NICT) [Makoto Nagao, President], KDDI R&D Laboratories Inc. (KDDI Labs.) [Tohru Asami, President, CEO], and Nippon Telegraph and Telephone Corporation (NTT) [Norio Wada, President & CEO] conducted the world's first experiment to achieve an information processing infrastructure, i.e., a Grid, dynamically over the GMPLS-based network through the use of a research and education network, JGN II, operated by NICT.

In this joint experiment, AIST, KDDI Labs., and NTT collaborated on the basic functional specifications for the interface between the Grid Resource Scheduler (GRS) and the Network Resource Management System (NRM). Through this collaboration, users are able to receive services from multiple network operators using this common interface. NICT developed technologies for the operation and management for the GMPLS network as well as for its optimization, by collaborating with KDDI Labs. and NTT, in order to achieve such services.

Until now, E-mail or phone call exchanges were required in advance to configure adequately the network equipment in order to reserve optical paths among remote sites. In the experiment, however, the GRS and NRM co-function to enable fully autonomous reservation of the optical paths that are required to establish the grid. With this technology, it is possible to establish a Grid, i.e., the information processing infrastructure, using co-functioning globally distributed computers and storage devices, over which various kinds of services can be provided.

AIST, KDDI Labs., and NTT are currently in the process of establishing the detailed specifications for the interface between the GRS and NRM, and are aiming to make this technology open and a global standard. NICT is continuing with the research and development of the optimization and operation/management of the GMPLS network. There are plans for presentations and demonstrations covering this experiment at

iGrid2005 (The international GRID), which will take place in San Diego, CA (USA) from September 26, 2005.

BACKGROUND

A Grid is a technology that utilizes a network according to the requests from users by utilizing various kinds of resources such as computers, storage devices, and observation devices, which are geographically distributed. The Grid uses these resources in a flexible, simple, integrated, and efficient manner, and it represents an infrastructure.

In order to provide high-quality services that enable efficient use of remotely located resources, a bandwidth-abundant and stable network that connects these resources is indispensable. Nevertheless, computing resources and network resources are managed independently of each other, and as such it is difficult to combine various resources freely to establish a Grid (See Fig. 1). There is therefore a need to reserve the required network bandwidth according to the demand.

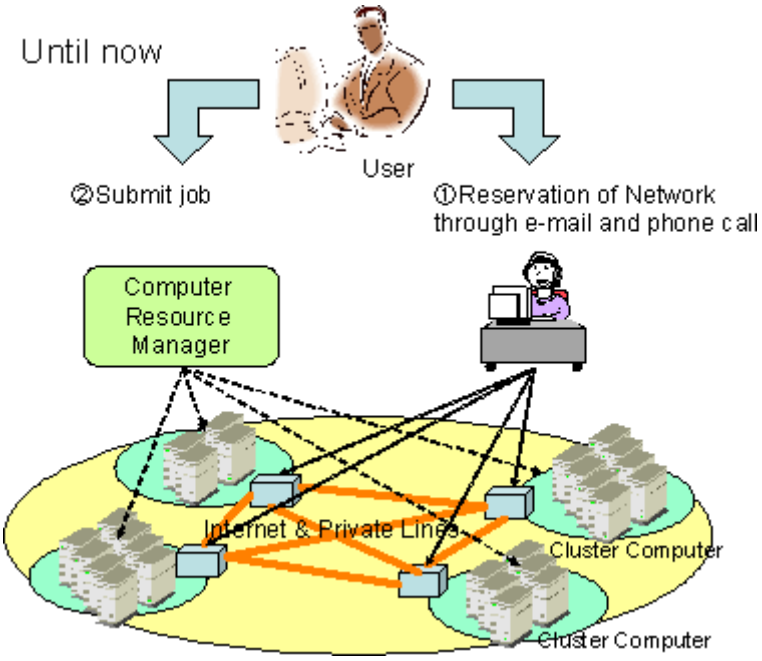

Figure 1. Network usage configuration of the current grid

EMPLOYED TECHNOLOGIES

In order to address the problem mentioned in the preceding section, an architectural framework can be effective, where not only computing resources, but also network resources themselves that connect computing resources are recognized as a part of the managed resources and are dealt with integrally. In other words, the required network bandwidth is reserved through the co-functioning of the GRS, which reserves overall resources, and the NRM, which flexibly establishes optical paths, with an adequate bandwidth between defined locations using the defined interface. With regard to the network control technology, the GMPLS technology, which is currently undergoing standardization for the control of optical paths, is applied. Using these technologies, it is possible to connect geographically distributed computers and/or storage devices freely on an as-necessary basis using the appropriate transmission bandwidth. Furthermore, the potential for cost reduction as well as drastic enhancement of both computation efficiency and usability (See Fig. 2) is anticipated.

Since resources to be provided and managed in a Grid environment are geographically distributed, the network, which connects these resources, is likely to extend over

several regions and countries, and thus may be provided by multiple network operators. Therefore, it is important to have a common interface among network operators to enable the exchange of information that is required for co-functioning between the GRS, which manages the computing resources, and the NRM, which manages the network.
In order to specify the interface between the GRS and NRM and to penetrate such an interface as an open and global standard technology, AIST, KDDI Labs., and NTT focused on the interface specifications, and designed a basic set of its functional specifications. The NICT Tsukuba JGN II Research Center focused on establishing optimization and operation/management techniques for the GMPLS network. As a result of these activities, this experiment where the GRS reserves the required computing resources and the network in advance to achieve temporarily a Grid for users was successfully conducted by the collaborators. Scientific computations were executed over the Grid in order to identify the usefulness of this technology.

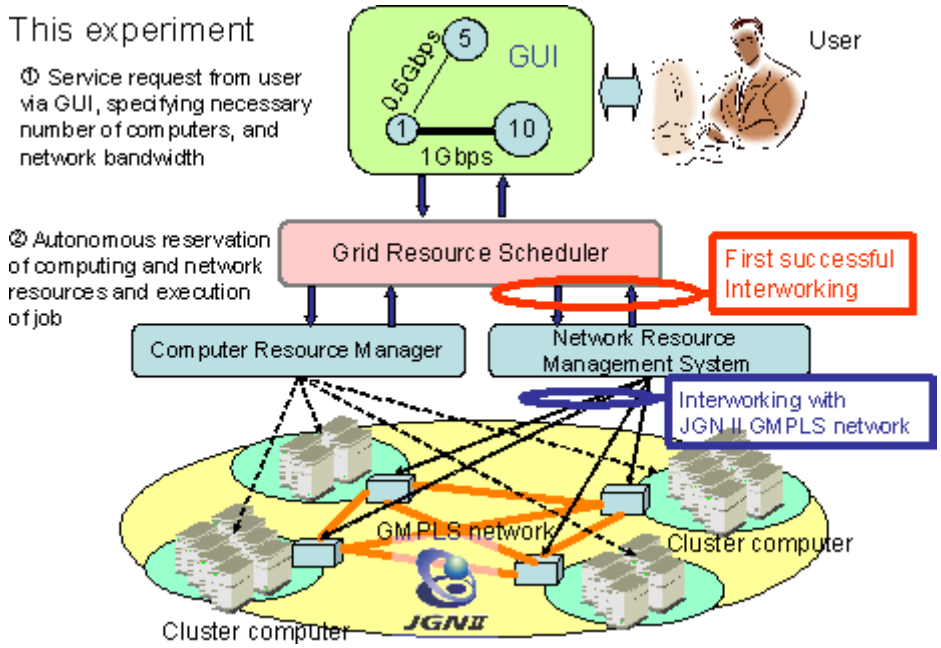

Figure 2. Grid interworking with optical network

DETAILS OF EXPERIMENT

To conduct this experiment, AIST, KDDI Labs., and NTT collaborated to specify the basic functionality for the interface between the GRS and NRM, whereas NICT developed, in collaboration with KDDI Labs. and NTT, the optimization and operation/management techniques for the GMPLS network.
NICT (The Tsukuba JGN II Research Center and the Osaka JGN II Research Center), KDDI Labs., and NTT established a feasible environment into which AIST's GRS and KDDI Labs.' NRM, both of which are based on the defined interface specifications, were implemented. The experimental results showed for the first time in the world the successful establishment of a Grid as the information processing infrastructure by using the advanced reservation of both computing and network resources that the users require, over which scientific calculations were executed.

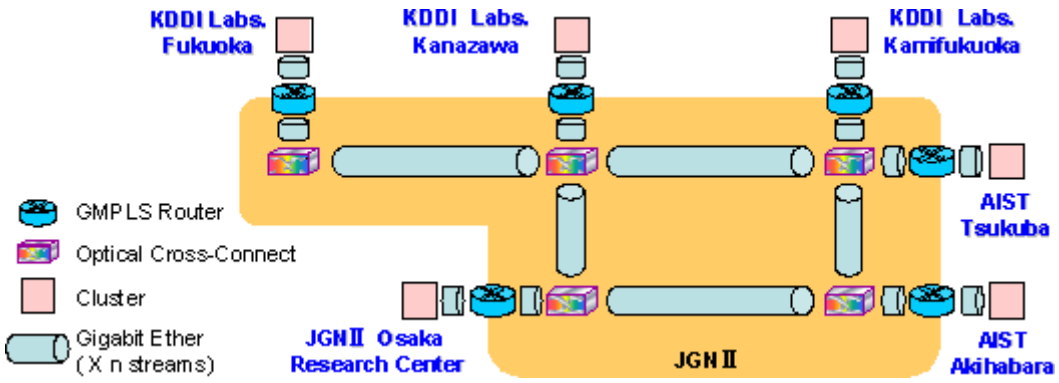

Figure 3. Network and cluster configuration for the experiment

The GMPLS network that was deployed over JGN II was used for this experiment and consisted of optical cross-connects (OXCs) and GMPLS routers. Clusters distributed over six locations in Japan (Tsukuba, Akihabara, Kamifukuoka, Kanazawa, Osaka, and Fukuoka) were connected through this network (See Fig. 3). Both the grid middleware, Nif-G2, which AIST developed, and Globus Toolkit 2 (GT2) were used at each location.
The GRS advance-reserves resources according to the request from the GUI and sends back an acknowledgement to the request. The GRS was developed by utilizing the Globus Toolkit 4 (GT4) and provides services based on WS-RF. Once the GRS receives a request for both computing and network resources from a user, it sends an inquiry regarding the available resources to the computer resource management system and the NRM, and it instantaneously advance-reserves resources that meet the request. The NRM provides functionalities such as advanced-reservation and tear-down of optical paths upon inquiry via the Web Service interface from the GRS.
In the experiment, a user specified the necessary number of locations and CPUs, the necessary bandwidth required for the locations, the time for usage, etc. to the GRS through the GUI. The computing resources and GMPLS network resources were reserved as the result of interworking between the GRS and NRM and a simulation problem on molecular dynamics was executed on the computers that were distributed over a very wide area.

FUTURE ACTIVITIES

AIST, KDDI Labs., and NTT are focusing on the detailed specifications for the interface between the GRS and NRM, and they are aiming to make this technology open and a global standard. NICT is continuing its research and development of optimization and operation/management techniques for the GMPLS network. There are plans for presentations and demonstrations covering this experiment at iGrid2005, which will take place in San Diego, CA (USA) from September 26, 2005.

TERMINOLOGY

Grid

A Grid is a technology that utilizes a network according to the requests from users by utilizing various kinds of resources such as computers, storage devices, and observation devices, which are geographically distributed. The Grid uses these resources in a flexible, simple, integrated, and efficient manner, and it represents an infrastructure.

GMPLS (Generalized Multi-Protocol Label Switching)
GMPLS is a protocol-suite that is an extension of MPLS (Multi-Protocol Label Switching), which is used for the purpose of controlling IP routers. GMPLS can control optical network equipment such as optical cross-connects.

JGN II
JGN II is an open test-bed environment that has been operated by NICT since April 2004, and provides an ultra high-speed and intelligent test-bed network for research and development. JGN II is an extension of the previous JGN (Japan Gigabit Network: A gigabit network for research and development), which was operated until March 2004.

Grid Resource Scheduler
The GRS is a program that autonomously allocates schedules including the service time and serving order of computers and storage devices, which are used to establish a Grid.

Network Resource Management System
A system managing and controlling resource of GMPLS network to coordinate optical path between cluster sites for Grid applications using Web-service interface..

iGrid2005
A biyearly international showcase focusing on demonstrations of middleware and scientific computations that require advanced high-speed networks. iGrid2005 will attract participants from over twenty countries and have around fifty real-time demonstrations.

Optical Path
An optical path is gigabit-class high-speed communication channel established between a node-pair. Since it occupies one entire wavelength, it is characterized by a high degree of exclusivity and can guarantee communication quality.

Optical Cross-Connect (OXC)
OXC is high-capacity network equipment that can switch the input optical signals to an arbitrary output port by changing the optical switch configuration.

Grid Middleware
Grid Middleware is a software-suite supporting the execution of applications over a Grid.

Ninf-G2
Software developed by AIST to support the development and execution of Grid applications based on a programming model called GridRPC, which allows for the execution of programs at a server computer in a remote environment.

Globus Toolkit (GT2, GT4)
One type of grid middleware developed by the Argonne National Laboratory and the University of Southern California, USA. GT2 (Globus toolkit 2) has been used widely as a de facto standard, whereas GT4 (Globus toolkit 4) is a brand-new version launched in April 2005 and is re-implemented based on the WS-RF concept.

GUI
GUI is an abbreviation for Graphical User Interface. It offers information through graphics and is an interface between computer and user operable by using pointing

devices such as a mouse.

WS-RF (Web Service Resource Framework)
A methodology used to represent resources to the server side of Web Services for the purpose of retaining its status. It is a functionality added in accordance with the request from the Grid community although it had been missing in the previous Web Service framework.

Web Service Interface
The Web Service Interface is a framework that provides services by utilizing the HTTP protocol used for data transport over the World Wide Web (WWW) and a general-purpose description language, XML.

Computer Resource Management System
The Computer Resource Management System is a program that controls computation equipment (resource) such as computers. In practice, it consists of individual computer management systems controlling each cluster computer and a program to integrate the clusters. The functionality may be held by the Grid middleware.

Cluster computer
An aggregation of a number of individual computers constructed to function as a single computer system.

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