The Cyber Science Infrastructure (CSI) will be an advanced research and education environment for academic information, under which universities and research organizations connect their existing computer systems on high-speed network. It will then be possible to share system software, academic contents, databases, and for institutions to share personnel and research groups. The Cyber Science Infrastructure is currently being implemented by the National Institute of Informatics and the Inter-University Information Technology Centers.

CSI is based on the Science Information Network (SINET3), by first adding a University Public Key Infrastructure (UPKI), with security which is oriented toward inter-university collaboration, and then, building Science Grid using NAREGI Middleware. With Science Grid, researchers can form research communities, so-called Virtual Organizations (VO) in a dynamic fashion, according to the needs of the research. By sharing computing resources, experimental equipment, data and software, the members of a VO can pursue advanced research by conducting large-scale simulations more efficiently, running coupled simulations, or using large-scale data more effectively, for example. The Next-Generation Supercomputer will be positioned as the National Leadership System, which communicates and collaborates with various supercomputers at universities and research institutes over the Cyber Science Infrastructure.
Science Information Network 3

Network Topology of SINET3

Multiple Layer Services
SINET3 is an integrated network providing all transfer layer services. Users can freely choose the best transfer layer for their applications. SINET3 enables economical service provision and flexible network resource assignment for ever-changing and unpredictable service demands.

Multiple VPN Services
A closed user group environment (virtual private network: VPN) is essential for ensuring the security of collaborative research. Users can choose from L3VPN (IP), L2VPN/VPLS (Ethernet), and L1VPN.

Multiple QoS Services
SINET3 provides QoS by identifying applications, VPNs, and physical/logical ports. Layer-2/3-based QoS has four priority classes: expedited forwarding (EF), network control (NC), assured forwarding (AF), and best effort (BE). Layer-1-based QoS has the smallest packet delay, no delay variance, and no packet loss.

Service Categories in SINET3
SINET3 has five service categories: transfer layer, secure (VPN), quality-of-service (QoS), bandwidth-on-demand (BoD), and network performance monitoring.

Bandwidth-on-demand (BoD) Services
SINET3 provides bandwidth-on-demand (BoD) services on layer-1. Users can specify destination, duration, bandwidth with a granularity of 150 Mbps, and route option. The BoD server receives reservation requests, schedules accepted reservations, and triggers layer-1 path setup.

Network Performance Monitoring Service
SINET3 will give users network information, such as backbone traffic and delay. Access to this information should help to improve usability and facilitate network research.
Inter-University Authentication and Authorization Platform for Japanese Cyber Science Infrastructure

Summary of UPKI

We are undertaking the construction of University Public Key Infrastructure (UPKI), which is intended to achieve an inter-university cooperation that makes use of educational and research computing systems, digital contents, networks, and business systems at almost 800 universities and other institutions in Japan, in safe, convenient, and effective ways. We are promoting an Inter-university authentication federation by developing UPKI common specifications, and by developing applications using the PKI.

UPKI Three Layers Architecture

- Open Domain PKI (Public PKI)
  - Issuing public certs for servers and individuals in the internet by PKI service provider.
  - Using for authentication, signature and encryption on the internet.

- Campus PKI
  - Using campus network for secure access and secure transaction.
  - SSO, VPN, 802.1X, e-Approval, etc.
  - Issuing certs for server and faculty staff/students in campus network by each organization.

- Grid PKI
  - Using to authentication for NAREGI.
  - Issuing certs for HPC resources and NAREGI users by NAREGI-CA.

Construction of UPKI

- In 2006
  - UPKI Initiative

- In 2007
  - UPKI Common Specifications
  - Issues to promote and standardize

- In 2008
  - UPKI Common Specifications
  - Issues to promote and standardize

- In 2009
  - Issues to promote and standardize

UPKI Initiative

- Issues to promote and standardize
- Issues to promote and standardize
- Issues to promote and standardize

UPKI Common Specifications

- Issues to promote and standardize
- Issues to promote and standardize
- Issues to promote and standardize

Application

- We are operating public CA on trial for academic use, and issue server certificates over hundred to universities in Japan.

CA Software

- We released the open source software NAREGI-CA to researchers and students can do access to national grid in safe, convenient, and effective ways.
Hierarchical and Seamless HPC Environment

As a part of “Development and Application of Next-Generation Supercomputer” project, we at NAREGI project have been also investigating the most efficient computational environment for the researchers nation-wide in the forthcoming peta-scale computing era. The user environment should be hierarchical and seamless, including the national leadership class machine, the university supercomputing centers and departmental/labouratory level clusters etc., and should provide the means for accessing the computer systems nation-wide. Such environment will be best realized through the Cyber Science Infrastructure (CSI) framework. In particular, the Science Grid environment based on the NAREGI Grid middleware, which is being developed at the National Institute of Informatics, will be able to federate the geographically dispersed computing resources with diversified architectures most efficiently to conduct the advanced multi-scale/multi-physics/multi-discipline simulations for science and engineering applications.

- Next-generation Supercomputer
  - Supercomputer suited to large-scale data processing

- University/Research-facility Supercomputer
  - Supercomputer suited mainly to mid-scale data processing

- Japan’s computing resources can be used efficiently by connecting supercomputers of all scales and architectures.

- Science Grid (NAREGI)
- Science Information Network (SINET3)
- Laboratory-level system
  - PCs and PC-clusters suited mainly to small-scale data processing

Creates an environment that enables seamless use of all resources, from PCs and PC-clusters, to supercomputers at Universities and research facilities and even next-generation supercomputers.
During FY2006, the National Institute of Informatics initiated the “e-Science Pilot Project” to gather the knowledge and experiences as the use cases from the computational research communities. The following is the list of such projects.

<table>
<thead>
<tr>
<th>Research Facility Name</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Hokkaido University Information Initiative Center</td>
<td>Development of a system to solve large-scale parallel problems using genetic algorithms.</td>
</tr>
<tr>
<td>2  Center for Computational Materials Science, Tohoku University</td>
<td>Forming a VO for Asian Materials-Design Simulation.</td>
</tr>
<tr>
<td>3  Center for Computational Sciences, University of Tsukuba</td>
<td>Forming and operating JLDG, a base for data sharing in the computational particle physics (Lattice Gauge Simulation).</td>
</tr>
<tr>
<td>4  Institute for Solid State Physics, University of Tokyo</td>
<td>Development of new methods and algorithms for computational solid state physics.</td>
</tr>
<tr>
<td>5  Information Technology Center, Nagoya University</td>
<td>Forming a VO for computational science of turbulent flow.</td>
</tr>
<tr>
<td>6  Solar-Terrestrial Environment Laboratory, Nagoya University</td>
<td>Forming a VO for Geo-space Science Virtual Laboratory.</td>
</tr>
<tr>
<td>7  Kyoto University</td>
<td>Research on forming a VO for Electromagnetic field analysis.</td>
</tr>
<tr>
<td>8  Research Institute for Sustainable Humansphere, Kyoto University</td>
<td>Studies on the effective use of widely distributed computing resources for large-scale plasma particle simulations.</td>
</tr>
<tr>
<td>9  Osaka University</td>
<td>Simulations of the high-energy-density states using high-powered lasers.</td>
</tr>
<tr>
<td>10 Osaka University</td>
<td>Development of a grid foundation for optimizing remote operation of ultra-high voltage electron microscopy.</td>
</tr>
<tr>
<td>11 National Astronomical Observatory of Japan</td>
<td>Development of prototype middleware for the analysis of distributed astronomical data using NAREGI.</td>
</tr>
<tr>
<td>12 National Institute for Fusion Science, Japan</td>
<td>Forming a Virtual laboratory for the nuclear Fusion research.</td>
</tr>
<tr>
<td>13 Institute for Molecular Science</td>
<td>Promotion of a Nano-science VO.</td>
</tr>
<tr>
<td>14 Institute for Molecular Science</td>
<td>Promotion of a Molecular Science VO.</td>
</tr>
<tr>
<td>15 High-energy Accelerator Research Organization</td>
<td>Forming a VO for High Energy Physics.</td>
</tr>
</tbody>
</table>
Development of Grid Network Services

In the science grids, the grid middleware handles the grid resource management, such as computing resource and network resource and so on. The grid middleware has been proposed and developed for the efficient and distributed processing of grid applications. On the other hand, the network service architecture for the grids has been also proposed and developed for management of routing, network resource allocation and scheduling based on network monitoring information while cooperating with the grid middleware. Therefore, we investigated the grid network service framework, consisted of monitoring, allocating, and scheduling services collaborated with grid middleware.

Network Interconnection between Grid5000 and NAREGI

The network interconnection between Grid5000 and NAREGI is now operational and some preliminary tests began this summer. The international research project investigates network characteristic and performance on international wide area grid environments using NAREGI network measurement systems and active/passive measurement tools. Those systems enable to measure network path states and performance by active measurement and application traffic over the path by passive measurement.

SINET3: Next-generation Science Information Network

The next-generation science information network, called SINET3 will provide a rich variety of network services and adapt flexibly to the needs of the research and education community. The network services include multi-layer services.