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NII Today

National Institute of Informatics News

Special Feature:

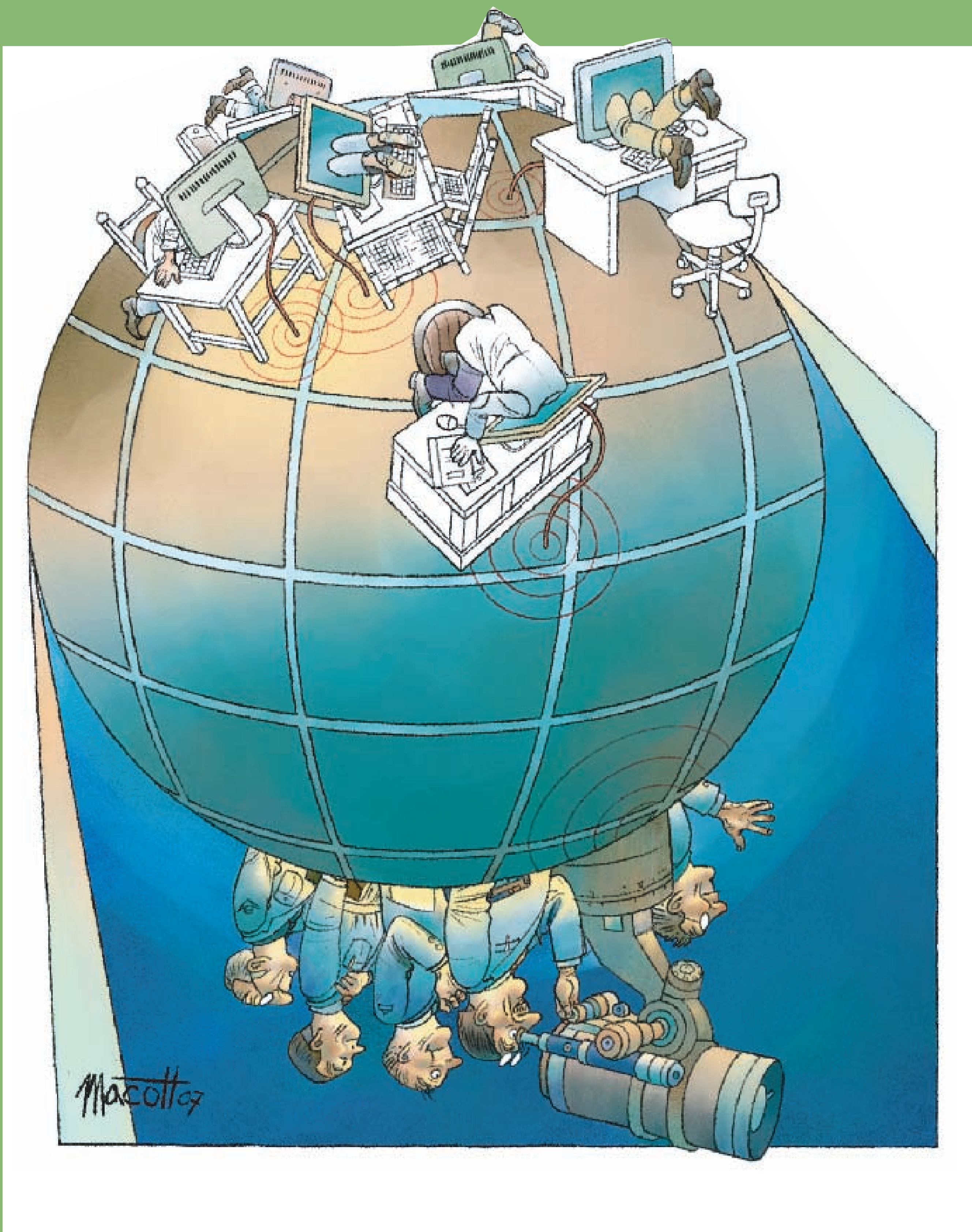
SINET3, the Academic Lifeline

Flexibility on the Leading Edge

One of the World's Preeminent Ultra-High-Speed Science Information Networks

Elementary Particle Experimentation Accelerated by SINET3

A Cutting Edge Collaboration



Shigeo Urushidani
Professor, Research and Development Center for Academic Networks
National Institute of Informatics

NII Interview: Shigeo Urushidani＋Yuri Aono

Flexibility on the Leading Edge

The Latest Science Information Network

SINET3

the Academic Lifeline

Aono: The new Science Information Network called SINET3 has been in operation since June of last year.

Please tell us about it.

Urushidani: One of the key missions of NII is to provide academic information infrastructure to research and educational institutions. NII built SINET in 1992, and Super SINET, which links together leading-edge research centers with ultra-high-speed circuits, in 2002.

SINET3 integrates SINET and Super SINET and provides further improved service quality. The volume of communications is growing every year by a factor of from 1.5 to 2, so network improvement is an urgent task.

Aono: What specifically does integrate mean in this case?

Urushidani: IP network services, Ethernet services, and even dedicated line services are provided in a single network.

The dedicated line can be configured on-demand, and this is done by designating the destinations, the bandwidth, and the start and end times. This is a revolutionary advance, and NII was the first to put it to practical application. Before this it was necessary to lay optical fiber or set up some other individual circuit. That would take three or fourth months, and the charges were expensive. Now we can set up a virtual dedicated expressway within a single link in no time at all.

Aono: Where are dedicated lines used, and what kind of occasions are they used on?

Urushidani: They are used, for example, when exchanging high volumes of information. Data can be sent smoothly, without any congestion, and it doesn't inconvenience other users. For instance, the National Astronomical Observatory of Japan is working on a project to link together radio telescopes at locations like Yamaguchi, Gifu, and Tsukuba to create a high-resolution virtual radio telescope. This is the eVLBI Project. The traffic includes huge amounts of observational data, so a dedicated line is set up for the purpose. The network is used most on weekends, so the SINET3 on-demand service is perfect for it.

Aono: Is there any other application that needs SINET3 to work?

Urushidani: SINET3 can set up a virtual private network (VPN). When people at various different centers are conducting research together, this makes it possible for them to communicate over a closed network. People can use this to create a virtual laboratory on the Internet.

Nuclear fusion, seismology, high energy, and other fields also use VPN to share data from observation equipment and measurement devices among researchers throughout the country in realtime. There is also real need for ways to transmit high-definition video imagery of surgery so that people can learn the surgical techniques being used. When the imagery is compressed, it

Internet protocol (IP): A telecommunications standard for the Internet

Ethernet: A telecommunications standard for office computers and related devices, used mainly in local area networks (LAN). Ethernet has lately become faster and used over wider areas.

eVLBI Project: A fiber optically coupled very long baseline interferometry (VLBI) project.

On-demand: A service provided to users when those users require it.

Router: A telecommunications device that determines the destinations of communications and routes them on a moment-by-moment basis.

Synchronous digital hierarchy (SDH): An international standard for high-speed digital transmission utilizing optical fiber.

Link capacity adjustment scheme (LCAS): A technology for changing the bandwidth allocated to a service without affecting communications.

Generalized multi-protocol label switching (GMPLS): A telecommunications standard that sets up a virtual dedicated line.

Yuri Aono

Editor, The Mainichi Shimbun

A convenient, low-cost information network that far surpasses anything in Europe or North America

takes time to uncompress it, and delays can be a problem. That imagery can be transmitted in an uncompressed form if a VPN is set up over a high-bandwidth dedicated line just while the surgery is taking place.

A VPN can be set up over an IP network, over Ethernet, and over dedicated lines. When Ethernet is used, the users can route VPN data wherever they want to, and this makes it possible to build a more user-centered telecommunications environment. The practice of setting up international networks that link together the Internet2 network in the United States, GEANT2 in Europe, and other academic information networks of that kind is also becoming increasingly common.

Thoroughgoing quality is guaranteed not only for dedicated lines, of course, but for all our services. Information is ranked by four levels of priority and controlled accordingly. That makes it possible to send it smoothly, without congestion.

Aono: There must have been some difficult technical hurdles.

Urushidani: Academic information networks in Europe and North America have separate lines set up for the purpose of providing dedicated line service. In Japan, however, the universities exist in a harsh working climate where operating subsidies are being reduced 1% every year. Faced with the conflicting demands for diversified services and reduced charges, we came up with the idea of putting it all together in a single line.

Network design involves subtleties in the way different technologies are combined. Designs can be devised to realize a variety of different functions and characteristics. For this, we racked our brains for ways to combine the various functionalities of IP routers and next-generation SDH devices.

LCAS and GMPLS are key technologies involved in setting up a dedicated line on demand. When we set up a dedicated line, we secure bandwidth. However, we have to do this so other services are not interrupted. These technologies make that possible. SINET3 represents the first time in the world that anyone has managed to operate both these technologies stably on an actual network.

Aono: It really is the work of a network architect, isn't it? About how many people were involved in the design work?

Urushidani: The project involved a great many people. The basic design work was done by the members of the Council of the Organization for Science Network Operations and Coordination. For the detailed design, we brought in telecommunications service providers and equipment manufacturers. I myself spent a whole year on the project, and part of that time I was making fine design revisions in light of test results. We were making a tremendous effort to stay on schedule, so this experience was a battle with stress, too.

Aono: Where will SINET3 go from here?

Urushidani: SINET3 includes practically all of the network functionality that is conceivable at this point. The next thing I think we should do is to make more people aware of the network's practical value. One point to emphasize is that VPN can help lead research in new directions, so it would be good if people used it more. I also expect people to think up new capabilities and functions they want as they use the network. I'm working in particular on some measures to arouse the interest of people in the humanities, and encourage their use of SINET3.

A Word from the Interviewer

The volume of information flowing over computer networks continues to expand, and the services demanded by users becomes more diverse. The funding to deal with them readily, however, is not available. It is ironic to think that constraints of this kind were part of the context that gave rise to the most advanced science information network. The acronyms and IT technical terms that kept popping up made heavy going for me, but the strong backbone shown by this network designer, one of a few who overcame most demanding conditions, made it all possible. One wonders how the techniques of the Internet Craftsman will be used in the research community. The unsung heroes who support scientific research from behind the scenes deserve some attention.

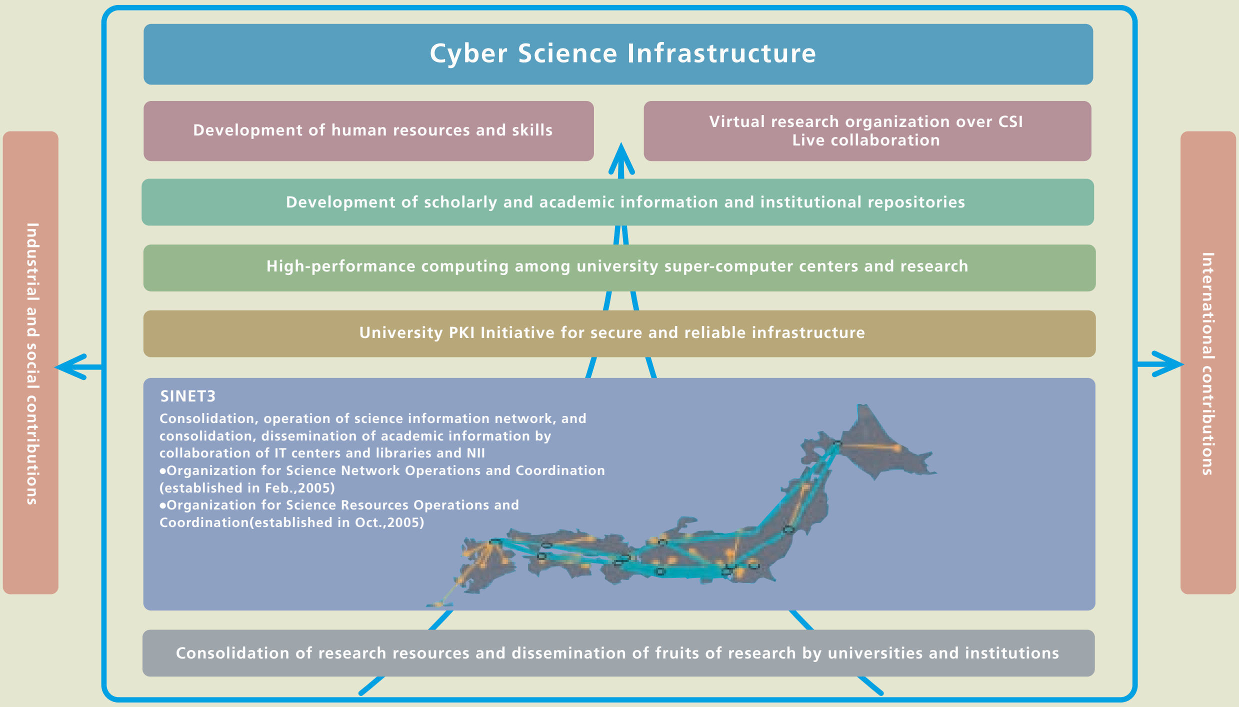
NII Special

SINET3 the Academic Lifeline

One of the World's Preeminent Ultra-High-Speed Science Information Networks

SINET3 entered full-scale operation in June 2007. Its hybrid optical IP technology and backbone with maximum capacity of 40 Gbps make it one of the world's preeminent ultra-high-speed networks. It is the core of the leading-edge Cyber Science Infrastructure (CSI) that the National Institute of Informatics (NII) is building in collaboration with universities and research institutions in Japan. This article explains the characteristics of SINET3, describes the services it offers, and presents comments from some of its users.

"SINET3 has made it possible to provide services that SINET and Super SINET were not able to offer." — Both Associate Professor Shunji Abe of the NII Information Systems Architecture Science Research Division and Mr. Junichi Sayama of the SINET Operation Team, Academic Network Division, Cyber Science In-



The Cyber Science Infrastructure (CSI)

The methods of science used to divide theory and practice. Now, however, we are free to use supercomputers to carry out computations, and we can share large amounts of data in conducting research. This means that a third method has emerged. It is e-Science. It is said that creation of the organizational framework to move toward e-Science will determine Japan's future capabilities in science and technology and competitiveness in industry.

An essential element of e-Science is Cyber Science Infrastructure (CSI). This is an advanced information infrastructure intended to enable the sharing and effective utilization of computers, databases, and related resources, as well as the creation of a virtual environment for research. The National Institute of Informatics (NII), universities and other research institutions are working in coordination to promote the construction, expansion, and operation of CSI. This is a strongly motivated endeavor to make the enormous masses of information and the computational resources held within the academic community into a shared asset that will serve as the foundation for research activity.

NII has established two organizations in collaboration with the academic community: the organization for Science Network Operations and Coordination and the Organization for Scientific Resources Operations and Coordination as frameworks to expedite the construction of the CSI.

NII Special

SINET3
the Academic Lifeline

Koji Okamura
Associate Professor, Research Institute for Information Technology, Kyushu University
Visiting Associate Professor, NII Organization for Science Network Operations and Coordination

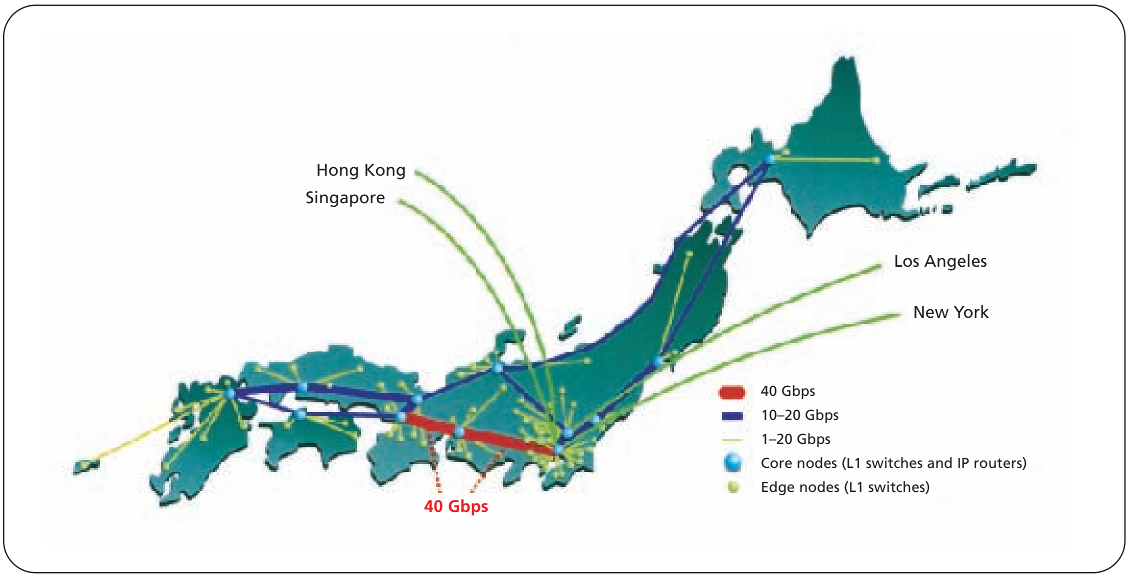
tions that would find it difficult to hire network administrators can fully be supported by NII for their network management."

Flexible Operation with Public Dissemination of Information

We also interviewed three members of the Organization for Science Network Operations and Coordination. These three took part in discussions on the construction and operation of SINET3.

Associate Professor Koji Okamura of the Research Institute for Information Technology at Kyushu University says that SINET3 was intended to "reduce delays in information traffic." The distances between Tokyo and Sapporo and between Tokyo and Fukuoka are about the same, at approximately 1000 kilometers, but the information round-trip time for the former is 0.15-0.16 seconds while for the latter it is 0.2 seconds. The difference is caused by the difference in the number of relay devices along the route, and this can cause considerable performance degradation when downloading large volumes of data. SINET3 has improved the situation by reducing the delay between Fukuoka and Tokyo. In the past there were sites that could not be reached by SINET/Super SINET, but in SINET3 there are no more sites that cannot.

Associate Professor Okamura went on to remark that "The advances made in public disclosure of SINET3 traffic flow information are also something to welcome." As network administrators can obtain the traffic flow information on SINET3, they can dynamically manage the network for example by avoiding congested routes and selecting the optimal route. The security information dissemination system, which provides security information to network administrators and users, has also had a significant impact. As Associate Professor Okamura says, "SINET3 is an enormous network system, but the SINET3 information dissemination systems have mitigated the non-transparency of the network." From the perspective of information protection, the question of



SINET3 Network Topology

frastructure Development Department at NII, said the same thing. Associate Professor Abe is also Director of the SINET Promotion Office, Research and Development Center for Academic Networks at NII.

Aiming for More Reliable Systems

SINET3 is the ultra-high-speed network system that forms the core of the Cyber Science Infrastructure (CSI). SINET entered operation in 1992 as an information lifeline supporting research and education. Super SINET was launched in 2002 as an ultra-high-speed network environment for the purpose of advanced research. SINET3 is the heir of those systems. The transition from SINET and super SINET was begun in April 2007, and full-scale operation began in June of that year.

With core nodes located at the data centers of 12 telecommunications service providers and edge nodes at 62 universities and other institutions, SINET3 links together more than 700 organizations and institutions. The institutions that can use the Science Information Network include universities, national and other public research institutes, for experiments, special public corporations, academic societies, and so on. Private-sector research organizations conducting joint research with universities can also be connected.

SINET and Super SINET had placed IP routers at 62 nodes (universities and other such institutions), with a single Tokyo-Nagoya-Osaka loop built as an upper layer that accommodates backbone nodes. SINET3 drastically changes this structure. Specifically, SINET3 divides the network up between a core layer (backbone) and an edge layer (research facility nodes). The core layer has high-performance optical IP routers and core L1 (layer 1) switches. The edge layer has edge L1 switches and L2 switches. The adoption of the optical IP hybrid architecture with L1 switches and high-performance IP routers makes it possible to carry large volumes of traffic efficiently and flexibly. There are higher volumes of information traffic between Tokyo, Nagoya, and Osaka, and those links therefore have a line speeds up to a maximum 40 Gbps. Furthermore, The whole network of SINET3 is constructed in a multi-loop configuration to enable high-speed rerouting in the event of faults . This realizes resilience and high reliability in the face of disasters and network failures.

Providing Highly Convenient Services

In addition to adopting the most advanced technology, as seen in the optical IP hybrid technology, and structuring the network with multiple loops to provide high-speed rerouting functionality for service with safety and a sense of security, another feature of SINET3 is that it is also capable of providing highly convenient services. SINET3 places the emphasis on its users, who can receive the following five service categories: (1) Multi-layer services, (2) multiple VPN services, (3) multiple services related to Quality of Service (QoS), (4) bandwidth on-demand services, and (5) value-added services.

Let's take a closer look at the multiple layer services. Until recently, when users wanted to use an Ethernet network (L2), it has been common to use dedicated L2 equipment for Ethernet networks. SINET3, however, implements multiple services, whether IP network (L3) or Ethernet network or dedicated line network (L1) services, within a single network. This has been made possible by the optical IP hybrid architecture, which makes it economical to create advanced services for which the demand is uncertain. The fourth of the five types of services, bandwidth on demand, represents the first practical application of such a service in the world. Furthermore, these services will gradually be upgraded in terms of functionality and scale.

Also Advanced Levels of User Support

SINET3 support is provided primarily by the SINET Promotion Office headed by Director Abe. User consulting covers such questions as, "What kind of services can we get?" "What kinds of procedures are necessary to receive a service?" and "What connections should we establish for which services?" It also extends to troubleshooting support, listening to user requests, and activities to promote widespread use of SINET3 technology. As Director Abe says, "It's a feature of SINET3 that network management is handled by NII, so even smaller universities and other institu-

Shunji Abe
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Director, SINET Promotion Office, Research and Development Center for Academic Networks

Junichi Sayama
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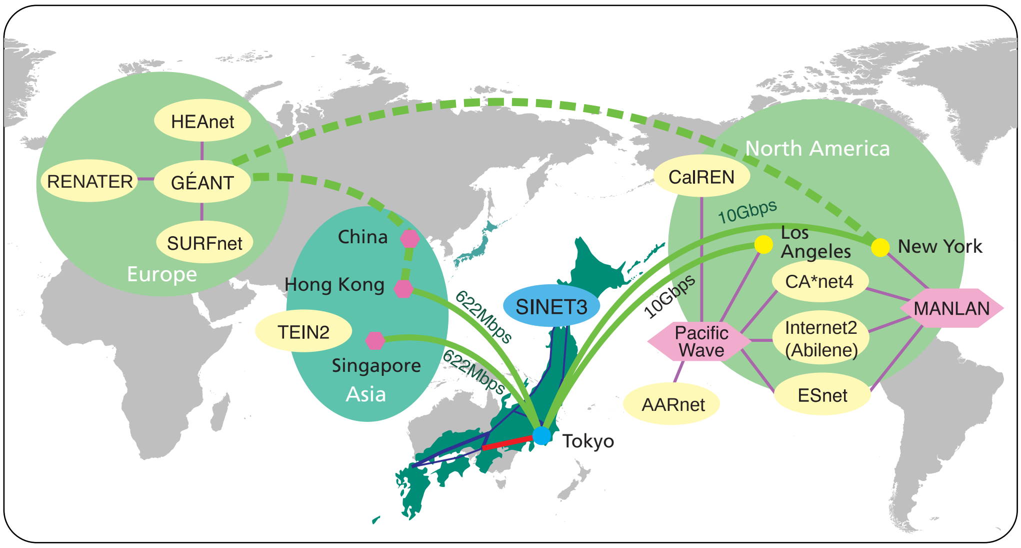

Interconnection with Overseas Research and Education Networks

how much information to be disclosed publicly is difficult to resolve, but there is no way this problem can be avoided. He added, "There are many uses, such as volcano observation data and remote medical treatment systems, that handle large amounts of data. I expect SINET3 is going to become increasingly important as research infrastructure."

Use of Computers Dispersed Throughout Japan in the Laboratory

Professor Mutsumi Aoyagi of the Research Institute for Information Technology at Kyushu University also remarked that "SINET3 is an indispensable tool for research and development." Professor Aoyagi has been a sub-leader of the Science Grid NAREGI Program (NAREGI stands for Japanese National Research Grid Initiative) during the period from academic year 2003 to 2007.

Science Grid NAREGI coordinates supercomputers at universities and research institutions throughout Japan so that they can be used for simulations and a variety of other purposes. It provides an essential tool for new materials development, nanotechnology, biotechnology, and others such scientific research fields of the future. This is one of the pillars in the creation of CSI. As Professor Aoyagi says, " The Science Grid NAREGI enables researchers to sit in their own laboratories and use computers located throughout the country as though they were a single computer. This gives them the capability to carry out complex simulations and other demanding applications." Bringing together researchers from many different fields on the network can increase the possibility of generating new ideas. Professor Aoyagi emphasized that "SINET3 is the most appropriate network system for implementing the Science Grid NAREGI software."

Overseas Coordination from a Global Perspective

SINET3 is strengthening international connections. It is connected to New York with a link that operates at 10 Gbps, and to Los Angeles with a link of 2.4 Gbps now upgraded to 10 Gbps to finally reach the Europe. It also has links to Hong Kong and Singapore both from Tokyo. SINET3 is aiming to become the core of the international research and education networks.

Professor Shigeki Goto of the school of Science and Engineering at Waseda University is enthusiastic about mutual coordination with overseas institutions. He is also active as key person in Asian information networks. "Networks can be classified into commercial or academic networks. It is important to observe that almost every country has at least one academic network," says Professor Goto, who went on to point out that "Japan has the advanced SINET3. Not only that, but Japan has a very high level of technology for network operation, so we can make significant contributions to make in this regard." He added, "We can't think about the future of networks just in domestic terms. It is necessary to take a global perspective." In Asia, he said, this is going to be of particular importance.

As the core of the Cyber Science Infrastructure (CSI), SINET3 has now become an essential component of academic research and development. It has also, become an important part of international academic networks through the Internet. It is to be hoped that this network will be developed and deployed still further. (Written by Masami Nakamura)

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Elementary Particle Experimentation Accelerated by SINET3

SINET3, operated by NII, has become an indispensable presence in elementary particle physics research. One major purpose of the ATLAS experiment is to search for the Higgs particle, which is one of the greatest puzzles of the Standard Model of particle physics. Now the ATLAS experiment is about to begin, and SINET3 will play a major role in it by transmitting the experimental data.

Hiroshi Sakamoto
Professor, International Center for Elementary Particle Physics
The University of Tokyo

ATLAS (*1)
A Toroidal LHC Apparatus
ATLAS is the name of a measuring device for use in elementary particle experiments. It is an international project.

GeV (*2)
Gigaelectronvolt. "G" signifies one billion, and eV is a unit of energy. When the mass of one proton is converted into energy, the amount of energy released is approximately 1 GeV. The surface temperature of the sun is approximately 0.5 eV.

The place is a suburb of Geneva, in Switzerland. About 100 m below ground, there is a giant oval-shaped particle accelerator, 27 km long, that extends over the border into France. This is the Large Hadron Collider (LHC) at CERN, the European Organization for Nuclear Research. The device used to measure the collision with each other of protons accelerated in the LHC is ATLAS (*1, photograph on right).

The large volumes of data from this ATLAS experiment need to be handled in realtime, which means that the required network extends across the entire world. That network links to the SINET3 Scientific Information Network operated by NII, which connects it with the ATLAS Regional Analysis Center at the University of Tokyo.

SINET3 Supports International Projects

ATLAS is a very large structure, equivalent in size to a seven-story building, that houses an array of some 100 million sensors. The amounts of data they handle are enormous. In the course of a year, it comes to as much as 4 PB, where PB stands for petabyte (1,000 trillion bytes). Analyzing this mass of data requires the capacity of 100,000 computers linked together. Not only that, but ATLAS is a large-scale project that has approximately 1,900 participating researchers in 35 countries around the world. ATLAS therefore includes such a large number of computers that it would be unrealistic for researchers to attempt to access them individually.

Professor Hiroshi Sakamoto of the International Center for Elementary Particle Physics at the University of Tokyo was one of the group that began preparations for the ATLAS experiment toward the end of the 1990s. In order to improve an environment that would facilitate research, they came up with the idea of combining the use of grid computing and international networks side by side. At that time, these two technologies had reached the stage where it appeared that practical application would be feasible. Therefore the idea was that computers located in different areas around the world would be connected in parallel over a network. This would make it possible to access the data at any location, and would enable analysis using as many computers as required. The capabilities of SINET3 would be required to realize this concept in practice.

SINET3 can make international connections with a network bandwidth of 10 Gbps (sending 10 gigabits of data per second). The Regional Analysis Center at the University of Tokyo uses 4 Gbps of that bandwidth. Exchanges with other countries take up another 2 Gbps, and a further 2 Gbps are set aside for the use of researchers in Japan. The observational data acquired by ATLAS is stored at key network nodes at CERN and several other worldwide locations. From there it passes through numerous nodes and is collected at the Regional Analysis Center. The data is further distributed from that Center to 15 research institutions in Japan.

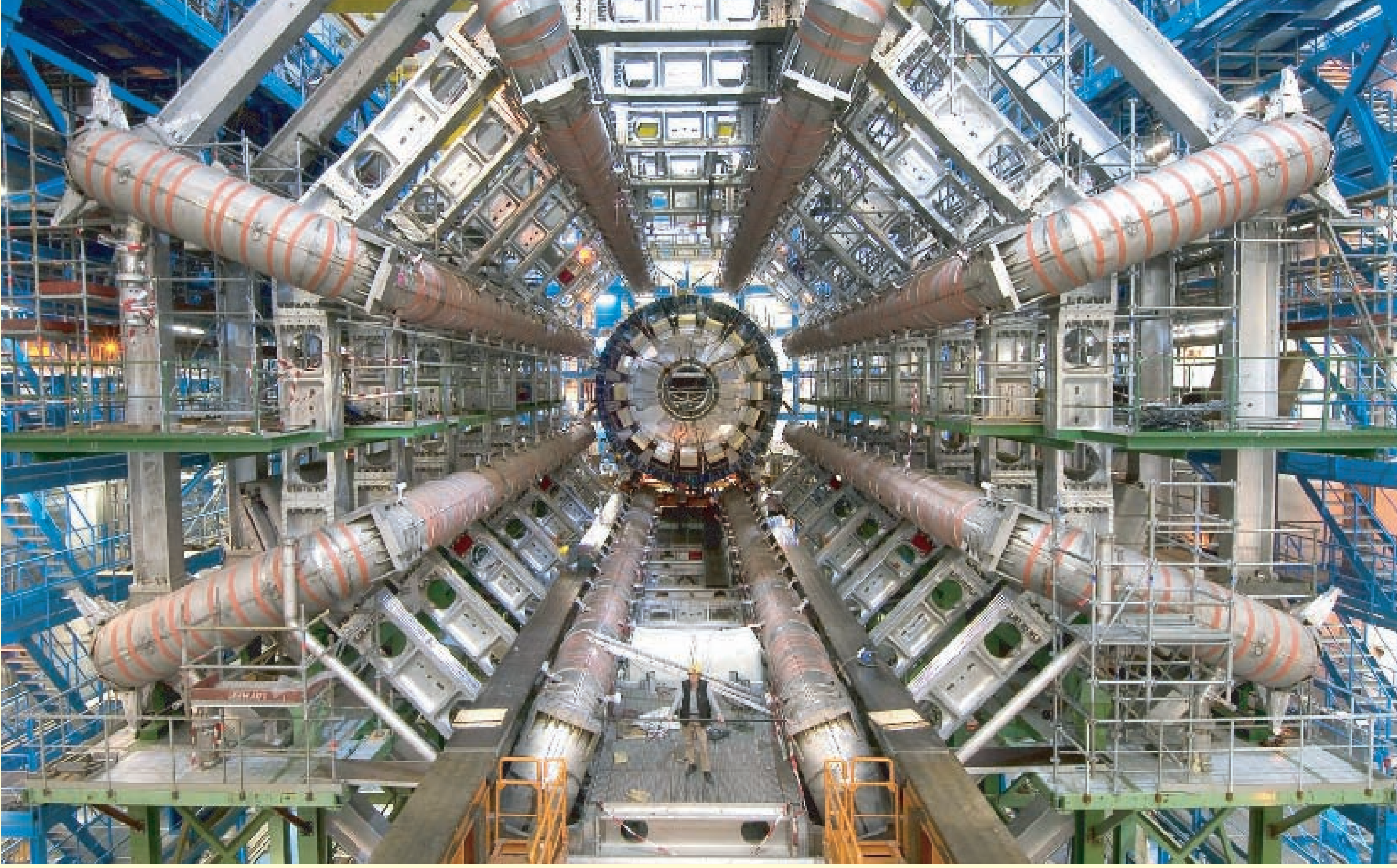
The Standard Model and Beyond

Professor Sakamoto's research topic is verification of the Standard Model of elementary particle physics. The Standard Model is a hypothetical step toward a unifying theory that explains three of the four forces governing the natural world, namely (excluding gravity) the electromagnetic force, the weak force, and the strong force.

Considerable progress has been made toward verification of the Standard Model, but a major puzzle still remains. That is the discovery of the Higgs particle. This particle is needed for elementary particles to acquire mass, and its discovery is the greatest issue forestalling acceptance of the Standard Model as a theory. A major objective of the international ATLAS project is to carry out direct measurement of this elementary particle and to investigate its properties.

According to the Standard Model, the Higgs particle should have been found in the vicinity of 100 GeV (*2). However, no trace of it has yet been found. ATLAS is capable of generating much higher levels of energy, up to 14 TeV (TeV stands for teraelectronvolt, or one trillion volts). Professor Sakamoto has high expectations: "I think we will be able to find the Higgs particle using ATLAS."

Another objective of ATLAS is to build up the theory that is beyond the Standard Model. Considering the performance of the experimental equipment,



Interior view of ATLAS under construction (copyright CERN)

there is every likelihood that phenomena not explained by the Standard Model will be detected. The existence of unknown and unexplained phenomena does not necessarily mean that the Standard Model is defective. As Professor Sakamoto explains it, "The theoretical notion we refer to as the Standard Model is fulfilled when it clarifies matters within its explanatory scope. At that point we begin constructing a theory that possesses a new framework."

The Start of the Experiment Draws Near

The environment in which the experimentation of the international ATLAS project will take place is ready. During the final rehearsals in February and May, the equipment will be operated under conditions nearly identical to actual operating conditions to determine whether the devices will function as planned. Professor Sakamoto said, "I am hoping that the experiment can begin this coming summer, perhaps as early as July." The ATLAS plan envisions a 15-year period of experimentation. What results will be achieved during that time, and what impact those results may have on elementary particle physics, are matters for pleasurable anticipation.

The Future of Particle Accelerators and Networks

After studying nuclear physics in graduate school, Professor Sakamoto joined the TRISTAN Project (*3) in 1985, then the SSC (*4) in 1989. He has been involved all along in the most advanced elementary particle experiments. It was inevitable that he would join ATLAS, but he is also looking ahead to the next stage: "I'm very interested in participating in the ILC (International Linear Collider) Project, which is the next-generation accelerator."

Professor Sakamoto also observed that "Domestic networks in Japan have reached quite a good level of improvement, but the links to Asia and Australia are still far from that level. We are hoping for further improvement of international networks." The strong point of grid computing is that it can basically handle all computers in parallel. Network environments are unequal, however, so the degree of freedom available to end users is very limited. He expanded on this: "Look at electricity, for example. Insert a plug in a power outlet and you can have electricity anywhere. I think that grid computing should be deployed more widely so that anyone who hooks up their personal computer will be able to deal with information freely. The IT infrastructure should be improved to that point." Professor Sakamoto is aiming to achieve further improvements not only in elementary particle physics, but also in the network infrastructure that supports that research.

(Written by Tomoaki Yoshito)

TRISTAN (*3)
Transposable Ring Intersecting Storage Accelerator in Nippon. This electron-positron colliding accelerator was operated from 1986 to 1995 under the High Energy Accelerator Research Organization It was proudly claimed that, when TRISTAN entered operation, it had the highest collision energy in the world.

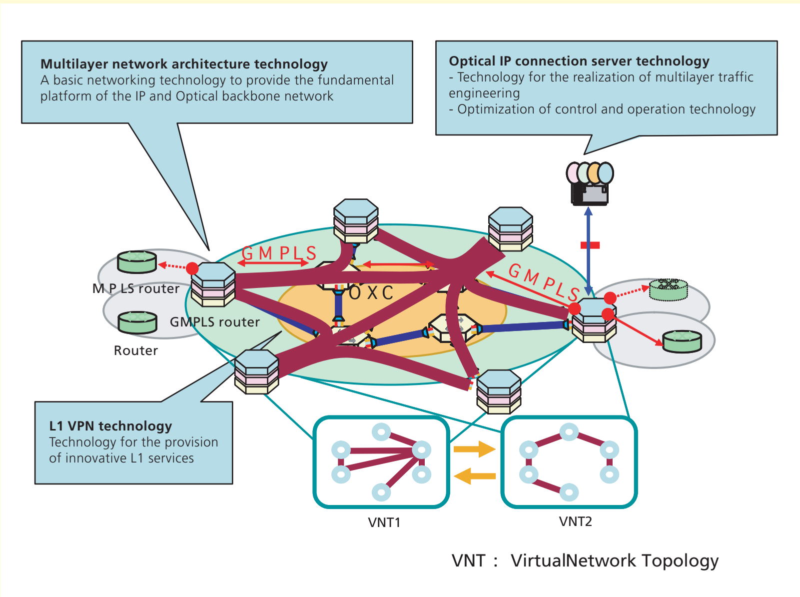
SSC (*4)
The Superconducting Super Collider was a gigantic accelerator, 87 km in circumference, that was scheduled to be constructed in the United States. It would have achieved ultra-high collision energies of 40 TeV.

A Cutting Edge Collaboration

Thinking about the combination of technologies and making the final decision are all up to you — network design involves a great deal of lonely work. The place that Professor Shigeo Urushidani casually turned to for advice was NTT Network Service Systems Laboratories. So what exactly was the collaboration between NII and NTT that played such an important role in the practical realization of SINET3?

On February 1st 2008, a demonstration was carried out to try to send 1.8-gigabyte images every second between NII and Hokkaido University. This moment was the first time in history that Layer-1 on-demand service had been achieved through a working network.

Layer-1 on-demand service is one of the distinguishing sales points of SINET3, providing users with a line with the necessary volume at the necessary time. Since nobody transmits vast amounts of data the entire time, providing lines with only the necessary volume and only when they are needed is an essential way of thinking in order to ensure there is no waste on the network and it can be efficiently used. The technology that made this a reality is Layer-1 on-demand service using GMPLS (Generalized Multi-Protocol Label Switching), which was dreamt up by Professor Urushidani and NTT Network Service Systems Laboratories. This technology made it possible to arrange the network resource in accordance with network traffic volumes more flexibly.



Research at NTT Network Service Systems Laboratories
The fusion of optical network technology with IP network technology is being researched for dynamic resource allocation and efficient resource management.

NTT Network Service Systems Laboratories' ideas are also being put to work in attempts to enable lines to be used by as many people as possible at any single time. For example, with just one user it isn't hard to decide the network's shortest route. But in real life, of course, a line is used simultaneously by many people. The number of users and their nature varies form time to time, so it is far from easy to decide what the ideal data flow is. We, the users, might not take the slightest bit of notice about the fact, but computers are always making these calculations in order to provide a comfortable network environment.

Surmounting the Hurdle of Practical Realization

In order to provide a network environment that is in keeping with day and age, NTT Network Service Systems Laboratories conducts comprehensive research into everything from materials to systems through to operations. Professor Urushidani worked here as a research leader until 2006, and gained the participation of his former colleagues in the consideration of technologies for the development of SINET3.

Ichiro Inoue, senior researcher NTT Network Service Systems Laboratories, who says that he commutes between the NTT lab in suburban Tokyo's Musashino City and the NII office in downtown Chiyoda Ward, describes this effort to balance his work thus: "There's a huge difference between the lab's work, which requires me to think about solving immediate and visible issues, and thinking about the cutting edge technologies required by SINET3. So I have to 'switch' my brain for each task." Clearly the task is a great deal more specialized than usual network development. Looking back on the project. NTT Network Service Systems Laboratories' Kaori Shimizu says: "I learnt that examining these sort of issues is essential in order to get to actual operation. There was a real buzz around the team members immediately before the launch of the service, and I'm really pleased to have had the chance to experience

Ichiro Inoue and Kaori Shimizu, who have held lengthy discussions with Professor Urushidani about SINET3.

that atmosphere."

Collaboration is about "Give and Take"

SINET3 itself is not merely a network that harnesses state-of-the-art technologies. Its users are cutting edge researchers handling massive data in fields such as nuclear fusion and astronomical observations, and they use state-of-the-art applications in the analysis of this data. The fact that this sort of 'state-of-the-art' network is actually up and running appeared to have quite an impact on the lab members, who are usually involved in the development of commercial networks. However there is no guarantee that general public users will not suddenly start to use applications essential to the state-of-the-art network. The technical development already has the next five to ten years in its sights. GMPLS, the key technology in the Layer-1 on-demand service, was under discussion for eight years before it actually reached practical realization.

As Inoue and Shimizu explain, "We think that technologies that we will be able to use in commercial networks will come out of the state-of-the-art network. The idea in the Layer-1 on-demand service of building a network between the people who need it, at the time that they need it, could be applied to other smaller networks. SINET3 provides plenty of hints about the construction of new networks, and we'll be watching it with great interest."

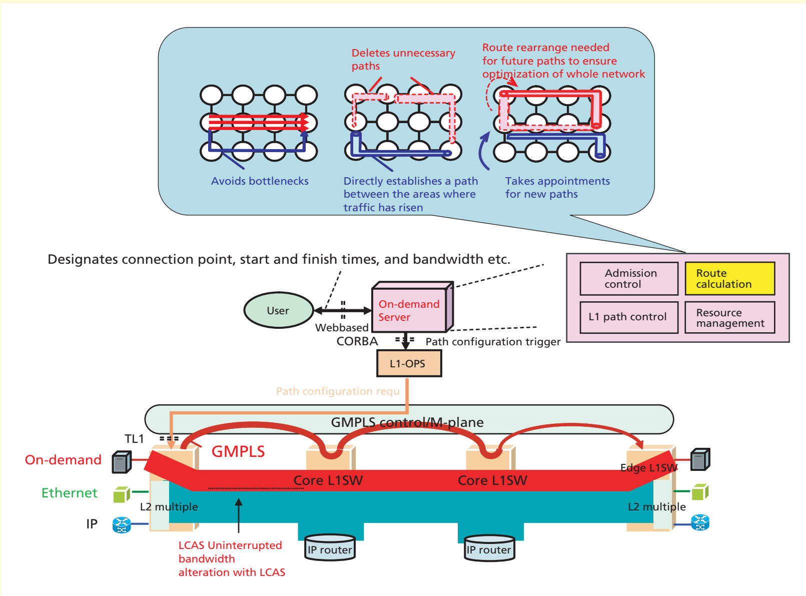
SINET3 has succeeded in making installation costs cheaper than the average network by reducing the number of IP routers. This sort of ingenious touch will surely be put to use elsewhere. It would appear that working on SINET3 has been of great significance to NTT Network Service Systems Laboratories.

The Never-ending Story of Network Development

SINET3 came on-line in June 2007, but Inoue and Shimizu don't see this as the end of the story. They are thinking about finding issues and making improvements, in order to make this infrastructure even better. For example, those using the Layer-1 on-demand service currently have to make an appointment with the server for the time and volume. But if this can be changed so that instructions can be given straight to the network, it will become even more user-friendly.

When the on-demand L1 service starts to become fully-fledged, users will start to voice their opinions about its ease of use, and no doubt areas that need improvement will increase. As Inoue says, there is no end to technological development: "Ways of using the network change each day. You may think it will suffice today, but tomorrow there will be calls for improved technologies and functions. On the other hand, if somebody suggests some hitherto unknown, fantastic technology, we have to respond to it."

This is not the first time that NTT Network Service Systems Laboratories and NII have collaborated. The two parties worked together on expanding the functions of SINET, SINET3's forerunner. What sort of network will be proposed as a result of their next collaboration? (Written by Akiko Ikeda)



Control mechanism of the on-demand L1 service

NTT Network Service Systems Laboratories made suggestions about route computation and L1 path control

NII ESSAY

A Beauty Contest Took Place

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Japan's first "beauty contest" has been held (in the field of IT, it must be added). Hitherto, the number of commercial wireless communication licenses and the number of applications for them have exactly matched, quite coincidently, rendering any contest for them unnecessary. However, when the Ministry of Internal Affairs and Communications (MIC) put out a call for enterprises to carry out telecommunications business using the 2.5 GHz spectrum, they received applications from four companies for just two available licenses. This necessitated screening (through a comparative hearing process) to decide which of the companies would be awarded the licenses.

What Is a "Beauty Contest"?

The 'beauty contest' was originally introduced by the English economist John Maynard Keynes (1883-1946), in his 1936 work *The General Theory of Employment, Interest and Money*. Keynes suggests that professional market participants act in accordance with the views of general public participants rather than their own views or preferences. "Professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole," he wrote.

The licenses were for broadband mobile communication system enterprises such as WiMAX operators, which are expected to become a part of the core (or one of the 'beauties') of the next-generation wireless communications sector. So a beauty contest was held because of the need to evaluate not only their commercial viability but also perspectives touching upon the interests of the whole of Japanese society (such as service area developments, fiscal base, technological capabilities, and network opening). Another peculiarity of this bidding is that major mobile telephone companies were excluded from the bidding in an effort to stimulate competition.

Towards Better System Design

Elsewhere, the auction system is becoming increasingly used in the Anglo-Saxon countries. Certainly, in the "perfect market" where the flow of information used in economics and transactions proceed smoothly, the most appropriate distribution should be achieved (the Coase theorem) - but things don't actually go as well as this. Problems have occurred such as the German auction in which the operator invested so much money in acquiring the license that the launch of its service became delayed, or the extraordinarily cheap auction that was held in New Zealand. Alterations to the system are under examination with the application of game theory.

In Japan, the reallocation of spectra is expected in the future. However, there are still issues such as dissatisfaction with the screening method in beauty contests, and the danger of system design failures in auctions. When, to whom, and how should the portioned spectra be allocated? Many other issues remain, including how to treat competing and supplementing spectra, preventing monopolies and collusion, and continuing transactions after allocation. It looks as if the search for a new methodology to solve these problems and find "a real beauty" will continue for quite some time.

Weaving Information into Knowledge
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