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Special feature

SINET4

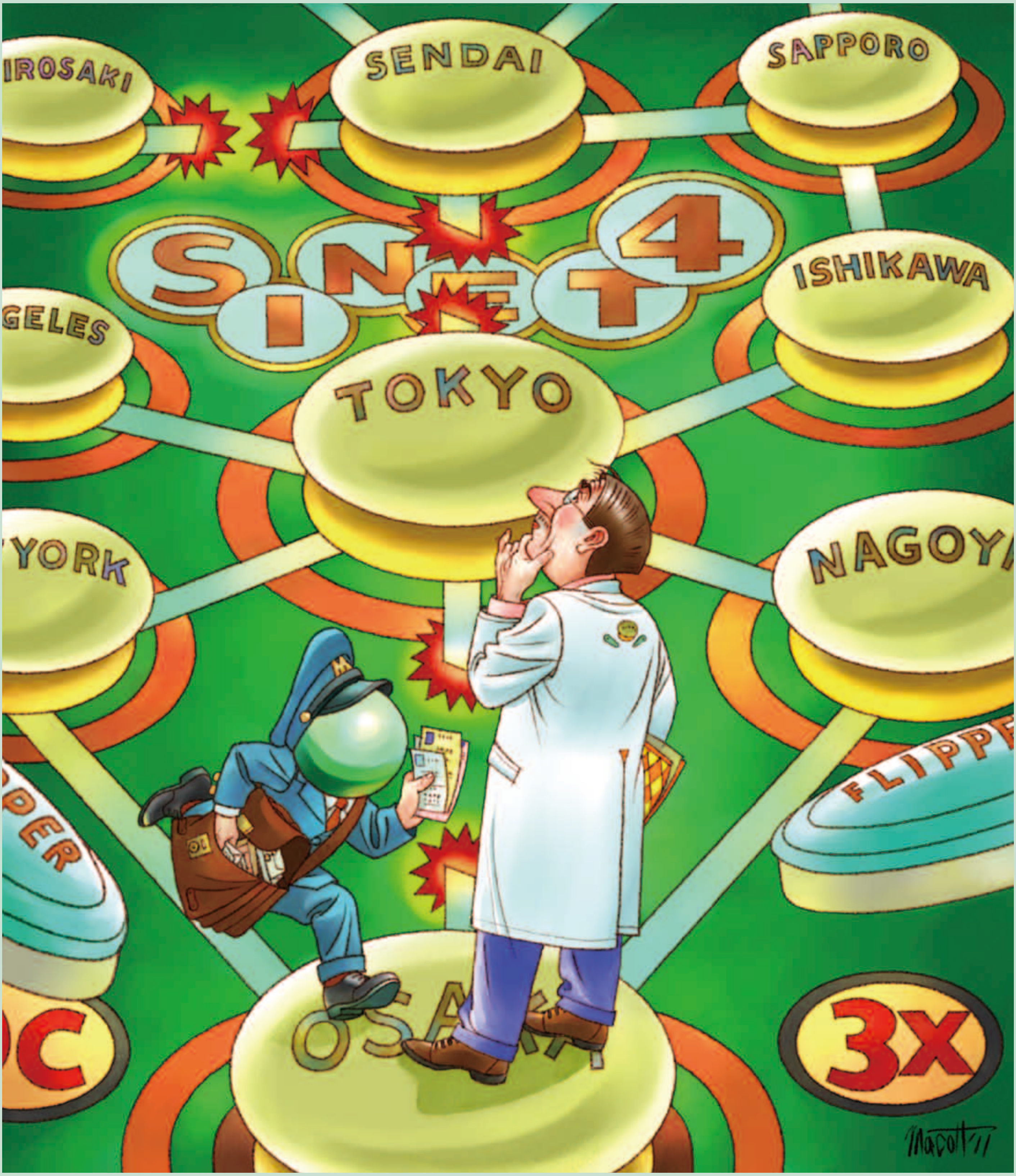
The Next Stage of Information Lifelines

SINET4, Robust Enough to Withstand Even the Great East Japan Earthquake —Reliability Supporting the Exchange of Academic Information—

Faster and More Robust. The New, Evolved SINET4

SINET4 has been offering services,despite the Great East Japan Earthquake

Education, research and regional contributions developing from migration to SINET4



NII's science information network (SINET) connects universities and research organizations throughout Japan. April 2011 marked the launch of "SINET4", offering increased stability. How will this ultra-high speed transmission network change the face of Japanese research?

NII Interview

SINET4, Robust Enough to Withstand Even the Great East Japan Earthquake

—Reliability Supporting the Exchange of Academic Information —

The Fourth Generation of SINET

Takita The "SINET (Science Information NETwork)" has been used as an Internet backbone since 1992, and it has entered its fourth generation this year. It links aproximately 700 universities and research organizations throughout Japan. What kind of research has it been used in so far?

Aoki SINET works behind the scenes in the research world, supporting the exchange of academic information. For example, the testing of the Kobayashi Maskawa Theory at Tsukuba's High Energy Accelerator Research Organization produced an enormous amount of data. SINET was used to share that data with universities such as Tokyo University and Tohoku University, for use in real-time analysis. We are proud that this high capacity network was able to contribute, in its way, to the winning of the 2008 Nobel Prize in Physics.

Takita Its strength lies in its ability to smoothly and easily move the massive amounts of data needed for academic research.

Aoki The National Astronomical Observatory of Japan is one of SINET's biggest users, with radio telescope observation data from across the country being sent over virtual private circuits at specified times. In the field of seismic research, data from Japan's measurement network is instantly transmitted to multiple research organizations. The data produced by individual earthquake sensors is small, but there are many sensors, so high bandwidth circuits are necessary.

Takita Couldn't commercial high bandwidth networks be used?

Aoki There is a variety of commercial network services, but only SINET offers the flexibility to create virtual private networks (VPN)[*1] connecting only joint researchers, transmitting data at times specified by researchers. NII has patented the system for specifying connection destinations and bandwidth on an on-demand basis at the L1 (leased line) level. Our job, as an inter-university research institute, is to provide a network which our users, researchers, find easy to use.

Takita What has changed with the move to SINET4?

Takekawa The new SINET offers greater reliability. In SINET3, under the core nodes[*2] were local sites called "edge nodes". Edge node equipment was installed in individual universities. With SINET4, we've eliminated these edge nodes installed in individual universities, and placed all nodes, core and edge, in private data centers. This is because universities suffered from connection reliability problems: they are subject to power outages due to statutory inspections, and due to access limitations, troubleshooting and resolution are delayed when faults occur. By using data centers, which are manned 24 hours a day, and which offer emergency power supply units, we are able to offer a more stable network.

Functions Withstood the Great East Japan Earthquake

Takita Were there any problems when the Great East Japan Earthquake hit?

Takekawa The data centers are highly earthquake resistant, and nodes which experienced power outages as a result of the earthquake were kept online using emergency power supplies. There was redundancy for the lines connecting the nodes, so even though the

Toneo Aoki

Deputy Director, Cyber Science Infrastructure Development Department, NII

Toyomi Takekawa

Director of Academic Infrastructure Division, Cyber Science Infrastructure Development Department, NII

Tokyo - Sendai line completely failed, the network stayed up by switching to the Tokyo - Sapporo - Sendai route.

Takita How many core and edge node sites are there?

Takekawa There are eight core nodes: Sapporo, Sendai, Tokyo, Nagoya, Kanazawa, Osaka, Hiroshima, and Hakata, and there are 42 edge nodes. With SINET4, universities and research organizations access individual nodes to use SINET services.

Takita SINET4 also offers improved bandwidth, right?

Takekawa 40Gbps[*3] connections are used between core nodes. The Tokyo - Sapporo route is still 10Gbps, but that will be raised to 40Gbps by year's end. We plan on increasing the bandwidth of the Tokyo - Osaka connection, which carries quite a bit of data, to 80Gbps by the end of the year, and to 120Gbps in the next 3 years. The access connections from universities and research organizations to the edge nodes, which they arrange themselves, can offer high transmission speeds of up to 40Gbps through a combination of dark fiber[*4] and WDM[*5] technology. These speeds are 1000 times greater than the maximum bandwidth of 50Mbps when SINET first started, in 1992.

Takita High speed access is now available to universities and research organizations across the country, then.

Aoki Until the year before last, there were no edge nodes in 13 prefectures in the Tohoku and Kinki regions, so they were unable to enjoy the fruits of SINET's high speed network. With SINET4, edge nodes have been installed in those prefectures, finally eliminating this disparity.

Takita The network has really become much stronger. Hasn't this resulted in skyrocketing costs?

Takekawa We've majorly overhauled the network design connecting core nodes and edge nodes with SINET4. Data center usage fees do cost a lot, but by replacing the former leased line connections between universities and edge nodes in SINET3 with a combination of WDM and dark fiber in SINET4, we've recouped these expenses, and also been able to increase bandwidth. We also optimized equipment when replacing node devices, cutting power utilization in half.

Takita What kinds of research activities will use the SINET4 platform in the future?

Aoki There is an experiment underway now that involves placing supercomputers in cold regions, such as Hokkaido, in order to reduce the power costs involved in cooling. There are also ideas about using supercomputers in western Japan due to the power shortages forecast for eastern Japan this summer. I expect there will be a greater movement towards distributing computational resources, and sharing the results of that approach. All of these are based on the existence of the highly reliable, high speed SINET4 network.

*1 VPN: This stands for "Virtual Private Network". VPNs use sections of many share transmission lines as virtual private leased lines to designated transmission sites.

*2 Node: Facilities in which transmission equipment and electrical facilities, etc., have been installed, for use in the academic information network.
Edge nodes are nodes containing transmission equipment which connects to edge lines and access lines.
Core nodes are nodes containing transmission equipment which connects to core lines and edge lines.

*3 bps: This stands for "bits per second". This unit indicates how much data can be transmitted in 1 second. 1Gbps = 1 gigabit per second. 1Mbps = 1 megabit per second. "Giga" represents 10^9, and "mega" represents 10^6.

*4 Dark Fiber: Optic fiber which has been laid by telecommunications companies, but which is not being used to supply services.

*5 WDM: This is short for "Wavelength Division Multiplexing". With this technology, multiple optical signals with different wavelengths are transmitted simultaneously over a single optic fiber, offering high transmission speeds.

Comment from the Interviewer

The Great East Japan Earthquake dealt a devastating blow to Japan's academic infrastructure. In the Tohoku and Kanto regions, experimental and observation equipment in research organizations was destroyed. Even now that repairs have been completed, operations have not fully been resumed, due to worries of electrical shortages. It would appear inevitable that Japan's scientific research would grind to a halt. Hope, however, has come in the form of support from research organizations in regions which weren't affected by the disaster, and the fact that the SINET4 network infrastructure remained robust enough to support research distribution. We will need to continue to consider what type of research structure to put in place in this country of frequent natural disasters.

Kyoko Takita
Writer
Science News Department
The Yomiuri Shimbun

Faster and More Robust.
The New, Evolved SINET4

The Japanese academic backbone network, “SINET”, is used to transfer data at ultrahigh speeds between the over 700 universities and research institutions that connect to it. It forms part of the information infrastructure which supports cutting-edge academic research, such as the verification of the Nobel-Prize winning Kobayashi Maskawa Theory, and the transfer of massive volumes of seismic and astronomical observation data. NII has been involved in its development, construction, and operation since the 1990s. April 2011 marks the full-fledged launch of its fourth incarnation, “SINET4”.

Further Emphasizing SINET’s Strengths as a Cutting-Edge Academic Backbone Network

The most outstanding feature of “SINET” is that it is connected to special R&D and leading educational resources. These include, for example, large-scale facilities such as accelerators with total circumferences of dozens of kilometers and massive experimental nuclear fusion reactors, as well as radio telescopes and seismic measurement equipment located throughout the country, high-definition or 3D ultra-realistic media devices, and enormous academic databases.

Numbered among these are the supercomputers in universities’ information technology centers and the Next-Generation Supercomputer being developed by RIKEN. High expectations have been placed on “SINET4” for the high-speed transfer of the high volumes of data among the supercomputers and a large number of user sites.

“SINET has already contributed to a great deal of leading edge research. One of those was the high speed transfer of the massive loads of data produced by the Belle measurement equipment of the High Energy Accelerator Research Organization in Tsukuba City. This proved tremendously useful in verification of the Kobayashi Maskawa Theory, which led to a Nobel Prize,” explains Professor Shigeo Urushidani (Director of the Research and Development Center for Academic Networks), general manager of SINET4 at NII.

In recent years, it has been increasingly used in international projects. It has been connected to the ATLAS measurement equipment (used to record high energy proton collisions) of the Large Hadron Collider (LHC) in Switzerland, transferring up to 4 Gbps (see note 3 on page 3) over international circuits, in order to perform realtime analysis on the massive data produced by the LHC. It has also been used in international experiments related to the enormous volumes of data expected to be transferred by the “ITER” experimental fusion reactor being built in France.

SINET is not, however, merely an infrastructure for rapid transfer of large data volumes. One of its notable features is that it adds various research oriented service functions.

“For example, a virtual private network has been established along with quality-of-service control functions and multicast functions for seismic research in order to securely and simultaneously distribute the data nationwide. As for astronomy, transferring massive volume of data produced by radio telescopes would entail exhausting the network bandwidth, so SINET offers layer 1 (L1) on-demand functions for transferring data between specific radio

Shigeo Urushidani
Professor, Information Systems Architecture Science Research Division, Director, Research and Development Center for Academic Networks, NII

Michihiro Aoki
Special Appointment Professor, Research and Development Center for Academic Networks, NII

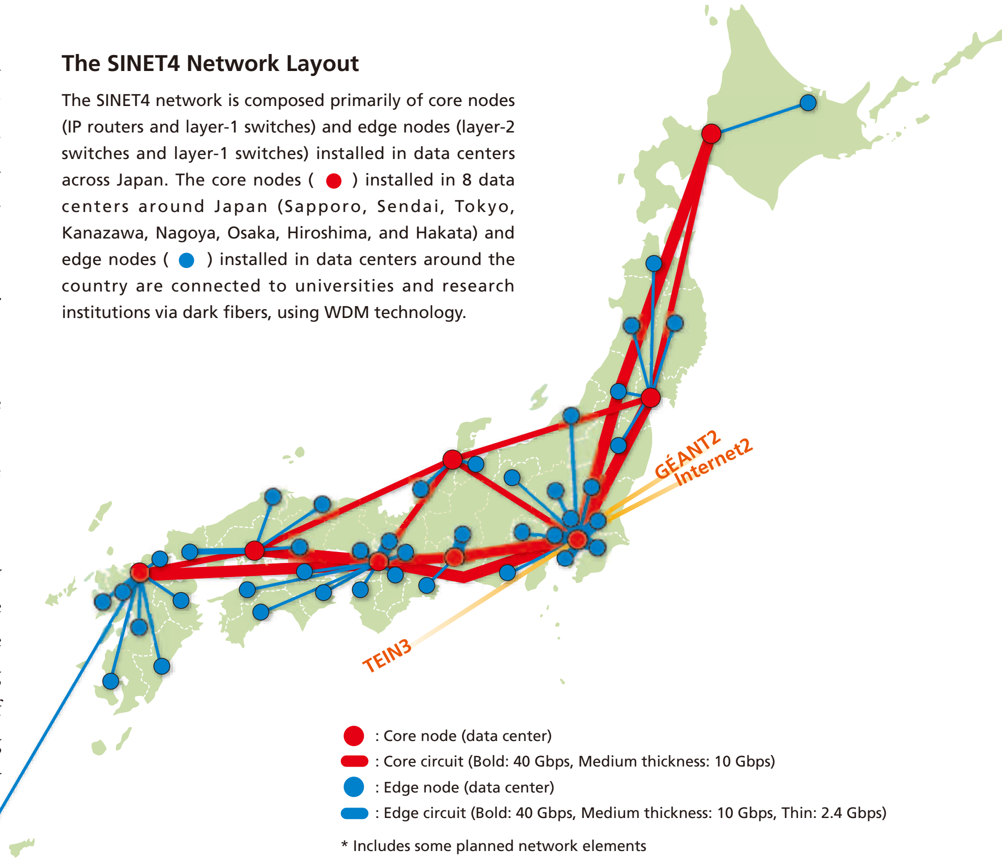
telescopes and the National Astronomical Observatory of Japan with specified end-to-end bandwidths for specified durations. These L1 on-demand functions and virtual private network capabilities are essential for accelerating cooperation between universities and research institutions in cutting-edge research," explains Professor Urushidani.

SINET is also used as a tool for high-resolution video transmission, used in remote lectures and meetings, playing an important role in the ability to transfer course credits across universities. The L1 on-demand function's ability to transmit uncompressed high-resolution video is especially important for conferences requiring a sense of immediacy and presence, and remote surgeries for which data transmission lag cannot be tolerated. Its massive 1.6 Gbps of bandwidth enables vivid, natural feeling communication thanks to the extremely minimal lag.

"SINET is connected to diverse, leading-edge resources," says Professor Urushidani, "making it possible for it to flexibly supply a variety of services, including not only high-speed connectivity, but also multilayer functions supporting IP (Internet Protocol), Ethernet, and leased lines, VPN (virtual private network) functions which offer closed private networks on a project-by-project basis, and resource-on-demand functions necessary for irregular transfers of large volumes of data, such as data from astronomical observatories."

The SINET4 Network Layout

The SINET4 network is composed primarily of core nodes (IP routers and layer-1 switches) and edge nodes (layer-2 switches and layer-1 switches) installed in data centers across Japan. The core nodes (●) installed in 8 data centers around Japan (Sapporo, Sendai, Tokyo, Kanazawa, Nagoya, Osaka, Hiroshima, and Hakata) and edge nodes (●) installed in data centers around the country are connected to universities and research institutions via dark fibers, using WDM technology.



Placing All Nodes at Data Centers for Increased Reliability

These services have been carried over from SINET's previous incarnation, SINET3, which began operations in 2007, but one of the main requests of SINET users, with the migration to SINET4, was for increased node stability.

In the past, edge nodes, which serve as connection points to participating institutions, were located in several selected universities. However, with this arrangement, it is difficult for support staff to go onsite in the event of problems, and power outages resulting from disasters are also a point of concern. This is why the decision was made to move all edge nodes to robustly outfitted data centers. SINET is also working towards completing node installation in all prefectures within the fiscal year, resolving the disparity between the prefectures with edge nodes and the 13 prefectures in which edge nodes have not yet been installed.

The 12 core nodes used by SINET3 have been pared down to 8 for SINET4, and the number of edge nodes, which was 62 with SINET3, has been reduced to 29 (42, once edge nodes have been installed in the remaining prefectures). All of these nodes have been migrated to data centers. Aggregating nodes has made it more economically feasible to provide faster bandwidths, creating an ultra-high speed network with connections between core nodes reaching a world record 40Gbps, connections between core and edge nodes falling between 2.4 and 40Gbps, and connections between edge nodes and participating institutions between 1 and 40Gbps.

Needless to say, the construction of a network with this scale has required a correspondingly large overall framework. NII Research and Development Center for Academic Networks Special Appointment Professor Michihiro Aoki, leader of the migration team which managed the migration to SINET4, explains:

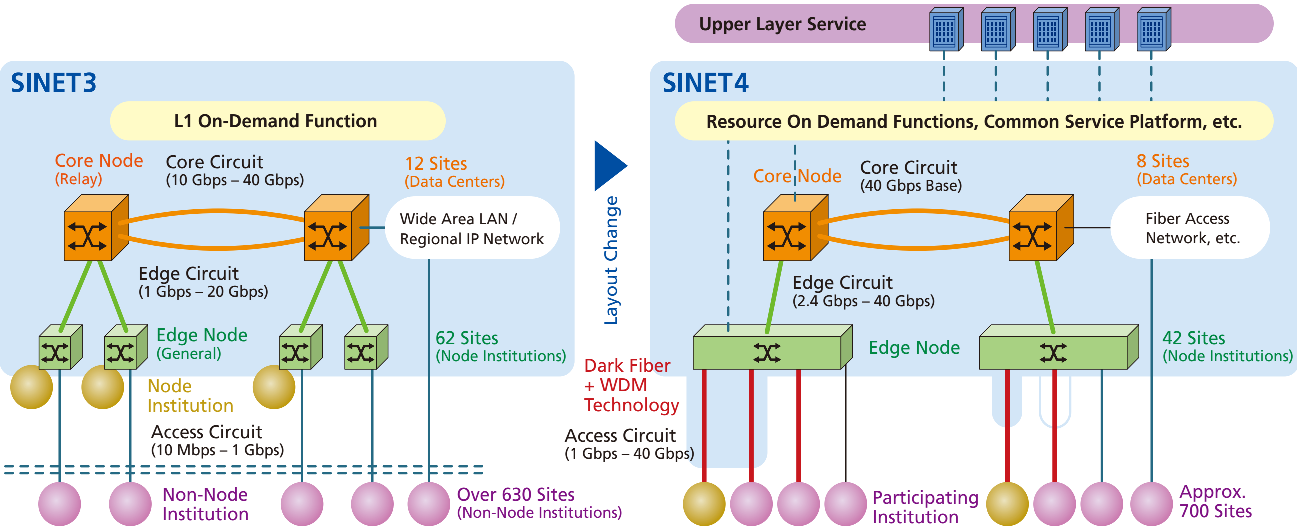
"The primary feature of SINET4 is that it uses VPNs to create virtual dedicated networks between joint research projects, in addition to creating independent logical networks for individual services on a single backbone. In order to do that, SINET has used a combination of products from different vendors, and NII has developed its own leading-edge software, such as the software used by the on-demand control function.

The migration work has involved a wide

Special feature

SINET4

The Next Stage of Information Lifelines



Layout Differences between SINET3 and SINET4

SINET4 carries over SINET3's architecture, while moving edge nodes and core nodes to data centers, eliminating past disparities between universities with nodes and those without, and working towards all prefectures being outfitted with nodes. It has also been significantly strengthened to enable real-time transfer of large volumes of data.

range of activities, in addition to backbone construction, such as building network supervising systems, installing uninterrupted power supplies (UPS), connecting access lines to individual sites, and setting up international circuits. We established the framework with the cooperation of many different vendors and telecommunications carriers."

This migration presented individual managers with many challenges, due to the fact that it represented a major overhaul of the network design. Akihiro Sato, a member of NTT-ME, which was responsible for access lines (the circuits connecting edge nodes and individual institutions) reflects:

"We were able to provide speed improvements affordably by combining WDM (Wavelength Division Multiplexing) technology (see note 5 on page 3), which uses multiple optical signals with differing wavelengths, with dark fibers, optic fibers which have been laid but are not in use, to connect edge nodes and universities. With SINET4, we are offering 62 high-speed access lines, but this installation required the connection of around 500 dark fibers. To maximize optical transmission efficiency, we selected the access line routes with the least number of fibers possible. Thanks to this, we were able to offer high-quality and high-speed access lines."

Takuro Sono, a member of Internet Initiative Japan (IIJ), which was responsible for supplying IP routers and layer 2 multiplexers for use in individual nodes, goes on, "We delivered almost 150 devices, installing them in around 100 sites, and laying a total of 6,000 interconnecting cables. It was difficult to carry this all out over the course of just a few months, but it was a very valuable experience to be involved in the design of the multifunctional SINET backbone from its design stage, designing it to make optimal use of the functions offered by each device."

Overcoming Obstacles to Carry Out a Smooth Migration

SINET4 has also been designed to provide stronger international connectivity. Plans are underway to increase bandwidth in connections to the USA from 20 Gbps to 30 Gbps, and to increase Asian circuits from 1.2 Gbps to 2.4 Gbps. Teppei Anzou of Softbank Telecom, which is responsible for SINET's Japan-US circuits, discussed the difficulties caused by the Great East Japan Earthquake.

"Just as we were about to start the migration, the Japan-US undersea cable was severed by the earthquake. We managed to secure a usable cable, which normally takes over 6 months to procure, in a mere 2 or 3

Akihiro Sato

NTT-ME Corporation

Takuro Sono

Internet Initiative Japan Inc.

Teppei Anzou

Softbank Telecom Corporation

Junichi Sayama
SINET Team, Academic Infrastructure Division, Cyber Science Infrastructure Development Department, NII

Yasuhiro Kimura
NTT Communications

Hideharu Maruyama
KDDI Corporation

Takeshi Mizumoto
NTT East

days, making it in time for the migration. Normally, a ship would have to be sent out to lay cable, but due to the tsunami and the nuclear reactor situation, this was not possible. Things were tight, but we managed to pull off the migration successfully."

Migrating a network service without any outages is not an easy task, even without an earthquake. The migration period overlapped with university entrance exams and new student admissions, so stopping the system during working hours was out of the question, so the brunt of the migration work had to be performed on weekends and late at night. The Cyber Science Infrastructure Development Department's Junichi Sayama, who manages operations at NII, was one of those tasked with handling users at individual sites.

“The migration was planned to take place at this time of the year, so migration work hours were coordinated from the very start. The earthquake caused major schedule changes, but thanks to the abundant cooperation of users, node managers, contractors, and families, we were able to start SINET4 as scheduled.”

Hideharu Maruyama of KDDI, which was in charge of connectivity to the “Third Generation Trans-Eurasia Information Network (TEIN3)” for Asian use, expressed his thanks to the sites involved.

“We connected SINET4 and TEIN3 via IP routers in Singapore. These IP routers also connect to other academic networks, both domestic and international, so we had to scramble to coordinate the migration to ensure that it went smoothly, as we couldn't negatively impact these other networks. In particular, there were many people in Japan as well using the network, so we had to work together with sites in Japan in performing the switchover work. Of course, there were difficulties, but I think it was significant that we were able to demonstrate this level of collaboration and cooperation to Asian countries."

SINET4 Stayed Up Throughout the Great East Japan Earthquake

SINET4's high level of reliability was demonstrated, coincidentally, by the Great East Japan earthquake. Fortunately, the process of switching over to edge nodes in data centers had already been completed in the Tohoku area by March 11, when the earthquake hit. Yasuhiro Kimura, of NTT Communications, which is in charge of SINET4's domestic edge and core circuits, discusses this.

“Actually, both edge circuits and core circuits had been provided with redundant routes in order to handle this kind of emergency situation. It was difficult preparing equipment and materials, finding underground routes in good condition, and installing L1 switches providing complex service functions, all within a shorter than usual time-frame, but it's a good thing that these measures were taken in advance.

By that, I mean that both the Sendai - Tokyo and Sendai - Kanazawa circuits were severed, but the backup routes, Sendai - Sapporo and Sapporo - Tokyo, which were connected via the Sea of Japan, were still active. We were able to reroute via Sapporo to transfer data, so Sendai was not cut off.”

During the planning stage, there were some of the opinions that, from a financial perspective, circuit redundancy was not necessary, but this preparation paid off. Data centers also played an important role during this disaster. Takeshi Mizumoto of NTT East, which was in charge of the data center migration, explains, “Data centers are designed to be earthquake resistant, so no equipment collapsed or was damaged. However, the earthquake caused power outages over a large area, and, in particular, in Sendai, the data center selection standard of “10 to 20 hours of power supply capabilities in the event of an earthquake” was far exceeded, with commercial power being down for a maximum of 96 hours. We were able to bring in fuel for the emergency generators, however, and thus successfully prevented any system outages.”

Professor Urushidani, who presided over the successful launch of SINET4 despite a major earthquake, carries an expression of relief on his face, but has already turned his eyes towards the future.

“In the near future, we would like to further increase the speed of the network, as well as adding new services such as cloud computing, which has received greater attention due to the earthquake. SINET is always behind the scenes, but it would make me very happy if it could continue to contribute to academic development such as new discoveries.”

(Written by Madoka Tainaka)

SINET4 has been offering services, despite the Great East Japan Earthquake

Academic networks are an important infrastructure for supporting scientific activities.Thus, network failures have a huge influence on research activities and on the cooperative frameworks among industry, academia and government. There is an increasing number of network problems that we need to assume, such as data surges, attacks by outside parties, or sudden damage to lines or unforeseen power outages. In light of all this, SINET4 managed to avoid the worst-case scenario of line outage in the earthquake.

SINET4: Functioned even during the earthquake

March 11th, 2011. SINET4 backbone has already been constructed, and the migration from SINET3 to SINET4 was being accelerated toward the following month's full-fledged start of SINET4, right when the 9.0-magnitude earthquake, the strongest in the nation's history, was recorded in the sea off Miyagi Prefecture. Fixed and mobile telephones were highly congested. Although a huge amount of damage was inflicted on infrastructure namely to power, gas and water in the areas surrounding the quake, with SINET4, which had completed the migration in the areas, connectivity was kept among nodes, which experienced no connection outages.

Therefore, users at universities and research institutions using SINET managed to avoid becoming victims. They were able to restore their equipment and power and were able to use their networks as usual.

SINET4 has been undergoing huge structural modifications. The goal is to make it high-speed, capable of offering a variety of services and giving the edge nodes a high degree of stability, etc. in comparison to the previous SINET3. Without these efforts, SINET4 probably never would have had the high degree of fault tolerance from the earthquake. Shinji Takano, Chief of SINET Team, Academic Infrastructure Division, Cyber Science Infrastructure Development Department of NII, who is involved in the migration to SINET4, recalls the moment the earthquake struck.

"When the quake happened on March 11, we were lucky in that SINET4 was operating at most of the sites in the Tohoku region. It was running concurrently with SINET3 in order to migrate the networks. In fact, we faced line breakages between the major sites, due to the earthquake. But as a countermeasure to the damage, redundant lines maintained by SINET4 helped us prevent network disruption. If SINET3 had been left as it was, the Tohoku region and Hokkaido would have been affected."

Shinji Takano

Chief of SINET Team, Academic Infrastructure Division, Cyber Science Infrastructure Development Department, NII

Yutaka Ishikawa

Director of Information Technology Center
Professor of Computer Science Department
The University of Tokyo

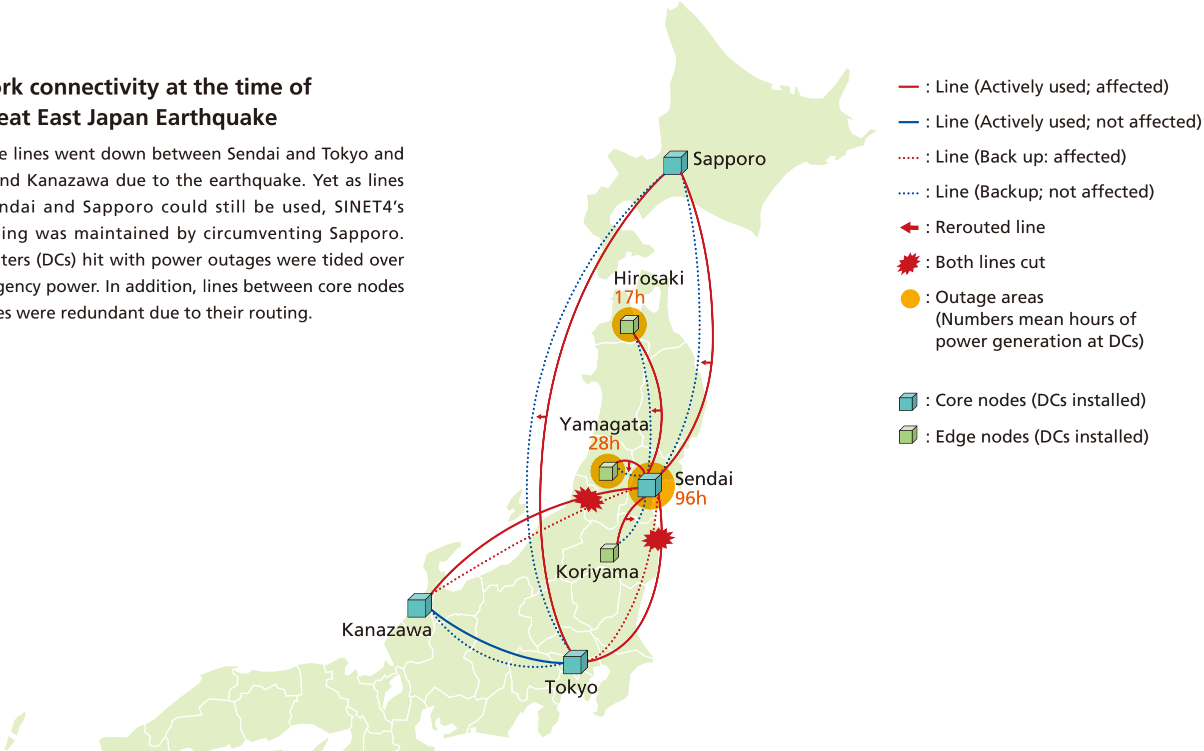
Redundancy designed for a large-scale disruption

Indeed,what has been changed in SINET4? Mr.Takano says: "With SINET3, data centers had been set up in 12 main bases, including Tokyo and Osaka, and core nodes were installed. From there, users could be accommodated through edge nodes at 62 universities nationwide. Thus, if network failures occurred with the edge nodes, then they would have affected users downstream. Solving that problem was one of the goals of migrating to SINET4.

With SINET4, core nodes have been installed in eight data centers, while the edge nodes have each been reduced in number. Nodes have instead been installed in each of Japan's prefectures, along with having all the nodes put into data centers as a measure to deal with natural disasters and power outages. Furthermore, connectivity between a pair of nodes is redundant;

Network connectivity at the time of the Great East Japan Earthquake

Backbone lines went down between Sendai and Tokyo and Sendai and Kanazawa due to the earthquake. Yet as lines from Sendai and Sapporo could still be used, SINET4's functioning was maintained by circumventing Sapporo. Data centers (DCs) hit with power outages were tided over by emergency power. In addition, lines between core nodes and edges were redundant due to their routing.



two lines take different physical paths. In the latest disaster, the lines laid out along the Pacific Coast were lost; however, redundant lines that circumvented the Japan Sea coast and linked to Hokkaido were activated. By connecting Sendai to Tokyo through Hokkaido, we were able to offer regular network service. The access lines for users from the edge nodes also utilized the new technology that integrates dark fiber (see note 4 on page 3) and WDM technology (see note 5 on page 3)," he explained.

There was in fact a core node in Sendai, Miyagi Prefecture, which is located near the epicenter. However, it wasn't cut off and managed to function. Stability of the network, even in the event of a sudden earthquake, was definitely assured to SINET4's users. High Performance Computing Infrastructure (HPCI) is apparently considering using the high-speed lines offered by SINET4 for supercomputers and storage owned by 13 universities and research institutions nationwide. Yutaka Ishikawa, a director of Information Technology Center, the University of Tokyo, gives high marks to SINET4's fault tolerance.

"HPCI's goal is to jointly utilize the supercomputer resources distributed throughout the country. But key to this will be the high-speed networks across the nation. The fact that researchers on the outskirts of Tokyo don't utilize other regional resources stems from a communications speed problem. That is basically due to the considerable amount of time required to send huge volumes of research data they have on hand and to receive the results of their calculations. However, SINET can use 40 Gbps of high-speed line on a national scale, and furthermore, it can offer a stable service, as shown in the latest earthquake. It has a high level of reliability as a backbone, and feels very safe to use."

In the aftermath of the earthquake disaster

In addition, a big issue in the recent quake was insufficient electrical power. Even at the University of Tokyo, a 30% cut in power was implemented. Thus, operations of supercomputers at information technology centers degenerated, and we started to see users who were unable to utilize the systems. Prof. Ishikawa would like to utilize HPCI, which was mentioned earlier, to respond to these kinds of issues that occur in the aftermath of earthquakes.

"HPCI has yet to be constructed. Even so, concerning that part of the resources lacking due to the degeneration of operations of the University of Tokyo's supercomputer, we are currently making adjustments with the view of using a framework conceived through HPCI that would allow us to use the resources of the universities of Hokkaido, Kyoto and Kyushu. The shared start of HPCI was for the autumn of 2012, but the plan has been accelerated. From this point, we will be working on the linkages among organizations, such as making appropriate forms, etc., and we are starting work on drawing up rules at the central level. HPCI is not solely for users at the University of Tokyo. The utilization of a framework in a bottom-up approach from the users is expected to lead to an inherent approach to using HPCI and to make it easy to spread the idea of selecting the most appropriate resources from supercomputers nationwide, in line with the nature of users' research."

"We are facing a review of our infrastructure due to the recent earthquake," Prof. Ishikawa said.

"As a premise to maintaining our infrastructure, we must think about securing the essential systems that can be operated at nodes and about redundancy that would disperse them throughout a wide area. No matter what happens, that is the only move that will determine such a priority. The refinement of concrete countermeasures is being demanded. Also, I suppose that the most important thing is to inherit the countermeasures and never to forget them."

Mr.Takano points out the same issues.

"After the earthquake, many users have deployed new data repositories in Western Japan and are thinking of ways to disperse their data. In order to respond to those requirements, the SINET4 line from Tokyo to Osaka will be upgraded to 80 Gbps during the current fiscal year, and to a planned 120 Gbps in 2014."

The reliability fostered by recent experiences will clearly lead to greater and greater expectations toward NII from now on.

(Written by Kaoru Watanabe, April 19, 2011.)

Education, research and regional contributions developing from migration to SINET4

Full-fledged operation of SINET4 got under way in April 2011. Being a further development of SINET3, vast improvements to the network led to the realization of high speeds and stability. In particular, the installation of bases, called "edge nodes," in all the country's prefectures similarly allowed the use of high speed lines at universities and research institutions nationwide. We asked Akio Yuki, president of Yamagata University, about what changes SINET has brought.

A comfortable network environment realized by SINET4

"I think that universities have three roles. These are education, research and making regional contributions. At Yamagata University, we put particular efforts into education. We want to create a university with student education at the core. We strive to offer a place where students can study independently. Nowadays, the maintenance of a network environment is indispensable in fulfilling those roles. Regarding the rebirth of the old academic information network operated by the National Institute of Informatics (NII) from this April from SINET3 to SINET4, I have a lot of expectations, and I would like to express appreciation for the efforts that have been taken on it today," said the university president, commenting on his expectations for SINET4.

Akio Yuki

President, Yamagata University

SINET3 was connected to locations nationwide with high-speed line that had a maximum speed of 40 Gbps, and it offered network services to universities and research institutions nationwide via node universities established at various locations. However, those node connections tended to be concentrated in the Tokyo metropolitan region. Thus, there were as many as 13 prefectures that did not have node universities connected by high-speed line, leading to disparities by region within the network-connection environment. Yamagata Prefecture was one of these. It could connect through the University of Tohoku in Miyagi Prefecture but the line was thin, with a volume of 100 Mbps, and it became bottlenecked when the network was used."With the migration to SINET4, nodes were also installed in Yamagata Prefecture, and the disparities among regions were corrected. Furthermore, nodes were installed in data centers, assuring stability. Thanks to this, high-speed line will become available at this university from the spring, which I see as a big development," he says.

Supporting students' independent study by maintaining a telecommunications environment

The migration to SINET4 will enable the quick introduction and modification of network services, according to President Yuki.

"The University of Yamagata welcomes large numbers of foreign students from abroad. But due to the Great East Japan Earthquake, many of the students were evacuated to regions that get few earthquakes, and we also saw some return to their home countries temporarily. For these students, we hurriedly started offering the e-learning service, which allows the study of Japanese language even from an evacuation location or one's home when one is outside Japan. I was keenly aware that SINET4 was indeed a godsend, as it allowed us quickly to offer critical services at a critical time," he says.

In addition, services and businesses that had been implemented in the past are enhancing that content, he says.

"In order to quickly realize high speed and evenness in the treatment of cancer in the Tohoku region, this university developed the "Tohoku Cancer EBM Project" in fiscal 2008, mainly in medical departments. In particular, we're offering a re-education system not just for universities and research institutions but also for doctors employed at regional hospitals, with the goal of educating and training health providers who are tasked with cancer treatment. This content has come to our university as well, and in addition to research and attending lectures, lectures are available that use e-learning system classes, which feature question-and-answer sessions and which allow interaction. Doctors and many other people at medical institutions have been taking part. I expect that the recent migration to SINET4 will lead to an enhancement in lecture content and that the classes will start being offered to more people who want to take them," he says, explaining the future plans.

"I think this will be useful in vitalizing joint research and academic exchanges with people overseas. One example of joint research is with the European Organization for Nuclear Research (CERN), which is based in Geneva, Switzerland." Equipped with a circular-shaped accelerator with a circumference of 27km, CERN is the world's largest particle-physics laboratory, and it has forged agreements involving joint research with Yamagata University. "A plan is in progress with CERN to have interactive lectures via high-resolution video, and for SINET4 would be indispensible for realizing this as well."

Along with ending regional disparities among network environments, the migration to SINET4 has also enabled the availability of a rich academic environment for students and researchers, regardless of whether they are at home or abroad.

"Area Campus Mogami" of Yamagata University

Yamagata University is actively involved in cooperative efforts with regions. "Area Campus Mogami," which is being developed to tie together regional facilities with the university, is one such example.

Participating in regional communities supported by networks

Being the only state-run university in its prefecture, Yamagata University is working on forging ties with regional industries to make cultural contributions to the region. One of these is the "Area Campus Mogami." Yamagata Prefecture's Mogami region, which has nurtured a distinctive culture in the mountains and hilly regions that line the Mogami River, is an area of farming and mountain villages blessed with abundant nature. Even so, the region is grappling with the problem of depopulation.

"Area Campus Mogami" is involved in developing the campus from a soft approach, through network connections between Yamagata University and facilities belonging to this region's cities, towns and villages. Using students' expertise and interests as a starting point, this has been launched as a linkage model for realizing regional cooperative efforts with universities, as it shares local resources with teaching staff and residents of the region. About 200 students participate annually, he says.

"These activities did not stop with regional linkages created through the network, but they also developed into an opportunity for students to have direct experiences with regional industries and culture by having the students leave the classroom, go out and have farming experiences or help out with festivals. Furthermore, these experiences were shared via the network, and we are seeing the development of the activities being passed for the following years. This was an experiment that linked depopulated regions with postsecondary institutions via a computer network, and it is now becoming an indispensible part of vitalizing regional communities."

Maintaining a network environment, including using the network for lifelong-learning and extension programs for prefectures' residents, is attracting attention of not just the universities, but of the residents themselves and surrounding regions.

The operation side also has expectations for SINET4's countermeasures. In particular, the SINET4 network managed not to go down during the recent Great East Japan Earthquake, and the sense of security fostered by the network is being bolstered, even for disasters. Now that the network plays a critical role for regional communities, the high level of SINET4's fault tolerance has become extremely assuring as a preventative safeguard. "In fact, through the experience of the disaster, problem points of countermeasures for malfunctions at the university became clarified. In order to take advantage of the merits of SINET4, which stands up well to malfunctions, efforts are under way on countermeasures, even at this university, including the installation of uninterruptable power-supply systems and generators."

The current migration to SINET4 can also serve as a good opportunity to vastly develop the regional network environment, according to President Yuki. "We must think about ways of utilizing SINET in whatever ways possible. It will be important to bring in the world's expertise to the regions and to convey regional power to Tokyo, Osaka and other metropolises. In order to offer a rich academic environment to students at this university, huge expectations will be directed at NII in the future as well," he says.

(Written by Kaoru Watanabe)

NII ESSAY

The true value of researchers is now being held accountable after the Great East Japan Earthquake in 2011

Asanobu Kitamoto
Associate Professor, Digital Content and Media Sciences Research Division, NII

The Great East Japan Earthquake took place on March 11, 2011. While I offer my deepest sympathies to those who have suffered or continue to suffer from this disaster, I pray that the day when we can see the future comes not a moment too soon. Even though I was personally not directly affected by the disaster, I harbor a huge sense of shock, even now, and I feel that the world before 3/11 was in the distant past. The earthquake has confronted me anew with the question, "What am I researching for?" How will the new knowledge gained during the last earthquake be effectively used in Japan, now said to be in a period of higher seismic activity? Amid an outlook of electricity shortages for a prolonged period, how should the electricity for research equipment be effectively used? Furthermore, how can we reform Japan in the aftermath of 3/11? We have arrived at a time when Japan's researchers are being held accountable for their true value.

The difficulty of prompt action in the early stages

On the day the big earthquake struck, I spent the entire night in a conference building, being one of those people who couldn't make it home. Information had already become chaotic, and I was overwhelmed by the massive amount of information being circulated. However, data management in times of emergencies was part of my research projects. In order to exploit research findings to fit to the emergency situation unfolding before my eyes, I went in rapid-reaction mode and started to engage in information gathering. Earthquakes, tsunamis, and then the nuclear accident: The real world was undergoing rapid changes.

In hindsight, the thing that gave me an acute sense was the fact there was no choice but to use the knowledge and tools on hand to their fullest extent during that early stage. Procuring knowledge and creating useful tools in reaction to the very real events cannot catch up on the rapid change of reality. I will summarize the lessons learned from the earthquake and its aftermath so that our knowledge and tools can be instantly deployed in times of emergencies. I believe this is what needs to be done as a precaution for the next disaster.

Let's share researchers' knowledge as we look toward recovery

The long-term recovery efforts are currently fully underway. However, there was an immense number of assorted problems created by this large-scale disaster, and there are multiple and multifaceted issues surrounding them. Researchers from numerous disciplines need to come together, leverage the expertise of their own, and share their wisdom to provide solutions. The specialized knowledge provided by only a single researcher has its limits if we look at the immense scale of the problems. We need to come up with new solutions after marshalling our efforts, based on the common objective of solving the problems.

The Great East Japan Earthquake is without a doubt a rare large-scale natural disaster in Japan's history, although there is also the aspect that numerous instances of inaction led to a great extent of the damage. I hope that this inaction is not repeated and that a large number of researchers actively strive to resolve the problems resulting from the Great East Japan Earthquake so that society's trust in research will be enhanced.

Weaving Information into Knowledge

NII

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TEL:+81-3-4212-2131 FAX:+81-3-4212-2150
e-mail: kouhou@nii.ac.jp

Cover illustration

SINET3, which was used widely as a platform to support academic research, was reborn on April 2011 as "SINET4." The new SINET4 has become a faster and more stable network and it offers a full range of services. What is more, the recent Great East Japan Earthquake was a testament to its ability to endure disasters.