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NII Interview

SINET—Connecting Japan's Knowledge

Achieving innovation that establishes a data-centric society

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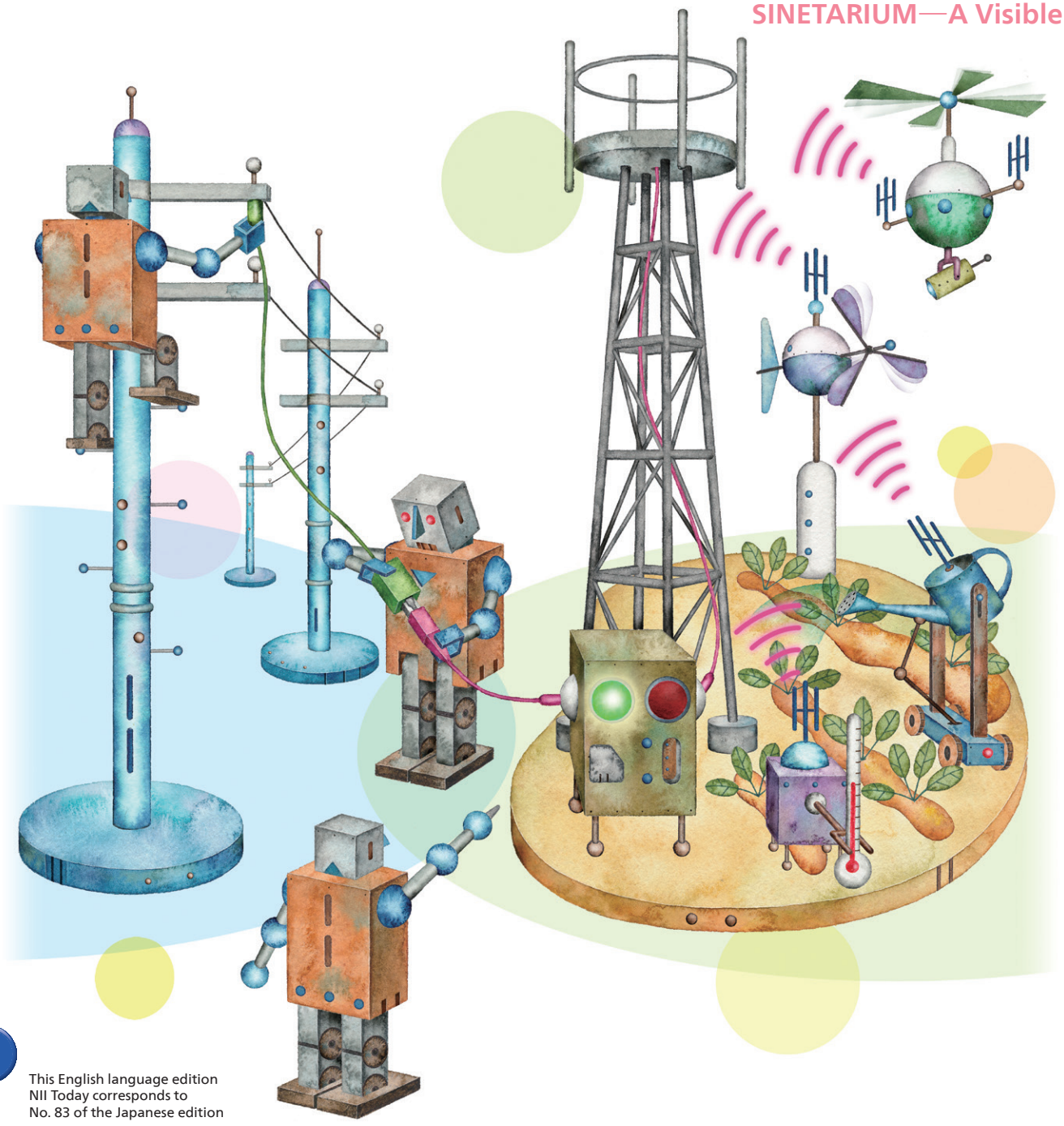

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SINET—Connecting Japan's Knowledge

Achieving innovation that establishes a data-centric society

Shojiro Nishio
President, Osaka University

Masaru Kitsuregawa
Director General, National Institute of Informatics

Interviewer:
Keiichi Murayama
Nikkei commentator

The academic information network, SINET5 (Science Information NETwork5), built and operated by the National Institute of Informatics (NII), continues to evolve by, for example, connecting directly to mobile communication environments. Using this information infrastructure that is spread across Japan, Osaka University has launched an enormous project that aims to create innovative services in health-related fields. How should we view Japan's challenges and potential so as to emerge as an innovative nation? We talked to NII's Director General Masaru Kitsuregawa and President of Osaka University Shojiro Nishio.

What is Osaka University's definition of Life Design Innovation?

Murayama Could you explain more about the Initiative for Life Design Innovation (iLDi) Project at Osaka University?

Nishio One of Osaka University's strengths is medical care. We have a network of hospitals in the prefecture of Osaka, including the Osaka University Hospital. This allows all of the medical data contained in clinical records and the like (electronic health records: EHRs) produced at the 19 affiliated hospitals to be collected at the university in a unified format. This has great significance, and overseas researchers consider this data to be world class. We wanted to use this data to discover knowledge in the field of health, so we applied for the Research Hub Support Project for the Realization of Society 5.0, newly launched by the Ministry of Education, Culture, Sports, Science and Technology, and our research hub, iLDi, was selected.

Masaru Kitsuregawa

Osaka will host the World Expo in 2025. The theme is "Designing Future Society for Our Lives." Osaka University itself is keen to take advantage of its strength in medical care to promote a variety of research with "life" as a central theme. With the progression of IoT (Internet of Things) technologies, we don't stop at collecting EHR data, but are more and more rapidly becoming able to gather personal health records (PHRs) that include information such as blood pressure and heart rate. Furthermore, it is becoming easier to collect data on the daily activities of living and time series information telling us what a person is doing every day. An EHR or PHR to which this kind of data has been added is called a personal life record (PLR), and we want to promote the health of people's bodies and minds by creating unprecedented life design innovation based on PLRs. In addition to health and medical care, we want to investigate states of learning and enjoyment. Ultimately, this is an immense project that will realize improvements in QOL (quality of life) and healthy longevity.

Osaka University couldn't do this alone. For this huge undertaking, 14 universities from across Japan, RIKEN, Osaka Prefecture, Osaka City, the Kansai Economic Federation, the Osaka Chamber of Commerce and Industry, and twenty businesses are involved. We are targeting students and faculty on Osaka University campuses first, but our ultimate goal is to implement the project at the World Expo.

The Role of SINET in Society 5.0

Murayama What specifically do you expect to implement by 2025?

Nishio Although it is quite difficult to predict five years ahead in the field of information, I think that perhaps the ambient services that collect surrounding data without people having to take any action and provide warnings or information about current situations in a natural, discrete way will mature.

Looking back on the paradigm shift of our networked society, the advent of the Internet led to most people in the world connecting to each other. The ubiquitous era is next: "anybody,

anywhere, anytime." We have been freed from the constraints of time and space. In contrast, Society 5.0 is an environment in which necessary support and services are meticulously implemented so people can live in comfort. It is the "for the present, for society, for all of us": the embodiment of an ambient society. It can be described as the ultimate computing environment, in which people don't need to take any independent action. I think that these kinds of services will be implemented in the areas of wellness, lifestyle, and edutainment (multimedia and content aimed at learning while having fun) by around 2025. This will be a milestone of any networked society and will require huge amounts of data.

Murayama In that case, the role played by SINET, as a data infrastructure, will grow.

Nishio Our project is currently underway in the Kansai region of Japan, but rather than being confined to this region, we aim to make it our success story by expanding it to the entire country in the future. SINET is the only infrastructure for this kind of nationwide expansion. Partnerships with private companies will also be necessary, and SINET is hugely significant in terms of promoting cooperation. SINET is really the lifeline, the main artery. Now that SINET provides a mobile environment, it will be possible to transfer huge amounts of data and also collect information easily.

Society will be supported by powerful networks, data, and research

Murayama Now that SINET has been strengthened with a focus on mobile capability, where does SINET's advantage lie?

Kitsuregawa To put it simply, households have a communication speed of 100 M (mega) bps, whereas SINET is roughly 1,000 times faster at 100 G (giga) bps. The existence of huge amounts of data is the core of Society 5.0, and this makes SINET an essential infrastructure. Osaka University's iLDi Project is collecting "lifelog" records as well as health records. Compared to occasional blood test results, information on the medicines that people are taking, etc., the amount of data about people's everyday lives will be far greater.

A huge amount of data will also come from numerous installed cameras. Rather than activities being confined to Osaka University, a style of collaborative research in which professors at various universities access the data must be enhanced. SINET is the only means of making this a reality. I want it to be regarded as an extremely powerful infrastructure.

In Society 5.0, data will come from everywhere. We must build a network capable of absorbing this data. That is why we have introduced mobile and LTE, and launched a new service. We have already had many approaches and applications. This kind of network will build the future era of Society 5.0. Osaka University is a pioneer in that it has created the Institute for Datability Science to promote data use, and I think that it will explore diverse applications.

SINET will energize Japan by providing a 100G network that people can use without any restrictions related to location, even at rural universities. We will also continue to introduce 400G lines and strengthen international lines. Japan is the only country to have such a powerful network. By promoting this network and advancing data-driven research, we will support future society using data. That is our approach to Society 5.0.

Murayama So, the SINET infrastructure and the projects that are developed upon it, such as Osaka University's project, will move forward in tandem, right?

Nishio SINET connects about 900 academic research institutions in Japan, and the number of users exceeds three million. I feel that the current SINET5 will revolutionize the governance of research at Japanese universities. I heard from a prefectural governor that collaboration with a university in his prefecture has resulted in AI being successfully implemented in agriculture. The university is connected to SINET, so it can share AI-based agricultural data with other universities via SINET and expand its creative activities throughout Japan without being restricted geographically. Up until now, there were few examples of joint research based on data. Going forward, universities nationwide will be able to put their combined efforts into creative activities based on the idea of data as constituting a valuable asset. SINET is essential infrastructure for that.

Creating new research models using NII's two pillars of research and OT

Murayama As we enter an era of turbulent environmental change, Japan is facing many social and economic challenges. Pulling together knowledge to solve these problems is becoming increasingly important, but is momentum for collaboration between universities building?

Nishio The awareness of the younger generation in particular is changing, and momentum is building. If we build systems for managing data in the cloud and develop security measures properly, researchers' work will not be disrupted even if they move from one university to another. It will also become possible to cross-link data from different fields.

Kitsuregawa NII is a research institute, so it naturally conducts research, but it also has business activities and operates SINET.

Shojiro Nishio

Completed a doctoral degree (Doctor of Engineering) at the Graduate School of Engineering, Kyoto University, in 1980. Data engineering is his area of expertise. Worked in posts such as research associate at the Faculty of Engineering, Kyoto University, before becoming a professor at the School of Engineering, Osaka University, in 1992, and a professor at the Graduate School of Information Science and Technology, Osaka University, in 2002. Prior to current post (from August 2015), served in various positions at Osaka University including Founding Director of the Cybermedia Center, Dean of the Graduate School of Information Science and Technology, and Executive Director / Executive Vice President. Has received numerous awards, including the Medal with Purple Ribbon in 2011, and was named a Person of Cultural Merit in 2016.

Organizations like this with two main pillars are rare, even if we look globally. SINET's services are not implemented by asking one vendor to provide everything. NII builds and operates the system by procuring optical fibers called dark fibers and then procuring transmitting and receiving devices at both ends of these fibers from different vendors and putting the various components together. It really is "handmade." This kind of OT (operational technology) experience is valuable. By actually being involved in operating the network, we gain expertise that could never be obtained by asking a single vendor to do it all, and we gain an intuitive sense of usage trends, technical issues, and the future direction.

We recently launched a security service. We put in place a system to protect institutions, primarily about one hundred national universities, from cyberattacks. This began operating in July 2017 and has been well received. Around the time that I was appointed as Director General of NII, I asked university professors what they wanted from NII, and a huge number requested security services. I decided that NII would offer the services that it should provide, rather than the services it wants to.

In Japan, there are many cryptography researchers but hardly any cybersecurity researchers. Why? Because there is hardly any data to serve as research material. Starting next year, we plan to start providing researchers with attack pattern data and sanitized malware obtained from SINET. Training professions in cybersecurity is a major challenge, and we are aiming to solve that fundamental issue. Of course, NII's security center also accepts and trains people from various universities, but having business activities where security is actually implemented is extremely important.

Even YouTube didn't have a business model in the beginning. They were offering a large number of videos, but didn't start generating a profit until much later. Rather than trying to put out a finished service from the outset, the trend in IT is to go through a cyclical process in which a service is launched little by little and improved as suggestions are received from users and numerous discussions are held, and this process is more fitting for an inter-university research institute.

What will become of innovation in Japan?

Murayama As well as solving social issues, Society 5.0 has the ambitious goal of simultaneously growing the economy. However, there is a debate about whether Japan has sufficient innovation capability. Currently, the USA and China have strong presences in the field of IT, and it seems difficult to find a Japanese product or service that is changing the world.

Nishio Taking the field of information and communications as an example, in research such as AI (artificial intelligence), there is considerable strength in numbers. China has an unimaginable number of researchers as compared to Japan. Even with our lesser numbers, Japan must come up with a way to leave its mark on the world. If we take an approach of valuing the implementation of AI and big data analysis technologies in society, the possibilities of creating innovation lie in the fields where these advanced technologies are applied. Take, for example, the next generation of communication: the 5G network. Although the USA and China could be considered competitors, as we approach the implementation phase of 5G, it could be said that Japan is leading the way, as 5G infrastructure has been properly built and can be put into practical use without any problems here. Using SINET's framework, we will successfully integrate the latest AI, big data analysis, and IoT with 5G. This is the way that I hope Japan will strive to develop innovation.

People make innovation happen. The employment situation for university graduates is gradually changing. Bill Gates and Steve Jobs—great innovators in the field of information—launched venture companies instead of entering employment after graduating from university. Top graduate students in the information field, even at Japan's leading universities, no longer list joining a major corporation as their highest priority. Many are starting their own businesses. Though this trend may be lagging behind the USA, it is becoming a reality in Japan. In AI venture companies in particular, there is a growing trend towards driving global innovation. An environment conducive to starting businesses has developed, and I think that it is particularly easy in the field of information.

Looking back at the history of universities, the term "University 1.0" applies to universities in the Middle Ages. The University of Bologna in Italy and the University of Coimbra in Portugal during those times, for example, focused on professional training based on classical research and education. The second generation, University 2.0, began with the University of Berlin established in 1810. This university implemented education with a focus on research. It established the chair system, and this was also adopted by the Meiji government in Japan. University 3.0 began in 1876 with Johns Hopkins University in the USA, where the world's first graduate school system was established. The objective of establishing graduate schools was to collaborate with industry —in other words, contribution to society.

In contrast, what I call "University 4.0" refers to universities engaging with society to develop creative activities: co-creation with society through universities. If universities and society collaborate a little more closely than they currently do and work together in fundamental areas, there is the potential for new innovation to emerge.

Murayama So you're saying universities have changed with the demands of society, and what is being demanded now is innovation that serves society.

The humanities are necessary for innovation

Murayama In concrete terms, how can we make innovation happen?

Nishio Three steps are required to make innovation happen. Science and technology are vital for the first step, and unfortunately Japan has stopped there. Understanding what users want is the second step. Think of the cell phones of the past. It was predicted that cramming them with every possible function would make them sell well, so they were made multifunctional; however, a cell phone for the elderly equipped with only the same functions as a desk telephone has become a huge hit among older people. The third step concerns legislation. There must be no regulations that cause manufacturers to hesitate to create products. I think that we need to think about these three steps and develop professionals to work in these areas.

What is important going forward is to develop students with a grounding in the humanities so that they understand legislation and will tenaciously achieve international standards. Unless this is done consistently, the emergence of innovation in Japan will be in jeopardy. We cannot compete if we only have representatives

in the natural sciences. Representatives in the human and social sciences are essential because the problems we have to solve to make innovation happen are so complex. Looking at the Sustainable Development Goals (SDGs) set by the United Nations too, it is important that the human and social sciences take the lead and involve the natural sciences. I think that this course of action might be called for in Japan's 6th Science and Technology Basic Plan starting from FY 2021.

NII aims to be unique to Japan

Kitsuregawa I am a naturally optimistic person, and I think that Japan will be fine. Admittedly, we have become an affluent country and some complacency has set in. In the past, we had engineers like Fujitsu's Toshio Ikeda, who decided to manufacture computers in an era when there were none in Japan. Sony and Honda were also born. Why don't we see people like those nowadays? Perhaps universities need to re-examine how they inspire students. Also, I see a disproportionate emphasis on the race to get papers published in the top journals as a fundamental problem. It is not the only problem, but the idea of "publish or perish" has persisted for a long time.

Nonetheless, I think that Japan has valuable assets that Google, Facebook, and others do not possess. We have to compete using assets unique to Japan. An obvious example is that Japan is the only country with approximately 70,000 centenarians. Only in Japan are so many elderly people living healthy lives. Western countries can talk about longevity, healthy life expectancy, nursing, and so on, but the only country that can substantiate it is Japan.

Quality is important when it comes to data. We established a research center for medical big data. In Japan, 12 million endoscopies are performed annually. Most of the medical images are collected, and powerful data sets are emerging in Japan. The USA and China do not have anything similar. NII's Center has already collected more than 10 million medical images and is promoting the development of AI. The point that I want to make is extremely simple. As a general principle, we don't aim to be number one. If there is a number one, there has to also be a number two and a number three. There is nothing to be gained by playing that kind of game now. We aim to be unique to only Japan. We might fail, of course, but I think that even Soichiro Honda, the founder of Honda Motor Co., Ltd., must have been prepared for a certain degree of failure. It's important to take on challenges when there's a chance to win big.

Next-generation SINET is crucial for integrating data science and computing science

Murayama What is expected from the next-generation infrastructure SINET6?

Nishio SINET has rapidly become a strong system and has quickly reached 100G. Uniting this with co-creation activities is very important. Collaboration with science based on big data and computing science using supercomputers is expected to enhance SINET's functions even further. Japan's supercomputing centers are already connected to SINET, but the creation of systems and environments linking them more closely will form a foundation for further advancing Japan's academic level. As computers performing quantum computing are also connected to SINET and data is becoming increasingly cloud-based, an environment in which data science and computing science develop synergistically will be established, and SINET will become the world's leading network.

Kitsuregawa The integration of data science and computing science is unavoidable. Also, computers for machine learning will become increasingly important. Talented students on the west coast of the USA are choosing which companies they want to work for according to criteria such as how much data and computing power they have. That is why the British company DeepMind was acquired by Google and why Professor Hinton of the University of Toronto joined Google to make deep learning a reality. Under these circumstances, the role played by SINET, which can be described as a transport route for data, the fuel of AI, is continuing to grow, and with our focus always on the cutting edge, we intend to develop new data services along with 5G.

(Photography by Yusuke Sato)

A Word from the Interviewer

With its groups of corporate giants such as GAFA (Google, Apple, Facebook, and Amazon), the USA leads the global IT competition. China is in pursuit with a national commitment to AI development. Japan tends to be overshadowed by these two big players, but can it regain its strength? Although they expressed it in different ways, the answer from both the President of Osaka University, Shojiro Nishio, and NII's Director General, Masaru Kitsuregawa, was "Yes." Taking the example of medical care, as a country with a population that has a long lifespan, Japan has a wealth of data on elderly people in good health, and the intellectual capital of universities and companies can be brought together using infrastructure such as SINET. Japan certainly has the potential to create value that no other country can imitate. As I listened to this discussion, I felt more and more optimistic.

If a successful model could be created in Japan, it would sweep away the mood of stagnation and turn the tide. The entrepreneurial spirit of the people involved is being tested again.

Keiichi Murayama

Graduated from the School of Law, Tohoku University, in 1992, and joined Nikkei Inc. in the same year. In the Industry Department, covered areas including IT/electronics, automotive, and medical news. After studying abroad at Harvard University and working at the US Silicon Valley Bureau, became Senior Staff Writer in 2012. Also served as Editorial Writer from 2015. Assumed present post in 2017. Responsible for IT and startups. Most recent book is *Startup Kigyoka no Riaru* (The Real Lives of Startup Entrepreneurs).

The Past and Future of SINET (Science Information NETwork)

Sending and receiving greater volumes of data faster and more securely

Shigeo Urushidani

Deputy Director General, National Institute of Informatics / Professor, Information Systems Architecture Science Research Division / Director, Cyber Science Infrastructure Development Department / Director, Research and Development Center for Academic Networks / Professor, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies

The Science Information Network SINET5 has evolved significantly. In FY 2018, international lines were strengthened to connect to Europe and Asia, as well as the USA, at 100 Gbps. In addition to building an environment for fast transfer of research data internationally, NII started operation of the Wide-Area Data Collection Infrastructure connected directly to a mobile communication environment. This has made possible more extensive collection and use of research data. I asked Deputy Director General of NII, Shigeo Urushidani, who is also Director of the Research and Development Center for Academic Networks, about the past and future of SINET—the network that supports Japan's cutting-edge research.

Essential academic information infrastructure

SINET (Science Information NETwork) is an information communication network built and operated by NII as academic information infrastructure for universities and research institutions throughout Japan.

All 47 of Japan's prefectures are connected by 100 Gbps lines. The nodes are connected in a mesh-like pattern allowing shortest-path connections, and minimization of latency is a major advantage. The network has both the robustness to immediately change the path when there is a malfunction and the flexibility to allow the introduction of new services simply by configuring the nodes at each end.

More than 910 institutions are currently using SINET, including all of Japan's 86 national universities, as well as other public universities, private universities, junior colleges, colleges of technology, inter-university research institutes, and independent administrative institutions. SINET is also interconnected to many overseas research networks, including America's Internet2 and Europe's GÉANT, making it essential for the smooth distribution of academic information, not only in Japan but internationally.

Shigeo Urushidani

The history of functional updates

Operation of the academic information network that would become the predecessor of SINET began in 1987. In 1992, the service was launched under the name SINET as an Internet backbone linking 29 locations. In 2002, Super SINET connecting 14 locations with a maximum bandwidth of 10 Gbps using optical transmission technology began operating in parallel.

Launched in 2007, SINET3 inherited the characteristics of SINET and Super SINET, and the service was diversified by making it compatible not only with IP services but also with L2VPNs (Virtual Private Networks) and QoS (Quality of Service) control. Nodes were deployed in 34 prefectures, and Tokyo and Osaka were connected by 40 Gbps lines.

In 2011, nodes were deployed in all 47 prefectures and the network evolved into SINET4, which connected Sapporo to Fukuoka via 40 Gbps lines. High reliability was achieved by installing nodes in data centers, duplicating lines, and securing redundant pathways between core nodes, and when the Great East Japan Earthquake struck in March 2011, services could be maintained without any interruption to the network.

The current SINET5, launched in April 2016, ensures sufficient bandwidth for cutting-edge research, regional revitalization, and so on, by connecting all 47 of Japan's prefectures at 100 Gbps,

and the network organically connects clouds, academic content, security equipment, etc.

Achieving both high performance and high reliability

Deputy Director General Shigeo Urushidani, who also serves as Director of the Research and Development Center for Academic Networks, has worked to evolve SINET based on requests from universities and research institutions. He explains the features of SINET5, a high-performance highly reliable network, as follows:

"Not only does it cover the whole of Japan with 100 Gbps connections, but it also makes high-performance communication possible by minimizing latency between any nodes. In addition to Internet services, users can benefit from a wealth of communication services such as VPN services that implement secure communication environments and on-demand services that establish communication environments flexibly. SINET5 is unique in that users can rapidly get diverse high-performance communication environments at low cost with only having their access lines."

Robustness is also a major advantage. Each SINET5 node is installed inside an earthquake-resistant data center with an exceptional power supply, and redundant configurations are implemented hierarchically in the optical transmission layer, packet transmission layer, and IP layer. Service diversification is supported by implementing the Internet, VPN, on-demand services, etc., using a logically isolated network. Also, both high performance and high reliability are achieved in the packet transmission layer by connecting each node by a shortest path and redundant paths.

Japan has suffered a series of major natural disasters in recent years with the Kumamoto earthquakes in April 2016, heavy rainfall in Hokkaido in August 2016, heavy rainfall in western Japan in July 2018, and the Hokkaido Eastern Iburi earthquake in September 2018. Optical fibers were severed as a result of each of these disasters, but SINET5 continued to operate stably by instantly switching paths.

Towards next-generation SINET

SINET5 has undergone major evolutionary advances.

One is the strengthening of international lines. Tokyo and Los Angeles (America) were already connected by a 100 Gbps line, but in March 2019, Los Angeles and New York were also connected at 100 Gbps. In February 2019, Tokyo and Amsterdam were connected by a 100 Gbps line, as were Amsterdam and New York (see figure).

"Adding to the Atlantic Ocean line means that even if the Pacific Ocean or European line was severed, we would continue to be connected to the USA and Europe, and it also allows load balancing according to fluctuation in demand," says Deputy Director General Urushidani. Links with Asian countries were also strengthened by connecting Tokyo and Singapore via a 100 Gbps line in March 2019.

Another evolution is operation of the Wide-Area Data Collection Infrastructure connected directly to a mobile communication environment since December 2018. SINET-dedicated virtual networks were built within the mobile networks of three carrier companies. By directly linking this mobile communication

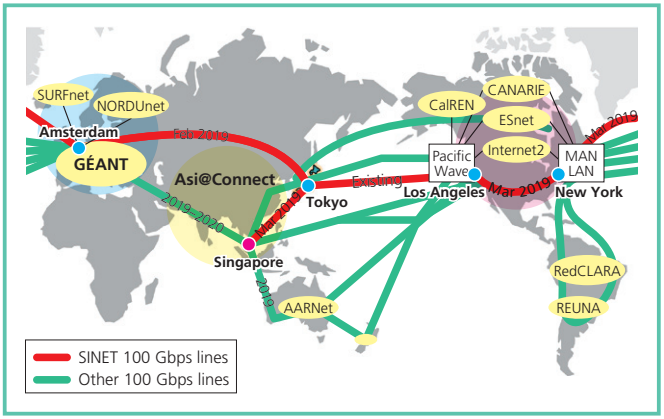


Figure SINET's international lines (end of FY 2018). Japan–US cooperation, such as Belle II, strengthened by a 100 Gbps line to the US, Japan–Europe cooperation, such as LHC, strengthened by a 100 Gbps line direct to Europe, and cooperation with Asian countries strengthened by a 100 Gbps line to Asia.

environment and the VPN services provided by SINET5, it has become possible to collect research data directly from areas that cannot be connected by wired network lines and remote locations such as at sea. Operation for verification of functions and performance is currently underway with 31 topics selected from 22 organizations in the fields of agriculture, forestry, and fisheries, natural infrastructure, medical care/life sciences, social systems, and information infrastructure.

"The SINET-dedicated virtual networks are isolated from the Internet and VPNs are formed within them for each research project, making it possible to use mobile features in an extremely secure communication environment. Speeds are still low, but the next step is to provide compatibility with 5G, which should solve this problem," says Deputy Director General Urushidani.

The introduction of 5G is scheduled for FY 2020, and implementing a mobile environment capable of rapidly transmitting large volumes of data and high-resolution images will make a wider range of uses possible and broaden research.

The installation of a 400 Gbps line connecting Tokyo and Osaka is also scheduled for FY 2019. This will be the world's first installation of a long-distance line that makes the enormous bandwidth of 400 Gbps freely available.

"There is vigorous use related to supercomputers between Tokyo and Osaka, and the 100 Gbps bandwidth is sometimes used up, so the aim is to improve this."

Specific developments in the next version of SINET are unclear at this point, but it appears that installation of 400 Gbps lines nationwide and 1 T (tera) bps lines between some locations will be considered. Also, the network will evolve based on the demands of universities and research institutions, such as accommodating new services by introducing the functionality of edge computing. Following interviews with each university and research institution, the basic concept for the next version of SINET will be solidified in FY 2019, and the service will start in FY 2022.

SINET continues to evolve as academic information infrastructure. Its role in providing reliable support for Japan's advanced research activities remains unchanged.

(Interview/Report by Katsuyuki Okawara, Photography by Tadashi Aizawa)

Start of SINET Wide-Area Data Collection Infrastructure

Science information network required in Society 5.0 era

How can academic research contribute to realizing the advanced people-centered information society of Society 5.0? To answer that question, NII has built the SINET Wide-Area Data Collection Infrastructure and started demonstration testing using a mobile communication network. As a result, NII hopes to provide advanced examples of a data-driven society in which the physical world and the cyber world are seamlessly connected. We asked Research Professor Koji Sasayama, who has been instrumental in building the infrastructure, about the new service.

Koji Sasayama
Research Professor, Research and Development Center for Academic Networks, National Institute of Informatics

Q Please tell us about the SINET Wide-Area Data Collection Infrastructure.

A SINET is a science information network that has been provided to universities and research institutions since its launch in 1992, and has been continually improved. The new Wide-Area Data Collection Infrastructure connects a mobile communication environment directly to the fixed SINET (see figure).

Japan is currently aiming for Society 5.0, a society in which data are used for the benefit of people. To achieve this, it is first necessary the collect data. Without big data, it is impossible to find new value in the promising next-generation technologies of IoT and AI.

Connecting a mobile communication environment directly to SINET has made it possible to collect data from a much wider area than ever before. Data can even be collected from remote locations in the mountains or at sea. Mobile terminals were successfully connected to SINET before now, but because connections went via the Internet, there were risks such as viruses. In the Wide-Area Data Collection Infrastructure, closed networks are built by connecting SINET's virtual private network (VPN) and the mobile communication environment directly. This makes it possible to collect data securely.

Q What developments will the new infrastructure bring to academia?

A In the world of wireless communication, there is a buzz surrounding the launch of 5G in 2020. With 5G, communication speeds will increase to 10 Gbps. This will allow trouble-free viewing of 4K video, and the fact that such fast communication will be possible wirelessly is astonishing. In addition, 5G will be able to handle one million devices within an area of one square kilometer and will have a transmission and reception latency of less than one millisecond. This improvement in communication capability will result in further development of the IoT society, in which everything is connected to the Internet, and for example, will make safe autonomous driving much more likely. Other innovative applications may emerge, but the truth is that industry is concerned about how 5G can be used effectively in business, and mobile carriers are concerned about how they will provide services for their customers' diverse applications.

Meanwhile, the academic community of Japan includes the finest minds in the world and is overflowing with ideas about 5G applications. However, currently, not all researchers with groundbreaking ideas have sufficient research infrastructure resources, so research that involves collecting and processing huge amounts of data is not being carried out quite as efficiently as it could be.

That is why we decided to bring the two together. We explained the purpose of the Wide-Area Data Collection Infrastructure to several carriers and cloud service providers, and asked them to provide data processing environments under academic conditions. Combining these environments with NII's data collection infrastructure and transfer network will allow researchers to work on groundbreaking research themes easily and efficiently (see Page 9). The aim is for the research results obtained here to lead to revitalization of industry, so this can be regarded as part of academia's efforts to help implement Society 5.0.

Q Demonstration testing has already begun, hasn't it?

A Since December 2018, 31 topics have been selected and testing has started. Of particular note is the large number of topics related to agriculture, forestry, and fisheries. The availability of mobile communication has resulted in fields that were until now unrelated to computing and communications becoming involved (see Page 10).

We are still looking for ideas and continuing to take applications for demonstration testing themes, and we hope that as many topics as possible will be demonstrated in this period up to March 2020. If groundbreaking research results are obtained from those themes, the significance of the new service will be validated. Furthermore, if this generates businesses or collaborations between industry and academia that can benefit society, it could take us a step towards the data-driven society of Society 5.0.

(Interview/Report by Akiko Ikeda, Photography by Tadashi Aizawa)

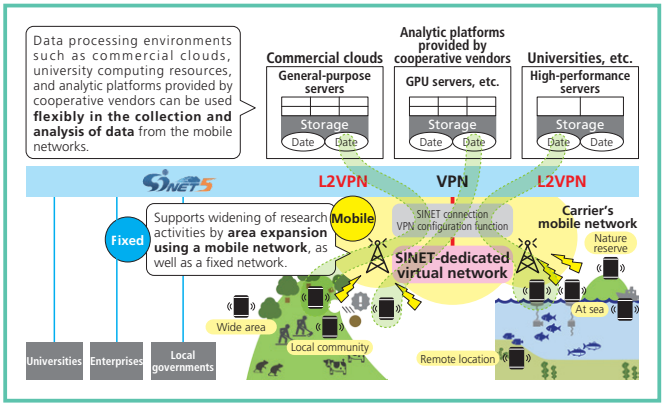


Figure Mobile networks allow data to be collected from remote locations. The collected data enters SINET directly and is sent to a data processing environment, such as a commercial cloud, which means that the data is always in a secure environment.

Commentary

What is the Wide-Area Data Collection Infrastructure?

The first mobile service provided by SINET, the Wide-Area Data Collection Infrastructure, is an academic network service with the following four characteristics. ① Receives radio waves from the three major domestic mobile carriers to expand the area of research activities, with the aim of promoting burgeoning IoT-related research; ② provides a secure environment by forming a SINET-dedicated closed virtual network that is isolated from the Internet; ③ creates a virtual private network for each research project, allowing secure high-performance transfer of research data; and ④ provides diverse computing environments for processing the collected/transferred research data.

It is not enough to simply *collect* IoT-related data. Value can only be created after massive amounts of data have been *accumulated* in an easily retrievable format, *shaped* into a form suitable for analysis, and *aggregated* with existing data. Therefore, a data processing platform equipped with these functions is necessary. Furthermore, a cycle must be constructed in which the *analysis* results are *visualized* and displayed in such a way that they can be understood by researchers, after which the data is processed to *verify* the contents, additional data to be *collected* is identified, and these are fed back to the next data use (Figure 1).

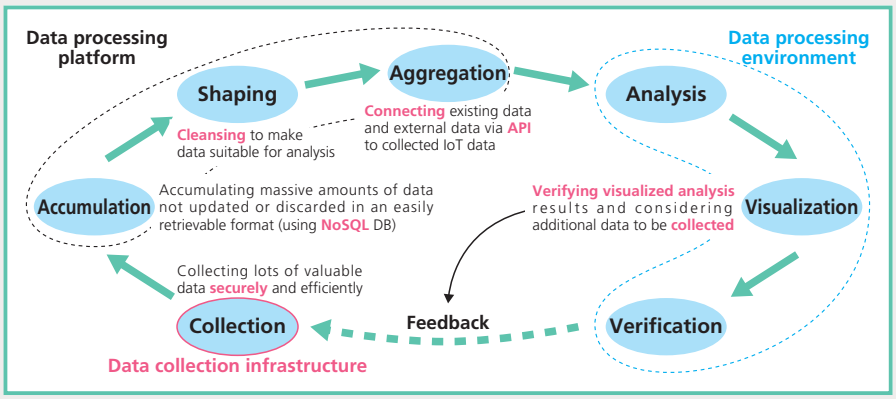


Figure Process of IoT data use

SINET provides data processing environments that accomplish these things through its existing function that connects to university computing resources and commercial clouds, but now it is newly providing "analytic platforms provided by cooperative vendors." These are processing environments being offered to researchers under academic conditions by eight carrier/cloud service providers who are cooperating with this initiative (see table below). Using these environments in conjunction with NII's mobile service and backbone network service will allow researchers to proceed with their work quickly and efficiently. This initiative will allow the creative ideas of brilliant researchers in academia to be reliably demonstrated and enable Society 5.0 to be presented as an effective business model pioneered by academia.

(Written by Koji Sasayama)

Implementing Diverse IoT Research Using SINET Mobile Network

Director General Kitsuregawa addressing the press conference

No.	Company name	Data processing environment
1	NTT Communications Corporation	・Data processing services by Things Cloud ・Collection and utilization of information using biological data
2	KDDI Corporation	・KDDI Multi-access Edge Computing (MEC) platform for evaluation
3	SoftBank Corporation	・SoftBank's cloud-based data processing services
4	Nippon Telegraph and Telephone East Corporation	・Smart Innovation Lab
5	Amazon Web Services, Inc.	・Amazon Web Services (AWS)
6	Saga IDC Co., Ltd.	・SINET data processing environment demonstration platform services
7	Sakura Internet Inc.	・Sakura's cloud-based data processing services
8	Microsoft Japan Co., Ltd.	・Microsoft Azure IoT Services

Table Each company's data processing environment

On December 20, the day before demonstration testing of the SINET Wide-Area Data Collection Infrastructure began, NII held a press conference to give an overview of the new service and explain its features. First, Director General Kitsuregawa described the aim of the service, saying, "Society 5.0, promoted by the Japanese government, is a data-driven society. Collecting the data that seeps from society is important for achieving Society 5.0, and the SINET Wide-Area Data Collection Infrastructure makes that possible. With SINET's mobile network, diverse IoT research can be implemented in which subjects are closely monitored and the data is utilized."

Next, Deputy Director General Shigeo Urushidani discussed the features of the Wide-Area Data Collection Infrastructure, explaining, "Placing everything from the terminal to the analysis platform in a highly secure environment allows researchers to conduct their research activities with peace of mind."

Also, a representative from each of the eight private-sector companies that are cooperating with the demonstration testing described their data processing environment. The reporters attending the conference showed a high degree of interest in the new SINET initiative, asking questions such as "What are the advantages of this service to researchers?" "How does it differ from existing IoT services?" and "What kind of social problems is it expected to solve?"

Director General Masaru Kitsuregawa (center, front row), Deputy Director General Shigeo Urushidani (center, back row), and representatives from the eight companies providing data processing environments.

Solutions to Japan's Agricultural Issues Now on the Horizon

Changes resulting from SINET mobile network

The connection of SINET to a mobile network has made wide-area data collection possible, and this will accelerate the use of IT/IoT in agriculture, forestry, and fisheries. Signs of change are already starting to be seen in mango production on Miyako Island and cattle grazing in semi-mountainous regions.

Development of high-quality fruit cultivation system based on spatio-temporal IoT

Professor Shiro Tamaki, Department of Computer Science and Intelligent System, Faculty of Engineering, University of the Ryukyus

In 2016, farming families on Miyako Island in Okinawa Prefecture suffered a financial blow as a result of a poor mango harvest that was just 40% of the previous year's crop. Professor Shiro Tamaki of the University of the Ryukyus stood up and took action, thinking that he wanted to do something to help. He wanted to take advantage of his specialization in IT/IoT to control the cultivation environment. To do so, first, he had to determine the optimum growing environment for mangoes.

He made sensors for measuring factors such as temperature, humidity, CO_2 concentration, and light intensity. Installing the sensors inside a mango greenhouse, he continued his research while collecting a variety of data. The data revealed that if CO_2 and LED light are provided, growth can be sped up by roughly one month and high-quality fruit can be harvested (see photograph). This could lead to increased income and profits, but because controlling the growing environment is costly, it cannot be implemented lightly. Therefore, Professor Tamaki wants to determine the best control method. However, according to him, the data collected so far are insufficient.

"Using the SINET Wide-Area Data Collection Infrastructure, I can collect growth data from mango greenhouses all over Okinawa. Analyzing these data by using AI will reveal the best control method. I want to get that knowledge back to the farmers," says Professor Tamaki. If this makes stable mango cultivation possible, not only will loss of income due to crop failure become a thing of the past for farmers, but they can also expect reductions in the growing period and increases in crop yield.

This is not Professor Tamaki's only idea for application of the SINET Wide-Area Data Collection Infrastructure. He is collecting and analyzing data on the color difference of each grade of mango and attempting to link this to automatic identification. The new infrastructure could bring a wider variety of benefits to fruit cultivation systems.

Effect of CO_2 application and supplemental LED lighting (time of flowering). CO_2 and supplemental LED lighting was applied to the left half of the mango greenhouse. The results show that mango growth varies greatly depending on the environment.

Beef production using IoT grazing management system —raising cattle using a smartphone

Professor Takafumi Gotoh, Department of Agricultural Sciences and Natural Resources, Faculty of Agriculture, Kagoshima University

Wagyu has gained worldwide recognition as delicious Japanese beef characterized by its beautiful marbling. Creating the highest grade of beef requires highly nutritious feed and a managed breeding environment, and the costs involved in importing grain for feed and disposing of manure mean that raising the cattle is costly. Meanwhile, the beef that generally appears on Japanese dinner tables is lean meat, and 60% of it is imported from the USA or Australia. Professor Takafumi Gotoh of Kagoshima University has discovered a new way for Japanese livestock farmers to survive this competition.

The price war with imported beef means that the cost of producing good-quality lean wagyu has to be controlled. Professor Gotoh had the idea of making use of natural grass in the mountains and forests for grazing cattle (see photograph). To that end, he is considering using IT and a program aimed at improving the constitution of the cattle so that they fatten up well on grass. "Approximately 70% of Japan is mountainous, and 50% is covered in forests. In addition to that, there is disused farmland, so there are plenty of grassland resources." Quantity of feed does not appear to be a problem. However, as well as extensive pastures amounting to approximately one hectare per head of cattle being required, grazing in mountains and forests is difficult to manage. Therefore, Professor Gotoh invented a grazing management system that monitors and controls the behavioral characteristics of the animals by using IT/IoT. The system can be operated entirely from a smartphone.

Joining the SINET Wide-Area Data Collection Infrastructure will not only allow the cattle grazing devised by Professor Gotoh to be carried out over a wider area but will also make it possible to collect detailed data about the cattle, including health status and timing of giving birth. Such data could be used to optimize grazing management, helping Japanese livestock farmers and making environmentally friendly sustainable beef production a reality.

(Interview/Report by Akiko Ikeda)

Grazing in a semi-mountainous region. The cattle can be herded together when necessary using the IoT grazing management system. They eat grass and produce manure, which becomes fertilizer for the grass. This is how sustainable beef production will become a reality.

Commentary

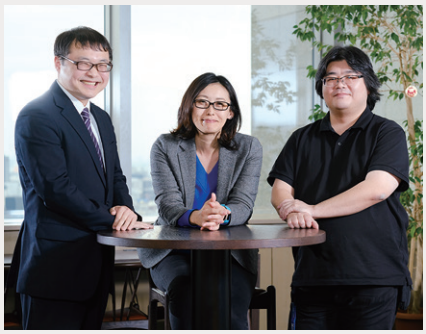
SINETARIUM

NII × anno lab

Production cooperation: anno lab
Planning cooperation: Creative Cluster Institute

SINETARIUM—A Visible SINET

Since June 2018*, SINETARIUM, a projection mapping of changes in data flow in SINET on a map of Japan, has been on display in the first floor lobby of the National Center of Sciences (the building that houses NII's main departments). SINETARIUM visualizes the unseen flow of data in the network and deepens understanding of how SINET is used in academic research and education. Yuko Okamoto, URA (Research Administrator), Yoshihiro Kubota and Mayuko Saito, SINET Team Technical Staff, and Ryosuke Imai, SINET Team Project Technical Support Specialist, were responsible for the production of SINETARIUM, and we asked them about the exhibit and its aims.



Creators of SINETARIUM: Yuko Okamoto, URA (center); Yoshihiro Kubota, SINET Team Technical Staff (left); and Ryosuke Imai, SINET Team Project Technical Support Specialist (right).

—— What kind of work is SINETARIUM?

It is an exhibit that visualizes the rate of data traffic flow in SINET5, the Science Information Network built and operated by NII. By visualizing activities in academia such as the academic research and educational activities generated by the use of SINET5, we are attempting to deepen understanding of current scientific research.

Specifically, on a map of Japan that is projected so that it fills up the entire space, mapped particles and lines change dynamically according to the flow of data in SINET5. Also, when a viewer approaches the map, it shows more detailed flow rates for a particular region.

As well as presenting log data that was originally just a series of numbers in an easy-to-understand way, we use visuals and sound so that viewers can feel the changes in information directly.

—— What initiated the production?

Director General Kitsuregawa inspired us to wonder whether it was possible to visualize NII's activities. We wanted to show the research and business activities to everyone on an impressive large screen. This was achieved with the help of SINET Team technical staff: Yoshihiro Kubota, Mayuko Saito, and Ryosuke Imai.

—— What difficulties did you face in the production and how did you solve them?

How to make data that cannot be seen "visible." We brainstormed with staff many times about what should be shown and how so that visitors would get an intuitive sense of how the data are flowing and being used, imagining a story.

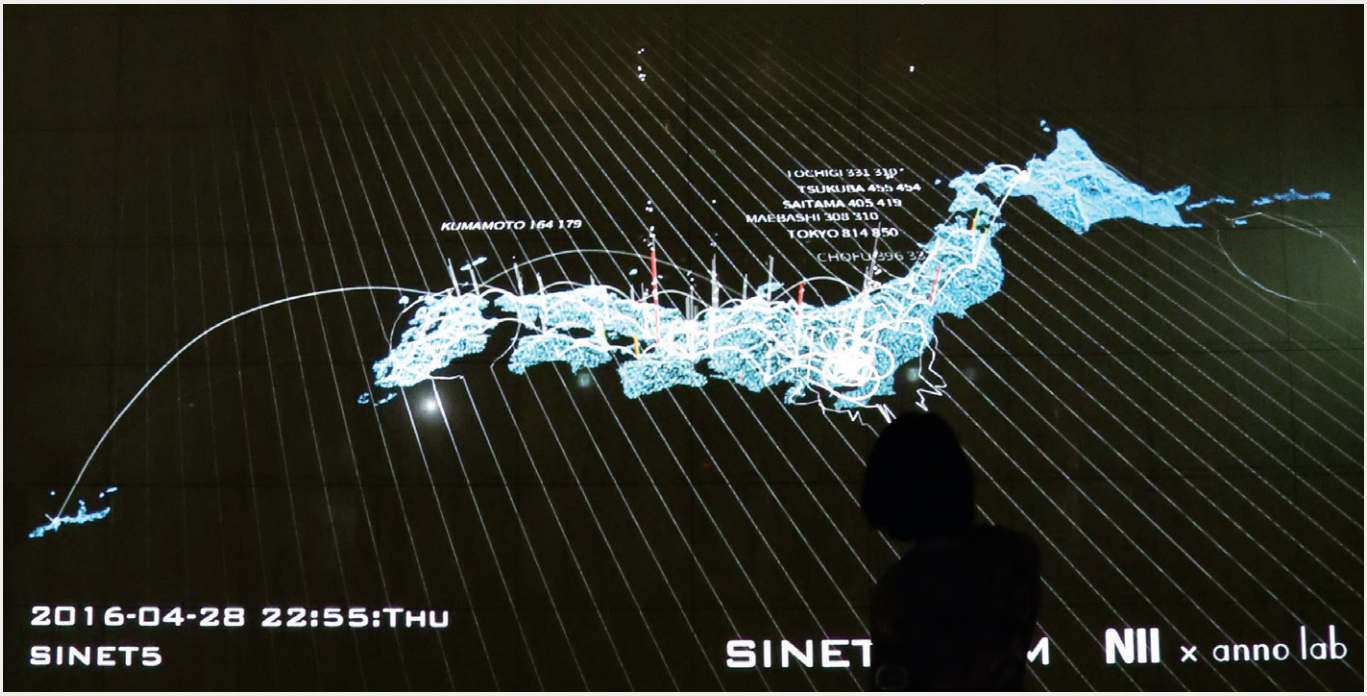
—— What do you want to communicate through SINETARIUM?

By updating the data traffic flow rates that are being recorded from moment to moment, it is possible to see the changes that occurred during recent disasters, such as the heavy rainfall in western Japan in July 2018 or the Hokkaido Eastern Iburi earthquake in September 2018. Watching it allows you to understand how the network infrastructure maintained redundancy and recovered. Also, when you watch the lines and particles flitting across the screen gradually become more and more animated before settling down as time passes from dawn to daytime and then into evening and night, you get the feeling that the rhythm of intellectual activities performed all over Japan every day are like the breath of life itself.

We hope that the SINETARIUM will make more people realize the importance of the network that we all take for granted.

(Photography by Tadashi Aizawa)

* SINETARIUM closed temporarily in December 2018, but it is scheduled to re-open this summer.



Supporting Advanced Large-Scale Research with Ultrahigh-Speed Lines Circling the Globe

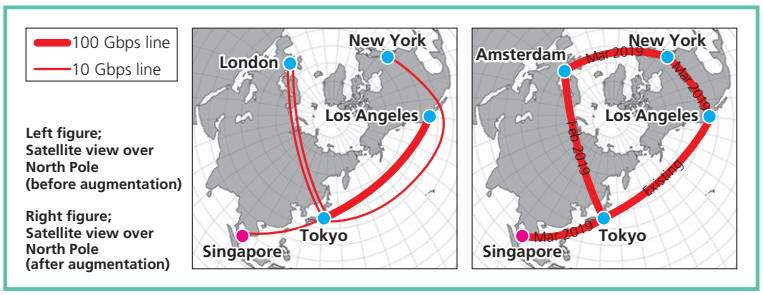


Figure Configuration of SINET international lines (comparison before and after augmentation)ment

Motonori Nakamura

Head, Academic Authentication Systems Office, Academic Infrastructure Division, Cyber Science Infrastructure Development Department / Project Professor / Deputy Director, Research and Development Center for Academic Networks, National Institute of Informatics

Strengthening the increasingly in-demand European Line to 100 Gbps

International collaboration on state-of-the-art large-scale research in fields such as high-energy physics and astronomy has grown in recent years. SINET connects Japanese research institutions and institutions overseas to each other via international communication lines to enable various transmissions of large volumes of data.

"We want to support international academic collaboration by providing a pleasant and convenient network environment," says Research Professor Motonori Nakamura, Head of the Academic Authentication Systems Office. As well as supporting international communication lines, he promotes infrastructure for international academic collaboration through internationally standardized authentication mechanisms such as eduroam and GakuNin.

SINET's international lines have been gradually strengthened, and when SINET5 was launched in April 2016, Tokyo and Los Angeles were connected at 100 Gbps, Tokyo and London were connected at 20 Gbps (two 10 Gbps lines), and Tokyo–New York and Tokyo–Singapore connections were each realized by a 10 Gbps line.

That was sufficient to cope with the communications traffic at that time, but now, three years later, the situation has changed. "The employment of 100 Gbps lines increased rapidly between 2018 and 2019 worldwide," says Research Professor Motonori Nakamura. In Japan, the surge in communications traffic with Europe is particularly striking.

There are numerous research institutions in Europe, including the European Organization for Nuclear Research (CERN) in Switzerland, ITER and the European Space Agency (ESA) in France, and the European Space Operations Centre (ESOC) in Germany, and the volume of data exchanged in international joint research has increased dramatically. Both of the two 10 Gbps lines to London frequently reached their peaks, and it would have eventually resulted in a substantial decline in communication speed.

To solve these problems, a 100 Gbps SINET line between Tokyo and Amsterdam was put into operation in February 2019. Then, in March 2019, 100 Gbps lines were put into operation for Los Angeles–New York–Amsterdam and Tokyo–Singapore. "There is no other research network that circles the globe, across the Pacific and Atlantic Oceans," says Research Professor Motonori Nakamura proudly.

International collaboration toward global networking

What are the benefits of linking New York and Amsterdam? "The main aim is to provide a backup system in the event that the Tokyo–Amsterdam line is disconnected because of an accident or natural disaster. Problems with international lines are not rare, and it takes time to repair lines that have been cut or become faulty. In order that research projects not be brought to a standstill during such times, an alternative route that allows communication, even if it is slightly slower, must be secured."

For the Amsterdam line, negotiations were made with Russian telecommunications companies to gain permission to use lines installed along the Siberian Railway. It is impossible to secure communication lines to all regions of the world only by ourselves, so skillful cooperation with other countries for permission to use local lines is the key for successful support of international joint research.

"Strengthening networks efficiently while reducing costs is a global challenge, and cooperative arrangements are developing among the representatives of different countries, including lending lines efficiently to each other," says Research Professor Motonori Nakamura. International conferences bringing together people involved in academic networks, such as the Internet2 Global Summit, the TNC, and the APAN Meeting, have been held at a pace of one or two per year in the USA, Europe, or the Asia-Pacific region. Trusting relationships have already been built between the participants at these conferences*, and friendly cooperation can be obtained for testing, temporary restoration in the event of natural disasters, or the like. "We need to extend the network into new regions such as South America and Africa, and building new cooperative arrangements that include these regions is an issue going forward," says Research Professor Motonori Nakamura about the future outlook.

(Interview/Report by Yuko Hiratsuka
Photography by Tadashi Aizawa)

* NII collaborates with networks including GÉANT (Europe), SURFnet (Netherlands), NORDUnet (Northern Europe), CANARIE (Canada), Internet2, TransPAC, PacificWave (USA), SingAREN (Singapore), and TEIN (Asia) with cooperation from JGN (NICT), MAFFIN (Ministry of Agriculture, Forestry and Fisheries), and WIDE of Japan.

World-Class 400G Line for Tokyo—Osaka Connection

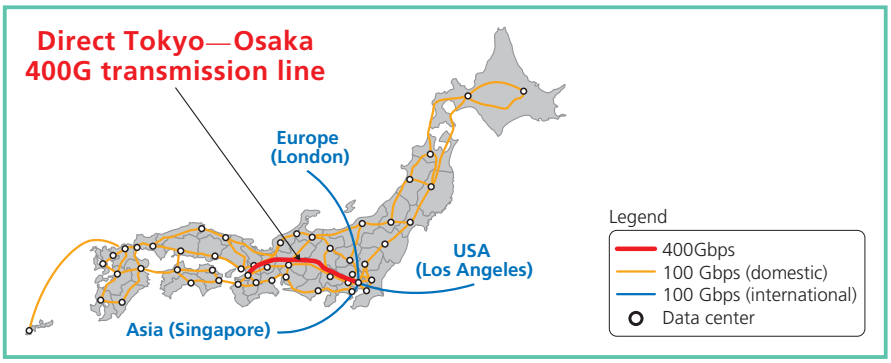


Figure Long-distance 400G transmission line for Tokyo–Osaka scheduled to commence operation in December 2019

Takashi Kurimoto

Associate Professor, Information Systems Architecture Science Research Division, National Institute of Informatics / Associate Professor, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies

Japan's transmission technology leads the world

SINET5 currently connects all 47 of Japan's prefectures, from Hokkaido to Okinawa, via 100 Gbps high-speed lines. At the beginning of SINET5, the line speed was sufficient because the line speed was increased from 40Gbps in SINET4 to 100Gbps in SINET5. However, data amount of communication continues to increase every year. For example, total data carried by SINET in 2016 increased 1.55 times compared to that in 2015. As a result, the network become congested and it will be difficult to provide sufficient network communication in the near future.

In order to avoid congestion, a 400 Gbps line that allows more data transmission between Tokyo and Osaka will begin in operation in December 2019. This 400G line can provide a better environment to communicate between east area researchers and west area researchers in Japan. Adding to it, this line can also provide a better environment for west area researchers in Japan to access foreign research institutes through international lines. Because the international lines to North America, Europe, and Asia are upgraded to 100 Gbps and these international lines are connected to Tokyo.

"A speed of 400 Gbps is world class, and it is Japan's technology that leads the world," says Associate Professor Takashi Kurimoto of the Research and Development Center for Academic Networks, who is leading the speed upgrade of SINET5. Professor Kazuro Kikuchi at the University of Tokyo proposed digital coherent technology in 2004. This brought about a breakthrough in optical transmission technology, which was limited to a speed of 10 Gbps. In the global development competition, major manufacturers in Japan collaborated to successfully develop and commercialize key 100 Gbps devices ahead of the rest of the world. Subsequently, they continued to develop technologies, and this has resulted in a 400 Gbps line becoming a reality.

Achieving increased distance, as well as higher speed

"The technology to increase both optical transmission distance and speed are important," says Associate Professor Kurimoto. Compared to connecting the fiber between Osaka and Tokyo via multiple relay nodes, connecting the fiber between Tokyo and Osaka without a relay node has significant advantages in terms of cost and reliability.

To connect the fiber between Tokyo and Osaka without a relay node, the quality of the optical fiber is very important. For example, when the air is clear, you can see distant mountains. Similarly, high-quality fiber can deliver signals far away. Thus, new high-quality fiber is deployed to connect them.

A commercial service which connect a distance of 500 km at a speed of 400 Gbps has never been provided before. The commercial service is required "to be capable of operating 24 hours a day, 365 days a year." Thus, "there is a hurdle whether stable operation can be sustained in real field."

How will the network accommodate the ever-increasing amount of communications traffic in the future? Associate Professor Kurimoto answers as follows.

"It is important to provide an environment that allows researchers to carry out their research easily, without any feelings of frustration. For that reason, we are already working on demonstration testing of a 600 Gbps transmission environment*.

It is very difficult to predict how much traffic will be in the academic world in 10 years. Because it is expected not only to the explosive increase in research data in the future big science, but also to changes in data amount due to the evolution of IoT and AI technologies. But, SINET have to be designed with a future of more than 10 years. Therefore, SINET that can carry data by sufficient speed at the required timing in response to the future demands of researchers, that is what I consider to be the most important issue."

(Interview/Report by Yuko Hiratsuka,
Photography by Tadashi Aizawa)

*Successful testing of the world's fastest 600 Gbps per lambda optical transmission and 587 Gbps data transfer.
https://www.nii.ac.jp/news/release/2018/1211.html

NEWS 1

Scientific support for sports performance

Professor Akira Maeda of the National Institute of Fitness and Sports in Kanoya gives lecture at Special SINET Session

On February 12, NII hosted the second Public Lecture: Special SINET Session. These sessions present cutting-edge research for using the Wide-Area Data Collection Infrastructure, a new service that connects SINET5 directly to mobile telecommunications.

This time, Professor Akira Maeda, Director of the Sports Performance Research Center and Executive Adviser to the President at the National Institute of Fitness and Sports in Kanoya, gave a lecture titled "New Sports Performance Research Toward Tokyo 2020—Exploring the Performance of Top Athletes" (see photograph).

Before the lecture, Deputy Director General Ichiro Satoh addressed the audience saying, "Efforts to utilize data in sports have been made before, but now they have shifted into a phase where data are collected and used in realtime. This requires a network that not only senses data but delivers it rapidly for analysis." He also introduced the "sports performance research" at the National Institute of Fitness and Sports in Kanoya as a promising example of research using SINET's services.

The only national university for physical education offering four-year courses, the National Institute of Fitness and Sports in Kanoya established the Sports Performance Research Center in March 2015. The Center uses science to support athletes by measuring a wide variety of movements using methods that more closely resemble actual competition. Athletes can identify problems in their own movements based on the measured data, and this can lead to improvements in their performance and competitive skills. Currently, many athletes aiming for the Tokyo Olympics and Paralympics are using the Center's equipment and receiving support from Professor Maeda and his team.

Professor Maeda introduced some specific initiatives that are being implemented at the Center.

For example, on a running track covered with a 50 m force platform (a device that measures the amount of force acting during movements such as walking, running, and jumping), all ground reaction forces from a starting line, through acceleration, to a finish line can be measured every stride, and the amount of force during running (vertical direction, direction of travel, horizontal direction), the points where the feet contact the ground on each stride, the amount of exercise, etc., can be calculated. The data obtained from the force plate can be monitored immediately, so athletes can discover their bad habits and weaknesses then and there, and work to improve them.

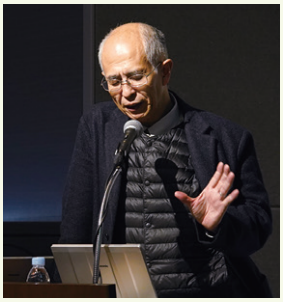
The Center also has a motion capture system that can analyze the movements of an athlete in detail using positional information from markers fitted onto their body. In this system, a 3D space is created by arranging multiple special-purpose cameras that emit infrared rays, and 3D positional information is obtained as digital data from the reflective markers moving within the space. Force platforms can be used simultaneously, making it possible to measure sprinting movements in more detail.

Professor Maeda said, "We want to provide scientific evidence, not only to Olympians but also to junior athletes and ordinary people in Japan. By valuing their individual differences and providing data, we want to encourage the intrinsic motivation that really makes them give their all."

NEWS 2

Considering the application of AI in law

Professor Ken Satoh gives lecture at the SCJ Public Symposium



The Science Council of Japan Public Symposium "Approaches to Law Using AI" (co-host: NII) was held on January 24 at TKP Garden City Premium Jimbocho. The event gathered together AI researchers and legal scholars, who outlined the application of AI technologies in law and discussed expectations regarding AI research.

NII's Professor Ken Satoh, Principles of Informatics Research Division, took to the podium and gave a lecture titled "Current Research on the Application of AI in Law" (see photograph). Professor Satoh is conducting research in the new discipline of juris-informatics, which combines AI, informatics, and law, and he is working on implementing the "presupposed ultimate fact theory," part of the legal reasoning done by judges, on a computer.

Professor Satoh cited some issues regarding the application of AI useful in law, such as the fact that it is currently confined to the level of information retrieval, and the fact that digitization of judicial precedents is lagging behind in Japan, making machine learning on judicial precedents impossible. He also pointed out that "in law, legal explanations of results are required, and explanation generation tasks are impractical in technologies such as deep learning." He said that more advanced analysis and implementation of legal reasoning are necessary to make the application of artificial intelligence to law more substantial. He concluded by saying that although there are numerous technical problems regarding the application of AI to law and supporting real legal reasoning using AI is difficult, it is an extremely interesting topic of research.

NEWS 3

Associate Professor Mizuno gives lecture, Associate Professor Koibuchi demonstrates "submerged computer"

ROIS Symposium 2018

The Research Organization of Information and Systems (ROIS), which comprises NII and other institutions, held its symposium titled "New Initiatives Towards SDGs—Japan's Contribution Using Data Science" at Ito Hall, the University of Tokyo, on February 8. The symposium introduced cutting-edge research in data science.

From NII, Associate Professor Takayuki Mizuno of the Information and Society Research Division gave a lecture titled "Do Your Possessions Come from a Clean World?—Initiatives in Informatics Towards Building Sustainable Global Supply Chains" (see photograph). Associate Professor Mizuno presented an initiative aimed at making the diamond distribution process more transparent by using blockchains and research on network analysis using inter-company transaction and media report information.

In the poster exhibition area, Associate Professor Michihiro Koibuchi of the Information Systems Architecture Science Research Division demonstrated a "submerged computer," which is cooled directly by submerging the motherboard equipped, which includes the CPU, in a water tank or in the sea for efficient cooling.

NEWS 4 Professor Takano gives lecture at Toyama High School

Explains to high school students how searching works

Professor Akihiko Takano of the Digital Content and Media Sciences Research Division gave a lecture at Tokyo Metropolitan Toyama High School on January 12 (see photograph). This lecture was planned by Toyama High School SSH (Super Science High School) Information Department as part of a series of lessons exploring knowledge and tasks. It was attended by approximately 80 first- and second-year students.

Principal Yoichi Fuse introduced the talk saying, "Survival in the future information society will require the selection and utilization of information to generate new ideas. I think that this lecture will give you some valuable tips for improving your ability to use information."

Next, Professor Takano took to the podium and spoke on the theme of "From Search to Association—Are You Being Manipulated by Your Searches?" He explained how searching works using "Associative searching—Webcat Plus," "*Sou*—IMAGINE Book Search," and "Cultural Heritage Online," which he developed.

After the lecture, a realtime online survey of the students' understanding and interest indicated a high level of interest, and questions included "Is it possible to search in English in the same way?" "What is the background to associative searching?" and "What happens with copyright?"

Professor Takano concluded by saying, "Major discoveries do not happen as long as you are sticking to the status quo. It is important to stand by your beliefs and keep on trying."

NEWS 5 Technical staff from University of Tokyo Earthquake Research Institute and other institutions visit NII

They experience SINET and advanced informatics research

Thirty-eight technical staff members involved in earthquake and volcano observation and similar activities at the University of Tokyo Earthquake Research Institute, Hokkaido University, Tohoku University, Nagoya University, Kyoto University, and Kyushu University visited NII on January 24, where they gained a better understanding of state-of-the-art informatics research and services such as SINET5, built and operated by NII.

At the beginning, Research Professor Motonori Nakamura explained the expected roles of SINET5 and the status of new service development in a lecture titled "Ultrahigh-speed Science Information Network Towards the Era of Society 5.0" (see photograph). Next, Research Professor Koji Sasayama of the Research and Development Center for Academic Networks introduced the SINET Wide-Area Data Collection Infrastructure, which has been undergoing demonstration testing since December 2018. He also introduced services such as GakuNin Cloud, a cloud support service, and GakuNin RDM, a research data management service that promotes open science. Also, from NII's Digital Content and Media Sciences Research Division, Associate Professor Kenro Aihara presented examples of "data collection and use in CPS/IoT environments" from long-term monitoring to crowdsensing, and Associate Professor Asanobu Kitamoto presented case studies related to meteorological and terrestrial phenomena demonstrating "from data to information, and to action."

The participants asked questions about the use of mobile services in earthquake/volcano research and system management in cloud services, and they expressed high hopes for NII's academic information infrastructure and research.

NEWS 6 Development of new model for high-speed synthesis of natural speech

"Neural source-filter model" introduces neural networks to classic method

A research team comprising Project Researcher Xin Wang, Project Assistant Professor Shinji Takaki, and Associate Professor Junichi Yamagishi of the Digital Content and Media Sciences Research Division has developed a neural source-filter (NSF) model for high-speed high-quality voice synthesis. This new model combines a speech production model released in 1960 with new techniques developed using deep learning, and it is capable not only of generating high-quality speech waveforms closely resembling a natural human voice but also of stable learning via neural networks.

The NSF model requires only about one hour of voice data for neural network machine learning, and thanks to the simple structure of its neural networks, it can obtain correct predictive results without extensive parameter tuning. Also, large-scale tests have demonstrated that speech produced by the NSF model is comparable in quality to that generated by WaveNet, a speech synthesis method based on deep learning developed by an influential overseas ICT company.

Samples of the machine learning data used in this evaluation (source code, trained models) and samples of actual synthesized speech (Japanese/English) are available at the sites listed below.

Source code
https://github.com/nii-yamagishilab/project-CURRENNT-public

Trained models (may be executed to generate English-language voices)
https://github.com/nii-yamagishilab/project-CURRENNT-scripts

Voice samples (Japanese/English)
https://nii-yamagishilab.github.io/samples- nsf/index.html

At the site below, you can listen to and compare a natural human voice with voices generated using a source-filter vocoder, WaveNet, and the NSF method.
https://youtu.be/yr_xMq1gxKY

SNS "Hey, this is great!" Hottest articles on Facebook and Twitter (December 2018 – February 2019)

National Institute of Informatics, NII (official) Facebook
www.facebook.com/jouhouken/

NII has started providing Yahoo! Chiebukuro data (3rd Edition) to researchers at universities and public institutions in the Informatics Research Data Repository (IDR) of the Center for Dataset Sharing and Collaborative Research. (01/16/2019)

National Institute of Informatics, NII (official) Twitter
@jouhouken

[NII Today No. 81]
"New Software Engineering for Machine Learning: How to Assure the Quality of AI" Fuyuki Ishikawa [Associate Professor, Information Systems Architecture Science Research Division] Interviewer: Keiichi Murayama [Nikkei commentator] (02/04/2019)

Bit on Twitter! Twitter
@NII_Bit

I've just passed 1,000 Twitter followers!! Thanks for all your support. I'm going to carry on spreading the word about NII and informatics in an easy-to-understand way. Have a good year everyone! (12/28/2018)

* Some text edited/omitted.

Essay

Expectations for Research Infrastructure That Will Forge Our Future Society

Satoshi Sekiguchi
Vice President, National Institute of Advanced Industrial Science and Technology (AIST) / Director General, Department of Information Technology and Human Factors

As April rolls around, the month brings fresh-faced and optimistic new employees and students. These young people truly are digital natives, and the smartphones that they operate so skillfully are a seemingly integral part of their bodies and lives. In the past, new staff training included tasks such as reporting how a certain computer was connected to the network, and at that time, the cables were still installed above the ceiling. Technology's progress has made technology itself invisible, and this is perhaps the inevitable fate of IT. Our daily lives, in which we are connected to everyone, everywhere, at all times, are supported by ceaseless labor behind the scenes.

In Society 5.0, new value is expected to be created in sectors such as transport, medical and nursing care, manufacturing, agriculture, food, disaster prevention, and energy. None of this is surprising to an information researcher who has worked on implementation as an endpoint of technology. There are countless individual solutions when confined to each sector. Instead, I think that the real excitement lies in transforming individual cutting-edge technologies into commodities and constructing platforms aimed at horizontal development.

Data linkage infrastructure for Society 5.0 is being prepared by establishing data models, ontologies, and so on. However, researchers must tackle head-on problems such as how to move petabyte-scale data at high speeds, how to deliver such data as input in short amounts of time, and how high-performance processing can be performed.

About 20 years have already passed since the idea of distributing large-scale data and high-performance computing (HPC) in the form of grid computing using high-speed networks was born. I myself contributed to making that idea a reality, and the role played by NII's SINET was huge. As time went by, HPC using artificial intelligence (AI) and HPC-based AI became real issues, and also, the required scale expanded.

Currently, AI Bridging Cloud Infrastructure (ABCI), established by the National Institute of Advanced Industrial Science and Technology, is in operation at the University of Tokyo's Kashiwa Campus II, and it boasts world-class computing performance and data processing capability. ABCI is connected to SINET5 at 100 Gbps and can be accessed by academic research institutions and private enterprises inside and outside of Japan. A partnership agreement has just been concluded with NII. Furthermore, the University of Tokyo plans to gather data platforms constructed in cooperation with SINET here. High-speed networks for academic research, such as SINET, are joining together a wide variety of data, computing power, software, and people. Expectations are growing for R&D infrastructure that accelerates research endeavors.

Future Schedule

April 22—24 | AI/SUM: Applied AI Summit (Sponsor/Exhibitor) at Marunouchi Building and Shin-Marunouchi Building (Marunouchi, Tokyo). For details and registration, go to **https://www.aisum.jp/ja/.**

NII Week ＼ **Introducing NII's Research and Business Activities** ／

Location: Hitotsubashi Hall (Hitotsubashi, Chiyoda-ku, Tokyo) and other venues

May 27—28 | Japan Open Science Summit 2019. For details and registration, go to **https://joss.rcos.nii.ac.jp/.**

May 29—30 | NII Academic Information Infrastructure Open Forum 2019. For details and registration, go to **https://www.nii.ac.jp/openforum/2019/.**

May 31—June 01 | NII Open House 2019 (Public exhibition/presentation of research results). For details and to apply for events that require advance registration, please go to **https://www.nii.ac.jp/openhouse/.**

June 01 | Information Session on the Department of Informatics, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies. For details, go to **https://www.nii.ac.jp/graduate/entrance/guidance/.**

Notes on cover illustration

This illustration shows the sensing of a farm environment, collection and analysis of data, and implementation of optimal production control. Supporting this is SINET and a mobile network connected to SINET. Demonstration testing in the field using the mobile network has begun.

Weaving Information into Knowledge
NII

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