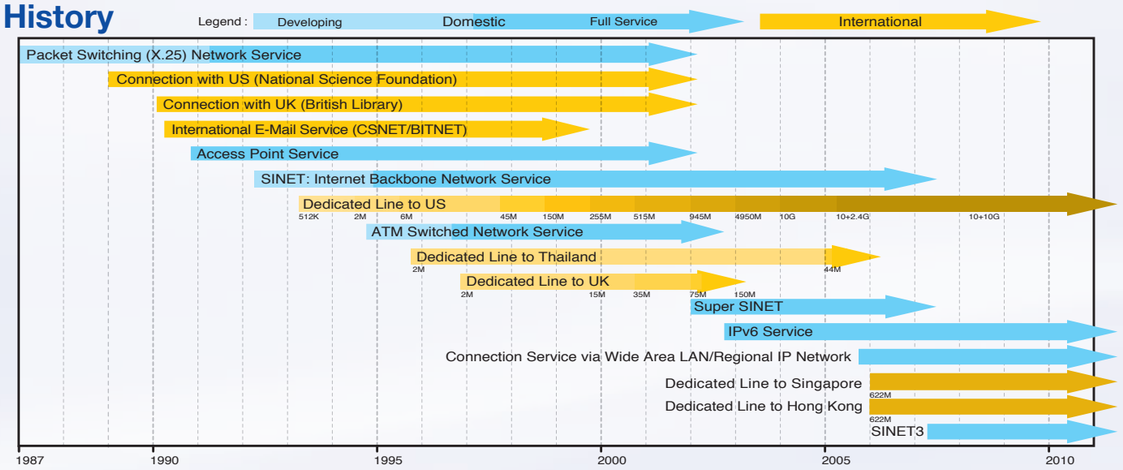
History



SINET Promotion Office

The SINET Promotion Office was established in October 2007 in order to promote the use of SINET. It provides consulting on the advanced use of the network, user support, and training and promotion regarding network services, and also carries out an educational campaign. If you experience any trouble or find something you do not understand, please contact us for assistance.

【Main activities in fiscal 2009】

- Held presentations on SINET services in Kanazawa, Hokkaido, Nagoya, Kyoto, Fukuoka, Hiroshima, and Tokyo
- Conducted survey of performance-related problems and provided advice on usage
  (E-mail responses: 206; Phone responses: 73; Visitors received: 4; Visits made: 12)

【Please direct queries to】

SINET Promotion Office
Research and Development Center for Academic Networks
Tel: +81-3-4212-2269 Fax: +81-3-4212-2270
E-mail: support@sinet.ad.jp

Services

User consultation/response

Consulting on the use of network services

Interviews/surveys on user requests

Solicitation of comments and requests for SINET3

Troubleshooting of performance-related problems

Support for network service usage problems and performance improvements

Technology promotion and educational campaign (lectures and technological exchanges)

Presentations on using SINET3, educational campaign, case examples of SINET3 promotion, creation of documentation, and publication of information on the Web

Academic Information Infrastructure Open Forum

The Open Forum was launched in June 2009 as a framework for enhancing collaboration and information exchange among universities and research institutions in order to strengthen the Cyber Science Infrastructure (CSI), which supports the growth and development of academic research and education.

【Main activities】

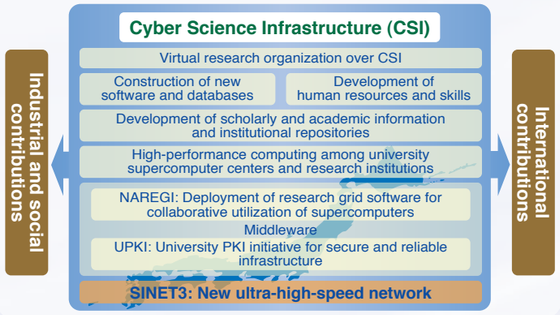
- Exchanges of CSI-related information and technology
- Taking steps to further increase the speed of access lines for SINET4
- Studies to address the increasing need for cloud-based services for scientists

【Please direct queries to】

Academic Network Division
Cyber Science Infrastructure Development Department
Tel: +81-3-4212-2262 Fax: +81-3-4212-2270
E-mail: openforum@nii.ac.jp

Cyber Science Infrastructure (CSI)

The National Institute of Informatics (NII) is promoting the development of the Cyber Science Infrastructure (CSI) through cooperation with universities and other organizations. CSI supports Japan's academic research and educational activities and strengthen international competitiveness.
SINET3 plays an important role as the core component of CSI.



Inter-University Research Institute Corporation
Research Organization of Information and Systems
National Institute of Informatics
NII

2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430 URL http://www.nii.ac.jp/

Contact SINET Planning Team, Academic Network Division
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E-mail: support@sinet.ad.jp URL http://www.sinet.ad.jp/

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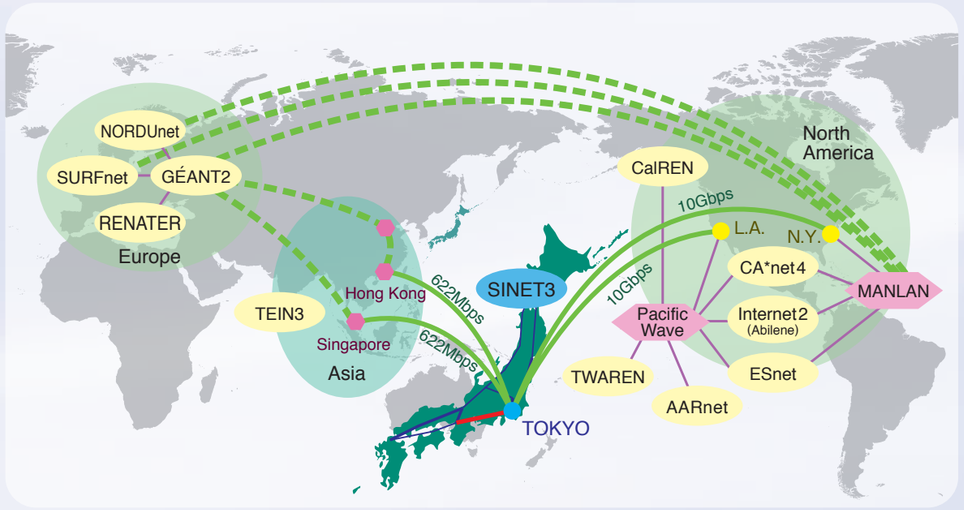
Science Information NETwork 3

The Science Information Network (SINET) is an information and communication network connecting universities and research institutions throughout Japan via nationwide connection points (nodes). It is designed to promote research and education as well as the circulation of scientific information among universities, research institutions, and similar entities. SINET is also connected to research networks such as Internet2 in the U.S. and GÉANT2 in Europe to facilitate dissemination of research information and collaborations over networks.

SINET3 began operations in April 2007, and it replaces the previous SINET and Super SINET. SINET3 plays an important role as the core component of the Cyber Science Infrastructure (CSI).

2010 - 2011

Network Architecture of SINET3



Before April 2007, the National Institute of Informatics (NII) had operated two academic infrastructures, the Science Information Network (SINET) and Super-SINET. SINET was a nationwide academic internet backbone, and it promoted research and education at more than 700 universities, research institutions, and related entities. The network provided pure IP-based services, and the line speed was up to 1 Gbps. Super-SINET provided a high-speed network environment, with line speeds up to 10 Gbps, to academic institutions concentrating on such research areas as high-energy physics, nuclear fusion science, space and astronomical science, genome analysis, nanotechnology research, simulation sciences, and grid computing.

After taking into consideration the increasingly diversified requirements and functional limitations of current equipment, i.e. IP routers, NII decided to construct SINET3, a next-generation academic infrastructure that integrates SINET and Super SINET.

SINET3 is a hybrid network composed of layer-1 switches and IP/MPLS routers. It provides layer-1 end-to-end circuit services as well as IP and Ethernet services in a cost-effective manner, and it enables flexible resource allocation in response to service demands.

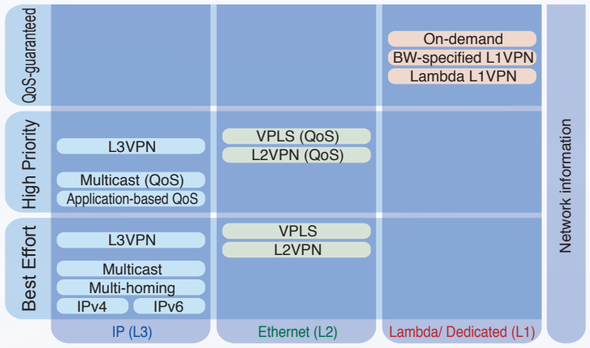
The network has a two-layer transport structure with edge and core nodes. To reduce the number of expensive IP routers and provide multi-layer services, the network does not have IP routers in the edge layer. The edge node is an edge layer-1 switch with layer-2 multiplexing. It is located at a university or research institution and accommodates user equipment. The core node is composed of a high-end IP/MPLS router and a core layer-1 switch located at a public data center.

As of April 2010, the network has 63 edge nodes and 12 core nodes, i.e., 75 layer-1 switches and 12 IP/MPLS routers. The line speed between the edge and core nodes is 1 to 20 Gbps, and the backbone line speed between the core nodes is a maximum of 40 Gbps. The network deploys Japan's first STM256 (40 Gbps) lines between Tokyo, Nagoya, and Osaka. The backbone links form three loops to enhance network resiliency nationwide and to enable quick service recovery after network failures. The topology also enables efficient use of network bandwidth by sharing backbone links among users for all services.

SINET3 Services

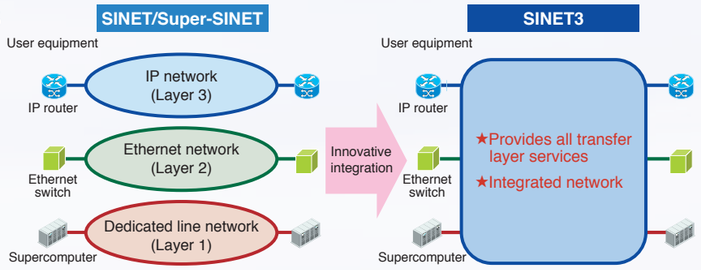
Service Categories in SINET3

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



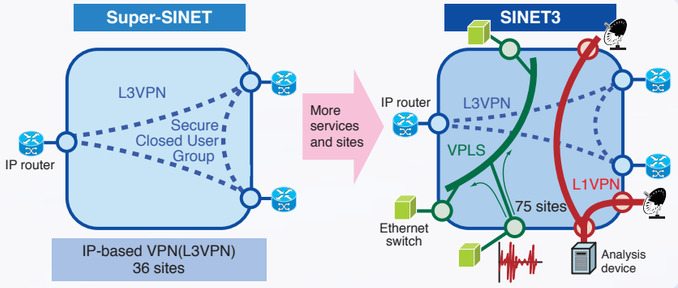
Multiple Layer Services

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



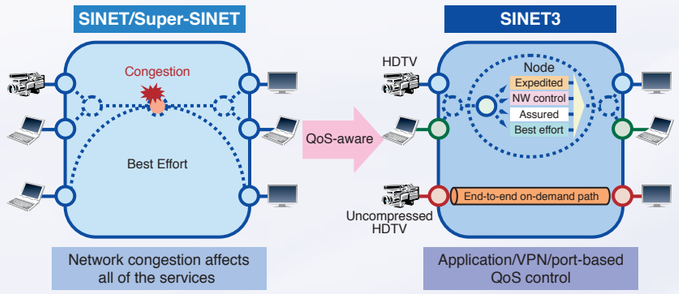
Multiple VPN Services

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



Multiple QoS Services

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

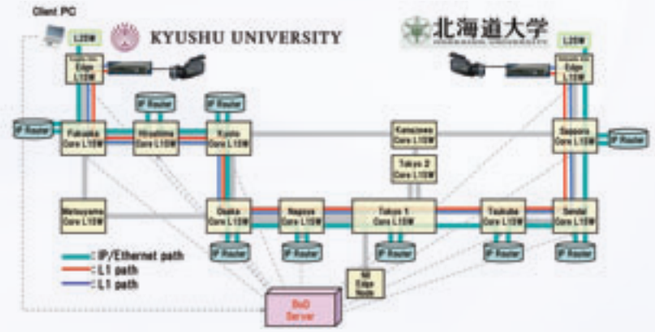


Network Information Service

SINET3 gives users performance measurements (throughputs and round trip times) and security information, which will help to improve usability and facilitate network research. (For traffic information, please contact SINET Promotion Office.)

Bandwidth-on-Demand Service

SINET3 provides Bandwidth-on-Demand (BoD) service on layer-1 (a dedicated line with quality assurance). Users can specify destination, duration, bandwidth with granularity of 150 Mbps, and route option. The BoD server receives reservation requests, schedules accepted reservations, and triggers layer-1 path setup. The service enables users to transmit extremely large volumes of data using high-quality communications instantly, whenever necessary. It offers an environment for the acceleration of innovative scholarly research and the development of academic applications.



Demonstration of L1 BoD between Kyushu University and Hokkaido University (Dec. 2, 2008)(Note: Connected with L1 paths totaling 2 Gbps)

Confirmation of bandwidth reservation

Comparison of SINET/Super SINET and SINET3 services

Service Menu			SINET	Super SINET	SINET3	Notes
User Interface	Serial	1.5Mbps or less	✓			Service terminated at end of August 2008
	Ether family	10Mbps (Ethernet)	✓		✓	
		100Mbps (FE)	✓	✓	✓	
		1Gbps (GE)	✓	✓	✓	
		10Gbps (10GE)			✓	Limited node availability at present. Individual requests to be studied for implementation.
	SDH/SONET family	2.4Gbps (STM-16)		✓	✓	Only for large data transfers.
Network Service	L3 service	IPv4	✓	✓	✓	
		IPv6	✓		✓	SINET3 uses native IPv6.
		Multi-homing	✓		✓	
		Full routes			✓	
		Multicast			✓	
		L3VPN		✓	✓	
		Application-based QoS			✓	
		Multicast (QoS)			✓	
		L3VPN (QoS)			✓	
	L2 service	L2VPN			✓	
		VPLS			✓	
		L2VPN (QoS)			✓	
		VPLS (QoS)			✓	
	L1 service	On-demand*			✓	IF: GE, 2.4G (STM-16), 10GE. Granularity: 150Mbps.
		Dedicated line		✓		SINET3 provides on-demand services instead.
	Network information service	Security information	✓	✓	✓	
		Performance measurements			✓	Throughput measurements, round trip time measurements
		Traffic information			✓	Please contact SINET Promotion Office for details.

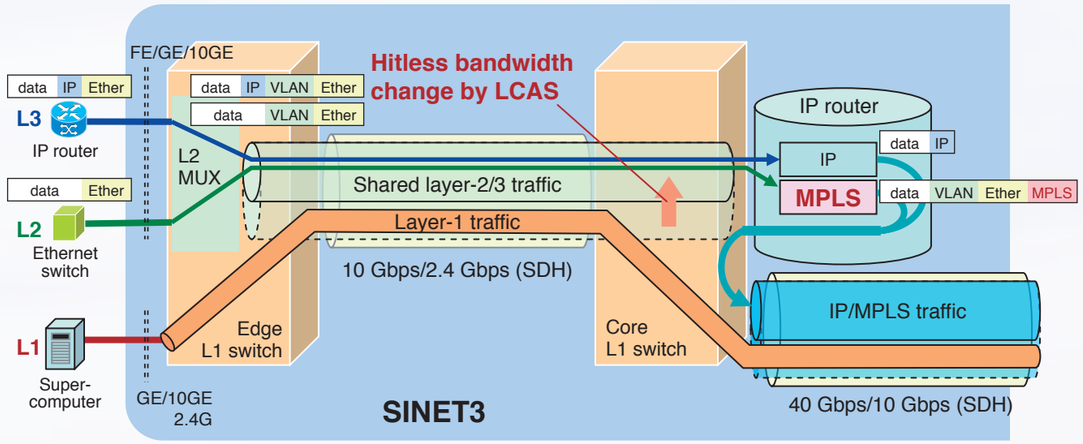
* The lambda and BW-specified L1VPN services were integrated into the on-demand service upon its full implementation.

SINET3 Technologies

Accommodation of Multi-layer Services

L3 and L2 traffic are accommodated in the shared bandwidth by L2 multiplexing and are transferred to IP routers, where traffic is encapsulated with MPLS* labels as needed. L1 traffic is assigned a dedicated bandwidth and separated from L3/2 traffic. The bandwidth of L2/3 (or IP/MPLS) traffic can be hitlessly changed by LCAS*.

*MPLS: Multi-Protocol Label Switching, LCAS: Link Capacity Adjustment Scheme



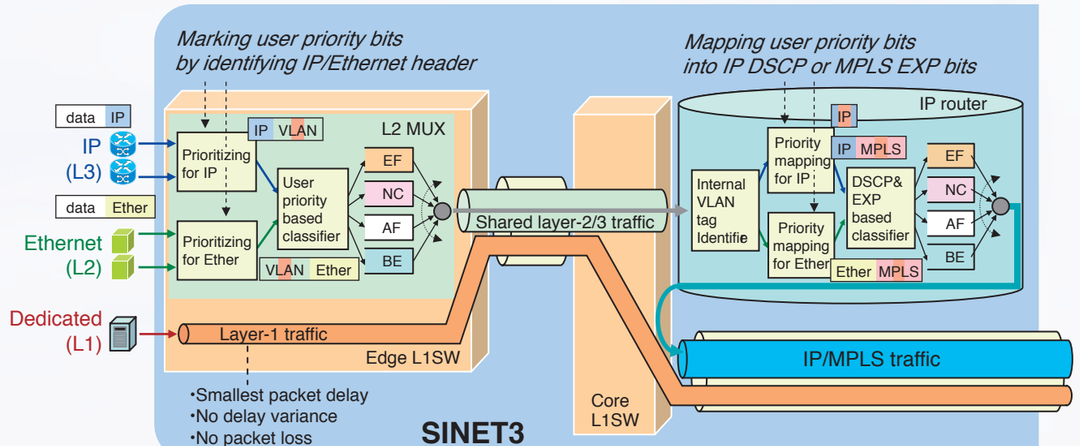
Accommodation of Multi-QoS Services

Layer-3/2 QoS:

- User priority bits of internal VLAN tags are marked at edge L2 MUX.
- User Priority bits are mapped into DSCP (IP) or EXP (MPLS) bits at IP router.
- There are four priority (forwarding) classes: EF, NC, AF, and BE.

Layer-1 QoS:

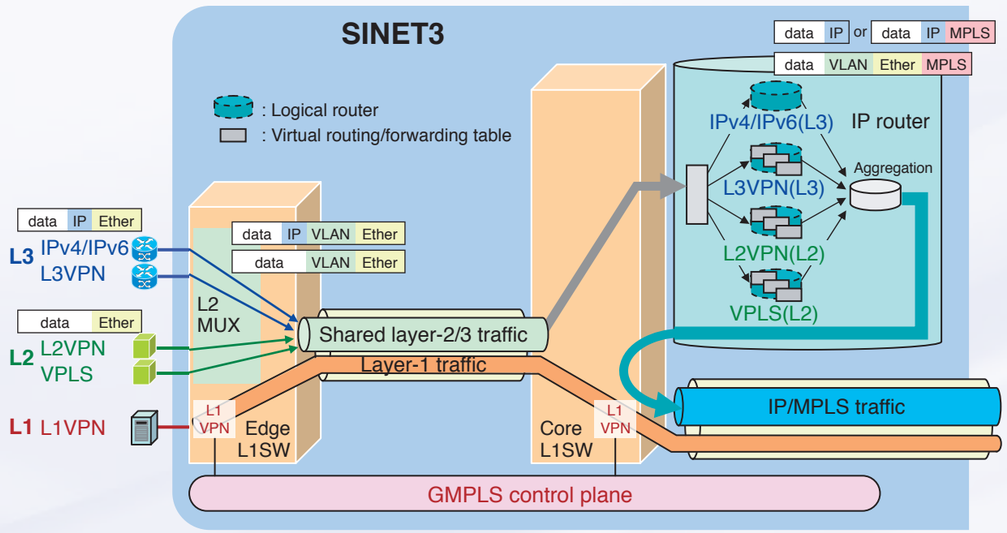
- Layer-1 switches assign the end-to-end bandwidth on demand.



Accommodation of Multi-VPN Services

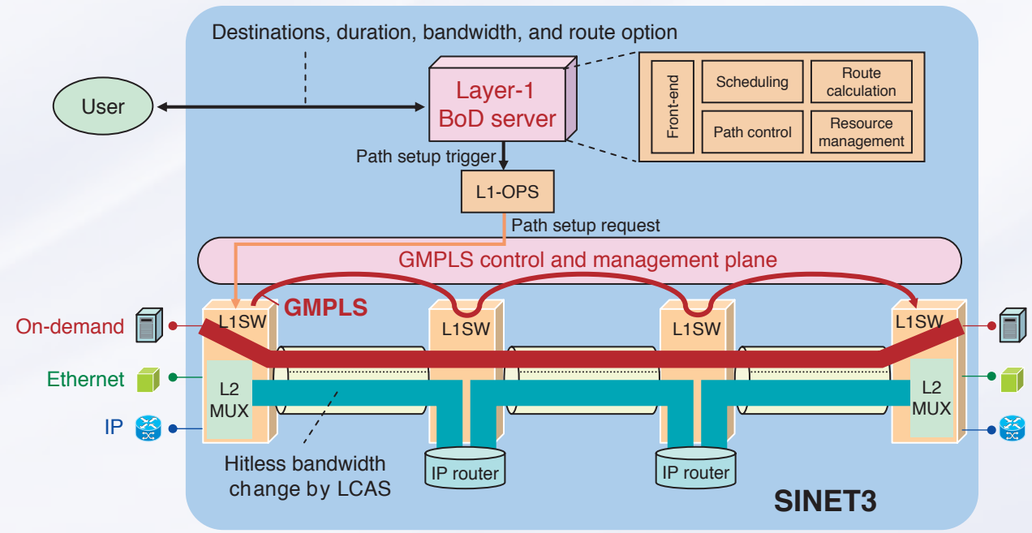
L3VPN, L2VPN, and VPLS are logically separated by internal VLAN tags and logical routers. Each logical router exchanges different protocols for each VPN service. L1VPN and on-demand services need GMPLS* protocols to set up layer-1 paths and have a separate control plane from that of the IP routers.

*GMPLS: Generalized MPLS



Architecture of Bandwidth-on-Demand (BoD) Service

The BoD server receives reservation requests, schedules the accepted requests, and triggers layer-1 path setup of the source layer-1 switch via L1-OPS. The source layer-1 switch sets up the path to the destination by using GMPLS. The BoD server changes the bandwidth of L2/L3 traffic by LCAS via L1-OPS as needed.



Case examples using SINET3

Use of international connection

Internet connection VPN QoS L1

— The “Belle experiment”: Major contribution to verification of the theory of Kobayashi and Maskawa, Nobel Laureates in Physics —

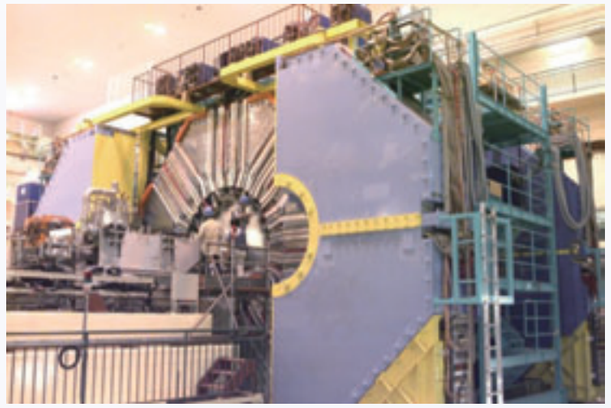
Dr. Makoto Kobayashi, Honorary Professor Emeritus of the High Energy Accelerator Research Organization (KEK), and Dr. Toshihide Maskawa, Professor of the Faculty of Science, Kyoto Sangyo University and Professor Emeritus of Kyoto University, were awarded the Nobel Prize in Physics 2008 for the Kobayashi-Maskawa Theory. The Belle experiment, carried out at KEK, contributed greatly to verification of the theory. SINET3 plays an important role in the Belle experiment.

In the Belle experiment, the KEK-B accelerator is used to generate numerous pairs of B and anti-B mesons, and the discrepancies in the distances traveled by the mesons before their decays are measured precisely using the Belle detector. The circumference of the KEK-B detector is 3 kilometers, and light travels about 300,000 kilometers a second, which means that electrons and positrons cross each other 100,000 times a second. In the experiment, only intriguing events are extracted, but there still are some 200 events per second to be recorded. This means that the daily data volume amounts to about one terabyte. The accumulated experimental data accounts for one petabyte on hard disks and five petabytes on magnetic tapes.

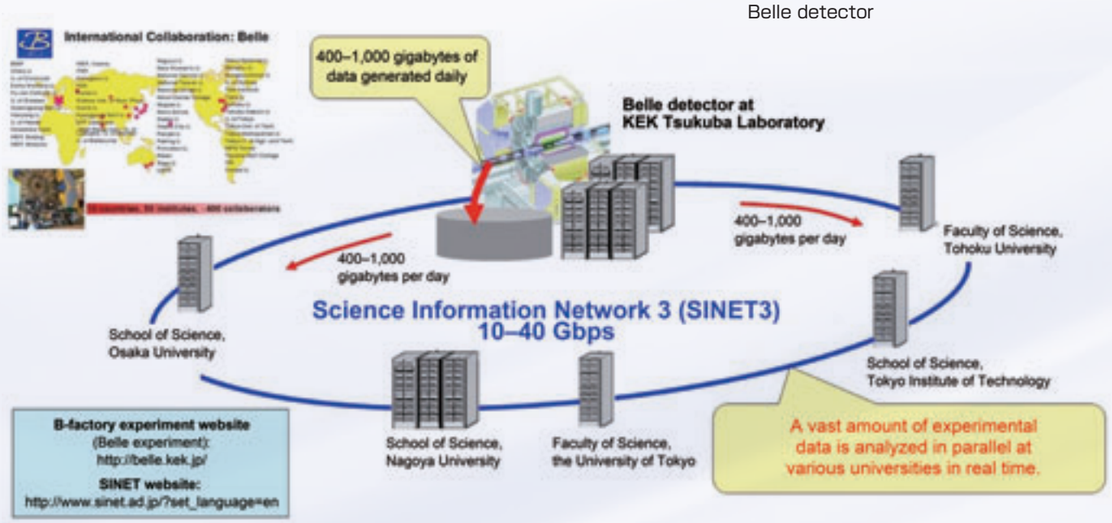
Networks play an important role along with the analysis system and storage devices. The data outputted from the Belle detector are analyzed not only at KEK but also at other universities. Similarly, simulation data prepared at other universities are sometimes brought to KEK. For this reason, a high-speed network is essential for exchange of large volumes of data in short periods of time.

In the Belle experiment, SINET and Super SINET have been put to use. SINET3 L3 VPN services are now used to connect KEK with Tohoku University, Tokyo Institute of Technology, the University of Tokyo, Nagoya University, and Osaka University. SINET3 networks are also used for exchange of data with universities across Japan and some 40 universities and research institutes abroad in 14 countries.

Dr. Nobuhiko Katayama of KEK, the key figure in the experiment, says that SINET is the aorta of the networks supporting the Belle experiment, highlighting its importance.



Belle detector



Use of international connection

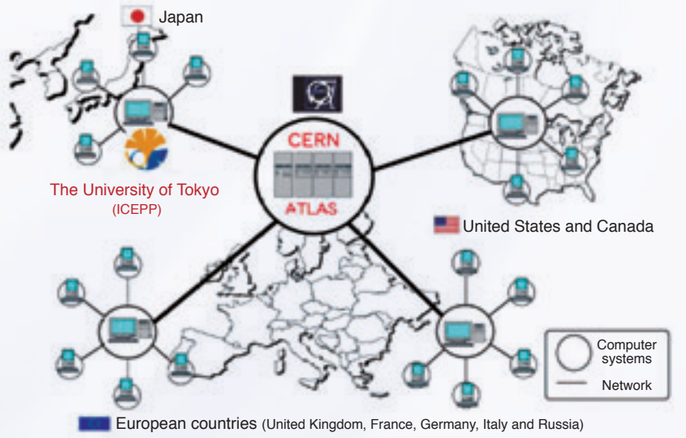
Internet connection VPN QoS L1

— Distributed analysis of enormous amounts of data produced by the LHC accelerator —

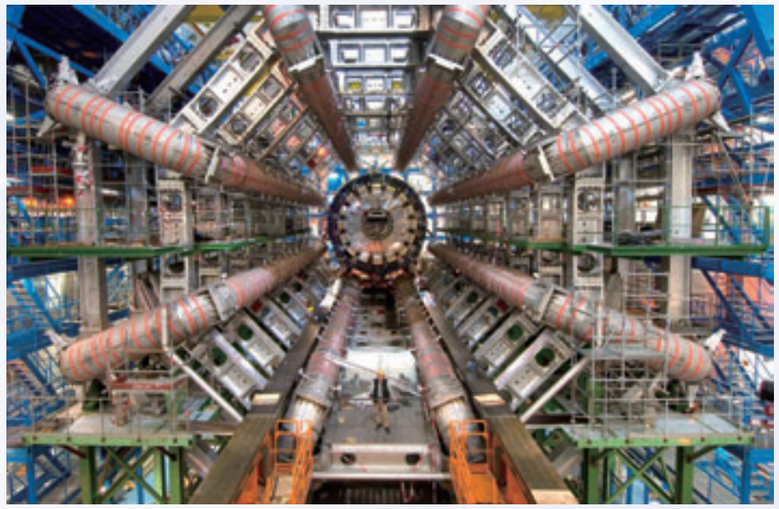
The International Center for Elementary Particle Physics (ICEPP) at the University of Tokyo, along with other Japanese research institutes, is participating in the ATLAS Experiment, a collaborative international experiment using the Large Hadron Collider (LHC) accelerator. Producing an enormous quantity of data far in excess of that associated with experiments of the past, the ATLAS Experiment will require incredible amounts of data storage equipment and computer processing facilities in order to process and analyze the data and produce physics results. The Worldwide LHC Computing Grid (WLCG), which provides this processing power through computer systems distributed across the globe, has been deployed, and ICEPP is responsible for serving as a regional center for data analyses in Japan.

ICEPP has a 10 Gigabit Ethernet connection to SINET3 through the university’s LAN. SINET3 international lines are being used to transfer huge amounts of data among ICEPP and the computing center in Lyon, France, the European Organization for Nuclear Research (CERN), and other European centers. As of spring 2009, preparations are being carried out toward the start of the full-fledged data taking phase in the fall of 2009. Test and tuning of the grid system as well as preparations for physics analyses are being done using cosmic ray data and an enormous quantity of simulation data. In this way, SINET3 is providing a tremendous support for this kind of large-scale, collaborative international experiment.

Note: The Large Hadron Collider of CERN is a giant particle accelerator of the world's highest energy in which two proton beams running in opposite directions collide head-on with each other. Its construction was completed in the summer of 2008.



Regional centers and world-wide network for ATLAS data analysis (Source: ICEPP)



The ATLAS detector during assembly (Copyright CERN)

Case examples using SINET3

For full details, please see the SINET3 website. http://www.sinet.ad.jp/case-examples?set_language=en

High Energy Physics and Nuclear Fusion Science

Neutrino Research
Outline: Data sharing for precise observation of solar neutrinos and observation of atmospheric neutrinos, proton decay, etc.
Institutions: Kamioka Observatory (ICRR, The University of Tokyo) **Services:** L2 VPN, L3 VPN

Lattice QCD Simulation in Research on Hadron Physics and the Standard Model of Elementary Particles
Outline: Sharing and use of data via the network by a lattice QCD data-sharing system
Institutions: University of Tsukuba, KEK, Kyoto University, Osaka University, Hiroshima University, Kanazawa University **Services:** L3 VPN

Nuclear Fusion Research for a Clean Future Energy
Outline: Remote participation in research including experiments (such as Large Helical Device experiments), data analysis, and simulation
Institutions: National Institute for Fusion Science (NIFS), University of Tsukuba, Kyushu University, (NIFS Rokkasho Research Center) **Services:** L2 VPN, L3 VPN

Space Science and Astronomy

Optically Connected VLBI Observation Using SINET3 L1 On-demand Service
Outline: Interconnection of radio telescopes for real-time, high-sensitivity interferometry
Institutions: National Astronomical Observatory of Japan (NAOJ), Hokkaido University, Yamaguchi University, NIFS, KEK **Services:** L1 on-demand

Studying the Sun with the Solar Observation Satellite Hinode
Outline: Sharing Hinode satellite data for research on the mechanism of heating of the corona
Institutions: Institute of Space and Astronautical Science (ISAS), NAOJ, and solar physics researchers worldwide **Services:** L1 VPN

Environmental Science, Meteorology, Earth Science

Receipt, Processing, Archiving, and Dissemination of Satellite Data
Outline: Receiving, archiving, and dissemination of satellite observational data, especially from the weather satellite Himawari.
Institutions: Chiba University (Center for Environmental Remote Sensing) **Services:** IP Dual

Building and Operation of the Japan Data Exchange Network (JDXnet) for Earthquake Observation Data
Outline: Transmission of seismic wave data in real time to universities and other institutions throughout Japan
Institutions: 10 institutions, including the Earthquake Research Institute, the University of Tokyo **Services:** L2 VPN

International Sharing of Extra-Large Volumes of Data from VLBI Observations
Outline: Connecting with observatories worldwide as backbone network underlying e-VLBI
Institutions: Geospatial Information Authority of Japan and observatories worldwide **Services:** International Connection

Remote Learning

Use of HD Interactive Remote Lectures and IPv6 for Training in the Healthcare Information Field
Outline: Use of HD interactive remote learning in a joint project in the field of engineering-based medicine
Institutions: Yokohama National University, Yokohama City University **Services:** IP Dual

Remote Lecture System Linking 18 UGAS Universities across Japan
Outline: Multipoint-controlled remote learning among 18 universities that make up the United Graduate Schools of Agricultural Sciences
Institutions: Tokyo University of Agriculture and Technology, Etc. **Services:** IP Dual

Interactive Remote Learning System Linking the National Universities of Three Hokuriku Prefectures
Outline: Interactive remote learning among national universities in three prefectures of the Hokuriku region, with a focus on the humanities
Institutions: Kanazawa University, Toyama University, Fukui University, Japan Advanced Institute of Science and Technology **Services:** IP Dual

Interactive Remote Learning in Special Support Education
Outline: Interactive remote learning in the field of special education
Institutions: Ehime University, Tottori University **Services:** L2 VPN

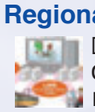
Remote Use of Computing Resources, Experimental Facilities, Etc.

Remote Control System with Haptic Feedback
Outline: Creation, operation, and testing of a remote control research network linking Toyohashi University of Technology and national colleges of technology
Institutions: Toyohashi University of Technology, Hakodate National College of Technology **Services:** QoS

Network Research

Use of SINET3 L1 On-demand Service to Evaluate iSCSI-APT Performance
Outline: Research on high-speed transmission of large data volumes, utilizing SINET3's features (broad bandwidth, high quality)
Institutions: Osaka University, Hokkaido University, Kyushu University **Services:** L1 on-demand

Regional Revitalization and Career Training



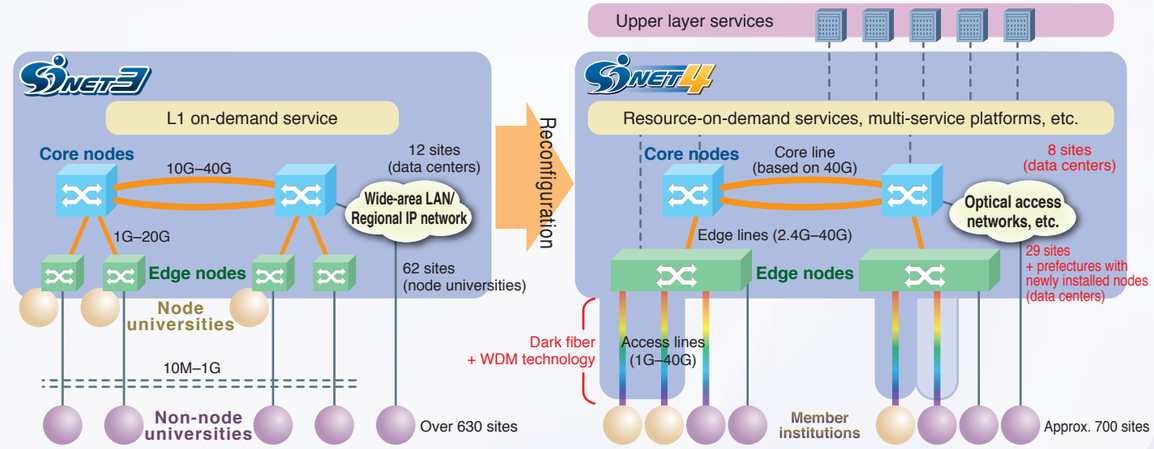
Developing the Human Resources to Build a Better Shikoku Based on the Collective Results of the “Knowledge of Shikoku” Project
Outline: Training of human resources for community development by eight partner universities in Shikoku, using SINET as high-speed information infrastructure
Institutions: Kagawa University, The University of Tokushima, Naruto University of Education, Ehime University, Kochi University, Shikoku University, Tokushima Bunri University, Kochi University of Technology **Services:** IP Dual

About SINET4

SINET4, the next-generation Science Information Network, will start operation in April 2011.

SINET4 Development Goals and Architecture

Higher network speed: Higher speeds will be achieved economically by reconfiguring the network and adopting solutions including dark fiber and WDM technology.
Higher edge stability: Both edge nodes and core nodes will be located at data centers.
Elimination of service gaps: High-speed access will be extended to non-node universities, and all prefectures will have at least one node.
Upper layer deployment: Interfaces and multi-service platforms will support upper layer services.
Greater ease of use: SINET4 will inherit SINET3's architecture, with services such as resource-on-demand strengthened and expanded.



SINET4 Network Configuration

Core nodes: Core nodes will be integrated, for a final total of eight.
Edge nodes: Edge nodes in the same prefecture will be integrated as far as possible. In areas with core nodes, the edge nodes will be integrated with them. The number of prefectures with no node locations (13 at present) will be gradually reduced; four will acquire their first node in fiscal 2011.
Line configuration: The number of hops required to reach Tokyo or Osaka will be reduced as far as possible, and rerouting will be provided in case of failures.