National Institute of Information and Communications Technology

NICT

Greetings from the President

As Japan's sole public research institute specializing in the field of information and communications technology (ICT), the National Institute of Information and Communications Technology (NICT) is charged with propelling research and development in ICT from its fundamentals through application areas. At the same time, we aim to spread and roll out our R&D outcome in society and create innovation, in cooperation with universities, industry, local governments, and research organizations in Japan and overseas.

In recent years, as the fact that we cannot pass a day without individual ICT terminals indicates, ICT is the most basic and indispensable function which supports business activities and people's lives. Moreover, IoT (Internet of Things) environment, in which everything that exists surrounding us, in addition to the terminals such as PCs and smartphones, are connected to a network, has been created, and various connected services are being realized.

The newly connected services and data are raising innovation to create new values in a variety of fields. Because of contribution of these new ICT, cyber space is going even further to enhance and expand. The fusion of the cyber space and real space is progressing rapidly, and a cyber-physical space, as a new life space, has been formed. In addition, not only "benefits to be connected" but "risk caused by being connected" is also expanding, thus cyber security and privacy protection have become important issues.

In the midst of this, the entire social system is needed to change to a form suitable to the cyber-physical space.

In order to demonstrate its potential fully in the new paradigm, in the Fourth Medium- to Long-Term Plan that started from April 2016, we are devoting ourselves to tackling the world's leading edge fundamental and basic R&D for ICT, based on these five foundations:

- "Watch" the real world through ICT
- "Connect" society through wireless and optical communications technologies
- "Create" new value through data utilization, etc.
- "Protect" society from sophisticated and complicated cyber attacks
- "Develop" new horizons of information and communications,

In addition, improving the quality of research and development, in order to more effectively implement our achievements to society, it is essential to build a system of collaboration among industry, universities, local governments, and research institutions at home and abroad. NICT, as a hub for open innovation in the field of ICT, will comprehensively promote broad range of efforts, in close cooperation with relevant parties, from the basic and fundamental research and development to support for new business activities, and will continue to contribute to the realization of a new social system.

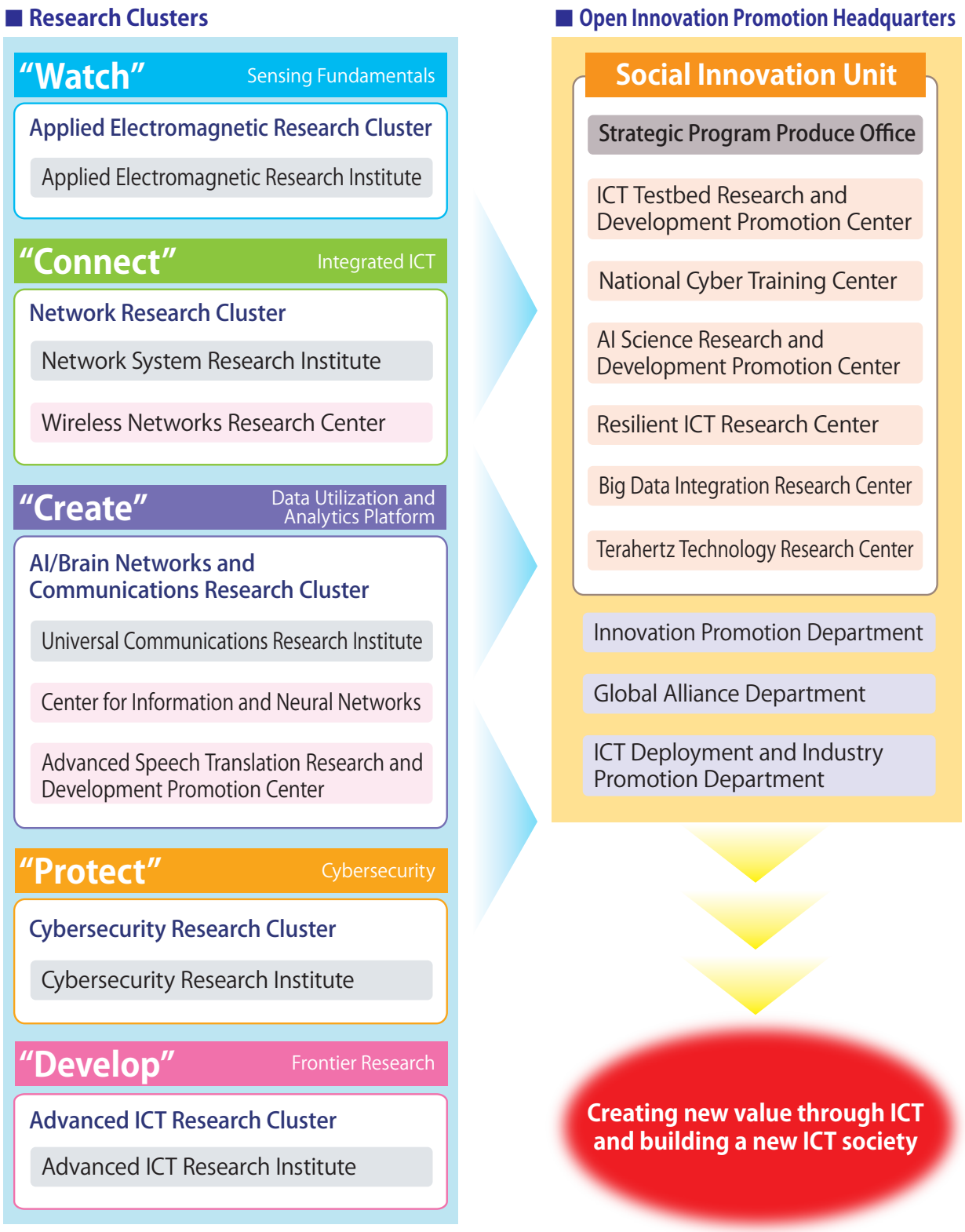
NICT will work hard toward the development of information and communications, which are the foundation of social and economic activities. We look forward to your support and cooperation in this endeavor.

Dr. Hideyuki TOKUDA

President
National Institute of Information and Communications Technology

As the only public institution that specializes in ICT, NICT promotes research and development, comprehensively carries out collaboration with industry, academia, and government and business promotion, etc., and works toward the realization of an affluent, safe and secure society.

NICT R&D and Open Innovation Promotion System

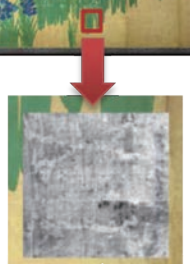


This is the field where we "watch" the real world through ICT.
We work on R&D in technologies to observe and collect information on various phenomena and conditions surrounding human society by safely utilizing electromagnetic waves (radio waves to light).
These technologies enable early detection of atmospheric phenomena such as localized torrential rain, wide-range ascertainment of disaster conditions such as earthquakes, stable use of radio infrastructure for aircraft operations, etc.

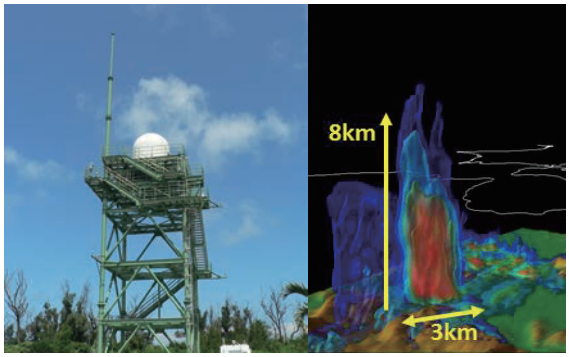
Remote sensing technology

We aim to improve monitoring and forecasting technology for severe atmospheric phenomena such as localized torrential rainfalls, and R&D on the technology necessary for early detection of precursory phenomena and understanding of development mechanisms. In addition, we are working on R&D for performance advances in synthetic aperture radar (SAR), which is capable of rapid ascertainment of disaster situations such as earthquakes, global monitoring and prediction technology for climate and weather, and nondestructive sensing technologies for cultural assets.

Nondestructive sensing via electromagnetic waves of the "Eight Bridges" folding screen by Ogata Korin (image courtesy of: Metropolitan Museum)



In this example of nondestructive sensing, gold leaf is revealed by its uniform reflection under the paint



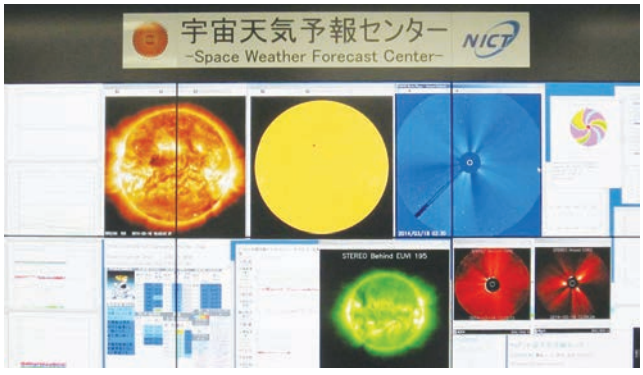
Phased array weather radar (left), example of 3-dimensional structure of rainfall (right)

Space environment measurement technology

We accurately measure the ionospheric conditions etc., that impact radio wave propagation such as short-wave communications and satellite positioning, contributing to stable use of radio infrastructure for aircraft operation, etc.

In addition, we conduct R&D on technology for measurement and prediction concerning the space environment, which is indispensable to the stable operation of satellites, and technology for radio observation systems and solar wind propagation models for solar activity monitoring.

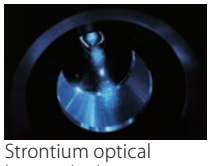
Solar wind observation satellite data receiving antenna



Space Weather Forecast Center

■ Space-time standards technologies

We conduct R&D on fundamental technologies for generating, evaluating, and utilizing precise time and frequencies. Our activity includes the generation and dissemination of Japan Standard Time with a high degree of stability and reliability, development of highly precise frequency standards (atomic clocks) and their remote comparisons, which are accommodated to the future definition of the second, and development of real applications that take advantage of accurate time and frequencies.



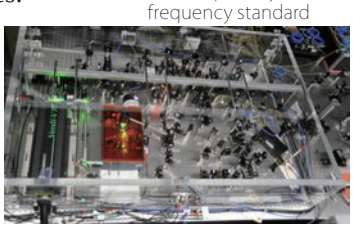
Strontium optical lattice clock

Cesium primary frequency standard

Japan Standard Time generation system

34-m antenna (Kashima)

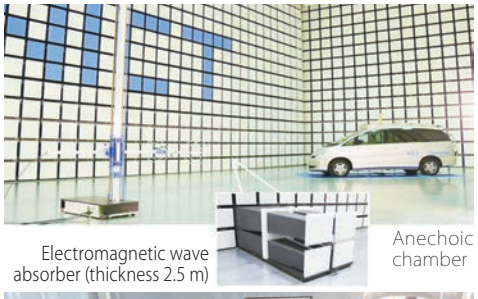
Satellite receiver antennas



Optical frequency comb

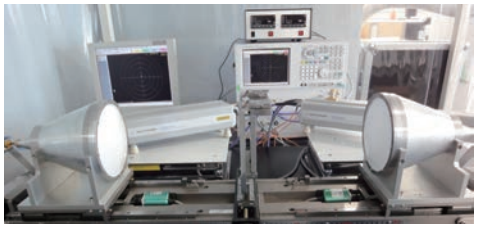
■ EMC technologies

We conduct R&D on technologies with the capability to measure unwanted electromagnetic waves emitted from communications equipment and consumer electronics devices with high bandwidth and high-precision for the maintenance of clean electromagnetic environments. We also conduct R&D on technologies for evaluating human exposure to electromagnetic waves that are required for assuring radio wave safety. With these efforts, we contribute to the establishment of national and international technical standards for the electromagnetic environment, and to the development of safe and secure ICT technologies.

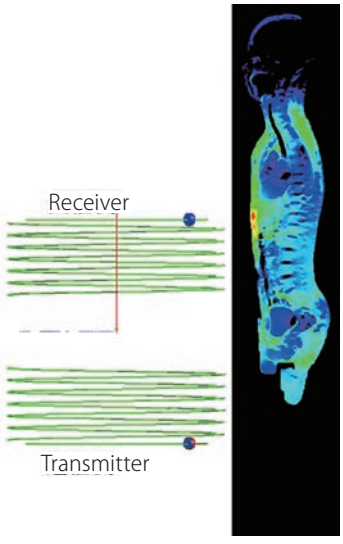


Electromagnetic wave absorber (thickness 2.5 m)

Anechoic chamber



Electric constant measurement system for biological tissue in the millimeter-wave band



Numerical analysis of induced electric fields in the human body in the proximity of wireless power transmission systems

Technological field that “connects” society through wireless and photonics communication technologies. With the aim of realizing networks to handle the explosive increase in communications volume following the 5G (5G mobile communications system) era and new value creation and the revolution in the social system of the IoT (the Internet of Things) era, we work on R&D on fundamental technologies to bring ICT together.

Innovative network architecture technologies

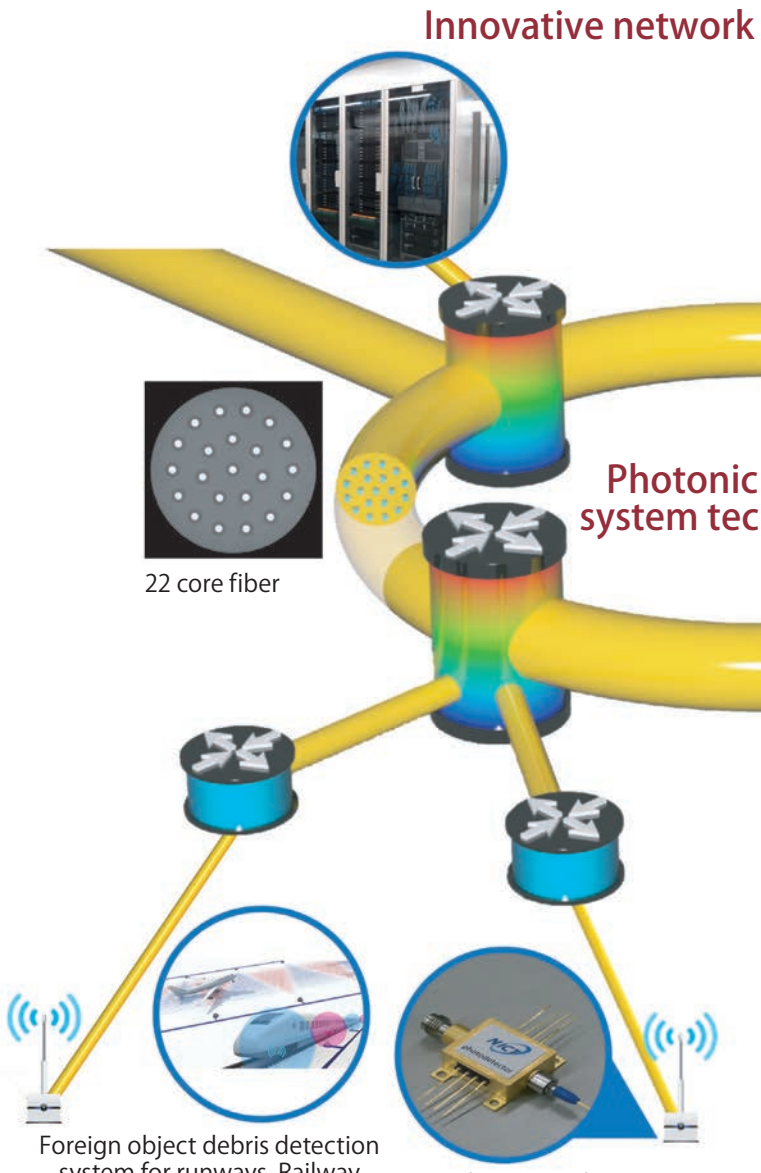
We perform research into key enabling technologies to realize innovative networks able to support a myriad of future IoT services and the rapidly evolving cloud technology. In particular, we pursue research on technologies for ‘automation of dynamic, on-demand network configuration and control’ and ‘efficient information dissemination and sharing based on information-centric networking concepts’.

Photonic network system technologies

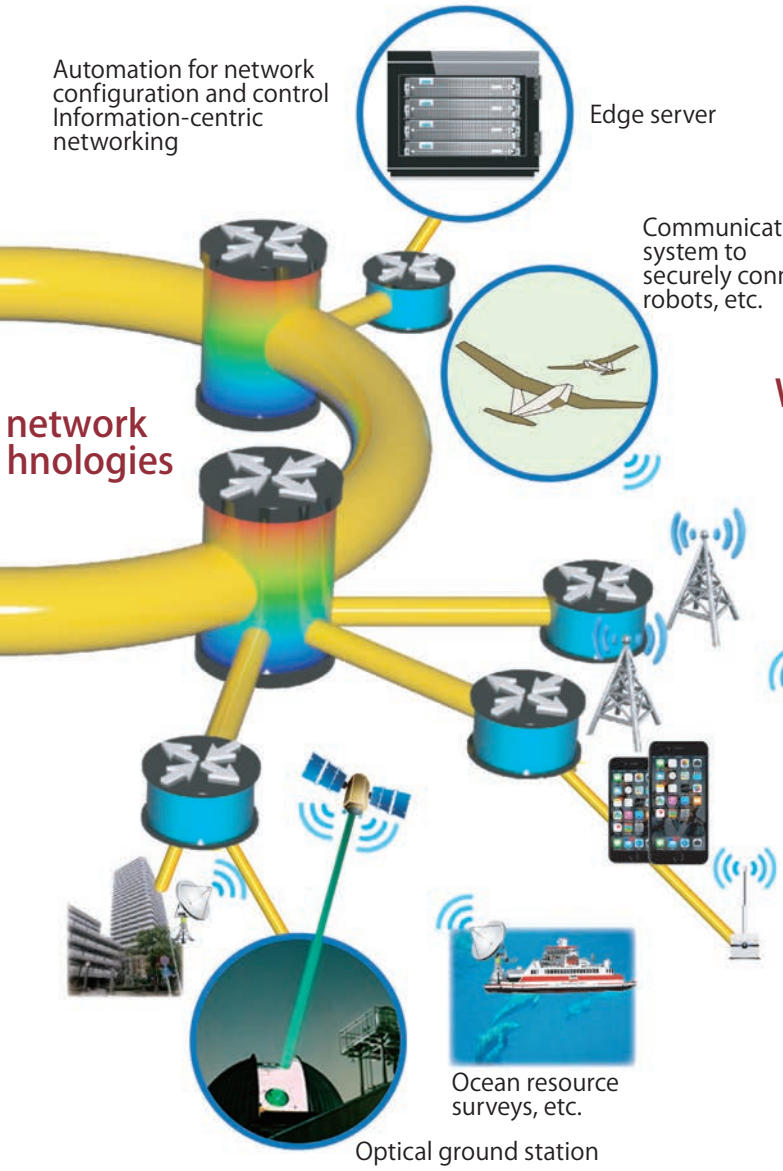
We perform research into ultrahigh-capacity multi-core fiber transmission technologies and optical integrated network technologies to meet the increased demand for data services, predicted to increase by three orders of magnitude from today by 2020. This research includes investigation of both high-capacity point-to-point transmission and fully dynamic, flexible network systems able to accommodate rapid traffic fluctuation and the diversification of data services.

Optical access device technologies

Toward the beyond-5G era, we conduct R&D on ICT hardware technology for the efficient convergence of optical and ultra-high-frequency electromagnetic waves to realize highest transmission capacity/distances and unlimited transmission medium optical access networks. In addition, we aim to establish technologies to enable 100 Gbps-class high capacity communications to end users.



architecture technologies



Satellite communications technologies

■ Wireless network technologies

Wireless networks will play a vital role in the IoT and 5G eras and thereafter. Therefore, we conduct R&D on network technologies compatible with systems that utilize robotics technologies, etc., data collection systems compatible with Big Data, and intelligent transport systems, and the like. In addition, we are working on research on the development of unexplored frequency domains involving wireless regions and radio wave propagation characteristics.

Wireless network technologies

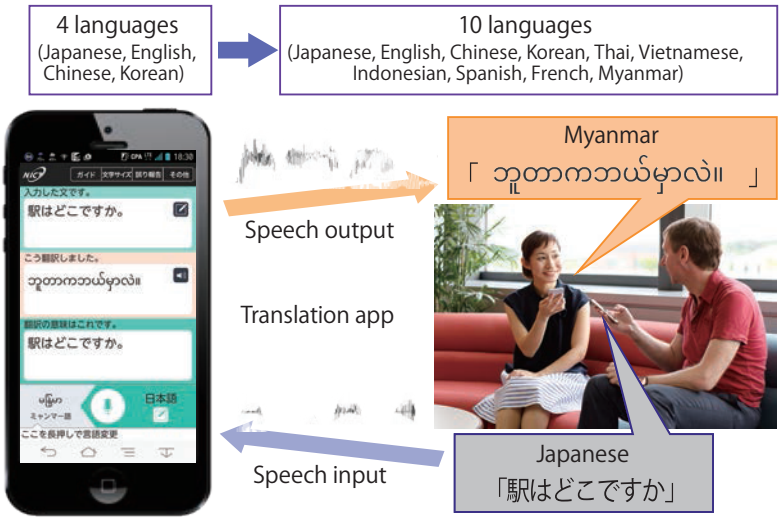
■ Satellite communications technologies

We are promoting R&D on optical satellite communications network technologies to achieve the higher speeds and larger communication capacity that will be necessary along with the increasing sophistication and diversification of the satellite missions, and the onboard laser communication equipment which enables 10 Gbps-class optical data transmission. In addition, for the next engineering test satellite, we are working on R&D on broadband satellite communications network technologies for marine, aviation, emergency, and the like.

This is a fundamental area to “create” new value through data utilization.
We conduct R&D on fundamental technologies for the creation of new knowledge and value through the application of artificial intelligence and big data analysis, as well as brain information communications, and the like. From the ICT standpoint, we will conduct studies using the huge amounts of information in the world as well as studies on human brain function, and aim to establish fundamental technologies that will be utilized in a variety of real world activities.

■ Advanced speech translation and dialogue system technologies

In order to realize free communications beyond the boundaries of language, we conduct R&D on automatic translation technology to handle translation of speech and dialogue on a practical level as well as long sentences in speech. In one of these efforts, we are aiming at the practical use of a speech translation system covering 10 languages in such aspects of living as travel, medical care, and disaster prevention for the Tokyo 2020 Olympic and Paralympic Games.

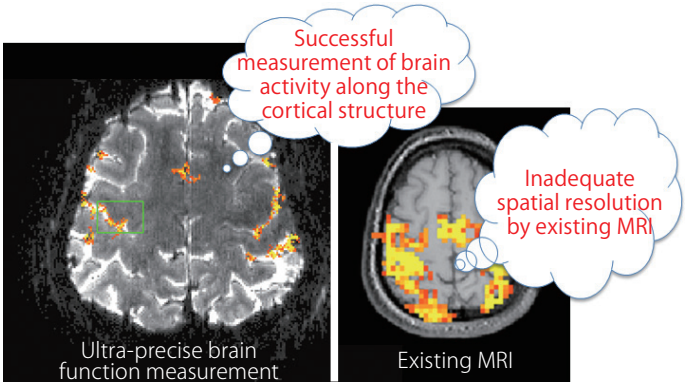


VoiceTra, a multilingual speech translation app for smartphones

■ Brain-inspired information and communications technology

We conduct research and development in the field on brain-inspired information processing. For example, we study brain network organization underlying human cognition and behavior, and build assistive technologies designed to enhance human experience as well as support elderly and disabled people. We engage in research to build new technologies, ranging from using brain-imaging methods to evaluate products and services, to the design of robots capable of sensing human emotions.

7T-MRI

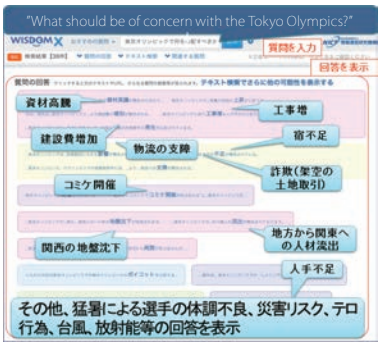


An example of ultra-precise brain function measurement

This indicates that the measurements were done so precisely that it was even possible to recognize that brain activity is occurring along the cerebral cortex.

■ Social wisdom analysis technologies

We do research and development on natural language processing technologies on textual big data, in order to allow anyone to identify and extract useful expert knowledge (social wisdom) from the large amount of texts that our society produces, and to help her/him to conduct proper decision-making by consulting the social wisdom. We also conduct research on technologies to extract disaster-related information in real-time from the internet and other information sources, and provide this in an easily understandable way.



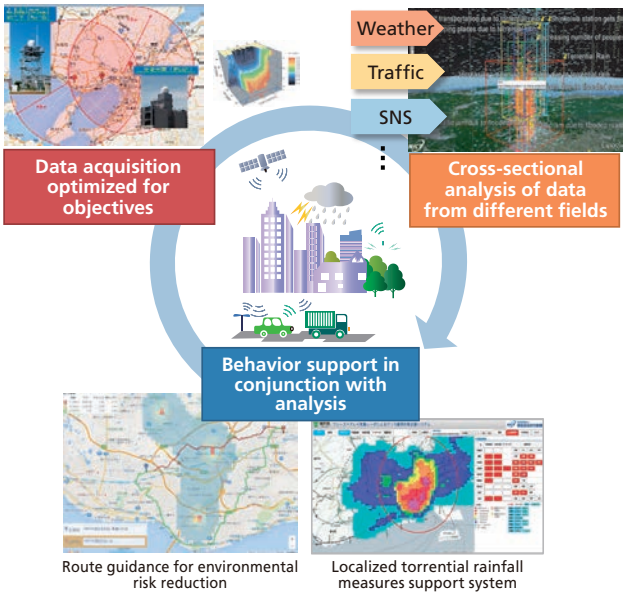
WISDOM X, large-scale Web information analysis system, publicly available
http://wisdom-nict.jp/ (Japanese only)

Example of results provided by DISAANA, DISAster information ANAlysis system, publicly available
http://disaana.jp/ (Japanese only)

■ Real-space data analysis technologies

We conduct R&D on data acquisition and analysis technologies or data mining technologies in order to collect and analyze real space information including environmental data acquired from a variety of sensors and devices, and social data related to social living cross-sectionally, so that the impact on specific social systems such as traffic due to flash rainstorms or environmental changes can be analyzed as model cases.

In addition, we are developing and testing fundamental technologies for feedback of analysis results and to provide advanced situational awareness and behavioral support, to optimize and heighten the effectiveness of social systems.

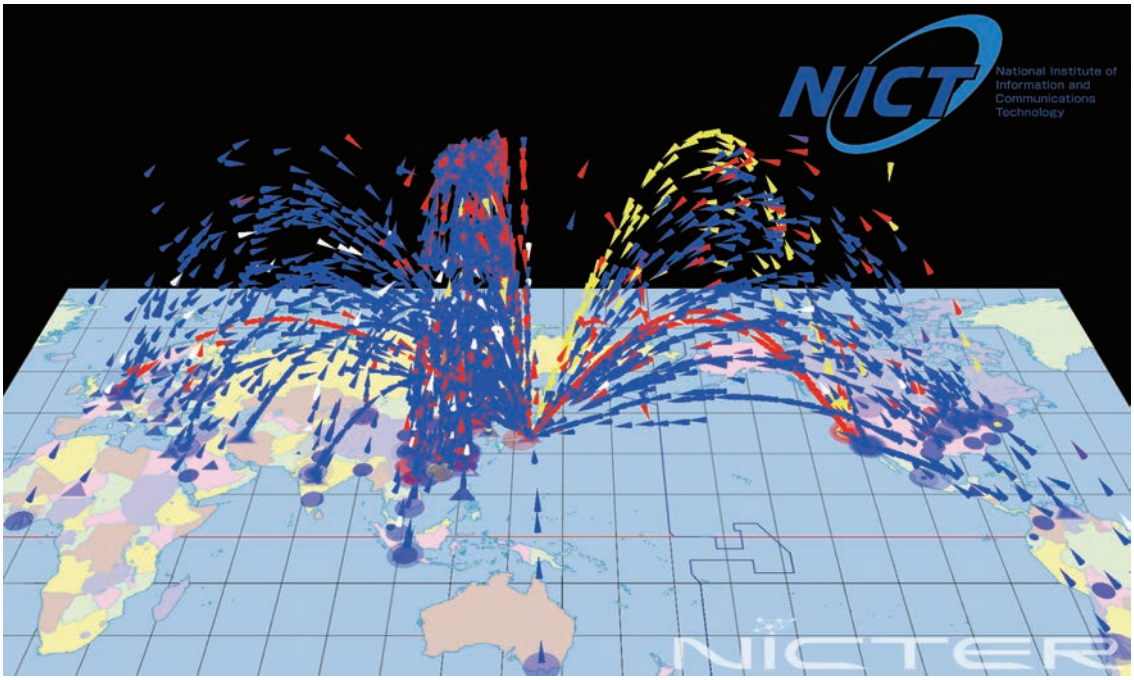


Real-space data analytics technologies

This is a technological field to “protect” society from cyber-attacks that are becoming more sophisticated and complex. We conduct R&D on state-of-the-art cyber-security technologies for tactically countering cyber-attacks and also cryptographic technologies to support the safety and security of society from the theoretical aspect. For improved security in Japan, we will also dedicate to enhance real-world deployment of R&D outcomes.

Cybersecurity technologies

We conduct R&D on cutting edge cyber-attack monitoring and analysis technologies, to enhance cyber protection capability on such things as government agencies, local government, academic institutions, companies, and critical infrastructure. In addition, we aggregate information related to cyber-attacks on a massive scale and establish multimodal analysis and automated countermeasures technologies. Furthermore, we aim to promote quick R&D outcome deployment.



NICTER, Network Incident analysis Center for Tactical Emergency Response

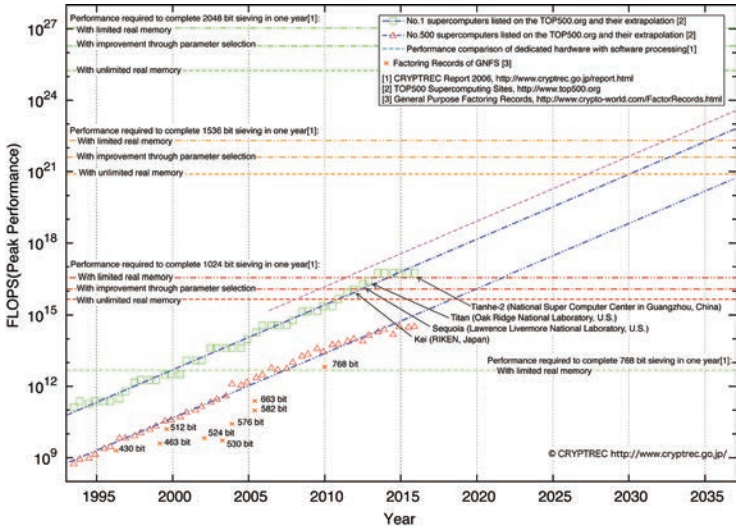
DAEDALUS counter-cyber-attack alert system

NIRVANA Kai cyber-attack integrated analysis platform

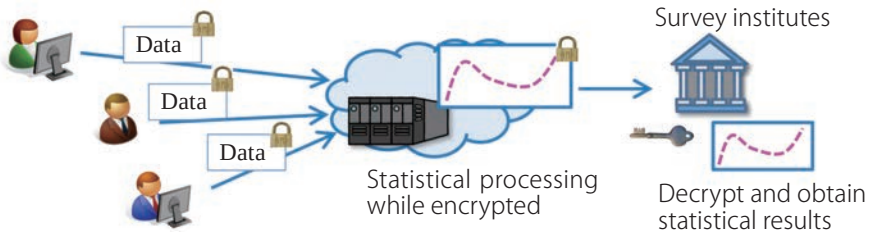
Cryptographic technologies

We conduct R&D on encryption and authentication technologies and cryptographic technologies with new functionalities to build safe and secure ICT systems as well as to meet new social needs associated with IoT evolution.

In addition, we will promote the security evaluation of new cryptographic technologies and dissemination of these to a variety of systems that support people's lives, as well as promote R&D on privacy protection technologies for practical utilization of personal data.



Security evaluation of cryptographic technologies in wide use in society
(Figure of RSA public-key cryptosystem)



Clustering big data while encrypted

Security testbed development and operations technology

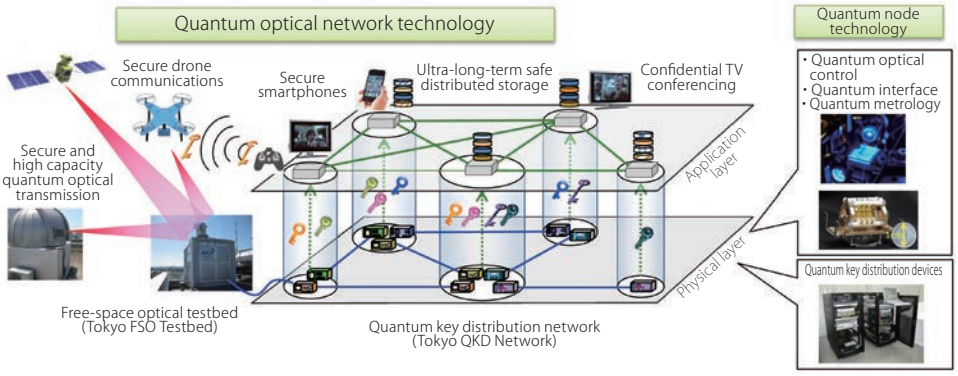
We conduct R&D on technologies for emulating cyber-attacks in a safe environment, and construction of security verification platforms that will be indispensable for verifying newly developed protection technologies. In addition, our technologies will provide support for offering of cyber exercises for human resources development in the cyber security field.

Portable cyber exercise pack

"Developing" new horizons in the fields of research in information communications technology.
We are working on R&D in leading edge and fundamental technologies for aggressive innovation in the ICT area. To share expertise and technology from a broad range of research areas, we are blazing the path to different approaches and methods from existing ICT, and will establish new concepts and new frameworks to serve as the basis for ICT to support a prosperous, safe and secure society of the future.

Quantum info-communications technology

We develop quantum optical network technology to realize quantum key distribution secure against interception and deciphering risk at any time in the future, and quantum optical transmission enabling a flexible control of the balance between transmission efficiency and safety in line with the purposes of use. In addition, we work on fundamental R&D on quantum node technology for precision control of the quantum-mechanical characteristics of light and matter, which are foundational to the development of quantum optical networks. From creation of new theories, to proof-of-concept experimentation, to trial operation on the testbed, we will contribute to society by making end-to-end efforts, both in terms of development of basic science and transfer of technology to industry.

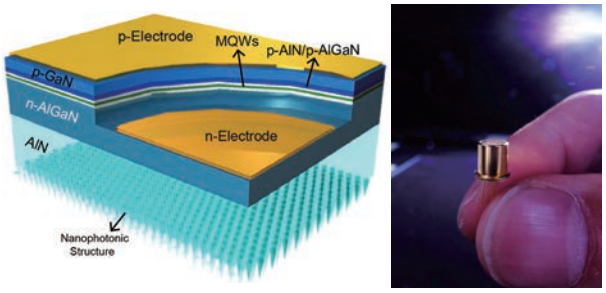


Overview of quantum optical network and quantum node technologies

Novel ICT devices

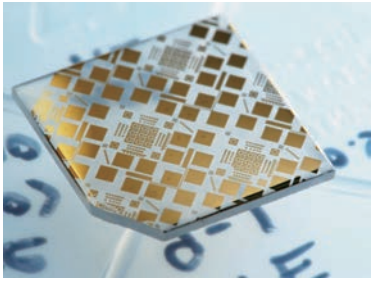
We conduct R&D on fundamental technologies for electronic devices that leverage the superior physical properties of such new semiconductor materials as gallium oxide, aiming at practical implementation in high-efficiency electronic devices and information communication devices that can be used in extreme environments based on these research outcomes. In addition, we conduct R&D on technology for use in realization of deep-UV optical ICT devices, for which uses are highly anticipated in a wide variety of fields like ICT sterilization, the environment, and health care.

Deep-UV optical ICT devices



Schematic and photograph of AlGaN-based deep-UV LED devices

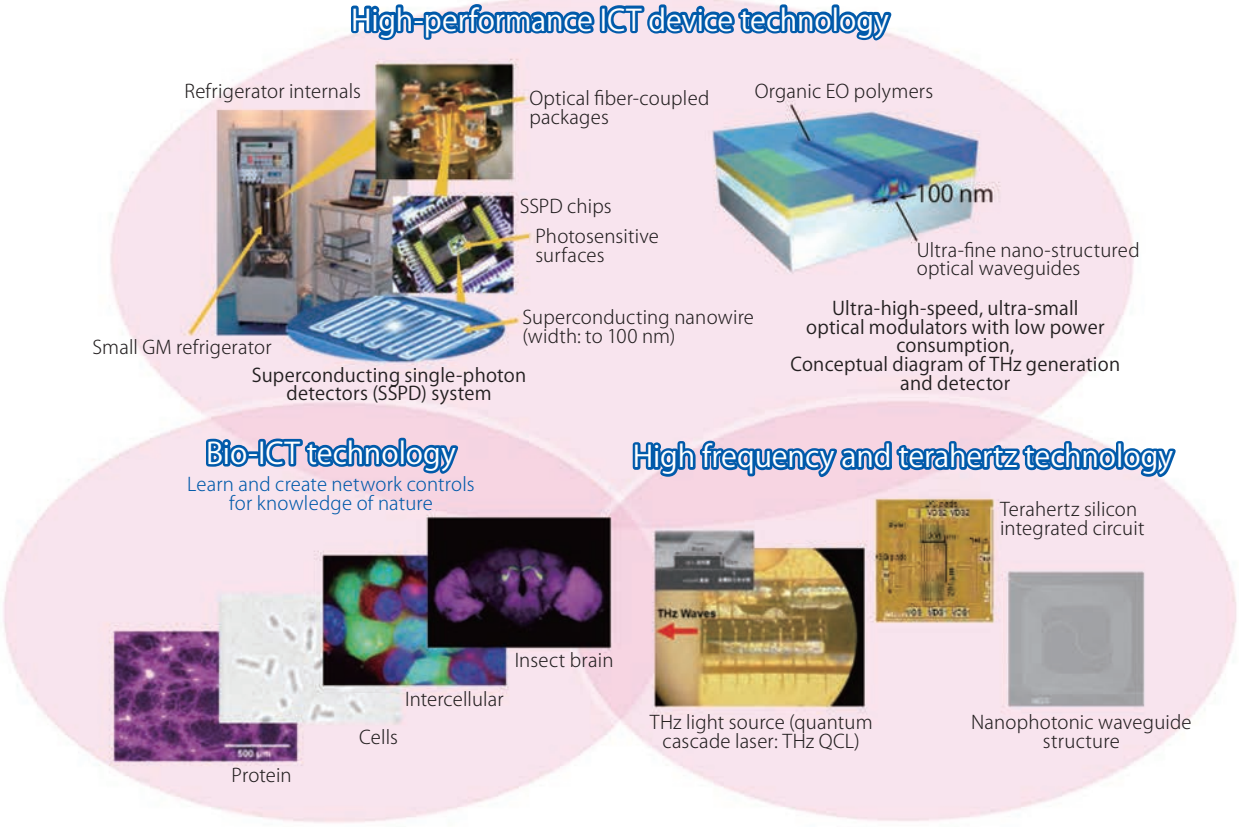
Oxide semiconductor electronic devices



Ga_2O_3 power device chip

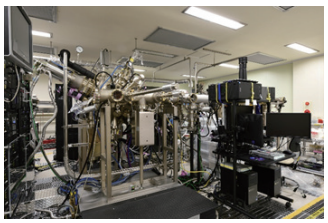
Frontiers in ICT

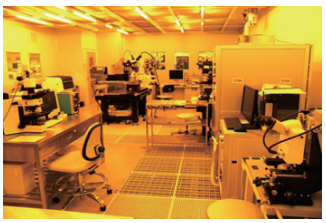
We conduct R&D on high performance ICT device technologies to dramatically facilitate solutions to problems involving communications speeds and power consumption. In addition, we contribute to the development of unexplored frequency regions through R&D on wireless communication systems that use the terahertz band. Furthermore, we conduct R&D on technologies for systems for such things as measurement, evaluation, and copying using information transmission and processing for organisms.

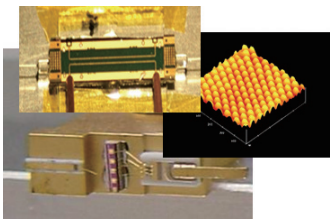


Advanced ICT Device Lab

The Advanced ICT Device Lab is a broad open research facility, serving as an open innovation base for the collaboration among industry, academia, and government. We promote advanced hardware development research for device design, testing, implementation, and evaluation, to create innovative device technologies for communications over a convergence of all optical and ultra-high frequency radio wave regions.


High-quality, semiconductor crystal growth apparatus


High resolution lithography


High-speed, broadband optical devices using nanostructures

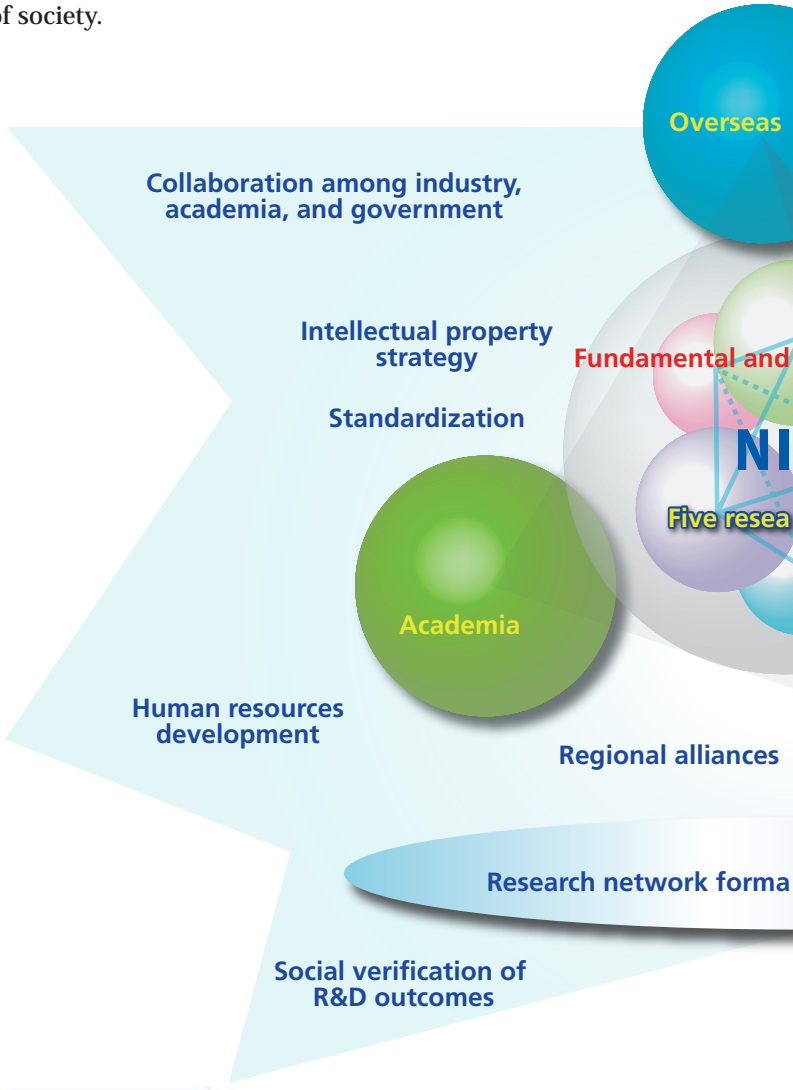
Innovation

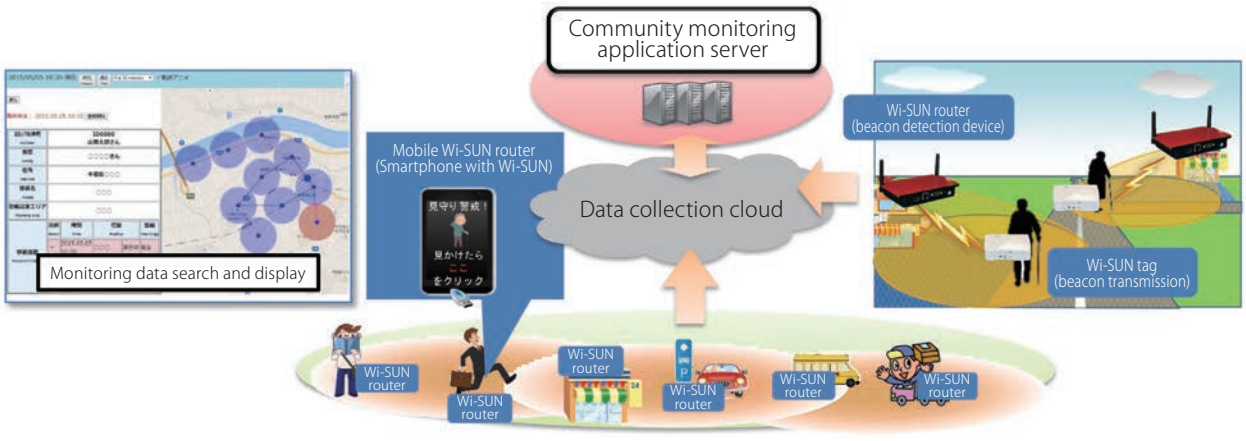
Creating innovation and new value for society

As a public R&D organization, NICT is expected to serve as a base for open innovation to promote industry-academia-government collaboration, regional cooperation, and international cooperation to realize an environment that produces innovation through ICT.
At the Open Innovation Promotion Headquarters, in order to meet these expectations, we promote strategic cooperation while effectively carrying out technological demonstrations and public demonstrations, thus contributing to the ICT transformation of the whole of society.

Resilient ICT Research Center
(Tohoku University, Katahira Campus)

Practical cyber-defense exercises (CYDER)





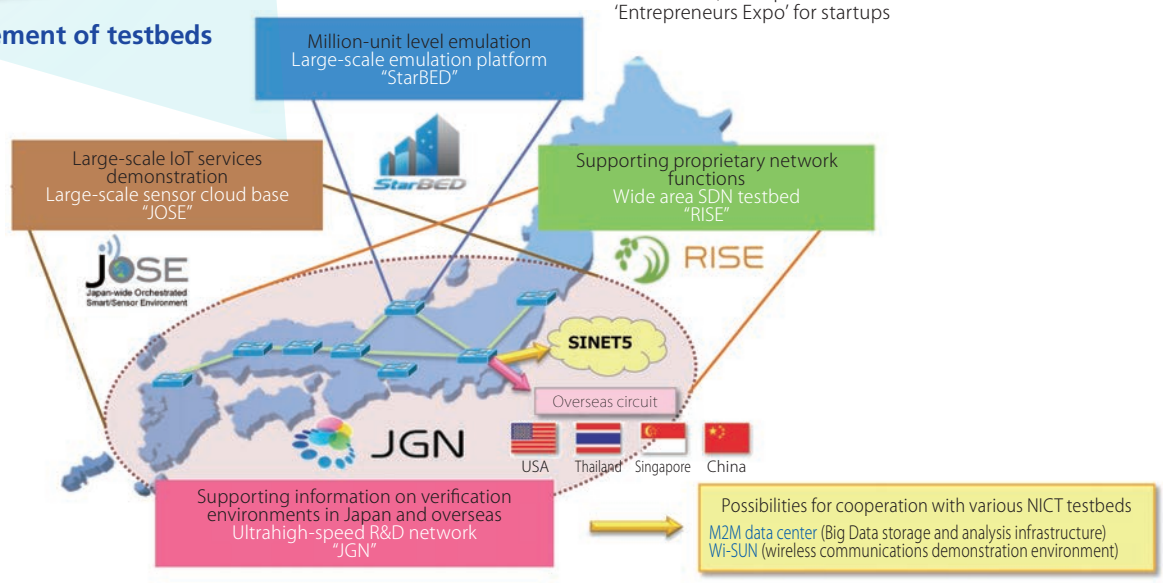
Elderly monitoring system utilizing Wi-SUN

Open Innovation Promotion Headquarters efforts

- Building testbeds to enable technological demonstrations and social verification
- Reinforcing efforts for open innovation creation
- Promoting efforts for realization of resilient ICT
- Promoting strategic standardization activities and intellectual property utilization
- Strengthening international dissemination of R&D outcomes
- Supporting ICT venture creation

Workshop on Rural ICT (Phnom Penh, Cambodia)

Pitch events, 'Entrepreneurs Koshien' for students and 'Entrepreneurs Expo' for startups



NICT Overall Testbed conceptual diagram

NICT primary facilities

Koganei-shi and Kodaira-shi, Tokyo

Headquarters

Applied Electromagnetic Research Institute
Network System Research Institute
Cybersecurity Research Institute
Open Innovation Promotion Headquarters
ICT Testbed Research and Development Promotion Center
National Cyber Training Center
AI Science Research and Development Promotion Center
Terahertz Technology Research Center
Big Data Integration Research Center

Nomi-shi, Ishikawa (Ishikawa Science Park)

Hokuriku StarBED Technology Center

Seika-cho, Souraku-gun, Kyoto (Keihanna Science City)

Universal Communication Research Institute
Advanced Speech Translation Research and Development Promotion Center

Kobe-shi and Akashi-shi, Hyogo

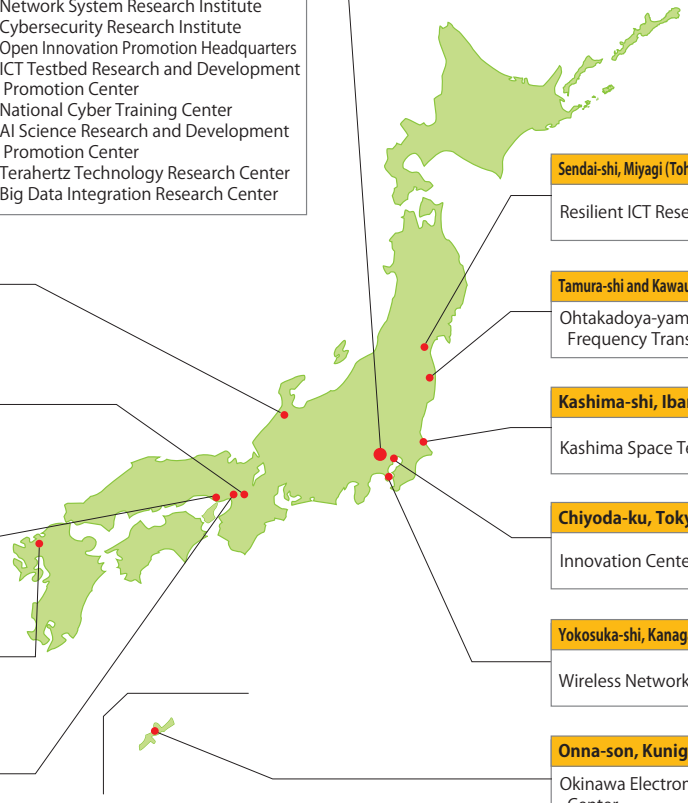
Advanced ICT Research Institute

Saga-shi, Saga and Itoshima-shi, Fukuoka

Hagane-yama LF Standard Time and Frequency Transmission Station

Suita-shi, Osaka (Osaka University Suita Campus)

Center for Information and Neural Networks



Sendai-shi, Miyagi (Tohoku University Katahira Campus)

Resilient ICT Research Center

Tamura-shi and Kawauchi-mura Futaba-gun, Fukushima

Ohtakadoya-yama LF Standard Time and Frequency Transmission Station

Kashima-shi, Ibaraki

Kashima Space Technology Center

Chiyoda-ku, Tokyo

Innovation Center

Yokosuka-shi, Kanagawa (Yokosuka Research Park)

Wireless Networks Research Center

Onna-son, Kunigami-gun, Okinawa

Okinawa Electromagnetic Technology Center

History

● Communications Research Laboratory (CRL) ● Telecommunications Advancement Organization (TAO)

Oct. 1896: ● Radio Telegraph Research Division is established as a part of the Electrotechnical Laboratory, Ministry of Communications
Jan. 1915: ● Hiraiso Branch opens
May 1935: ● Testing and Examination for Radio Equipment Type Approval starts
Jan. 1940: ● Frequency Standard Radio Service (JJY) starts (Kemigawa)
Jun. 1948: ● Radio Physics Laboratory is integrated
Aug. 1952: ● Radio Research Laboratory is established
May 1964: ● Kashima Branch opens (30-m diameter Parabola Antenna Facility completed)
Aug. 1979: ● Communications and Broadcast Satellite Organization (CBSO) is established
Aug. 1982: ● Kimitsu Satellite Control Center opens
Apr. 1988: ● Reorganized from Radio Research Laboratory to Communications Research Laboratory
May 1989: ● Kansai Branch opens (Kobe)
Oct. 1992: ● Renamed as the Telecommunications Advancement Organization (TAO) Commencement of advanced communication and broadcasting research and development
Jul. 1997: ● Yokosuka Radio Communications Research Center is established
Jul. 2000: ● Keihanna Info-Communication Research Center is established
Jan. 2001: ● Ministry of Posts and Telecommunications becomes Ministry of Public Management, Home Affairs, Posts and Telecommunications
Apr. 2001: ● Communications Research Laboratory, Incorporated Administrative Agency is established
Jul. 2001: ● Promotion system on facilitating research and development in private basic technology commences
Mar. 2002: ● Satellite control operations are terminated
Apr. 2003: ● Partial takeover of operations of Promotion Center for Facilitating Research and Development in Private Basic Technology
Apr. 2004: National Institute of Information and Communications Technology, an incorporated administrative agency (NICT) is established by merging CRL and TAO
Apr. 2012: Resilient ICT Research Center is established
Apr. 2013: Center for Information and Neural Networks is established
Apr. 2015: Renamed as National Institute of Information and Communications Technology, National Research and Development Agency

National Institute of Information and Communications Technology

4-2-1, Nukui-Kitamachi, Koganei, Tokyo 184-8795
URL：http://www.nict.go.jp/en/
For inquiries about NICT, please contact Public Relations Department.
Tel：+81-42-327-5392　Fax：+81-42-327-7587
E-mail：publicity@nict.go.jp

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