Japan’s “Sixth Science, Technology and Innovation Basic Plan” (1) calls for the realization of Society 5.0 as the society of the future we should aim for. In addition, the fourth interim report on “New Information and Communications Technology Strategy” (2) emphasizes the promotion of R&D for, and implementation in society of, information and communications technology (ICT), which is the foundation of all industrial and social activity.

Based on the government’s policy, NICT’s fifth mid-to-long-term plan (April 2021 to March 2026) inherits the “five priority R&D areas” of the fourth mid-to-long-term plan, and promotes open innovation by widely disseminating our R&D results within society. The “five priority R&D areas” are the areas of Advanced electromagnetic technology, Innovative networks, Cybersecurity, Universal communication, and Frontier science. We are working on advanced, basic, and foundational themes in each area from a medium-to-long-term perspective. In addition, we will promote cross-sectional and strategic R&D in four research fields that should be pursued strategically (the “four strategic fields”).

The strategic fields are:
- Beyond 5G
- AI
- Quantum ICT
- Cybersecurity

NICT’s Beyond 5G R&D aims to establish elemental technologies and architectures for the next generation of fifth generation mobile communications systems (5G) and their implementation in society. In AI, we will work to establish simultaneous interpretation technology at the practical level to realize the human-centered society that Society 5.0 is aiming to create. In the field of Quantum ICT, we will establish technologies for the realization of an integrated satellite/terrestrial quantum network, including unbreakable quantum cryptography and quantum-node technology. In the field of Cybersecurity, we aim to establish technology to deal with cyberattacks by aggregating and analyzing relevant information, and technology to ensure safety even in an age of quantum computers.

Collaboration across fields is also important for building a total system that links elemental technologies in addition to advancing them. Through these activities, NICT is promoting open innovation in order to contribute to solving social and regional issues, digital transformation, and value creation in social systems for the new era, and achieving SDGs, including diversity and sustainability.

NICT will maximize the results of these initiatives, with the entire organization working together for the development of information and communications technology, the most important social infrastructure. We appreciate your support and cooperation.

National Institute of Information and Communications Technology
President TOKUDA Hideyuki

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(1) Cabinet decision dated March 26, 2021
(2) Information and Communication Council (IIC) Interim Report dated August 5, 2020
Advanced Electromagnetic Technology Area

Remote Sensing Technology
Space Environment Technology
Electromagnetic Compatibility Technology
Space-Time Standards Technology
Digital-Optics Technology

Radio Research Institute

To realize the smart life of the future
Radio Research Institute engages in R&D of various technologies related to "electromagnetic waves," such as radio waves and light, and promotes activities related to utilizing those technologies in society. Currently, human societies are trying to integrate cyberspace (virtual space) and physical space (real world) to balance both economic development and solutions for societal problems.

Radio Research Institute is conducting a variety of research to realize the functions of: "sensing (measurement/observation)" - aggregating information from the physical space into cyberspace using various sensors; "processing (information processing)" - creating "future visions" in cyberspace by analyzing various kinds of data; and "actuation (operation/actions)" - creating action affecting physical spaces by utilizing data in cyberspace. The results obtained from our research will make it possible to identify changes promptly and precisely in climate and space environments, and correctly assess social conditions, including disaster situations. We will also be able to make highly accurate predictions of the future to realize a smart life in the real world.

Cutting-edge technologies utilizing the properties of electromagnetic waves

- Remote sensing technology involves R&D on technologies to observe desired targets from the ground, aircraft, or satellites and technologies for advanced analysis of the obtained data, which contributes to disaster prevention and mitigation, monitoring of global climate change, improvement of prediction accuracy in weather forecasts, etc., and elucidation of the mechanisms of global warming and water circulation (photos 2 and 6).

- Space environment technology involves R&D for technologies to improve the monitoring (photos 1 and 7) and forecasting concerning the space environment, which is affected by solar activity, leading to stable use of radio waves and maintenance and management of societal infrastructure.

- Space-time standards technology involves setting standard national frequencies, transmitting standard frequency by radio waves (photo 4), disseminating stable and highly accurate Japan Standard Time (photo 5), and developing optical frequency standards and portable atomic clocks.

- Digital-optics technology involves R&D on optical elements using diffraction of light, and precision optical measurement technology, as well as implementation and industrial deployment for highly efficient and inexpensive optical communication modules, head-up displays, next-generation AR systems, and next-generation advanced microscopes (photo 8).

NICT also provides space weather forecasts (https://swc.nict.go.jp) continuously, 24 hours a day, seven days a week.

Electromagnetic compatibility technology involves R&D to ensure electromagnetic compatibility (EMC), which is essential for smooth interoperability of communication devices and electric/electronic devices and for secure and safe use of new radio wave systems (photo 9). NICT also provides calibration services to inspect the performance of radio equipment indispensable for socioeconomic activities.

Electromagnetic spectrum and its uses

Radio wave
Light
Ionizing radiation
Infrared
Ultraviolet
X-ray
Gamma ray

100 km
10 km
3 km
30 kHz
300 kHz
1 km
1 m
10 m
100 m
1 mm
10 mm
100 mm
100 ìm
3 THz
VLF
MF
HF
VHF
UHF
Microwave
Millimeter wave
Submillimeter wave
Standard frequency and time signal service
AM broadcasting
FM broadcasting
GNSS
Wi-Fi
TV
Cellular phone
Rainfall radar
Anti-collision radar

Radio Research Institute makes our future safer and richer using electromagnetic waves.
Innovative Networks Area

Computing and AI-Enabled Networking Technology
Next-Generation Wireless Technology
Photonic Network Technology
Optical and Radio Convergence Technology
Space Communications Fundamental Technology
Terahertz Wave ICT Platform Technology
Resilient ICT Technology for Severe Physical Environment

Network Research Institute
Driving R&D on network technologies supporting Beyond 5G and dissemination of R&D outcomes

Toward the realization of Beyond 5G
Network Research Institute conducts R&D on establishing network toward Beyond 5G to support the society in the 2030s, such as the SDGs. In particular, we conduct R&D on basic and system technologies in the area of optical, wireless (terrestrial, satellite), and networking to realize ultra-wideband, ultra-low latency, and resilient communications. The institute collaborates with companies and universities to innovate basic technologies of networks and aims to standardize and to disseminate the technologies.

Extension of three-dimensional seamless networks
For the coming Beyond 5G, it is expected to integrate terrestrial networks and non-terrestrial networks (NTN). We conduct R&D on wireless network technologies that globally extend three-dimensional seamless communication networks including the ocean and space, via a network composed of satellites, aircraft, and drones, and on technologies for optical satellite communications (photo 1).

Also, we contribute to diversification and expansion of terrestrial wireless communication systems for the Beyond 5G, through conducting R&D on wireless system assessment technologies that simplify evaluations for complex wireless systems in an actual operational environment that require a lot of human resources and time (photo 5).

Ultimate speed for us
While information is delivered to us via an optical backbone network, it is converted into electrical, optical, and radio signals. To deliver enormous amounts of information promptly, we establish an optical network technology of tens of petabits per second class (more than 1000 times the traffic of Japan in 2020) based on multi-core optical fibers in which multiple passages are arranged in one optical fiber (photo 3).

Millimeter-waves and terahertz-waves, which are expected to be used in access networks, have a shorter reach than radio waves used in 4G and 5G, so a large number of radio stations are required. It is necessary to reduce the power consumption and the cost of the system. We contribute to solving the problem with technologies that simplify network systems by harmonizing optical signals and radio signals, and ICT hardware technologies for optical signal circuits (photo 2).

In addition, we run Advanced ICT Device Laboratory, which is an open hub for creating innovative ICT hardware devices by consolidating device technologies (photo 4). We collaborate with Terahertz Technology Research Center at Beyond 5G Research and Development Promotion Unit, to drive on research on communication by using terahertz waves.

Resilient ICTs for SDGs around the world
We have conducted on R&Ds and activities that contribute to reducing network failures after natural disasters and shortening the period until recovery. Based on our achievements, we make them evolved as supple and tough “Resilient ICTs” toward Beyond 5G. In particular, we have begun to conduct R&D on information and communication technologies in environments where wireless communication is difficult to be used, technologies that adapt when a network is disconnected, and technologies that detect, visualize, and distribute sudden changes in natural phenomena to people and systems (Photo 6).

Keyword is Flexibility
In the field of networking, we conduct R&D on distributing highly reliable information with low latency by utilizing finite communication and computing resources and measurement data effectively with AI technologies and programmable networks (photo 7). We aim to establish technologies for coexistence of various ICT services, by extending three-dimensional seamless communication networks, by increasing the capacity of the network, and by utilizing resources flexibly.

Ground station for special satellite communication
Experimental equipment for photonic network system
High-definition device processing machine in the Yellow Room
Base station for simultaneous transmission
Remote monitoring for online lecture
Remote controlling of drone flying
Experimental radio transceiver for R&D
Cybersecurity Area
Cybersecurity Technologies
Cryptographic Technologies
Cybersecurity Trainings
Development of a Government-Industry-Academia Cybersecurity Base
Surveys of IoT Devices with Improper Setting of Passwords, etc.

Protecting society from increasingly complex and sophisticated cyber attacks

In order to enhance Japan’s ability to innovate to create unprecedented value and transform social systems, it is essential to, as part of the national capacity to protect society (life, property, and information), enhance the sophistication of technologies in the area of cybersecurity in order to protect social systems from rapidly increasing numbers of cyberattacks. This is an urgent challenge for the nation as a whole, and the demands from society on NICT in this area continue to increase.

As one of the top research institutes in the area in Japan, Cybersecurity Research Institute aims to enhance the national capacity to deal with cyberattacks and promote secure data utilization, and conducts a wide range of activities from basic research to practical technology development based on strong societal demand, as well as implementation of relevant results within society.

In accordance with national government policy, the Institute also conducts cybersecurity training, is developing a government-industry-academia cybersecurity base, and carries out surveys of IoT devices with inadequate password settings, etc.

Cybersecurity Laboratory conducts R&D on automatic analysis and visualization technologies that support situational understanding of cyberattacks by observing them from multiple angles (photos 1, 2, 5, 6), while Security Fundamentals Laboratory endeavors to carry out R&D aimed at the establishment of cryptographic infrastructure for the quantum computing era, as well as work on technologies for secure data utilization that contribute to solutions for societal challenges such as working from home (photo 3).

National Cyber Training Center runs cyber training for security operators from government and the private sector, as well as SecHack365, a program to foster young security innovators for those aged 25 or younger (photos 4 and 7), while National Cyber Observation Center surveys IoT devices with inadequate password settings and provides the information to internet service providers.

Cybersecurity Nexus - was established in April 2021 with the aim of creating an advanced platform that will serve as a nexus for government, industry, and academia (Photo 8). Specifically, it aims to improve Japan’s cybersecurity capability by collecting, storing, analyzing, and providing cybersecurity information domestically, as well as by sharing a common platform for fostering cybersecurity experts throughout society as a whole.

Improving society’s cybersecurity capacity through collaboration between government, industry, and academia

Although large-scale collection and storage of actual data related to cyberattacks is essential for R&D in the cybersecurity area, many organizations in Japan are unable to collect a sufficient amount of data, which leaves R&D stagnating and cybersecurity self-sufficiency lagging.

In order to overcome this situation, a new organization - Cybersecurity Nexus - was established in April 2021 with the aim of creating an advanced platform that will serve as a nexus for government, industry, and academia (Photo 8). Specifically, it aims to improve Japan’s cybersecurity capability by collecting, storing, analyzing, and providing cybersecurity information domestically, as well as by sharing a common platform for fostering cybersecurity experts throughout society as a whole.
Universal Communication Area

Multilingual Communication Technology
Data-Driven Intelligent Communication Technology
Smart Data Analytics Technology

Creating an AI research platform and utilizing it for R&D

Universal Communication Research Institute (UCRI) is one of Japan’s leading R&D centers in the area of AI, and aims to achieve universal communication and to establish mutual understanding among people. In addition to its large-scale computational resources, UCRI is developing an AI R&D platform (photo 7) using a high-quality, large-scale database especially focused on the Japanese language, and is promoting R&D of the three core technologies that leverage the platform.

The three core technologies are: Multilingual communication technology, which enables low-latency AI simultaneous interpretation that can be used in business situations (photos 1 and 2); Data-driven intelligent communication technology, which enables spoken dialog systems to use virtual personalities to converse with users based on their interests and backgrounds (photos 4, 5, 6); and Smart data analytics technology, which enables real-world analyses and predictions by connecting all kinds of public and private sensing data from various fields (photo 3).

Contributing to solving social issues and creating new values through R&D and its dissemination

In terms of R&D, UCRI will create unique, top-class core technologies unbound by precedent and home them into universal technologies with broad scope for use. We will then develop and expand demonstration and commercialization systems utilizing those technologies in an industry-government-academia collaboration that will lead to their implementation in society, and feed the issues and knowledge created by society back into our R&D activities. We aim to create this kind of positive spiral to develop and disseminate our core technologies throughout society.

UCRI has some of the largest data and computing resources held by any public research institute researching the relevant area in Japan and plans to further increase them in the future. We will accelerate the positive spiral by enhancing these activities through collaboration with overseas and domestic institutions to become the leading R&D institute in Japan with an AI research platform.

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Under our AI research platform, we will contribute to solving society’s challenges and creating new values by removing language, knowledge, and data-utilization barriers in global businesses, elderly care, environmental risk reduction, etc., and by achieving a perfect balance of “research” and “dissemination.”
Advanced ICT Research Institute
Creating and developing innovation beyond conventional concepts

Opening up new horizons in ICT

Of the five research institutes at NICT, Advanced ICT Research Institute is the one positioned to focus on conducting advanced and basic research. With the goal of “creating and developing innovation beyond conventional concepts” in ICT, our role is that of "opening up the future" by pioneering, without fear of failure, seemingly barren frontiers with science.

The Institute is involved in a wide range of areas, such as Frontier ICT (photos 2, 6, 7, 8, 9), Advanced ICT devices (photos 1 and 10), Quantum ICT (photo 5), and Neural ICT (photos 3 and 4), and the organization itself is the largest of the five NICT research institutes. In addition to conducting research in a variety of areas, from basic science to engineering, it is anticipated that the Institute will make effective use of its wide range of fields to achieve interdisciplinary fusion and create completely new areas of research. In fact, fusion research in the fields of devices and biotechnology has already begun. It is also an important role of the Institute to support such active interdisciplinary research.

We are also living in an age where the question of how to make use of basic research for the benefit of the world is a more pressing one. Some of the research projects that the Institute is working on will take 20 to 30 years to produce results, but by releasing some of our developed technology to the world we are able to get early feedback, which we can then use again in our research. Some of these topics currently under research are expected to be implemented in society in the near future.

Quantum ICT for a safe and secure society

Of the four areas being strategically promoted by NICT, research into quantum ICT aims to, in cooperation with the newly established Quantum ICT Collaboration Center, create highly confidential networks that protect critical information in the government, medicine, infrastructure, and finance sectors over the very long term. For example, there is quantum key distribution, which uses the quantum mechanical properties of light to make it possible to share a secure cryptographic key (random number) between two remote parties. This eliminates the threat of key information being decrypted, even if computing power increases significantly in the future. Its safety is guaranteed by the laws of physics. Also proceeding is research on the application of quantum technology within the nodes of an optical network - so-called "quantum network" research - with the aim of transmitting quantum states themselves over long distances, and we aim to introduce quantum technology in stages. In addition, we are also engaged in research looking decades into the future involving the development of elemental technologies for improving the performance of quantum computers.
Promoting the development and operation of ICT testbeds

With the aim of supporting and promoting a wide range of research activities, including R&D of advanced network technologies and experimental verification of various applications, we develop and provide a high speed R&D network testbed named “JGN,” which enables verification of various technologies and services from backbone networks to applications using a real wide-area network environment; a large-scale emulation testbed named “StarBED” for developing verification platforms for the IoT era; and the DCCS (Data-Centric Cloud Service), which is a service-layer testbed to develop new applications through advanced and open utilization of various data, including research results (photos 1 and 2). These testbeds can be used by anyone who signs a joint research agreement with NICT.

Promoting R&D and publicizing its results

For the realization of Beyond 5G and the resolution of social issues, NICT conducts commissioned research utilizing the capacity of industry, academia, and government, and provides opportunities for joint research and researcher interaction with domestic and overseas companies and universities while promoting joint R&D through collaboration with NICT’s own R&D (photos 4 and 7). In addition, we also engage in active standardization efforts with industry, academia and the public sector and transform R&D results into socially beneficial products by acquiring and effectively using intellectual property licenses (photo 3). Furthermore, to promote open innovation on a global scale, we facilitate joint research with overseas research organizations and universities (photos 5 and 6), promote international interaction between researchers, and collect relevant information through NICT’s Overseas Centers.

Contributing to the development of the ICT field

In order to create ICT start-ups with innovative technologies and services, we support the discovery of students and promising young entrepreneurs who aspire to start their own businesses, and in addition to holding the Entrepreneur “Koshien” Tournament and Entrepreneur Expo (photo 8), we support visits by overseas researchers to research organizations in Japan by offering international exchange programs and organizing international researcher meetings. We also promote support for information-barrier-free access enabling the use of ICT by anyone, including the elderly and people with disabilities.
### Organization

#### Radio Research Institute
- **General Planning Office**
- **Radio Propagation Research Center**
  - Remote Sensing Laboratory
  - Space Environment Laboratory
- **Electromagnetic Standards Research Center**
  - Electromagnetic Compatibility Laboratory
  - Space-Time Standards Laboratory
- **Applied Electromagnetic Research Center**
  - Digital Optics Laboratory

#### Network Research Institute
- **General Planning Office**
- **Advanced ICT Device Laboratory**
- **Network Architecture Laboratory**
- **Photonics ICT Research Center**
  - Photonic Network Laboratory
  - Optical Access Technology Laboratory
- **Wireless Networks Research Center**
- **Resilient ICT Research Center**
  - Planning and Collaboration Promotion Office
  - Sustainable ICT Systems Laboratory
  - Robust Optical Network Laboratory

#### Cybersecurity Research Institute
- **General Planning Office**
- **Cybersecurity Laboratory**
- **Security Fundamentals Laboratory**
- **Cybersecurity Nexus**

#### Universal Communication Research Institute
- **General Planning Office**
- **Advanced Reality Technology Laboratory**
- **Advanced Speech Translation Research and Development Promotion Center**
  - Advanced Speech Technology Laboratory
  - Advanced Translation Technology Laboratory
- **Data-driven Intelligent System Research Center**
  - Big Data Integration Research Center

#### Advanced ICT Research Institute
- **General Planning Office**
- **Kobe Frontier Research Center**
  - Superconductive ICT Device Laboratory
  - Nano-scale Functional Assembly ICT Laboratory
  - Bio-ICT Laboratory
  - Neuro-ICT Laboratory
  - DUV ICT Device Laboratory
- **Koganei Frontier Research Center**
  - Planning Office
  - Quantum ICT Laboratory
  - Terahertz ICT Device Laboratory
  - Green ICT Device Laboratory
- **Center for Information and Neural Networks**
  - Suitsa Planning Office
  - Brain Networks and Communication Laboratory
  - Brain Function Analysis and Imaging Laboratory
  - Neural Information Engineering Laboratory

#### Open Innovation Promotion Headquarters
- **General Produce Office**
  - Produce Office
  - Technology Promotion Office
- **Social Innovation Unit**
  - Strategic Program Produce Office
    - Research Planning and Promotion Office
    - Regional/Industry-Academia Collaboration Promotion Office
  - **ICT Testbed Research and Development Promotion Center**
    - ICT Testbed Coordination and Planning Office
    - ICT Testbed Research, Development and Operations Laboratory
    - Social-ICT System Laboratory
  - **Innovation Promotion Department**
    - Collaborative Research Promotion Office
    - Commissioned Research Promotion Office
    - Funded Research Promotion Office
    - Intellectual Property Promotion Office
    - Standardization Promotion Office

#### Beyond 5G Research and Development Promotion Unit
- **General Planning Office**
- **Beyond 5G Design Initiative**
- **Terahertz Technology Research Center**
  - Planning Office
  - Terahertz Laboratory

#### Quantum ICT Collaboration Center
- **General Planning Office**
- **Quantum ICT Design Initiative**

#### General Affairs Department
- **General Affairs Office**
  - Personnel Affairs Office
  - Legal and Compliance Office

#### Financial Affairs Department
- **Finance Office**
- **Contract Office**
- **Facility Office**

#### Strategic Planning Department
- **Strategic Planning Office**
  - Evaluation Office

#### Operation Planning Department
- **Operation Design Office**
- **DX Design Office**
- **Radio Wave Management and Manufacturing Office**

#### Public Relations Department
- **Public Relations Planning Office**
- **Press Office**

#### Innovation Design Initiative

#### NICT Knowledge Hub
- **IGS Development Office**
- **Audit Office**

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As of April, 2021
Outline

Main Businesses
- Research and development of technologies related to the electromagnetic distribution of information and the use of radio waves
- Support of individuals and organizations pursuing research and development in the field of advanced communications and broadcasting technology
- Promotion of businesses in the communications and broadcasting sectors

Establishment Date
April 1, 2004

5th Mid-To-Long-Term Plan
April 2021 - March 2026

Number of Personnel
1,204 (as of April, 2021) (Including fixed term employees)

Location of NICT facilities

Headquarters
Radio Research Institute
Network Research Institute
Cybersecurity Research Institute
Big Data Integration Research Center
Koganei Frontier Research Center
Beyond 5G Research and Development Promotion Unit
Quantum ICT Collaboration Center
Open Innovation Promotion Headquarters

Koganei-shi and Kodaira-shi, Tokyo

Nomi-shi, Ishikawa (Ishikawa Science Park)
Hokuriku StarBED Technology Center

Saga-shi, Saga and Itoshima-shi, Fukuoka
Hagane-yama LF Standard Time and Frequency Transmission Station

Onna-son, Kunigami-gun, Okinawa
Okinawa Electromagnetic Technology Center

History
Oct. 1896 Radio Telegraph Research Division is established as a part of the Electrotechnical Laboratory, Ministry of Communications (C)
Jan. 1915 Hiraiso Branch opens (C)
May 1935 Testing and Examination for Radio Equipment Type Approval starts (C)
Jan. 1940 Frequency Standard Radio Service (JJY) starts (Kemigawa) (C)
Jun. 1948 Radio Physics Laboratory is integrated (C)
Aug. 1952 Radio Research Laboratory is established (C)
May 1964 Kashima Branch opens (80-m diameter Parabola Antenna Facility completed) (C)
Aug. 1979 Communications and Broadcast Satellite Organization (CBSO) is established (T)
Aug. 1982 Kimitsu Satellite Control Center opens (T)
Apr. 1988 Reorganized from Radio Research Laboratory to Communications Research Laboratory (C)
May 1989 Kansai Branch opens (Kobe) (C)
Oct. 1992 Renamed as the Telecommunications Advancement Organization (TAO), Commencement of advanced communication and broadcasting research and development (T)

Grants 28.07 billion yen
Subsidies from supplementary budget 31.99 billion yen
Total: 73.30 billion yen

Other income 250 million yen
Income from funded research 10.13 billion yen
Other subsidies 2.87 billion yen

Fiscal Year 2021 Budget

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