NTT R&D is Creating New Value by Open Innovation and Collaboration Initiatives

Under the NTT R&D vision of developing cutting-edge technologies that contribute to the advancement of society, science and industry, NTT has approximately 2,500 researchers engaging in a wide range of diverse research activities, from basic research to R&D that supports the business development initiatives of operating companies. R&D is the source of the NTT Group’s growth potential. On that basis, the NTT Group creates competitive technologies and engages in open innovation / collaboration initiatives with a wide range of corporations, universities, and research institutions. In this way, we strive to create new value.

R&D Fields

Our R&D covers a wide range of technical fields, from innovative communications services designed to be provided on a network, next-generation information network infrastructure technology that will make new services possible, to basic cutting-edge research producing new principles and products, such as world-class optical technologies.

Capabilities of the Comprehensive Commercialization Functions

A key to ensuring the early application of the technologies developed by the Laboratories to the NTT Group’s business is our comprehensive commercialization activity, in which the commercialization team formulates marketing and business plans and forms alliances with relevant parties. As we press ahead with the full-scale deployment of next-generation services, we are creating new services through collaboration within the NTT Group and with other enterprise partners.
The role of the telecommunication provider has shifted from providing telecommunications, which connects people to people, to providing information communications, which connects people with the information they need. To enable the NTT Group to transform itself and take on the role of enhancing the value of various industries through the provision of ICT in the coming years, NTT R&D aims to become a value-added enabler that accelerates the creation of new values, by providing technologies that can meet a wide range of needs.

As technical disciplines are swiftly becoming increasingly interdependent, and the demand for rapid technical development intensifies, it has become imperative to manage R&D based on the principle of open collaboration instead of closed in-house development. NTT R&D is strengthening its open innovation. It works with external organizations giving priority to four goals: rapid development, market-in, finding missing links, and entry into new markets.
Research and Development of Communication Services

By continuing to produce globally applicable and innovative ICT services, we fulfill our mission of creating the core competencies required for the NTT Group to become a leading company in service innovation. Backed by our advanced "information processing", "media processing" and "security technologies", we are developing "secure cloud computing platform" and are "creating innovative ICT services" that can be deployed on that platform and will enrich society and our lives. We are also providing support services. They include those provided through the OSS Center to assist the NTT Group in adopting OSS, those provided by NTT-CERT to enable the Group to strengthen its security operations, and those provided through ICT service design activities to enhance the user experience (UX) of services provided by the NTT Group.

Representative R&D Fields

| Information Navigation | User Experiences |

Creation of advanced broadband and ubiquitous services with new added value, and service platform technology that supports these services

We are working on information navigation technology, which selects information useful to the user from among the vast quantity and variety of information available on the network, and provides it in a convenient and easy-to-understand manner adjusted to the user's purposes and circumstances. To enhance the user experience, we are developing technologies that facilitate the provision of content in a form suitable for the user's device environment and that also support the design of services which take the user’s digital literacy into consideration.

| Audio, Speech & Language | Video & Image |

Media processing technology for extremely natural and highly value-added communication services

We are pressing ahead with R&D of audio signal processing and video signal processing technologies to realize high-quality and highly value-added voice, acoustic and video communication. We are also developing speech recognition/synthesis and natural language processing technologies, and image processing and highly realistic communications technologies with a view to realizing natural and easy-to-understand communication and content delivery services.

| Cloud Computing Platform | OSS Support | Software Development Technology |

Next-generation platform technology for cloud computing and technologies for system development, operation and maintenance

We are developing an open cloud platform that will achieve efficient development and provision of next-generation services capable of responding rapidly to a range of needs. We also support the use of open source software (OSS) and the migration from proprietary software to the OSS to reduce the TCO of both next-generation and existing services. In addition, we are promoting R&D in the area of software development technology to make dramatic improvements in the productivity of system development.

| Cryptography and Security |

Cryptographic and security technology with advanced protection to enable provision of safe and secure services

We are developing cryptographic and security technologies to help realize a safe and secure society, as well as analysis and assessment technologies that support the operation of security services. In addition, we are strengthening the security operations of the NTT Group based on the activities of NTT-CERT, an organization set up to support computer security.

Representative R&D Examples

Technology that Supports Super-High-Reality Media Communication Services

Immersive Telepresence Technology: "Kirari!!"

This technology makes possible a media communication service that enables spectators at the competition venue and remote sites to have the feeling of being joined together and share in the thrill and excitement. We are developing the following technologies in order to enhance the sensation of reality by providing spatial information for a live viewing involving a number of people.

1. Object extraction technology for highlighting a specific athlete
2. Super-wide video stitching technology for enabling viewers to look at the entire field
3. Advanced MMT technology for enabling resynchronization of media information and reconstruction of spatial environment
4. Sense-of-reality design technology that provides natural and three-dimensional video and audio representation

Technologies that make up Kirari!!

Kirari, which combines different media technologies developed by NTT Laboratories, transports every information of a competition venue and reconstructs the spatial environment for viewers to feel highly realistic sensation as if they are participating in the sports event.

- Collection of materials
- Media processing and encoding
- Media delivery
- Media presentation

High realistic representation of the competition through real-time streaming
Technologies for Highly Realistic 4K/8K Video Services

HEVC-Compliant Video Encoder LSI and Software Encoder

We are developing technologies that can efficiently compress ultra-high-definition videos (U-HDTV videos), such as 4K/8K videos, which are currently becoming popular. With conventional methods, transmitting U-HDTV video to the homes is unrealistic, due to the large amount of data, which is eight-fold greater than HD. The latest video coding standard, H.265/HEVC, can reduce the bit rate to half of what can be achieved by the previous standard. We have developed an encoder that facilitates use of HEVC, making it possible to transmit ultra-high-definition videos to the home.

Technology that Supports Cloud Computing

Technology for Coordinated Operation of the Cloud Controller and the Network Controller

We are developing technology to build, on demand, a customer-specific virtual environment (virtual server, virtual storage, virtual switch/router, etc.) on the cloud, and to expand the customer-specific virtual network between the customer site and the cloud or between different sites within the cloud. This facilitates the transition of systems at the customer’s site to a cloud, and the transition of virtual environments from one cloud to another in case of a disaster or a pandemic.

Technology that Supports Network Safety and Security

Anti-Malware Technology

This technology is designed to facilitate detection, collection, and analysis of malware, such as computer viruses, and countermeasures against it. The technology uses honeypot trap to detect and collect malware samples and attacks targeting a variety of vulnerabilities, analyzes their functions using both dynamic and static analysis, and uses the analysis results to develop countermeasures. In order to be able to respond to ever-evolving attacks quickly, we are working on unknown attack detection technology, malware analysis technology that makes use of virtualization, and many more.

Technologies that Support the Safe and Secure Use of Highly Confidential Data

Secret Sharing and Secure Computation

Secure computation is a technology that allows carrying out analyses of encrypted, indecipherable data. The data is first divided, using secret sharing, into random-looking fragments which are distributed on separate servers, and one can then perform data analysis without reconstructing the original data. This makes it possible to process highly sensitive data to be in a safe and secure manner; for example, statistical analysis of confidential medical data can be conducted while fully preserving security and privacy. By developing a novel algorithm achieving world-record breaking performance, we have already enabled commercial-grade applications of secure computation that were previously considered out of reach, and we are now directing our R&D efforts towards applying it to even larger-scale and more complex targets.

Specific Research Topics

Information Navigation
- Behavior modeling technology
- Behavior support technology
- Device virtualization technology

User Experiences
- Service architecture design
- Platform technology
- for harmonizing web services
- Human centered design

Speech, Audio & Language
- Speech recognition/synthesis
- Audio signal processing
- Natural language processing

Video & Image
- Video signal processing
- Image processing
- High-reality communications

Cloud Computing Platform
- Open cloud platform technology
- Network virtualization technology (Ryu)
- Cloud operation and monitoring technology

OSS Support
- Support of migration to OSS
- OSS platform operation support

Software Development Technology
- Software development management technology
- Software engineering technology

Cryptography and Security
- Information security
- Network security
- Security management
Research and Development of Technologies that Support the Infrastructure for an Information Network Society

We are aiming to provide networks that will be selected by our customers due to the value they offer to service providers and other customers in order to enhance the value of industries and contribute to the development of the Japanese economy and a wide range of services. To achieve this, we are working on network architecture, network technology, operations technology, communication traffic & service quality, access network technology, infrastructure technology and environmental platform technology.

Representative R&D Fields

- Network Architecture
- Network Technology
- Operations Technology
- Communication Traffic & Service Quality
- Access Network Technology
- Infrastructure Technology
- Electromagnetic Environment Design Technology
- Environmental Impact Assessment Technology

Service co-creation network based on Netrosphere Concept

Netrosphere Concept aims at providing quickly, reliably and at low cost a variety of services that users, such as service providers and other customers, will need when our future networks are introduced. Based on this concept, we are developing architecture that enables the user to access and other network functions flexibly. We are also developing network technology that will keep a range of devices, from terminals, network devices to servers, safe and secure in order to support the creation of a variety of services in the age of IoT.

One-stop operation that contributes to the creation of new services and industries

With a view to providing operations that encompass networks, clouds and applications, we furnish service providers with operation services that enable them to maintain and operate networks and services in an integrated manner, and network providers with a one-stop operation function that makes more efficient use and operation of resources possible. In addition, we are working on social platform operations that provide, through a common API, advanced functions based on security and Big data technologies. The objective is to promote the creation of B2B2X services and eventually enable individuals to create services easily.

Access network technology and infrastructure technology that contribute to creation and expansion of new services

We are aiming to provide a flexible access network that will make connecting to networks easy, simple and secure to use, and can support a wide range of service demands. For this purpose, we are adopting a multi-faceted approach to R&D, including advanced systems that allow services to be accessed via optical fibers and wireless access, optical fibers with a new structure that allow transmission of a large volume of data, technologies for maintaining and managing communication infrastructure equipment, and a network control system that allows efficient operation of access networks.

Environmental Platform Technology

Electromagnetic environment design technology and Environmental impact assessment technology

To protect the global environment and ensure high network reliability, it is important to reduce the impact of future networks on both climatic and electromagnetic environment. To reduce the environmental loads and electromagnetic disturbance generated by ICT device that will comprise future networks, we are formulating requirements that will govern their design and development process. We are also studying how to assess the environmental impact caused by changes in society and our lifestyle that will result from the widespread use of future networks.

Representative R&D Examples

New R&D Concept that Transforms the Roles of Carrier Networks

Netrosphere Concept

We are undertaking R&D to implement the “Netrosphere Concept,” which aims at creating new value in collaboration with a diverse range of partners. This concept involves network technologies, such as multi-service fabric (MSF), new server architecture (MAGONIA), and next-generation access system architecture (FASA), separation between optical and electric devices, separation between software and hardware, and modular implementation of network functions. The objective is to meet a wide range of needs quickly, reliably and at low cost by providing customer-requested functions through a collaboration mechanism that makes one-stop operation with the network provider possible.
Network Configuration Technology for Flexible Control of General-Purpose Switches

MSF (Multi Service Fabric)

The network configuration technology that controls general-purpose switches flexibly will enable to build a virtual network for each service and a network provider. Without relying on dedicated devices, high network redundancy will be accomplished due to combining the switches with optical transport technologies. Modularized network functions are deployed on a common service platform while ensuring high performance and reliability. In terms of disseminating a B2BX2 business model that is constructed on the service platform supported by MSF, modularized service functions via API, for example, “Atelier N”, are provided as a collaboration environment. We will verify the usefulness of these technologies using a test environment that implements the NetroSphere Concept, and provide feedback on any needs that may come to light.

Use of Forecast-Based Proactive Control to Achieve Low Cost and High Communication Quality

Proactive Network Control Technology

Depending on external conditions, traffic on the network may fluctuate and exceed what has been forecast. To continue to provide high-quality service to its customers, NTT aims at building an inexpensive network that is adaptive to traffic variations by enhancing network availability not through excessive investment but using virtualization technology, such as SDN. Specifically, we forecast variations in the volume of traffic and communication quality caused by external factors, such as large-scale events and disasters, and proactively change the routing and functional allocation, thereby preventing any disruption to communications or degradation in communication quality and providing a stable user experience.

Access Network that Provides a Wide Variety of Communication Services

Access System Technology

To be able to provide a flexible and economical network, it is necessary to have access systems that satisfy all of a diverse range of service specifications. Time wavelength division multiplexing (TWDM) technology, which we are developing, multiplexes a number of wavelengths on a single fiber. This allows a wavelength different from those being used by existing systems to be assigned to a new service, making it possible to build an economical and high capacity network. We are also studying next-generation access systems, including technologies for implementing some access system functions in the form of software components.

Estimating the Environmental Contribution of an Enterprise

Technology for Estimating the Reduced Environmental Load on Society Using ICT

It has been difficult to estimate the “By ICT effect” of ICT services provided by an enterprise. Our new technology estimates an enterprise’s “By ICT effect” based only on publicly available information with a workload that is acceptable in practice. Although this technology has been developed for the NTT group companies, ICT vendors can also use it.

Specific Research Topics

Network Architecture
- Future network architecture

Network technology
- Technology for simplifying transport
- Network function virtualization and distributed processing technology

Operations technology/Communication Traffic & Service Quality
- Operation enhancement technology
- Communications traffic and quality technology

Environmental platform technology
- Energy management system technology
- Technology for the numerical evaluation of reduction in environmental impacts, such as environmental assessment

Access network technology
- Optical access system
- Wireless access system

Infrastructure technology
- Communication infrastructure maintenance and management technology
Research and Development of Cutting-Edge Technologies

To create principles and concepts that will open up new horizons and to devise innovations that will help solve social issues by integrating different technical disciplines, our R&D program covers a diverse range of projects including a broadband of everything, information and communication device technology, health and environmental sensing device technology, new functional materials, device integration technology, communication science, and physics and materials science.

Representative R&D Fields

**Broadband of Everything**

We are undertaking a wide range of R&D with a vision represented by the following keywords: “Value-Added”, “Manageable Flexibility” and “Extreme”. Our objectives are to enhance the reliability of, and dramatically increase the capacity of, our photonic wireless network technology, which leads the world, to create an innovative next-generation network architecture and next-generation services, and to provide safe, secure and clever ICT services that integrate the real world and the cyber space.

**Information and Communication Device Technology**

We are developing innovative communication devices in pursuit of a flexible and efficient high-speed, high-capacity network that will add value to network communications. We are also working on health and environmental sensing device technology that will lead to new ICT opportunities. Programs aimed at improving the performance of these devices and exploring potential applications are also underway. Through strategic open innovation, we are ensuring the steady advancement of development work in these areas toward the widespread deployment of the respective technologies.

**New Functional Materials, Device Integration Technology**

We are currently conducting research on three technologies: social device technology, which will revolutionize the user experience and help addressing several social issues; integrated optoelectronics technology, which will introduce further innovation into telecommunications and information processing for breakthrough performances; and technology for integrating heterogeneous materials and crystals onto the same device. Through these initiatives, NTT is seeking to create highly innovative technologies with groundbreaking features while strengthening and expanding its core competencies.

**Communication Science**

With a view to building a new technical infrastructure that connects people with information in the current and future society where people are surrounded by a vast quantity and variety of information, we are seeking to create new concepts, discover new principles and invent innovative technologies in the fields of “Human media processing”, “Interactive communication environment”, “Human information science”, “Natural language”, “Learning-based world interpretation”, “Innovative computation theory” and “High-quality acoustic processing and encoding”.

**Physics and Materials Science**

As a pioneering strategic basic research theme in the forefront of academia, we are focused on “Quantum information processing”, which develops innovative quantum computing and quantum networking technologies, and are conducting basic research on new materials and nano-devices from a long-term perspective. We have also established Nanophotonics Center to carry out research on “Integrated nano-photonics” that will enable large-scale and high-density integration of optical functional elements.

Representative R&D Examples

**Cooperative Wireless LAN Technology that Enables Highly Efficient Communications**

Next-Generation Wireless LAN Platform with Network Control to Reduce Interference

NTT is studying a cooperative wireless LAN that achieves a 10-fold increase in throughput over conventional systems in an environment where wireless access points are installed densely. While promoting standardization of the high efficiency wireless LAN (HEW) which allows flexible use of space and frequency resources, NTT is developing a network control engine that makes efficient use of wireless resources in order to realize a next-generation wireless LAN service platform that can handle rapid growing wireless communication traffic.

**Technology to Realize a High-Capacity Scalable Optical Network**

Super-High-Density Space-Division Multiplexing Optical Communication Technology

We are developing core technologies for a next-generation optical communication system using multi-core, multi-mode optical fibers in order to realize a scalable optical network that allows high-capacity transmission with a transmission rate on a single optical fiber that exceeds the current rate by a factor of 100 to 1,000. By combining a multi-core fiber having 12 cores and a multi-mode fiber, in which 3 signals are multiplexed in 3 different modes on a single wavelength, we conducted the world’s first successful experiment of super-high-density space-division-multiplexing transmission with the number of space multiplexed signals exceeding 30 (36 space multiplexed signals: 3-mode multiplexing times 12-core multiplexing).

Increase in transmission capacity: MxN > 100

Multi-core fiber (number of cores: M)  Multi-mode fiber (number of modes multiplexed: N)  Rectangular grid  Inter-channel gap  Inter-channel gap  Digital signal processing circuit (DSP)
Daily Life-Assistance Technology that is Easy for Anyone to Use

Hitoe, a Functional Material that Enables Bioelectric Information to be Continuously Monitored Simply by Wearing a Garment Made of the Material

As part of its research into nanobiology, NTT has developed PEDOT-PSS, an electrode material that can be used to monitor bio-electronic signals. In collaboration with Toray, NTT has developed a commercial, highly durable, functional material, hitoe, which can detect bioelectric signals with high sensitivity. The material is made by applying a special coating on a nanofiber fabric, a cutting-edge fiber material. This was made possible by a technology developed for a conductive fabric that uses PEDOT-PSS. By wearing a hitoe garment capable of monitoring bioelectric information, the user can measure his/her heart rate and electrocardiogram easily without discomfort.

Innovative Device Technology for Future High-Speed Large-Capacity Transmission Systems

Phase-Sensitive Amplification Technology to Make Ultimate Low-Noise Optical Amplier a Reality

To further increase the transmission capacity of optical communication, we are developing a phase-sensitive amplifier (PSA) that realizes ultra-low noise amplification without signal degradation thus overcoming the theoretical limitations in systems based on conventional optical amplifiers. Moreover, the PSA can retrieve degraded optical signals after optical fiber transmission over long distances. We have performed the first demonstration of high-order QAM (16QAM) signal amplification with a PSA, which uses the world’s highest efficiency PPLN”, a key component in a PSA, as the optical amplification section.

Innovative Technology that Leads to Scientific Understanding of Human Senses

Buru-Navi —Force Display Utilizing Characteristic of Human Perception—

When a small mass in a hand-held device oscillates along a single axis with asymmetric acceleration (strongly peaked in one direction and weakly sustained in the other), the holder typically experiences a kinesthetic illusion characterized by the sensation of being continuously pulled (or pushed) by the device. Although the average magnitudes of the two opposing forces are the same, reducing the magnitude of the longer and weaker force to below a sensory threshold makes the holder feel they are being pulled to one direction.

Advanced Thin-Film Materials Technology Leading to Innovative Device Designs

Detaching GaN-Based Thin-Film Devices from Substrates without Hassle

NTT has been carrying out research on the growth of nitride semiconductor thin films. We have recently developed a novel process for the release of GaN-based thin-film devices such as LED’s from substrates. In this process, an extremely thin and cleavable layer is inserted between the substrate and thin-film device, which serves as a perforation line. As a result, an easy and damage-free detachment of thin-film devices by mechanical force is achieved. Thin-film devices utilizing our novel release technique will serve a wide range of applications such as ultra-thin LED’s and transparent solar cells sensitive only to ultraviolet light.

Specific Research Topics

- Broadband of Everything
  - IoT (Internet of things) enabler technology
  - NSC (Network Supported Collaborative Work) technology
  - Edge computing technology
  - Programmable node technology
  - Super-high-speed wireless technology capable of accommodating an extremely large number of terminals
  - Ultra-high speed, high-capacity optical network technology
- Information and Communication Device Technology
  - Digital coherent device technology
  - Optical interconnection device technology
  - Optical node switching technology
- Health and Environmental Sensing Device Technology
  - Environmental and medical sensing technology
  - Healthcare application technology
- New Functional Materials, Device Integration Technology
  - Optoelectronics integration technology
  - Extremely low power-consumption wireless terminal technology
  - Millimeter wave and terahertz wave technology
  - Super-high-speed wireless communication, imaging
  - Silicon photonics
- Environment and Energy
  - Technology for smart maintenance of infrastructure
  - Energy management technology
- Communication Science
  - Media information processing
  - Communication environment
  - Machine learning
  - Natural language processing
  - Mathematical science
  - Human science relating to perception, recognition and motion
- Physics and Materials Science
  - Materials science
  - Physical science
  - Optical science
3 Cutting-Edge Research Centers, Centers of Excellence (CoE) in Fields of Distinction

We are driving R&D for innovations in future information communication by establishing research centers in the three areas of machine learning, photonic networks, and nanophotonics, directed by distinguished senior scientists who are at the international forefront in their respective fields.

Machine Learning and Data Science Center

We are aiming at realizing a “high-amenity world anytime and anywhere” by predicting the flows of people, goods and information in the near future using Big data analysis that integrates machine learning, data mining and parallel computation technologies, and by controlling these flows proactively.

Specific Research Topics
- Machine learning and data mining engine
- Highly efficient computation engine based on Jubatus
- Spatiotemporal multidimensional collective data analysis
- Discovery of signs of network faults

Innovative Photonic Network Center

Realization of a scalable optical network with the capacity beyond one peta bit per second on a single optical fiber

We are exploring next-generation core optical communication technologies for future scalable optical network that accommodate ever-growing use of cloud services and smartphone services. Scope of our research incorporate new technical area such as massive digital signal processing, space-division multiplexing, and low-noise amplification and photonic preprocessing based on electronic/photonic integration (for technical details, See page 7).

Specific Research Topics
- Massive digital processing technology for optical communication
- Low-noise optical amplification and photonic preprocessing to enhance S/N ratio
- Optical transmission technology using space division multiplexing
- Electronic and photonic integration technology

Nanophotonics Center

Realization of a photonic network chip using integrated nanophotonics

We are aiming at green ICT, i.e., an ultimate reduction in energy consumed for information processing, by introducing photonic network technology to a chip, using extremely large-scale photonic integration technology that can densely integrate a large number of photonic devices with different functions.

Specific Research Topics
- Large-scale photonic integration technology to realize a photonic network chip
- Photonic crystal and Si nanophotonics technology
- Ultra-low power nanophotonic device
- Exploration of new phenomena/novel devices based on nanophotonics
NTT R&D Creating World-Leading Technologies and Opening up the Future of ICT

“Do research by drawing from the fountain of knowledge, and provide specific benefits to society through commercial development.” These words have been handed down as the philosophy of NTT Laboratories, since the inauguration of Electrical Communication Laboratory in 1948. They convey the strong desire to create world-leading technologies and to contribute to the advancement of society, science and industry by developing commercial products and services. Guided by this philosophy, NTT Laboratories are undertaking R&D in wide-ranging areas, from basic research to commercial development, with an eye fixed on business applications. In the drastically changing ICT field, it is important to strike a balance between medium- and long-term research and short-term development. In short-term activities, we are pursuing rapid development, with an eye kept on the market. The driving forces behind this are pursuit of open innovation both within and outside the NTT Group, and our comprehensive commercialization functions, which ensure the early business application of R&D results. In our medium- and long-term research, we aim to occupy the world’s number one position in terms of our competitive edge and technical capabilities by assessing the impact of the technologies we are studying on the NTT Group’s future business and society, and through our determination to attain technological predominance. As a world ICT innovation center, NTT Laboratories will continue to create new value by undertaking its research and development from a global perspective and with a sense of urgency.

Hiromichi Shinohara
Representative Director, Senior Executive Vice President, Chief Technology Officer, Head of R&D Strategy Department, Nippon Telegraph and Telephone Corporation

Katsuhiko Kawazoe
Senior Vice President of Service Innovation Laboratory Group

Tadashi Ito
Senior Vice President of Information Network Laboratory Group

Yoshiaki Sato
Senior Vice President of Science and Core Technology Laboratory Group

Jun Itoda
Senior Vice President of Intellectual Property Center

NTT Fellow

“NTT Fellow” is a title given to researchers who have made globally recognized achievements in research, and are expected to continue to produce valuable results in research areas essential to NTT. As a top-level NTT researcher, an NTT fellow heads a “Special Laboratory” and is responsible for driving forward innovative research in a critical area.

Tatsuaki Okamoto
Secure Platform Laboratories
Cryptography
• Invention of “intelligent cryptosystem,” a new-generation cryptosystem suitable for the age of cloud computing
• Received Purple Ribbon Medal in the spring of 2012

Takehiro Moriya
Communication Science Laboratories
Speech/audio signal encoding
• Highly efficient encoding for next-generation IP telephone
• Core technology for transmission of highly realistic a/c signals
• Received Purple Ribbon Medal in the spring of 2010

Naonori Ueda
Communication Science Laboratories
Big data analysis & statistical machine learning
• Proactive & real-time intelligent control/navigation for human, things, and information
• Contribution to natural and social sciences by machine learning
“Distinguished Researcher” is a title given to innovative researchers who have been recognized as outstanding both within and outside NTT. “Senior Distinguished Researcher” is a title given to highly outstanding “distinguished researchers.” They are responsible for leading innovative research or cutting-edge technical development in research areas considered to be important for the NTT Group in the long term.

Yutaka Miyamoto
Senior Distinguished Researcher
Network Innovation Laboratories
Director of Innovative Photonic Network Center
Research on ultra-high capacity optical transmission for future optical transport network

Masaya Notomi
Senior Distinguished Scientist
Basic Research Laboratories
Director of Nanophotonics Center
Quest for novel optical phenomena and development of next-generation optical integration technology using photonic nanostructure

Makio Kashino
Senior Distinguished Scientist
Communication Science Laboratories
Research on the brain mechanisms underlying flexible listening and deep communication

Hiroshi Saito
Senior Distinguished Engineer
Network Technology Laboratories
Research on network science using an interdisciplinary approach

Hiroaki Gomi
Senior Distinguished Scientist
Communication Science Laboratories
Elucidation of interactive information processing for motor control, sensation, and perception

Masaki Nagata
Senior Distinguished Researcher
Communication Science Laboratories
Research on statistical machine translation based on deep syntax analysis

Hiroshi Yamaguchi
Senior Distinguished Researcher
Basic Research Laboratories
Semiconductor nanomechanical devices

Shin’ya Nishida
Senior Distinguished Scientist
Communication Science Laboratories
Psychophysical research on the principles of information processing by the human brain, which can produce rich visual experiences

Koji Muraki
Senior Distinguished Researcher
Basic Research Laboratories
Research on quantum emergent physics via electron interaction engineering in semiconductors

Masayuki Abe
Senior Distinguished Researcher
Secure Platform Laboratories
Research on cryptography, in particular on secure cryptographic protocols

Shingo Tsukada
Senior Distinguished Researcher
Basic Research Laboratories
Persistent acquisition of bio-signals to investigate the pathophysiology of diseases using cutting-edge materials

Shinji Matsuo
Senior Distinguished Researcher
Device Technology Laboratories/ Basic Research Laboratories
Research on photonics-electronics convergence devices based on heterogeneously integrated III-V compound semiconductor with silicon platform

Akira Fujiwara
Senior Distinguished Scientist
Basic Research Laboratories
Research on ultimate electronics based on the control of single or a few electrons in semiconductor nanostructures

Kunio Kashino
Senior Distinguished Researcher
Communication Science Laboratories
Research on fast recognition and search technology for real-world media information

Seishi Takamura
Senior Distinguished Researcher
Media Intelligence Laboratories
Research on super high efficiency video coding

William John Munro
Senior Distinguished Scientist
Basic Research Laboratories
Theoretical quantum information science and technology

Tomohiro Nakatani
Senior Distinguished Researcher
Communication Science Laboratories
Audio and speech signal processing for capturing and recognition of human conversations
NTT R&D Organizational Structure

**[Yokosuka R&D Center]**
- Service Innovation Laboratory Group
  - Service Evolution Laboratories
  - Media Intelligence Laboratories
- Science and Core Technology Laboratory Group
  - Network Innovation Laboratories
- Information Network Laboratory Group
  - Access Network Service Systems Laboratories
  - Broadband of everything
  - Access network technology
  - Operations technology

**[Musashino R&D Center]**
- Information Network Laboratory Group
  - Network Technology Laboratories
  - Network Service Systems Laboratories
  - Access Network Service Systems Laboratories
  - Service Innovation Laboratory Group
    - Software Innovation Center
    - Secure Platform Laboratories
  - Science and Core Technology Laboratory Group
    - Network Innovation Laboratories
    - Intellectual Property Center

**[Atsugi R&D Center]**
- Science and Core Technology Laboratory Group
  - Device Innovation Center
  - Device Technology Laboratories
  - Communication Science Laboratories
  - Basic Research Laboratories
  - Health and environmental energy devices technology
  - The factorial social science and technology
  - Communication science
  - Physics and material science

**[Tsukuba R&D Center]**
- Information Network Laboratory Group
  - Access Network Service Systems Laboratories
  - Access network technology
  - Operations technology
  - Infrastructure technology

**[NTT Keihanna Building]**
- Science and Core Technology Laboratory Group
  - Communication Science Laboratories

**[NTT Shinagawa Twins Bldg./NSS- II Bldg.]**
- Service Innovation Laboratory Group
  - Software Innovation Center
  - OSS support
  - Software development technology

**[Otemachi First Square East Tower]**
- Research and Development Planning Department
  - Comprehensive commercialization functions

**[R&D Center in North America (Palo Alto)]**
- NTT Innovation Institute, Inc.
NTT R&D Organizational Structure

**Service Innovation Laboratory Group**

- Service Evolution Laboratories
  - Creation of innovative broadband and ubiquitous services and technologies, and research and development of service provision platform configuration technology.

- Media Intelligence Laboratories
  - Research on elemental media processing technologies, which provide the basis for broadband and ubiquitous services, and development of engines for these technologies.

- Software Innovation Center
  - Promotion of open innovation centered on the development of open source platforms, collaborative service development with NTT operating companies, and other R&D.

- Secure Platform Laboratories
  - Research and development of cryptography and security technologies essential to a safe and secure society.

**Information Network Laboratory Group**

- Network Technology Laboratories
  - Research and development of network architecture, communication traffic & service quality, and convergence network & services.

- Network Service Systems Laboratories
  - Research and development of network services and the next-generation information network technologies.

- Access Network Service Systems Laboratories
  - Research and development of the next-generation information network technologies and access system & network for creating new access services.

**Science and Core Technology Laboratory Group**

- Network Innovation Laboratories
  - Research and development of communication system architecture and services based on state-of-the-art wired/wireless technologies for future networks.

- Device Innovation Center
  - Research and development of devices, modules and sub-systems that will pave the way to new ICT opportunities as well as to the next-generation network.

- Device Technology Laboratories
  - Research and development of novel cutting-edge technologies and materials that will create value for people, business and society by combining photonics and electronics.

- Communication Science Laboratories
  - Discovery and creation of new approaches and concepts in intelligent communication, media information, and human science to revolutionize information communication technologies.

- Basic Research Laboratories
  - Fundamental research in physics and material science to invent and discover new & novel network technologies beyond our current limitations.

**Intellectual Property Center**

Strategic acquisitions of patents invented by the Laboratories, as well as risk management and active use of the intellectual properties owned by NTT Group.

**Research and Development Planning Department**

Formulation of R&D strategy, implementation of the comprehensive commercialization functions for business exploitation of technologies produced by the Laboratories.

**NTT Innovation Institute, Inc.**

Research and development of cloud computing technologies and information security for realizing global cloud services of the NTT Group.

For inquiries: visit NTT R&D website [http://www.ntt.co.jp/RD/e/](http://www.ntt.co.jp/RD/e/)