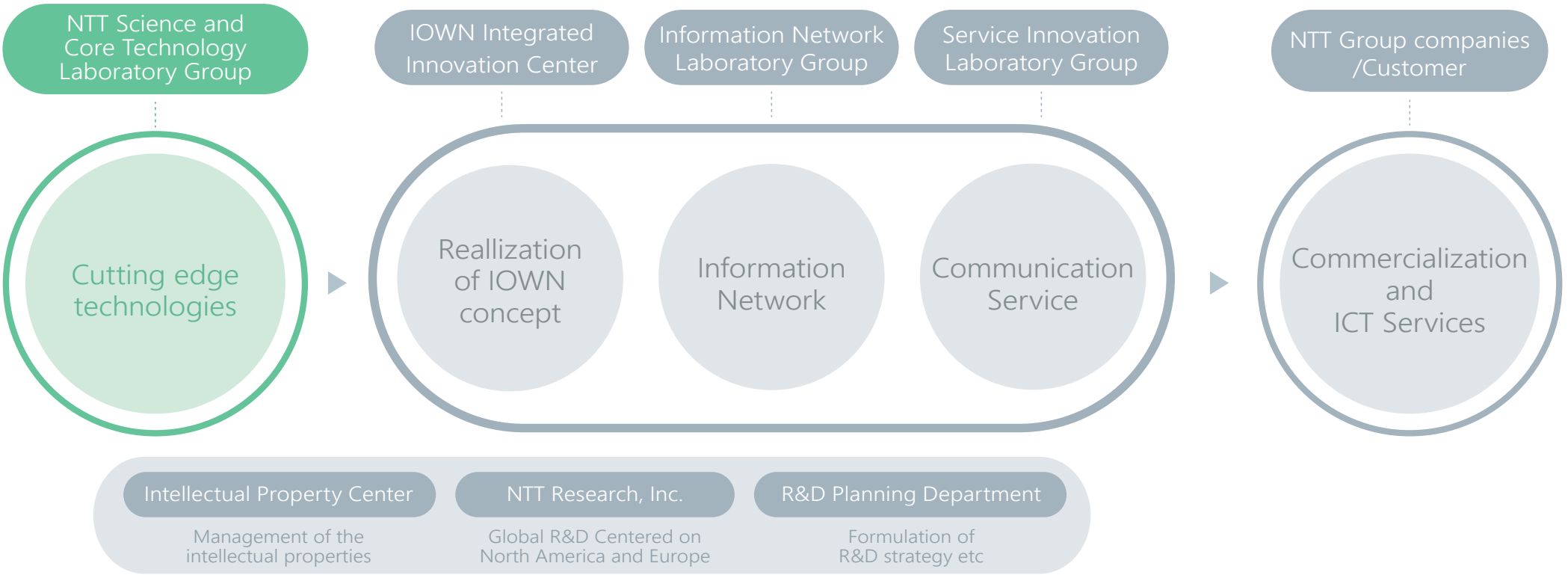
Introduction of

# NTT Science and Core Technology Laboratory Group

# NTT Science and Core Technology Laboratory Group

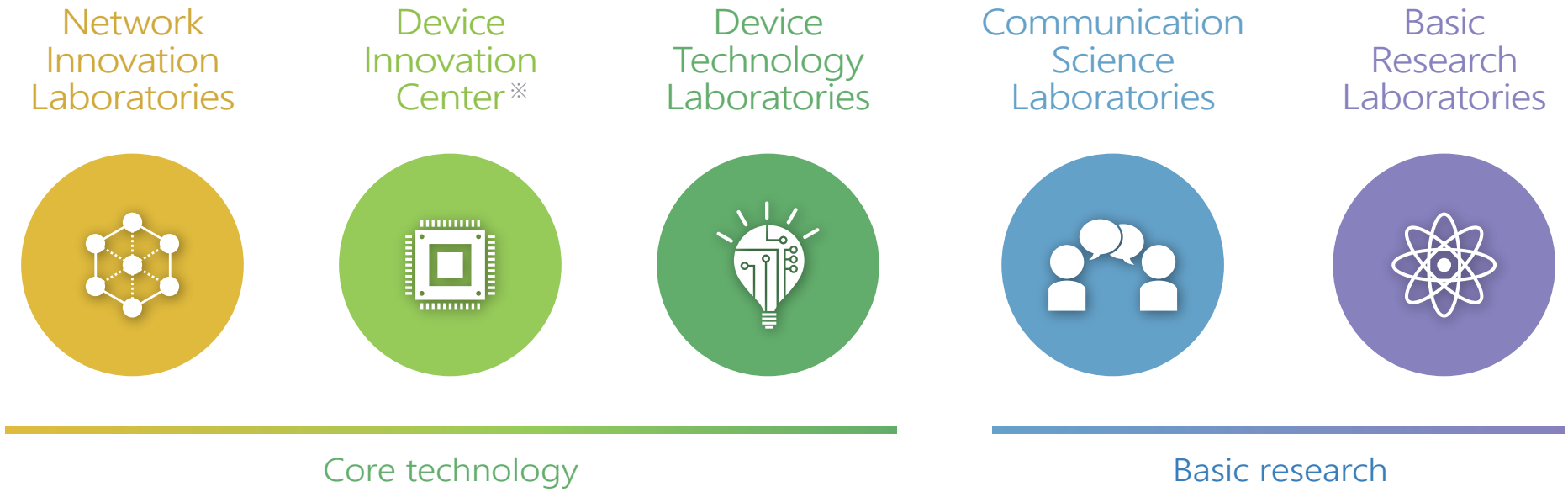
NTT carries out basic research and development activities at IOWN Integrated Innovation Center and three laboratory groups in a wide range of fields, including some of the most advanced ICT research in the world.
NTT Science and Core Technology Laboratory Group holds a global perspective as a center for fundamental research into cutting-edge components, materials, and systems.

Senior Vice President of R&D,
Head of NTT Science and Core Technology Laboratory Group
Akira Okada



# About us

The four Laboratories of NTT Science and Core Technology Laboratory Group are undertaking R&D in the three research areas. These areas are futuristic communications and networks, photonic technology and ubiquitous technology, and science, respectively.




※ Became a subsidiary of IOWN Integrated Innovation Center in July 2021 due to reorganization of NTT Laboratories.

# Network Innovation Laboratories

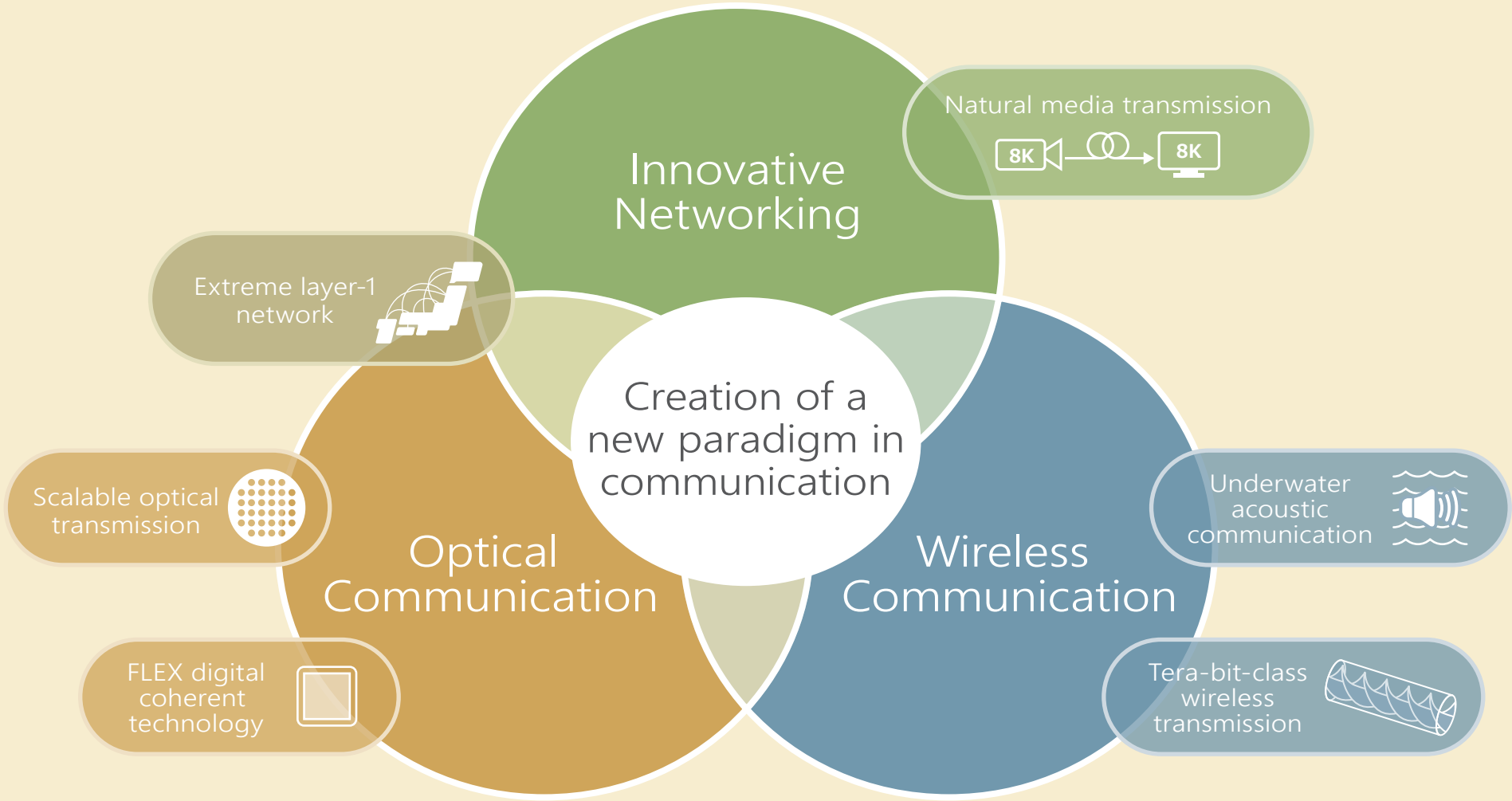
Director
Kazunori Akabane

OUR MISSION

## Technology for higher communication capacity to achieve previously impossible services for a better society

Networks have benefited from new technologies and configurations such as virtualization and open-source software brought about by dramatically increased performance of devices and hardware and development of software algorithms. Looking forward, innovation for even further increase in capacity by overcoming the limitations of optical fiber and the issues of limited frequency resources is needed for networks to continue to serve as essential infrastructure. The Network Innovation Laboratories have taken on the challenge of implementing previously impossible services with network technology that makes utmost use of the world's top-level technology for increasing communication capacity.

# Pursuing advancement of network systems

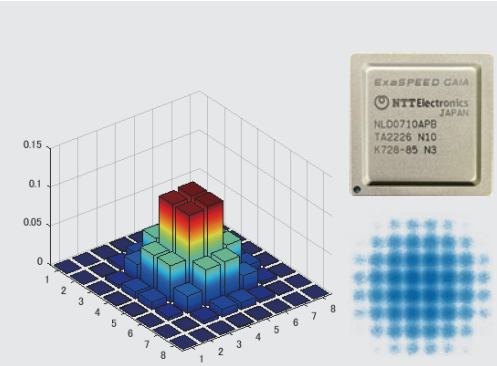



Taking optical transmission technology to the extreme

New possibilities for wireless communication

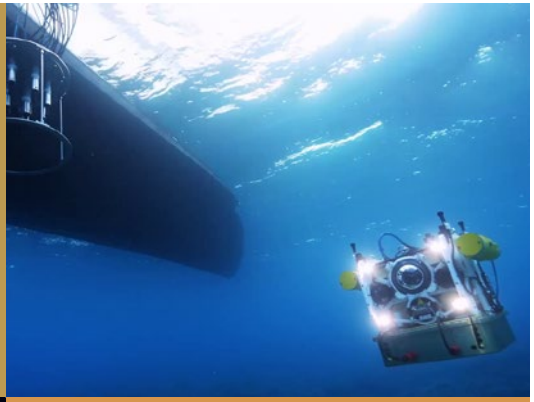
## Flex digital coherent technology

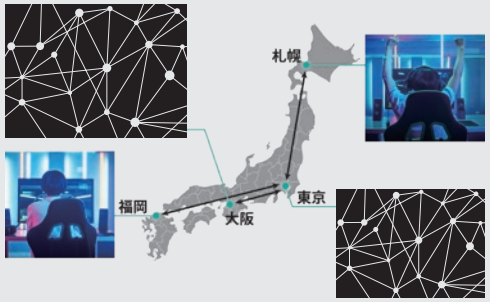
High-capacity optical-transmission technology that achieves 100-Tbps-class transmission per optical fiber by using digital signal processing by LSIs




## High-capacity acoustic communication under water

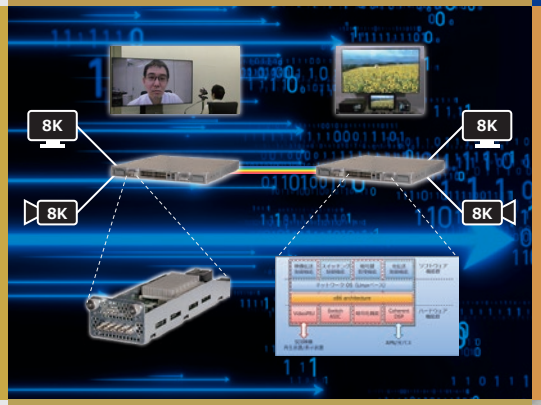
Acoustic communication that enables high-definition video transmission under the sea (where radio-wave communication is difficult)






## Extreme layer-1 network

Layer-1 network technology that contributes to implementation and advancement of APN services by optimal path configuration, latency control, etc.

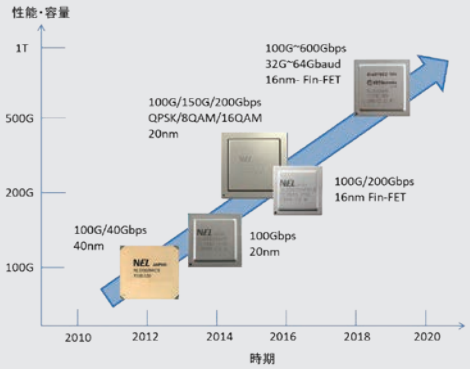



## Natural media transmission

Ultra-low-latency video transmission of uncompressed 8K 120-fps high-definition video within 1 ms

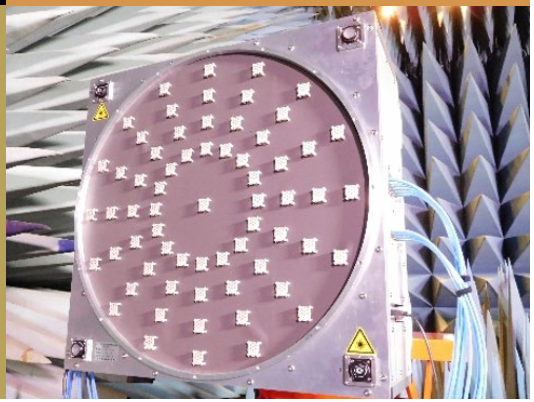
## Scalable optical transmission

High-capacity transmission that utilizes ultra-broadband optical amplification and relay, etc. and space-division multiplexing to achieve peta-bit-class optical link




## Tera-bit-class wireless transmission

Wireless transmission using orbital angular momentum (OAM) to achieve terabit transmission capacity



# Device Technology Laboratories and Device Innovation Center

OUR MISSION

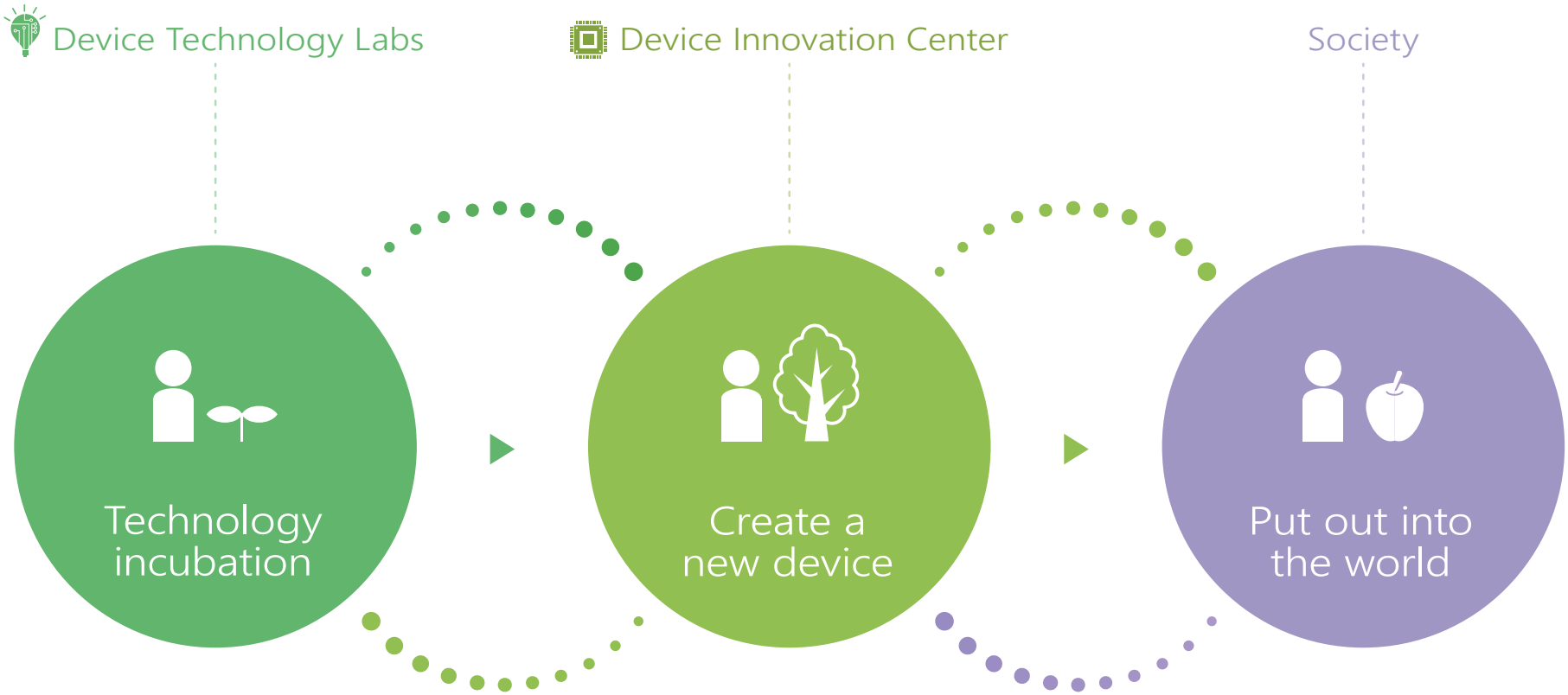
## Development of innovative devices overcoming the limitation of present technology and create new value

The Device Technology Laboratories are doing R&D on compelling new technology for new growth and major impact on industry and society.
In order to seamlessly commercialize innovative technologies, we are working closely with the Device Innovation Center, which is in charge of device development at the IOWN Integrated Innovation Center.
Both facilities will continue to contribute to a prosperous future with R&D that produces new value and services to create a communication environment that is more enjoyable, safe, and secure.

Director
Hirokazu Takenouchi
(Device Technology Labs)

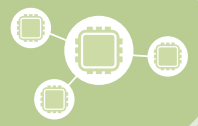
Director
Takashi Saida
(Device Innovation Center)

# Each laboratory plays a specific role in creating devices and value



# Create cutting-edge technologies that provide value for solving social problems and creating the future

Create information-processing devices that open the post-Moore era

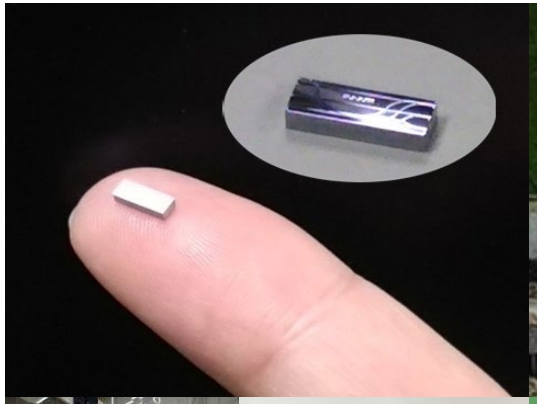


Realization of APN and 6G, namely, a high-capacity, low-power, low-latency, scalable communication network



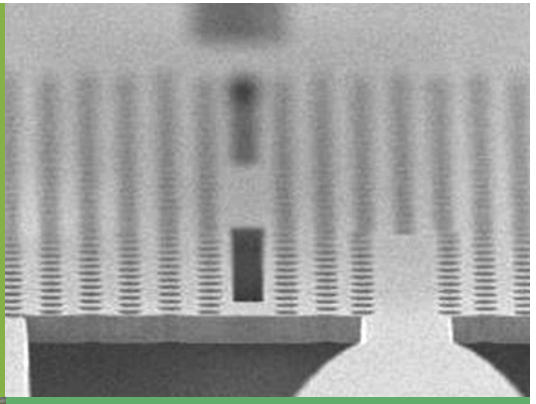

Create natural devices that integrate into and enrich people's lives

Creation of a sustainable society through security and safety of infrastructure and conservation of the global environment



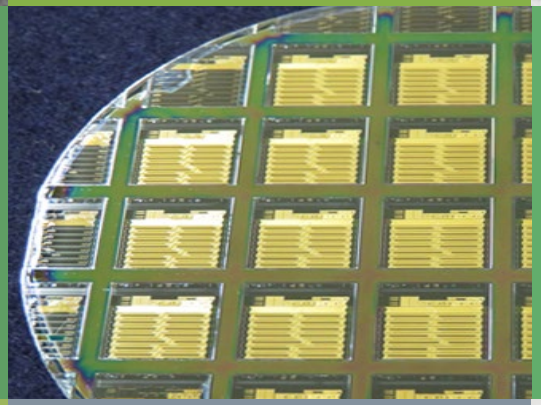
## Photonics-electronics convergence devices

A compact, energy-efficient system-on-a-chip (SoC) that converges photonics and electronics by integrating optical and electronic devices on silicon



## Natural and sustainable devices

Natural devices that control the interface between machines and people/nature; eco-friendly devices with a low environmental impact that contribute to a sustainable society



## Ultra-low-noise optical amplifier

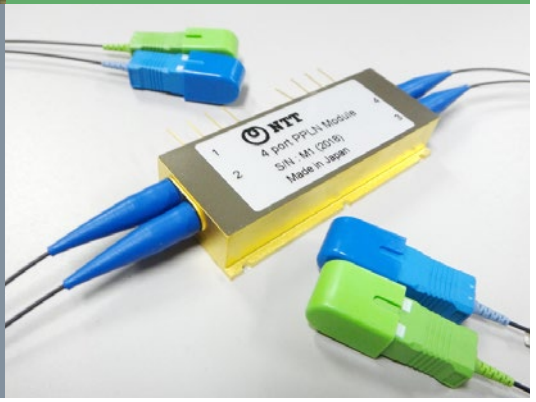
Periodically poled lithium niobate (PPLN) waveguides that greatly extend optical transmission distances

## Infrastructure maintenance technology

Smart infrastructure maintenance technology that contributes to both improved safety and reliability and efficient maintenance and management of telecommunications infrastructures

## Wearable sensing devices

hitoe®, a wearable sensing device developed for long-term acquisition of heart rate and other physiological data for medical and lifestyle applications




C3fit IN-pulse series (GOLDWIN INC.)
TX02 (NTT TechnoCross Corporation)

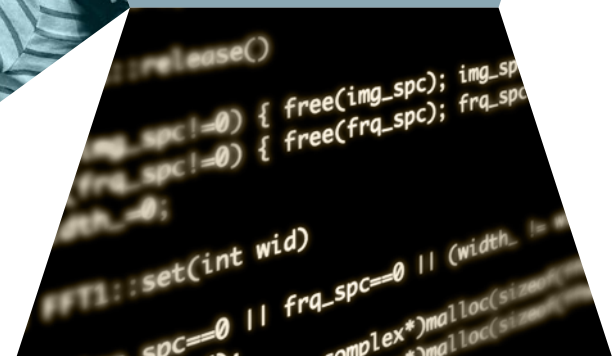
# Communication Science Laboratories

Director
Futoshi Naya

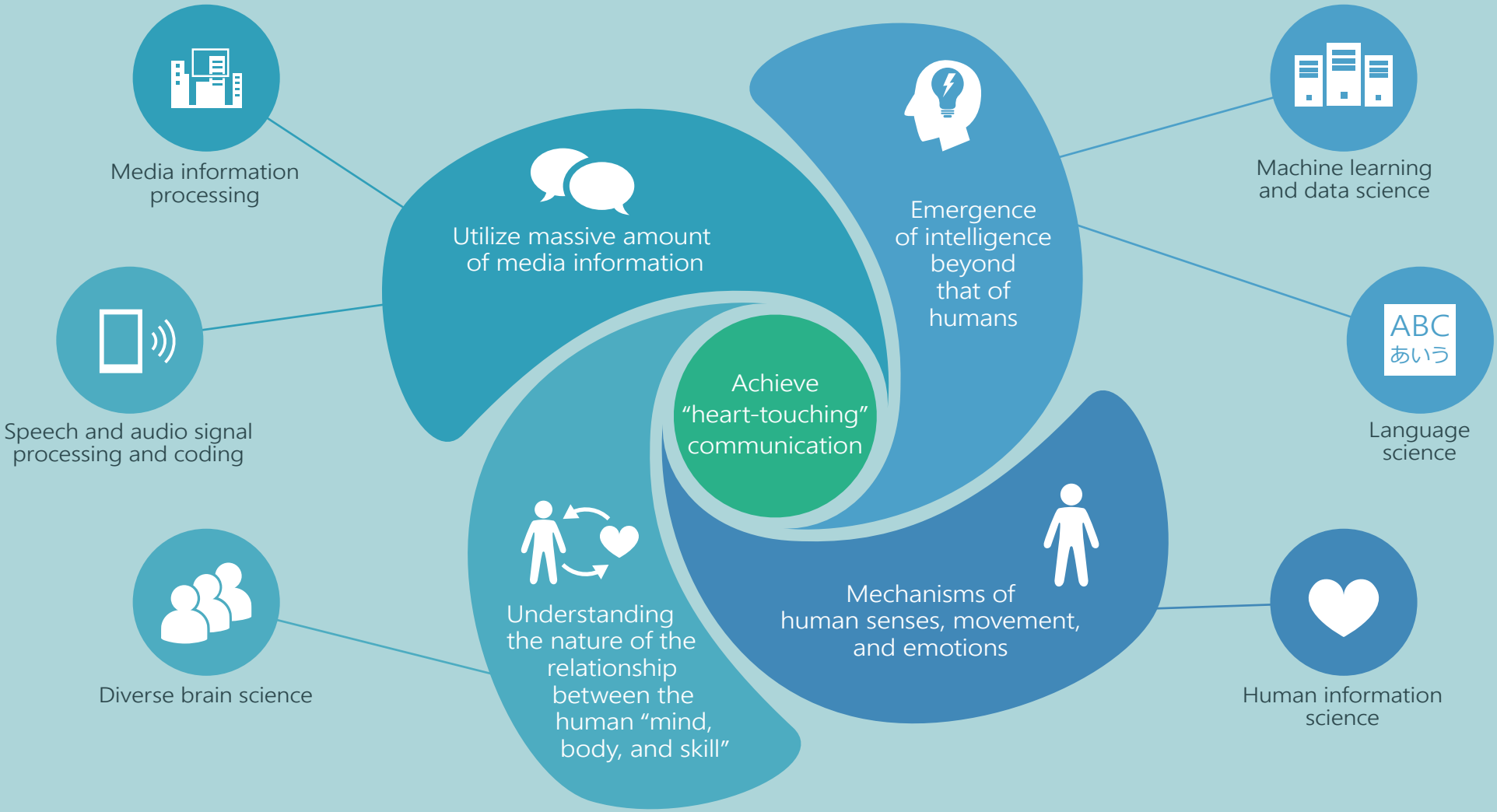
OUR MISSION

## Achieve communication that 'reaches the heart'

We are moving from the era of communication by 'telephone' to a new era of communication with a diverse range of information devices. In this transition, we must rethink the nature of communication between people, between people and computers, and between computers. The Communication Science Laboratories are working to build a new technological platform for connecting 'information' and 'people' by approaching the problem from the two directions of information science and human science.



# Create innovative technologies by understanding the nature of humans and information

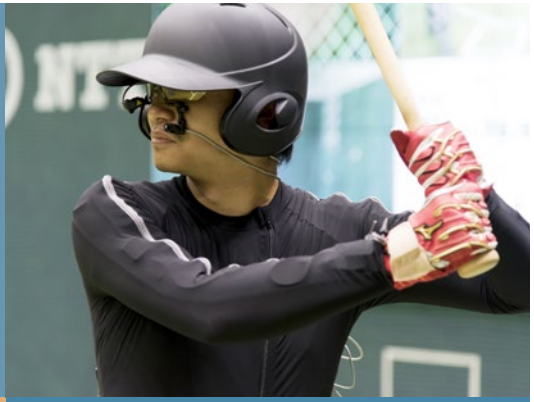


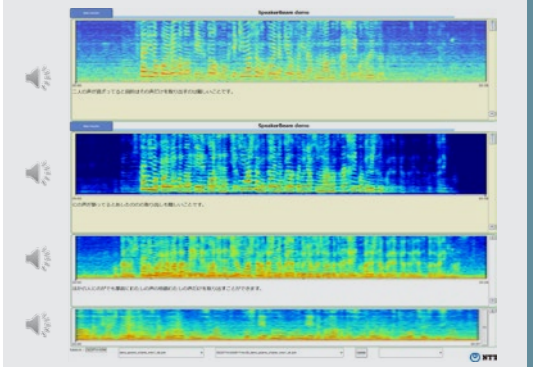
## Human information science

Explaining mechanisms underlying various human sensory perceptions, motor behaviors, and emotions.
Proposal of innovative methods for presenting information, such as “Hen-Gen-Tou” (illusion-based projection) and “Buru-Navi” (utilization of pseudo attraction force in mobile devices), and for improving performance in sports.

## Diverse brain science

Fundamental understanding of the relationship between the human mind, body, and skill by explaining the diversity of brain functions that support the superior cognitive functions of top athletes





## Speech and audio signal processing and coding

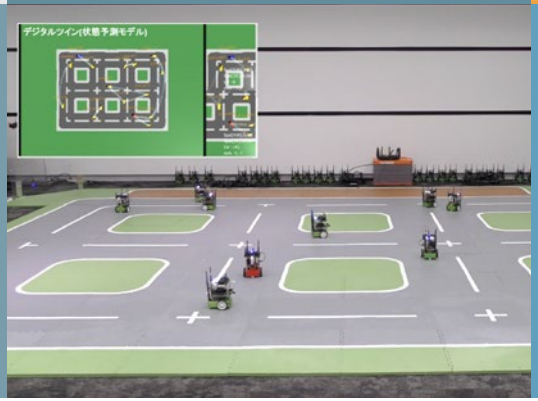
Realizing natural conversation between people and computers by combining world’s most effective noise reduction, dereverberation, source separation, and highly accurate automatic speech recognition techniques.
Lossless algorithms for distortion-free audio data compression as well as proposal of international standards.


## Language science

Clearer understanding of human language acquisition and use and application in research on natural language processing for skillful manipulation of language by computers

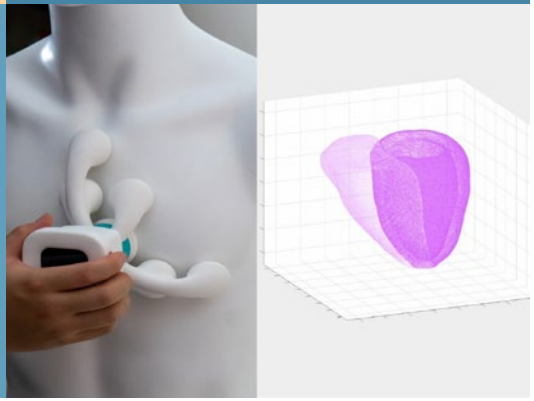
## Machine learning and data science

Achieving near-future prediction and pro-active control with extensive intelligent processing and simulation based on interlinked data from constantly-changing real-world people, objects, and physical phenonema



## Media information processing

Research on technologies for fully utilizing various types of media information, including sound, images, and sensor information. These technologies include (i) recognition and understanding of scenes, situations, and states, (ii) quick search for desired information, and (iii) transformation of information to suit individual purposes.



# Basic Research Laboratories

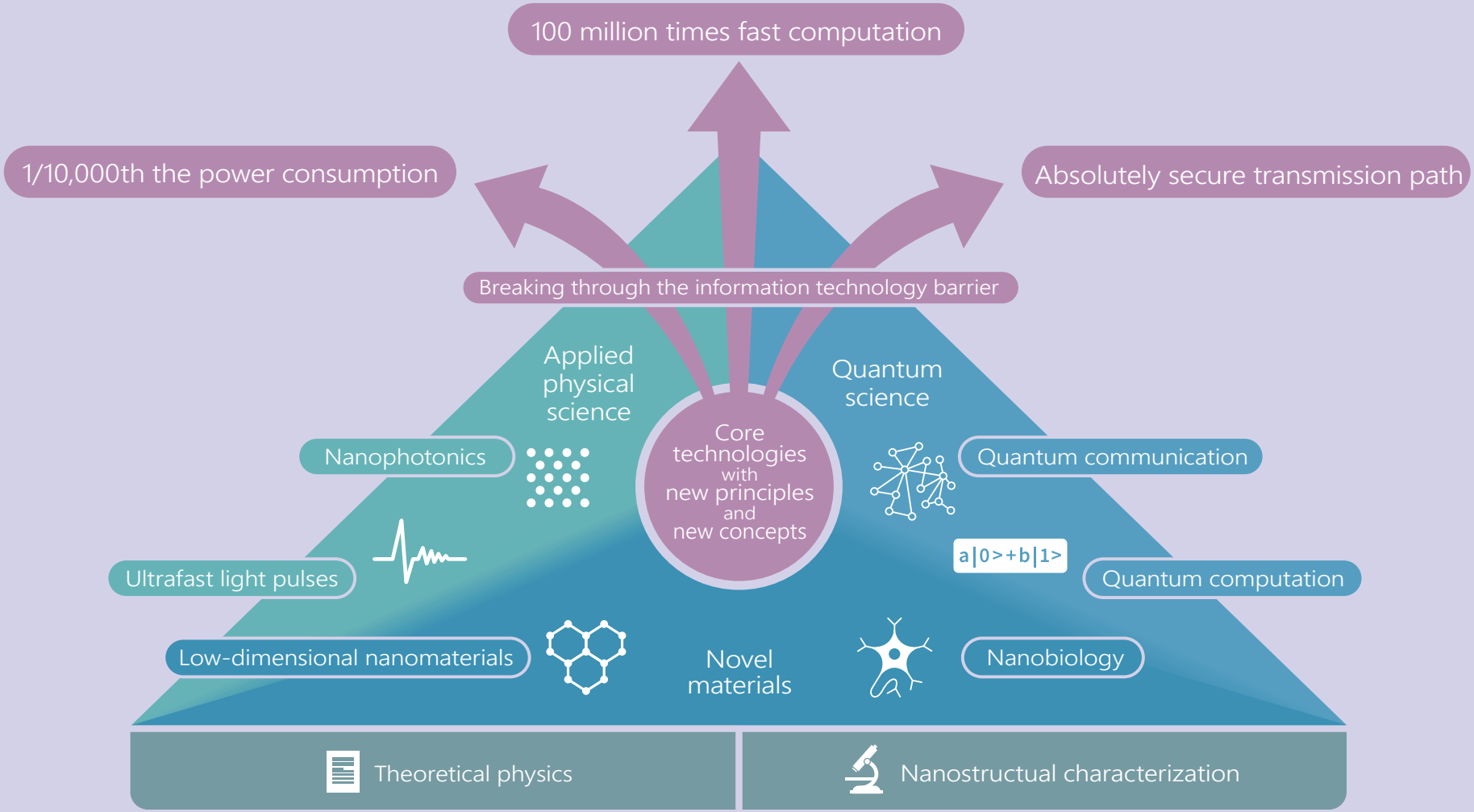
Director
Katsuya Oguri

OUR MISSION

## New principles and concepts to bring about revolutionary changes in society

The mission of BRL is to promote advances in science and contribute NTT's business. To achieve this mission, we conduct basic research on novel materials, their functional physical properties, and quantum science. Our fundamental management principle is to have an open-door policy. This is shown by our collaboration with other NTT laboratories as well as many universities and research institutes in Japan, the US, Europe, and Asia.
We also organize "Science Plaza" events and international conferences on Quantum Physics and Nano-Science at Atsugi R&D Center to disseminate our research results and obtain feedback. we also sponsor the "BRL School," which is dedicated to young researchers around the world.

# Our goal is to produce high-impact results in the fields of novel materials, functional physical properties, and quantum science, based on both theory and experiment.

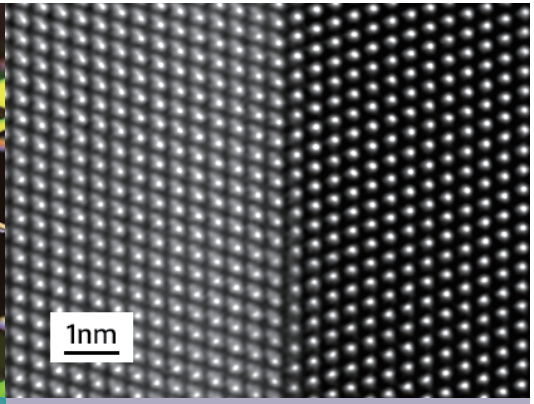


## Low-dimensional nanomaterials

Technology for forming graphene and other nanomaterials using a low-energy electron microscope and a new microscope for probing the optical and electrical properties of nanostructures

## Quantum communication and computation

Establishing fundamental technologies using the principle of quantum mechanics for secure communication and large-scale computation

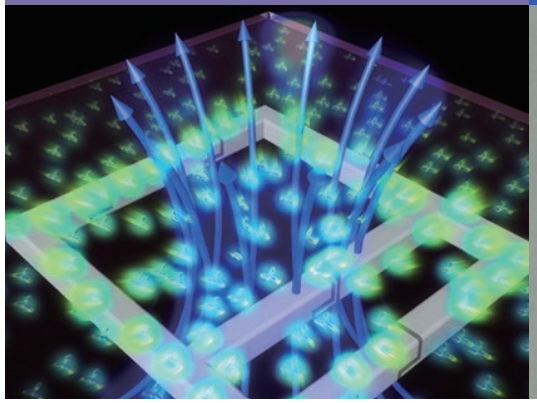


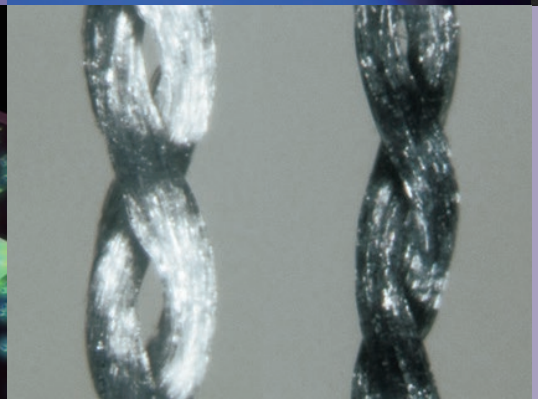

## Nanobiology

Collaboration with other companies in using conductive polymers and nanofibers to develop hitoe®, an electrode material that is compatible with the human body, for use in wearable electrodes

## Nanophotonics / Quantum-optical integrated circuits

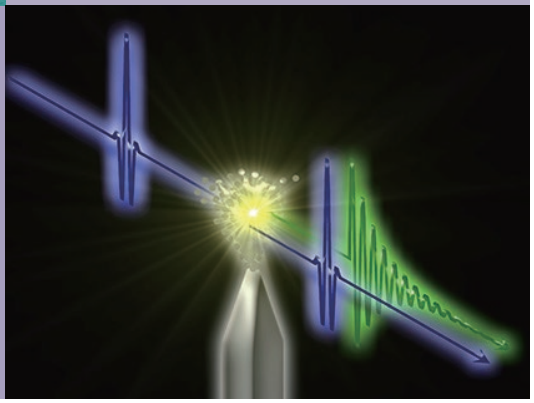
Development of an advanced information chip that features high-density integration using photonic crystal technology for light manipulation





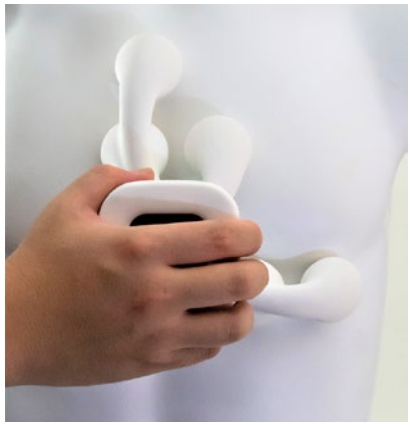
## Ultrashort light pulses

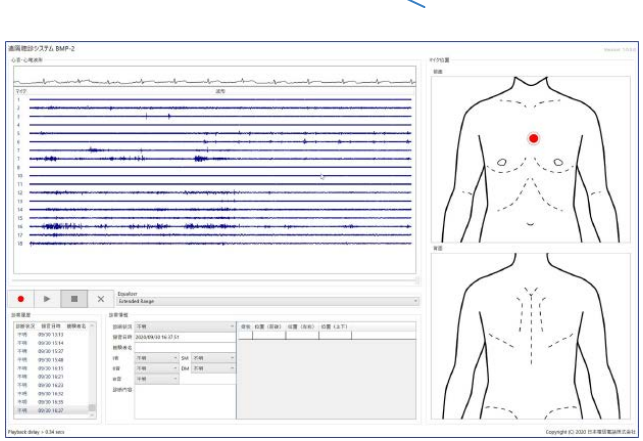
Using ultra-fast attosecond light pulses to clarify the movement of electrons within atoms and other micro-world events (attosecond = $10^{-18}$ second)



# Bio-Medical Informatics Research Project

We are conducting basic and applied research in areas such as AI analysis of medical and genome information, real-time biosensing technology and new biocompatible materials. We promote research and development in the medical and health fields in cooperation with NTT Research Inc., NTT Life Sciences, NTT Group Medical-Healthcare Division and other medical institution.



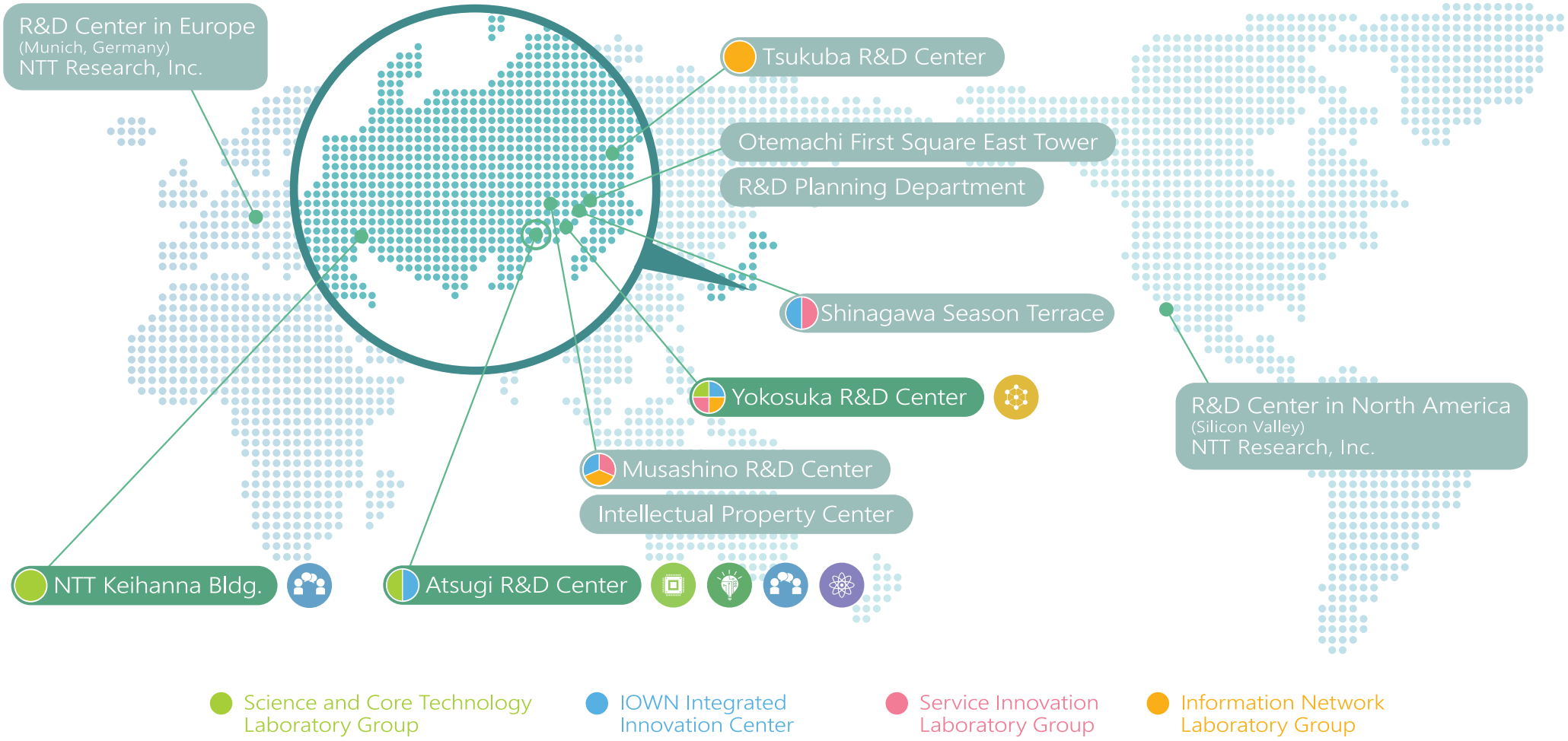


Above: AI-tele stethoscope
(left: Wearable examination system with multi-channel acoustic sensors and electrocardiographic (ECG) electrodes,
right: Handheld system equipped with acoustic sensors, ECG electrodes, a pressure sensor and an accelerometer)

Below: Remote control terminal screen

# Location of NTT Science and Core Technology Laboratory Group

Our R&D spreads over three locations, with the Atsugi R&D Center as the main facility and including Yokosuka and Keihanna.



# NTT Fellows

## Takehiro Moriya

Speech/audio signal processing and coding

- Highly efficient encoding for next-generation IP telephone
- Core technology for transmission of highly realistic audio signals

## Naonori Ueda

Big data analysis & statistical machine learning

- Spatio-temporal statistical analysys
- Contribution to natural and social sciences by machine learning

## Makio Kashino

Human information science, cognitive neuroscience

- Elucidating the brain function underlying auditory cognition
- Elucidating and shaping the brain function of athletes

## Shingo Tsukada

Medicine, physiology, biomedical interface & data analysis

- Biomedical information measuring wear "hitoe" and related technologies
- Biocompatible implantable medical electrodes are made of electroconductive polymer and flexible fibers

## Yutaka Miyamoto

Scalable Optical Transport

- R&D for mitigating physical limit (Capacity Crunch) of long-haul optical transport based on today's single mode fiber

## Hiroshi Yamaguchi

Semiconductor nanomechanical devices

- Novel signal processing technologies using nonlinear dynamics
- Ultra high performance sensing devices using quantum hybrid structures

## Kunio Kashino

Crossmodal media information processing, biomedical informatics

## Masaya Notomi

Research on integrated nanophotonics for novel phenomena and optical processing

## Shinji Matsuo

Heterogeneously integrated photonic integrated circuits

- Heterogeneous integration of III-V compound semiconductor on Si photonics circuit
- Development of Photonics-Electronics Convergence Devices

(As of April 2023)

# NTT Senior Distinguished Researchers

## Hiroaki Gomi

Elucidation of interactive information processing for motor control, sensation, and perception

## Masaaki Nagata

Neural machine translation based on context and situation

## Koji Muraki

Research on quantum emergent physics via electron interaction engineering in semiconductors

## Akira Fujiwara

Research on ultimate electronics based on the control of single or a few electrons in semiconductor nanostructures

## Tomohiro Nakatani

Audio and speech signal processing for capturing and recognition of human conversations

## Hiroshi Sawada

Research on mathematical model and data analysis for understanding real-world phenomena

## Hiroki Takesue

Information processing technologies based on quantum optics

## Tessei Kobayashi

Language acquisition science and educational support

## Junji Watanabe

Development of tactile information transmission technology and research on its social impact from the viewpoint of human science

## Hirokazu Kameoka

Media scene analysis and generation for communication ability augmentation

## Takahiro Kawabe

Investigating innovative information presentation methods based on perceptual illusion

## Hideki Yamamoto

Design and thin-film synthesis of novel superconductors and magnetic materials along with elucidation of the underlying physics

## Shiro Saito

Quantum information technologies based on superconducting quantum circuits

## Toshikazu Hashimoto

Research on optical circuit technology to manipulate lightwaves for novel information processing

## Yoshitaka Taniyasu

Research on functional materials for green innovation

(As of April 2024)

# NTT Senior Distinguished Researchers

## Noboru Harada

Speech/audio signal processing,
coding, and standardization

## Tomoharu Iwata

Machine Learning
for Imcomplete Data

## Doohwan Lee

Orbital angular momentum (OAM)
multiplexing transmission
for terabit-class wireless communication

## Norio Kumada

Ultrafast electron dynamics
in two-dimensional systems



(As of April 2024)

NTT Science and Core Technology Laboratory Group official website
https://www.rd.ntt/e/sclab/

NTT Technical Review
https://www.ntt-review.jp/

October 2024