

CON NECT TO MOR ROW

Technology

Pioneer

Communication

2023 ETRI TECHNOLOGY REPORT

KOREAN

ETRI

Connect to
Tomorrow

2023 ETRI
Technology Report

ETRI

ETRI 한국전자통신연구원
Electronics and Telecommunications
Research Institute

THE INNOVATIVE PIONEER, ETRI

Electronics and Telecommunications Research Institute
pioneers a new world with creative attempts
and innovative technology development.



CONNECTING TO TOMORROW

Science and technology connect the present to the future that everyone dreams of, which is safe, comfortable and happy.



President Greeting

We now face a global era that changes every minute.

I believe the most important thing in such an era is to develop the ability to quickly comprehend the international situation and respond to the changes.

Last year, the government designated 12 national strategic technologies. Most of these, such as semiconductors, displays, secondary batteries, advanced mobility, cyber-security, artificial intelligence, next-generation communication, advanced robots and manufacturing and quantum technologies, are based on information and communication technology. Therefore, ETRI bears a heavy burden, indeed.

ETRI, as the largest government-funded ICT research institute in Korea, also has the responsibility of leading the development of the ICT industry and contributing to the nation’s innovation and growth by developing intelligence information technology for the future.

In addition, along with the missions of R&D, corporate support and service, we must fulfill our roles in providing the infrastructure for super-intelligent information society, realizing super-performance computing, achieving hyper-connected infrastructure, realizing ultra-realistic services and developing converged national intellectualization technology.

Accordingly, ETRI designated 6 core strategic technologies and is fully promoting the mission-centric R&D. These include artificial intelligence semiconductor and computing, security technology, AI and software, 6G communication, metaverse and digital convergence technology. ETRI will strive to innovate the nation and society digitally by achieving these 6 core strategic technologies within the given period.

I intend to lead the innovation by continuously researching and developing the technologies with the help of the newly created research organization.

All employees of ETRI will work together and give their best efforts to research and development, so that the people can enjoy more comfortable, safer and happier world. I would appreciate your heartfelt support and encouragement for ETRI, so that it will be loved and recognized by the people and become the best research institute in Korea.

ETRI will play its role as the technology pioneer that creates happier future through digital innovation.

Thank you.

President,
Electronics and Telecommunications
Research Institute

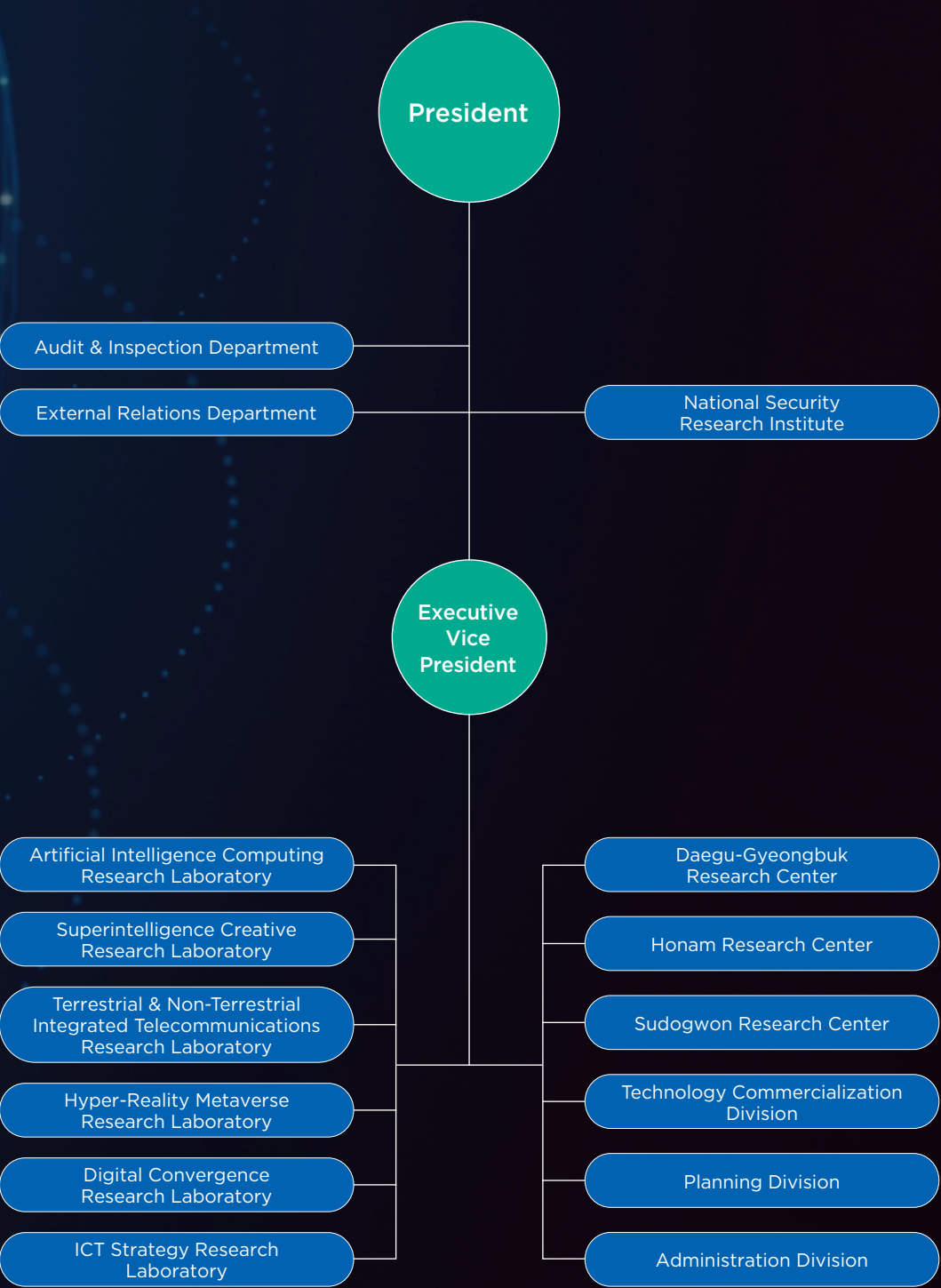
Bang, Seung Chan



Vision & Management Goal



Organization



History

1976.12.30.

KERTI ESTABLISHED

Established for electric research and testing

KIET ESTABLISHED

Established for semi-conductors and computers



1977.12.10.

KTRI ESTABLISHED

KECRI became independent from KIST and KTRI was established on Dec 31, 1976 as a research institute specialized in telecommunications

1977.12.10.

Independent from KIST and renamed itself as KTRI



1976.12.31.

KECRI WAS FOUNDED

as an affiliate of KIST Established for R&D in telecommunications technology

Established KE RTI, KIET and KECRI, the origins of ETRI

1976.12.30.

KERTI (Korea Electric Research and Testing Institute) was established

KERTI (Korea Electric Research and Testing Institute) was established

1976.12.31.

KECRI (Korea Electronics & Communications Research Institute) was founded as an affiliate of KIST

1981.01.20.

KETRI ESTABLISHED

(consolidation of KTRI and KERTI)

Established KETRI

1981.01.20.

KETRI (Korea Electrotechnology and Telecommunications Research Institute) was established in consolidation of KTRI and KERTI

1985.03.26.

ETRI ESTABLISHED

ETRI Institute specialized in information and telecommunications (consolidation of KIET and KETRI)

Established ETRI

1985.03.26.

ETRI, institute specialized in Information and Telecommunications was established (consolidation of KIET and KETRI) to meet with the emphasize on electronics field



1997.01.31.

ETRI

Korean name of ETRI officially changed

1997.01.31.

Based on regulations for electronics and telecommunications



1985

1996

1997



1996.01.01.

SERI TRANSFERRED TO ETRI

SERI, data process department of KIST, transferred to ETRI as an affiliate

Data process department of KIST transferred to ETRI as an affiliate

1996.01.01.

SERI (Systems Engineering Research Institute) was opened as data process department of KIST. In accordance with government restructuring of the Ministry of Science and Technology to the Ministry of Information and Communication, SERI became affiliate of ETRI on January 1, 1996

1998.05.25.

Incorporated into ETRI

1970s

1976

- Established KIST affiliate, KTRI
- Established KIET
- Established KERTI

1977

- Established KTRI

1980s

1982

- Developed Korea's first memory semiconductor 32K ROM

1983

- Developed 8-bit educational computer

1984

- Localized 16-bit UNIX computer

1986

- ♦ Developed TDX which opened the “one-household, one-telephone” era

1988

- Developed 565 Mbps optical communication system

1989

- ♦ Developed 4M DRAM, which led to the development of 16M, 64M, and 256M DRAM

1990s

1990

- ♦ Developed 32-bit microprocessors

1991

- Launched TDX-10
- Developed TiCOM II

1994

- Developed digital satellite broadcasting system

1995

- ♦ Commercialized the world's first CDMA mobile telecommunications system

1996

- Developed a vehicle-mounted antenna for satellite broadcasting

1999

- Developed a synchronized IMT-2000 (CDMA2000) STP system prototype
- ♦ Developed and commercialized nonsynchronized IMT-2000 (WCDMA)

2000s

2004

- ♦ Developed the world's first portable broadband Internet WiBro prototype

2005

- Exported first Korean embedded software development solution
- ♦ Launched terrestrial DMB services

2006

- Developed a wireless home network ultra-wideband (UWB)
- Developed the world's first transparent AMOLED

2007

- Developed the world's first 3.6 Gbps fourth generation mobile communications technology (NoLA)

2008

- Developed an SMMD-based realistic 4D system technology

2009

- ♦ Developed an eco-friendly OLED lighting technology that illuminated the world

2010s

2010

- ♦ Developed the world's first fourth generation LTE-Advanced technology
- Developed a smart ship technology (SAN)

2011

- Developed an adjustable transparent AMOLED display panel
- Developed a packet-optical integrated transport network technology

2012

- Developed the 100 times faster fiber-optic Internet
- ♦ Developed a portable automatic Korean-English interpretation app, GenieTal
- ♦ The world's first terrestrial 4K UHD Broadcasting System Commercialization

2013

- Developed a DB-call-based intelligent English learning system, GenieTutor

2014

- Developed the world's first 10 Gbps OCES+3.2 Tera fiber-optic Internet

2015

- Developed an RoF-based mobile fronthaul technology (High Five ESCoRT)

2016

- Developed an optical-circuitpacket switching system

2017

- Developed a high-performance language intelligence software, Exobrain

2018

- Developed a UHD mobile broadcasting technology

2019

- Developed a 25 Gbps-class Tactile Internet TIC-TOC

2020s

2020

- Developed a visual intelligence source technology platform, Deep View

2021

- Developed core technologies for AI that understands roads, objects, and people

2022

- Developed Micro LED Transfer, Bonding Technology

2023

- Developed Factory Energy Management System (FEMS) Standard Platform for Maximizing Factory Energy Efficiency



Key Representative Core Technology Recognized for Economic Ripple Effects of Over 10 Trillion Won or Global Uniqueness and Excellence.

1) Analyzing Organization and Period: DAVA, November 2016 to April 2017.
2) Analysis Period: 1976 to 2016 (40 years)

The Main R&D Field

18

Artificial Intelligence
Computing Research
Laboratory

24

Superintelligence Crea-
tive Research Laboratory

30

Terrestrial &
Non-Terrestrial Integrated
Telecommunications
Research Laboratory

36

Hyper-Reality Metaverse
Research Laboratory

40

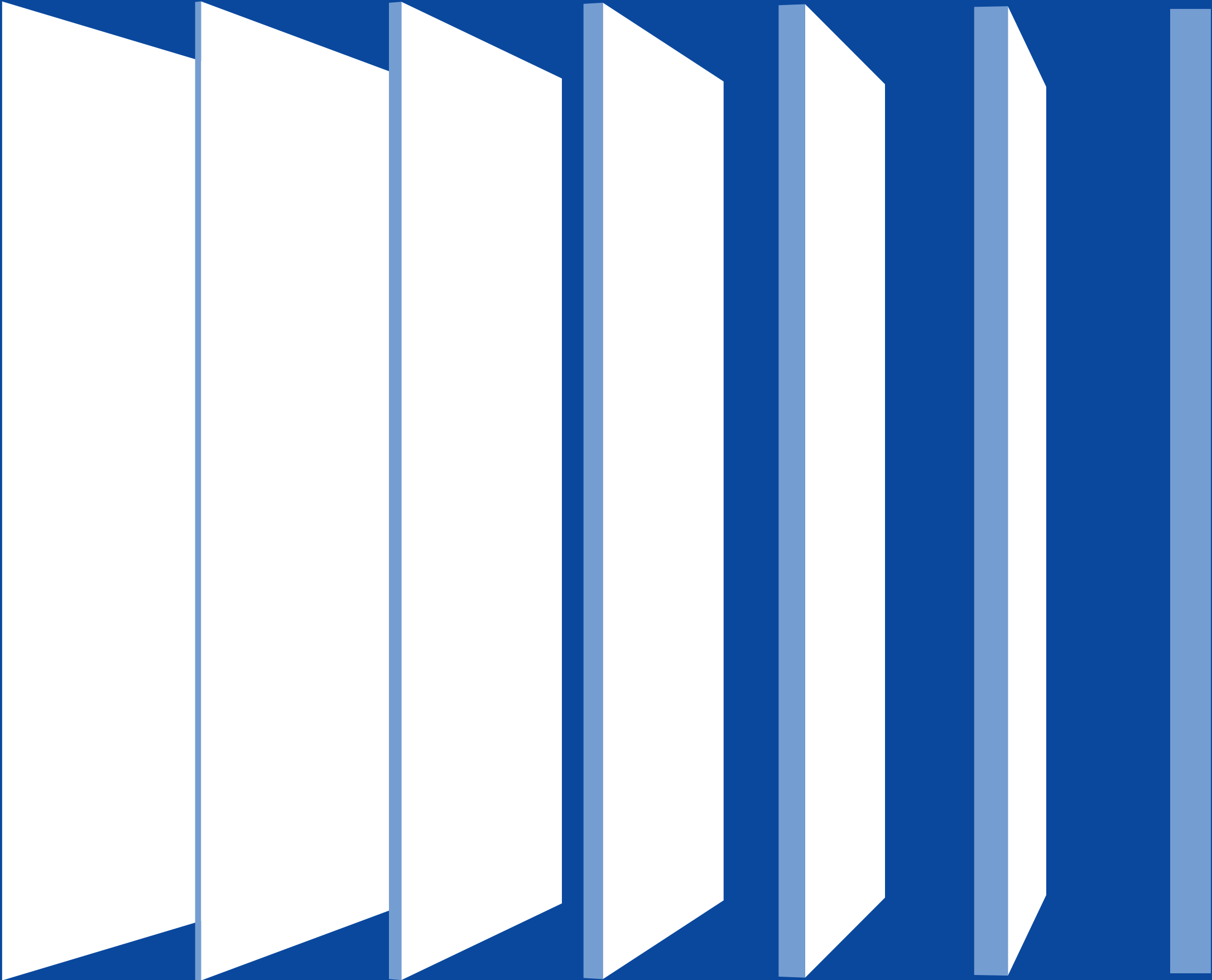
Digital Convergence
Research Laboratory

46

ICT Strategy
Research Laboratory

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Regional Research
Centers



Artificial Intelligence Computing Research Laboratory



▶ Interview Clip



Cho Il Yeon,
Senior Vice President



Kim Yun Kon,
Senior Researcher

Future Computing Research Division

AI SoC Research Division

Cyber Security Research Division

Quantum Technology Research Division

Artificial Intelligence Computing Research Laboratory is developing ultra-high performance hardware and software strategies for artificial intelligence to realize ETRI's vision of being a technology pioneer in creating a digitally innovative and happy future world.

In addition, we have established the strategic goal of achieving disruptive innovation in computing through the development of computing systems and infrastructure that overcome performance limitations. To accomplish this, we are actively developing core technologies in computing systems, including intelligent semiconductors and quantum computing hardware, as well as system software that supports these advancements.

In particular, we are dedicated to developing AI supercomputers and cybersecurity technologies using ETRI's expertise, with the goal of addressing societal issues. To achieve these objectives, we actively engage in close collaborations with domestic and international universities, businesses, and other specialized institutions possessing expertise in relevant fields.

Future Computing Research Division

The Future Computing System Research Division is dedicated to researching and developing high-performance computing systems required for the hyper-scale artificial intelligence models to learn fast and conduct real-time and highly efficient inferences. We explore a memory-centric approach to computing architecture and develop new mechanisms for processing and managing data to accelerate the processing of large-scale data and overcome existing limitations. Furthermore, we aim to de-

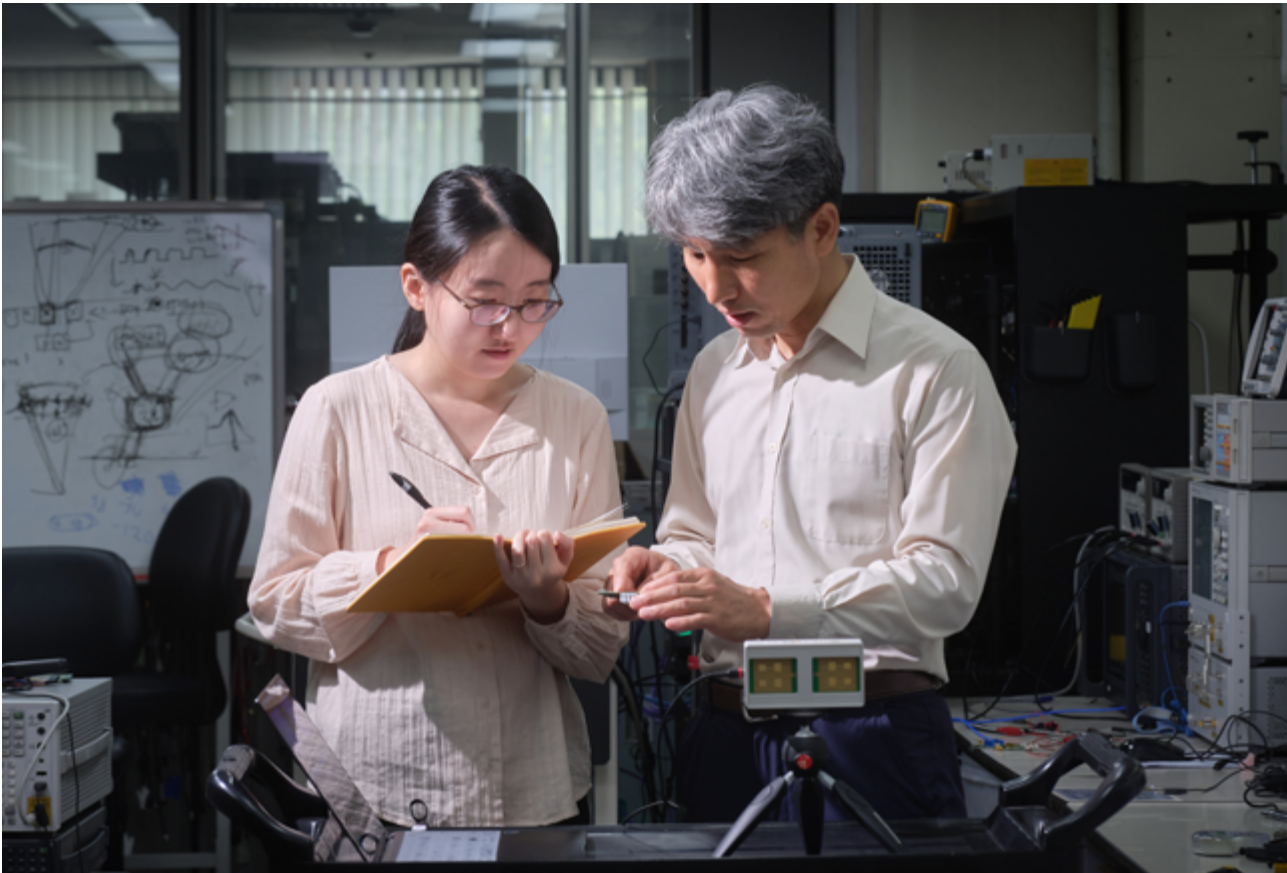
velop the multi-cloud technology that links the high-performance computing technology to the cloud services across the world and effectively provide various AI services. Currently, our Division focuses on a range of research areas, including high-performance computing systems, cloud computing software, supercomputing, edge computing, storage systems, AI computing systems, intelligent CPS platforms, embedded intelligence, software for



AI SoC Research Division

The field of AI semiconductor has a significant growth potential and the ability to lead the global market. AI SoC Research Division researches, designs and develops ultra-large artificial neural network SW/HW semiconductors that can be trained under the transformer model, which has reached the pinnacle of digital neural networks in achieving human-like intelligence. The goal of the Division is to research and secure the original technology for the gigabyte-level memory-integrated NM-PIM processor semiconductors of petascale performance. Furthermore, to overcome the limitations of traditional von Neumann

computing, we are developing neuromorphic computing technologies that simulate neural networks with fused memory and processing capabilities, enabling ultra-low power, high-performance parallel computing. We are also pursuing the advancement and industrialization of ultra-low power RISC-V edge processors and semiconductor technologies for sensing biological, object and spatial signals, while having interest in developing the original technologies of controlling semiconductors for quantum computing.



Cyber Security Research Division

We research and develop key cyber security technologies in various areas of cyber security, such as quantum-era encryption, avatar authentication, intelligent systems and networks, device and user protection, hacking detection and response, and testing and verification of various security fields, for people to enjoy the upcoming digitally transformed environment more safely. Four research sections and one center, including Cryptographic & Authentication Base Technology Research Section, AI Convergence Security Research Section,

Intelligent Network Security Research Section, System Security Research Section and Cyber Warfare Technology Research Center are conducting researches on highly advanced cyber security technologies to realize a safe cyber world by guaranteeing high degrees of freedom in the connections between various subjects that make up the metaverse, such as networks, systems, devices, users and avatars, and by incorporating preemptive and proactive security functions.



Quantum Technology Research Division

The future of national competitiveness will be determined by the capability to handle large scale data, intelligence, secure communication channels, high performance computing and hypersensitive sensing, which will require new forms of data collection, transmission, processing and networking technologies. By taking advantage of the unique quantum nature of superposition, entanglement, and high sensitivity to external environments, quantum technology will revolutionize the next generation of information and communication technology as a game changer by enabling faster, safer and more precise systems. Quantum Technology Research Division primarily conducts research and development on quantum computing,

quantum communication and quantum sensing. Quantum computers will improve the performance of computing used for artificial intelligence by using a computational power far beyond those of classical computers. Quantum communication will develop through wired, wireless and satellite communication channels, and is expected to expand to quantum internet in the future. Quantum sensing can measure physical quantities with extreme accuracy that were previously unmeasurable, which can lead to groundbreaking advances in a wide variety of fields such as medicine, environment, autonomous driving, space and more.

Superintelligence Creative Research Laboratory

2



**Intelligence
Information
Research Division**

**Mobility Robot
Research Division**

**Creative & Basic
Technology
Research Division**

**Materials &
Components
Research Division**

Superintelligence Creative Research Laboratory carries out diverse researches from materials and components to finished products, such as autonomous driving vehicles and robots, to strengthen the technological competitiveness of Korea. We seek to discover the original and epoch-making technologies, so that we can exceed limitations of current technologies and prepare the next-generation technologies.

We research core technologies for the next-generation AI core technologies by which the AI will constantly see, hear and learn like human; and intelligence mobility and robot technologies that makes decisions on its own based on the surroundings while functioning autonomously and safely at the same time. Furthermore, we research technologies related to smart materials, next-generation semiconductor and intelligent components to secure the materials, components and equipment technology, which is at the core of global competition. On the other hand, we research creative and innovative subjects, such as terahertz technology, brain mimesis technology and low-carbon integration technology, in diverse ways, which can realize inventive ideas. There is a risk of failure, but we intend to be prepared for the coming generation by planting the tree of creative technologies that captures the opportunity amid uncertainty.

Superintelligence Creative Research Laboratory will continuously act as the catalyst, creating the virtuous circle in the Korean industry ecosystem by transferring the results of researches and sharing APIs and data. We will lead Korea securing the world-class technologies by continuously collaborating with the world's leading research institutes.

▶ Interview Clip



Min Ok Gee,
Senior Vice President



Jin Han Bit,
Senior Researcher



Intelligence Information Research Division

Intelligence Information Research Division focuses on language intelligence, voice intelligence, visual intelligence, big data and human augmentation with the goal of developing artificial intelligence technology that can see, hear and learn on its own like human. In addition, we research the original technologies for complex intelligence and continuously growing artificial intelligence to be prepared for the next generation AI technology in the era of GPT. We seek to secure core technologies for intelligence in-

formation through selection and concentration, and support the industrial ecosystem by supplying and spreading our technologies through an open API platform to vitalize the domestic intelligence information industry. In addition, we intend to develop ICT convergence technology to help people recover their physical functions or abilities that have been deteriorated or lost due to aging, disease or disability and maintain healthy lives by enhancing physical, cognitive and sensory abilities.



Mobility Robot Research Division

The Division develops core intelligent robotics technologies that can cause robots and cars operate autonomously and safely and respond to the circumstances intelligently. These technologies will enable us to prepare for the future social changes, such as aging and reduced labor force. Specifically, the Division is developing core software related to perception, planning and controlling in connection with V2X. This software is designed to improve driving intelligence through collection of driving data and machine

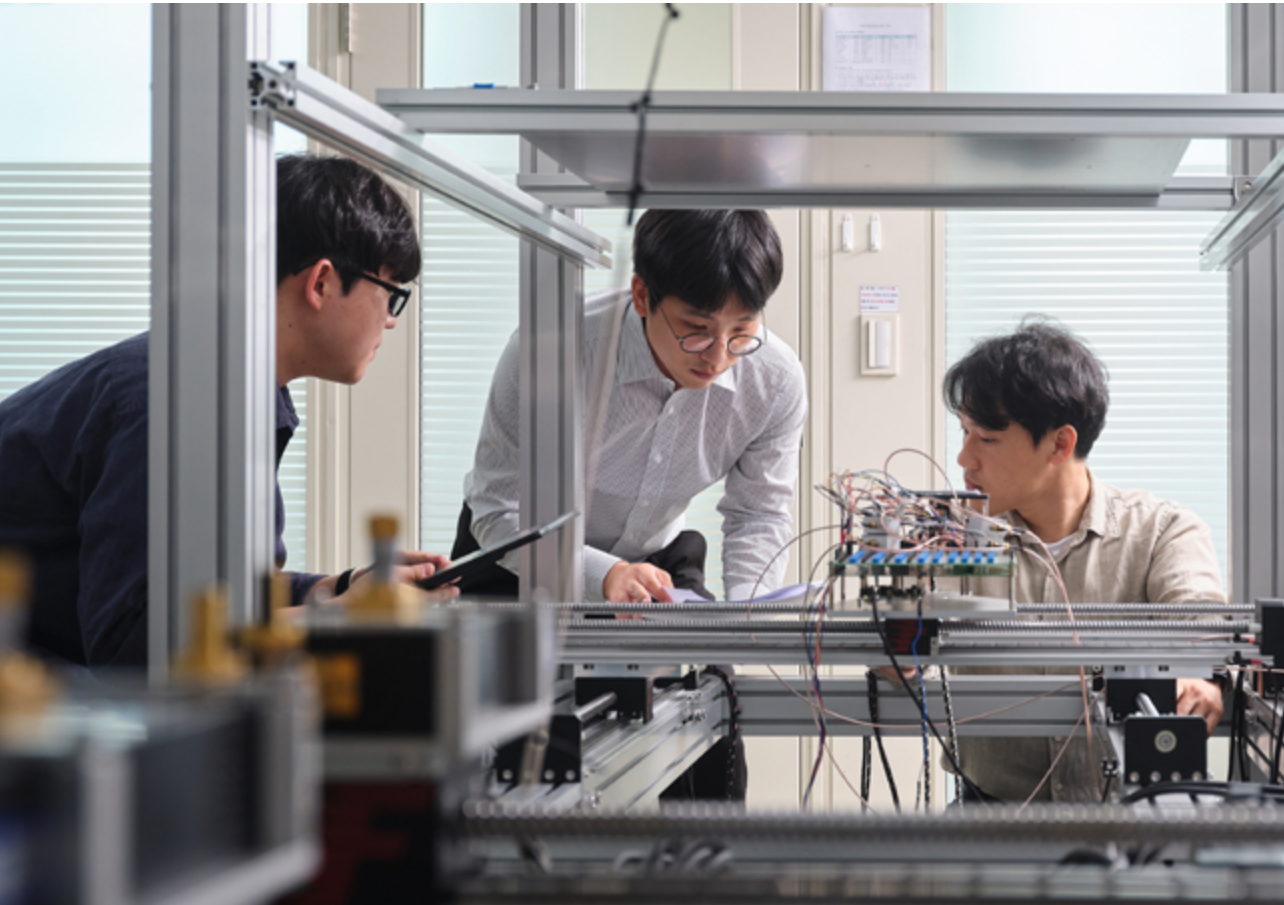
learning. Additionally, the Division is researching autonomous human-robot interaction technologies for social robots and human care robots, as well as the core technologies for field robots by which they can help people move and perform various tasks in uncertain indoor and outdoor spaces. Also, the Division is contributing to creation of mobility and robot research ecosystems and vitalization of industries by developing and disclosing the AI learning data specializing in large-scale driving and human care robot.

Creative & Basic Technology Research Division

Creative & Basic Technology Research Division aims to provide the strategic technologies for the future through creative and original research. We are the cradle of creative and basic research that focuses on identifying and developing challenging research topics.

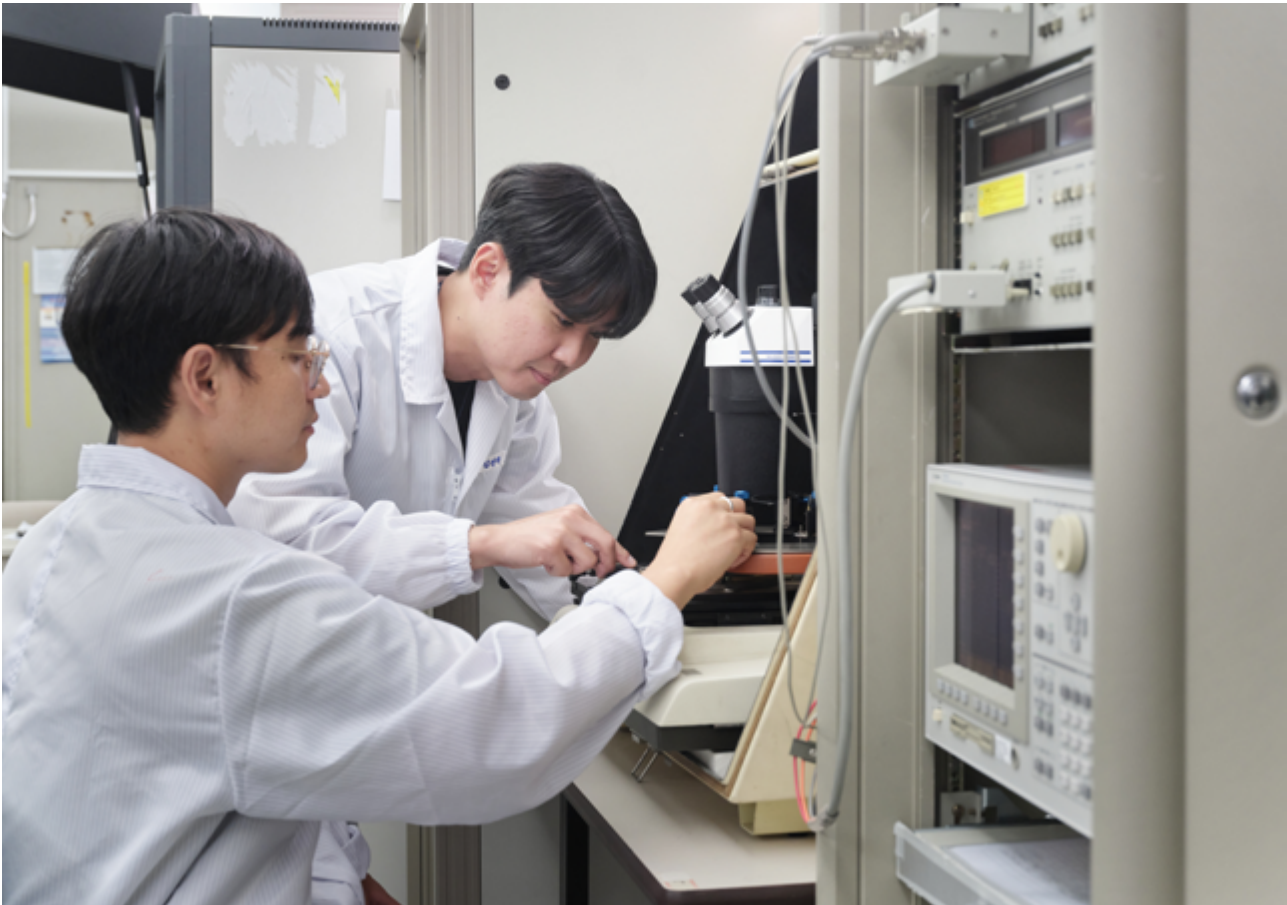
The research fields of the Division cover a wide range of topics, such as terahertz technologies, brain-morphic AI simulator, brain-nerve-behavior linkages research through neural interface and modeling and researches for new low-carbon and eco-friendly materials and processes.

Our research aims to develop the disruptive and challenging technologies for the next generation and to actively promote researches that can solve various industrial diffi-



Materials & Components Research Division

For the intelligent future society, Materials & Components Research Division researches the world's leading hardware technologies in the field of information and communication technology and their applications. By making creative convergence, we have been maximizing the synergy in the chain of materials, components, system and service and, in turn, securing superb technological leadership. The research area is categorized into smart materials (nanomaterials, thermoelectric materials, batteries, electromagnetic materials, iontronics materials, low-dimensional materials, meta surface, etc.), next-generation semiconductors (neuromorphic semiconductors, duplex devices, oxide semiconductors, etc.), intelligent components and sensors (electronic components for space aviation, digital x-ray source, intelligent sensors, etc.) and quantum application of topological insulators.



Terrestrial & Non-Terrestrial Integrated Telecommunications Research Laboratory

3

Mobile Communication Research Division

Network Research Division

Radio Research Division

Satellite Communication Research Division

Photonic-Wireless Devices Research Division

Terrestrial & Non-Terrestrial Integrated Telecommunications Research Laboratory studies technologies such as 5G+ & 6G mobile communication and networks, efficient use of radio resources, hyper-space satellite communication, and optical & RF material and components. In the communications sector, there are Mobile Communication Research Division and Network Research Division. Mobile Communication Research Division develops core original technologies for 5G+ & 6G mobile communication, small cell base stations, broadband wireless backhaul and intelligent wireless access technologies. Network Research Division develops information-and-knowledge-based intelligent networking technologies and ultra-speed, ultra-wideband, ultra-low-latency optical network technologies.

In the radio and satellite sector, there are Radio Research Division and Satellite Communication Research Division. Radio Research Division develops technologies to efficiently use the radio resources; technologies to cope with adverse effects of radio resources; base and fundamental technologies related to radio; and RF and antenna components technology. Satellite Communication Research Division engages in the researches with the goal of developing 6G hyper-space core original technologies and hyper-space core component technologies that overcome the limits of connectivity.

In the photonic and wireless sector, there is Photonic & Wireless Devices Research Division, which develops components for optical communication and optical convergence; RF and power components; and core technologies related to GaN thin film material and device that enable high-speed broadband wired and wireless information networks.

In the future, Terrestrial & Non-Terrestrial Integrated Telecommunications Research Laboratory will become the world's leading technology pioneer in hyper-connected 6G communication.

▶ Interview Clip



Baek Yong Soon,
Senior Vice President



Noh Hoon Dong,
Senior Researcher



Mobile Communication Research Division

We want to be a pioneer in the field of future mobile telecommunications in terms of technological leadership and standardization activities by developing fundamental and system technologies which can overcome the limits of performance, space and latency. Also, we pursue globalization of these technologies by cooperating internationally with other organizations and universities in EU, US and other parts of the world.

In parallel with the long-term development for breakthrough technologies as a first-mover, we are also developing customer-centric practical technologies for immediate commercialization and conducting R&Ds to resolve the social problems threatening public welfare.

Technologies we are mainly interested in are 6G wireless transmission and radio access, 6G system, intelligent ultra-dense small-cells, intelligent radio access, high-capacity moving wireless backhaul, and so on.



Network Research Division

Network Research Division, responding to various and complicated requirements for the future ICT and converged services, aims at creating original core technologies and their industrialization technologies along with leading standardization for wired and wireless optical communication, ultra high-precision, low-latency packet network, AI/ML-based network automation and intelligence, 5G+& 6G mobile core network and block-chain based decentralized networking core and application. We aim to contribute advances of ICT converged services by leading terrestrial & non-terrestrial integrated telecommunication technologies to be ultra-high-speed, massive capacity, ultra-low-latency, and high-reliable.

Radio Research Division

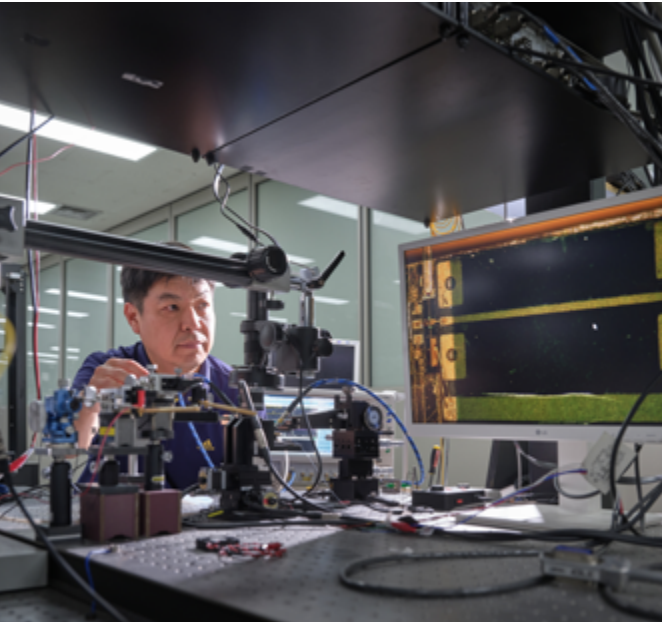
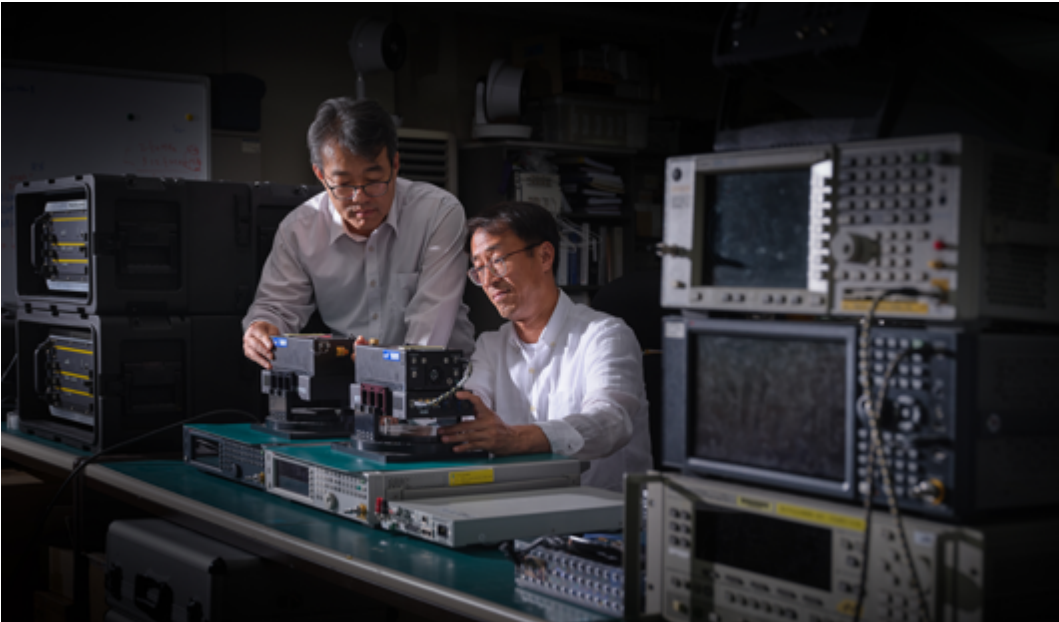
Radio Research Division develops radio wave technologies to push the great digital transformation forward. To efficiently use the limited frequency resources, we are working on radio resource technologies and developing radio environment monitoring technologies to respond to various and complex radio environments and services. In addition, we are exploring radio source technologies to discover new applications of radio waves and developing RF technologies to implement future wireless communication services that will provide various radio services beyond what is available today. Through these efforts, the Division aims to secure the world-class radio wave technologies and strives to establish Korea as a role model of the great digital transformation.

Satellite Communication
Research Division

Satellite Communication Research Division researches with the goals of developing hyper-space core technologies, leading hyper-space international standardization and securing hyper-space core component technologies, under the vision of leading the 6G hyper-space technologies to realize terrestrial and non-terrestrial integrated communication that overcomes the limitations of connectivity. Our major R&D technologies include spatial wireless transmission and wireless networking core technology, spatial communication modem and protocol SW implementation technology, spatial wireless transmission and spatial networking international standardization, satellite communication and space communication system technology, satellite payload system and component technology, and satellite ultra-precision navigation technology. Satellite Communication Research Division aims to become a global technology leader with the world's strongest competitiveness in the field of hyper-space, such as 6G LEO satellite

Photonic-Wireless Devices
Research Division

In pursuit of hyper-connected society, Photonic & Wireless Devices Research Division researches the compound optoelectronic semiconductor technology, an essential technology in building a ultra-high-speed broadband wired and wireless information communication network. The main research and development fields of the Division include millimeter wave band ultra-high frequency integrated circuits (MMICs) using InP, GaAs, SiGe and GaN; small, light and low-power transceiver modules; and photonic integrated circuits. We are developing optical component technology and millimeter wave photonic-wireless convergence modules for ultra-high-speed communication systems.



Hyper-Reality Metaverse Research Laboratory

Media Research Division

Hyper-Reality Metaverse Research Laboratory researches and develops core technologies to lead Korea's digital strategy, which is to leap into the new digital continent of metaverse which is expected to be the key industry in the future.

Content Research Division

To realize the hyper-reality metaverse service, the Laboratory is researching and developing: the three-dimensional spatial media technology that acquires the real space as it is, compresses and transmits the acquired data and reproduces it in an hyper-realistic sense; the XR space that provides bi-directional metaverse experience; ultra-realistic digital human and five senses interaction technologies that provide an interactive metaverse experience; and display device technology to provide hyper-reality experience.

Reality Devices Research Division

Approximately 330 researchers with master's and doctoral degrees in the fields of media, content, display and sensory devices are researching and developing the core technologies and creating relevant standards in and outside Korea. We are also contributing to the establishment of the metaverse industry ecosystem by actively cooperating with domestic and foreign universities, research institutes, and companies. We will try to advance the world of metaverse that makes imagination a reality by developing the world's best hyper-reality metaverse technology.

Interview Clip



Lee Jeong Ik,
Senior Vice President



Kang Chan Mo,
Senior Researcher



Media Research Division

Media Research Division develops the world's best next-generation core, original and standard technologies related to broadcasting and media, as well as the applied services to provide the hyper-realistic services that break the boundaries between virtual and real worlds beyond space-time constraint.

Media Research Division consists of Media Broadcasting Research Section, Media Coding Research Section, Immersive Media Research Section, Media Intellectualization Research Section, Digital Holography Research Section and ETRI-Busan Joint Research Section.

The Division has accomplished the world's best research and development achievements that have advanced the Korean broadcasting and media industries, including UHD

mobile broadcasting technology (ATSC 3.0), Media compression technology (HEVC, VVC, USAC, 3DA), ultra-wide vision technology, AI based media intelligence and public media technology and user-selective stereoscopic media service platform technology.

Currently, our major fields of research are media transfer research, next generation 2D and 3D media compression research, realistic media research, media semantic research, digital holography research, media-based digital social innovation, and XR-based realistic media service platform research. Our ultimate goal is to create world-class, hyper-reality spatial media services and to lead the development of global media technologies.

Content Research Division

Content Research Division aims to become globally competitive in its field of research by developing core original technologies for digital and cultural content which will realize hyper-reality metaverse services that maximizes communication and experience and fuses virtuality and reality.

We develop hyper-reality content technology, five-sense emotional interaction technology and intelligent content understanding technology to follow the trend of next-generation content development which can be summarized by the following keywords: intelligent, immersive, emotional and convergence, and to lead the development of real-world convergence experience technologies.

The core original technologies being developed by Content Research Division are expected to serve as the key growth engines that will drive the growth together with other industries in the era of the 4th Industrial Revolution.

Reality Devices Research Division

Reality Devices Research Division aims to develop the materials and parts for hyper-reality devices and provide services in a new life space called metaverse. We develop technologies such as the next-generation display, realistic image panel, stretchable display which is the core technology in the field of skin electronics component, spatial light modulator for digital holography, OLED microdisplay and sensory input and output panel that can input and output the human senses more vividly. In addition, we use our technology infrastructure to provide technological support, such as developing prototypes and solving difficulties for materials, parts and equipment companies in related fields.

Digital Convergence Research Laboratory

5



▶ Interview Clip



Kim Seung Hwan,
Senior Vice President



Baek Myung Sun,
Senior Researcher

**Air Mobility
Research Division**

**Industry & Energy
Convergence
Research Division**

**Digital Biomedical
Research Division**

**Defense & Safety
Convergence
Research Division**

Digital Convergence Research Laboratory takes on the central role of realizing ETRI's vision of 'Technology Pioneer Making Happy Future through Digital Innovation.'

We research and develop core technologies to achieve the vision. Based on the cutting-edge technology, we develop innovative solutions and services; take the lead in creating research outcomes that are felt by the public; establish a stable research environment; and foster a culture of enjoyable research collaboration. We develop key technologies to enhance domestic and international industrial competitiveness collaborating with a wide range of industries. To this end, we consider coming up with the solutions for the government and the public issues; achieving world-class research outcomes; and leading the establishment of international standards as important stepping stones. With creative talents and advanced infrastructure, Digital Convergence Research Laboratory strives to promote innovative technology development and discover new business models by working with various industries.

Air Mobility Research Division

Air Mobility Research Division focuses on the research and development of convergence technology to accelerate movement to the next mobility era, by leveraging ETRI's ICT capabilities in computing, artificial intelligence, and communications.

We develop infrastructure technologies for the air mobility using geo-spatial information, high-precision positioning, wireless communication for congested environments such as forests or urban area.

Core technologies on UAV which performs its mission

safely without human intervention and runs on top of air mobility infrastructure.

Output of these researches can be applied to various unmanned operation can be utilized for the rapid rescue of missing person with the swarm drones, as well as the delivery service with the collaboration between drones and robots.

Our eyes are on the research and development of next-generation UAM platform which runs various environment robustly.



Industry & Energy Convergence Research Division

Industry & Energy Convergence Research Division focuses on developing the intelligent solutions that will solve the issues in manufacturing, autonomous IoT convergence, agriculture, livestock and fishery, energy and environment.

The Division's main research and development areas are: ICT-based industrial autonomous and intelligent convergence technology; autonomous, intelligent and integrated industrial digital twin and metaverse technology; next-generation autonomous, distributed and collabora-

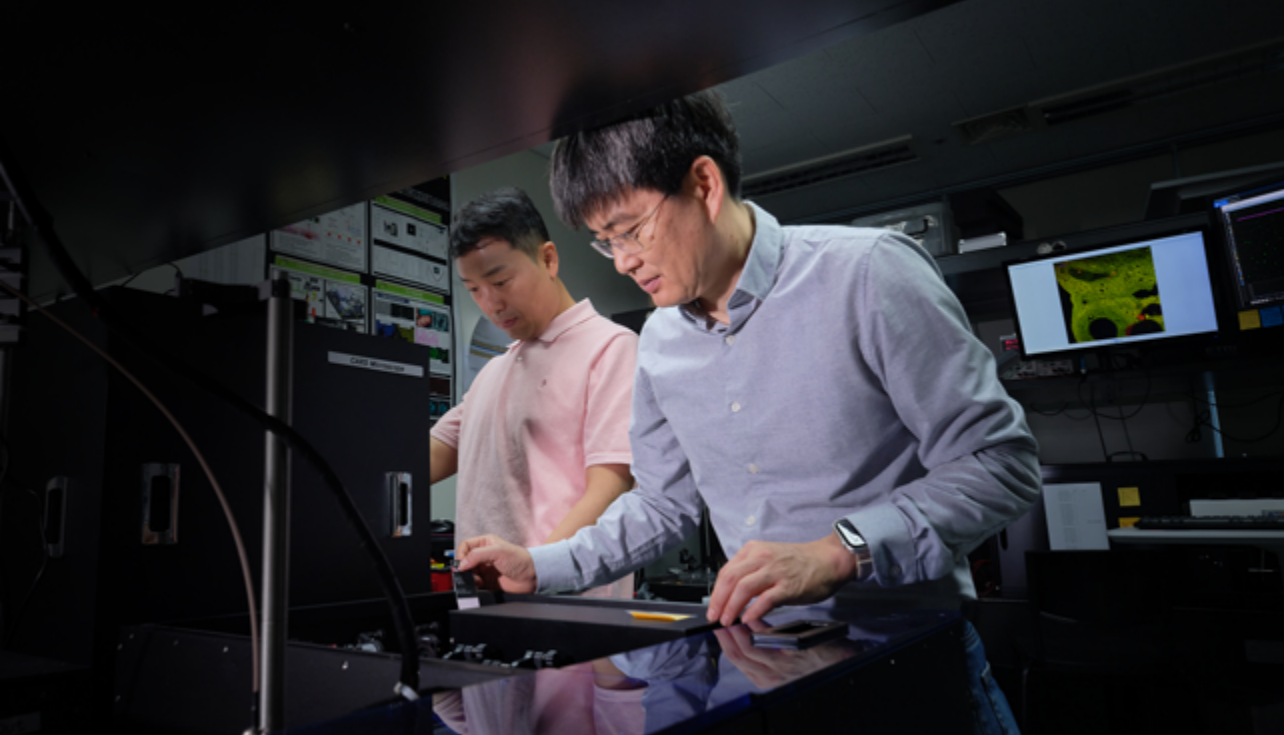
tive IoT and application technology; industrial digital platform technology; distributed and intelligent operation of eco-friendly energy and convergence service technology; carbon neutral infrastructure and digital service technology; digital infrastructure and management technology for solution of industrial, environmental and social problems; and industrial convergence service standard and security technology. The Division wants to become a digital transformation activator and a global leader in the future industries.



Digital Biomedical Research Division

Digital Biomedical Research Division intends to solve difficulties related to diagnosis and treatment of diseases caused by aging society and soaring medical expenses. The Division is researching and developing ways to overcome time and cost, the factors that hinder biological and medical R&D, and become more competitive using the ICT technologies. The Division is developing: a solution for intellectualization of medical care to help people live 100 years while staying healthy, which applies the ICT technologies to bio-technology and medical service; and the new biological and medical technologies that use the digital big data. The Division's main technologies under research and development are: a technology that creates a medical

intelligence for diagnosis and treatment of patients using a vast amount of clinical data; a technology that creates high-quality 3D medical images; a technology that detects digital biomarkers for diagnosis and management of disease; and the digital Raman molecular imaging technology for acquisition of high-precision information on diseases. In addition, the Division is researching and developing: the artificial muscle technology to provide personalized muscle strength support; the particle beam generation technology for precision treatment; the rehabilitation exercise big data platform technology that links the medical service provider and the local community; and the AI-based personalized rehabilitation exercise service technology.



Defense & Safety Convergence Research Division

Defense & Safety Convergence Research Division is dedicated to researching and developing intelligent solutions using domain-specific information and communication technology in the areas of national defense, policing, safety and disaster response to solve the problems occur to the people in their daily lives and build a safe Korea. In the defense sector, hyper-connected trust infrastructure technology; super-intelligent decision-making support technology; and super-realistic scientific training platform technology are being developed. In the field of policing, we are developing digital convergence technology for the entire cycle of scientific policing based on ICT technology. In the field of safety, technologies to ensure the workers' personal safety in the industrial sites are being developed. In addition, the field of disaster focuses on researching and developing comprehensive disaster safety management solutions to protect lives and properties of the people from disasters.

ICT Strategy Research Laboratory

6

Technology Strategy Research Division

Technology Policy Research Division

Standards & Open Source Research Division

ICT Strategy Research Laboratory establishes technological strategies and policies for creating large-scale R&D achievements and leading global standardization of ICT and converged technologies. Technology Strategy Research Division and Technology Policy Research Division are in charge of national policy planning and ICT technology acquisition program planning.

Technology Strategy Research Division explores new strategic technologies in the fields of ICT and convergence; examines feasibility; and establishes strategies on securing the technologies. Technology Policy Research Division conducts strategic researches for the industrial development of national strategic technologies, such as 6G, cyber-security and AI semiconductors.

Standards & Open Source Research Division, as a special ICT expert group on standardization policy, strategy and technology, conducts advanced researches on standard technologies and leads global ICT standardization activities for the core future technologies and the national strategic technologies. The Laboratory leads international standardization activities in de jure standard bodies, such as ISO, IEC and ITU-T, and major de facto standard bodies, such as 3GPP and IEEE. Also, it is strengthening research activities for consumer-oriented standard technologies, such as achieving ICT-based digital transformation and solving the social problems, and open source governance research activities for open R&D innovation.

Technology Strategy
Research Division

Technology Strategy Research Division conducts researches on mid-to-long-term national ICT R&D investment strategies and policies on fostering national strategic technologies to reflect government R&D policies in ICT fields, including semiconductor, display, cyber-security, artificial intelligence, next-generation communication, advanced mobility, and advanced robot and manufacturing. It explores emerging strategic technologies in the fields of ICT and convergence, where new growth potentials are expected. The Division establishes technology acquisition strategy that can create large-scale R&D achievements by exploiting these technologies. This division, also establishes the industrialization goals for ETRI's strategic technologies and research the performance improvement measures to achieve desired results by consolidating and concentrating ETRI-wide capabili-

Technology Policy
Research Division

Technology Policy Research Division conducts techno-economic and industrial analysis required for Korea and ETRI to develop the R&D policies, such as establishing ICT R&D policy goals and requirements, developing R&D environments to achieve the goals and establishing technology development plans. In particular, the researches on 6G, cyber-security, quantum computing, AI semiconductors and metaverse are our main subjects for 2023. In addition, we are studying the policies on promoting the broadcasting and telecommunications industries and encouraging competition therein, aiming to cause the research outcomes to take root in the industries as early as possible and to foster and revitalize the industries.

Standards & Open Source
Research Division

Standards & Open Source Research Division is a expert group specializing in domestic and international standardization policies, strategies, and open source in the field of ICT. The Division develops standard for future key technologies and national strategic technologies, as well as technologies and standards for convergence between ICT and other industries. Members of this Division also play a leading role in international standardization through de jure standardization organizations such as ISO, IEC, ITU-T, as well as major de facto standardization organizations such as 3GPP, W3C, IETF. Furthermore, the Division conducts open source research activities to drive open R&D innovation, which includes open source-based standardization, establishment and operation of open source governance, support for open source R&D activities, collaboration within and outside the organization, and nurturing of global leaders in open source.



Daegu-Gyeongbuk Research Center

Daegu-Gyeongbuk Research Center was established in 2006 and serves as a technology hub for fostering regional strategic industries in Daegu and Gyeongbuk. The Center's roles include strengthening R&D capabilities, strengthening technological competitiveness and creating added value in ICT and regional key industries.

To this end, we are striving to strengthen the R&D capabilities of new regional industries in connection with regional strategic industries by upgrading ICT convergence technologies in smart city, intelligent robot, smart medical services and future mobility.

The Center is becoming a regional research hub by supporting the development of technologies customized to the demands of local SMEs and focusing on the commercialization of technologies – the Center develops technologies that will solve the bottlenecks; provides technological advice and supervision; and disseminates and spreads ETRI technologies.

**Regional
Industry IT
Convergence
Research Section**

**Artificial
Intelligence
Application
Research Section**

**Medical IT
Convergence
Research Section**

**Robotics IT
Convergence
Research Section**

**Mobility IT
Convergence
Research Section**

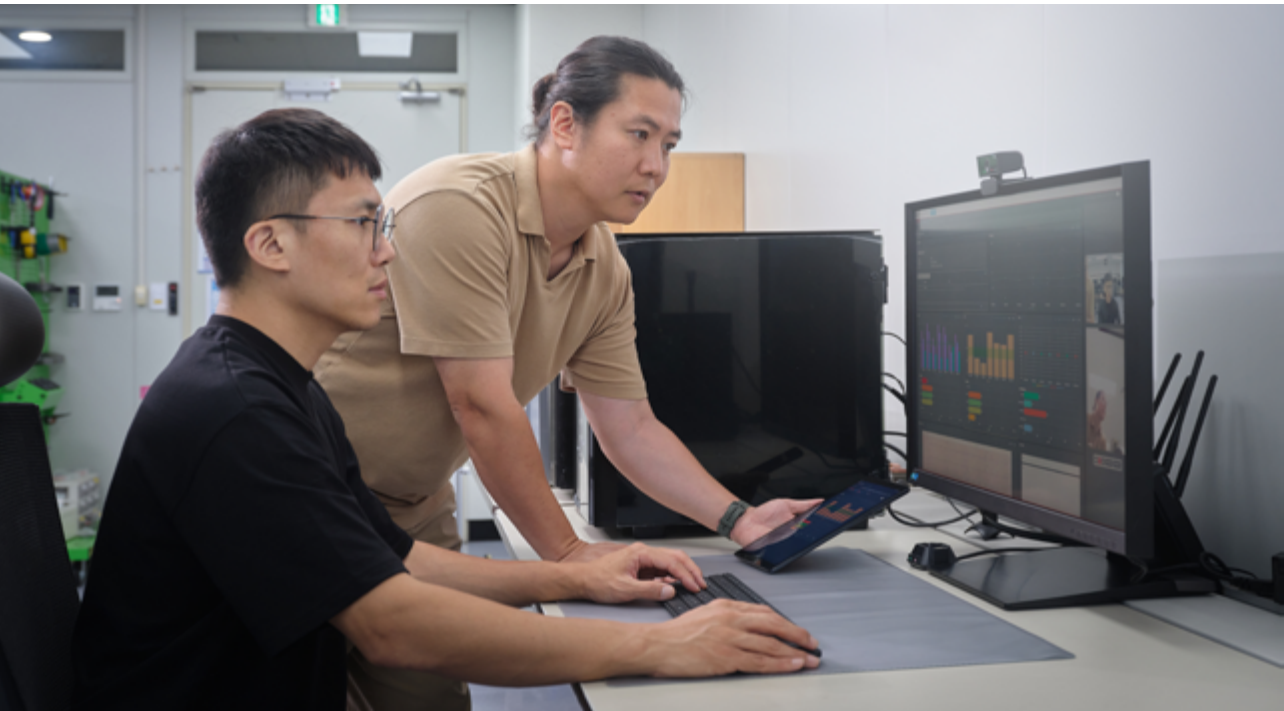
**Regional Industry IT
Convergence
Research Section**

Regional Industry IT Convergence Research Section supports new business planning, cooperation with local innovators, discovery of demand for technology and joint technology development to foster local industries. In addition, we provide on-site technical guidance advice, support the companies solve their technological bottle-necks and control the quality of technology.



**Artificial Intelligence
Application
Research Section**

Researchers in Artificial Intelligence Application Research Section are focused on researching and developing the technologies that apply machine learning and deep learning to satisfy the demand for AI technology in several domains of applications. The Section is focused on researching and developing: artificial intelligence application technology using object recognition and tracking technology for smart cities; and multi-recognition platform technology using edge cameras. The Section pursues ways to satisfy the on-going social demands by developing AI solutions and aims to support small-and-medium-enterprises by making highly demanded technological solutions accessible.



**Medical IT
Convergence
Research Section**

Researchers in Medical IT Convergence Research Section develop medical ICT convergence technologies together with local companies and with the aim of strengthening the technological competitiveness of the SMEs specializing in medical services in Daegu and Gyeongsangbuk region. We continuously discover the needs of consumers (hospital, company, etc.), develop core technologies that apply new technologies, such as artificial intelligence and blockchain, and jointly develop practical technologies with companies for rapid commercialization. In addition, we provide on-site technical guidance advice for the certification institutions to test and approve the medical devices (e.g., electrical and mechanical stability test, animal test, etc.).

Robotics IT Convergence
Research Section

Robotics IT Convergence Research Section is dedicated to developing control technologies for mobile robots and robot manipulators, as well as ICT convergence and its application technologies, to meet the demand for robot-related technologies in the Daegu-Gyeongbuk region. The Section mainly develops autonomous mobile robot technology, person-following robot technology, collaborative robot control and teaching technology, robot vision technology, multi-robot control and simulation technology, etc. In addition, the Section strives to commercialize technologies to satisfy the needs of robot companies and supports local companies by providing technological guidance and advisory services.



Mobility IT Convergence
Research Section

Mobility IT Convergence Research Section conducts researches in various fields of mobility that integrate artificial intelligence and information technology. The main research areas include: control platform technology (mobility); unmanned driving technology (mobility); AI-based mobility data analysis and prediction; cloud-based mobility application services; AI-based autonomous smart farm solution; connected smart farm bots; and integrated control systems for intelligent smart farming. In addition, we develop technologies to solve issues in the local community and engage in diverse activities for commercialization and spread of mobility and smart farming technologies by working with other R&D institutions in response to local companies' demands for technologies.

Honam Research Center



Honam Research Center serves as a technological hub in the Honam region that fosters the regional strategic industries through the ICT convergence technology R&BD.

To date, the Center has been supporting the development of leading technologies for the strategic industries in the region, customized technologies to nurture the local companies and commercialization of technologies to spread the technologies developed by ETRI.

In addition, the Center is in charge of providing the following technical supports: establishment and operation of 5G open test lab based on ICT convergence infrastructure; conducting accredited international certification tests; providing equipment and test bed; pilot-production of optical packaging; and providing various solutions to solve the technological bottlenecks of the companies in the region.

Optical
ICT Convergence
Section

Edge Computing
Application
Service
Research Section

Energy
Intelligence
Research Section

Optical
Packaging
Research Section

Artificial
Intelligence
Convergence
Research Section

Optical ICT Convergence Section

Optical ICT Convergence Section focuses on the development of space laser communication, image recognition and high-sensitivity optical sensors by integrating the ICT technology based on optical engine with the artificial intelligence. Using these technologies, the Section aims to develop adaptive space laser communication technologies that can respond to various situations, which can also be applied to CubeSat satellites. Additionally, the AI-based image recognition technology and the high-sensitivity optical sensor technology can be used by small-and-medium-sized enterprises in various fields, such as metaverse, smart city and environmental monitoring, enabling them to provide innovative services.

Edge Computing Application Service Research Section

Edge Computing Application Service Research Section researches and develops edge computing technologies for ultra-low-latency data processing and intelligence services for strategic industries in the Honam region, such as new energy, autonomous vehicles and smart cities that require real-time data processing. We research and develop real-time control and communication platforms together with the companies in the related areas to develop the technologies that can be used in the field and commercialize such technologies, including ultra-high voltage DC transmission and distribution converters, energy management solutions for factories and buildings, 5G open test labs and smart city service solutions based on edge computing.

Energy Intelligence Research Section

Energy Intelligence Research Section expertize energy IoT standard platform technology, energy data analysis technology and artificial intelligence technology to efficiently control energy facilities.

We applied sensor message protocol technology and platform technology, based on international standards, to Korea Electric Power Corporation and various other service providers. To further spread and commercialize the technology, we develop the international standards for IoT sensors, leading the standard both domestically and internationally.

We are working on developing core technologies for digital twin-based AI control, such as energy facility 3D modeling, abnormality diagnosis, predictive management, operation optimization and real-time CPS engine technology.



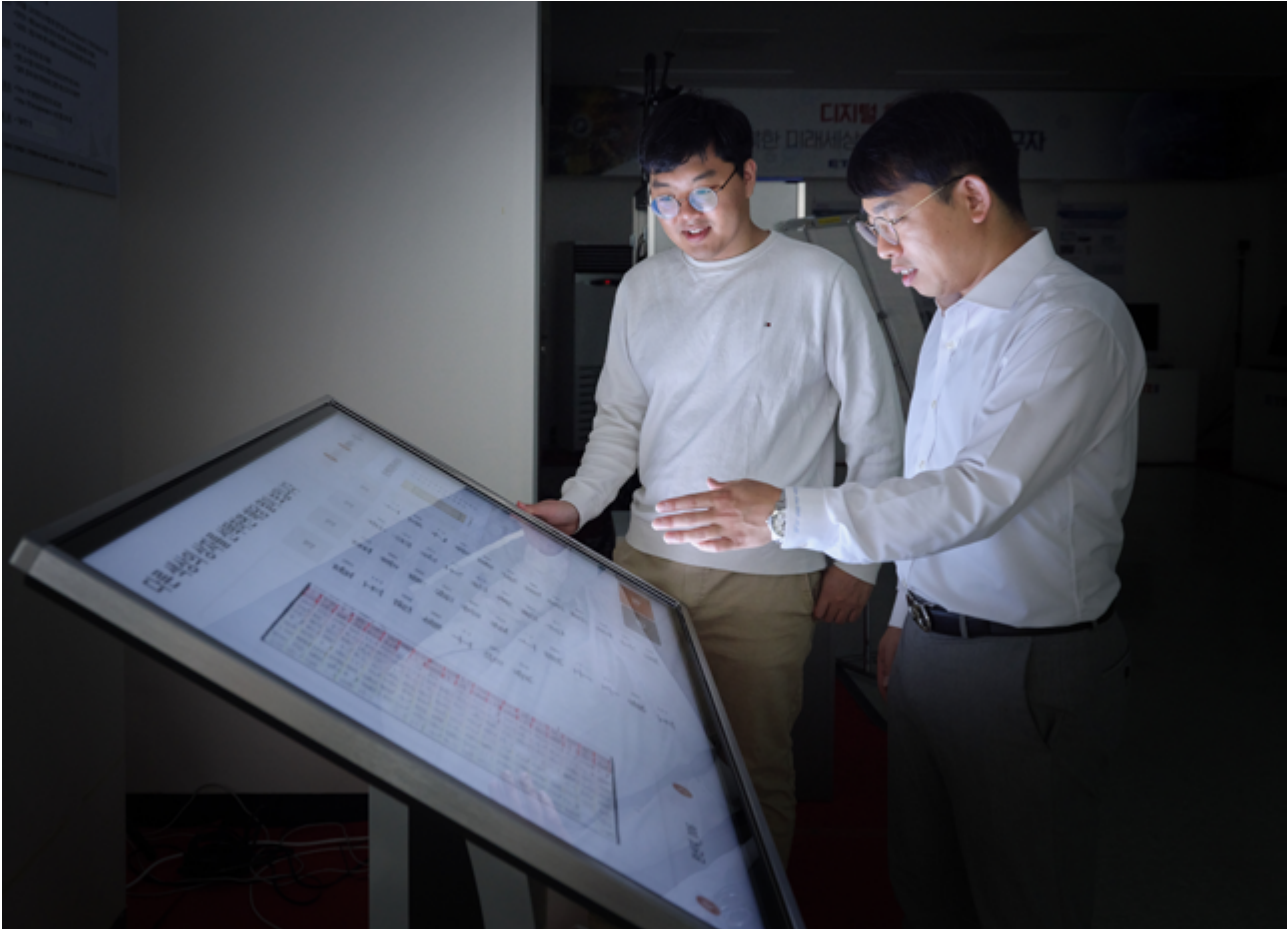
Optical Packaging Research Section

Optical Packaging Research Section focuses on localizing the core components for Tbps optical interconnection so that the intelligent information service network infrastructure (e.g., 5G & 6G mobile communication and artificial intelligence data centers) can process large volume of data at high-speed. We also help small-and-medium-sized enterprises by providing a prototyping service to support commercialization of their R&D achievements using equipment and facilities available from our Optical Packaging Assistance Center. In addition, we are dedicated to the commercialization of plenoptic microscopes equipped with the 3D imaging technology developed based on AI and deep learning, which will improve the faulty product detection accuracy of the vision recognition solution and strengthen the competitiveness of Korean manufacturing businesses.



Artificial Intelligence Convergence Research Section

Artificial Intelligence Convergence Research Section is making efforts to intelligently solve the social issues in the local area and advance the local industries by working with local industries, universities, research institutes and relevant organizations. In addition, to achieve technological innovation in various fields, such as digital healthcare and disaster safety, we use various forms of data, such as voice, video, text and sensor readings to advance the AI algorithms. Through empirical validation and technology verification, the Section strives to enhance reliability and practicality of research outcomes. Our goal is to advance the industries in Honam region by providing AI solutions that meet the field's requirements and AI convergence services that people can experience.



Sudogwon Research Center

9

Sudogwon Research Center supports co-prosperity and win-win growth of regional specialized industries, academia, research institutes and local governments in the field of system semiconductors and industrial intelligence.

In the field of system semiconductors, specialized talent training programs based on industry demand are being operated to nurture high-end SoC design personnel knowledgeable in the IT convergence. Also, the Center established a design infrastructure to support small-and-medium-sized semiconductor fabless companies, strengthen industrial competitiveness and localize the related parts. In addition, we are creating the next growth engine through research and development of secure cryptographic SoC hardware and the edge AI semiconductor software platforms.

In the field of industrial intelligence, we research and develop ICT convergence technology in the field of AI & data, emotional contents and smart manufacturing focused on solving and satisfying local social problems and demand for small-and-medium-sized enterprises. In addition, ETRI supports R&BD in connection with the research achievements of ETRI to spread ICT convergence technology necessary to foster the specialized industries in the Seoul capital area.

Artificial Intelligence Convergence Research Section	Contents Intelligence Research Section	Smart Manufacturing Application Research Section	SoC Human Resource Development Section	Security SoC Convergence Research Section
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Artificial Intelligence
Convergence
Research Section

Artificial Intelligence Convergence Research Section is created to work on convergence technologies in collaboration with local industries, academia and institutes for the community, and to promote the research performances of ETRI.

Especially, we take the lead in cultivating the AI industry ecosystem and promoting global hidden champions by providing the AI platform service from the research organizations of ETRI and building machine learning data that can be shared with the small businesses, including the start-ups, for their various AI projects.

Contents Intelligence
Research Section

Contents Intelligence Research Section is dedicated to spreading the technology of immersive contents to the industry through collaboration with innovative contents companies in the Seoul capital area. Specifically, we develop key technologies for communication between human and artificial intelligence that can be applied to various non-face-to-face contents service industries, such as education, marketing, manufacturing and public services. Additionally, we develop webtoon intelligence solutions to support webtoon contents companies, most of whom are located in the Seoul capital area, by increasing production productivity.

Smart Manufacturing
Application
Research Section

Smart Manufacturing Application Research Section conducts research and development to develop an AI-based data analysis framework for smart manufacturing innovation to support the manufacturing companies in the Seoul capital area, in response to the Fourth Industrial Revolution. Currently, we are providing various AI data analysis services through a web-based AI framework that enables manufacturing companies in Seongnam City to use the functions, such as regression, classification and forecasting modeling and feature selection, without having any special knowledge.





SoC Human Resource Development Section

SoC Human Resource Development Section trains the System-on-Chip(SoC) design personnel knowledgeable in the application system and semiconductor design to satisfy the industry's demand in the Seoul capital area where the SoC ecosystem is concentrated, and supports the development of system semiconductor specialist companies by providing the design software.

SoC is a key element that determines the competitiveness of products of the future, such as automobiles, robots and IoT, as well as that of a nation. To improve the

localization rate of core components for SoC and respond to the rapidly changing technological environment in a timely manner, training an adequate number of designers and providing the highly expensive design software infrastructure are urgently needed.

SoC Human Resource Development Section works with the national and Seoul Metropolitan governments to constantly strengthen the competitiveness and develop the semiconductor industry, which is a national future growth engine and an asset that ensures the national security.

Security SoC Convergence Research Section

Security SoC Convergence Research Section conducts R&Ds on specialized system-on-chip(SoC) solutions and regional ICT issues in the Seoul capital area. To satisfy public and technological demands, we focus on the security encryption SoC technology, consisting of homomorphic encryption hardware and software; SoC-based digital asset protection technology (virtual SoC platform); establishment of AI semiconductor cluster, to contribute to the enhancement of SoC technology which is a strategic industry in the Seoul capital area.



General Status

70

Personnel
Project Status

71

Patent Application
Technology Transfer

72

Standardization
Papers

73

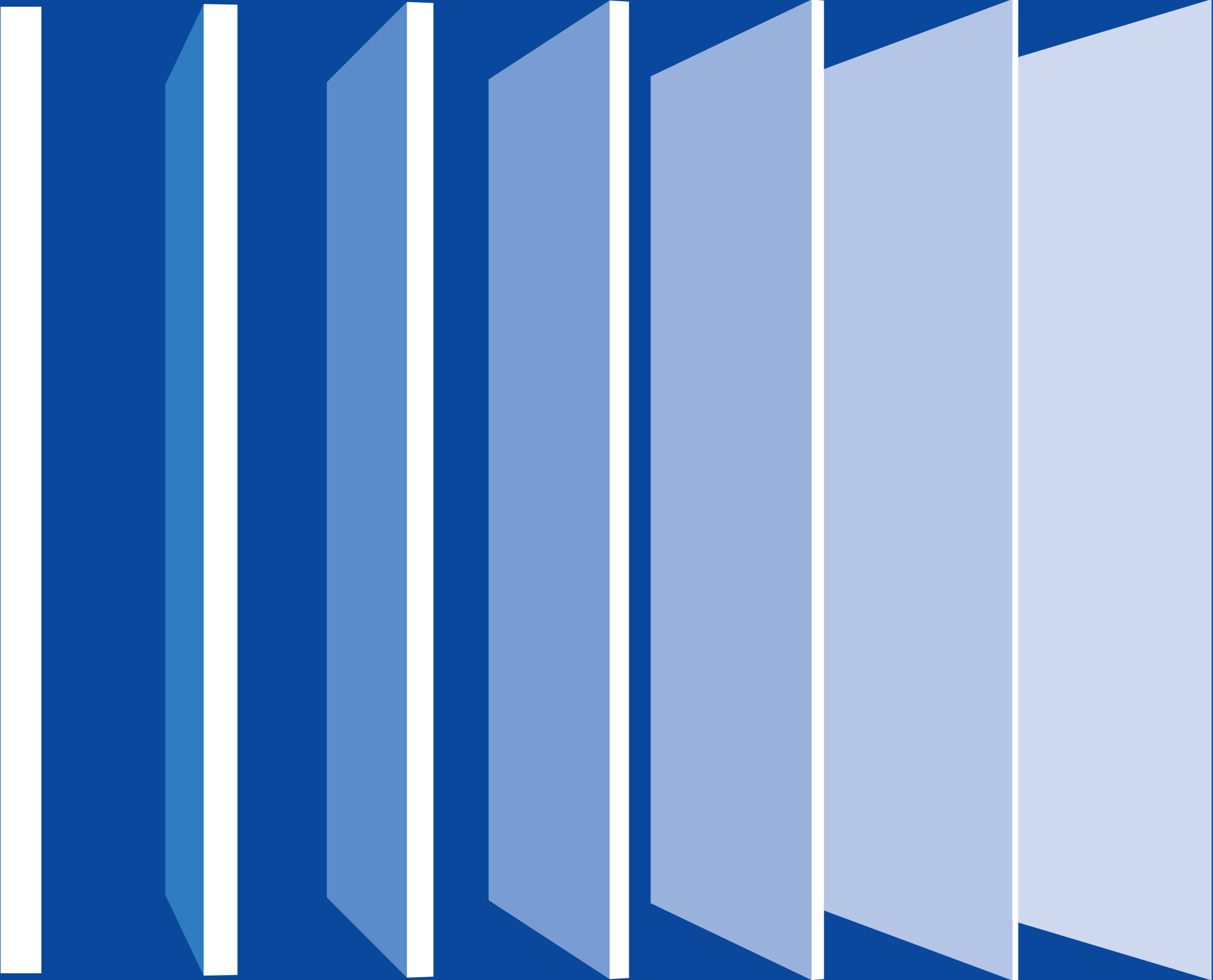
Status and Progress
of ETRI Start-up
ETRI Laboratory
Enterprise Status

74

Nationwide Regional
Research Center

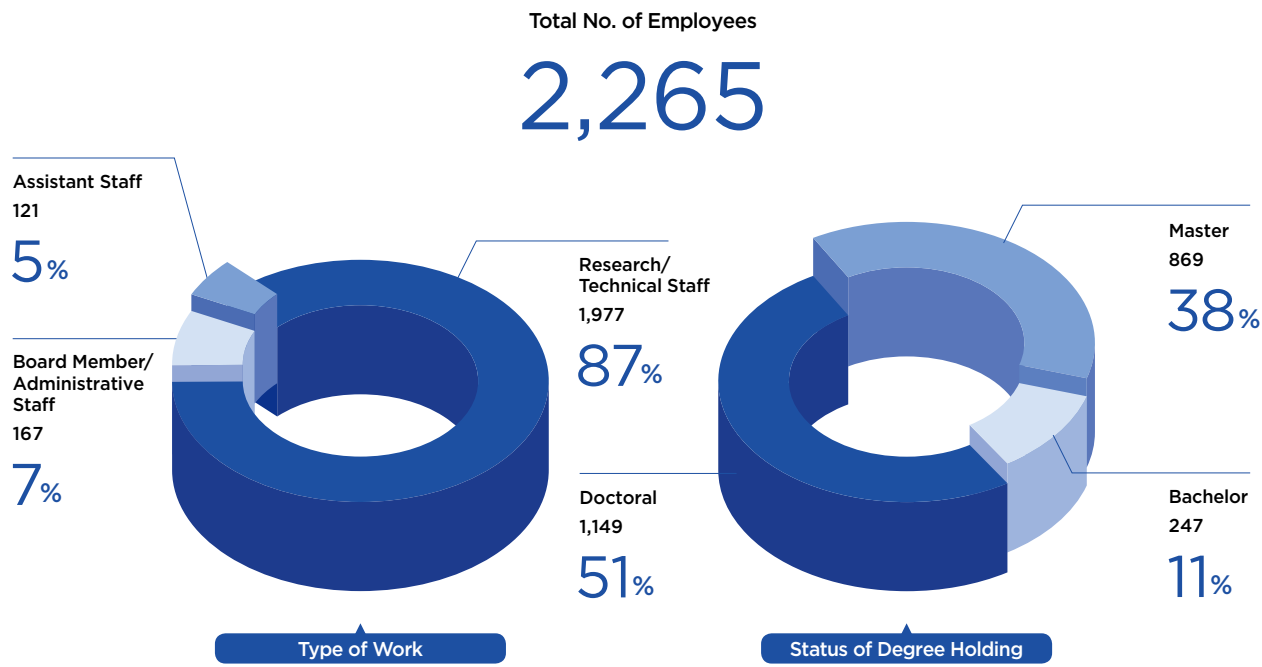
75

Global R&D
Cooperation Network



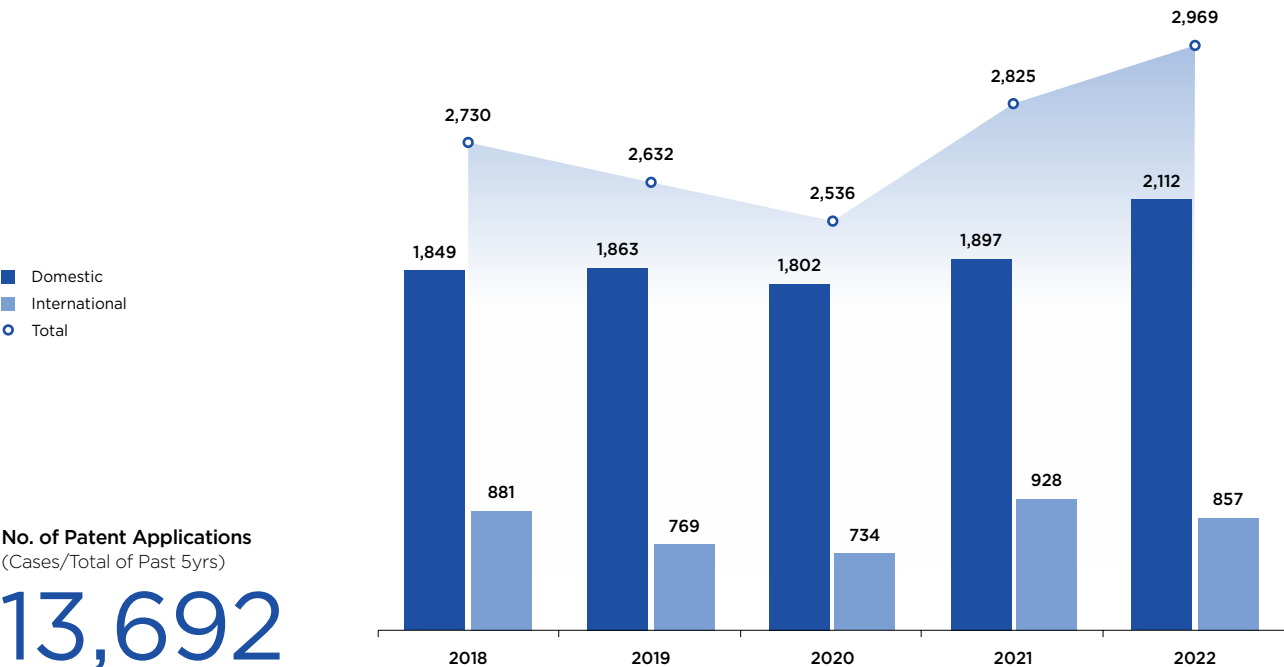
Personnel

(As of Dec. 31, 2022)



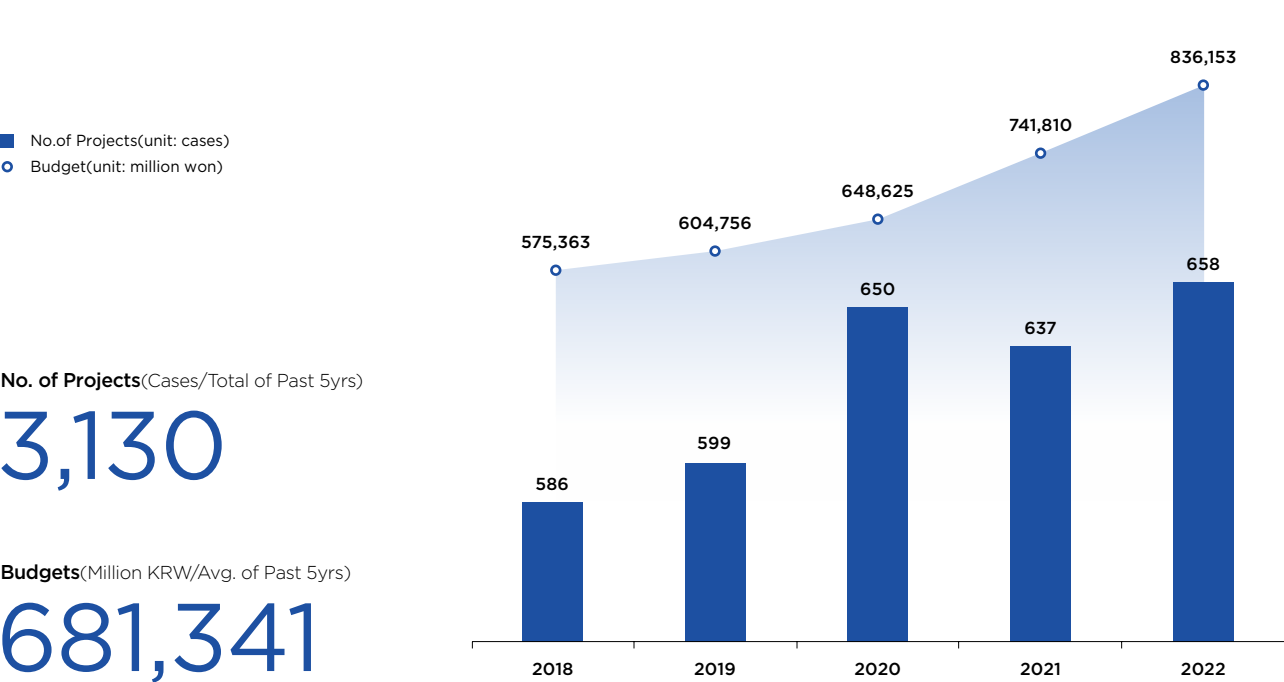
Patent Application

(As of Dec. 31, 2022)



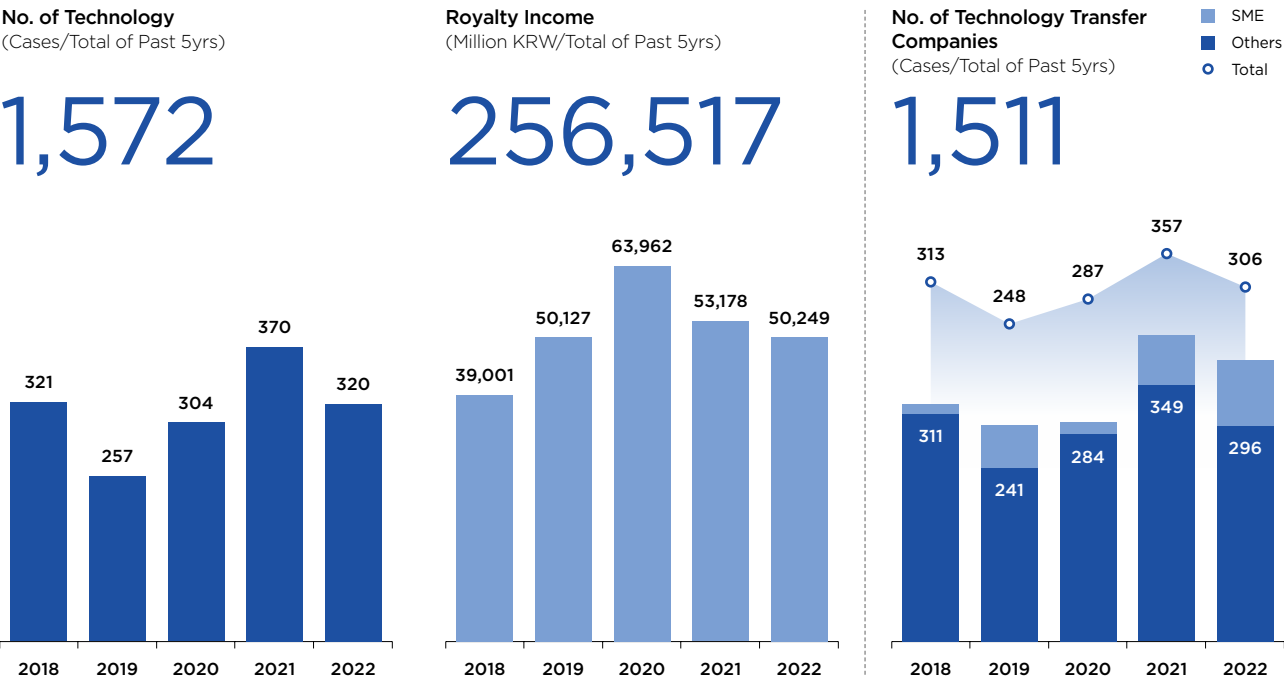
Project Status

(As of Dec. 31, 2022)



Technology Transfer

(As of Dec. 31, 2022)



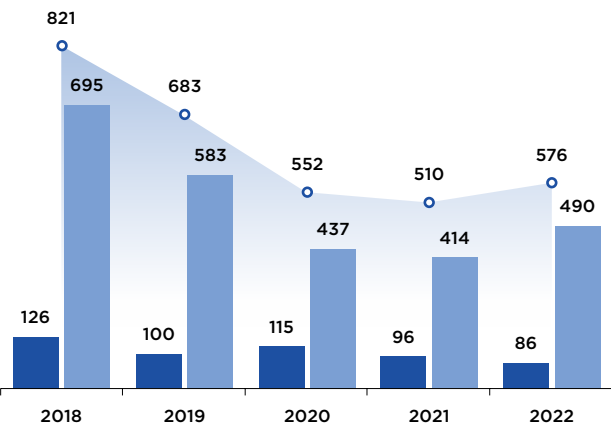
Standardization

(As of Dec. 31. 2022)

No. of Standards Contribution Adopted
(Cases/Total of Past 5yrs)

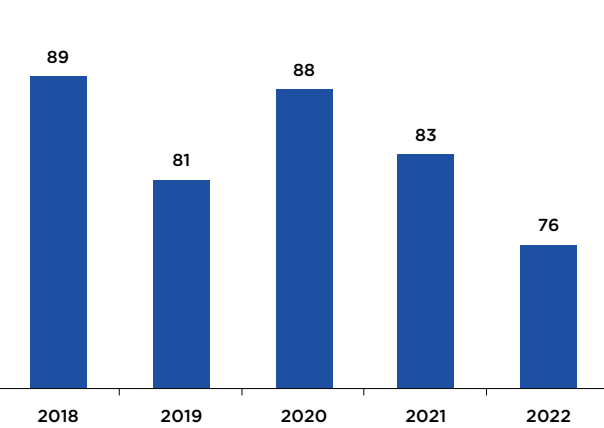
3,142

■ Domestic
■ International
○ Total



No. of Standard Leaders
(Avg. of Past 5yrs)

83.4



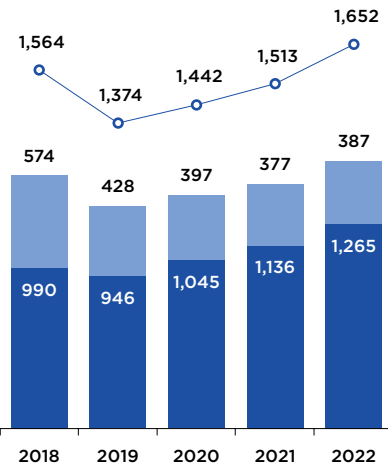
Papers

(As of Dec. 31. 2022)

No. of Papers
(Total of Past 5yrs)

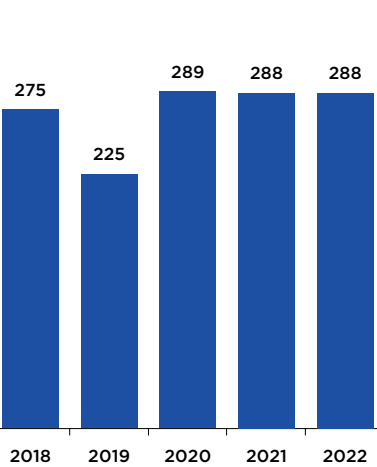
7,545

■ Domestic
■ International
○ Total



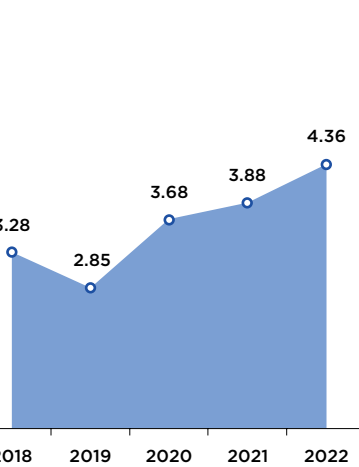
No. of SCI Papers
(Total of Past 5yrs)

1,365



Average IF
(Avg. of Past 5yrs)

3.61



Status and Progress of ETRI Start-up

(As of Dec. 31. 2022)

841

No. of Companies
After the establishment
of Sambo (Trigem)
Computer in 1980,
approx. 841 companies
have been established

27

Initial Public Offering
27 of ETRI Alumni
Companies are listed on
the KOSPI [2],
KOSDAQ [22], KONEX [3]

593

Billion
KRW

Sales
As of end of 2022
Among 47 Companies
Approx. 593 billion KRW

	Gachisoft(Co.)		BLUETILELAB(Co.)		AllNewSystems(Co.)
	GonggamSensor(Co.)		BIBIM PLANETICO(Co.)		Optella(Co.)
	GuberNet(Co.)		BnTSoft(Co.)		INOPTIX(Co.)
	NEWRATEK(Co.)		Bigpicturelabs(Co.)		Coxlab(Co.)
	Dri&B(Co.)		SOUNDUSTRY(Co.)		Quantum AI(Co.)
	THEPEACH(CO.)		Solarinno(Co.)		CREADE(Co.)
	Developtainment(Co.)		SOLWITH(Co.)		Tutorus(Co.)
	DIGITALSENT(Co.)		SMATCH(Co.)		TEAM3F(Co.)
	Dicto(Co.)		SPOTTER(Co.)		pebbblous(Co.)
	Linewalks(Co.)		Speech Laps(Co.)		Forsedu(Co.)
	Radar&Space(Co.)		PINES&S(Co.)		Protos(Co.)
	Locaila(Co.)		ARKLINK(Co.)		play46(Co.)
	LUCENTBLOCK(Co.)		RCN(Co.)		HAJIYO(Co.)
	Looko(Co.)		RTst(Co.)		한국청정발전기술
	Magenta robotics(Co.)		ACROSSSPACE(Co.)		AID Korea(Co.)
	MetaRPAS(Co.)		EXOSYSTEMS(Co.)		HANCOM AT(Co.)
	(Co.)VITEALTH		nspectra(Co.)		Hojeonable(Co.)
	Batoners(Co.)		elssen(Co.)		Holistic Manifold(Co.)
	BABBLE(Co.)		mforus(Co.)		HURA(Co.)
	BWsystem(Co.)		oprocessor(Co.)		

ETRI Laboratory Enterprise Status

(As of Dec. 31. 2022)

90

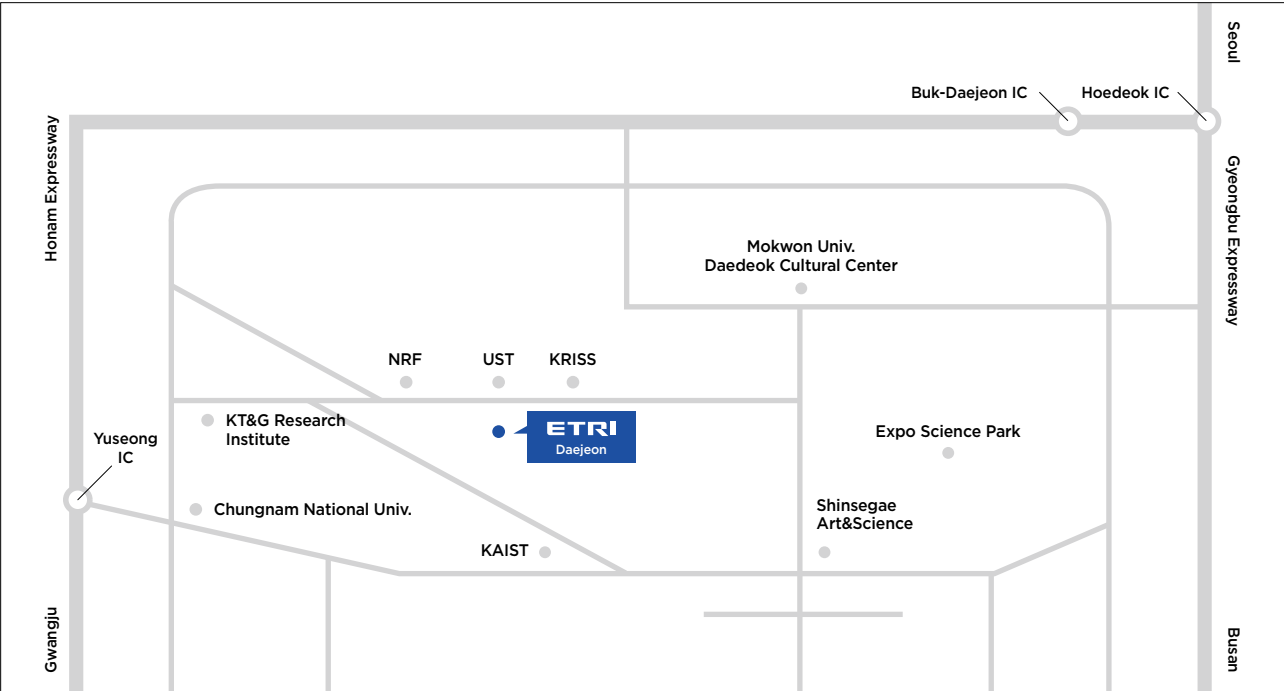
Registered Companies
ETRI has set up 90 ETRI
Laboratoy Enterprises
through successful
commercialization of
research outcomes since 2007.

67

Companies in Operation
67 ETRI laboratory
Enterprises in Operation

	GAION(Co.)		SALUS MS(Co.)		(Co.)InnoRay
	Gamma Spectra(Co.)		SHAREBOX(Co.)		E&D(Co.)
	Gridaenergy(Co.)		SHARECHEM(Co.)		Eintelligence(Co.)
	GreenZone(Co.)		StandingTALL(Co.)		EPhotonics(Co.)
	GIRJAESOFT(Co.)		Secuworks(Co.)		IN2WISE(Co.)
	NEOSTACK(Co.)		CH Solution(Co.)		INTU Works(Co.)
	Devstack Inc.		icerti(Co.)		JUNGSANGLIDAR(Co.)
	DNI(Co.)		EYEQ Lab Inc.		JNE WORKS(Co.)
	DEEP INSPECTION(Co.)		RNSlab(Co.)		Gene System(Co.)
	Leadpointssystem Inc.		Antrorse(Co.)		curaum(Co.)
	MINDS(Co.)		URBAN DATA		Cruxell(Co.)
	Market Of Material(Co.)		LAB(Co.)		TEXTORY(Co.)
	MOLPAX BIO(Co.)		AI Systems(Co.)		To be smart(Co.)
	Movto		Altech(Co.)		Fionsystems(Co.)
	MINTROBO(Co.)		NDOS(Co.)		ParkingGo(Co.)
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	Bird Letter(Co.)		Optella(Co.)		PDXen(Co.)
	VODABI(Co.)		Optiple(Co.)		HarborMAX(Co.)
	BEAUnex(Co.)		Y-tech(Co.)		HANCOMINTERFREE(Co.)
	Blue Tile Lab(Co.)		Weeksung Media(Co.)		Hojeonable(Co.)
	BTWorks(Co.)		Withmind(Co.)		kokonut(Co.)

Nationwide Regional Research Center



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13488, Korea
Tel. 042.860.6114



Honam Research Center

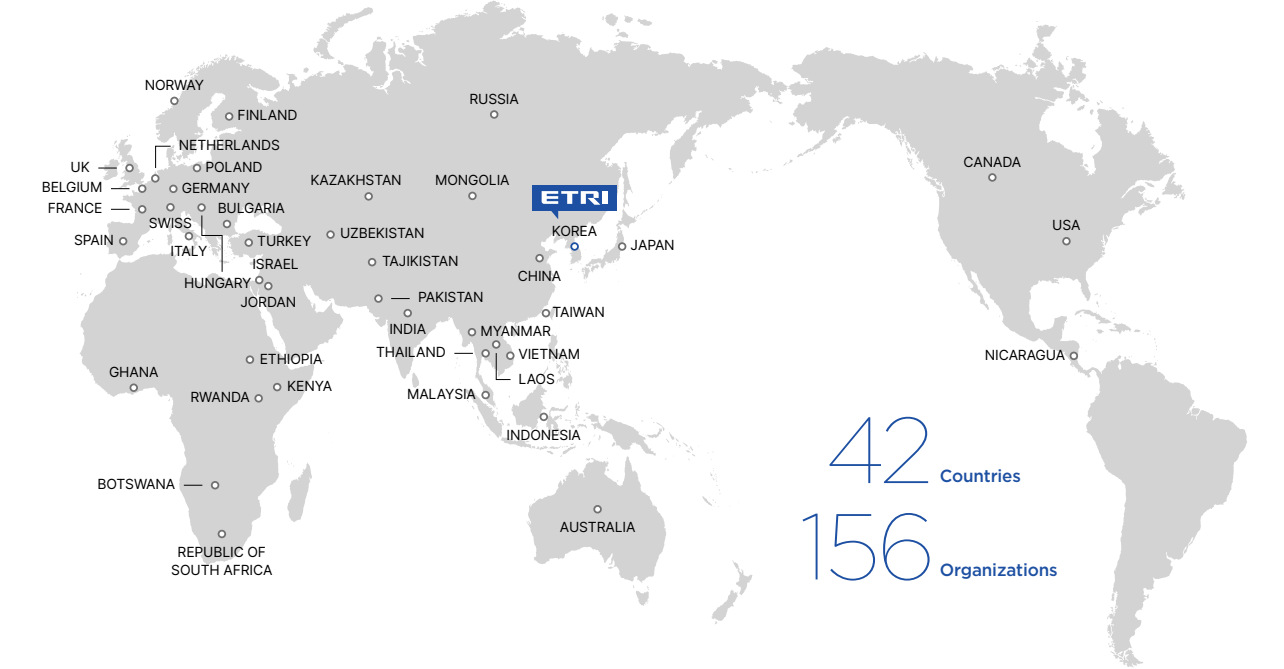
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Dalseong-gun, Daegu, 42994, Korea
Tel. +82.53.670.8000

Global R&D Cooperation Network



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CHINA Tongji University / JIITRI / NIC-Yangtze Delta	MYANMAR Mytel / UCSY	
ETHIOPIA Ministry of Science and Technology / Adama Science and Technology University	NETHERLANDS Wageningen Livestock Research	
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GHANA Council for Scientific and Industrial Research	POLAND Warsaw University of Technology / University of Gdansk	
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KAZAKHSTAN Transtelecom	TAJIKISTAN Technological University of Tajikistan	
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	TURKEY PTT	

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