ETRI ICT INNOVATOR LEADING THE 4th INDUSTRIAL REVOLUTION

2017 @ETRI

Electronics and Telecommunications Research Institute

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ETRI Technology Report
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CONTENTS

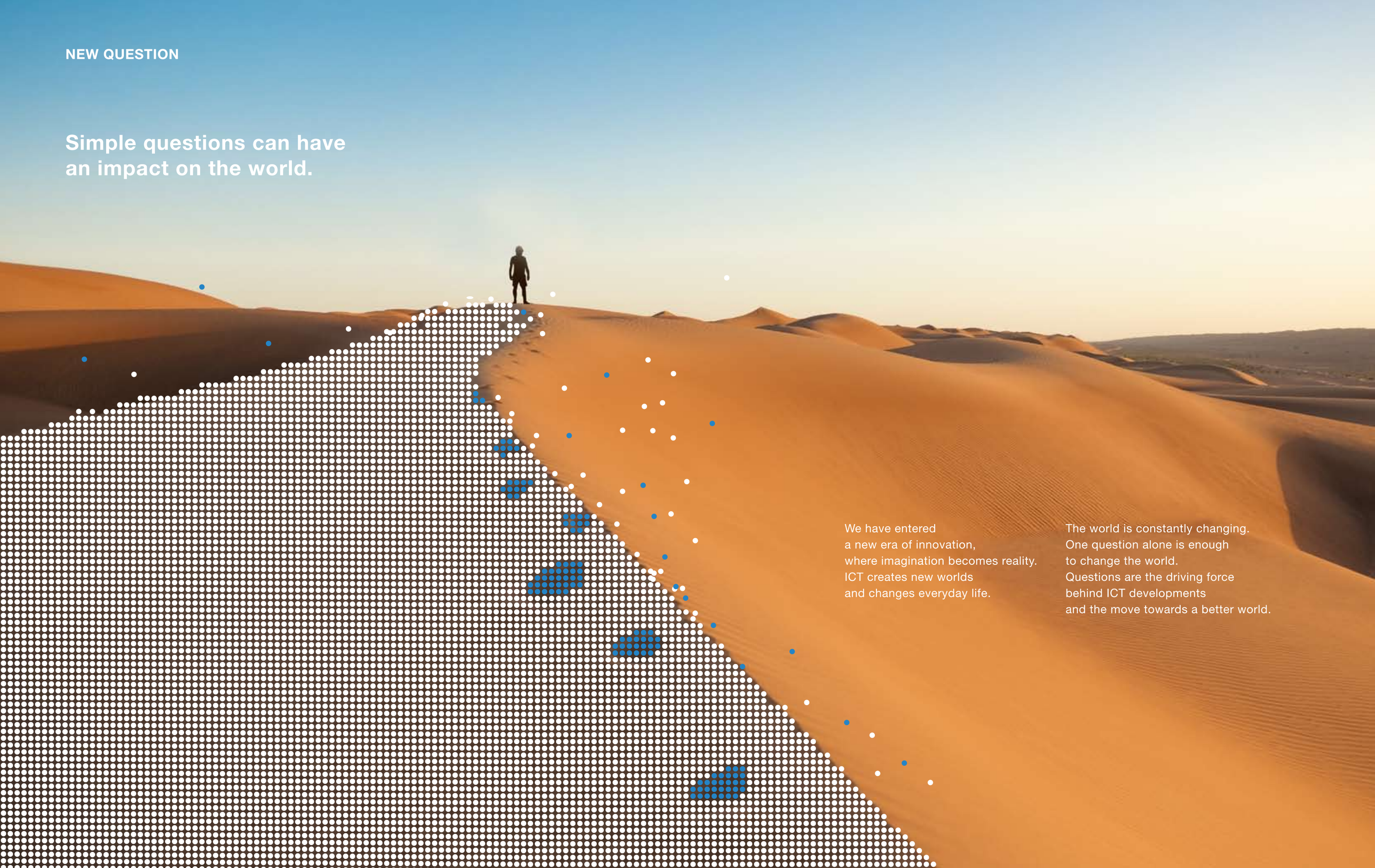
NEW WORLD

Questions have the power to change the world.

With the developments in ICT,
What kind of questions should be asked
to change our lives for the better?

The question to ETRI:
“What kind of world are you hoping to create?”

Simple questions can have an impact on the world.



We have entered
a new era of innovation,
where imagination becomes reality.
ICT creates new worlds
and changes everyday life.

The world is constantly changing.
One question alone is enough
to change the world.
Questions are the driving force
behind ICT developments
and the move towards a better world.

HISTORY

1976. 12. 30

KERTI & KIET established

1981. 01. 20

KETRI established
(consolidation of KTRI and KERTI)

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

1985. 03. 26

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

1996. 01. 01

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

1997. 01. 31

ETRI
ETRI's Korean name changed

1976

- Established KECRI, KIET, and KERTI, the origins of ETRI

Dec. 30, 1976 KIET(Korea Institute of Electronics Technology) was established to research in the field of electronics, e. g. semi-conductors, computers

Dec. 30, 1976 KERTI(Korea Electric Research and Testing Institute) was established to research in the field of electrics

Dec. 31, 1976 KECRI was founded as an affiliate of KIST for systematic research and development in the field of communication technology and introduction and development of 'Electronic Switching System'.

Dec. 10, 1977 Independent from KIST and renamed itself as KTRI

1981

- Established KETRI

Jan. 20, 1981 KETRI(Korea Electrotechnology and Telecommunications Research Institute) was established in consolidation of KTRI and KERTI

1985

- Established ETRI

March 26, 1985 ETRI, institute specialized in Information and Telecommunications was established(consolidation of KIET and KETRI) to meet with the emphasize on electronics field

1996

- Data process department of KIST transferred to ETRI as an affiliate

June 27, 1967 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.

May 25, 1998 Incorporated into ETRI

1997

- ETRI's Korean name changed

Jan. 31, 1997 Based on regulations for electronics and telecommunications

R&D MAJOR ACHIEVEMENT

1970s

1976
- Established ETRI, an affiliate of KIST
- Established KIET
- Established KERTI

1977
- Established KTRI (Korea Telecommunication Research Institute)

1980s

1982
- The nation's first semiconductor product '32K ROM chip'

1983
- 8-bit educational computer

1984
- 16-bit UNIX domestic computer

1986
- Launched TDX-1

1988
- 565Mbps optical communications system

1989
- 4M, 16M, 64M and 256M DRAM

1990s

1990
- 32-bit microprocessor

1991
- Launched TDX-10
- TiCOM II

1995
- Commercialize CDMA for the first time in the world

1996
- CDMA ATM exchanging machine

1999
- Synchronized IMT 2000(CDMA2000) STP system

2000s

2004
- WiBro prototype

2005
- ETRI succeeded in exported embedded SW solution
- Terrestrial DMB service launched

2006
- Wireless home network(UWB)

2007
- The world's first 3.6Gbps 4th generation mobile communication technology(NoLA)

2008
- The world's first digital content vending machine

2009
- SMMD-based 4D system technology

2010s

2010
- 4G LTE-Advanced Technology
- Smart ship technology(SAN)

2011
- Transparency adjustable AMOLED display
- Packet-optical integrated transport network technology

2012
- 100 times faster optical Internet technology
- Korean/English portable automatic interpretation technology

2013
- Automated valet parking technology using a smart phone

2014
- OCESTRA, Optical Internet technology

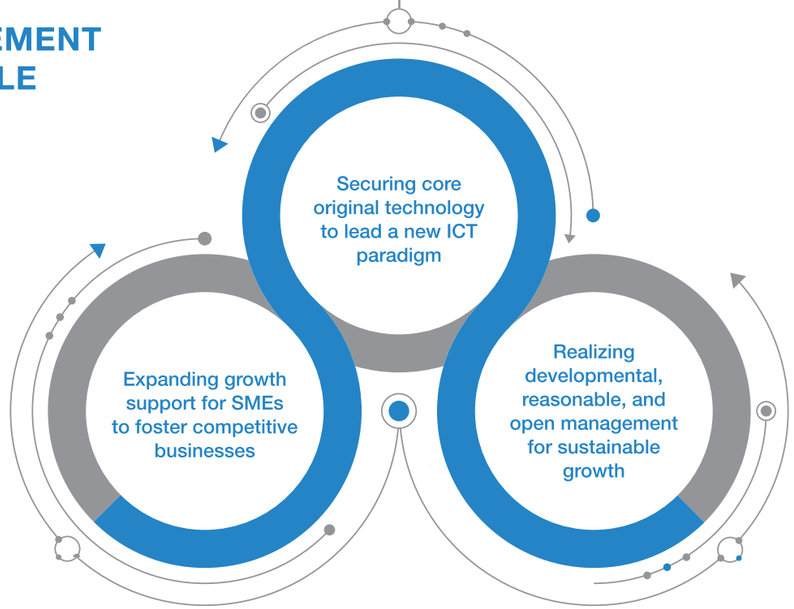
2015
- High five escort technology

2016
- Exobrain : Natural Language Processing & Question Answering SW.

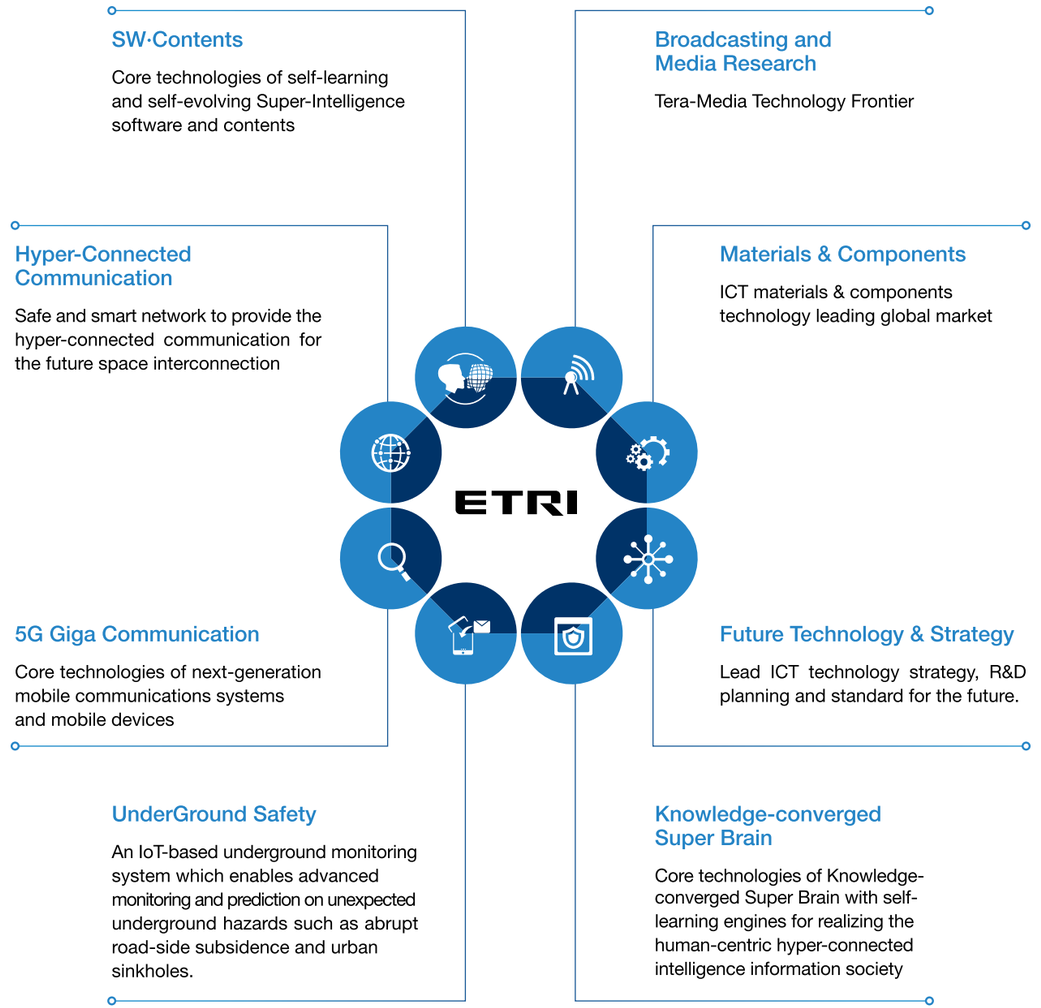
ETRI makes contribution to the nation's economic and social development through research, development and distribution of industrial core technologies in the field of Information, Communications, Electronics, Broadcasting and Convergence technologies.

VISION

MANAGEMENT PRINCIPLE



COMMON CORE TECHNOLOGY



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ICT INNOVATOR LEADING THE
4th INDUSTRIAL REVOLUTION

Research Fields

Future Technology & Strategay Research Laboratory

Drawing coordinates of our future with scientific forecasting and design

Vision
Laboratory for planning of R&D for integrated technology planning of future technologies, for a better future.

Goal
Policy-technology-standards-business planning of core ICT technologies to drive the fourth industrial revolution.

Q What does the Future Technology & Strategy Research Laboratorydo?

A "The development of science and technology as well as information and telecommunications is changing the world in a profound way. As breakthroughs in artificial intelligence are blended with the technologies of various industrial fields, changes that we are experiencing now are clearly different from those of the past. Among other aspects, we should take note of the complexity, as well as the speed of the change. As many say, we are now living in the era of the 4th Industrial Revolution. At this crucial point, our task is to observe these tremendous and complex changes from an integrated perspective and to come up with preemptive responses, that is, strategies, to the changing environment. We study what directions to take, what technologies to acquire in advance, and which resource allocation strategies to follow to maximize effectiveness. To this end, multidisciplinary professionals in the fields of future technology, industry, economy, policy, and standardization are working together on various projects here at the Future Technology & Strategy Research Laboratory."

Q Please share the history of ETRI's future strategy research.

A "Before the Future Technology & Strategy Research Laboratory was established, there were different departments, each responsible for research project planning and research content, that is, technical, planning. At the advent of the 4th Industrial Revolution, however, we decided to establish the Future Technology & Strategy Research Laboratory in early 2016 to rather aggressively respond to profound changes that are happening in a more complicated way and at a faster speed. The functions of the Laboratory include budget planning, resource allocation, and technological protocol standardization functions in addition to market analysis, technical planning, and project planning functions.

After we launched this integrated research body, we suggested 'Integrated Strategic Planning' as governing principles of ETRI's R&D planning methodology. This guideline dictates that a 'ripple effect', that is, impact, should be the priority when making decisions on which research to conduct and which technology to develop. In other words, the priority in our research should be given to technology that has a public value and can help resolve social issues. To make this work, technology analysts and market and economics analysts collaborated to develop the Impact Index and applied it to the technical and project planning process, making us an effective decision-making body.

In the meantime, we selected 'Artificial Intelligence' as the main research area to focus most of our research capabilities on. This decision was made based on our consensus that ICT competitiveness should be further strengthened to more effectively respond to the 4th Industrial Revolution. With regards to this, we defined three main directions of 'Hyper' technology. The first is 'Hyper-connectivity', where people are 'always' connected to the internet in any form and any time, enjoying giga-level internet/computing on-the-go via optical internet and 5G mobile communication with further expanded connectivity through the IoT. The second is 'Hyper-intelligence', where the advances in artificial intelligence software technology, which has been expanding its territory into autonomous navigation, automatic translation and interpretation, precision medicine, and investment analysis, are surpassing the capability of humans at least in part. The third is 'Hyper-realistic', where we can freely switch to and from reality and virtual world, thanks to advances in 3D images, ultra-high resolution imaging, and AR/VR/CPS technology. In addition, we refer materials and parts used in these three hyper areas 'Hyper materials.'

We named the process of transforming the entire social, economic, and industrial system operating on analog systems into digital intelligence, 'Intelligent Digital Transform (IDX)' where new values are created through 'chemical' convergence of the existing analog systems with the four 'Hyper' technologies introduced above. The thrust of this movement is to chemically merge our technological expertise and knowledge with the four Hyper ICTs so that ETRI can be a leader in the era of the 4th Industrial Revolution. We have issued various publications on future technology, as we believe that people's perception must change along with the changing national system. The <Issue Report> and <Maker Movement> published in 2016 have been received well and contributed greatly to the popularization of ICT."

Q When was the turning point of the Future Technology & Strategy Research Laboratory?

A "Our transformation into the Future Technology & Strategy Research Laboratory is not limited to our name and organizational changes. We define our identity as a 'Specialized organization for integrated planning and research.' If research planning in the past was task-oriented, "administrative" work, our current and foremost important role is strategic decision-making based on research. With these principles in mind, we have developed an integrated strategic plan during 2016 and 2017 since our inception."

Q What kind of future does the Future Technology & Strategy Research Laboratory dream of?

A "The trend in science and technology changes every second. If we fail to predict where the 4th Industrial Revolution is heading, we will fall behind before we know it and perhaps never be able to catch up again. Now, direction is more important than completeness or difficulty of a technology. Depending on the direction taken, a totally different result will be obtained. Therefore, as the brain of ETRI, the Future Technology & Strategy Research Laboratory will serve as a guide that instantly reads the changes in the world and navigates the most promising road to follow."

Future Technology & Strategay Research Laboratory

Economics of Technology Research Division

The Economics of Technology Research Division is an organization that anticipates the evolution of the future society and discovers the necessary skills to contribute to maximizing the social and economic performance of R&D in the ICT sector. Established at the end of the 1970s, the division focused on economic feasibility study of large-scale R&D projects for fostering Korea's ICT industry, which was in its infancy. We are now working as a think-tank of national ICT policy by carrying out studies related to ICT market needs, economic feasibility of technology to be developed, and ICT market promotion policies and strategies.

Out key achievements include the publication of the <Future Society Research and Technology/Industry Ecosystem Analysis Report> (2016) for future technology demand forecasts. In addition, we publish a report on the market response and the ripple effect of the technology to be developed and the planning technology (in 2016). We also provide a report on logical base research, objective evaluation of industrial policy, and policy alternatives to establish fair market regulations and competition policy for balanced and robust development of the ICT industry. In line with the efforts to introduce these achievements both internally and externally, we are publishing Insight Report and Internal Report; in 2016, 27 Insight Reports and 17 Internal Reports were published by our Division.

Currently, we focus on social science research to strengthen ETRI's R&D planning capability. The details include ICT policy trends and issues analysis, key issues to resolve national and social problems, research on promising R&D areas for domain strategy, domain-driven core value research through analysis of industrial ecosystems, analysis of mutual influence between technology and society, and research on technological impacts of ETRI R&D. In particular, we are actively promoting IDX strategy to intellectualize all industrial areas at the advent of the 4th Industrial Revolution.

We aim to be a 'Verifier for Social Application & Adaptation of Technology.' To this end, all members share analytical models and techniques to promote analytical expertise. In line with that, we are striving to create a horizontal organizational culture centered on researchers so that they can freely demonstrate their individual competence. In addition, we seek to become the top professional group that develops and leads the logic of market competition and regulatory policy not limited to the field of telecommunications but also in the environment where broadcasting, media, and communication fields are converged in harmony."

Future Technology & Strategay Research Laboratory

Future Technology Research Division

The Future Technology Research Division sets the technological vision of ETRI and oversees the technical part of integrated ICT R&D planning for the 4th Industrial Revolution (by establishing and promoting an integrated technological plan for future R&D for all researchers). To accomplish this, we are establishing mid- to long-term technological development plan at ETRI, identifying strategy, research focus, and creative technology for the future, discovering core seed technology, and creating preceding patent applications. In particular, we are conducting not only the overall planning of large-scale convergence projects, but also searching for core research areas for the next generation through cooperation with research departments.

As a result of Phase 1 of the integrated planning in 2016, we completed the Future Technology Vision and Implementation Strategy v1.0. Based on this, we completed the 'ETRI Mid and Long Term Technology Development Plan 2025 v1.0' at the end of 2016. In addition, we have developed intelligent infrastructure in hyper-connectivity, an AI doctor in hyper-intelligence, terra-media in hyper-realism, and human augmentation technology in the convergence area. As for creative technology, we have significantly expanded creative and challenging research to be the first-mover in R&D, and developed relevant seed technologies in DNA computing and brain engineering. In Phase 2 in 2017, we are actively conducting research on strategic technology development focusing on mid-to-long term technology to resolve national and social issues, research on focused technology planning with remarkable mid-term impact in consideration of marketability and technological merit, creative research on disruptive innovation to create new sources of market opportunities, and studies on seed technology development. By the end of 2017, we plan to complete the ETRI Mid and Long Term Technology Development Plan 2025 v2.0, laying the foundation for technological planning in 2018 with a competitive and effective technological roadmap.

Our mission is to set the directions in technological policy to create a sustainable research environment and to discover future-oriented and seed technologies, along with strategizing and planning for future technology. In addition, we also need to serve as a control tower in large-scale planning projects, while seamlessly completing the ETRI Mid and Long Term Technology Development Plan 2025.

The task ahead of us is to turn ETRI's R&D into a 'First Mover' type, actively responding to the rapidly changing ICT environment and leading government R&D policy. To achieve this goal, we aim to establish a virtuous circle system of strategic and key research areas, creative studies, and seed technol-

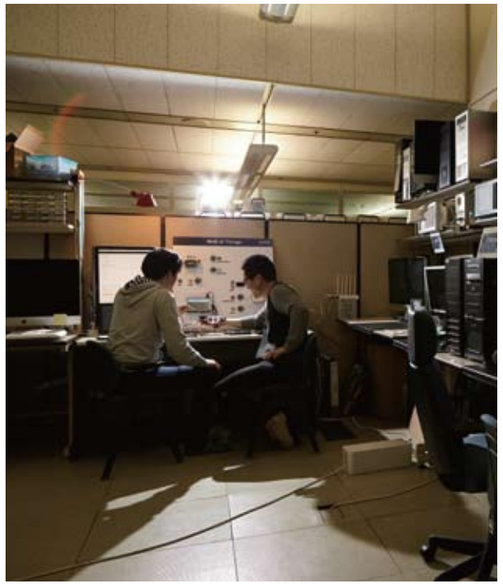
ogy, with the vision of cultivating ‘specialists in discovery of future-leading technology.’ Through this comprehensive technological planning, the Future Technology Research Division will keep searching for ‘the next big thing’ on behalf of ETRI and, by extension, our country.

Future Technology & Strategay Research Laboratory

Protocol Engineering Center

The Protocol Engineering Center was established in 1989 as a national response to strong need for global ICT standardization. At that time, as foreign ICT products and services were gradually introduced in Korea, demand for relevant protocols and a national standardization system for the ICT sector increased, and ICT protocol activities by experts representing the Republic of Korea in the global ICT standardization organization were crucial.
Currently, the Protocol Engineering Center governs ETRI’s standardization projects and protocol setting in domestic and international ICT fields. The standardization activities of the Center can be roughly classified into four categories. The first is preemptive technology standardization for tapping into future markets. This includes efforts to lead the standardization of various technologies such as Internet, Cloud, Big Data, Mobile Web, Wearable, Smart Media, and 5G/IMT-2020 network. The second is R&D-associated standardization designed to bring the results of R&D into the market. In cooperation with ETRI’s R&D department and external parties in the industry, we are

actively promoting efforts to promote domestic and international standardization of research achievements. The third is standardization for expanded public benefits. We are establishing technical standards for broadcasting communication facilities for government-led implementation of public benefit and fair market orders. In addition, we are also promoting activities for standardization in telecommunication information protection policy and technical support, wireless power transmission, smart factories, smart farming, E-healthcare, and ICT convergence service technology. Last but not least, we are striving to lead national standardization policy-building to raise and protect our national status and interests. Since most of the missions we conduct require policy-wise support, we are closely cooperating with the related government organizations in our endeavors. Based on these standardization activities in four categories, we plan to further concentrate on standardization patent filing and convergence standardization to lead the global market going forward. With the Open Source Center established in June 2017 serving as a leader, we will also make efforts to promote commercialization of the research achievements through operation of open source-based governance and creating a shared R&D environment where businesses can freely participate to bring comprehensive breakthroughs in ETRI’s R&D efforts. The ultimate goal of these efforts in standardization is to secure a global market. To achieve this goal, we will focus on creating global standardization patents as well as technological patents and developing convergence technological protocol in line with the trend of convergence in ICT, thereby raising our status globally as a value-creating, standard-setting organization.



SW·Contents Research Laboratory

Software and Contents Technology Planting the Seed of Korea's Digital Innovation Today for a Great Harvest Tomorrow

Vision
Leading of Super intelligence Technology

Goal
Technical development of self-learning and self-evolving super intelligence software & contents

Q What does the Future SW·Contents Research Laboratory do?

A "With numerous devices of the world going electronic, software and contents technology ('SW·Contents Technology,' hereinafter) is gaining greater importance as a core technological element. In particular, the ongoing shift from the personal computing environment to the mobile-based, portable device environment is driving changes in SW·Contents Technology. In response to such changes, the SW·Contents Research Laboratory is carrying out research and development with a goal to enhance Korea's technological competitiveness in SW·Contents Technology. To this end, researchers at the laboratory implement an entire cycle of R&D from basic research and development of core technology to its commercialization in a strategic manner, thereby reinforcing Korea's prowess in software and contents. At the same time, the laboratory endeavors to secure firm ground to foster a new market through creative software-converged R&D, while enhancing global competitiveness by building an open, cooperative system for R&D."

Q Please share the history of ETRI's SW·Contents research.

A "The beginning of ETRI's research on software and contents goes back to 1989. At the time, the laboratory was called the 'Computer Research Group,' which was responsible for research on both software and hardware technologies. The group changed its name to the 'Computer SW Technology Research Laboratory' in 1998, and then to the 'Computer SW Research Laboratory' in 2014, and started performing research on contents in conjunction with computer software. Then, in early 2016, with the addition of bio and robotics as new research areas, the laboratory became what it is today and was renamed the 'SW·Contents Research Laboratory." Currently the biggest research organization at ETRI, the laboratory is composed of five divisions and one research group that are committed to developing super-intelligent SW·Contents Technology that Korea needs to prepare for and embrace the 4th Industrial Revolution and the intelligent information society. More specifically, the laboratory's areas of research range from basic technologies such as high-performance computing and cloud technology, embedded software technology, verbal, vocal, and visual intelligence technology, and big data, to application technologies for intelligent contents, autonomous vehicles, intelligent robots, and for ICT-bio convergence, building on the research on the base technologies. In addition, to enhance mid- to long-term competitiveness in software technology, the laboratory is also performing research on original technology for manycore OS, next-generation intelligent information, and human augmented reality."

Q When was the turning point of the Future SW·Contents Research Laboratory?

A "Software is at the heart of the 4th Industrial Revolution. The biggest buzzwords for this revolution are artificial intelligence (AI) and cloud, which are the essential platforms for survival in the digital era. Considering that software is the foundation for such platforms, it can be said that software will determine a country's competitiveness. What is certain is that Korea will be able to seize an opportunity in the new revolution by successfully combining its strengths in network, contents, and device with software. While we have an overall framework for market creation thanks to the government's support for the software industry in promoting R&D and nurturing research personnel, we still need to collect diverse ideas to decide on the specific policy direction. The SW·Contents Research Laboratory will continue to secure technological competitiveness required of software to successfully perform its role as national infrastructure, while endeavoring to realize intelligent information society in which AAAI (assisted, augmented, and autonomous intelligence) is enabled."

Q What kind of future does the Future SW·Contents Research Laboratory dream of?

A "In the end, the SW·Contents Research Laboratory's goal is to realize 'people-oriented technology.' Our top priority is to find the best way to deliver convenient technology to people. While some technologies require huge investments as seen in large corporations, what we hope to develop is a technology that can offer convenience and ease of use to under-invested areas. In other words, our goal is to ensure that everyone, from those living at the city center to the socially marginalized and even students living in remote islands, enjoys the same services. In particular, children in rural areas are less likely to benefit from educational contents than those in cities. This is mainly because educational contents are expensive and it can be quite costly to support virtual reality for such contents. In this regard, we aim to foster an environment in which technology is distributed to everyone fairly and evenly."

SW·Contents Research Laboratory

Creative Content Research Division

The Creative Content Research Division is exploring and developing a variety of technologies ranging from virtual reality, computer graphics, and computer vision, intelligent interaction, computer games, and realistic e-learning to contents copyright protection and distribution.

Starting in the 1990s, the System Engineering Research Institute comprised content-related research divisions such as the Emotional Engineering Research Division and the Image Processing Research Division. Later, in 1998, the institute was merged under ETRI. With the implementation of the IT839 policy by the Ministry of Information and Communication in 1994, the Creative Content Research Division was established to focus on the development of digital content—one of the nine major growth engines.

The division's most representative achievements are its "computer graphics" technology (2006) that was used to create virtual vessels and weaponry appearing in such films as Hanbando and The Restless, and the "digital actor" technology (2006), which digitally reproduced the main actor performing dangerous action scenes or the countless people in the crowed instead of using stuntmen or extras. The "digital portrait technology" (2006) that enables users to create their own portraits by using the automatic brush touches of Vincent van Gogh is another example. "Storytelling using virtual reality," a technology that lets toddlers and preschool children experience and enjoy classic children's stories in a virtual space (2009), is in operation currently at 36 national and public libraries across Korea including the National Library for Children and Young Adults. Last but not least, "black box-based load test technology for an online game server" (2010) allows systemic analysis of errors of a game server by creating numerous virtual users.

Among more recent successes, the export of indoor VR theme park technology (2015), which offers an amazing sense of reality and immersion, to China is one of the greatest achievements. The technology has been introduced to the 751-D Park in Beijing, China and has been in commercial operation since January 2016. At the moment, we are working with other regions in China such as Suzhou, Ganzhou, Chongqing, and Hangzhou to introduce the technology. It is expected that the technology will spread across Korea as well, and the Lightning Man Space Center's Experience Hall in Ulju County of Ulsan is in the process of adopting this technology to offer a service to the public starting from October 2017.

With the impending arrival of the 4th Industrial Revolution, the Creative Content Research Division is placing the greatest emphasis on the virtual and augmented reality (AR) technology. Vigorous technology development is underway at the laboratory for a broad scope of areas ranging from several original technologies such as experiential VR technology, wide area 3D restoration and ultra-high precision scanning technology, camera tracking AR core original technology and service technology, to core application technologies required for service convergence. Our highest priority is to develop the technology for intelligent contents that can be customized for individual users based on their respective preferences and standards.

The Creative Content Research Laboratory will continue to develop core original technologies to ensure that people in the age of the 4th Industrial Revolution will fully enjoy the culture that will enrich our lives with greater fun and entertainment, while also performing its role as the global leader in intelligent contents technology.

SW·Contents Research Laboratory

Bio-Medical IT Convergence Research Division

The Bio-Medical IT Convergence Research Division is developing new and innovative technology by converging bio-medicine with IT. The Bio-Medical IT Convergence Research Division was established in 2001 for the development of IT-BT convergence technology. To usher in the era of "healthy living for 100 years," the division is carrying out research to implement medical IDX[1] consisting of disease diagnosis with maximum convenience, effective medical equipment for treatment, and a diagnostic support system to assist doctors' diagnosis, keeping in step with the shift in the medical paradigm from diagnosis and treatment of diseases to prevention and management.

Major research achievements include x-ray imaging-based bone density measurement technology (2000) introduced to about 300 hospitals in Korea, vital sign monitoring technology (2009) that has been successfully commercialized and utilized for physical and health examination for students, urine analysis technology (2010) for urine analyzer products being sold at online shopping sites, a drug administration support system (2014) being exported to overseas markets, and bio-sensor chip technology (2011 and 2015) which turned into a business by a spin-off company.

The main research projects being conducted by the Bio-Medical IT Convergence Research Division are technology to generate photons using a laser for a photon treatment device for common use, a noninvasive blood glucose measurement technique, AI-doctor technology for early diagnosis and prediction of cardiovascular diseases, mental health monitoring technology to diagnose and predict a person's status of mental health in an objective manner, and converged imaging diagnostics for effective diagnosis of breast cancer.

The bio-medical field is garnering attention as the next-generation growth engine in which major global corporations are investing. In particular, IT giants are fiercely competing against one another to preempt the healthcare service ecosystem built around ICT. Meanwhile, venture start-ups that are armed with technological capabilities and specialized services are also making headway in the market. In addition, the paradigm of medical services is shifting to more advanced technology such as precision medicine, and various companies are accelerating their R&D efforts to stay abreast of the changing environment.

Against this backdrop, the Bio-Medical IT Convergence Research Division has a vision to realize the era of "healthy living for 100 years" by developing basic technologies to help ensure that every citizen will enjoy healthy living for up to 100 years. The division's focus is on R&D for universal medical services that will be particularly helpful for the medically marginalized.

1) IDX refers to a science and technology revolution that will make the digital world of today more intelligent (super intelligence), more tightly and closely connected (super connectivity), and more realistic (super reality).

SW·Contents Research Laboratory

Intelligent Robotics Research Division

The Intelligent Robotics Research Division is developing technology to embed intelligence in moving objects such as autonomous smart vehicles and intelligent robots, while also exploring core technologies for intelligent robotics required to address pending social issues such as convenience, safety, welfare, and the aging population that are gaining importance as items on the national agenda.

ETRI launched the Intelligent Robot Research Division in 2004 to conduct research related to intelligent robots. In the same year, the Telematics Research Division was founded to stimulate research on smart vehicles. In 2017, to maximize synergy under the keyword “mobility,” the two divisions were integrated into the Intelligent Robotics Research Division.

The division’s major achievements include a multihop-based, offshore broadband communication system (2014) that enabled a minimum 1 Mbps transmission speed for a range of up to 100 km off the shore, and a “smart guidance system for visual information” (2013) designed to help the visually impaired traveling on foot by recognizing direction, location information, and object information (bus number, person to meet, etc.) at various locations such as a subway station, pedestrian walkway, and a bus stop, and providing such information in a text-to-speech (TTS) format.

In addition, the Intelligent Robotics Research Division embarked on the Open Platform for Robotic Service (OPRoS) project in 2008, aiming to create a platform for robotic software development over the entire lifecycle from the development of robotic software to its simulation, test and distribution. The platform will help realize common use of robotic software and contents while also offering reusability, transplantation, and extensibility. In addition, the division successfully developed software in 2013 that could prompt a vehicle to run via a smartphone and to perform automatic driving and parking within a parking lot by using information marked on the ground surface such as parking lines, as well as camera sensors on the vehicle. This is just one example of how high added value can be created in major industries through convergence between automobiles and IT, and the platform is expected to help solve problems involving underground parking lots such as theft and violence, and reduce traffic congestion around parking facilities.

At the moment, the division is working on an intelligent safety management system to prevent and respond to accidents occurring at a large-scale workplace. This year, the division has launched a project to develop original technology for information-robot convergence in which a human care robot interacts with a senior citizen to understand his/her appearance, behavioral characteristics, health conditions, lifestyle patterns, and personal relationships through continuous observation and monitoring, and to provide personalized health, lifestyle, cognitive and emotional services based on the monitoring. The project, known as “the real-environment human care robot technology development to address the challenges of the aged society,” is scheduled for completion at the end of 2021. Another ongoing research project deals with precision map. Precise map information is essential for autonomous vehicles, but the current model used to express data on a precision map may involve errors due to manual work and it is difficult to keep a precision map updated on a real-time basis. To complement such shortcomings, the division is developing software technology to generate a gradually evolving precision map featuring 10 cm-level lane precision, thus allowing constant updating of the map, which is an essential function of a map service. Furthermore, the division aims to develop a comprehensive cognitive system that allows natural communication between humans and robots (machines). As part of this endeavor, researchers are currently developing image/video recognition technology for user identity recognition, user location identification and human following, robot instruction gesture recognition and human behavior recognition, sensor-converged user information (identity/location, behavior, age/gender) recognition, and technology for social interaction between human and robots (recognition of facial expressions/emotions/intentions).

The Intelligent Robotics Research Division will establish itself as Korea’s best expert group in robotic software technology that will lead the country into the 4th Industrial Revolution, while fulfilling its role as an “evangelist” for autonomous vehicle technology, a core element of the next-generation traffic infrastructure.

SW·Contents Research Laboratory

Intelligence Information Research Division

The Intelligence Information Research Division consists of a research organization at its center that has been investigating natural language processing and speech recognition for over 20 years, since the 1990s, long before the division took its current form, as well as of other research departments working on image processing and data processing, management, and analysis.

Researchers at the Intelligence Information Research Division are not only leading the domestic technology development efforts in terms of natural language processing and speech recognition but they are also striving to accumulate R&D capabilities that are on a par with the global level. The division is focusing its research energy on securing world-class research capabilities in video and image processing, which is gaining importance around the world. Furthermore, the division is endeavoring to develop a variety of technologies for data analysis, storage, and management to produce high-quality data that can be applied to the actual industrial fields.

The division's major research outcomes include the development and commercialization of technology to automatically translate patent documents from Korean to English (2005), development of the automatic interpretation tool GenieTalk and its service launch for the public (from November 2012 to May 2015), Exobrain Question Answering technology that won the EBS Janghak Quiz Show (2016), commercialization of speech recognition technology for call centers (2016), and provision of health and welfare pilot services using population simulation technology (2016).

The division is now pushing ahead with the "SW Grand Challenge" as its major program, which includes Exobrain and Deep View projects whose development started in 2013 and 2014, respectively. Exobrain is a knowledge mining project whose Phase 1 development resulted in winning the EBS Janghak Quiz Show. Building on this success, the technology will be further enhanced to offer descriptive question answering functionality in specialty areas (patent, laws, finance, etc.) for commercialization in the future. Meanwhile, the Deep View project aims to study how human eyes understand objects by using ICT, and is developing a technology that functions like a human eye to understand and deduce from movements between an object and another object, and to predict what behavior will ensue. Also, the Intelligence Information Research Division has developed GenieTutor, an English learning technology using interactive speech recognition to allow English learning through natural conversation with a computer for the first time in the world, and is working to launch commercial services. Furthermore, the division is trying to overcome the limitations of the existing deep learning technology through the development of original technology for autonomous growth-enabled cognitive computing using complex intelligence, while also laying the foundation to develop innovative AI targeting multimodal interface[2] including voice, video, and linguistic intelligence.

The Intelligence Information Research Division is committed to strengthening its research capabilities through selection and concentration. Among various AI research areas, technology development will be focused on specific research items by selecting only those that the ETRI headquarters has secured competitiveness for and that are considered to have the potential to play a crucial role in the development of Korea's AI industry in the future, especially in the areas being pursued by ETRI such as voice, visual information, and smart data. To that end, each research group will strive to acquire core element technologies to enable intelligent information in their respective areas through selection and concentration. The division will also strive to reinvigorate the ecosystem for private industries by providing the technologies and related data it has secured to the private sector as open APIs[3] through an open platform for sharing, and in doing so, help private businesses enhance their capabilities in intelligent information technology and activate Korea's ecosystem for the intelligent information industry. Lastly, the Intelligence Information Research Division will contribute to developing Korea's own intelligent information industry by strengthening its research capabilities internally and creating internationally acclaimed research outcomes through the adoption of various research methods, while making continuous efforts building on the division's existing world-class competitiveness.

2) A multi-modal interface is designed to enhance user-centric work efficiency by building a ubiquitous computing environment without the need for a special device, by using various biometric techniques such as speech recognition, gesture recognition, a device pen, behavior recognition, and touch recognition, apart from common user interfaces such as a keyboard and a mouse.

3) Open APIs refer to publicly available APIs that can be utilized by Internet users to develop their own application programs and services rather than simply receiving web search results and user interface only.

SW·Contents Research Laboratory

Infra/Core Software Technology Research Division

The Infra/Core Software Technology Research Division is investigating original technology for system software such as operating systems, middleware, and development environment, which are essential elements in operating a variety of computing systems ranging from small-scale embedded systems to large, high-performance, cloud systems.

Major research outcomes include TiCOM-III (1994), which was developed through the high-speed midsize computer system development project. TiCOM-III was commercialized and applied to the national public administrative network, and recorded an accumulated sale of 30,000 units in the private sector up to 2000. The BADA database management system (DBMS) (2000), upon completion of development, was transferred to Samsung Electronics, Daewoo Communication, and Goldstar for application in their products, and it also provided a strong foundation for Altibase and RealTime Tech[4] to grow into DMBS specialists. The division's GLORY-FS cloud storage project (2012) aimed to develop the world's top-class storage technology for cloud services to let users save, access, and share data over the Internet, and the developed technology was introduced to SK Telecom (T Cloud), LG Uplus (U+ Box/Webhard), and KT HiTel (Paran) as commercial services used by the entire public. Apart from this, the Infra/Core Software Technology Research Division developed the MAHA supercomputer for genome analysis (2016), the nanoQplus lightweight operating system (2008), the Qplus-AIR operating system for aircraft (2012), EDDS (2012), a standard data distribution service for weapon systems, and Qplus-WEB (2014) for mobile web-accelerated operating systems.

More recently, the Infra/Core Software Technology Research Division has independently devised its own storage connection network technology for the first time in the world to prepare for the era of the exascale[5] computing to arrive in 2020 and to advance into the field of ultrahigh performance, ultra-energy saving, exascale storage

4) Altibase and RealTime Tech are application software developers and suppliers

technology. Further development is now underway for the technology with its application to smart factories and drones, which are representative domains of the 4th Industrial Revolution. In particular, the division is developing software for accelerated intelligent information processing for smart devices to ensure that AI technology of the new revolution will be utilized in the embedded field as well. Once the technology is developed, it will be utilized as a core technology that will enable acceleration of intelligent imaging processing performance in the civilian and military fields.

SW·Contents Research Laboratory

SW·Contents Basic Technology Research Group

The SW·Contents Basic Technology Research Group is performing research on software and contents that will help secure creative "seed" technology for the future and overcome the limitations of existing technology. In order to realize ICT that always puts people at the forefront, the group's researchers are working hard to develop original technology for a transparent and flexible user interface and its application systems, as well as technology to make system software more efficient in preparation for the next-generation computing age based on manycore[6], and to overcome technological limitations. The group's endeavors do not end at realizing technological convergence of software only. Rather, the group pursues "consilience" with humanities that focus on people, in order to secure original technology to enable comfortable user interfaces (UIs)[7] and user experience (UX)[8].

In the field of transparent transducer and UX technology, the division is exploring user experience-oriented interfaces that can be applied to information/electronic devices of the future. In particular, anticipating that devices equipped with transparent and flexible displays of the future will require a transparent and flexible user interface as well, we are carrying out research on original technology and new-concept application fields built around transparent actuators, transparent sensors, and interaction techniques to realize a new tactile input/output interface.

In the field of computer operating systems, the division is studying manycore operating systems that offer higher performance with an increasing number

5) Exascale computing refers to computing systems capable of at least one exaflops, or a quintillion calculations per second. One quintillion (exa) is 1,000 quadrillion, and one quadrillion (peta) is 1,000 trillion.

6) Manycore refers to integrating dozens or hundreds of cores in a single process. Multicore, on the other hand, is when a board has multiple processes on it, with each process being called a core.

7) User interface (UI) is a user's first point of contact. It can be understood as the graphic interface we commonly see on mobile and web services or on apps. It lets users understand and use a screen more conveniently and easily.

8) User experience (UX) refers to the collective sum of all experiences that a user has from a supplier's product or service, as well as from interactions with all other elements that are involved in providing the product or service to the user.

9) Human enhancement technology is designed to enhance human beings with stronger physical, intellectual, or social abilities in augmented reality. A variety of technologies that offer new sensations beyond the five senses of human beings will greatly contribute to the development of this technology.

of cores. Computer systems equipped with as many as 15 and 18 cores have been introduced lately, and considering the ongoing trend, it is expected that a manycore system using well over 100 cores and even thousands of cores will emerge within the next few years. In preparation for this future, the division is examining if Linux of today offers sufficient performance for the manycore environment, and if not, how we can overcome the technology's current limitations in performance. This research is being carried out at the "Next-Generation OS Basic Research Center" jointly by researchers from ETRI and several research institutes under renowned universities both at home and abroad.

Meanwhile, the division aims to maximize human welfare by complementing or augmenting human abilities in an ICT-based, ubiquitous environment through its research on wearable computing technology. Currently, the SW·Contents Basic Technology Research Group is focusing on human enhancement technology[9] that will be used to understand human beings' physical and psychological circumstances, and to complement and augment human abilities, with a goal to develop a technology that will enhance the quality of life and happiness index. To that end, the group's research investigates physical enhancement to complement human sensory abilities based on human information recognition technology, cognitive enhancement to learn a user's circumstances, experience, and even sensibility, and to recognize his or her intentions, and interactive technology that maximizes convenience of use and wearability.

The research team pursues collective intellect through open research, which is characterized by cooperation with universities at home and abroad, and publication of research outcomes, while endeavoring to transform the secured original element technology into practical use as well. By performing original research to identify and nurture technology that the society of the future will demand, the SW·Contents Basic Technology Research Group aspires to open a new global frontier in providing user-centric creative technology and in realizing a warm, intelligent society that will tear down barriers and overcome limitations.

Hyper-connected Communication Research Laboratory

Vision
The Game Changer of Secure, Safe and Smart Hyper-connected Communication Technology

An age where everything is connected through networks
A core hyper-connected intelligence platform that realizes an intelligent society

Q What does the Hyper-connected Communication Research Laboratory do?

A "Connectivity is the key to the Fourth Industrial Revolution. By the Fourth Industrial Revolution, we mean the advent of a hyper-connected society that will be able to create value from a world where everything is connected. Hyperconnectivity is giving birth to new innovative technology and businesses, blurring the boundaries of existing industries, businesses, and technology. HCRL serves as a key enabler to lead the core hyper-connected infrastructure technology."

Q Please share the history of ETRI's Hyper-connected Communication research.

A "HCRL was established in January 2016 by integrating the Network Research Division, Information Security Research Division, IoT Research Division, and other relevant convergence sectors, with the mission to carry out effective research and development for the world's most innovative hyper-connected infrastructure technology. Since then HCRL has initiated various research and development efforts under the theme new hyper-connected platform technology, which goes beyond the existing concept of communication. The Network Research Division holds a very long legacy, matching that of ETRI. Its contribution to realize and expand the high-speed information society earlier than the original plan was possible thanks to the development and commercialization of its technology that ranges from TDX (1982), which opened an era of one phone per household using the first locally-developed switcher to broadband ISDN (1998), to a 10Gbps Optical Transmission System (1998), Optical Access Network Technology that provides 10Gbps per subscriber and a 100Gbps Optical Transceiver Technology (2014), and subsequently 10 Terabit Optical-circuit-packet Converged Switching System Technology (2016). The Information Security Research Division has been committed to research and development, particularly for information security technology of private sectors, since 2000. Its achievement to date includes National Public Key Infrastructure Technology (1999) and FinTech Security Technology, or FIDO[1] (2015), to name a few. The IoT Research Division and convergence sectors have been committed to developing a common infrastructure technology for the IoT, ranging from the development of RFID Technology (2004), a Sensor Network (2007), and an IoT Service Platform (2013) to High-reliablility IoT Wireless Communication (2014). The Postal Technology Sector has been committed to researching informatization and automatization for use in the Postal Technology Research Center. Its achievements including the Postal Mail Sorting Machine (2008) and Self Service Post Office Technology (2014) are increasingly being used nationwide. The latter, which enables mail acceptance and delivery service without tellers physically being present, particularly had an effect of substituting around 154.1 billion won worth of imported devices and entailed 266 domestic/foreign patent applications and 35 successful technology transfers, including the Korean Address Recognition System."

Q When was the turning point of the Hyper-connected Communication Research Laboratory?

A "To realize the Fourth Industrial Revolution and a Hyper-connected Intelligent Society, a new concept of the Hyper-connected Intelligence Platform, or Open Digital Connectome (ODC), is inevitable. This Open Digital Connectome refers to the platform where interconnections and networks of people and things operate in a similar manner to how neurons and synapses connect and work in the human brain; the ODC will be a new turning point for our laboratory. We will design the concept of ODC technology and focus on creating an open ecosystem together with industry, academia, and research centers at home and abroad."

Q What kind of future does the the Hyper-connected Communication Research Laboratory dream of?

A "Hyperconnectivity is a technology that creates a borderless future, which allows and enables people and various things to connect seamlessly. With intelligent technologies, it will lead to a paradigm shift that will blur the boundaries in almost all industries and create accelerated innovation towards Fourth Industrial Revolution. HCRL will serve as a hyper-connected organic cluster where people and things can closely communicate and interact. We will create creative and disruptive innovations, and will serve as a key enabler to lead the Fourth Industrial Revolution."

1) FIDO (Fast Identity Online) Technology: A new authentification technology that leverages biometric identifiers such as fingerprint, iris, face-recognition, voice, and palm veins, as well as other authentification devices such as smart watches, smart cards, and passcodes for easy access and heightened security, rather than relying on a combination of ID and passwords offered by IDO Alliance as an international standard.

Hyper-connected Communication Research Laboratory

Hyper-connected Basic Technology Research Divison

The Hyper-connected Basic Technology Research Division aims to develop research on infrastructure technology and mobile edge computing hyper-connected basic technology for “Massive IoT connectivity”, which holds the key to Fourth Industrial Revolution. Our greatest achievement includes the development of nerve electrodes that stimulate the nerve cells in the brain (2016) and the subsequent publication of a biomimetic synapse research methodology that helps the rehabilitation of stroke patients in a world renowned journal, <Nano Letters(IF 13.8)> (2016). The successful development of our wearable platform technology capable of monitoring human activity and flexible data processing has also won favorable reactions at the Mobile World Congress (MWC) in late February this year. Our division is currently working on basic technology to establish a hyper-connected society that will wirelessly connect people, things, and physical to cyber space. We are committed to researching Trust Information Infrastructure (TII) technology that collects, analyzes, and shares trust data based on the definition of a trust framework in social, cyber, and physical spaces; wearable technology of a platform structure capable of monitoring human activity and flexible data processing; and deep-buried people-detection technology for rapid rescues using wireless imaging devices, which will be the foundation of future innovation technology. Other areas of focus include quantum computing (quantum dot qubit-based quantum computing system) and brain engineering (synapse-related brain information recognition technology). The world is currently engaged in fierce competition to develop industrial basic technology in order to cope with the Fourth Industrial Revolution. There is a focus particularly on the importance of developing autonomous and cognitive hyper-connected technology based on artificial intelligence. We will be the key enabler in leading technology innovation of the upcoming hyper-connected society by developing a creative, challenging, and sustainable basic technology.

Hyper-connected Communication Research Laboratory

Information Security Research Division

With the advent of a hyper-connected intelligent information society, we are facing an ever broadened and diversified point of contact with cyber attacks. Our division focuses on proactive research in the fields of cyber-crime, cyber-terror, and infrastructure freeze in order to cope with “hyper-connected threats” and aims to enhance industrial competitiveness and construct a crimeless and safe country. Our greatest achievement includes the development of National Public Key Infrastructure Technology (NPKI) (1999) used by most of our citizens. Many Koreans use NPKI, which is an electronic certificate of a personal seal required for internet banking, e-commerce, and e-government service in finance, telecommunication, and public organizations. HCRL developed the infrastructure technology for NPKI, its issuance, and management in 1999 and subsequently transferred this technology to a local company. The development of FinTech authentification technology, or FIDO (Fast Identity Online) (2015), also had a powerful ripple effect throughout the country. We developed the authentification device, the server, the system, and client technology in compliance with FIDO 1.0 standard (2015). This technology passed the first FIDO interoperability test (2015) and is be-

2) USIM (Universal Subscriber Identity Module): An IC card chip whose use is mandatory in carriers using asynchronous 3G mobile communication (WCDMA).

ing used in local financial institutions after its technology transfer to more than 30 companies. In 2004, we developed the Universal Subscriber Identity Module (USIM)[2] with multiple services including user authentification, global roaming, transportation card, and e-commerce. We also developed a 20Gbps High-Performance Intrusion Protection System and DDoS Defense System (2010) in the area of network security technology; Intelligent Cyber Attack Recognition and Traceback Technology (2013) to cope with sophisticated hacking; and New AI-based Automatic Malicious Code Analysis Technology (2015). Other recent developments include new core authentication technologies, one being biometric authentication that uses face-recognition, voice and keystroke information, or user behavior information, for smartphone subscribers and the other being multiple authentication that further strengthens security by using a combination of more than two authentications. Developments undertaken also include Information Security Technology, such as encryption, authentication, and recognition, Network Attack Response Technology, Mobile Device Security Technology, and Convergence Security Technology. Based on past experiences, we are focusing on technologies that will help cope with environmental changes and market demands. This means we will continue to focus on basic technology to handle hyper-connected threats in an intelligent information society, undertaking topics on Reinforced FinTech Security to prevent financial accidents; Safe Data Protection to prevent data loss; Reinforced Physical Protection to protect lives and facilities; Network Attack (e.g.) APT attacks Response; System and Device Protection in a mobile environment; and Key Industry Protection to cope with control network attacks. With the goal of becoming a global information security leader in an intelligent information society, we plan to propose a national cyber-safe solution by carrying out research and development on proactive information security technology that will help us to cope with hyper-connected threats, such as cyber-crime, cyber-terror, and infrastructure freeze and contribute to further strengthening the technological competitiveness of the national security industry.

Hyper-connected Communication Research Laboratory

Network Research Division

Network Research Division is committed to the research and development of fast, safe, and smart hyper-connected intelligent infrastructure innovation technology in order to boost technological competitiveness of the national security industry and propose an infrastructure solution on the national, public, and industrial level. Our greatest achievements include leading the “Quick Internet” by developing and commercializing Optical Access Network Technology that provides 10Gbps per subscriber; 100Gbps Optical Transceiver Technology (2014); and subsequently 10 Terabit Optical-circuit-packet Converged Switching System Technology (2016). We have secured a safe infrastructure technology by developing Trusted IP Network (TIPN), which supports the reliability required by special purpose networks, e.g. the military, through a logical network separation in existing network and integrated access control. We are working with industry to apply this technology for special purpose networks at home and abroad. Last but not least, we have developed SDN/NFV-based Distributed Virtual Infrastructure Platform Technology as part of smart infrastructure technology that enables significant improvement in the flexibility of networks by responding intelligently to various applications and situations, along with an international standard (2016). This technology has been applied to local private cloud networks and carriers. Currently, we are focusing on developing an innovative structure and basic technology for Hyper-connected Trust Intelligent Information Infrastructure, which will form the basis of an Open Digital Connectome. Our major research topics to enable these goals include Open Network OS Technology to secure infrastructure base technology; Computer-Networking Tightly-coupled Virtualization Platform Technology; Giga-Tera Optical Transmission Technology and 100Gbps Wireless and Wire Converence Optical Access Technology to achieve high-speed fiber optic communication; and End-to-end All-optical Networking Technology. We are committed to research on Hyper-connected Intelligent Infrastructure and Core Technology as part of Trust Intelligent Infrastructure Technology; 5G Network Technology; SDN-based Trust Networking; and Ultra-low Latency Networking Technology. We are working on mission-oriented infrastructure and convergence application technology in order to apply these technologies to special-purpose infrastructure, e.g. public or military. Our eventual goal is to become “a game changer of safe and smart hyper-connected technology,” by leading the basic innovative infrastructure technology characterized as “hyper-connected”, “trustworthy”, and “intelligent”, and fostering specialized companies that are small but strong in the area of infrastructure, including optical networks,

Hyper-connected Communication Research Laboratory

IoT Research Division

Under the vision of “Beyond Connectivity”, the IoT Research Division aims to realize a society of Human-Things Symbiosis by developing hyper-connected intelligent spaces consisting of smart things. We are carrying out a wide range of R&D projects in the IoT fundamental & core research areas and the IoT convergence areas. The former includes the RFID Technology (2004), Sensor Networks, Highly Reliable IoT Wireless Communication, and IoT Service Platform, while the latter includes the Industrial IoT, the Public IoT, and the Human Care IoT. We developed leading technologies, including Mobile RFID Reader (2006) and 900MHz Band Sensor Node and USN Middleware (2007) and initiated a relevant international standard. We also succeeded in developing the SUN (Smart Utility Network, IEEE 802.15.4g) technology (2012), one of the low-power wireless communication technologies required in Highly Reliable IoT Wireless Technology, secured a patent for a related international standard, and successfully manufactured the chip set (2015). In the IoT Service Platform area, we developed the Open IoT Platform that can process data collected from the sensors of different devices and transmitted to the server through the network and secured the patent for ITU-T international standard. We are also contributing to Korea’s IoT industry by developing IoT Convergence Services in diverse areas - Smart Home, Smart Grid, Smart Factory, and IoT in Disaster Safety. The IoT Convergence Service area focuses on executing Digital Transformation through the IoT in existing industrial areas, such as manufacturing, energy, disaster relief, and the environment. It is the hope and goal of the IoT Research Division to leverage these efforts to become the leader of the Next IoT Technology, which will be founded on IoT-AI convergence.

ICT Materials & Components Research Laboratory

Robust Foundation to Overcome
the Challenges of the 4th Industrial Revolution

Vision
Innovator of ICT materials and components leading global market

Goal
Development of ICT materials and components for realizing the 4th Industrial Revolution

Q What does the ICTMaterials&ComponentsResearch Laboratorydo?

A “Just like fabric and threads are needed to make clothes, materials are needed to make any product. That goes the same for ICT products. ICT Materials & Components Research Laboratory is developing technologies that will serve as basic materials to build ICT products, such as modules, accessories, and other various base technologies required to make ICT products.”

Q Please share the history of ETRI’s ICTMaterials&Componentsresearch.

A “The ICT Materials & Components Research Laboratory traces back to the days when ETRI was still known as KIET (Korea Institute of Electronic Technology). Established in 1976, KIET had a mission to nurture domestic capabilities for electronics, computers, and semiconductors, making particular efforts to develop semiconductor components. As a chef learns to add more variety to the dishes he cooks with greater experience and expertise, research advances with the same elements. Initially, the ICT Materials & Components Research Laboratory focused its research endeavors on memory semiconductors and semiconductor process equipment, and once that research was on track, the laboratory was able to expand its research scope to system-on-chip (SoC), displays, and optical components to meet the demands of society and industries. In particular, through the successful commercialization of 32K ROM in 1983 and domestic development of 4M DRAM in 1989, ETRI made great contributions to the development of memory semiconductors using domestic technology. In the 2000s, ETRI continued to play a pivotal role in helping Korea secure the technology basis for information and communication through the development of components for broadband wired and wireless communication, as well as communication and broadcasting convergent components.”

Q When was the turning point of the ICTMaterials&ComponentsResearchLaboratory?

A “From the 2000s until recently, the ICT Materials & Components Research Laboratory focused on expanding its research scope to encompass diverse fields. Going forward, the laboratory will set a clear research direction through selection and concentration. More specifically, it will focus on developing basic technologies related to materials and components, reality devices, photonic/wireless convergence technology, and intelligent SoC, to accomplish its mission to ‘develop ICT materials and components to realize the 4th Industrial Revolution.’”

Q What kind of future does the ICTMaterials&ComponentsResearchLaboratorydreamof?

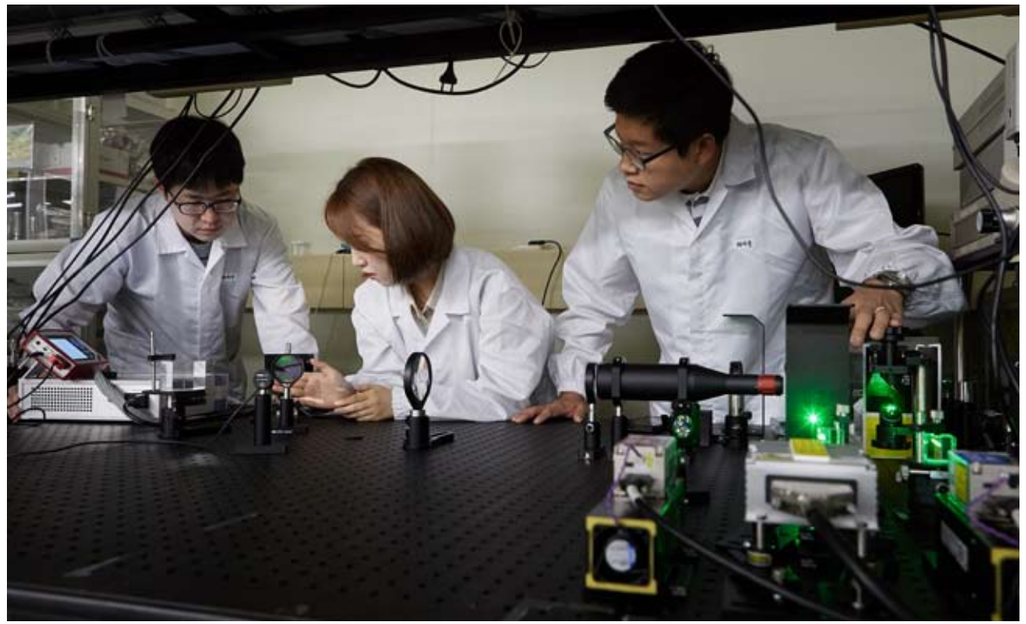
A “Our goal is to contribute to the 4th Industrial Revolution through the development of ICT materials and components. Materials are put together to comprise a component, and components are put together to comprise a system. Among the four laboratories at ETRI, the ICT Materials & Components Research Laboratory is the only organization that studies materials and components rather than systems. Through its research on ‘meta-materials,’ the ICT Materials & Components Research Laboratory will support the other three laboratories pursuing ‘hyper connectivity’, ‘hyper intelligence,’ and ‘hyper reality,’ while laying a firm foundation for Korea to actively address the challenges of the 4th Industrial Revolution.”

ICT Materials & Components Research Laboratory

Materials and Components Basic Research Division

The Materials and Components Basic Research Division is conducting diverse research to develop core material/device basic technology related to diverse IDX fields (IT, energy, manufacturing, medicine, etc.) that will lead the 4th Industrial Revolution.
Major research achievements of the Materials and Components Basic Research Division include metal 3D printing material/equipment technology capable of low temperature processing (2017), flexible or color-adjustable solar cell technology (2016), the world's first digital x-ray tube technology for both medical and industrial purposes (2016)[1], metal insulator transition[2] device technology (2015), silicon photonic device technology (2015)[3], high sensitive infrared sensor technology (2016), and ultra-compact gas sensor technology (2016).
Currently, the division is developing flexible 2D semiconductor material/device technology to replace the existing silicon-based 3D semiconductors by using graphene, known as an ideal nano material, and 2D materials, while working on 3D printing material/process technology that can be used to make artificial prosthetic arms and RFID (electronic tags), 3D packaging technology that can dramatically reduce the size of modules and systems, and thermal dissipating material/device technology that enables pollution-free energy conversion. In addition, the division is developing a super high-density nano electron emitter that generates electrons by using nanometer-size materials with a pointed tip as an alternative to existing thermal electron emitters requiring heating at a high temperature to emit electrons and thus consuming large amounts of power, while also carrying out research to apply the technology to medical diagnostic instruments. Furthermore, the division is making vigorous efforts to develop silicon photonic chips that will allow photonic transmission of data between chips within a computer, rather than transmission using electric signals, as well as neuron devices by utilizing the metal insulator transition (MIT) phenomenon.

1) Digial x-ray tube technology : Production of digital X-ray tubes based on nano field emitters with carbon nanotubes as field-emitting materials
2) Metal insulator transition device technology: Conversion of insulators into conductive metallic bodies by application of a stimulus
3) Silicon photonic device technology : Technology that enables ultra-high speed data communication between chips or within a chip through photon path formation in semiconductor chips



ICT Materials & Components Research Laboratory

Reality Device Research Division

Reality Device Research Division is researching and developing next-generation displays and sensors that can reproduce human senses more realistically.
Following the development of Korea's first OLED in 1994, the division went on to develop flexible OLED display, OLED illumination and transparent OLED display technologies in the 2000s, which served as the foundation for Korea's display industry. Meanwhile, the electronic ink manufacturing technology (2005) that enabled clear reading of e-books was commercialized to open up a niche market. Smart light shutter technology (2014) offering adjustable window transparency and color paved the way for creating a new industry in which conventional industries are merged with ICT. In the field of sensors, a variety of sensors including image infrared sensors and acoustic sensors (MEMS microphones) are being developed by using microelectromechanical systems (MEMS[4]) technology. In addition, commercialization is underway for sound field security sensors using acoustic sensors, MEMS microphone for smartphones, and thin-film speaker technology for smart devices. Furthermore, attempts are being made to merge MEMS with other sensor technologies. One such attempt is a smart gas sensor that detects various kinds of environmental gases existing in the atmosphere. As for sensors, the Reality Device Research Division has been performing research on integrated sensor technology by studying not only sensing devices but also communication circuit technology for amplifying and processing signals, and

4) MEMS (microelectromechanical systems): Semiconductor process technology that produces ultra-small precision machines in ㎛ or ㎜ units

5) Skin electron device technology : Electronic device technology that functions similarly to human skin

battery technology to supply energy wirelessly without power connection.
The Reality Device Research Division is developing next-generation display technology that generates and senses sight, hearing, smell, touch, and taste. In terms of sight, the division is developing the next stage of flexible displays, known as stretchable displays, which can be stretched to bend against multiple axes rather than a single axis. Also developed by the division are a virtual/augmented reality image display (sight) for implementing ultimately realistic imagery, a MEMS microphone (hearing), sensory input/output panel (touch), and a nano material-based gas sensor (smell). Furthermore, the division is developing skin electron device technology[5] as a new domain by building on the division's existing prowess in display and sensor technology, while pioneering several new areas including transparent biometric sensors for biometric identification and brain interface devices.
The Reality Device Research Division will realize hyper-realistic services by developing technology that allows input and output of information that resembles reality as closely as possible for human to human, human to object, and object to object information exchange.

ICT Materials & Components Research Laboratory

Photonic/Wireless Convergence Research Division

The Photonic/Wireless Convergence Research Division is developing optical communication devices and various optical sensing technologies utilizing such devices to enable hyper-connected, hyper-intelligent, and low-delay network composition to support data centers and long-distance communication.
Major research achievements include the development of a RSOA device (2006) and a WDM-PON system[6] using the ROSA device for the first time in the world for giga-level subscriber network communication (2007), and the development of a real-time, 3D laser imaging system (2012) that can be applied to self-driving vehicles and robotics, and for security and defense purposes. WDM-PON, in particular, is a technology that allows communication at multiple different wavelengths without generating interference, presenting a new alternative at a time when the demands for optical communication are growing exponentially and the use of such communication is becoming increasingly commonplace. Another outstanding achievement is the development of a high-output amplifier for next-generation radars (2013) with greatly enhanced power density and efficiency using GaN semiconductors. The division also succeeded in real-time demonstration of OFDM-based, 100Gbps long distance communication for the first time in the world (2013). Meanwhile, commercialization efforts are underway for a 100Gbps optical transceiver and core components for data centers through technology transfer to a number of Korean companies from 2013 to 2016.
Currently, the Photonic/Wireless Convergence Research Division is focusing on the development of ultra high-speed, ultra-compact, low-power optical communication modules, while also developing high-density, optoelectronic integrated devices to accommodate the exponentially increasing demand for optical communication. In addition, the division is working to develop and commercialize LiDAR technology[7] for self-driving vehicles and drones, while also exploring basic technology to implement quantum computers, building on the division's capability in photonic integrated circuit technology secured from optical device development. Meanwhile, the division plans to expand its GaN-based RF device technology[8] not only to the military munitions market but also to the market for base station and handset amplifiers for 5G mobile communication[9].
The 4th Industrial Revolution is built on hyper connectivity, and the development of optical communication devices is essential to realize ultra high-speed,

6) WDM-PON system : Establishment of low-cost optical network in a PON (Passive Optical Network) structure by assigning multiple subscribers to a single wavelength based on the WDM (Wavelength Division Multiplexing) method
7) LiDAR technology : Laser-based distance-to-target measurement device that offers improved measurement precision, bearing resolution, and SN ratio compared to existing radars
8) GaN-based RF device technology : RF power amplification technology using GaN (gallium nitride) compound semiconductors for application to transmission modules in next-generation multi-function radars
9) Base station and handset amplifiers for 5G mobile communication : Development of power amplifiers for base stations, power amplifiers for terminals, and high-efficiency power conversion devices for base stations to facilitate 5G mobile communications

low-delay network composition. The Photonic/Wireless Convergence Research Division will step up its efforts to develop much needed, highly integrated optoelectronic devices to ensure optical components are applied to more diverse fields. Also, the division plans to utilize the technology secured from the development of optical communication devices in order to achieve optical sensing technology for various fields including healthcare, transportation, education, and welfare, and to further widen its scope of application.

ICT Materials & Components Research Laboratory

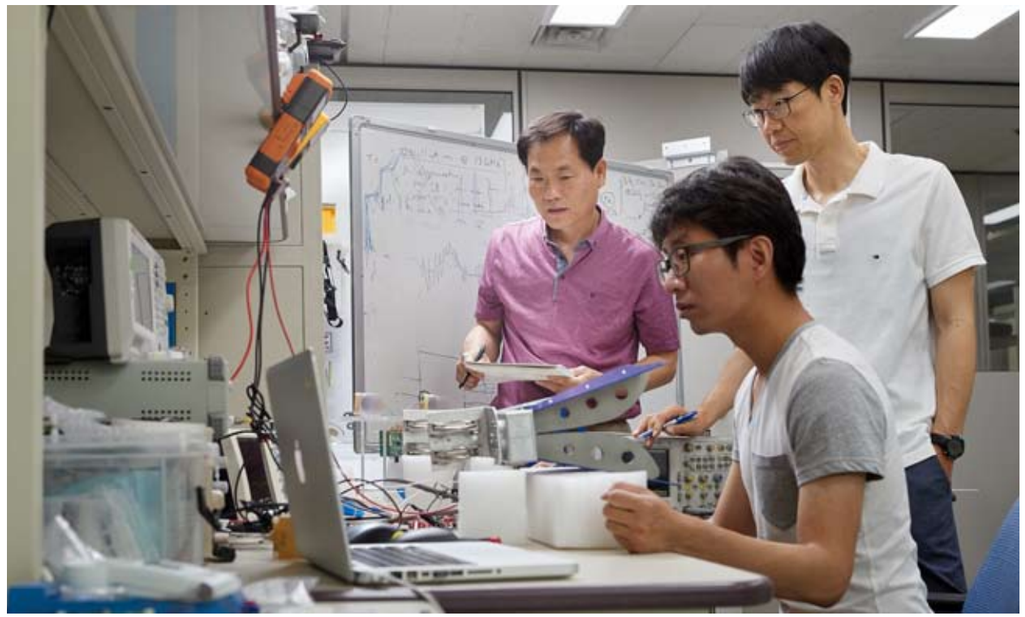
Intelligent SoC Research Division

To prepare for the 4th Industrial Revolution, the Intelligent SoC Research Division is researching and developing Intelligent System-on-Chip (SoC), for which the demand as a core element of the intelligence information industry of the future is growing dramatically.

In the early days of ETRI, the Intelligent SoC Research Division focused its research efforts on developing main components of a computer system, and successfully introduced the 8-bit microprocessor chip for the first time in Korea (1983). The division's most stellar and representative achievement is the semiconductor source technology (4M DRAM in 1989) for DRAM (joint development of 4/16/64M and prior research for 256M), which remains Korea's flagship product for export today. Developed by ETRI as a R&D leader and commercialized by three companies that participated in the development, the DRAM technology served as a springboard for Korea, a latecomer in the semiconductor industry, to soar as the world's leading semiconductor producer. Following this success, the division has continued to produce world-class research outcomes including a core chipset for mobile communication (2000), a terrestrial DMB chipset (2005), core components for multimedia processing (2010), a low-power, high-performance signal processor (2011), digitally converged CMOS-based RF circuits (2012), and new-concept human computer interaction (2016).

The time calls for cultivation of the AI-powered semiconductor industry as a new growth engine to overcome the crisis faced by the SoC industry, which forms a major axis of the domestic semiconductor industry together with memory semiconductors. Against this backdrop, the Intelligent SoC Research Division endeavors to develop intelligent semiconductors that can be applied to AI by building on the division's existing SoC research capabilities. As the first achievement of this effort, the division successfully developed high-performance, embedded "Aldebaran" processor technology (2016), and transferred it to industrial enterprises.

With the recent spread of AI services, countries around the world are fiercely competing against one another over the development of highly integrated semiconductor chips designed exclusively for AI. Keeping in step with the changing environment, the Intelligent SoC Research Division strives to meet the demands of the AI society by creating high added value through the development of intelligent semiconductors for various areas ranging from mobile communication, vehicles, and the IoT to smart appliances.



Broadcasting·Media Research Laboratory

Vision
Tera-Media Technology Frontier.

Where Cutting-edge Broadcasting Technology Becomes Reality Competing on the World Stage

Q What does the Broadcasting Media Research Laboratory do?

A "In the future, viewers will be able to adjust the screen to view characters at desired angles or at closer distances. The Broadcasting and Media Research Laboratory is conducting fundamental research on tera-media[1] technology to provide ultra-realistic services aimed at 'improving the quality of life.' It strives to facilitate the efficient use of frequency resources and to promote public safety."

Q Please share the history of ETRI's ICT Materials & Components research.

A "The Broadcasting and Media Research Laboratory seeks to establish a Tera-Media Technology Frontier based on research in broadcasting and media, radio and satellite, and unmanned vehicles. From encouraging researchers to embracing challenges, the Broadcasting and Media Research Laboratory has attained world-class results in T-DMB, high-definition 3DTV, open IPTV, a Cheollian satellite communication transponder, and CR technology.
The laboratory is focusing its efforts on ultra-realistic media, such as 3DTV, smart TV, UHDTV, and panorama displays; in satellites, such as broadcasting/communication satellite payload, satellite navigation, next-generation VSAT and ground segments, wireless RF and MMIC for satellites, and unmanned vehicles; and in radio technology, such as frequency sharing, radio wave engineering, and wireless charging. It is playing a key role in boosting the global presence of Korea in next-generation broadcasting, media, and satellite technology."

Q When was the turning point of the ICT Materials & Components Research Laboratory?

A "We have become the first in the world to establish a system for UHD broadcasting[2] services. The launch of UHD broadcasting in Korea is a historic event that will have an impact on the world. We also succeeded in the world's first field test of LDM technology, integrated with a new type of video compression technology, in cooperation with well-known companies such as Technicolor and ATEM. We are expanding collaborative pursuits with Canada's CRC, Japan's NHK, China's NERC-DTV, Germany's Fraunhofer, and Spain's UPV/EHU and iTeam. The laboratory plans to enter foreign markets by exporting its key technology to Europe's DVB and China's broadcasting firms. Moreover, it will form partnerships with broadcasting companies and medium-sized enterprises to participate in related international conferences. ETRI's world-renowned broadcasting and media technology will be a reassert Korea's status as a leading country in ICT."

Q What kind of future does the ICT Materials & Components Research Laboratory dream of?

A "As a pioneer of the broadcasting industry, the Broadcasting and Media Research Laboratory aims to establish standards for an open ecosystem and to acquire tera-media technology, providing viewers with ultra-realistic services that blur the boundary between virtuality and reality. Now that we are ahead of the world, it is more important than ever to exercise our creativity. Soon, viewers around the world will be able to experience a new realm of media made possible by Korean technology."

1) **Tera-media:** Refers to media of tera byte data, which provide more realistic experiences than UHD broadcasting (e.g. holographic image)
2) **UHD broadcasting:** Broadcasting technology with four times the pixels of HDTV; provides a realistic experience through large displays of 60 inches or larger.

Broadcasting Media Research Laboratory

Media Research Division

The Media Research Division is developing core technology, standard technology, and applications in next-generation broadcasting and media, so as to provide ultra-realistic services that blur the boundary between virtuality and reality while breaking free of space-time constraints.

The division's major achievements include the development of wireless broadcasting transmission technology and a terrestrial broadcasting transmission system for multi-channel broadcasting (2016), the development of video/audio encryption technology and a video/audio coding/decoding system for increased storage/transmission efficiency of various video signals and audio signals in omni-directional spaces (2016), HD to UHD conversion technology, and 3D sound technology for media services such as UHDTV, digital cinema and VR/AR (2016), open smart broadcasting platform technology and interactive media creation platform technology (2016), context-aware digilog signage platform technology (2016), and disaster information platform technology based on unmanned vehicle images and IoT sensor information (2016).

The division focuses on wireless transmission for UHD quality services that surpass 4K[3], wired transmission for multi-giga services with simultaneous transmission of up/down signals, network convergence transmission for various application services, and applications technology including public welfare broadcasting for the socially vulnerable and disaster alarms. In realistic AV, it is conducting research on video/audio compression, resolution measurement and improvement, dimensional sound reproduction, and data transmission based on audio signals. In tera-media, it covers the acquisition of information from multi-input images, generation of large-screen images, and reproduction for multi-projection, HMD, and mobile environments. In smart media, it is working on media service platforms such as a smart broadcasting platform based on image/text analysis and metadata generation, an interactive media creation platform based on Internet of Media (IoM), video search and recommendation technology, a context-aware space-integrated digilog signage platform based on object recognition/tracking and HMD, and a disaster information platform based on unmanned vehicle images and IoT sensor information.

The Media Research Division plans to develop smart media services and nurture the domestic smart media industry for Korea to realize its vision of becoming a leader in smart media. It will achieve standardization of distribution platforms and acquire tera-media platforms to provide viewers with ultra-realistic experiences in the form of video and audio services, blurring the boundary between virtuality and reality.

3) **4K:** Provides four times the pixels of a general full HD display (1980 x 1080).

Broadcasting Media Research Laboratory

Radio & Satellite Research Division

The Radio & Satellite Research Division is the only research institute in Korea dedicated to radio wave engineering and management, and satellite communications and broadcasting technology. It has developed new methods of wireless communication and technology for joint use of frequencies to maximize frequency resources, and provided spectrum engineering services to support related government policies. Its development of national satellite infrastructure covers a wide range of fields, such as payloads, ground segments, control stations, and navigation. These activities are aimed at enhancing Korea's global presence in satellite frequency and orbital resources. Recently, the division has expanded its research to devices and application systems for the use of terahertz waves.

The division's major research achievements include cognitive radio technology for TV white space (2011), development of multi-purpose satellite control systems (Arirang 1 and 2) for domestication of satellite technology (2000, 2004), development of communications payload for ocean monitoring satellite (Cheollian) (2009), development of a broadband radio wave directional detection system (2015), a cup holder type, high DoF wireless charging that was well received at CES 2017 (2016), and the development of a tuneable terahertz generating module expected to be of high value to smart factories (2016).

At present, the division is focusing on the development of radio wave interference analysis and radio wave efficiency enhancement, radio wave detection, the effects of electromagnetic waves on health, self-resonant short-distance wireless charging, applications of terahertz waves, anti-jamming for public satellite infrastructure, payload technology for next-generation broadcasting satellites, and navigation system augmentation.

Many electronic devices are becoming wireless, and location-based wireless services are expanding to outer space. The increased use of radio waves has led to a higher frequency demand, stricter safety requirements, and more effective wireless charging technology. This has also been accompanied by a greater demand for location accuracy and stiffer competition among private firms in the space industry. In response to the changing times, the Radio & Satellite Research Division is developing technology to support terahertz frequencies, enable safe and effective wireless transmission, improve navigation accuracy, and prevent jamming[4] attacks.

4) **Jamming:** The intentional disruption of signals to interfere with wireless communications, GPS navigation, and radar detection.

Autonomous Unmanned Vehicle Research Division

The Autonomous Unmanned Vehicle Research Division was established in 2017 to conduct ICT research on unmanned vehicles, an industry that has come under the spotlight with the advent of the fourth industrial revolution. Among the many areas of unmanned vehicles, the division is focusing on drones. Given the increasingly important role of ICT, the drone industry is expected to transition from an aviation-centered to an ICT-centered industry. The division is developing ICT to strengthen Korea's global competitiveness in unmanned vehicle technology, serving as a technological hub of the local ecosystem, and building a collaborative network in unmanned vehicle applications.

Currently, it is engaged in the development of high-reliability communications and security software for various unmanned vehicles, two projects on safe maneuvering and integrated pilot tests, the development of EO/IR radar for illegal flight detection, ICT development including three-dimensional precision measurement, environmental detection and risk avoidance, and self-execution of missions, and the development of a standard platform for wireless communications, safe maneuvering, and operation of unmanned vehicles during disasters.

The Autonomous Unmanned Vehicle Research Division plans to enhance the competitiveness of the domestic unmanned vehicle industry and to produce world-class results. In particular, it will focus on the development of drone-related radar technology for safe maneuvering and autonomous mission operations. The division will expand its research to manned drones and flying cars, and work towards the widespread utilization of unmanned vehicles in public, commercial, and military sectors.

Meteorological Satellite Ground Segment Development Center

The Meteorological Satellite Ground Segment Development Center has been developing a ground system that satisfies the performance requirements of the geostationary meteorological satellite (GK-2A, Cheollian 2A), due for launch in 2018 as a follow-up to the first geostationary multi-purpose satellite (Cheollian). The center seeks to maximize synergy by collaborating with domestic and international groups, and plans to adopt state-of-the-art technology in electronics, IT, and telecommunications to ensure the stability of satellite operations over its 10-year life cycle. For this purpose, it is developing supporting technology such as control systems, meteorological data processing/analysis technology, space meteorological data processing/analysis technology, and meteorological data management and service technology. Related technology is being continuously developed for the new ground segment following the upcoming launch of the polar-orbiting meteorological satellite.

The Meteorological Satellite Ground Segment Development Center successfully completed planning (2011) and preliminary research (2012 to 2013) for the geostationary meterological satellite ground segment. Currently, it is focusing on the establishment of infrastructure (server, network, basic facilities, etc.), software development, and the development of algorithms to derive meteorological data from observations. Korea will be the third in the world, following Japan and the United States, to feature a next-generation meteorological payload. Its ground segment is expected to exhibit similar or better performance compared to Japan and the United States.

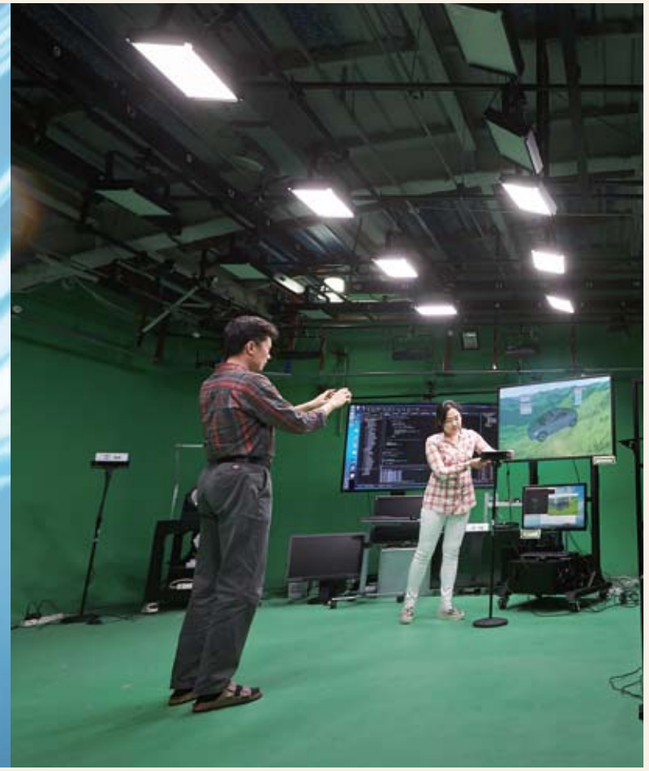
The Meteorological Satellite Ground Segment Development Center plans to develop a more reliable geostationary meteorological satellite ground segment for accurate meteorological predictions, and to exert all efforts for stable utilization of the ground segment under the National Meteorological Satellite Center by conducting experiments before and after satellite launch.

5G Giga Communication Research Laboratory

Opening up a truly ‘Mobile’ life
With the next generation mobile telecommunication technology

Vision
The global leader in 5G mobile communication industry.

Goal
1. To develop core technologies of next-generation mobile communications systems and mobile devices
   - aiming global No.1 on 5G standard patents competitiveness in 2020
2. To provide the world-first 5G commercial service in 2020



Q What does the 5G Giga Service Research Laboratory do?

A We are now witnessing an era of mobile life where we can do almost everything on mobile platforms. 5G Giga Service Research Laboratory (‘5G Lab’) is conducting research in wide-ranging areas to further advance mobile life where we can enjoy ultra-high-speed communication service anytime and anywhere. As of now, we are striving to develop 5th generation (5G) mobile communication technologies for the 2018 PyeongChang Winter Olympics with an aim to make it an ‘ICT’ Olympics.

Q Please share the history of ETRI’s 5G Giga Service Research.

A The 5G Lab was made by integrating several research divisions that had been conducting their studies individually, in order to more effectively carry out the ‘Giga Korea’ project that the Korean government has been actively promoting with the goal of realizing the era of ‘Hyper Connectivity’ in which people and all objects are connected to the telecommunications network. The Giga Korea project, which is now in its fifth year, is a national project initiated by the Korean government as it seeks to secure the top rank in the global ICT sector. It is a large-scale project that started in 2013 and is planned to be completed in 2020, with investment worth KRW 550.1 billion. In this project, ETRI is a leading institute in the technology development part. Although it has been only two years since the organizational overhaul was conducted and 5G Lab established, it dates back to nearly 40 years when ETRI first began to conduct relevant studies in this field. The ongoing 5G mobile communication technology research is based on our past achievements ranging from wireless transmission to mobile communication technology, developed through the 1st generation to the 4th generation mobile communication eras. In recent years, we have been striving to complete ‘Hyper Connectivity’ technologies with various research outcomes, focusing on service-oriented technologies such as mobile communication systems using high frequency, holography, and super multi-view display technology.

Q When was the turning point of the 5G Giga Service Research Laboratory?

A “The 2018 PyeongChang Winter Olympics, which is now less than a year away, is both a starting point and a finish line for the 5G Lab. In the meantime, we are accelerating our endeavors to develop a mobile hotspot[1)] network, high-speed close proximity communication, and 5G champion and super multi-view display technologies for a successful ‘ICT’ Olympics at PyeongChang in 2018.

Q What kind of future does the 5G Giga Service Research Laboratory dream of?

A Our vision is to achieve reputable global competitiveness in the ICT sector by developing world class 5G mobile communication technology. To that end, we are adding fresh fuel to the related research fields, with the goal of launching 5G commercial service by 2020 for the first time in the world. Furthermore, we are also focusing on securing source technologies for the next generation mobile communication and mobile devices so that we gain a first-mover advantage in key technologies for the ‘Beyond 5G (B5G).’ sector. To achieve this goal, we will continue to expand and develop our research arena with a special emphasis on moving network technology and ultra-dense network technology that covers high-volume traffic.

1) hotspot : A base station that transmits radio waves to enable wireless access to ultra-high speed Internet

Broadcasting Media Research Laboratory

Mobile Application Research Department

Following the 1st generation with analog voice calls, the 2nd generation with digital mobile phones, and the 3rd generation with wireless Internet and video calls, we are now living in the 4th generation (4G) mobile communication era where we can enjoy high-speed mobile services based on LTE-A. Despite the enormous advancements made thus far, users' expectations for higher quality in mobile services are constantly growing. The Mobile Application Research Department has been conducting research in mobile communication technologies to meet those ever-growing needs for over 30 years, and continues to lead the way now.

For example, we commercialized a CDMA mobile communication system for the first time in the world in 1996, contributing greatly to making Korea a digital powerhouse. After we opened up the 2nd generation mobile communications with CDMA, we soon realized 3rd generation mobile communication technologies through the development of W-CDMA, a broadband technology. We have led the history of Korea's mobile communication technology, with successful development of the Wibro mobile communication system enabling wireless Internet access in 2005, the LTE mobile communication system (3.9G mobile communication system) providing multimedia service in 2007, and LTE-Advanced technology (4G mobile communication system), for the first time in the world, where high-quality multimedia service and broadcasting service can be enjoyed on-the-go.

Not being complacent about our past achievements, we continue to conduct research in diverse fields to provide users with faster and more convenient services with higher quality. In particular, we have focused on research related to 5G mobile communication technology in recent years. For example, small cell base station SW is a technology to accommodate the skyrocketing mobile data traffic; although having a small output, it can be installed in a hotspot in homes or cities under a shaded area and provide high capacity and high speed transmission with an energy saving effect as a bonus. We are also developing technologies to prepare for the IoT environment where a large amount of information can be transmitted between our smart phone and things around us such as home appliances, road signs, ads, and exhibits of museums, in real time. Zing is wireless communication technology that transmits information at giga speed within close proximity (less than 10cm). This can be applied to various fields such as mobile devices, wearable devices, wireless storage devices such as USB memory devices, and various media advertisements such as posters and signs. In addition, we are also developing cellular-based NB (narrow band)-IoT technology featuring wide coverage, low cost, low power, long battery life and multiple device acceptance, as well as millimeter-wave based MHN (Mobile Hotspot Network) mobile wireless backhaul technology that provides giga-speed data transmission to objects moving at high speed in a group. In these research endeavors, we are collaborating with EUCAST in small cell, Corp in Zing, Nesslab in NB-Iot, and Cleverlogic and KMW in MHN mobile wiles backhaul technology.

Although there is fierce competition in the mobile communication sector with many domestic and international organizations actively participating in R&D and international standardization, it still is a promising research field at the same time. By concentrating on market-oriented mobile telecommunication technology development, we will continue to help enhance the competitiveness of Korea's SMEs in global market, thereby contributing to the further development of mobile communication industry. Going forward, we aim to be the leader in mobile telecommunication service technology both at home and abroad, by successfully developing the 6th and the 7th generation technologies in the future..

Broadcasting Media Research Laboratory

Mobile Transmission Research Department

The Mobile Transmission Research Department was established in 2016 by integrating existing research departments to focus on source technology development and systematic and continuous R&D capabilities for the 5G technology and beyond. With the aim of developing innovative source technologies for the next generation mobile communication, the Mobile Transmission Research Department is doing its utmost to proceed with this goal step by step, building on the past achievements of ETRI in mobile telecommunication system ranging from CDMA, WCDMA, and Wibro.

For example, we are focusing on the development of a millimeter-wave mobile communication system, which is emerging as the next generation mobile communication frequency for broadband mobile service, in order to develop ultra-high-speed data transmission mobile communication technology to cope with an explosive increase in traffic. With regards to this, we successfully developed and demonstrated the millimeter wave mobile communication system for the first time in the world in 2016, making it a stepping stone for early commercialization of 5G mobile communication by 2020. In addition, we are also accelerating the development of standard technologies, especially core source technologies (LAA, Massive MIMO, Massive IoT, etc.) for 5G mobile communication, and expect to generate royalty income from global companies in the 5G mobile communication sector.

In addition, in order to develop infrastructure technology to provide convergence service based on 5G mobile communication, we are conducting ‘Industrial IoT’ and ‘Ultra-low delay’ projects to develop mission-oriented low-latency and highly reliable source technology for mobile communication. Through these projects, we plan to develop the core technology for a service-based optimal network that meets various convergence service requirements, making it a stepping stone for the development of mobile communication convergence technology in other industries as well.

In addition, we have contributed to the creation of new markets by developing RF (radio frequency) component technologies for such as beamformers, power amplifiers, and plasma antennas and promoting technology transfer to SMEs. As of now, we are actively supporting SMEs, serving as another important mainstay of the mobile communication industry ecosystem, by carrying out various industry-oriented projects such as channel measurement and modeling for 5G mobile communication and development of components for radio waves and antenna technology.

To achieve an era of all industrial elements having their own intelligence being connected to other industries on a continuous basis, we seek to be the first mover in the global mobile communications network sector by providing transformational networking technologies/solutions and building an ecosystem in mobile communications where all enterprises, large and small alike, are effectively connected with one another. Ultimately, we plan to play a role as a leader who sets the direction in the international mobile communication industry.

Broadcasting Media Research Laboratory

Giga Service Research Department

The Giga Service Research Department was established in early 2016 based on the Realistic Emotion Platform Laboratory (Convergence Research Department), Next Generation Image Laboratory (SWContent Research Laboratory), and Digital Holography Laboratory (Broadcasting Media Research Laboratory). The purpose of this overhaul was to increase synergy in the Giga Korea project, which had been conducted by three different research departments. The Giga Service Research Department is developing the core technology for Tele-Experience service to achieve the goal of ‘Realization of the Era of Hyper Connectivity’. We are also developing giga media-based video conferencing technology and realistic experiential technology, with the key object of making the PyeongChang Winter Olympics a ‘5G ICT Olympic Games’. To this end, we are striving to develop core technologies by organically combining C, P, N, and D technology, representing Content, Platform, Network, and Device, respectively.

Our main project areas are the next-generation content technology required for acquisition, processing, and service of giga-level high-capacity super multi-view,/ holographic realistic content that can interact with many users, a realistic collaboration SW platform supporting convergence between heterogeneous services, a next-generation media creation and immersive application service based on realistic and emotional information, technologies for real-time generation, compression/transmission, and reproduction of digital holograms in stereoscopic space. We have also developed techniques to generate real-time super multi-view (108 points) and CG content and technology to see those images in 3D without wearing special glasses, distinctively advanced from the general 3D technology. We are also developing technologies for devices with which users can enjoy holograms, which they could watch only at theaters in the past, in their home. When those technologies are applied in the PyeongChang Winter Olympics, it will be possible to see the player interview video directly on a 5G bus in the venue or at the athletes’ village via a hologram or super high multi-view image right away.

The purpose of the Phase 2 project, which will be started next year, is to improve the performance of technologies in terms of image size and colors, with the goal of real-time tele-experience content. During Phase 2, we will also connect the technologies developed in Phase 1 to the 5G network and develop other necessary and appropriate technologies. We hope that our achievements in R&D are successfully applied and utilized in the 2018 PyeongChang Winter Olympics, and, going forward, adopted in various commercial media platforms and services.

UGS Convergence Research Department

Protecting our people from sink holes by making our country safer through convergence technology

Goal
Development of IoT-based underground grid system, providing early detection, prediction and responding of underground events

Q What does the UGS Convergence Research Departmentdo?

A “We are witnessing a lot of property damage and loss of life due to ground subsidence known as ‘sink holes’. To prevent these unfortunate accidents, the UnderGround Safety (UGS) Convergence Research Department was established. Ground subsidence occurs mainly due to the leakage of soil particles from the old sewerage facilities in metropolitan cities. Therefore, to prevent such accidents, year-round monitoring of the conditions of facilities, especially leakages, is very important. This requires integrated management of the facilities that were managed separately before. Against this backdrop, the UGS Convergence Research Department is developing an underground space safety management system based on the IoT that predicts and responds to abnormal symptoms of underground space by collecting and analyzing information, including groundwater distribution and changes in underground space.”

Q Please explain the research areas of the UGS Convergence Research Department.

A “We are conducting research for the development of an IoT-based disaster prediction and response system, real-time nationwide risk monitoring technology for underground facilities, urban underground structures and surrounding ground monitoring technology, and real-time prediction technology for urban groundwater and geological environment. In the first year (2015), a test sensor was developed and tested with underground water supply and sewage pipes at the Andong River Experiment Center of the Korea Institute of Civil Engineering and Building Technology. In the second year (2016), testbeds were installed around Wolpyeong Station in Daejeon and the testing was successfully completed. With regards to this, various other technologies have also been developed. First, a prevention system for water pipe leakage, known to be the cause of sinkholes, was developed in 2016. This system introduced sensors to the gate valve inside a manhole to monitor and detect leaks via IoT-based telecommunication, thereby preventing sinkholes in advance. A high resolution sewage pipe exploration robot was also developed in 2017, and it can identify the exact location of cracks with an error margin of 30 cm or less. Not only does the robot detect where a pipe is broken or compromised, but it automatically creates status reports of the pipelines. Thanks to this technological advancement, dangerous tasks that have otherwise been performed by humans can now be conducted by robots. We also developed a sensor to detect cracks in railway structures such as rail tracks and tunnels in 2016. This has also helped to improve the accuracy and safety of the inspection results by automating the process of visual inspection conducted manually thus far. In 2017, we developed another type of sensor that comprehensively monitors changes in groundwater level as well as its temperature and turbidity to detect groundwater drawdown, which is the cause of ground subsidence. In the meantime, we have completed a three-dimensional underground map for implementation of the Special Law on Underground Safety Management in 2016 and established a dedicated system to transmit underground safety information without incurring communication costs on the basis of IoT in 2017.”

Q What is the department’s current research status and what are its areas of concentration?

A “The UGS Convergence Research Department was launched in December 2014 as a 3-year project and is now in its third year. Our ultimate goal is to develop an underground space safety management system based on the IoT that preemptively monitors, forecasts, and responds to abnormalities in the underground space by analyzing the underground geological environment, groundwater distribution and changes, and combined monitoring data on urban railways. Currently, we are developing commercial products based on test sensors that have been successfully tested for the second time. As soon as the core technology development is completed, within this year, the pilot service will be conducted at Wangsimni Station in Seoul. After it passes the final verification process, the commercial product development project will be completed.”

Q What kind of future does the UGS Convergence ResearchDepartment dream of?

A “The UGS Convergence Research Department was launched in December 2014 as a 3-year project and is now in its third year. Our ultimate goal is to develop an underground space safety management system based on the IoT that preemptively monitors, forecasts, and responds to abnormalities in the underground space by analyzing the underground geological environment, groundwater distribution and changes, and combined monitoring data on urban railways. Currently, we are developing commercial products based on test sensors that have been successfully tested for the second time. As soon as the core technology development is completed, within this year, the pilot service will be conducted at Wangsimni Station in Seoul. After it passes the final verification process, the commercial product development project will be completed.”

KSB Convergence Research Department

Super Brain to Solve Social Issues
Making a Human-Centric,
Hyper-Connected Intelligent
Information Society a Reality

Vision
To make our nation a Leading Country for Human-centric Hyper-connected Intelligence Informationization

Goal
Development of Self-machine learning type Knowledge-Convergence Supe-Brain Intelligence technology

Q What does the KSBConvergenceResearchDepartment do?

A "The KSB (Knowledge-converged Super Brain) Convergence Research Department (KSBCRD) was established to cope with the 4th Industrial Revolution, which is shaking not only the economy and industries but also our lives, and to prepare for the upcoming era of the Internet of Everything (IoE). Among the changes happening today, the public may feel most familiar with artificial intelligence (AI). The AI computer Go program AlphaGo that recently defeated Ke Jie (9-dan professional of China) following its win against Lee Sedol (9-dan professional of Korea) in 2016, is becoming so smart that it is now safe to say that AI is ahead of human beings at least in the game of Go. The power of AI comes from its ability to learn by itself, or self-learning ability, and KSBCRD aims to develop its own AI with self-learning capability. More specifically, the department aspires to play a leading role in realizing a hyper-connected intelligent information society by developing a 'self-learning, knowledge-converged super brain platform.'"

● Please explain the research areas of the KSB Convergence Research Department.

A "Our research is characterized by three core values. The first value is the development of high-quality connective technology. The hyper-connected society in which people, things, data, and processes are all connected through the Internet will require real-time, mobile, and reliable connectivity among various objects. Therefore, KSBCRD is building an environment of high-quality connectivity among different objects by developing machine learning-based, intelligent network technology. The second value is the development of information intelligence technology, aiming to create a hyper-connected, self-machine learning engine platform that is able to self-learn data collected on a real-time basis and to provide intelligence suitable for individual services. For now, the plan is to develop this technology into a cross-domain, knowledge-converged platform that will consolidate knowledge from different domains by having intelligence capable of learning various knowledge and by strengthening expert knowledge of each domain. The third value is the establishment of diverse intelligence services and demonstration of their effectiveness. KSBCRD's self-machine learning, knowledge-converged super brain platform will be used for developing service technology for each domain. For now, the priority is on establishing services in the fields of energy, industrial plants, and health. KSBCRD is developing a technology to learn a building's internal and external environments through real-time detection and to perform energy management suitable for each building section, while learning data to detect leakage in plumbing fixture of a plant, such as a power plant, to make sure even blind spots and dead zones are monitored on a real-time basis to prevent disasters. At the same time, KSBCRD is developing another technology to predict geriatric diseases such as stroke by learning health diagnostic data and bio-signal data." The development will be carried out in two phases with each consisting of three years. For Phase 1, KSBCRD plans to establish element technologies and test beds for individual fields in Year 1 (2016), carry out research on hyper-connected, self-machine learning engine framework, high-quality connected network, and data preprocessing and machine-learning for each domain in Year 2 (2017), and develop a self-machine learning engine in 2018, which will be used to design and implement intelligence services for each domain. Then, during Phase 2 (from 2019 to 2021), a hyper-connected, cross-domain, knowledge-converged platform and domain expert intelligent service technology will be developed.

Q What is the department's current research status and what are its areas of concentration?

A "KSBCRD came into being in December 2015 after applying for the research program in September the same year, and is carrying out research on a six-year schedule. As mentioned above, our goal is to develop a self-machine learning, knowledge-converged, super brain platform. To that end, we are currently investigating how to apply the platform to the energy domain for optimizing a building' energy use, to the plant domain for preventing leakage accidents at plants, and to the geriatric medicine domain for enabling early prediction of stroke among the elderly. Today, we have established test beds in the three domains to collect data, which are used to develop learning models and prototypes for the hyper-connected, self-machine learning engine platform."

Q What kind of future does the KSB Convergence Research Department dream of?

A "The areas to which the super brain can be applied are limitless. First and foremost, companies that have accumulated data can use the super brain to develop intelligent information services. For this, we are collecting feedback from companies and various other entities with demands for the super brain, and reflect their needs in our research. In addition, while we are mainly investigating models for the three domains of energy, plant, and early disease prediction at the moment, we are planning to expand the research scope to domains related to social issues of today such as traffic and food safety to offer intelligent services based on expert knowledge in each domain. We at KSBCRD hope that the 'self-machine learning, knowledge-converged super brain platform' will play the role of an ecosystem for the intelligent information society and, in doing so, contribute to enhancing the nation's growth, the public's lives, and economic and industrial development as well as the advancement of science and technology."

Daegu-Gyeongbuk Research Center

Converging Regional Industry and ICT Developing Daegu-Gyeongbuk Region and its Industries

Vision
Mecca of Daegu-Gyeongbuk R&D in ICT Convergence technology

Goal
- Maximizing R&D Capability to Motivate Growth in Regional Core Industry
- Development of ICT Convergence Technology for the Regional Core Industry (Automobile, Healthcare, Agriculture)

Q What does the Daegu-Gyeongbuk Research Center do?

A "Our mission is to help develop the industries in the region by commercializing source and supporting field-oriented technologies. We are developing core technologies that converge regional strategic areas such as automobiles, healthcare, and agriculture with ICT and pushing ahead with the development of practical ICT convergence technologies that reflect the demands of the local businesses. We are fully committed to developing the regional industries by carrying out R&D on the integrated environmentally-intelligent greenhouse platform technology, intelligent automobile smart sensors and vehicle safety system technology, and healthcare ICT convergence technology."

Q Please share the history of the Daegu-Gyeongbuk Research Center.

A "Daegu-Gyeongbuk Research Center was established in 2006 to strengthen regional R&D capacity in ICT and core industries and boost technical competitiveness, following the plan for a "Regional Information Technology Cluster" by the previous Ministry of Information and Communication. The center had initially focused on IT convergence technology only in the automobile sector, but soon expanded to agriculture and healthcare, and continuously provided technology support to foster strategic industries in the region.
We have an excellent track record of performance, large and small, during the past 11 years. Two of our greatest achievements are the foundation of two INNOPOLIS Research Institute Spin-off Companies. E-intelligence, founded in 2014, is an automobile parts manufacturing company, which commercialized technology that recognizes not only surrounding people and things but also vehicle lanes. Conferst was founded in 2015 based on the technology to recognize abnormal behaviors of traffic objects, like other cars, through a video screen while driving. It is planning to take its business abroad with the launch of its multi-lane vehicle volume information recognition system in 2016. Conferst also collaborated with Datavision, a security system manufacturing company, developing a security zone access control system based on their technology to recognize people's access through a CCTV using multi-sensors. The company also initiated agriculture and IT convergence businesses to foster regional industries. Together with Yeongcheon Agricultural Technology & Extension Center, Gyeongsangbuk-do Agricultural Research & Extension Services, Gyeongbuk Institute of IT Convergence Industry Technology, and Invako, the center has collected and processed meteorological data, applied a machine-learning algorithm, and developed a frost forecasting technology in 2016 to provide a pilot service for frost forecasts. It is also leveraging ICT to initiate diverse projects that will enhance technological competitiveness and create added value for the major industries in the region."

Q When was the turning point of the Daegu-Gyeongbuk Research Center?

A "Daegu-Gyeongbuk Research Center, which celebrated its 10th anniversary last year, is fully committed to supporting regional industries wishing to do business abroad. An example of its best practices is the installation of an integrated smart-farm operating system (Integrated Greenhouse Controller Pilot System) in the greenhouse of Bachumba, Mongolia, in November 2016. This technology, still being piloted today, is a customized greenhouse operating system for Mongolia's geographical location and poor climate; it allows farmers to grow fruit and vegetables even in the winter when the temperature drops to -40°C We will build a successful model of INNOPOLIS Research Institute Spin-off Companies by continuing to support companies like E-intelligence and Conferst in growing their businesses abroad."

Q What kind of future does the Daegu-Gyeongbuk Research Center dream of?

A "If landing was our vision during these past years, our next vision will be a great leap forward towards growth; with a stable research environment and past performance in R&D and business support in place, the center will further strengthen its role as a hub that helps maximize R&D capability for major future industry and motivate growth in regional core industry. We hope to become a "Mecca of Daegu-Gyeongbuk R&D in ICT Convergence Technology."

Honam Research Center

"Close Partnership with Businesses based on Advanced Technology"
Research on Optical Communications and Applications Technology Provides a Promising Future for the Regional Industries

Vision
Technical hub for the promotion of the leading and strategic industries of the Honam region through R&BD of IT convergence technology

Goal
1. R&BD and proliferation of promising leading products for regional strategic industries
2. Photonics-based process innovation platform establishments and supports for industrialization
3. Securing Optical convergence video management solution and optical engine technology
4. Securing Optical Access Nework Terminal Solution and Optical Application Component Integrated Technology

Q What does the Honam Research Center do?

A "Honam Research Center was established with a mission to develop its core technology and the region's strategic industry, optical communications, and support commercialization. During the past 16 years, we have been focusing on developing Optical Communications Component Technology and Optical Access Network[1] System and Service Technology and expanding the R&D sectors that would meet the demands of the region. We have particularly focused on developing Packaging Technology[2], which accounts for 70 percent of the cost of new optical communications components. While focusing on development, we have also secured the infrastructure and research capability to broaden our coverage to include the entire process from designing optical communications components to manufacturing and evaluating their specifications and reliability. Commercialization being the primary goal, we are now not only focusing on R&D but also devoting a large proportion of our work to supporting businesses in the region. Based on the existing technology and experiences, we will lay a technical foundation to expand our scope into diverse applications, including not only the optical communications, but also new areas, such as energy and automobiles.

Q Please share the history of the Honam Research Center.

A "Honam Research Center, previously the Optical Communications Component Research Center, was the first regional center established by ETRI in 2001. It was given its current name in 2005. The center initiated the FTTH service development test project to provide affordable high-speed-high-quality internet service by connecting optic fibers in lieu of telephone lines to each household. Dubbed the "In-house Optical Cable", FTTH is a high-speed internet subscriber network connected to each household through optic fibers (optic cables). As a result of this project, 20,000 households were connected to the FTTH network in Gwangju by 2009 and IPTV[3] testbeds were installed to provide a pilot service for interactive television. In 2006, we received approval from the American Association for Laboratory Accreditation (A2LA) to become Korea's first internationally-accredited lab to test and certify the entire areas of optical communications. This allowed optical communications companies to shorten their development cycle, cut testing costs, and facilitate entry into businesses abroad. By 2016, we handled a total of 3,123 (430 businesses) requests for testing and device support. In 2016 alone, we were able to cut testing costs by 1.16 billion KRW (21 businesses, 338 cases), shorten the development cycle by three months (business average), and create an increased sales effect of 24.9 billion KRW. In 2015, the 3D Convergence Commercialization Support Center initiated a project to rent 3D imaging equipment to businesses and in 2016, the Optical Packaging Technology Support Center was launched to build high-performance processing equipment and improve the effectiveness of optical communications component manufacturing and processing. Also, in 2016, we developed the Constrained Application Protocol (CoAP)[4] technology, an IoT international standard, applied it to KEPCO's energy IoT area, and completed technology transfer to various business entities wishing to enter the IoT market.

Q When was the turning point of the Honam Research Center?

A "Honam Research Center has expanded its R&D in optical communications component sectors to cater to the regional demand. Like other research centers around the world, it is at a turning point, facing the Fourth Industrial Revolution, which is changing not only science and technology but all of society. It is currently developing the FOG Computing Terminal Technology based on the Optical Subscriber Network System Technology, which has been the subject of research since the inception of our center. It is a technology that processes data close to where it was generated, instead of at a distant server. We plan to leverage this technology to foster the vehicle component industry: the technology will be applied to environment-friendly cars and used to develop vehicle network system. FTTH Service Technology has currently evolved to become Energy System Autonomous Control Technology. Jointly with Korea Electrical Power Corporation (KEPCO), our center is currently building the Energy IoT Service by developing the IoT Protocol, which will manage the electrical power facility through the IoT. There are also attempts to graft the optical communications packaging technology to the optical biosector. It will help develop a diagnostic imaging system by applying optical light to the healthcare sector. The development of drones and LED operation lamps are also underway to support regional ICT convergence technology. Various other technologies are being developed according to business demand in the region.

Q What kind of future does the Honam Research Center dream of?

A "To date, Honam Research Center has been contributing towards advancing the optical communications technology in the region. It is our vision to leverage these synergy effects to advance Korea's optical industry. In the R&D sector, we will explore new businesses linked to regional strategic industries, while carrying out joint research with small- and mid-sized enterprises based on their demand. We will have various support systems to resolve the technical difficulties faced by industries and provide 3D imaging equipment. Our near-term goal includes a careful selection of 10 locally specialized technologies that are based on potentially leading items by 2020. In the long-term, we hope to foster strategic industries in the region through R&D and industrialization of ICT convergence technology.

1) **Optical access network:** installing an optical cable network to expand originally only to central telephone offices to ordinary households.
2) **Packaging technology:** a single package offering optical communications components that determine the performance of its optical communications.
3) **IPTV:** interactive television service that uses the high-speed network.
4) **CoAP Protocol:** a standard protocol created to link various sensors to the internet; it is a web-friendly protocol that takes into consideration the memory, power, and performance of different sensors.

Seoul SW-SoC Convergence R&BD Center

Incubating fabless businesses by valuing human, technology, and the spirit of sharing

Vision
Core Hub for Software and System Semiconductor Industry Promotion

Goal
To Build SW-SoC R&BD EcoSystem

Q What does the Seoul SW-SoC Convergence R&BD Center do?

A "System-on-Chip (SoC) is a semiconductor that interprets or calculates data, unlike a memory semiconductor that stores information. SoC is applied to numerous fields such as automobiles, bio-industry, smart phones, DTV, etc, occupying almost 80% of the global semiconductor market. The SW-SoC Convergence R&BD Center is a place where manpower with specialized knowledge in SoC fields with great industrial potential is cultivated. We also contribute to the improvement of domestic SMEs' competitiveness and localization of parts through technical support for fabless companies[1]."

Q Please share the history of the Seoul SW-SoC Convergence R&BD Center.

A "The origin of the Seoul SW-SoC Convergence R&BD Center dates back to 1997 when the ASIC Design Center was opened. Although there have been a number of name changes and reshuffling, the key roles of our Center, which is manpower cultivation in SoC fields and SME support, have remained unchanged. From 1997 to 2016, the Seoul SW-SoC Convergence R&BD Center incubated a total of 118 companies, eight of which successfully achieved IPO[2] registration. From 2009 to 2016, a total of 502 design professionals were cultivated at the Center. In particular, 443 out of 502 landed jobs (employment rate: +90%), with 423 employed in 132 SMEs and 20 in 13 large conglomerates, playing a key role at the forefront of various industries. We have also strived to cultivate field engineers as well. From 1998 to 2016, the Center has provided 18,687 workers training sessions on design and technological trends in system semi-conductors in Korea. From 2004 to 2015, we led the development of the domestic system semiconductor industry through the provision of training to 1,819 architects[3] specialized in semiconductor design (Masters and Doctors). With a SoC design tool support and an IP support system, which are difficult to implement by SMEs without resources, we are also supporting more than 100 SMEs annually. In most cases, fabless companies have difficulties in constructing costly design infrastructure and developing original technology due to the high price and lack of design experts. We are contributing to improving their corporate competitiveness by supporting the SoC design tool infrastructure for fabless companies. We are also developing a SW-SoC virtualization platform to help fabless companies quickly turn their ideas into products in the form of collaborative laboratories with the companies in need of such technology."

Q When was the turning point of the Seoul SW-SoC Convergence R&BD Center?

A "The opening of the Semi-conductor Innovation Center established in Pangyo Cluster (Pangyo Creative Economy Valley) in June 2012 has been a turning point for the Seoul SW-SoC Convergence R&BD Center. Building on the support of the Semi-conductor Innovation Center, we are actively expanding and strengthening our R&D prowess in SW, AI, and SoC fields in Pangyo Valley where many small but strong software businesses are clustered for synergy."

Q What kind of future does the Seoul SW-SoC Convergence R&BD Center dream of?

A "In 2015, Korea accounted for 17.4% (US $ 60.4 billion) of the global semiconductor market worth $347.3 billion, but our global market share of intelligent semiconductors stood at only 3.9% in 2014 and 4.3% in 2015. In China, there are about 600 fabless companies and the Chinese companies are dominating the semiconductor market through M&A. Compared to this, there are only 150 fabless companies (12 listed), and they are struggling due to the rising development costs and design infrastructure costs, with operating profit standing at around 7.5%. Against this backdrop, it is our mission to serve as an incubator for the domestic fabless companies. At present, the key tasks of the Center are developing a SW-SoC open platform, supporting SW-SoC development infrastructure, and nurturing intelligent semiconductor design specialists. Among other areas, we focus on becoming the R&D headquarters in the metropolitan area by attracting SW-related research fields such as artificial intelligence from ETRI (Daejeon) while maintaining our SW-SoC convergence R&D functions. In addition, we also seek to contribute to securing global competitiveness of our companies in the field of intelligent semiconductors by designing and operating a training course based on the actual demand in the industry and nurturing semiconductor design specialists who can be deployed in the field immediately."

1) **Fabless company:** A company that specializes only in semiconductor design and sales without a factory (fab) that produces semiconductors.
2) **IPO (Initial Public Offering):** The first listing of a public offering of a company (in which a non-listed company sells its shares to an unspecified number of investors according to legal procedures and methods, and discloses its financial information in order to be listed on a securities market or the KOSDAQ market)
3) **Architect:** A person who looks at the whole system from a technical point of view and is responsible for the entire design and implementation by leading the development team.

Technology Commercialization Division

Value Realization of Technology through Commercialization, Lowering the Door Sill and Nurturing Cooperation

Vision
Business partner for supporting SMEs growth

Goal
- To operate systems for promoting commercialization, secures IPR, and conducting license agreements.
- To support the growth of SMEs in ICT industries and enable them to create quality jobs and drive the national economic development.
- To support establishing and nurturing start-ups and research institute companies.

Q What does the Technology Commercialization Division do?

A "Technology Commercialization Division (TCD) is responsible for 'facilitating commercialization and technology transfer of R&D outcomes, and supporting and cultivating small- and medium-sized enterprises (SMEs).' Among these, TCD's most fundamental role is to help SMEs strengthen competitiveness through technology transfer. To serve the aforementioned roles, the division comprises the R&D Commercialization Department, Intellectual Property Department, and SMEs Cooperation Department. Technology commercialization starts with transforming research outcomes into knowledge property of value. To this end, TCD supports the process of turning ideas from the research field into rights, while performing activities designed to enhance the value of such rights. Realization of the value inherent in the developed technology is another crucial step towards commercialization. From early on, ETRI took the lead among government-funded research institutes in the efforts for technology commercialization by launching several activities to achieve value realization of technology, such as technology marketing, technology entrepreneurship, and patent licensing both at home and abroad. Its patent utilization and research productivity (the ratio of revenues from technology fees against research funds committed) stand at 56% (as of 2016) and 9% (as of 2015), respectively, which are well above the average levels of government-funded research institutes at 35% and 4.5%, respectively. It can be said that technology commercialization that begins with value realization through technology transfer is completed when the companies to which the technology was transferred achieve success in the market. This is precisely the reason why TCD is focusing on supporting and cultivating SMEs together with commercialization.
All of these endeavors in common require two things – cooperation and communication between the research department, commercialization department, and enterprises. TCD is carrying out not only technology marketing based on a network of cooperation in which the research department, SMEs, businesses of middle standing, and relevant organizations in commercialization are participating, but also various other activities to support businesses through research personnel, research infrastructure, and technology assistance tailored to the needs of each enterprise."

Q Please share the history of Technology Commercialization Division.

A "TCD was formerly the 'IT Technology Transfer Evaluation Center (ITEC),' which was established in 2004 to take sole charge of transfer and evaluation of R&D outcomes and of support for SMEs. ITEC laid the foundation for technology commercialization by government-funded research institutes by implementing a variety of programs ranging from evaluation and authentication of technology assets to technology transfer and commercialization. ETRI began to pursue technology commercialization in earnest from 2008. At the time, the government strengthened its policies to support SMEs as well as technology commercialization, which caused several organizational changes within ETRI, leading to the establishment of TCD directly under the ETRI director as a single, consolidated division to perform knowledge property management, technology marketing, and SME support functions. Thereafter, identification and utilization of outstanding patents, technology marketing, and follow-up support for technology transfer were carried out in a comprehensive manner over the entire cycle of R&D. With the establishment of the 'Converged Technology Research Production Center,' TCD began offering services closely attuned to the needs of businesses, and since 2013, the division has been operating a platform for technology commercialization in which various technology commercialization projects and SME support activities performed by different departments are managed in an integrated manner.

Q When was the turning point of the Technology Commercialization Division?

A "To sum up the changes TCD has gone through, one can say that it has "lowered the door sill and nurtured cooperation." With growing roles and expectations for government-funded research institutes in terms of technology commercialization, and support for SMEs, TCD has strived to transform itself ceaselessly by establishing preemptive and forward-looking strategy to foster 'a new ecosystem for technology commercialization' leading to 'diffusion of research outcomes to millions, thousands of millions, and trillions,' and 'cultivation of strong businesses to serve as an advance base.' More recently, TCD is making special efforts to enable SMEs to organically link and utilize the support they require for robust growth by creating a platform for growth/commercialization support programs. As the old saying 'pecking at the same time' goes, communication with businesses is essential for these efforts to bear fruit. "Lowering the door sill" means that TCD is placing the greatest value on communicating with research departments within the organization as well as businesses outside. Representative examples of TCD's efforts to facilitate communication include 'E-family business support' designed to provide technology support tailored to individual businesses, the 'E-community program' to ensure coexistence and cooperation with large corporations and companies of middle standing, and 'commercialization pre-validation contract,' which provides companies with an opportunity to verify the commercial feasibility of their products."

Q What kind of future does the Technology Commercialization Division dream of?

A "TCD has contributed to the growth of SMEs and companies of middle standing in Korea as well as to the country's economic development by performing a bridging role to link technology with the market. TCD will continue to work hard to enhance potential application of technologies and to help more companies grow through their use of technologies developed by ETRI. Taking one step further, TCD is poised to pursue technology commercialization with a goal to enter the global market. As part of this effort, TCD is actively helping Korean businesses to which ETRI transferred its technology advance into overseas markets, and outcomes of these efforts are gradually appearing one after another. One such example is TCD's support given to a company to which ETRI transferred its 'greenhouse control system technology' when it entered the Mongolian market. Although it is currently at the pilot project level, it is the best example of global technology commercialization being pursued by TCD. TCD's reason for existence is to diffuse ETRI's research outcomes across markets at home and abroad, thereby nurturing businesses, creating jobs, helping develop the economy, and ultimately enhancing Korea's technological competitiveness. Although specific functions of technology marketing, technology transfer, technology entrepreneurship, E-community, and support for SMEs differ, the future being created by TCD will be characterized by 'communication' and 'growth.' TCD will surely meet your expectations with even greater achievements in the future."

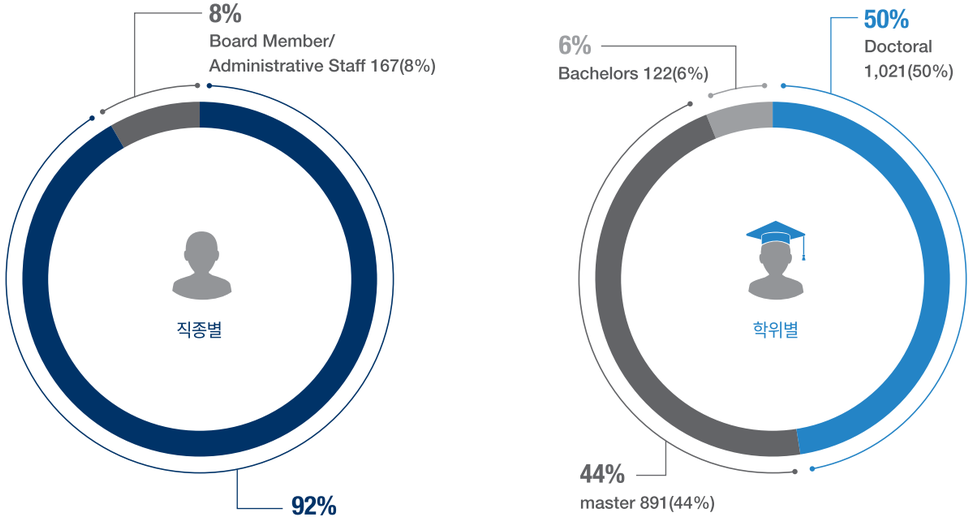
2017 @ETRI

ICT INNOVATOR LEADING THE
4th INDUSTRIAL REVOLUTION

General Status

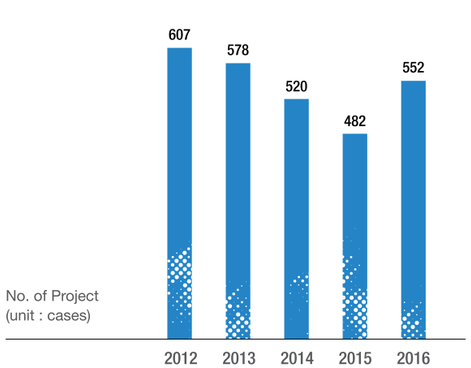
PERSONNEL STATUS

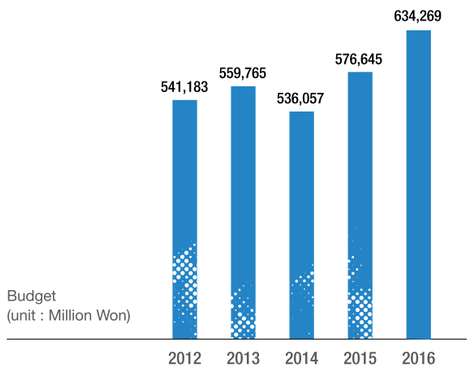
Total : 2,034(as of year 2017)



PROJECT STATUS

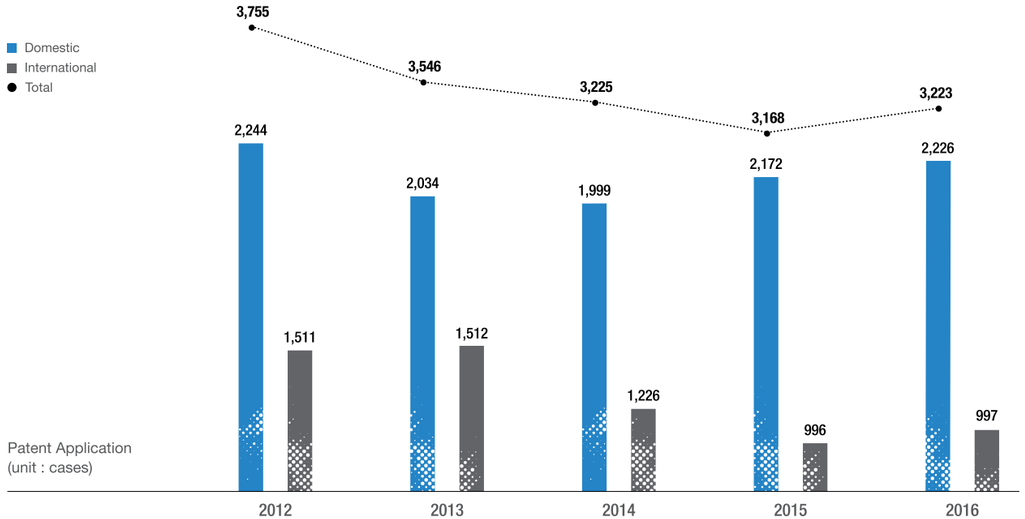
No. of Project / Budget : 2,739 project / 2.8479 trillion won(Total of past 5 years)





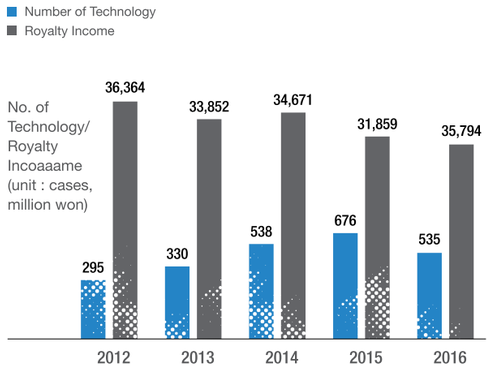
PATENT APPLICATION

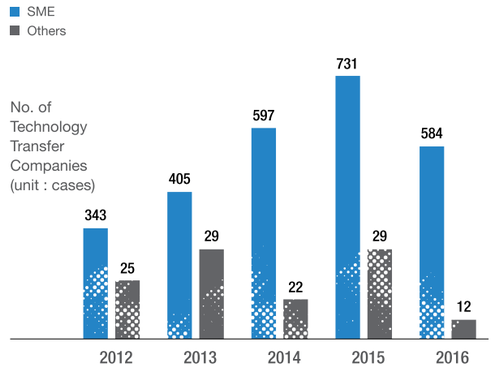
No. of Patent Application : 16,917 cases(Total of past 5 years)



TECHNOLOGY TRANSFER

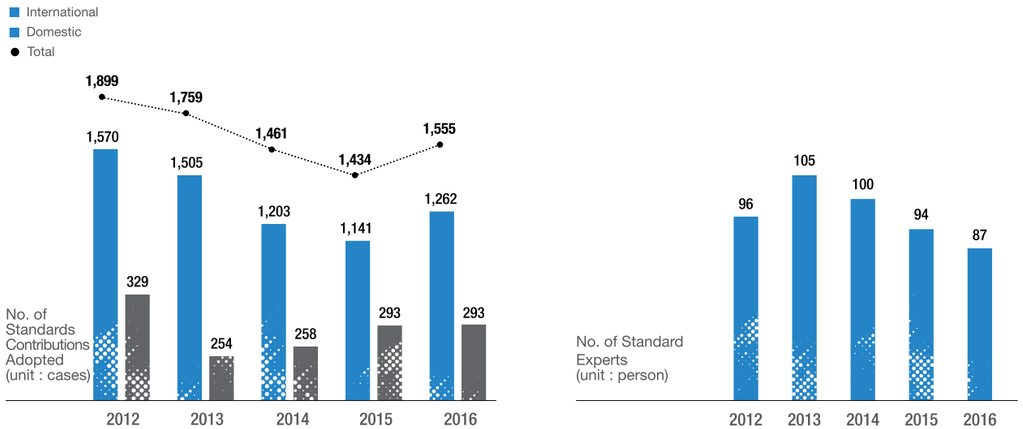
No. of Technology / Royalty Income : 2,374 cases / 172.5 billion won(Total of past 5 years)





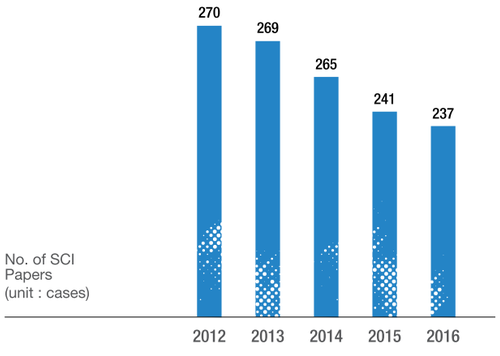
STANDARDIZATION

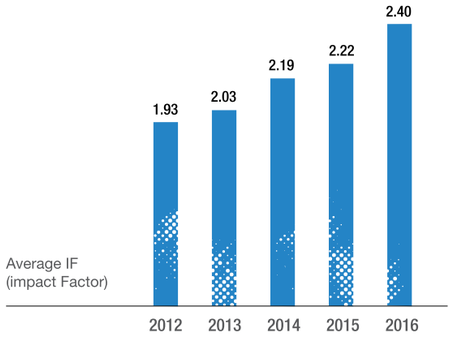
No. of Standards Contributions Adopted for total of past 5 years : 8,337 cases/498 Experts



SCI PAPERS

No. of SCI Papers/Average IF : 1,282 cases(Total of past 5 years)/2.15(Average)





STATUS AND PROGRESS OF COMPANIES ESTABLISHED BY ALUMNI

• ETRI Companies

590 Companies

After the establishment of Sambo (Trigem) Computer in 1980 approximately 590 companies have been established

8 Initial Public Offering

8 of ETRI Alumni Companies are listed on the KOSPI [1], KOSDAQ [6], KONEX [1] (As of 2016)

KOSPI : Comtec Systems(Co.)
KOSDAQ : AP Systems(Co.), Innowireless(Co.), SNS Tech(Co.), RF Semi(Co.), ELK(Co.), Secuve(Co.)
KONEX : Wiworld(Co.)

250 About Alumni Companies

As of 2016 / Among 104 Companies

2,144.4 Billion KRW Revenue

As of 2016 / Among 104 Companies

2,541.2 Billion KRW Total Assets

As of 2016 / Among 104 Companies

ETRI LABORATORY ENTERPRISE STATUS

40 Registered Companies

ETRI has set up 40 ETRI Laboratory Enterprises through successful commercialization of research outcomes since 2007.

34 Companies in Operation

34 ETRI Laboratory Enterprises in Operation (As of 2016)

BT Works(Co.), TEST MIDAS(Co.), 3D Nuri(Co.), Sogware(Co.), SmartQ Technologies(Co.), KCP(Co.), Sugentech(Co.), Aritel(Co.), Imfact(Co.), Hojeonable(Co.), Enlighting(Co.), Clouxen(Co.), New-run(Co.), Solid Link(Co.), MINDs(Co.), Syntekabio(Co.), WOOKSUNG MEDIA(Co.), Gamma Spectra(Co.), RNSLab(Co.), KFRT(Co.), eKdac(Co.), JSLIDA(Co.), Bird Letter(Co.), HarborMax(Co.), Optella(Co.), Conferst Inc, Icerti(Co.), icerti(Co.), Gene System(Co.), HANCOM INTERFREE(Co.), Devstack Inc, ch solution co.,ltd, WiseTHAN(Co.), Gridaenergy (Co.), SNET(Co.)

NATIONWIDE REGIONAL RESEARCH CENTER

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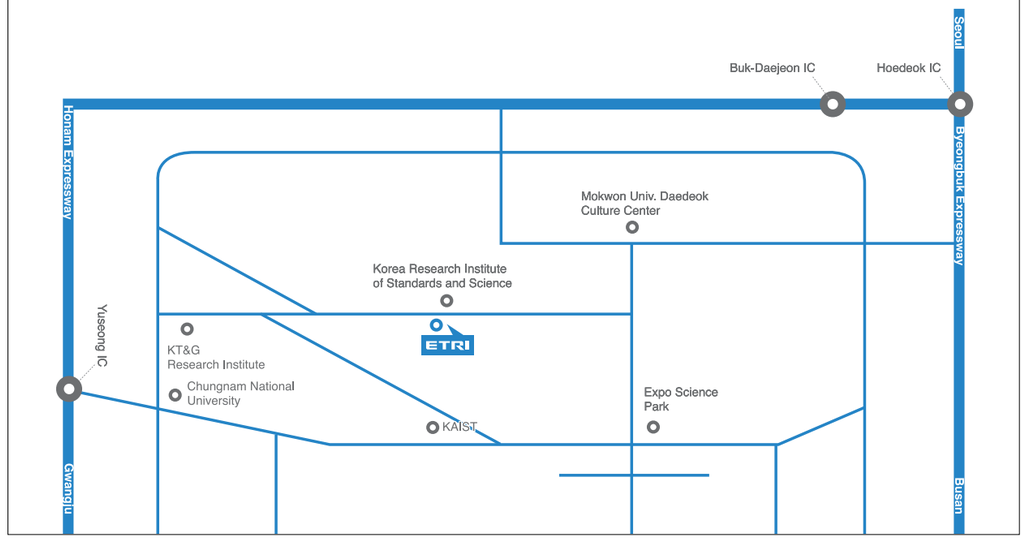

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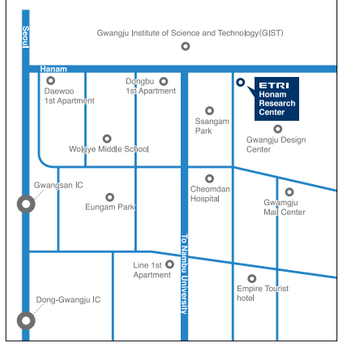

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33countries **102**organizations

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