Chapter 3 Research and Development for the Future Society

As discussed in the previous chapters, in the midst of rapid social change and increasing uncertainty about the future, it is necessary to proactively design the future society from a medium- to long-term perspective while expanding possibilities and options for it. This chapter introduces the government's legislative, planning, and R&D efforts for the future society.

Section 1 Government's Legislation and Planning Efforts for the Future Society

1 Amendment of the Basic Act on Science and Technology, Etc.

The Basic Act on Science and Technology, enacted in 1995, prescribes the basics of measures for the promotion of science and technology, but the definition of "science and technology" to be promoted does not include "science or technology whose sole concern is the humanities," nor does it refer to the concept of "creation of innovation." However, the rapid development of science and technology innovation, including globalization of society, digitization, AI, and the advancement of life sciences, has had a significant impact on the state of human beings and society, while the state of human beings and society is inseparable from advances in science, technology and innovation. In order to confront the various challenges of today's increasingly complex world, it is necessary to comprehensively promote science, technology and innovation creation based on a deep insight into the nature of human beings and society.

Under these circumstances, the government plans to add "science or technology whose sole concern is the humanities" to the scope of the Basic Act on Science and Technology, based on the discussions held by the Working Group on Institutional Issues under the Expert Panel on Basic Policy of the Council for Science, Technology and Innovation (CSTI) (the Working Group is chaired by an expert member of the CSTI, Takahiro Ueyama). At the same time, it has submitted to the 201st ordinary session of the Diet a bill to partially amend the Basic Act on Science and Technology, etc. to introduce the concept of "creation of innovation."

The bill looks to change the name of the Basic Act on Science and Technology to the Basic Act on Science, Technology and Innovation and position "improving the level of science and technology" and "promotion of the creation of innovation" as concepts of equal importance in the provision prescribing the purpose of the law. The bill defines "the creation of innovation" as "the creation and dissemination of new value through scientific discoveries or inventions, the development of new products or services, or other creative activities to create significant economic and social change." In addition, as policies for the promotion of science, technology and innovation, the bill includes matters such as considerations concerning the characteristics of different fields, interdisciplinary and comprehensive R&D, balanced promotion of academic and non-academic research, and response to social issues by combining knowledge and experience in all fields. Furthermore, the Science and Technology Basic Plan has been renamed to the Basic Plan for Science, Technology and Innovation, and measures for securing and fostering researchers and human resources to create new projects have been added.

The bill also includes specific measures to promote science, technology and the creation of innovation,

such as explicitly stipulating that an R&D corporation can conduct joint research, etc., with a business in which it has invested, reviewing the Small Business Innovation Research System (Japanese version of SBIR) to strengthen ministries and agencies' cooperation under the initiative of the Cabinet Office, and establishing a new secretariat for the promotion of science, technology and innovation in the Cabinet Office with a view to strengthening its function as the command post.

2 Promotion of Science and Technology Policies from a Long-term Perspective Based on the Science and Technology Basic Plan

Based on the Basic Act on Science and Technology, the government formulated the Science and Technology Basic Plan in order to promote science and technology in a comprehensive and systematic manner over a five-year period with a ten-year perspective, and has been implementing systematic and consistent science and technology policies from a long-term perspective.

In order to formulate the next plan starting from FY2021, the government is now discussing what science, technology and innovation policies under the next plan should look like from two perspectives: one is a forecast based on the review of what has been accomplished up to the Fifth Science and Technology Basic Plan, and the other is a backcast from a vision for the future, keeping in mind the social trends such as the progress of the digital revolution and the drastic changes in the geopolitical environment. In particular, specific measures to realize Society 5.0, a human-centered society advocated in the Fifth Science and Technology Basic Plan, are being discussed, such as creating an environment where young researchers can engage in high-risk, high-impact research initiated with their own ideas, and establishing a domestic ecosystem where science, technology, and innovation that will revolutionize the social system continues to emerge. In response to the Prime Minister's advice, the CSTI established the Expert Panel on Basic Policy to review the current plan and discuss the direction of the next plan, including the image of a desirable future and measures to realize the Society 5.0.

Section 2 Drawing Up a Vision for a Future Society, and Research and Development and Other Efforts to Achieve It

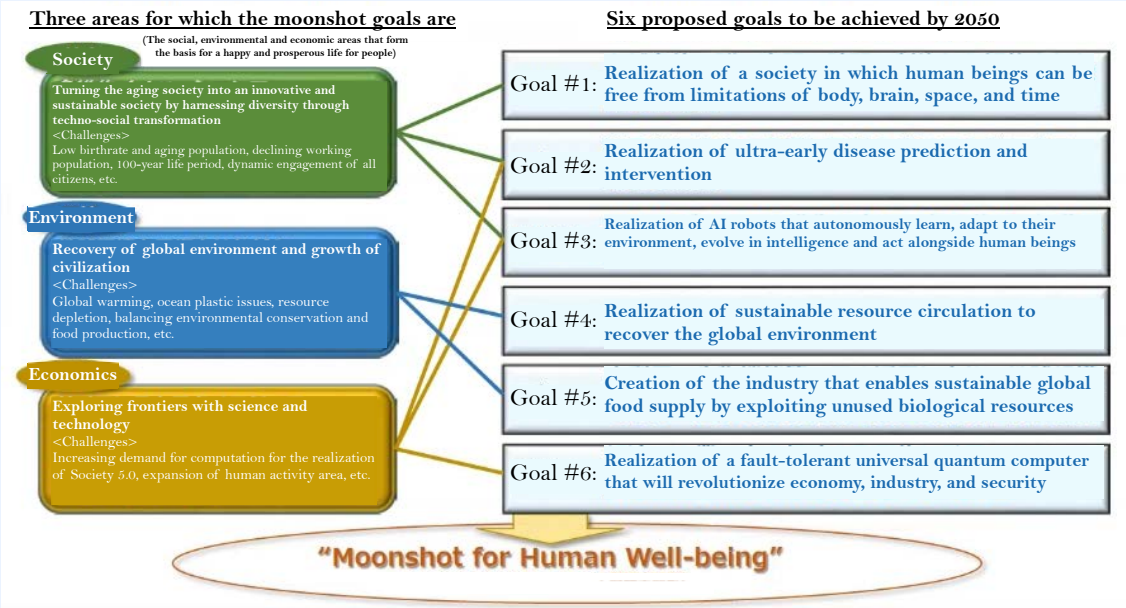
1 Moonshot Research and Development Program

The Moonshot Research and Development Program was established in FY2018 as a mechanism to promote high-risk, high-impact R&D based on bold ideas that are not an extension of conventional technologies, with the aim of creating disruptive innovations originating in Japan.

In March 2019, the Visionary Council on the Moonshot Research and Development Program was established under the Integrated Innovation Strategy Promotion Council to discuss the moonshot goals that the government aims to achieve through this program. In the council meeting, the vision of a desirable future and the specific examples of goals to be achieved were discussed. In addition, specific candidate goals were also discussed at the Moonshot International Symposium held in December 2019. Based on the results of these discussions, the CSTI decided on the following six goals to be achieved by 2050 at its meeting held in January 2020.

Moonshot Goal #1: Realization of a society in which human beings can be free from limitations of body, brain, space, and time
Moonshot Goal #2: Realization of ultra-early disease prediction and intervention
Moonshot Goal #3: Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence and act alongside human beings
Moonshot Goal #4: Realization of sustainable resource circulation to recover the global environment
Moonshot Goal #5: Creation of the industry that enables sustainable global food supply by exploiting unused biological resources
Moonshot Goal #6: Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security

■Figure 1-3-1/Goals for the Moonshot R&D Program



Source: Cabinet Office

From now on, the Japan Science and Technology Agency (JST), the New Energy and Industrial Technology Development Organization (NEDO), the Bio-oriented Technology Research Advancement Institution (BRAIN) of the National Agriculture and Food Research Organization (NARO), and the Japan Agency for Medical Research and Development (AMED) will provide funding for high-risk, high-impact R&D activities under the program.

2 Center of Innovation (COI) Program

The Center of Innovation (COI) program was launched in FY2013 by JST to support vision-driven, challenging, and high-risk R&D for up to 9 years, based on the vision of a desirable society in 10 years (Figure 1-3-2).

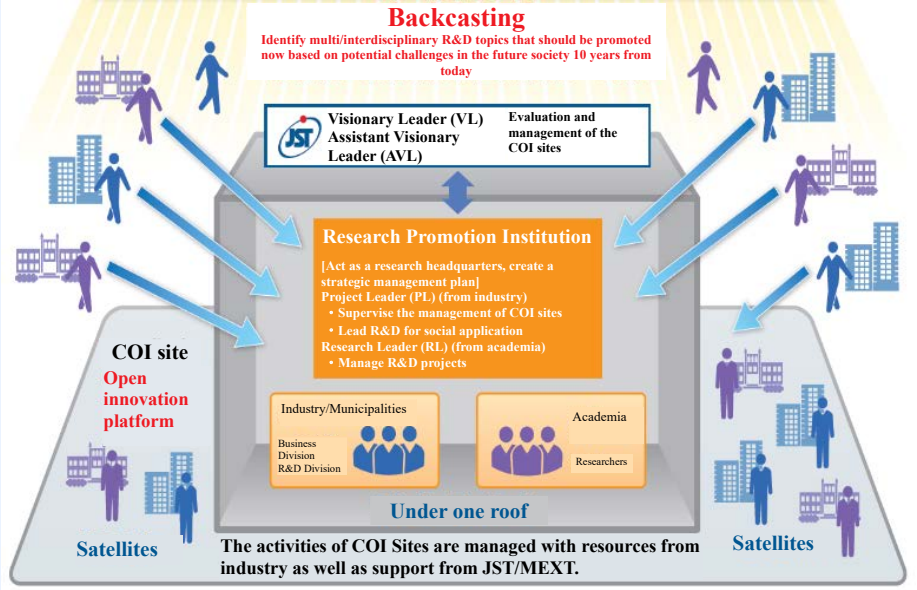
Under the COI program, R&D topics that should be tackled today are defined based on the vision of a

desirable society in 10 years (backcasting-type R&D), and then universities, companies, and other entities involved work together "under one roof" to engage in R&D from basic research to commercialization through industry-academia collaboration. Through this, the program aims to break down the barriers between existing fields and organizations and realize innovations through industry-academia collaboration that cannot be realized by industry or academia alone, while also seeking to establish an innovation platform in Japan for the continuous creation of innovations. The three visions set out in the COI program are as follows.

Vision 1: Secure sustainability as a country advanced in its aging population and declining birth rate
Vision 2: Create a living environment with a high quality of life as a prosperous and reputable country (Smart Japan)
Vision 3: Establish a sustainable society with vitality (Active Sustainability)

Efforts for achieving these goals are promoted at seven sites for Vision 1, four sites for Vision 2, and seven sites for Vision 3 (Figure 1-3-3).

■Figure 1-3-2/Structure of the COI Program



Source: JST

■Figure 1-3-3/Examples of COI Sites and their achievements regarding each Vision

Source: MEXT

3 Miraikan

As a science communication hub open to the world, the National Museum of Emerging Science and Innovation (Miraikan) has continuously promoted projects to explore the roles of science and technology, and collected wisdom across all fields to contribute to the global future of human society. Based on the 5th Science and Technology Basic Plan, which aims to realize a future society in which real and virtual spaces are highly integrated, the museum opened the permanent exhibition "Digitally Natural - Naturally Digital" in November 2019. The exhibition explored how our view of nature and the world will change in the future when computers and AI that runs on them are highly developed. Miraikan's Open Lab is an initiative that serves as an open testing ground for researchers and citizens to create cutting-edge science and technology together. Under Open Lab project "Gentle and Friendly AI 'reco!' —the relationship started from touching AI," an AI was installed in the exhibition area to analyze participants' personality traits and what they thought of an exhibition and make recommendations for other exhibitions. This is a demonstration experiment to improve the museum's recommendation function by using AI. With an eye to the future where AI is part of people's daily lives, the museum aims to develop an AI that can support people and provide them with new values, and to contribute to the creation of safe and secure communities through this.

Gentle and Friendly AI "reco!"
Source: Miraikan

Miraikan also promotes activities to connect non-specialist visitors with researchers to think together about the future vision of society brought about by science and technology. In FY2019, through the Opinion Bank (a permanent exhibition where people's opinions are expressed as responses to a questionnaire on issues surrounding science and technology) and the talk sessions, the visitors and researchers discussed the concept of the "hospital in the body" as a future medical technology, its social application, and changes in the future society together. An experimental classroom was also developed and held in which elementary and junior high school students were given an opportunity to explore the diversity of aquatic habitats in their surrounding environment using environmental DNA analysis methods. It also provided an opportunity for the participants to think about advanced science and technology as something closely related to them and how they can contribute to the future of society by applying technology.

4 2025 World Exposition in Osaka, Kansai, Japan

The theme of the 2025 World Exposition in Japan ("Osaka/Kansai Expo"), scheduled to be held from April to October 2025, is "Designing Future Society for Our Lives." The central and local governments and the business community are working together to make the Osaka/Kansai Expo a success as an Expo that bring people closer to the SDGs, as "People's Living Lab" (a laboratory for future society) where new ideas are created and tried out for social application, and as a catalyst for the revitalization of the local economy to show the world the appeal of Japan.

The METI held eight meetings of the Working Group for the Realization of the Expo Plan to deepen the discussion on themes, venue planning, and other matters and released a report in July 2019 based on public comments and interviews with 131 experts.

The report described the venue plan shown below as an example. It states the Expo site should be an ultra-smart venue that embodies Society 5.0, in which efforts for the demonstration and social application of new technologies, services, and systems are made. The report also points out that ideas from and engagement of the private sector should be actively sought from the planning stage.

- Use AI and other technologies to control the traffic of visitors to realize zero waiting time at the venue.
- Use 100% renewable energy and hydrogen, and achieve zero CO_2 emissions in the venue.

- Implement next generation mobility systems between the main stations and the venue, such as automatic driving and flying cars.

As of June 2020, the Japan Association for the 2025 World Exposition, the organization that prepares and operates the Osaka/Kansai Expo, is developing a basic plan including a venue plan.

Large plaza: Khu Exhibits and events using AR (augmented reality) and MR (mixed reality) technologies will be held to provide opportunities for visitors to interact with each other.
Source: METI

5 Smart City

Smart cities are efforts to solve urban and regional problems through the use of advanced technologies such as the IoT and big data, and are a leading initiative for the implementation of Society 5.0, which Japan aims to achieve.

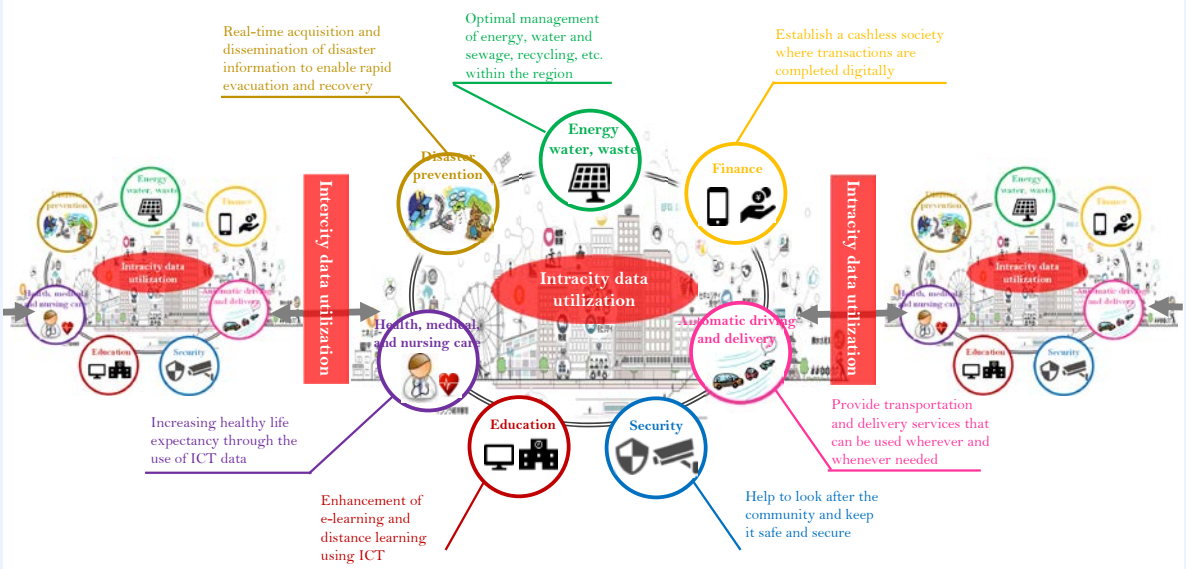
In Japan, relevant ministries and agencies are collaborating with local governments, companies, and universities to promote a total of more than 100 smart city projects. In addition, companies have come up with their own smart city concepts and are taking the lead in construction, in undertakings such as Panasonic Corporation's Sustainable Smart Town and Toyota Motor Corporation's Woven City.

For example, Aizuwakamatsu City has established a platform for aggregating and analyzing a variety of data held by local governments and other entities and developed a mechanism to provide local information and administrative guidance tailored to the needs of individual citizens through mobile phone applications and other means, which are being used by a large number of citizens. In Sapporo, with the aim of solving the problem of the third lowest healthy life expectancy among government ordinance cities, the city is implementing measures such as giving citizens "well-being points" based on the number of steps they took, which can be used on public transportation. The Otemachi/Marunouchi/Yurakucho area of Tokyo is developing a disaster dashboard to overcome its vulnerability to natural disasters and to collect real-time information and provide appropriate information in the event of a disaster.

The 591 organizations participating in these initiatives (as of the end of March 2020) have established the Smart City Public-Private Partnership Platform as a platform for project support and information exchange. Utilizing this platform, the public and private sectors are working together to vigorously

promote smart city projects throughout Japan.

■Figure 1-3-4/Overview of smart cities



Source: Cabinet Office

Section 3 Initiatives for Solving Problems through Science and Technology

The Tokyo 2020 Olympic and Paralympic Games ("Tokyo 2020 Games"), which have been postponed to 2021, will be an opportunity for Japan to demonstrate to the world its initiatives for realizing the vision of a desirable future society (Society 5.0) and the scientific and technological developments it has achieved. The government intends to take this opportunity to communicate Japan's strengths in science and technology to the world.

This section introduces scientific and technological initiatives that Japan has been promoting with an eye to the Tokyo 2020 Games, such as hydrogen technology to address environmental and energy issues; automated driving technology to address urban issues and the declining birthrate and aging population in rural areas; video, audio, and streaming technology with a sense of presence; and multilingual voice translation technology to eliminate the language barrier.

1 Environmental and Energy Technologies Toward the Creation of a Hydrogen Society

Hydrogen is considered a promising energy source that helps the world to achieve decarbonization because it does not emit any CO2 when consumed and can be used in various fields such as transportation, industry and electricity. Other applications of hydrogen include fuel cell vehicles and buses. It can also be used as a combustion gas or in industrial processes.

Japan has been positioning hydrogen energy as an important option for future decarbonization. Based on the Basic Hydrogen Strategy decided in a relevant ministers' meeting in 2017 and the Strategic Roadmap

for Hydrogen and Fuel Cells announced in 2019, Japan is developing technologies to expand the use of hydrogen, supporting the spread of hydrogen applications, and preparing the environment to realize a world-leading hydrogen society. In Japan, more than 300,000 ENE-FARM household fuel cells are already providing electricity and heat for households, and more than 3,600 fuel cell vehicles are in use, with more than 100 hydrogen stations already in operation.

In order for hydrogen to become even more widely used in the future, it is important to take an opportunity to communicate the potential of this clean energy source and make it familiar to many people from around the world. The Tokyo 2020 Games plans to use hydrogen as fuel for the Olympic cauldron and the Olympic torch. It is planned that hydrogen produced in Namie Town, Fukushima Prefecture, which has been striving to recover from the Great East Japan Earthquake and the accident at TEPCO's Fukushima Daiichi Nuclear Power Plant, will be used as a symbol of the "Recovery Olympics." A large-scale, renewable energy-derived hydrogen production demonstration facility equipped with the world's largest water electrolysis system (10 MW class) has been completed in Namie Town, Fukushima Prefecture, marking a step forward for the town's future energy.

Fuel cell bus
Source: Tokyo Metropolitan Bureau of Transportation

Fukushima Hydrogen Energy Research Field (FH2R)
Source: Toshiba Energy Systems & Solutions Corporation

Column 1-6

Fusion of Tradition and Modern Technology: Tokyo 2020 Olympic Torch

The Olympic torch to be used in the Tokyo 2020 Olympic Torch Relay was created by combining Japanese tradition and advanced technology.

The Olympic torch uses the motif of cherry blossoms, the most familiar flower to the Japanese people. The seamless, one-piece torch with a traditional cherry blossom pattern was produced with the same manufacturing technology as the one used in the manufacturing of the Shinkansen bullet train (aluminum extrusion molding).

The combustion part of the Olympic torch to light the Olympic flame has three combustion mechanisms to support the flame. The center part uses a combination of "catalytic combustion" and "premixed combustion" using platinum, which is characterized by the ability to keep a stable flame against mild wind and rain. The surrounding part uses "diffuse combustion," which makes a beautiful red flame rise up, although it is vulnerable to wind. In the event of wind or rain, the combustion in the center will continue even if the red flame in the surrounding part is obscured. When the wind and rain subside, the flame will rise again from the center.

In addition, for the first time in the history of the Olympics, hydrogen will be used as fuel in some sections of the relay route. Hydrogen is called "clean energy" because it does not emit greenhouse gases such as CO_2 when burned.

The hydrogen will be produced at the Fukushima Hydrogen Energy Research Field (FH2R) in Namie Town, Fukushima Prefecture, under cooperation between the NEDO and the METI.

<Reference URL> Tokyo 2020 Olympic Torch
https://tokyo2020.org/ja/torch/about/brand-design-torch

2 Automated Driving Technology

MaaS combines automated driving, AI, open data, and other technologies to integrate sharing services with the conventional means of transportation and mobility to shape the next generation transportation. The basic idea of MaaS[1] is to use information and communications technology to seamlessly connect means of transportation and provide solutions for traffic congestion and environmental problems in urban areas and for vulnerable road users in rural areas. It is expected that automated driving technology will also be added in the future

Under the SIP 2nd Phase "Automated Driving for Universal Services" led by the Cabinet Office, the government has been promoting R&D in the following four areas: (i) development and validation of automated driving systems (demonstration tests), (ii) development of basic technologies for practical self-driving, (iii) fostering public acceptance of automated driving, and (iv) strengthening of international cooperation. Since October 2019, Japan has been conducting demonstration tests on the Tokyo waterfront. In these demonstration tests, a variety of participants from industry, academia, and other sectors in Japan and abroad have conducted technical verification experiments under actual traffic conditions using traffic environment information (such as signal information and merge support information) provided by roadside infrastructure in order to verify the technology necessary for infrastructure-coordinated automatic driving and promote the development of vehicles for international standardization and practical application of more advanced automatic driving.

In FY2019, in addition to conducting research on the impact of self-driving cars in mixed traffic situations, test-drive events were also held to foster social acceptance.

In the run-up to the Tokyo 2020 Games, Japan is working on the practical application of ART,[2] a next-generation urban transport system using automated driving technology, while also developing universal

1 Mobility-as-a-Service
2 Advanced Rapid Transit

transport infrastructure that can be used by everyone including the elderly and people in wheelchairs in a comfortable manner.

Source: Cabinet Office

3 Video, Audio, and Streaming Technology with a Sense of Presence

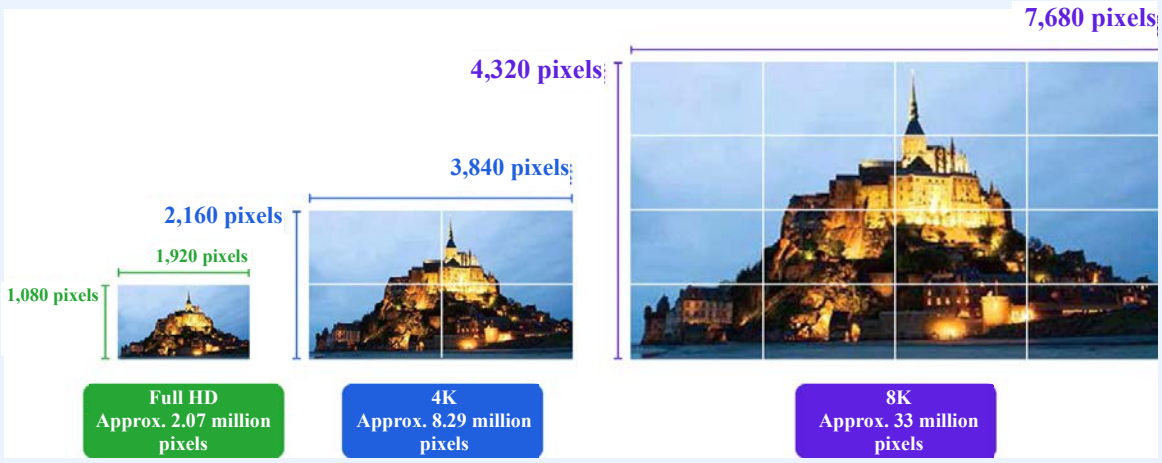
(1) Promotion of 8k Broadcasting

At present, under the initiative of the Ministry of Internal Affairs and Communications (MIC), the government is promoting 8K[1] as part of its efforts to upgrade broadcasting services. 8K has 16 times more pixels than the current high-definition television, which enables the enjoyment of ultra-high-definition three-dimensional images with a sense of presence. In addition, the incorporation of HDR[2] technology, which expands the expression of luminance, enables significantly more natural expressions even in scenes with significant differences in luminance without whiteout (a situation where bright areas are lost in white even though they are visible to the naked eye) or blackout (a situation where areas with insufficient light are blacked out due to insufficient exposure).

8K has also achieved significant audio performance improvements. Current audio systems in movie theaters and home theaters are mostly be 5.1ch, consisting of five regular speakers and one subwoofer. With 8K, the number of speakers has been increased significantly, with a 22.2 multichannel sound system. The 22.2 multichannel sound system consists of 22 normal speakers and two subwoofers. By arranging these speakers to surround the viewer in three dimensions, the direction of sound is reproduced to create a more realistic acoustic environment. With this technology, for example, a public viewing of a soccer match can be held in a three-dimensional sound environment with a high degree of realism, which gives the viewers the feeling as if they were watching the match in the stadium. NHK Science & Technology Research Laboratories is also working on R&D of 8K wireless cameras and 8K slow-motion filming systems to make it easier to capture important scenes in a dynamic manner in 8K sports programs.

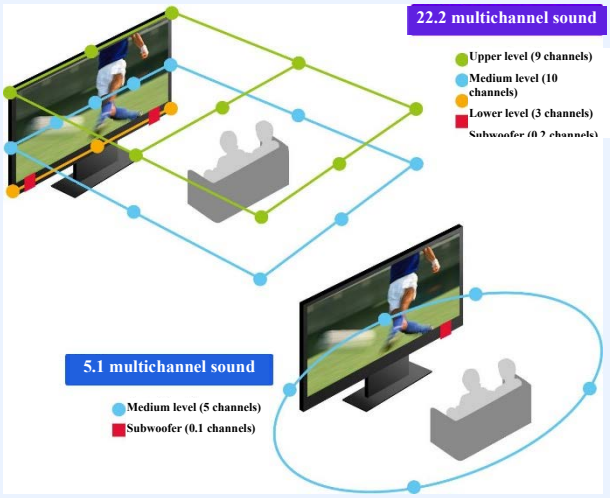
1 The "K" in 8K means 1,000, and 8K means 8,000. This term is derived from the number of horizontal pixels in an 8K display (7,680 x 4,320). The higher the number of pixels, the greater the detail of the image that can be displayed.
2 High Dynamic Range imaging

■Figure 1-3-5/Comparison of FHD, 4K and 8K



Source: Association for Promotion of Advanced Broadcasting Services

■Figure 1-3-6/Comparison between 5.1ch and 22.2ch sound systems



Source: Association for Promotion of Advanced Broadcasting Services

(2) Promotion of 5G (Fifth Generation Mobile Communications System)

The more video and audio information there is, the more data that can be transmitted. 5G enables faster and larger capacity communications, including the transmission of ultra-high quality 8K video. 5G enables ultra-high speed, multiple simultaneous connections, and ultra-low latency communications compared to the current 4G standard. It is the standard for future systems for the ultra-low latency mobile communication of large data, which will be essential for the realization of next-generation spectator systems.

So far, from 1G to 4G, the communication speed has been improving. Whereas the systems up to 4G have been developed as a tool for communication between people, 5G will connect all kinds of things, serving as a communication tool in the IoT era.

The term "ultra-high speed" refers to the aspired speed of 10 Gbps, which will reduce the download time of a two-hour movie from about five minutes to about three seconds.

The term "multiple simultaneous connections" refers to the fact that the number of devices that can be connected simultaneously from a single base station can be increased dramatically. For example, a few PCs, smartphones and other devices can now be connected to the Internet at home, but with 5G, it will be possible to connect up to 100 devices and sensors at the same time. Also, the National Institute of Information and Communications Technology (NICT) announced in March 2018 that it had confirmed the simultaneous connection of about 20,000 devices in a comprehensive 5G demonstration test. The 5G system could be used, for example, to keep track of the location and contents of a large number of items stored in a warehouse, or to remotely check the health of a large number of evacuees by providing them with wearable devices during a disaster.

The term "ultra-low latency" refers to the ability to minimize latency, or time lag, in communication networks. For example, real-time communication is necessary for applications that require a high level of safety, such as automated driving. The ultra-low latency can also be used in the fields of remote control of robots and telemedicine.

5G is being discussed for various applications, such as advanced control of industrial robots, precise remote control of construction and agricultural machinery, efficient stockbreeding, automated driving, and advanced telemedicine. In Japan, 5G services by mobile phone carriers have started in the spring of 2020, with base stations scheduled to be deployed in 98% of Japan by the end of FY2023. In December 2019, in addition to 5G services provided by mobile phone carriers, local 5G services were also institutionalized to enable flexible construction on a spot basis within a company's own building or premises in response to the specific needs of a region or industry. Mitsubishi Electric Corporation and NEC Corporation are investigating a "hybrid 5G" system that combines 5G services provided by mobile phone carriers with local 5G services within factories, aiming to optimize overall manufacturing by linking information obtained from within the factories and the public network.

As discussed above, 5G is an important foundation for the coming IoT era. Its realization is expected to change the nature of communication and lead to new business developments.

■Figure 1-3-7/Features of 5G

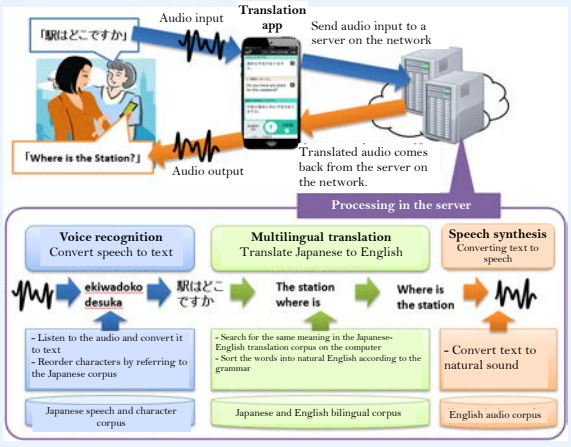
Source: MIC

4 Promotion of Multilingual Speech Translation Technology

In 2014, the MIC formulated the Global Communication Plan. With an eye on the Tokyo 2020 Games, it has been working to eliminate the global language barrier and promote uninhibited global exchange with the NICT's multilingual speech translation technology.

Specifically, under the MIC's R&D initiative, the NICT has introduced an AI learning computer (GPGPU) [1] for deep learning translation, improved the accuracy of translation and speech recognition, and expanded the number of supported languages. In 2019, translation accuracy has been improved to a practical level in 12 languages.[2] In addition, in October 2019, the NICT developed a function for automatic identification of the target language, which has been implemented for eight languages,[3] to replace of the previous multilingual speech translation technology, which required prior selection of the speaker's language.

■Figure 1-3-8/How multilingual speech translation technology works



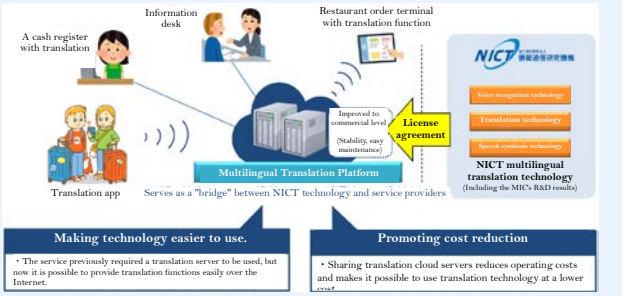
Source: NICT

Furthermore, in April 2019, the Multilingual Speech Translation Platform was established to promote the social application of the NICT's multilingual speech translation technology by developing an

1 General-Purpose computing on Graphics Processing Units
2 Japanese, English, Chinese, Korean, Thai, Indonesian, Vietnamese, Myanmarese, French, Spanish, Brazilian Portuguese, and Filipino
3 Japanese, English, Chinese, Korean, Thai, Indonesian, Vietnamese and Myanmar

environment that allows private companies to use it more easily. This has eliminated the need for private companies to build, operate, or manage their own servers, allowing them to concentrate on service development and delivery. The Multilingual Speech Translation Platform has been used for technical verification with an eye toward social application in translation services, with an emphasis on the fields of tourism (shopping), transportation (railways and taxis), medicine, and disaster prevention.

■Figure 1-3-9/Multilingual Speech Translation Platform



Source: NICT

These efforts have led to the transfer of technology from the NICT to the private sector and to the commercialization and the spread of a variety of translation services (terminals and applications). In fact, various services using the NICT's multilingual speech translation technology have been introduced to many industries such as tourism, retail (department stores, supermarkets, convenience stores, pharmacies, apparel, etc.), catering, transportation, medical institutions, financial institutions, local governments (for handling inquiries, disaster drills, etc.), and educational institutions (schools and boards of education). The NICT's multilingual speech translation technology has also been used in such events as the Tokyo Marathon and the Rugby World Cup 2019 in Japan, where it has proven to be useful and effective. The technology is expected to play an active role as an "omotenashi (hospitality) system" in a variety of settings, including the Tokyo 2020 Games.

Column 1-7

Development of Prosthetic Legs That Make Dreams Come True

A prosthetic leg is an artificial leg worn by people who have lost their legs due to injury or illness to compensate for the functions necessary for daily life. A sports prosthetic leg is a sport-specific version of it. Athletic records have improved dramatically since the 1990s, when the use of carbon-made sports prosthetics began in earnest; today, the world record in the men's 100 meters has reached the 10-second range, and the world record in the long jump has surpassed the record of the Olympic gold medalist at the Rio de Janeiro Olympics. Sports prosthetics have enabled those who have lost their legs to make their dreams of running come true.

Jarryd Wallace wearing a sports prosthetic leg
Source: K.K. Xiborg

K.K. Xiborg, a Japanese company that develops sports prosthetic legs domestically, uses a motion capture system to measure athletes' running to analyze the mechanisms of their running and create prosthetic legs that can receive optimal force from the ground (joint development with Sony Computer Science Laboratories, Inc., Toray Industries, Inc., and Toray Carbon Magic, Co. Ltd.). Athletes select the prosthetic leg that best suits them, and then find an optimal way to run with it while training.

Sony Computer Science Laboratories, Inc. is also developing an actively moving prosthetic leg called a "cyborg prosthetic leg" that uses motors and other electrical power to facilitate daily activities. This development is also part of a project supported by the JST's Core Research for Evolutional Science and Technology (CREST), which aims to overcome physical and psychological difficulties through the social application of AI technology. The product aims to achieve even smoother, more human-like foot function by moving the knee and heel joints based on estimations of the body's movements.

Cyborg prosthetic leg
Source: Sony Computer Science Laboratories, Inc.

<Reference URL> JST Science Window
https://sciencewindow.jst.go.jp/
<Reference URL> Fastest Speed and Fun Brought About by Sports Prosthetic Legs
https://sciencewindow.jst.go.jp/articles/2019/05/article034.html

Column 1-8 Face Recognition Technology Expected to Be Used for the Tokyo 2020 Games

Face recognition gates have been used at airports for departure and return procedures for Japanese nationals. Starting with Haneda Airport on July 24, 2019, Narita, Kansai, Fukuoka, Chubu, and New Chitose Airports have begun using face recognition gates for foreign nationals departing from Japan.

The Tokyo 2020 Games, which will bring many foreigners to Japan, will be an opportunity for Japan to demonstrate its technology to the world and attract global attention to its strength. Recently, biometric identification technology has been widely used around the world due to its increased convenience and heightened security awareness and the remarkable development of AI. NEC's face recognition system, which is scheduled to be introduced at the Tokyo 2020 Games, is 99.7% accurate under normal conditions and capable of checking against a database of 1.6 million records in 0.3 seconds. It is also expected to help in reducing the burden of identification procedures by humans.

<Reference URL> NEC Tokyo 2020 Special Site
https://jpn.nec.com/ad/2020/op/face-recognition/

Use of the face recognition system
Source: NEC Corporation

Column 1-9

Impact of Fiction on Real Society

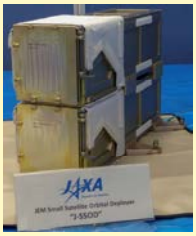
Fiction presents society with a certain view of the world, sometimes inspiring dreams and aspirations in many people, and generating energy for making them come true in the real world. This energy has the potential to lead to scientific and technological innovation.

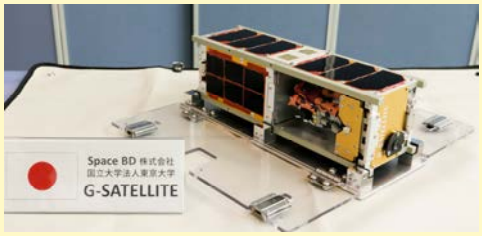
"Mobile Suit Gundam," a Japanese anime series that marked its 40th anniversary in 2019, is one of such works. Various events were held to commemorate the anniversary, and "Mobile Suit Gundam" has continued to have an enormous impact on real society. This column features two of such events as examples.

One is the development of "G-SATELLITE," a miniature satellite carrying miniature plastic model figures from "Mobile Suit Gundam," widely referred to as "Gunpla," as part of the Tokyo 2020 One Team Project promoted by the Tokyo Organising Committee of the Olympic and Paralympic Games. This miniature satellite with a size of approximately 10 x 10 x 30 cm and a weight of about 3 kg will be launched to the International Space Station (ISS) in March 2020, and then released into space from the Japanese Experiment Module, "Kibo," on the ISS. The "Gunpla" figures, which will leap out into space, are planned to send messages of support to the Tokyo 2020 Games while flying in low earth orbit.

The "G-SATELLITE" was developed by the Intelligent Space Systems Laboratory, Department of Aeronautics and Astronautics, Graduate School of Engineering, the University of Tokyo, with cooperation from Fukui Prefecture and three companies in the prefecture. Special materials and paints were used for the "Gunpla" figures to be brought on board the satellite, and they were designed to withstand the harsh environment of space (ultra-high vacuum, high/low temperatures, radiation, ultraviolet rays, etc.).

<Reference URL>
1. http://www.jaxa.jp/press/2019/05/20190515b_j.html
2. https://participation.tokyo2020.jp/jp/oneteam/08.html





Left: A small satellite release mechanism for releasing G-SATELLITE into space
Center: G-SATELLITE Right: One Team Project key visual
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The other is the Gundam Factory Yokohama, a collaborative project between Gundam Global Challenge and the City of Yokohama, which is planned to be opened at the Yamashita Pier in Yokohama. The themes of the project are pursuing a dream, exploring possibilities, and growing through discovering and overcoming challenges. The project aims to move an 18-meter life-size Gundam, reproducing Gundam's distinctive movements. In addition to the life-size moving Gundam, there will be a related exhibition at the "Gundam-LAB," which will be held in the same site. Apart from this, Gundam Global Challenge is also carrying out an open innovation project, namely, the GGC Research Open Simulator project by Professor Satoshi Okada of the University of Tokyo's Graduate School of Information Science and Technology. The project aims to create a system that allows young people around the world to freely participate in robot development, contribute to the development of the robotics field, and make the Gundam a reality through an open robot platform that uses Gundam's CG data.

It is hoped that this dialogue between fiction and the real world will contribute to the development of scientific and technological innovation.

<Reference URL>
1. https://gundam-factory.net/
2. https://gundam-challenge.com/index.html

GUNDAM FACTORY YOKOHAMA
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