[Tentative translation]

Integrated Innovation Strategy 2020

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Government of Japan

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PART I: General

1. Basic Concept

The novel coronavirus disease (COVID-19) that spread throughout the world from the beginning of 2020 is a large-scale infectious disease that is said to be the most challenging crisis since the Second World War,[1] and currently the countries of the world are expending all their efforts to stop the outbreak and establish a new form of daily life, called the new normal, to prevent the infection spreading again. Protecting the health of citizens is the top priority, and for that purpose countries have introduced a variety of measures, but on the other hand, the lockdowns and restrictions on movement and commuting, etc. imposed in regions throughout the world have left an impression on people of not only physical distance but also the "fragmentation" of society spiritually and psychologically.

Furthermore, in the last year, many abnormal weather events and large-scale disasters have occurred on a global scale. Due to these, many human lives have been lost, and many people who suffered harm have been forced to live inconvenient lives for long periods of time. Moreover, the core of the struggle for supremacy between countries, centered on the United States and China, has shifted greatly toward innovation, the struggle for technological supremacy between the enterprises and governments of each country is intensifying, and there have been other major changes in the situation surrounding innovation. For example, there has been the rise in leading overseas IT platforms and the moves by the governments of each country toward regulating them, the levelling off venture investment environment, and changes to corporate behavior focused on the SDGs.

It can be said that these changes to the situation are unprecedented, discontinuous changes that are not an extension of the previous situation. In order for the human race to overcome and adapt to the various critical issues in the world, it is necessary for our societies themselves to boldly make changes with a strong sense of crisis and sense of urgency. In particular, the urgent issues are to build a society that is strong with respect to infectious disease while restoring the connections among people once again and reforming the "solidarity" of society.

The Society 5.0 that Japan proposed in the Fifth Science and Technology Basic Plan (hereinafter referred to as the "Fifth Basic Plan") consists of activities to create a sustainable and resilient "human-centered society" by merging cyberspace and real space, and to use the power of science and technology and the innovation they bring about to overcome the difficult situations and pressing social issues we face to lead to growth, and create the kind of society in which no-one is left behind and people connect with each other in new ways.

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[1] In a March 31, 2020 press conference, United Nations Secretary-General António Guterres presented the perception that the novel coronavirus disease is "the most challenging crisis we have faced since the Second World War" and called for global solidarity.

The philosophy of Society 5.0 is more important now than ever before.

On the other hand, in Japan the changes in the situation in the last year have caused renewed awareness of the delay in the digitalization of Japan and the delay in the realization of Society 5.0 which was proposed before any other country in the world. In particular, regarding novel coronavirus disease countermeasures, the delay in digitalization and introduction of IT has shackled efforts to prevent infection while also continuing corporate activities and social activities.

Therefore, in the Integrated Innovation Strategy 2020, in PART I we will analyze the changes to the domestic and overseas situation in the last year and present the high-priority issues for the realization of Society 5.0 as a science, technology, and innovation (STI) policy.

In PART II, we make special note of the policies that should be tackled as STI policy in order to respond to the difficult situation caused by the novel coronavirus disease that is rampant throughout the world.

In PART III, we reliably apply the PDCA cycle to the objectives and measures incorporated in the Fifth Basic Plan and the previous Integrated Innovation Strategy (hereinafter referred to as the "Integrated Strategy"), confirm the implementation status of the related measures, and present improvement directions.

Since 1995 when the Basic Act on Science and Technology[2] was established, the relationship between humans and society and STI has become close and inseparable due to the rapid development of STI in recent years, including AI and the IoT, life sciences, etc., so the comprehensive promotion of STI based on deep insights into humans and society has become necessary. In light of these kinds of changes to the situation, in the 201st ordinary session of the Diet a law was established and promulgated to comprehensively revise the Basic Act on Science and Technology for the first time in 25 years.

The revised Basic Act on Science and Technology (the Basic Act on Science, Technology, and Innovation) added science and technology pertaining to the humanities and social sciences only to the items to be promoted by the Act, on the grounds that it will become important for the humanities and social sciences (the Basic Act on Science, Technology, and Innovation stipulates "cultural sciences" but this has the same meaning) to play an active role in confronting various increasingly-complex modern issues. Regarding the "creation of innovation," the Act revised the definition previously provided in the Law on the Revitalization of Science, Technology and Innovation Creation[3] and introduced a new concept in the Basic Act on Science, Technology, and Innovation.[4]

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[2] Act No. 130 of 1995

[3] Act No. 63 of 2008

[4] Regarding the "creation of innovation," the pre-revision Law on the Revitalization of Science, Technology and Innovation Creation provided that "Japan will generate new value and create major changes in economic society through development or production of a new product, development or provision of a new service, introduction of a new method for production or sale of a product, introduction of a new method for provision of a service, introduction of a new business

Specifically, in addition to the previous specific means leading to innovation creation that have in mind corporate activities such as the development, etc. of new products or new services, it provided for creative activities, namely scientific discoveries and inventions, and identified that "creation of innovation" is a wide-ranging concept in which diverse entities can be involved. The Integrated Strategy 2020 is based on this revision in all its aspects.

Fiscal 2020 is the last fiscal year of the Fifth Basic Plan. The Science, Technology, and Innovation Basic Plan to be formulated in FY2020 (hereinafter referred to as "Next Basic Plan") is the new medium-term plan for the country formulated for the first time under the Basic Act on Science, Technology, and Innovation. In light of the present situation, the new medium-term plan requires recovery from the large delay in the reforms of the social structure of Japan, and the realization of a true Society 5.0 that leads the world toward fundamental improvements to human well-being.

2. Domestic and Overseas Situational Changes

(1) The Battle with the Novel Coronavirus Disease

Regarding the novel coronavirus disease (COVID-19) caused by the novel coronavirus (SARS-CoV-2) that began spreading primarily in Wuhan City, Hubei Province, China in about December 2019, infected people had been confirmed on all of the seven continents on Earth except the Antarctic Continent by late February 2020, and on March 11, 2020 the World Health Organisation (WHO) made the assessment that "the spread of the novel coronavirus disease can be characterized as a pandemic" and it is having an enormous impact on activities in daily life and the economy and society, such as the forms of the daily lives of people, the forms of public services such as education, medical care, transportation, etc., the forms of supply chains in industrial fields, etc.

The fact that at the present time no decisive medical treatment methods exist is the largest cause for anxiety regarding the novel coronavirus disease, there is an increasingly serious situation in the medical care delivery system due to the spread of the disease, and it is having a serious impact on activities in the economy and society, and a variety of issues have come into sharp relief with regards to responses such as refraining from going out and temporarily closing schools, with the forms of public services including hospitals, and furthermore in the industrial field, such as supply chain problems, etc.

Japan issued its first declaration of a state of emergency under the Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response[5] and is expending all its efforts to take countermeasures, such as working to prevent the spread of infection, etc., but in

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management method, etc."
The Basic Act on Science, Technology, and Innovation provides that "Japan will create new changes in economic society by generating new value and disseminating that value, through scientific discoveries and inventions, the development of new products or new services, and other creative activities."

[5] Act No. 31 of 2012

its STI policy Japan is tackling this as an urgent issue, including the development of medical drugs and vaccines and promotion of the introduction of mechanisms to avoid human contact, such as remote education, telework, etc.

Then, after the infectious disease is brought under control, it will be necessary to greatly advance a digital transformation (DX) in order to establish a new normal, and to achieve a structural transformation, such as changing to a sustainable, resilient, and comprehensive society by revising regulations, commercial practices, and consumer behavior.

(2) Abnormal Weather and Large-Scale Natural Disasters Occurring Around the World

In the last year, many abnormal weather events and resulting large-scale disasters have occurred around the world. In Japan as well, overflowing rivers and mudslides due to heavy rains beyond expectations, damage to buildings and long power cuts due to strong winds and tornadoes, etc. have occurred, and situations frequently occurred in which many human lives have been lost and many people who suffered harm were forced to live inconvenient lives for a long time. Overseas as well, abnormal weather events and large disasters causing a lot of harm are occurring, including a heat wave in Europe, hurricanes in the United States, large-scale fires in Australia and South America, etc., bringing into view the forces of nature.

The meteorological disasters in recent years hint at the impact of global warming, they are also called the “climate crisis,” etc. and there is a high likelihood that disasters beyond our current expectations will continue to occur, so it necessary for Japan to broadly utilize its outstanding STI to advance climate change measures, and to prepare for disaster prevention in advance as much as possible, and in cases in which a disaster does occur, it is necessary for Japan to detect the signs of the disaster in advance using sensors, etc. and make efforts for disaster reduction to keep the harm to a minimum, by encouraging evacuation.

(3) Intensification of the Struggle for Supremacy in Innovation

Along with the progress in digitalization, the struggle for supremacy in innovation between countries centered on the United States and China has been intensifying. in October 2019 Google announced that it had used a 53-qubit quantum computer to demonstrate “quantum supremacy,” shocking the world. Furthermore, 2020 is the year in which the commercial service of the fifth-generation mobile communications system (hereinafter referred to as “5G”) starts in Japan, and it is thought that the features of 5G, including ultra-high speed, ultra-low lag, and a large number of simultaneous connections, will make new services such as automatic driving through the utilization of sensors, smart agriculture, etc. realistic. Regarding the 5G network equipment that provides the infrastructure for these kinds of services, cases are occurring overseas of restrictions being placed on government procurement of the equipment from specific manufacturers for security reasons.

In the context of this intensification of the cutthroat technology development competition and struggle for technological supremacy, technology leakage and cyber attacks have also become big

issues. Overseas, leakages of intellectual property from universities by international students, technology leakage by university professors as a reward for unauthorized donations from a third country, and cyber attacks on major enterprises targeting confidential information are occurring.

Also, countries are formulating national technology strategies and strengthening technology management with respect to emerging technologies such as AI and quantum technologies, etc., fundamental technologies such as semiconductor manufacturing technologies, etc., and software technologies for data analysis and control, on the grounds that they lead directly to not only industrial competitiveness but also national security too. For example, the United States announced a national strategy for the four high-tech and cutting-edge fields that it considers to be industries of the future, AI, quantum technologies, 5G, and advanced manufacturing, and because it is concerned about technology leakage it is considering the strengthening of technology management in international joint research. Anticipating the post-corona world, China has announced a New Infrastructure Construction policy to promote the development of infrastructure for next-generation services, including 5G, data centers, a charging network for electric vehicles, etc. In Europe, the European Commission established multiple multidisciplinary missions with their focus on the solution of specified issues in Horizon Europe, which is a science and technology innovation strategy for the seven years from 2021. In addition, Germany has newly established the Federal Agency for Disruptive Innovation (SPRIN-D) which supports the creation of high-impact innovation, and the Agency for Innovation in Cybersecurity which aims for innovation in the security field, and France has established the Defense Innovation Agency.

(4) Deepening of the Digital Society

The leading IT platformer companies in the United States and China called GAFA[6] and BATH[7] have led the digital society by playing a role as seedbeds that develop new businesses such as the sharing economy,[8] etc. by providing platforms for providing new services such as Internet sales and matching businesses, etc. to many companies and individuals.

On the other hand, the view is emerging that these platform companies doing business globally ensure their dominant position with data hoarding, and build oligopolies and monopolies through corporate acquisitions, etc. so if the situation is left unchanged, they will distort fair market trading, so each country is advancing discussions on the forms of regulations on platformer companies.[9] Furthermore, due to the nature of digital businesses that can provide services without needing a

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[6] This refers to four companies, Google, Apple, Facebook, and Amazon, all of which are leading IT companies in the United States.

[7] This is the collective name for Baidu, Alibaba, Tencent, and Huawei, the four leading IT companies in China.

[8] An economic mechanism established when assets owned by individuals are lent, borrowed, or exchanged between individuals thought the Internet.

[9] In the 201st ordinary session of the Diet, the Act on Improvement of Transparency and Fairness in Trading on Specified Digital Platforms (Act No. 38 of 2020) aiming to improve the transparency and fairness of trading on digital platforms was established.

physical base, taxation problems are occurring with the governments of each country. For this reason, an international investigation of the response to the taxation issues arising from digitalization of the economy[10] is being carried out in approximately 140 countries centered on the OECD and including Japan.

Going forward, as digital technologies penetrate into society further and the digital society deepens, it will be necessary to adopt a balance of values, which tends to involve tradeoffs; for example, between the improvement of convenience due to data centralization and ensuring the freedom and privacy of individuals, so we will be required to utilize the findings of the humanities and social sciences to review what happiness is for future human beings from the perspective of social welfare, and Japan will be required to cooperate and collaborate with each country to advance the development of rules that are acceptable globally, and use those rules as drivers of the growth of Japan.

(5) Changes to the Startup Environment

In the last few years, unicorns, unlisted venture companies with a corporate value of one billion dollars or over, have attracted more attention. A robust structure for fund flows was built as the vast funds procured by enormous venture companies were invested in the next startup, so many unicorn companies grew and thrived in each country. However, signs of decline in those fund flows[11] are now beginning to be seen. There are also trade problems, etc. due to the nationalism spreading throughout the world and the flow of funds surrounding enormous IT companies in the United States and China lacks transparency. In this context, fund flows to venture companies are beginning to level off; moreover, there are concerns about the impact of the novel coronavirus disease.

As venture companies that possess cutting-edge technologies have grown the world economy and transformed the existing industrial structure, there is a risk that the stagnation of fund flows for venture companies will lead to a stalling of the world economy.

(6) Changes to Corporate Behavior

Against the background of the abnormal weather events that have frequently occurred around the world, people's awareness of the climate change problem has been growing, and changes are also occurring at the behavioral level. Furthermore, interest in climate change is growing more and more. For example, at COP25 which was held in December 2019, a statement urging the state parties to undertake ambitious climate change measures was incorporated in the decision document.

Regarding the behavior of corporations, the United Nations proposed in 2006 that the perspective

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[10] In the BEPS (Base Erosion and Profit Shifting) Project by the G20/OECD, discussions are under way to reach agreement on a solution package based on an international consensus by the end of 2020 regarding the international taxation issue that the income of a foreign company cannot be taxed in the case that the company conducts its business activities without establishing a physical base inside a country.

[11] According to a survey by leading accounting firm KPMG, the amount of investment using venture capital globally in 2019 was 257 billion dollars, a decline of approximately 15% compared to 2018.

of Environment, Social, Governance (ESG) should be embedded in the investment decision-making process of institutional investors, and in 2015 the sustainable development goals (SDGs) were adopted in a United Nations Summit, etc., so interest in ESG investment and SDGs has been growing, and corporations that understand sustainability to be at the foundation of their business have been appearing. In October 2019 industrial and financial industry leaders from around the world came together to hold the world's first Task Force on Climate-related Financial Disclosures (TCFD) Summit in Tokyo in order to promote green finance that encourages the environment-related initiatives of corporations through the disclosure of climate-related financial information. Furthermore, at the World Economic Forum Annual Meeting (Davos Meeting) in January 2020, an argument was made for stakeholder capitalism, the idea that corporations must contribute to the interests of society overall, not only their shareholders.

3. Position of Japan

At a time of major changes to the domestic and overseas situation, it is necessary to correctly understand the position of Japan in the world in order for Japan to discern its new directions and lead the world. In order to understand the position of Japan, here we discuss the three perspectives of ① digitalization, ② innovation capability, and ③ research capacity.

① Digitalization

In the Fifth Basic Plan, Japan announced the concept of Society 5.0 to realize a human-centered society through a world-leading merging of cyberspace and physical space, and what has become unintentionally clear in the present infectious disease response is the delay in the digitalization of Japan. An international overview report[12] has also presented an analysis concluding that the digitalization of Japan has been delayed compared to other countries around the world, and in particular, the report indicates that the use of big data, the lack of international experience, and the ability of companies to respond to change are weak.

Furthermore, the problem that emerges when advancing digitalization is the problem of conflicting values. Adopting a balance reflecting the will of the people from the perspectives of guaranteeing security, trust, public health, etc. is required. Namely, should we accelerate the aggregation of personal information and behavior information or respect the freedom and privacy of individuals? Moreover, at a time when the struggle for supremacy in innovation is intensifying in the international community, adopting a balance in rule development for the promotion of digitalization which also includes the perspective of security is required. Namely, should we permit nationalism or should we promote international cooperation? At the G20 Osaka Summit held in June

[12] In the World Digital Competitiveness Ranking announced in September 2019 by IMD, a business school in Switzerland, Japan fell one ranking place from 2018 to be 23rd of 63 major countries. The report indicated that the weaknesses of Japan were its international experience, use of big data, and the ability of its companies to respond to change.

2019 Japan recommended Data Free Flow with Trust (DFFT) as the host country.

② Innovation Capability

According to the reports analyzing the competitiveness of countries around the world,[13] although the rankings for Japan's innovation capability have risen for a period of time there is still much room for improvement. In particular, multiple reports mention that human resources development is insufficient, that there is rigidity and a lack of diversity, including low female participation, in the labor market, and that Japan's companies lack the ability to respond to change. Furthermore, the reports indicate that the startup environment is substantially lagging among the developed countries.

Actually, at a time when the digital revolution is the driving force that is changing the face of social and industrial structures around the world, Japan has not been able to create large-scale innovation of the kind that overseas digital platformers have generated. Furthermore, it is considered that after the financial crisis triggered by the bankruptcy of Lehman Brothers, investment in research and development lagged behind compared to Western countries, and as a result time was required for the subsequent recovery in the creation of innovation.

Generally, economic growth can be analyzed into the parts of growth due to increases in capital and labor, the elements of production, and increases in Total Factor Productivity (TFP). In light of the facts that in the medium to long term the supply of labor is subject to population constraints, and investment which forms capital stock will be within the scope of added value, in order to grow the economy of a single country it is necessary to make added value larger by increasing TFP. From 2011 to 2015, Japan's TFP was at a comparatively higher level than the TFP of the United States, but there was a also rebound from the previous period when TFP was low, so we are in a situation in which caution is required regarding whether this trend will be sustained going forward.[14] Promoting innovation creation for the improvement of TFP is extremely important when building a resilient economy that is not affected by economic ups and downs.

Going forward, we will have to coexist with the coronavirus and then establish new systems and rules, services and businesses for recovery, and in that transformation period many innovations will

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[13] In the World Competitiveness Ranking announced in June 2020 by IMD, Japan fell four ranking places from 2019 to be 34th of 63 major countries. The report highly evaluated domestic demand and employment aspects whereas its evaluation of the efficiency of the government and companies was low.

In the Global Competitiveness Report 2019 announced in October 2019 by the World Economic Forum (WEF), Japan's overall ranking fell one ranking place from 2018 to be 6th of 141 countries. In particular, Japan's ranking for innovation capability fell one ranking place from 2018 to 7th. The report indicated that Japan's weaknesses were rigidity and a lack of diversity, including low female participation, in the labor market, and a risk-averse corporate culture.

In the Global Innovation Index 2019 announced in July 2019 by the World Intellectual Property Organization (WIPO), Japan's overall ranking fell two ranking places from 2018 to be 15th of 129 countries. The report indicated that Japan's weaknesses were the difficulty of starting a business, low labor productivity, and a low level of spending on education.

Regarding Japan's business environment, in its Doing Business report announced in October 2019 by the World Bank, Japan's overall ranking rose ten ranking places from 2018 to 29th of 190 countries. Japan was ranked particularly low for the "Starting a business" evaluation item, at 106th. The report indicated that the reason for this is that in all respects, including the procedures, time, and cost when starting a business, Japan is subordinate to the average for the OECD countries.

[14] From the Survey Research on the Current Situation of ICT in Japan (2018) by the Ministry of Internal Affairs and Communications. From 2011 to 2015 Japan's TFP was 0.44% and the TFP of the United States was 0.14%. Japan's TFP rose from 0.05% (2006 to 2010) to 0.44%.

quickly emerge, and some of them will become embedded in society. It is necessary for Japan to strategically anticipate a strong fightback in the future and develop an environment which creates innovation.

③ Research Capacity

With the research response concerning the novel coronavirus disease as one of the triggers, digital transformation (DX) of research activities is gaining attention worldwide; in particular, the possibility is emerging that research combining the gathering of big data and the utilization of supercomputers and AI will have an overwhelming impact. In this context, Japan possesses high competitiveness in this field. For example, the Fugaku supercomputer, which is aiming to commence shared use from 2021, became the first supercomputer in history to take the top rank in all four categories in the supercomputer rankings simultaneously. Japan is required to utilize this strength to advance data-driven research, and to advance international collaboration while strategically responding to the establishment of a platform integrating SINET, computational resources, data infrastructure, etc. In conjunction with this, the publication and sharing of research results and data using preprints (academic papers before peer review) is growing, so regarding these new mechanisms it is necessary to ensure quality and secure the rights and incentives of individual researchers while advancing investigations that could lead to the improvement of Japan's national interests based on the open and closed strategy.[15]

The environment surrounding researchers in Japan is tough. For example, there is a lack of stable posts, a lack of time to devote to research, and a lack of diversity in career paths for young researchers. This is one of the factors behind the decline in the rate of progression to second-stage doctoral courses and the decline in appeal for the researchers. Regarding the number of papers, the results of research, in the context that all of the other countries are increasing their number of papers, only Japan is remaining at the same level, so its international share is decreasing greatly. That trend is even more marked with regards to the number of papers receiving a high level of attention (number of adjusted top 10% papers).

An awareness of the problems concerning these kinds of issues is being shared at industry, academia, and government workplaces and in recent years signs of improvement are beginning to be seen. A survey by the Ministry of Education, Culture, Sports, Science and Technology's National Institute of Science and Technology Policy[16] surveys the awareness of researchers in industry, academia, and government every year, and according to its latest results, some degree of improvement is being seen. For example, there has been an improvement to the environment for the participation of female researchers and the evaluation of the development of human resources with

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[15] A strategy that is released that separates data into data that should be released (open) and data that should be protected (closed) based on the properties of the data.

[16] The Analytical Report for NISTEP Expert Survey on Japanese S&T and Innovation System (NISTEP TEITEN survey)" by the Ministry of Education, Culture, Sports, Science and Technology's National Institute of Science and Technology Policy conducts an ongoing awareness survey of approximately 2,700 leading researchers and knowledgeable persons in industry, academia, and government every year.

a spirit of entrepreneurship has risen.

However, it cannot be concluded that the current situation is necessarily adequate for global competition, so the Council for Science, Technology and Innovation (CSTI) compiled the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers in January 2020. The Comprehensive Package aims to improve the situation surrounding young researchers and fundamentally improve its appeal, by expanding posts for young researchers, providing costs for challenging research, improving the treatment of students in second-stage doctoral courses, and expanding diverse career paths and mobility, including in the industrial world, etc.

Furthermore, the Council formulated the Quantum Technology Innovation Strategy and the Progressive Environment Innovation Strategy, etc. to deal with issues that should be tackled nationally. Moreover, it has been developing structures to advance strategic research and development. For example, it has decided the Goals of the Moonshot Research and Development Program which is aiming for the creation of disruptive innovation in Japan.

4. High-Priority Issues

In light of the aforementioned changes to the domestic and overseas situation and position of Japan, the high-priority issue for Japan in the short term is strengthening the response to the difficult situation of Japan, including the novel coronavirus disease, disasters, etc. Then, in the medium to long term, the high-priority issue is to fundamentally transform the social structure by strengthening research capacity which is the source of the “knowledge” needed to respond to difficult situations and situational changes, and by creating value from the “knowledge” generated by research and development and implementing it in society, etc.

In particular, we must make every effort with a strong national commitment to advance digital transformation (DX), the so-called Digital Relocation of the Capital initiative, to turn the present crisis into an opportunity to quickly advance the shift to the digitalization of Japanese society, ensure that social infrastructure and rules including industrial structure and lifestyles such as working styles, etc. meet the requirements of digitalization, and realize the movement of economic and social activities to cyberspace to the extent possible.

In addition, Japan will give priority to investment in issues in anticipation of future needs, such as greening, sustainability, climate change problems, etc., and use the creation of innovation as the detonator of the recovery of the economy and society going forward. When doing so, it is important to revitalize the startup environment to enable the participation of the venture companies that bring about the paradigm shifts that are difficult for existing enterprises to achieve. Japan will formulate the Next Basic Plan, the new national five-year plan, during FY2020 under the Basic Act on Science, Technology, and Innovation so that the entire government can promote these kinds of initiatives. The said plan will clearly set out the role that Japan should play within the social issues of infectious disease, natural disasters, and digitalization and aim for the realization of a true Society 5.0 that leads the world toward fundamental improvements to human well-being.

(1) Response to the Difficult Situation We are Facing Due to the Novel Coronavirus Disease and Building of a Sustainable and Resilient Social and Economic Structure

Stopping the spread of the novel coronavirus disease is most important for protecting the lives and health of citizens. Many people who have experienced the threat due to the spread of the novel coronavirus disease strongly feel that the urgent issues are that it is necessary to advance the strengthening of the response to infectious diseases, namely development of pharmaceuticals and medical equipment and international information sharing concerning infectious diseases, in order to strengthen response capacities for the emerging and reemerging infectious diseases that are here now and will come again one day, and to tackle these challenges using the full power of STI, including not only the natural sciences but also the humanities and social sciences. In particular, the important points for mounting a response are ensuring the development of diverse human resources, the development of structures, and improvement of international collaboration.

Furthermore, there is a risk that a rapid fall in investment in startups and industry-academia collaboration research could occur in the field of innovation creation due to the impact of the novel coronavirus disease, so it is necessary to strategically anticipate a future strong fightback, support young researchers, etc. and collaborations between industry and academia, etc. which are aiming for startups and entrepreneurship, and aim for the maintenance of innovation ecosystems.

Moreover, recently changes have been forced to many aspects of social life, and in that process the delay in the digitalization of Japan and the vulnerability of social systems have been revealed. We are required to adapt to the new normal, in which we minimize the risk of infection while on the other hand aiming for the improvement of productivity and maintaining rich connections among people. It is necessary to consider this difficulty to be a large opportunity to achieve adaptation to the new normal, and to utilize the power of STI to advance the adoption of non-contact methods in education, research, industry, etc., a digital transformation (DX) promoting the use of new data from space, etc., a switch to a decarbonized society, and the building of a resilient and sustainable social and economic structure for the fightback and social transformation.

(2) Creation of Innovation that Overcomes Domestic and Overseas Issues and Leads to Growth

Due to the impact of the spread of the novel coronavirus disease, the strong need for remote services utilizing ICT, etc., such as telework and remote education, etc. which are able to respond to the current kind of situation, has come into sharp relief once again. In order to accelerate the realization of Society 5.0, we will build a resilient economic structure with respect to future difficult situations and build a sustainable social structure for the medium to long term, by overcoming the present crisis, the government giving priority to advancing the digital transformation (DX) in all fields through collaboration between the public and private sectors under the concept of wise spending, and quickly accelerating social transformation.

① Development of Core Communications and Data Infrastructure to Support Society 5.0

(Source of Knowledge)

(a) Development of Infrastructure to Support the Digitalization of Society

The development of infrastructure that supports the digitalization of society, such as new-generation mobile communications systems, is essential in the Society 5.0 era. We will contribute to further solutions to social issues and economic growth in Japan and also to the building of a sustainable international community by steadily conducting research and development into that infrastructure and aiming for its prompt diffusion into society.

Specifically, 5G, which commenced services in March 2020, is a next-generation mobile communications system with the features of ultra-high speed, ultra-low lag, and a large number of simultaneous connections, and it is expected that 5G with the functions of ultra-low lag and a large number of simultaneous connections further strengthened (hereinafter referred to as "Post-5G") will be utilized in diverse industrial applications such as factories and automobiles going forward. Therefore, we will aim to strengthen the infrastructure for the development and manufacturing of information and communications systems meeting the requirements of Post-5G by developing the technologies forming the core of these systems in Japan. Furthermore, in order to achieve the early and smooth introduction of Beyond 5G, the communications method of the next generation following 5G, and strengthen its international competitiveness, we will formulate and strategically tackle roadmaps for research and development, intellectual property and standardization, and deployment so that Beyond 5G services go live in about 2030, and in addition we will tackle the research and development of a variety of fundamental technologies.

(b) Realization of Data Free Flow with Trust and Social Implementation of a Data-Driven Society

We will promote initiatives for implementation of the Data Free Flow with Trust (DFFT) agreed at the G20 Osaka Summit held in June 2019.

Furthermore, we will aim for the creation of new value through the world-leading development of cross-sectional data federation in which the data exchange platforms for each of a variety of fields connects beyond barriers, and for the utilization of data across organizations and fields.

Moreover, as an advanced model of a data-driven society, we will promote the enhancement of the functions of SINET and initiatives for an information bank and data trading market, etc. originating in Japan in order to carry out social implementation, and we will tackle the establishment, etc. of mutually-approved protocols for trust services for their international standardization and data distribution with Europe and the United States.

(c) Development and Global Deployment of Research Data Infrastructure

We will take into consideration an open and closed strategy based on the national interest and the characteristics, etc. of the research fields, tackle the storage and management of research data in cyberspace, collaborate with the research data infrastructures of foreign countries to build an enormous "source of knowledge," and aim to realize a society in which all people can widely utilize

the research results. It is expected that this will lead to the acceleration of the creation of knowledge through new collaborations transcending affiliated institutions, specialist fields, and national borders.

To date we have formulated a range of guidelines, and the Ministry of Education, Culture, Sports, Science and Technology has taken the lead in carrying out the development of research data infrastructure systems. Furthermore, the Moonshot Research and Development Program carried out an investigation to promote advanced data management, for example, the early utilization of research data infrastructure systems, and it reflected the investigation results in operational and evaluation guidelines for the Program.

In FY2020 we will continue to promote the introduction of data policies to national research and development agencies and the introduction of mechanisms concerning the formulation of data management plans in the competitive research funding programs based on the guidelines, etc. formulated to date, and realize the full-scale operation of research data infrastructure systems within the fiscal year. Furthermore, regarding SINET, in addition to the upgrading of the network infrastructure for further improvement of the research environment, we will promote not only the gathering and forwarding of the data that is generated in diverse situations in research but also the enhancement of the functions for an integrated platform that merges the research data infrastructure systems with the former network infrastructure.

② Implementation of Society 5.0 (Social Implementation and Global Deployment of Knowledge)

(a) Implementation of Society 5.0 (Smart Cities)

We will carry out full-scale social implementation of Society 5.0 through the realization of smart cities. We will utilize the Smart City Public-Private Partnership Platform established in 2019, the Smart City Reference Architecture formulated in FY2019 as one of the results of SIP II, etc. for full-scale social implementation of the results of research and development and demonstration projects in government. Furthermore, in response to the revision of the Act on National Strategic Special Zones, we will promote early implementation of supercities equipped with data exchange platforms, through concentrated investment in existing projects of the relevant offices, ministries, and agencies, etc. The relevant offices, ministries, and agencies will cooperate to energetically tackle the overseas deployment of smart cities know-how and projects built up in Japan. Moreover, we will utilize international frameworks as well to effectively transmitting and promoting Japan’s concept of smart cities overseas.

In addition, the public and private sectors will collaborate to move all social and economic activities to cyberspace to the extent possible and realize the world-leading Society 5.0. When engaging in the social implementation of Society 5.0, we will advance in an integrated manner, collaborating with the concepts of Regional Circular and Ecological Sphere, etc. which solve the various issues of a region through the utilization of cutting-edge technologies.

Moreover, in 2025 the Osaka, Kansai World Exposition will be held. We will position this Expo as the “People's Living Lab (A laboratory for a future society),” tackle research and development

with the understanding that the Expo is an ideal opportunity to demonstrate the results of research and development, and, through the holding of the Expo, actively communicate Japan's research and development initiatives and the forms of its society after overcoming the novel coronavirus disease.

(b) Startups

It is important to revitalize the startup environment so that the venture companies which have the role of creating value from the "knowledge" generated from research and development and implementing it in society as businesses can thrive.

In order to further accelerate the creation and growth of startups, the public and private sectors will provide concentrated support for the startup ecosystem startup cities selected in July 2020, including the acceleration of startup creation in universities and the strengthening of accelerator functions, gap funding, etc., and we will carry out a review of the Japanese version of the SBIR and aim to improve its effectiveness, in order to form ecosystems that compete with the world's best and encourage social implementation of research and development results through startups. Moreover, in order to win in the global competition, we will strengthen the cross-sectoral collaboration of initiatives in the relevant offices, ministries, and agencies and government-affiliated institutions, "create" and "develop" outstanding startups, and accelerate initiatives that "connect" from the region to the world. Through the integrated promotion of these initiatives, we will form startup ecosystems that generate a series of startups from Japan that thrive globally.

(c) Utilization of Strategic Standards

In order to realize a Japan-led Society 5.0 through the "utilization of strategic standards," we will consider the form that the overall structure of society should take, build control tower functions for organically collaborating with a wide range of relevant parties including government organizations and affiliated institutions and private sector enterprises, encourage the monetization and social implementation of the technologies of Japan, and get the forms of utilization of standards to penetrate into the public and private sectors. Moreover, we will steadily develop intellectual infrastructure that contributes to the solution of social issues, and encourage the strengthening of international competitiveness and innovation in Japanese industries by promoting strategic initiatives for standards and intellectual property in emerging technologies.

(d) Promotion of Science, Technology and Innovation for Achieving SDGs (STI for SDGs)

In order to utilize the STI necessary for the realization of Society 5.0 to promote initiatives at the highest level in the world for the achievement of the 17 SDGs stipulated by the United Nations, we will formulate an STI for SDGs Roadmap in some fields, and the basic concept of roadmap formulation proposed by Japan at the G20 Osaka Summit was approved. In response to this, we will collaborate with international institutions such as the World Bank to provide support, etc. for roadmap formulation in the pilot countries. Furthermore, in order to deploy Japan's intellectual assets such as STI seeds, etc. internationally to contribute to the achievement of the world's SDGs,

we will tackle surveys and analyses and consultations with domestic and overseas stakeholders for the full-scale building and refinement of a platform that matches the intellectual assets with domestic and overseas SDGs needs and supports the creation of projects.

③ Transformation of Administrative Systems

(a) Digital Government

In order to not only respond to the novel coronavirus disease but also solve social issues such as the declining birthrate and aging population, it is necessary to thoroughly utilize the rapidly-progressing digital technologies to ensure that the national government, local governments, private sector business operators, citizens, and other people enjoy the benefits of digital technologies in all their activities and can strongly feel they have a safe and secure life and abundance.

For this reason, we must start by pushing through the administrative services reforms from the user perspective, and then promote the digitalization of the regions and the private sector to advance development of an environment suitable for a new era predicated on digital technologies.

When doing so, it is important to make efforts from the perspective of "digitalization," that is, building the new social infrastructure of the next era predicated on digital technologies, not so-called "digitization" which is only replacing previous methods with digital methods, such as enabling procedures carried out on paper and face-to-face to be simply carried out on-line, as in the digitalization to date.

Based on this idea, the Cabinet decided the Digital Government Implementation Plan in December 2019 based on the Digital Procedures Act (the post-revision Act on the Promotion of Administration Utilizing Information and Communications Technologies[17]), etc., and the Cabinet Secretariat and the relevant offices, ministries, and agencies will collaborate to accelerate the initiatives taking into account the response to the spread of the novel coronavirus disease.

(b) Promotion of Greater Innovation in Government Projects and Systems

In government projects and systems, it is necessary to actively utilize new technologies, including cutting-edge technologies, and to build mechanisms under which greater innovation in government projects and systems is carried out constantly, including developing systems to encourage the creation of innovation, reforming the regulations that are a factor obstructing the systems, etc. To date, we have tackled the formulation, etc. of public procurement guidelines for leadership of greater innovation by CSTI and the expansion of initiatives by each office, ministry, and agency, the aggregation and analysis of information pertaining to greater innovation, and encouragement of the utilization of small and medium-sized enterprises and venture companies, etc.

For the achievement of each objective, we will continue to promote initiatives for greater innovation in government projects and systems, and tackle prioritization of the necessary budget. In particular, based on the impact of the novel coronavirus disease, we will induce the development

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[17] Act No. 151 of 2002

and introduction of cutting-edge technologies, etc. and the expansion of investment in the private sector, while taking care to ensure that there is no delay in the recovery of the private sector's research and development investment compared to foreign countries.

(c) Evidence-Based Policy Making

From March 2020, concerning evidence systems, we started the use within the government of some functions such as visualization of the science and technology-related budget, analysis of the research capacity of national universities, national research and development agencies, etc. Furthermore, we utilized the data acquired as a consequence of building these systems for the follow-up to the Fifth Basic Plan, for the formulation of the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers and as the base data for the launch of the Program to Support Emergent Research. In FY2020, we will advance the expansion of functions, and start to use them within national universities and national research and development agencies.

Through this, we will promote Evidence-Based Policy Making (EBPM) that contributes to the management of the government research and development investment which primes private sector investment, with the aim of revitalizing innovation.

(d) Strengthening of the Control Tower Functions of Government

Based on the previous Integrated Innovation Strategy, the government established the Integrated Innovation Strategy Promotion Council (chaired by the Chief Cabinet Secretary) in July 2018 in order to achieve cross-sectoral and substantial coordination of the control tower councils deeply relevant to innovation such as the CSTI, the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society, the Intellectual Property Strategy Headquarters, the Headquarters for Healthcare Policy, the Strategic Headquarters for Space Development, the National Ocean Policy Secretariat, etc., and in July 2019 we established the Director General for Science, Technology and Innovation in the Cabinet Secretariat, with the aim of further strengthening collaboration among the control tower councils.

Moreover, in order to strengthen the control tower functions for coordinating cross-sectorally the Control Tower Council Secretariats, which are deeply related to STI policy, a revised draft of the Act for Establishment of the Cabinet Office[18] was established and promulgated in June 2020 in order to establish the Science, Technology, and Innovation Promotion Secretariat in the Cabinet Office in April 2021 as a permanent organization based on law.

Through this, we are intending to make collaboration and coordination with other Control Tower Council Secretariats closer and stronger when planning, formulating, and promoting STI policy, such as formulation, promotion, etc. of the Science, Technology, and Innovation Basic Plan and the Integrated Innovation Strategy under the Science, Technology, and Innovation Promotion Secretariat.

[18] Act No. 89 of 1999

(3) Strengthening Research Capacity, the Source of STI (Creation of Knowledge)

We will strengthen research capacity, the source of STI, and strengthen the qualities of the "human resources" which are Japan's greatest asset so that they are commensurate with the demands of this era, to build mechanisms under which young and old, male and female can all participate in society, under the philosophy of a human-centered society.

① Strengthening Research Capacity, the Source of Value Creation (Support for the Challenges of Young Researchers, Further Promotion of Humanities and Social Sciences, etc.)

In order to comprehensively and fundamentally strengthen Japan's research capacity through the triple reforms of human resources, funds, and the environment, the CSTI formulated the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers in January 2020. In order to achieve the objectives stated in the package, under the package, the government overall will advance the building of an environment leading to an improvement of the appeal of researchers, by steadily implementing system reforms and measures. In particular, in order to advance challenging research and research combining different fields, it is necessary to secure an environment in which researchers can dedicate themselves to their research without being bound by short-term results, so we have started support through the Program to Support Emergent Research. In conjunction with this, when considering the Next Basic Plan as well, we will carry out a study based on the latest data regarding the necessary measures and achievement objectives. Furthermore, in light of the fact that the promotion of STI is close to and inseparable from humans and society, we promote initiatives to solve the specific issues of society using further promotion of the humanities and social sciences and comprehensive knowledge that incorporates the knowledge with the natural sciences as well.

② Creation of Ecosystems through University Reforms, etc.

To date we have worked on ascertaining the needs of industry and academia in the Leaders' Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS), formulation of governance codes for national university corporations, and encouragement, etc. of the formulation of medium- to long-term personnel plans in national universities for the encouragement, etc. of the participation of young researchers, in order to ensure that universities, etc. become the core of ecosystems generating knowledge-intensive industries. Furthermore, the Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020. It includes a clarification to the effect that joint research can be implemented in business operators that have received investments from R&D institutes. Going forward, anticipating the 4th term mid-term objective periods of national university corporations, we will consider proposals to relax regulations, etc. to support the management reforms of universities, and develop the necessary policy, and promote the operation of governance codes of national university corporations and reforms of the national university corporation operation grants. Moreover, we will promote large-scale industry and academia Co-Creation among organizations by universities, national research and development

agencies, and private sector enterprises, etc., and make enhancements, etc. to the Guideline for Enhancing Industry-Academia-Government Collaboration Activities for the realization of a virtuous cycle of knowledge and funds.

③ Strategic Research and Development for the Solution of Social Issues

In FY2019 we decided six Moonshot Goals we will commence work on before anyone else. The objectives target social issues, etc. that are difficult to solve but they are expected to have a big impact if the projects are successful. In FY2020, we will promote Moonshot Research and Development Program under an integrated promotion structure involving the relevant offices, ministries, and agencies.

Regarding the results of SIP I, initiatives for social implementation are proceeding, and we will continue to ascertain the situation by conducting follow-up surveys. Regarding SIP II, we will implement an interim evaluation of the systems and issues during FY2020, reflect the evaluation in the systems from the next fiscal year onwards, flexibly revise the research and development structures and budget allocations, etc. in accordance with the evaluation results, and promote steady research and development pursuing social implementation.

Furthermore, regarding PRISM, taking into account the strategies, etc. formulated by CSTI, we will continue to promote the expansion of research and development investment by the public and private sectors through the acceleration, etc. of the projects of each office, ministry, and agency.

④ Development of Innovation Human Resources

In order to develop an environment in which ICT can be utilized in learning in the elementary and middle education stages, we have commenced the Global Innovation Gateway for All (GIGA) school project which aims to provide PCs/tablets to all pupils and to realize a communications environment that connects to households as well, and we have worked on recurrent education that responds to social needs and development of bases for innovation human resources development. In this context, human resources development responding to the Society 5.0 era in which social changes are extremely fast is increasingly important, so we will further promote education reforms and environment development concerning data and AI literacy, etc. from the elementary and middle stages to the university and graduate school stages. Furthermore, at a time when the industrial structure is changing rapidly, opportunities for relearning are necessary so that the new findings and viewpoints necessary in the realization of knowledge-intensive value creation can be obtained, so we will advance environment development such as support for the development of practitioner education and establishment of forums for discussion in industry and academia, etc.

⑤ Strengthening of an International Network

We will strengthen the international network in research and development in order to improve the research capacity of Japan, and in order to lead international collaboration in STI we will strongly promote measures concerning the promotion of international joint research in international

universities, etc., the globalization of universities, the development of international research hubs for cutting-edge research and development fields, the promotion of international standardization based on the Industrial Standardization Act,[19] and leadership of international rulemaking in AI social principles and the open science environment, etc. Note that when doing so, it is of course necessary from the perspective of the security of Japan to take extreme care to prevent leakages of sensitive technologies, and in addition it is necessary to ensure the soundness and fairness of the research (research integrity).

(4) Major Fields that Should Be Advanced Strategically

① Fundamental Technologies that Should Be Tackled Strategically

AI technologies, biotechnology, and quantum technologies are cutting-edge fundamental technologies that can have an impact on all STI, so we will promote the world's most advanced research and development, human resources development, and the upgrading of measurement and analysis technologies, etc. based on the strategies concerning each field formulated to date. Furthermore, at a time when the materials field, which has become a strength of Japan, is gaining importance as a fundamental field, international competition has become cutthroat, so it is necessary to formulate a new strategy and to promote initiatives with a strong national commitment.

(a) AI Technologies

The utilization of artificial intelligence (AI) is progressing widely in society and the United States, China, and other foreign countries have formulated national strategies concerning AI, and are engaging in fierce competition to lead the world. In this context, AI brings enormous benefits to society while on the other hand we perceive that appropriate development and social implementation of AI is required because its influence is so large, so in June 2019 Japan formulated AI Strategy 2019 (Integrated Innovation Strategy Promotion Council Decision) to disseminate "AI for Everyone: People, Industries, Regions and Governments."

This AI Strategy 2019 lays out the concrete objectives concerning education reforms, the rebuilding of research structures, social implementation, data-related infrastructure development, ethics, etc., and the measures that the national government should take the lead in tackling, and the relevant offices, ministries, and agencies, etc. are promoting each of the initiatives in order to realize the said objectives. Going forward, we will steadily execute this strategy, and will advance initiatives regarding how to secure the fairness, transparency, explainability, etc. of AI, as initiatives that will influence the degree of progress of social implementation of AI.

(b) Biotechnology

Regarding biotechnology, all industries are in a situation that can be described as becoming biological due to the progress of synthetic biology, genome editing technologies, etc. Western

[19] Act No. 185 of 1949

countries, China, etc. have positioned expansion of the bioeconomy as a national strategy, and are strongly promoting not only research and development but also diverse measures such as regulations, public procurement, etc. Based on these trends in the world, in June 2019 we formulated Bio Strategy 2019 (Integrated Innovation Strategy Promotion Council Decision), the first phase of a comprehensive policy package with the objective of "realizing the world's most advanced bioeconomy and society by 2030."

Based on Bio Strategy 2020 (Foundational Measures) (June 2020 Integrated Innovation Strategy Promotion Council Decision), which implemented and updated Bio Strategy 2019, we will steadily promote initiatives for the achievement of the objectives, including promotion of a market domain roadmap, formulation of biodata exchange and utilization guidelines and promotion of initiatives based on the guidelines, formation of and encouragement of investment in a global biocommunity and regional biocommunities, development of biomanufacturing demonstration and human resources development hub functions in the global biocommunity, etc.

(c) Quantum Technologies

At a time when AI and data exchange platforms are extremely important for the switch to a knowledge-intensive economy and society, quantum technologies are being positioned as the fundamental technologies that are the key to this switch. For example, expectations are rising of quantum computers and quantum measurement and sensing, quantum communications and cryptography and other quantum technologies as technological systems that will bring about dramatic innovations in realization of a productivity revolution in Japan, realization of a healthy and long-lived society, and in securing the safety and security of our nation and its citizens.

For this reason, in January 2020 Japan clearly established a vision of the future society made possible by quantum technologies, in order to compete with the best in foreign countries in the development of quantum technologies while securing the future growth of our nation and safety and security of our nation and its citizens, and then formulated the Quantum Technology Innovation Strategy (Integrated Innovation Strategy Promotion Council Decision) which paints the broader picture for the nation overall. Going forward, based on this strategy, we will strongly promote comprehensive and strategic initiatives for quantum technologies innovation with a strong national commitment.

(d) Materials

The materials field is a strength of Japan, but that strength has begun to be lost in recent years. We will formulate a government strategy concerning the materials field in order to tackle the creation of new value and industries through materials and the strengthening of the industrial competitiveness and research capacity that supports this, and to drive global industry and innovation.

Furthermore, in advance of the strategy, we will aim to promote an industry, academia, and government platform for the creation, sharing, storage, distribution, and utilization of good-quality materials data that greatly improves materials research and development capacity.

② Applied Fields that Should Be Tackled Strategically

At a time when global issues are becoming more serious, in applied fields such as safety and security, the environment and energy, food and agriculture, forestry, and fisheries, etc., Japan will anticipate opportunities for the solution of social issues while having its own strategy, and promoting initiatives through collaboration between industry, academia, and government. In particular, regarding the two fields of healthcare and space, we have respectively formulated the Healthcare Policy and the The Plan for Promotion of Medical Research and Development (March 2020 Cabinet Decision), and the Basic Plan for Space Policy (June 2020 Cabinet Decision), and it is necessary to strategically advance initiatives in line with these.

(a) Safety and Security (Realization of Comprehensive Security with Respect to a Wide Range of Threats, such as Large-Scale Natural Disasters, Global Outbreaks of Infectious Diseases, etc.)

As the security environment surrounding Japan grows increasingly testing, people's lives and social and economic activities are being exposed to a wide range of threats, including natural disasters such as earthquakes, volcanic eruptions, typhoons, etc., global outbreaks of infectious diseases, international terrorism and crimes, and cyber attacks to a greater extent than anticipated, as made clear by the response to the present novel coronavirus disease and a series of large-scale disasters. Furthermore, countries are engaging in fierce competition in cutting-edge basic research, etc. pertaining to safety and security, and the struggle for supremacy in STI centered on the United States and China is intensifying while on the other hand concerns are growing that cutting-edge technologies will pose a wide range of threats to people's lives, etc.

Actually, information gathering by each country is becoming more active, and leakage of technical information and technical human resources are already occurring.

In order to maintain the peace of Japan, secure the safety and security of our citizens, and realize comprehensive security, it is necessary for the relevant offices, ministries, and agencies, industry, academia, and government to collaborate to pool the advanced scientific and technological capacity of Japan.

In order to respond to these kinds of domestic and overseas environmental changes surrounding safety and security, we will deploy concrete measures taking into account The Direction of Science, Technology, and Innovation for Realization of "Safety and Security" formulated in the Integrated Innovation Strategy Promotion Council in January 2020.

As the security environment surrounding Japan grows increasingly testing, it is necessary to enhance observation, forecasting, analysis, etc. to accurately "identify" the threats themselves and to "identify" the technologies that can respond to the threats and the technologies that can become threats.

In order to appropriately utilize results taking into account the ambiguity of science and technology, we will carry out matching of technology seeds and technology needs, including identification and sharing of technology needs, ascertaining domestic and overseas research and

development trends, etc., and advance the building of a path toward identification of the important technology issues that should be strategically developed in Japan and the social implementation of those research and development results.

We will consider institutionalization, including new think tank functions, that will support this process.

Furthermore, regarding the important technologies for the realization of safety and security, the relevant offices, ministries, and agencies, industry, academia, and government will collaborate to tackle the promotion of research and development programs that include social implementation objectives, and to build a roadmap from research and development to social implementation, etc. as initiatives to "develop" and "utilize" these technologies.

Furthermore, we will advance initiatives for steady implementation of research and development results pertaining to disaster prevention and reduction, etc. in the national government and local governments, and in addition we will proceed with verifications of systematic factors that are hindering social implementation and as necessary investigate revisions to systems and operations such as public procurement and standards, etc.

As an initiative to "protect" technologies for preventing leakage, the relevant offices, ministries, and agencies will collaborate to tackle investigations of technology leakage prevention countermeasures responding to a variety of leakage channels, including systems aspects.

In addition to the previous initiatives, we will further advance information gathering about the actual state of technology leakage, including information theft in corporate acquisitions and cyberspace, and measures pertaining to technology management and results publication in foreign countries, while also summarizing the issues in initiatives in Japan going forward to advance investigations about the necessity, effectiveness, etc. of the measures and advance the building, etc. of a specific measures framework, and reliably take the structural measures, etc. necessary for realization of this policy.

(b) Environment and Energy

The need for creation of discontinuous innovation and early realization of costs that enable social implementation is growing in this field. For example, at COP25 held in December 2019, a statement urging the state parties to take ambitious climate change measures was incorporated in the decision document.

Taking into account this situation and aiming to establish by 2050 innovative technologies that enable the carbon-neutrality of the world and CO_2 reduction on a past stock basis (beyond zero), we formulated the Progressive Environment Innovation Strategy in January 2020 in order to achieve social implementation for the objectives laid out in the long-term strategy. In FY2020 we will reliably execute this strategy by launching the Green Innovation Strategy Meeting, advancing the implementation of the five fields, 16 challenges, and 39 technological themes (Innovation Action Plans), mechanisms for social implementation of these technologies (Acceleration Plans), and mechanisms for international co-creation and outreach (Zero-Emission Initiatives) presented in the

strategy, and compiling the status of progress as the Progressive Environment Innovation Strategy Progress Report every year.

Furthermore, when building the social and economic structure after the infectious disease is brought under control, we will aim to switch to a resilient and sustainable society for the realization of a “virtuous cycle of the environment and growth”.

(c) Health and Medical Care

As stated in PART II, stopping the spread of the novel coronavirus disease and preparing for further infectious disease going forward are urgent issues.

Additionally, as we go through the fourth industrial revolution, research and development is proceeding in the medical care field and life sciences fields globally, and it is expected that due to the acceleration of innovation in these fields, research and development such as elucidation of disease mechanisms and development of new diagnostics and medical treatment methods, drug discovery through the utilization of AI and big data, etc., and individualized medical care, precision medical care, etc. tailored to the situation of individuals will make progress. Against the background of these kinds of changes to the situation, we formulated the 2nd health & medical strategy and the Plan for Promotion of Research and Development in the Medical Care Field for the period FY2020 to FY2024 in March 2020.

Going forward, to promote research and development in the medical care field, we will collaborate with other funding agencies, in-house research institutions, and private sector enterprises to promote in an integrated manner research and development in the medical care field that is integrated from basic research to practical application, with support by AMED at the core.

Furthermore, to develop the environment for research and development in the medical care field, we will promote the development of structures and mechanisms in bridging research support hubs and clinical research core hospitals, the development and securing of specialist human resources such as biostatisticians, etc. and specialists in regulatory science, the dissemination and enhancement of regulatory science in research and development, etc.

Moreover, for the creation and global deployment of new industries, we will promote health management for the encouragement, etc. of health care industries other than public insurance, promote regional and occupational collaboration, and encourage initiatives for building the health of individuals, etc., and under the Asia Health and Wellbeing Initiative and the Africa Health and Wellbeing Initiative, we will aim to promote autonomous industrial promotion in each country and to contribute to a broad-based health and medical care field, in order to promote the global deployment of the health and medical care-related industries of Japan.

(d) Space

Today, when the role of space systems in the security, economy, and society of Japan is getting larger, space activities are moving away from the previous public sector-led approach into an era of public and private sector Co-Creation, and the revitalization of industries through the use of space

is being attempted in a wide range of fields. Moreover, due to the progress of space exploration, the domain of activities of the human race has gone beyond the Earth's orbit and is expanding to the surface of the moon and even further into deep space. Space is becoming more important as a frontier of science and technology and also as a driver of economic growth. Space can also become a large driver of the creation of innovation in Japan.

On the other hand, at a time when the growth of threats in outer space is being indicated, the momentum toward positioning space as a "warfighting domain" and an "operational domain" is growing in the United States and other countries, and space security has become an urgent issue. Furthermore, the building of constellations of small and ultra-small satellites is proceeding, which is changing the game in the space industry. The space equipment industry of Japan is lagging behind with respect to these trends, and at a time when the relevant technologies are rapidly evolving, reinforcement of industrial, scientific and technological infrastructure is an immediate challenge for the maintenance of the independence in space activities Japan built up after the end of the Second World War.

In June 2020 we compiled the new Basic Plan for Space Policy as the basic guidelines for a ten-year space policy, recognizing this huge potential of space and the severe situation Japan is currently facing, and anticipating the next 20 years.

Going forward, we will promote establishment of a structure for the Quasi-Zenith Satellite System that started service in November 2018 and a ten-unit system for the information gathering satellites, participation in international space exploration, promotion of space science and exploration, development and upgrading of mainstay rockets, investigation of future space transportation systems, building of a framework for strategically promoting the development and demonstrations of satellites, development of satellites contributing to disaster management, national resilience, and resolving global issues, expansion of the use of satellite data, and strengthening of the human resource base supporting space activities, etc.

(e) Food and Agriculture, Forestry, and Fisheries

Regarding food and agriculture, forestry, and fisheries, it is necessary to utilize the power of science and technology to protect and develop Japan's abundant food and environment, and to aim to strengthen the international competitiveness of agriculture, forestry, and fisheries for the expansion of exports, etc. by capturing the expanding overseas demand. For this reason, we will give the priority to tackling smart agriculture, forestry, and fisheries, environmental problems such as climate change, etc., biotech food and materials, etc. through collaboration with diverse fields outside agriculture, forestry, and fisheries.

Regarding agriculture, in order to respond to diverse needs, it is necessary to contribute to increasing productivity drastically and increasing the incomes of farmers by having farmers practice innovative agriculture in which data is fully used and smart agriculture technologies are introduced. Furthermore, we will contribute to increasing the brand power of the agriculture of Japan and reducing food losses and waste by deploying production bases utilizing our smart agriculture

technologies and systems to the Asia-Pacific and other regions.

Furthermore, regarding forestry and fisheries, we will implement new technologies such as ICT, AI, robot technologies, etc. in worksites to contribute to turning these industries into growth industries. Moreover, we will work on the response to climate change using sustainable agriculture, forestry, and fisheries, food and health utilizing cutting-edge biotechnologies, and the development of technologies such as smart breeding, new materials, etc.

(f) Other Applied Fields

In addition to the fields stated above, it is necessary to strategically tackle the oceanic field, the radiation and radioactive isotopes field, the field of "Monozukuri" (Manufacturing) and “Kotozukuri” (Value Creation) using data, etc.

PART II: Response to the Difficult Situation of Japan Caused by the Novel Coronavirus Disease (COVID-19)

CHAPTER 1: Analysis of the Current Situation

Regarding the novel coronavirus disease (COVID-19) caused by the novel coronavirus (SARS-CoV-2) that is thought to have broken out primarily in Wuhan City, Hubei Province, China in about December 2019, infected people had been confirmed on all of the seven continents on Earth except the Antarctic Continent by late February 2020. On March 11, 2020 the WHO made the assessment that "the spread of the novel coronavirus disease can be characterized as a pandemic" and it is having an enormous impact on activities in daily life and the economy and society, such as the forms of the daily lives of people, the forms of public services such as education, medical care, transportation, etc., the forms of supply chains in industrial fields, etc. The huge stagnation of human society has also become a tipping point that is greatly changing the value that people took for granted until now. This switching of value is much larger than the improvement of the convenience, efficiency, etc. of individuals and society by new technologies; it goes to the core of people's humanity, to the question "how should I live my life?"

A declaration of a state of emergency was issued based on the revised Act on Special Measures for Pandemic Influenza and New Infectious Diseases Preparedness and Response adapted to the novel coronavirus disease, and as all economic and social activities stagnated, there was a wide-ranging impact on STI. In particular, concerning the digitalization of society, the delay with respect to foreign countries in all situations including school education, research activities, telework, administrative procedures, etc. became noticeable. Furthermore, in STI activities as well, findings from social sciences such as behavioral economics, etc. and evidence-based policy decisions have been necessary and essential in controlling the disease outbreak, and the importance of the data for that purpose and the aggregation and analysis of the data, and infrastructure foundations such as communications networks and supercomputers, etc. has become extremely high. Changes in the innovation process are noticeable, and large changes are occurring. For example, the international sharing and utilization of research data has accelerated, including the rapid progress in the utilization of academic paper data published in preprints,[20] and the possibilities for innovation across fields are increasing, etc. On the other hand, the economic shock to the startup enterprises which play an important role in innovation is noticeable; furthermore, stagnation is occurring in the industry-academia collaborative research activities, etc. which are a source of new startups, so it is necessary

[20] This is an academic paper which is a manuscript written with the objective of publishing it as an academic paper in a journal (scholarly periodical) that is uploaded to a server on the Internet before peer review at the completion stage. Compared to an original academic paper published after going through peer review, etc., the results are published faster, enabling the rapid sharing of research results and the effective global utilization of the latest findings. It is necessary to be careful about the fact that sufficient reliability cannot be guaranteed because such academic papers have not gone through peer review, etc. but there are also indications that their use grew rapidly in analyses, etc. of the coronavirus disease, and the building of a selection mechanism by the market has been progressing.

to advance initiatives for recovery in order to avoid inviting a decline in the creation of innovation.

In a situation in which the problems with existing social systems have emerged in this way, in order to overcome the difficult situation the world is facing and establish a new daily life (a new normal), it is necessary to greatly advance digital transformation (DX), and revise regulations, commercial practices, and consumer behavior to advance the structural transformation to a sustainable, resilient, and inclusive society, and the philosophy of Society 5.0 proposed by Japan has now become even more important. Especially now, we are required to fully mobilize STI policy to advance the initiatives with a sense of urgency.

CHAPTER 2: Specific Measures

1. Strengthening of the Response to the Public Health Crisis

In the past the infectious diseases that caused global major disease outbreaks (pandemics) were not a one-off crisis; they brought crises to people's lives and society through intermittently continuing disease outbreaks, such as "second waves," etc. The Spanish Flu, an influenza that caused a pandemic during the First World War also killed more people in its second wave than its first. In the case of the novel coronavirus disease as well, it is necessary to advance our response appropriately keeping in mind medium- to long-term initiatives such as our response to the second wave, etc.

Furthermore, there continues to be a threat from not only novel influenzas and the present novel coronavirus disease but also from emerging infectious diseases, which are the infectious diseases that have been newly discovered in recent years, including severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), etc. Moreover, there are fears about reemerging infectious diseases such as tuberculosis, cholera, malaria, etc. which had been brought under control at one time and were perceived to be "infectious diseases of the past" but are now the number of people infected with these diseases is increasing in developed countries again. Furthermore, bacteria, etc. which are the cause of hospital-acquired infections that have antimicrobial resistance (AMR) with respect to medical drugs are emerging and medical treatment is becoming difficult in some cases. Many people who have experienced the threat from the spread of the novel coronavirus disease strongly feel that it is necessary to utilize all of the power of STI, including not only the natural sciences but also the humanities and social sciences, in order to strengthen our capacity to respond to these public health crises that are here now and the ones that will come in the future. The particularly important issues are developing and securing diverse human resources for responding to the crises, the development of structures, and the improvement of international collaboration.

(1) Overall Policy Investigation and Verification

○ Regarding the novel coronavirus disease, under the policies stipulated by the government such as the Basic Policies for Novel Coronavirus Disease Control (March 28, 2020 Novel Coronavirus Response Headquarters Decision, revised on May 25, 2020), etc., we will work on domestic and overseas collaboration while promptly promoting countermeasures such as the necessary research and development, etc. When doing so, we will investigate the necessary countermeasures keeping in mind issues such as the forms of application of regulations pertaining to medical care at times of emergency. [Cabinet Secretariat, MEXT, MHLW]

○ With the objective of strengthening public health crisis prevention, detection, and response capacities, we will carry out a verification of the novel coronavirus disease countermeasures at an appropriate time after the novel coronavirus disease crisis has ended. Furthermore, we will utilize scientific and technical findings to identify more effective initial responses and subsequent countermeasures with regards to a public health crisis, and utilize them in countermeasures against the emergence of infectious diseases and disease outbreaks which are a threat to the health security of Japan.

[Cabinet Secretariat, MHLW, relevant offices, ministries, and agencies]

(2) Promotion of Research and Development, etc. pertaining to Novel Coronavirus Disease Countermeasures

① Research and Development such as Development of Diagnostic Methods, Medical Treatment Methods, and Vaccines, and Development of Instruments and Systems, etc.

○ We will promote research and development aimed at overcoming infectious diseases. [AMED, MEXT, MHLW, METI]

- In order to develop diagnostic methods for the novel coronavirus disease, we will strengthen the testing structures in the National Institute of Infectious Diseases, and carry out foundational research and development, etc. of rapid diagnostic kits.
- In order to develop medical drugs for the novel coronavirus disease, we will select medical drug candidates and develop antiviral drugs using structural analysis technologies, etc., and investigate the therapeutic efficacy and safety of existing drugs with respect to the novel coronavirus disease.
- In order to promote development of those candidates for new drugs focused on a different mechanism of action, etc. from existing medical drugs which are medical agents that can be expected to have particularly good efficacy, we will provide priority support for research seeds for which research and development is already proceeding, and support for the research and development necessary for their early entry into clinical trials.
- We will support the implementation of basic research, non-clinical trials, and clinical trials through the active utilization, etc. of expert human resources and expert contractors for the

development of a vaccine for the novel coronavirus disease.

- We will support systems for simple, rapid and decentralized virus testing and prevention of the spread of infection, the development and demonstration, etc. of medical equipment, etc. for seriously ill patients, etc.
- We will gather data about the novel coronavirus disease in Asian countries.
- Through industry, academia, and government collaboration, we will promote research and development for the creation of innovative pharmaceuticals and medical equipment, etc., including novel coronavirus disease countermeasures.
- We will accelerate the development of prevention methods, diagnostic methods, and medical drugs by collecting and analyzing specimens such as blood samples, etc. domestically and overseas.
- We will develop diagnostics and medical treatment methods and clarify states of illness based on new research trends and scientific findings, etc., and implement survey research such as detailed examinations of epidemiological information, investigations of forms of structures for protection against infection, etc.
- We will strengthen and enhance the research base for novel coronavirus disease countermeasures, including strengthening support for drug discovery research and implementation of foundational research in overseas infectious disease research hubs, etc.

② Implementation of Research Tasks Utilizing a Cutting-Edge Research Base

○ We will advance the utilization of research concerning novel coronavirus disease countermeasures, in particular using the Fugaku supercomputer and SPring-8/SACLA.

[Cabinet Secretariat, MEXT, METI]

- We will utilize the trial use of the Fugaku supercomputer (implemented from FY2020), which has the objective of starting shared use from FY2021, to implement early research contributing to novel coronavirus disease countermeasures, such as identification of novel coronavirus disease medical drug candidates, etc., and we will implement research tasks contributing to novel coronavirus disease countermeasures through the extraordinary public recruitment of utilization of the computational resources of an innovative High Performance Computing Infrastructure (HPCI), which comprises the supercomputers of universities, national research and development agencies, etc.
- We will use the protein and material structural analysis technologies in SPring-8/SACLA to implement research tasks contributing to the development of medical drugs, medical materials, etc. for the novel coronavirus disease.
- From the perspective of advancing both social and economic activities and novel coronavirus disease countermeasures at the same time, we will aim for the realization of smart lives, and utilize the data and findings obtained from previous countermeasures to promote projects utilizing AI simulations, etc.

③ Development of an Environment for Research and Development

○ We will develop survey structures and a research base for novel coronavirus disease countermeasures. [AMED, MEXT, MHLW]

- We will upgrade safety evaluations, etc. of medical drugs and evaluate the performance of in vitro diagnostics, etc. pertaining to the novel coronavirus disease.
- We will develop structures for preventing the spread of infection through genome analysis, etc. pertaining to the novel coronavirus. For example, we will strengthen virus mutation analysis using genome analysis technologies and build structures for precisely ascertaining the spread, etc. of the mutated virus and survey structures using technologies that rapidly measures the antibody valence of blood serum samples.
- We will build a research and development platform that can immediately respond to a new infectious disease outbreak, by advancing research and development tailored to an infectious disease outbreak, such as the development of structures that can renovate and develop existing BSL3 units to tackle research and development using animal models of infection.
- We will develop a cryo–electron microscope in BSL3 facilities in order to strengthen and enhance functions for searching for target factors of anti-infective drugs for the development of medical drugs to treat the novel coronavirus disease.

④ Initiatives through International Collaboration

○ We will promote international collaboration and international joint research, etc. pertaining to the novel coronavirus disease countermeasures from the perspective of STI.

[STI, MOFA, MEXT, MHLW]

- We will investigate the forms of international research cooperation taking into account the discussions in the G7 Science and Technology Ministers' Meeting, the teleconferences by chief scientific advisors, etc., which have held exchanges of views regarding the role that science and technology plays in the encouragement of novel coronavirus disease countermeasures and economic recovery.
- We will promote collaboration concerning heath security, such as sharing the findings of each country, etc., in the Global Health Security Initiative (GHSI), an organization in which the G7, Mexico, the European Union, and the WHO participate.
- We will cooperate with the research funding agencies in each country to promote international joint research pertaining to the novel coronavirus disease by researchers in Japan and its partner countries in the fields of infectious disease modelling and resilience improvement, etc. We will encourage international collaboration for research tasks that have already been adopted by research funding agencies and are recognized as having scientific significance.
- We will support the establishment of an ASEAN Centre for emerging diseases and public

health emergencies covering all of ASEAN, with the objective of preventing the spread of the novel coronavirus disease and future infectious disease outbreaks in ASEAN and Japan.

- We will promote the acceleration of the "novel coronavirus disease countermeasures" at the Asian level and with the involvement of the industrial world, by building software projects (human resources development, data gathering, evaluation methods, etc.) that enable Asian joint development (clinical research and clinical trials) based on the capability and experience of Japan's clinical research hubs. We will build the software projects in an integrated manner combined with hardware support, etc. such as the medical equipment and supplies, etc. necessary for the hubs.
- We will made donations to the Coalition for Epidemic Preparedness Innovations (CEPI) and Gavi, the Vaccine Alliance.

⑤ Development of Structures for Early Practical Application of Vaccines

○ In parallel with vaccine development, we will develop production structures and buy syringes and injection needles, etc. [MHLW]

(3) Continuation of Economic Activities and Maintenance of the Functions and Strengthening the Response Capacities of Medical Care Institutions, Public Health Institutions, etc. when there is a Disease Outbreak, through the Utilization of New Technologies and Services

○ We will utilize the results of advanced diagnostics and medical treatment systems by AI hospitals, develop consultation assistance systems for the novel coronavirus disease using artificial intelligence avatars, and build data exchange platforms contributing to the development of medical drugs and vaccines. [STI]

○ Regarding the novel coronavirus disease countermeasures, through the activities, etc. of the tech teams called "Anti-Covid-19-Tech Teams" we will utilize IT and data to take initiatives for infectious disease countermeasures and new lifestyles from a macro perspective, and encourage information transmission using open data. Furthermore, we will link the contact confirmation app that notifies the possibility of contact with people who have tested positive for the novel coronavirus disease, which was designed as a part of the initiatives by the tech teams, with the Health Center Real-time information-sharing System on COVID-19 (HER-SYS) to create more effective measures to prevent the spread of infection in health centers, etc. [Cabinet Secretariat, PPC, MIC, MEXT, MHLW, METI]

○ We will carry out industrial development, including startups and ventures, so that the public health countermeasures and new technologies and services that supported the lives and economic activities, etc. of citizens at the time of the disease outbreak can be utilized in society after the disease outbreak as well. These initiatives contribute to STI for SDGs, so we will also utilize them in initiatives related to the SDGs. Moreover, we will publicly recruit and give awards in the Japan Open Innovation Prize, etc. for the wide gathering and horizontal

deployment of good example models. [STI, relevant offices, ministries, and agencies]

○ We will apply the results of research and development pertaining to information and communications technologies for countermeasures against the novel coronavirus disease, etc., and carry out demonstration experiments, etc. for the practical application of light irradiation equipment for sterilization using high-strength, deep ultraviolet LEDs that is portable and can kill the novel coronavirus, etc. efficiently. [MIC]

(4) Infectious Disease Countermeasures Research and Strengthening of Human Resources Development, Utilization of the Knowledge of the Humanities and Social Sciences

(Research Support and Development of Research Human Resources)

○ Through industry, academia, and government collaboration, we will promote research and development for the creation of innovative pharmaceuticals, medical equipment, etc., including novel coronavirus disease countermeasures. [AMED] [Restated]

○ We will provide support for research to infectious disease research hubs with a BSL4 facility at their core, conduct basic research that contributes to epidemiological research, prevention, diagnostics, and medical treatments in disease outbreak areas, and strategic international joint research, etc. that includes the humanities and social sciences fields, and work on the storage and utilization of clinical, epidemiological, and other data in preparation for future outbreaks, the basic research that can contribute to infectious disease countermeasures from a medium- to long-term perspective, and enhancement of the research base that supports those kinds of research. Furthermore, we will accelerate research and development for simulations of infectious diseases, etc. through user collaborations by local governments, the industrial world, etc. Moreover, regarding the infectious disease countermeasures research implemented by Japan for many years in countries around the world, we will promote the development of research human resources through basic research.

[Cabinet Secretariat, MIC, MEXT, MHLW, METI]

○ We will strengthen cooperation structures between the veterinary medicine field and the public health field using a one-health approach, in order to promote research pertaining countermeasures to emerging and reemerging zoonotic infectious diseases, etc. which have the potential to harm both people and animals. [MHLW, MAFF]

○ We will enhance the findings regarding the increase in infectious disease risk due to the temperature rises, etc. that are a consequence of climate change and provide information using the Climate Change Adaptation Information Platform (A-PLAT). Furthermore, keeping in mind the increasingly serious meteorological disasters caused by the impact of climate change, we will conduct surveys related to the multiple risks and countermeasures of infectious diseases and meteorological disasters, etc. and carry out investigations of countermeasures taking these into account. [MEXT, MOE]

(Humanities and Social Sciences Research, etc. Necessary for Investigations of Countermeasures)

○ Regarding the constraints on the lives and economic activities of the citizens when there is a large-scale outbreak of an infectious disease, the lifting of those constraints, and their social impact, etc., we will build industry, academia, and government networks and systems capable of investigations from multifaceted perspectives using not only data on medical care, etc. but also incorporating data from the social sciences such as economic indexes and data on transportation, logistics, human flows, etc., and we will advance the development of expert human resources possessing the knowledge necessary to prepare for emergency situations arising from outbreaks of infectious diseases or other risks and for normal times.

[Cabinet Secretariat, MEXT, MHLW]

○ Research that analyzes the reactions of citizens and consumers to the variety of social phenomena caused by the novel coronavirus disease in order to upgrade techniques such as evidence-based risk judgments, coordination among interests leading to the fair allocation of risk, the presentation of scientific evidence in social decision-making at times of emergency, etc. contributes to policy-making in public health administration, etc., so we will utilize these kinds of findings from the humanities and social sciences, including behavioral economics and social psychology, etc. to give priority to support for research that contributes to solution of the issues. [MEXT]

(5) Development of Structures in Preparation for the Occurrence of Future New Infectious Disease Crises

○ In order to improve the basic research capability pertaining to infectious diseases and develop and secure human resources, etc., we will provide the necessary support for the development, etc. of the BSL4 facility, and strengthen collaboration among the related institutions. Furthermore, we will work to strengthen the crisis management and response capacities of Japan with reference to the United States' CDC, etc., and we will develop rapid research and development structures such as crisis response pharmaceuticals and medical equipment, etc. to solve the issues at a time of emergency. [Cabinet Secretariat, MEXT, MHLW]

2. Support for Stagnating STI Activities
~ Emergency Support (Support for the Employment of Researchers, the Continuation of Research Activities, etc.) ~

Due to the impact of the novel coronavirus disease, there are concerns on the frontline of innovation creation that there will be a rapid fall in investment in startups and collaboration between

industry and academia;[21] moreover, constraints, etc. on the research activities of universities continue to be seen. There is a possibility that these constraints will go beyond a temporary stagnation in innovation activities and will have an impact even after the impact of the novel coronavirus disease has been brought under control to some extent.

On the other hand, in the transformation period when new systems and rules, services and businesses are established for the global reconstruction from the novel coronavirus disease, many innovations will arise and some of them will become embedded in society, so these activities are extremely important and have a decisive meaning. In Japan as well, it is necessary to work to maintain innovation ecosystems by strategically anticipating a future strong fightback and supporting young researchers, etc. aiming for startups and entrepreneurship and collaboration between industry and academia, etc.

① Maintenance and Strengthening of Ecosystems

○ Startups, which are key players in innovation, are in a situation in which their activities are forced into stagnation due to the rapid fall in the funds supply in response to fluctuations in the market and the enormous opportunity losses, etc. due to the stopping of operations by major companies, and there are concerns that the impact of this could last for a long time. For this reason, we will work to support the supply of growth funds based on public funds and the fund composition of private sector venture capital. Furthermore, in order to strengthen innovative research and development, etc. that contributes to the solution of social issues, in particular infectious disease and disaster countermeasures, by researchers aiming to create startups and ventures out of universities, etc. and the response to the post-corona social transformation, we will work on support for research and development such as large-scale funds support by research funding agencies, etc. (Gap Fund supply), etc., and the strengthening, etc. of investments by R&D institutes. Moreover, anticipating the time after the spread of the infectious disease has been brought under control, we will further promote the formation of startup ecosystems based on the Support Package for the Formation of a Startup Ecosystem compiled by the Cabinet Office, etc. in July 2020. [STI, MIC, MOF, MEXT, METI]

○ The domestic events and meetups and overseas large-scale events that provide opportunities for the expansion of projects by startups have all been cancelled, and therefore they are losing

[21] Due to the impact of the global financial crisis, triggered by the bankruptcy of Lehman Brothers, which occurred from 2007 to 2008, the amount of investment for startups declined from 279 billion yen (2006) to 87.5 billion yen (2009) (results from a survey by the Venture Enterprise Center (VEC)), so the growth of startups was hindered. Due to the impact of the novel coronavirus disease, a trend to freeze the supply of funds from VCs and major companies to startups is already emerging, so there are concerns that a lack of funds supply will occur in the same way as at the time of the bankruptcy of Lehman Brothers. Furthermore, regarding the amount of research funds, etc. in universities, etc. that are received from companies, a loss of approximately 108 billion yen occurred due to the global financial crisis (estimate by the Ministry of Education, Culture, Sports, Science and Technology). Even if we suppose that the decline in joint research expenditure from companies due to the impact of the novel coronavirus disease is at the same ratio as at the time of the bankruptcy of Lehman Brothers, there is a danger of a reduction of at least 200 billion yen of investment over the ten years from FY2020 (estimate by the Ministry of Education, Culture, Sports, Science and Technology).

opportunities to get new clients and funds and to secure human resources, so after the situation settles down we will provide support for utilizing existing projects and holding these activities. Furthermore, opportunity losses are occurring for students, researchers, etc. aiming to be entrepreneurs, so we will work on the provision of learning support using online content and the fostering of teachers in order to support challenges by the young talent that will drive the post-corona social transformation, and advance development of an environment for entrepreneurship activities including ICT, etc. and entrepreneurship education that includes the regions. [STI, MEXT, METI]

○ In order to prevent a rapid slowdown in the research and development investment for collaboration between industry and academia due to the impact of the novel coronavirus disease and avoid a vicious cycle, we will promote measures for joint research and development by industry, academia, and government aiming to create outstanding new projects leading to social transformation and the solution of social issues after the corona shock and measures for building a permanent ecosystem by encouraging open innovation and strengthening the functions of local universities. [STI, MEXT, METI]

○ We will contribute to the planning and formulating, etc. of precise, evidence-based policy, and maintain and strengthen the ecosystem, by surveying and analyzing the impact, etc. of STI activities on funds, human resources, environment, research process, results, etc. in universities, enterprises, etc. caused by the novel coronavirus disease. [MEXT]

② Maintenance of Research Activities

○ There are concerns about the stagnation of research activities and the impact on the careers and employment of young researchers such as doctoral course students, post-doctoral students, etc. due to the impact of the novel coronavirus disease, so we will sufficiently ascertain the impact on research activities on the front line, and we will work to support the continuation, etc. of the employment and research activities of doctoral course students, young researchers, and other outstanding researchers, etc., including flexible responses based on the situation regarding competitive research funding, promotion of remote and automated research facilities, etc. [MEXT]

○ Regarding bioresources, which are important for the national government to develop strategically, in order to maintain steady maintenance and provision in the context of the impact of the novel coronavirus disease, we will promote labor-saving to enable maintenance activities with the minimum human resources only, and the adoption of remote approaches such as the detection of and response to an emergency situation such as an abnormality in the breeding environment, etc. or a malfunction of the instruments, etc. [MEXT]

3. Promotion of Digital Transformation (DX) and Building of a Resilient and Sustainable Social and Economic Structure ~ Fighting Back and Social Transformation ~

Recently changes have been forced to many aspects of social life, and in that process the delay in the digitalization of Japan and the vulnerability of social systems have been revealed.

Going forward, we will not return to exactly the same situation as before the outbreak of the novel coronavirus disease, and there is a high likelihood that society will continue predicated on the existence of the novel coronavirus disease. However, it is possible to introduce and realize a new daily life, which should be called the new normal, in which we minimize the risk while on the other hand working to improve productivity and maintaining rich connections between people, and the major key to that is a digital transformation (DX) that has the potential to greatly transform the state of communication and society.

Furthermore, in order to build a resilient and sustainable social and economic structure, the promotion of DX and design of a decarbonized society, a recycling economy, and a diversified-type society are required.

It is necessary to understand this difficulty to be a major opportunity, achieve application to the new normal, and use the power of STI to advance the building of a DX promoting a switch to non-contact methods and the use of new data from space, etc. in all industries including education, research, agriculture, etc. and the building of a resilient and sustainable social and economic structure, for the fightback and social transformation.

① Promotion of Digital Transformation (DX)

○ We will proceed with acceleration of the GIGA school project presented in 2019 based on the AI Strategy, in order to provide PCs/tablets to all pupils, realize a communications environment that connects to households as well, and develop an environment in which school teachers can provide instruction and consultations, etc. remotely and online through the enhancement, etc. of human resources for ICT utilization. [MEXT]

○ We will endeavor to ensure that the development of advanced expert human resources does not stagnate due to natural disasters and the spread of infectious diseases, by accelerating the building of an environment for remote classes in not only elementary and middle education institutions but also higher education institutions. [MEXT]

We will build a utilization model for cutting-edge communications technologies (5G) in order to realize individually optimal and effective study and instruction with no time or distance constraints. [MIC]

We will accelerate the introduction of EdTech[22] to schools, etc., including the development of online content encouraging home-schooling, and we will respectively promote standardization and utilization enabling continuous data exchange and analysis, regardless of

[22] A coined word combining “Education” and “Technology.” All initiatives utilizing a variety of new technologies such as AI, big data, etc. in education.

whether the pupils transfer schools or advance to higher schools, regarding learning logs that store records of the study and projects of the pupils inside and outside school and regarding their state of health, etc., the development of an ICT environment based on cloud utilization, and presentation of a basic policy regarding personal information protection, etc.

[Cabinet Secretariat, PPC, MIC, MEXT, METI]

○ For realization of an environment in which research and development can be linked seamlessly on a nationwide scale and those activities can be continued, we will promote the digital conversion of the research and development environment and research techniques, including initiatives for smart laboratories featuring the automation of experiments utilizing AI and robot technologies, etc., promotion of initiatives implementing analyses, etc. by accessing research infrastructure through networks from remote areas, the development of high-speed communications networks, the thorough utilization of large-scale computational resources, and development of an environment for the effective and efficient creation, shared use, and utilization of research data, etc. Moreover, we will work to promote open science.

[MEXT, METI]

○ At a time when the shortage of manpower is rapidly becoming serious, we will clarify the agricultural management advantages of smart agriculture, which is capable of huge labor-saving, and accelerate its demonstration and implementation. [MAFF]

○ In public projects, we will promote DX in the infrastructure and logistics fields, etc., improve fundamental productivity and switch to non-contact and remote approaches by enabling processing in three-dimensional digital data of the series of processes from design and construction to maintenance and management, and stock utilization. [MLIT]

○ We will switch to new working styles on construction worksites with worksite demonstrations of unattended construction technologies utilizing core technologies such as 5G, etc. and by streamlining and upgrading, etc. supervision and testing utilizing three-dimensional digital data.

[MLIT]

○ In order to make port logistics smoother using digitalization, we will comprehensively convert the requests documents, etc. concerning ship-loading and ground transportation used by shipping companies, forwarders, etc. in exporting and importing to electronic formats, and we will improve productivity, safety, and security in port logistics worksites by building remote and non-contact operational environments. [MLIT]

○ We will accelerate research and development and the demonstration of technologies in space, etc. for the realization of advanced remote and automatic construction technologies using cooperation, etc. between the remote operation and automatic control of construction machinery.

[MEXT]

○ For development of a telework environment between administrative institutions and in the public and private sectors, we will develop, etc. an environment for easily holding web conferences in order to enable smooth communication in large-scale telework over a long period

and to continue administrative affairs without delay.

Furthermore, in order to provide support, etc. remotely and rapidly, without the constraints of time or place, to private sector business operators, we will enhance the functions and strengthen the operational structures of the general-purpose subsidy application system (jGrants) and strengthen the issuing capability of the shared ID system for business operators (GBizID) to make the issuing faster. [Cabinet Secretariat, METI]

○ We will investigate the appropriate utilization of satellite data for the streamlining and upgrading of the operations of the national government and local governments, and in the case that it is reasonable we will promote a private sector-led approach.

[Space, MIC, MEXT, MAFF, METI, MLIT, MOE]

② Development of the Environment Necessary for Digital Transformation (DX)

○ We will boost home learning, working from home, online medical examinations, etc., and we will promote the development of optical fiber to develop an environment in which people can obtain disaster information reliably no matter where they are. Furthermore, we will promote the switching of the entity responsible for broadband infrastructure from “public” to “private” in order to streamlining operation of the infrastructure. [MIC]

○ We will promote initiatives for the realization of Beyond 5G as the foundation of a resilient and vibrant society based on cyber and physical systems. [MIC]

○ As the foundation for non-face-to-face and remote activities, we will support the building of verification technologies concerning cybersecurity and support countermeasures for small and medium enterprises, and we will boost the development of technologies for deliveries using automatic travelling robots, the development of software that offers integrated management of multiple data centers decentralized in the regions, and capital investment to encourage the digitalization of small and medium enterprises. [METI]

○ We will strengthen climate change measures in digital fields. Specifically, there are concerns about the increase in CO_2 emissions in data centers, etc. as a consequence of the increase in communications traffic occurring due to the rapid digitalization of society, so we will promote zero emission data centers and the strengthening of the resilience functions of the data centers by upgrading and implementing energy-saving technologies and utilizing renewable energy.

[MIC, MOE]

○ Regarding provision of the position information useful for automatic travelling support, the provision of data about remote areas, and the quasi-zenith satellites, earth observation satellites, and communications satellites that contribute to communications, we will work on the development of more effective and efficient research and development structures while further accelerating their development and maintenance.

[Space, MIC, MEXT, MAFF, METI, MLIT, MOE, MOD, relevant offices and ministries]

③ Building of a Resilient and Sustainable Social and Economic Structure

○ We will enhance support for non-face-to-face and remote project activities, such as encouragement of the utilization of cross-border e-commerce, the building of a digital business negotiations platform, promotion of smart security, etc. [METI]

○ We will develop and provide support, etc. for technologies that contribute to making the supply chain resilient, such as the development of technologies that reduce the use as much as possible of parts materials with a high risk of supply disruptions or do not use them at all, the rapid and flexible rearrangement of the supply chain through data exchange, etc., the introduction of self-consumption-type photovoltaic installations, etc. utilizing PPA models, etc. that contribute to disaster prevention and the promotion of RE100, etc. [MEXT, METI, MOE]

○ In order to adapt to the post-corona world, we will advance the verification and introduction of environmental sanitation systems such as high-efficiency ventilation equipped with sterilization and energy-saving functions, etc. [MIC, MEXT, MOE]

○ In order to respond to the increase in logistics for consumers, we will advance decarbonization of deliveries by utilizing electric mobility. [MOE]

○ We will promote zero emission homes so that we can respond to the increase in working from home, including support for thermal insulation renovations of homes, etc. and for the wider adoption of ZEHs, etc. [MOE]

○ We will investigate revisions of the related systems, etc. in order to support digital-related research and development investment that contributes to economic recovery and to enhancing the industrial strength of the private sector. [METI]

○ We will tackle technology development and work toward the creation of prior examples for the full-scale utilization of information and communications technologies such as 5G, etc. on manufacturing worksites. [METI, MIC]

○ We will combine analyses using satellite data and ground observation data with analyses of the amount of activity utilizing IoT data and big data with a high temporal-spatial resolution to investigate improvements to the precision of estimates of greenhouse gas emissions. [MOE]

○ In order to boost behavioral modifications for the building of a decarbonized society that also responds to the coronavirus catastrophe, we will gather and analyze data about energy consumption, and use a combination of the findings of behavioral science such as nudge and boost, etc. (behavioral insights) and cutting-edge technologies such as AI/IoT, etc. (BI-Tech) to feedback personalized messages to each individual to encourage energy-saving behavior. [MOE]

○ In order to contribute to the response to the novel coronavirus disease, the building of a strategic supply chain for food, pharmaceuticals, etc., and preparations for climate change risks, etc., we will promote initiatives for utilizing biotechnology and renewable biological resources, etc. based on a biostrategy to realize a sustainable and renewable recycling economy and society (bioeconomy).

[Cabinet Secretariat, STI, SIPSH, CAA, AMED, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ In the context of changes such as increasing electricity consumption and growing individual logistics, etc. caused by the progress of digitalization, we will accelerate innovation in technologies that contribute to decarbonization in terms of technology development, green finance, social transformation, etc.; for example, realization of research and development investment reaching 30 trillion yen in the public and private sectors in the next ten years, as set out in the Progressive Environment Innovation Strategy, in order to achieve a switch to a truly sustainable and resilient society that is prepared for climate change risks as well.

[MEXT, METI, MOE]

○ In order to enable non-face-to-face quality confirmation, we will advance the building of the Smart Food Chain System, a platform enabling the sharing and utilization of information from production to processing, distribution, consumption, and exporting, and the optimization of the food chain overall.

[Cabinet Secretariat, STI, MEXT, MAFF, METI, MLIT]

○ We will pool the resources of Japan's agricultural research institutions for developing varieties in order to promote the development of new varieties that lead to the strengthening of the production base and development of the breeding streamlining technologies to support the development of new varieties, etc., so that we can supply through domestic production the agricultural crops that have a high degree of dependence on overseas countries. [MAFF]

○ We will advance the expansion of the development and use of space systems contributing to digitalization and remote approaches, while also ensuring the independence of Japan's space activities, to accelerate initiatives for strengthening of the science, technology, and industry infrastructure and realization of a virtuous cycle of expansion of the use of space, so that the doubling of the size of Japan's space industry by the early 2030s set out in the Basic Plan for Space Policy can be realized.

[Space, MIC, MEXT, MAFF, METI, MLIT, MOE, MOD, relevant offices and ministries]

○ We will advance support for international cooperation and the overseas deployment of Japanese technologies, etc. concerning corona reconstruction. For example, in September 2020 an online platform for government ministers from countries around the world to hold discussions and share information about reconstruction after the novel coronavirus disease, climate change, and environmental countermeasures for achievement of the "virtuous cycle of the environment and growth" will be held under the leadership of Japan. We will also contribute to maintaining the momentum of international cooperation for the success of COP26, which has been postponed to next year. [MOFA, METI, MOE]

○ We will promote the development and utilization of climate change risk information and contribute to greater resilience against meteorological disasters, taking into account the

dispersion of people and goods, etc. from cities to regions which is anticipated to occur due to the novel coronavirus disease countermeasures. [MOE]

PART III

In PART III, we confirm the implementation status of PART II in last year's Integrated Innovation Strategy and revise the objectives and measures for improvement.

For this reason, the format of PART III follows last year's Integrated Innovation Strategy while the new items are positioned in the corresponding chapters.

The basic format of each item is Objectives (new objectives and objectives that have been modified since last year are in ***italic and bold*** type), ① Implementation Status and Analysis of the Current Situation, and ② Measures and Solutions for Achieving the Objectives, but depending on the item we sometimes state the current situation and necessity instead of ①.

PART III: Item-by-Item Discussion
CHAPTER 1: Source of Knowledge

(1) Creating the Infrastructure to Support the Digitalization of Society

○ **Future Visions to be Pursued**

The development of infrastructure that supports the following digitalization of society, such as new-generation mobile communications systems, is essential in the Society 5.0 era so we will contribute to further solutions to social issues and economic growth in Japan and also to the building of a sustainable international community by steadily conducting research and development into that infrastructure and aiming for its prompt diffusion into society

- ***The fifth-generation mobile communications system which started services in March 2020 (hereinafter referred to as "5G") is a next-generation mobile communications system with the features of ultra-high speed, ultra-low lag, and a large number of simultaneous connections. It is expected that 5G with the functions of ultra-low lag and a large number of simultaneous connections further strengthened (hereinafter referred to as "Post-5G") will be utilized in diverse industrial applications such as factories and automobiles going forward, and it is a technology that can become the core of the competitiveness of Japan. We will strengthen the infrastructure for the development and manufacturing of information and communications systems meeting the requirements of Post-5G by developing the technologies forming the core of these systems in Japan***
- ***Due to the realization of the further upgrading of Beyond 5G, the communications method which is the next generation after 5G and is expected to be introduced in about 2030, the integration of cyberspace and physical space will make progress, and as a result a resilient and vibrant society will be realized in which the functions of physical space are expanded by cyberspace and even in the case that an unforeseen situation occurs in physical space, people's lives and economic activities are smoothly maintained through cyberspace***

○ **Objectives**

<Strengthening the Infrastructure for Post-5G Information and Communications Systems>

- ***Develop the Post-5G information and communications system that can become the core of the competitiveness of Japan going forward and the semiconductors used in the said system, as well as develop the cutting-edge semiconductor manufacturing technologies necessary in Post-5G***

<Promotion of Strategic Research and Development, etc. of Beyond 5G>

- ***In order to achieve the early and smooth introduction of Beyond 5G and the strengthening of its international competitiveness, formulate roadmaps for research and development, intellectual property and standardization, and deployment and to promote strategic initiatives. Specifically, establish the elemental technologies gradually from about 2025 and standardize in 3GPP, etc. so that Beyond 5G services go live in about 2030***

In addition to the above, promotion of initiatives for Promotion of Research and Development of Critical Technologies that Support Next-Generation Computing, Establishment of Fundamental Optical Technologies, Utilization of the Fugaku Supercomputer, and Strengthening of Space Systems

① Implementation Status and Analysis of the Current Situation

<Strengthening the Infrastructure for Post-5G Information and Communications Systems>

○ In the evolution of mobile communications systems up until the fourth-generation mobile communications system (4G) communications speed was the main focus, but 5G is a next-generation mobile communications system with the features of not only ultra-high-speed but also ultra-low lag and a large number of simultaneous connections, and currently commercial services are starting in countries around the world. Regarding 5G, based on the Act on Promotion of Developing/Supplying and Introducing Systems Making Use of Specified Advanced Information Communication Technologies[23] which is due to be enacted in FY2020, we will aim for the early dissemination of safe, secure, and trustworthy open systems.

○ It is expected that going forward Post-5G will be utilized in diverse industrial applications such as factories and automobiles, and it is expected that it will be a technology that can become the core of the competitiveness of Japan.

○ Currently overseas companies occupy the top positions in the market for information and communications systems for mobile applications, but Post-5G is relevant to industrial fields in which Japan has strengths, so it can be concluded that Japanese companies have a chance to catch up. Furthermore, the top three overseas companies account for 80% of the global share of the communications base stations market, but there are Japanese manufacturers remaining in Japan.

○ On the other hand, the situation is that the manufacturing capability for the cutting-edge semiconductors necessary in Post-5G is only overseas and does not exist in Japan.

○ Regarding information and communications systems and the semiconductors used in said systems, development competition is intensifying globally. At a time when 5G commercial services have started in countries around the world and Post-5G, which is equivalent to the second stage of 5G (the expansion period) is also beginning to be considered, it is necessary for Japan to urgently move to full-scale technology development as well.

<Promotion of Strategic Research and Development, etc. of Beyond 5G>

○ We will get 5G to penetrate into daily life, and realize cyber-physical systems integrating

[23] Act No. 37 of 2020

cyberspace and physical space. It is expected that in the 2030s this will progress further, a resilient and vibrant society will be realized in which the functions of physical space are expanded by cyberspace and even in the case that an unforeseen situation occurs in physical space, and people's lives and economic activities will be smoothly maintained through cyberspace. It is important for the government and the private sector to work as one to strategically realize Beyond 5G, the foundational infrastructure for this future, through international collaboration.

○ For the formulation of a national strategy, the Ministry of Internal Affairs and Communications has been holding the Beyond 5G Promotion Strategy Roundtable since January 2020 and it compiled the Beyond 5G Promotion Strategy in June 2020.

○ Regarding research and development, with 5G we have realized more than three times the system capacity of 4G through the establishment of technologies that increase capacity. Furthermore, we have achieved a throughput of a maximum of 27Gbps in an ideal environment through the establishment of technologies that increase speed. In order to realize an optical access infrastructure with the capacity for large volumes of communications traffic, we demonstrated uplink transmission more than 100 times (equivalent to 1,024 users and 70km) that of the current access system optical fiber (G-PON[24]). Furthermore, as a space division multiplex technology, we demonstrated short-range, high-capacity transmission through the introduction of multicore/multimode fiber, and contributed to the development of new optical access technologies, including the introduction of coherent technologies. Regarding access technologies combining light and electrical waves, it is thought that implementation of research and development, etc. into fundamental access technologies that do not depend on only one transmission technique, such as light, electrical waves, etc., is appropriate.

In Beyond 5G, larger capacity and low-lag communications are required, so research and development into the wired and wireless sections, the component instruments, and expansion of the areas, etc. is necessary, and concept papers, etc. have been published in the domestic and overseas public and private sectors.

<Promotion of Research and Development of Critical Technologies that Support Next-Generation Computing>

○ As a consequence of the explosive increase in data communications volumes and throughput in recent years, initiatives for increasing the speed of data processing and reducing electricity consumption in both the cloud and the edge have been proceeding.

○ Furthermore, at a time when Moore's Law due to the rapid improvement in semiconductor performance is coming to an end, the limits to computational capability by general-purpose CPUs, the constraints on communication bands between processors and memory as a

[24] Gigabit Passive Optical Network

consequence of the increase in the volume of data communications, the increase in electricity consumption caused by electric wiring and electric switches inside information and communications equipment, etc. are becoming bottlenecks, limits to the previous computing architecture centered on CPUs are coming.

○ With respect to the technological limit of computational capability, heterogeneous computing appropriately combining accelerators specialized in the computation of specific applications such as GPUs and FPGAs,[25] etc. are making progress, but a response to the constraints on the communications band and the increase in electricity consumption is unavoidable.

○ For this reason, discussions pertaining to the rebuilding of systems architecture, including processors, memory, and networks, have been gaining momentum, primarily in North America. In particular, new computing architecture combining optical and electrical technologies utilizing the photonics technologies in which Japan has strengths could be one solution. Therefore, it is necessary to take the lead for a paradigm shift and begin full-scale research and development for obtaining the layers which will be the key.

<Establishment of Fundamental Optical Technologies>

○ Due to the progress of cloud computing, the energy consumption of information and communications equipment is constantly growing, particularly in data centers, etc. One of the major factors behind this energy consumption is the electric wiring and electric switches inside the information and communications equipment. In order to reduce energy consumption in information and communications equipment, Japan is promoting development of optical electronics technologies in order to replace electric wiring and electric switches with optical wiring and optical switches that do not consume much energy.

○ We expect to succeed in the development of reconfigurable 400Gbps packet optical nodes capable of handling the diversification of communications services, and to deploy and utilize the products. Furthermore, we have demonstrated flexible optical path nodes and contributed to the establishment of technologies that track traffic fluctuations to reallocate wavelength resources.

Fundamental optical technologies are necessary and essential technologies for the achievement of greater capacity in communications overall, and further improvement of the technologies is required by the market. It is thought to be appropriate to take into account the research and development trends in private sector companies, to conduct research and development into optical hardware technologies and optical network advanced analysis and control technologies for open/programmable optical networks, and pursue the ultimate flexibility of optical networks.

<Utilization of the Fugaku Supercomputer>

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[25] Field Programmable Gate Array

○ The Fugaku supercomputer, which offers performance at the highest level in the world, is being developed with the aim of starting shared use in FY2021, and cooperative development for applications has been implemented in each field since the beginning of the Fugaku Development Project so that the supercomputer can be utilized in a variety of fields, in particular health and medical care, meteorological disaster prevention, and materials. In June 2020, Fugaku gained the world no. 1 ranking in the four categories of performance ranking for the world's supercomputers: TOP500 (raw computational performance), HPCG (computational performance close to real-world applications), HPL-AI (computational performance with regards to artificial intelligence), and Graph500 (big data processing performance).

<Strengthening of Space Systems>

○ Space systems, in collaboration with ground systems, provide the three-dimensional positioning data and remote sensing data ascertaining a variety of states on the ground that are important constituent elements of big data. Positioning, communications, observations, etc. by space systems have already become entrenched in daily life, and are a part of the important infrastructure for our economic and social activities.

○ Furthermore, in order to realize the advanced merging of cyberspace and physical space, smooth distribution of data is important in all spaces in which people and objects mingle, and space systems are becoming more important as infrastructure supporting the digitalization of society. For example, the realization of an advanced and safe information and communications network seamlessly connecting the land, ocean, air, and space is expected.

② Measures and Solutions for Achieving the Objectives

<Strengthening the Infrastructure for Post-5G Information and Communications Systems>

○ We will tackle the development of Japan's Post-5G information and communications systems and the strengthening of the manufacturing base by using the fund method to stably and efficiently develop the technologies that will be the core of an information and communications systems meeting the needs of Post-5G. [METI]

<Promotion of Strategic Research and Development, etc. of Beyond 5G>

○ Regarding research and development of the cutting-edge elemental technologies that will be the core technologies of Beyond 5G that Japan should strengthen, we will encourage research and development by private sector companies while promoting it in a concentrated manner for a limited period.

[MIC]

○ In order to effectively promote research and development of the cutting-edge elemental technologies, we will build the Beyond 5G Research and Development Platform to enable the participation of diverse players, including high-quality foreign human resources.

[MIC]

○ We will develop mechanisms enabling free use in principle of radio waves in high frequency bands, such as terahertz waves, etc., for a fixed period and using simple procedures. [MIC]

○ We will greatly relax the procedures for acquiring and changing experimental station licenses in the case of experiments, etc. conducted while satisfying certain conditions. [MIC]

○ Anticipating further into the future than Beyond 5G, we will discover and support ideas and human resources that can cause disruptive innovation using public recruitment in which they are given strong incentives such as prize money, etc. We will get people talking about Beyond 5G and expand the base of Beyond 5G research and development. [MIC]

○ Regarding research and development, we will aim for the establishment of network technologies with multiple communications functions capable of guaranteeing ultra-low lag and ultra-high reliability, etc. and fundamental sub-Tbps-grade media-harmonizing access technologies contributing to the realization of Tbps-grade communications capacity in the access network from the 6G era onwards as access technologies combining light and electrical waves, the research and development of wireless technologies for connecting reliably and efficiently to multiple automated driving system groups and drones, and the establishment of technologies for about the next five years such as wireless expansion technologies, etc. for connecting reliably even in extreme environments. [MIC]

○ Concerning the frequency band of the terahertz wave domain which is expected to be used in Beyond 5G, we will aim for realization of ultra-low lag, synchronized control, etc. through the upgrading of fundamental wireless communications testbed technologies, research and development of fundamental measurement system technologies, and establishment of techniques to supply base times and frequency standards designed for the diverse levels of precision required by the users, etc. [MIC]

<Promotion of Research and Development of Critical Technologies that Support Next-Generation Computing>

○ Anticipating the post-Moore era, we will promote research and development into the important critical technologies in the next-generation computing field and aim to master the important technological layers in ecosystems, including strengthening, etc. of computational capacity utilizing the photonics technologies in which Japan has strengths, spintronics technologies which have high potential as new memory technologies, and innovative technologies. [MEXT, METI]

<Establishment of Fundamental Optical Technologies>

○ We will implement the development of optical electronics technologies combining electronic circuits and optical circuits for the reduction of electricity consumption in data centers. [METI]

○ We will implement the development of innovative devices utilizing spin photonic technologies in order to go beyond the limits of previous electronics. [MEXT]

○ We will implement the research and development of fundamental technologies for ultra-high channel optical networks meeting the needs of ultra-high volumes of communications traffic in the 6G/Beyond 6G era. [MIC]

○ We will implement the research and development of hardware technologies for the realization of open/programmable optical networks in order to realize flexible optical networks that provide services adapted to communications demands and changes in the communications environment. [MIC]

<Utilization of the Fugaku Supercomputer>

○ We will start early shared use of the Fugaku supercomputer, which will provide the computational base for Society 5.0, during FY2021, and carry out initiatives pertaining to encouragement of further use of Fugaku by not only researchers in universities, national research and development agencies, etc. but also the industrial world and others, and we will promote social and scientific solution of issues and the strengthening of industrial competitiveness, etc. through further encouragement of the merging, etc. of data science and computational science. [MEXT]

<Strengthening of Space Systems>

○ In order to ensure the independence and strengthen the competitiveness of the satellites for positioning, communications, observation, etc. which are the infrastructure supporting the digitalization of society, we will build structures comprising industry, academia, and government entities which are equipped with survey analysis and strategy formulation functions and strong leadership, and under these structures we will promote the development of satellite-related innovative fundamental technologies. [Space, MIC, MEXT, MAFF, METI, MLIT, MOE, MOD]

○ We will promote the development of next-generation satellite communications technologies, such as satellite quantum cryptography and greater flexibility, etc. [MIC]

(2) Realization of Data Free Flow with Trust and Social Implementation of a Data-Driven Society

○ **Future Visions to be Pursued**

• Promotion of initiatives for implementation of the Data Free Flow with Trust (DFFT) was agreed at the G20 Osaka Summit held in June 2019

• Socially implement an advanced model of a data-driven society

• Utilize AI to lead the world in developing cross-sectional data federation that has functions for the safe and secure utilization, etc. of data[26] and for which the data exchange platforms for each of a variety of fields connect beyond barriers, and create new value through the utilization of data across organizations and fields

• Create a global data distribution market by having shared values with the international community concerning data distribution and protection and realizing data exchange with major countries such as Europe and the United States, etc.

○ **Objectives**

• In order to ensure the reliability of data, advance the organization of common rules pertaining to the authenticity of the provider of the data, the reliability of the data, etc. while promoting initiatives for the implementation of the common rules for their social implementation

• As an advanced model of a data-driven society, promote and carry out social implementation of initiatives for an information bank and data trading market, etc. from Japan, and promote initiatives for the establishment of mutual authentication of trust services for international standardization of the model and data distribution with Europe and the United States

• Technologies for cross-sectional data federation,[27] which easiliy provide interoperability and achieve smooth data federation with the data exchange platforms for each field will be developed while starting development by FY2020 and full-scale operation by FY2022

• Regarding fundamental technologies for cross-sectional data federation, after full-scale operation, transfer their maintenance and updating to the private sector sequentially

• Provide an environment enabling big data analyses using AI in cross-sectional data federation by FY2023

• Upgrade observation technologies, visualization technologies, and analysis technologies for overcoming increasingly complex and sophisticated cyber-attacks, including indiscriminate attacks and targeted attacks, and aggregate cybersecurity-related information on a large-scale and then conduct transverse analyses to verify the domestically-made security technologies and build an integrated intellectual foundation for cybersecurity that contributes to practical and advanced security human resources development

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[26] The world's most advanced server security and functions meeting the needs of issues such as personal information protection, etc.

[27] Fundamental technologies for carrying out data distribution among data exchange platforms for each field.

① Implementation Status and Analysis of the Current Situation

<Realization of Data Free Flow with Trust and Social Implementation of a Data-Driven Society>

○ Currently initiatives for data exchange are being advanced in the fields of agriculture, ports and logistics, nursing, etc. In order to efficiently advance data exchange between many players, it is important that certain rules be built and implemented regarding the reliability, etc. of the data, but the current situation is that the fields in which this kind of rule building is proceeding are limited. Moreover, in order to enable collaboration straddling fields, it is important that the common rules that each field should be careful about are built and implemented.

Based on this kind of perception of the issues, the Task Force for the Building of a Digital Society organized certain common rules that each field should be careful about in order to advance data exchange within fields and data exchange straddling fields, and referring to these rules is recommended.

○ For the opening of the data held by local governments, we will continually investigate revisions of the recommended data set which compiles data for which release by the government is recommended, and the rules and formats, etc. that the government should comply with when creating that data.

○ SINET, which is essential for the education and research of Japan, is operated as network infrastructure equipped with both high reliability and security which connects more than 900 universities, research institutions, etc. throughout Japan with a 100Gbps high-speed, dedicated line. Furthermore, regarding the research data infrastructure system that encourages management, release and search of research data utilizing a repository (NII Research Data Cloud), the Ministry of Education, Culture, Sports, Science and Technology has taken the lead in advancing development toward full-scale operation within FY2020.

○ We are implementing international standardization activities for Japan's original initiatives to encourage data distribution, such as the information bank and data trading market, etc. Regarding the data trading market, etc., we are promoting the activities of the new working group concerning data distribution established in the international standardization organization IEEE. Furthermore, from the perspective of endorsing the utilization of IEEE standards, we are promoting initiatives for establishing legal standards such as ISO, etc. in parallel.

<Development of Fundamental Technologies for Cross-Sectional Data Federation>

○ From FY2018 the CSTI and the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society took the lead and worked together with the relevant offices, ministries and agencies, private councils, etc. to advance investigation of fundamental technologies for cross-sectional data federation.

In FY2019, we implemented investigation of the architecture compiling the relationships of the function modules, repositories, etc. comprising the fundamental technologies for cross-sectional data federation.

○ Regarding smart cities, concerning data exchange, etc., we agreed to promote the projects of the relevant offices, ministries and agencies under a common basic policy, and in FY2019 we built a common architecture comprising the basic design guidelines for smart cities which stipulated the specific methods, etc. for making data exchange within a city and between cities easy. When building a common architecture, we organized and structured the demonstration projects and domestic and overseas use cases in diverse fields concerning smart cities, and the related standards and specifications, data, etc., and investigated city OS, data exchange, standard API, data structures, etc. across fields and business operators. Furthermore, we have compiled the architecture framework and definitions of terms, including for Japan's original initiatives such as the information bank, etc., for smooth distribution of personal data among data holders, people the data is about, and data utilizers, etc.

○ Regarding the geospatial information field, we built architecture for ensuring mutual operability among fields in the G-Spatial Information Center, and we have worked to encourage the opening and secondary use of the geospatial data held by the national government and local governments.

<Development of Data Exchange Platforms for Each Field> (For details refer to <Attached Table 1>)

○ The development of data exchange platforms and establishment of councils, etc. for each field with SIP at their core is being advanced through public and private sector cooperation, and we have built promotion structures.

<Building of an Integrated Intellectual Foundation for Cybersecurity>

○ Regarding cyber-attack observation, visualization, and analysis technologies, we have been continuously implementing test operation in CSIRT [28] inside NICT and commercial deployment from recipients of technology transfer since FY2016, earlier than initially planned. Furthermore, in response to a request, from FY2017 we have been continuously using these technologies to support cyber-attack surveillance for the 2020 Tokyo Olympics and Tokyo Paralympics [29] (hereinafter referred to as the "Tokyo 2020 Games"), starting earlier than initially planned.

Based on a legal revision in response to the emergence of the threat of cyber attacks based on IoT equipment,[30] since FY2018 NICT has been collaborating with telecommunications carriers to implement an initiative called NOTICE (National Operation Towards IoT Clean Environment) to carry out surveys of the IoT equipment which it is feared could be misused in cyber-attacks and warn users regarding said equipment.

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[28] Computer Security Incident Response Team

[29] On March 30, 2020 it was decided that the Tokyo Olympics would be held from July 23 to August 8, 2021 and the Tokyo Paralympics would be held from August 24 to September 5 the same year.

[30] The Act on Partial Revision of the Telecommunications Business Act and the Act on the National Institute of Information and Communications Technology (Act No. 24 of 2018)

On the other hand, the targets of cyber attacks are expanding to equipment other than computers, such as IoT equipment, so it is necessary to establish security technologies in the new network environment, such as 5G security verification technologies, connected devices security verification technologies for IoT and communications equipment, etc., and next-generation cloud security technologies, etc. Additionally, urgent tasks for establishing cryptography technologies that can be used safely in the quantum computer era are the upgrading of cryptography safety evaluation technologies and switching to new technologies such as cryptography resistant to quantum computers, etc.

② Measures and Solutions for Achieving the Objectives

<Realization of Data Free Flow with Trust and Social Implementation of a Data-Driven Society>

○ In order to advance the social implementation of the common rules organized in the Task Force for the Building of a Digital Society, we will utilize forums comprising the related people and related organizations in each field to boost close collaboration by the related people and related organizations and encourage further implementation of the common rules in each field. [Cabinet Secretariat]

○ In order to promote the utilization of data, in particular real data, we will clarify the structures, including the control tower functions, and then carry out an investigation of the forms of rule development pertaining to data governance, and reflect it in the Next Basic Plan. [Cabinet Secretariat, STI, SIPSH]

○ Taking into account initiatives for ensuring the data standards and quality of the basic information of society that have advanced the computerization of registers and ledgers containing information that could qualify as a base registry and developed them as a common vocabulary base, we will promote specification of the base registry and implementation of the development policy, and development of information systems and data standards in line with that, including data outside than the base registry. [Cabinet Secretariat]

○ We will give a general release to the function modules of the fundamental technologies for cross-sectional data federation as open-source software, and support the establishment of private sector organizations promoting diversified-type cross-sectional data federation based on the activities of portal management projects for managing repositories, function module and repository update projects, and projects that encourage the application of function modules to each industry, government, and academic organization that possesses data exchange platforms for each field, etc. [Cabinet Secretariat, STI]

○ We will continue development of the common core vocabulary of the field. [METI]

○ We will investigate forms of data trading markets as mechanisms for revitalizing highly-reliable data distribution that transcends company and industry type. [Cabinet Secretariat, STI, FSA, MIC, METI]

○ For the opening of data held by local governments, we will continually investigate revisions of the recommended data set which compiles data for which release by the government is recommended, and the rules and formats, etc. that the government should comply with when creating that data. [Cabinet Secretariat]

○ Regarding timestamps,[31] we will develop a national government certification system during FY2020, and take the initiatives necessary to ensure that it becomes a publicly effective technique for sending, receiving, and saving electronic documents. Regarding e-seals,[32] we will conduct wide-ranging surveys on use cases and organize the technical requirements, etc. during FY2020 for the founding of a private sector certification system based on certain criteria. Regarding remote signatures,[33] we will carry out an investigation taking into account the trends in technologies and operations to promptly clarify their positioning under the Act on Electronic Signatures. [MIC]

○ We will launch a Japan-Europe joint pilot project for the establishment of Japan-Europe mutually-approved protocols for trust services. [STI, MIC]

○ Regarding SINET, in addition to the upgrading of the network infrastructure for further improvement of the research environment, we will promote not only the gathering and forwarding of the data that is generated in diverse situations in research but also enhancement of the functions for an integrated platform that merges the Research Data Infrastructure System with the former network infrastructure. [MEXT]

○ In order to build fundamental technology capable of responding to the greater complexity of the data handled, including personal information, and of offering advanced security, reliability, energy efficiency improvements, etc., we will advance research and development of software systems targeting the large-scale social systems of the Society 5.0 era, and through close collaboration between the informatics field and applied fields we will advance the building of a large-scale research platform to accelerate innovation creation based on all types of data. [MEXT]

○ We will train architects for industrial data distribution. [METI]

○ Regarding the forms of regulations predicated on the utilization of digital technologies such as AI, the IoT, etc., the forms of commonalization of the systems of public services, and the forms of systems that comprise the technological foundation of new industries created through collaboration between different industry types, we will use the Digital Architecture Design Center as a hub while collaborating with the related private sector organizations, ministries, agencies, etc. to conduct a cross-sectional investigation and formulate the architecture. [METI]

○ We will provide support to private sector business operators carrying out platform development

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[31] A mechanism that certifies that electronic data exists at a certain time and said data has not been altered on or after that time

[32] A mechanism that can simply confirm the organization that issues electronic data such as invoices, etc., instead of the company's square seal

[33] The signing key of the signer is managed on a cloud server and the signer signs the electronic signature remotely

for data exchange and sharing between companies in non-competitive domains, centered on the five priority fields of the Connected Industries ("automatic travelling and mobility services," "Monozukuri" (Manufacturing) and robotics," "materials and bio," "plant and infrastructure maintenance," and "smart life"). [METI]

○ Japan will utilize the new working group concerning data distribution established in the international standardization organization IEEE and continue to show leadership in promoting it while also involving the related people in Japan and overseas. Additionally, we will continue to implement initiatives to establish legal standards such as ISO, etc. [MIC, METI]

<Development of Fundamental Technologies for Cross-sectional data federation>

○ In FY2020, we will commence the following initiatives to advance sequential social implementation.

[Cabinet Secretariat, STI, OPDVLE, MIC, MEXT, METI, MLIT]

- Regarding the development of fundamental technologies for cross-sectional data federation, we will continue to advance the development of common criteria for repositories of domain vocabulary, data, etc. and position information in order to ensure mutual operability, and to give a general release to search function modules, etc. as open-source software.
- We will develop rules and mechanisms encouraging the utilization of fundamental technologies for cross-sectional data federation while ensuring consistency with systems for the distribution and protection of data and trends in intellectual property strategies in foreign countries.
- We will encourage the dissemination of a city OS ensuring mutual operability, expandability, and sustainability based on a common architecture in the smart city field.
- Regarding the geospatial information field, we will strengthen the functions for mutual collaboration with each kind of data platform by field, using the G-Spatial Information Center as a cross-domain data exchange platform pertaining to geospatial information.
- We will promote initiatives for the development of an environment for securing the smooth cross-border transfer of data while also ensuring the appropriate protection of personal information.

<Development of Data Exchange Platforms for each Field> (For details refer to <Attached Table 1>)

○ We will continuously develop domain vocabularies,[34] metadata, standard APIs, etc. for the fields of agriculture, energy, health and medical care and nursing, automated driving,

[34] This is the vocabulary particular to a field, in particular, the major vocabulary that references other fields as well is organized as vocabulary common to a domain (hospitals, station names, emergency evacuation areas, etc.), and the vocabulary specified for use in an individual field is organized as the vocabulary particular to a domain (number of hospital beds, timetable, etc.) (IPA Overview of the Common Vocabulary Base).

"Monozukuri" (Manufacturing), logistics and commercial distribution, infrastructure, disaster prevention, earth environment, ocean, and space.

[Cabinet Secretariat, STI, space, ocean, MEXT, MHLW, MAFF, METI, MLIT]

<Building of an Integrated Intellectual Foundation for Cybersecurity>

○ We will upgrade observation technologies, visualization technologies, and analysis technologies for overcoming increasingly complex and sophisticated cyber-attacks, including indiscriminate attacks and targeted attacks, and aggregate cybersecurity-related information on a large-scale and then conduct transverse analyses to verify the domestically-made security technologies and build an integrated intellectual foundation for cybersecurity that contributes to practical and advanced security human resources development. [MIC]

○ We will create security verification technologies that meet the requirements of 5G, security verification technologies for connected devices such as IoT equipment and communications instruments, etc., and technologies that ensure data security and privacy and encourage safe data distribution and utilization, and establish fundamental cryptography technologies that can be safely used in the quantum computer era, by carrying out safety evaluations of cryptography technologies and developing new cryptography technologies such as quantum computer-resistant cryptography, etc. [MIC]

	Vision to be achieved (○) [Overseas benchmark examples] Specific examples (① ② ③)	Timing of the achievement of objectives (citation source)	Current initiatives <Initiatives for social implementation by SIP II (2018-22), etc. and their results>		Directions and issues going forward
			Data exchange	Initiatives for implementation	
Fundamental technologies for cross-sectional data federation	○ Lead the world in developing fundamental data exchange technologies that connect data in a variety of fields beyond barriers by FY2020 and commence full-scale operation by FY2022	FY2020 (development) FY2022 (operation) (Integrated Innovation Strategy)	• Implemented an investigation of architecture summarizing the relationships between the function modules and repositories, etc. comprising the fundamental technologies for cross-sectional data federation	• Regarding smart cities, concerning data exchange, etc., agreed to promote the projects of the relevant offices, ministries, and agencies under a common basic policy, and in FY2019 built a common architecture comprising the basic design guidelines for smart cities which stipulated the specific methods, etc. for making data exchange within a city and between cities easy	• Regarding fundamental technologies for cross-sectional data federation, ensure mutual operability with the data exchange platforms for each field while providing an environment in which big data analysis using AI is possible by FY2023 • Implementation new industries and new services through the promotion of social implementation of cutting-edge technologies using geospatial information in a variety of fields such as disaster prevention, agriculture, transportation, etc.
Smart cities	○ Introduce the systems of each field to the city in an integrated and synthetic manner, to contribute to the solution of the social issues of the city	-	• There are elemental technologies such as authentication, settlement, etc., but there are no moves to develop a	• In regions around the world, smart cities are being developed with the main objectives of the presentation of architecture for an entire city, creation	• In FY2019, determine the path to begin building an architecture predicated on ensuring mutual operability • Systems infrastructure capable of mutual connection, horizontal

	○ Design the systems and architecture common to Society 5.0, and encourage the industrialization of a common basis (platform) capable of horizontal deployment as a city OS, such as authentication, settlement, and data exchange platforms, etc.		comprehensive market as a city OS • In demonstration experiments in regions throughout Japan, introduce original data platforms for each demonstration city • Internationally, multiple investigations of frameworks, indicators, etc. are under way in standardization institutions such as ISO, IEC, ITU,[35] etc.	of new businesses, etc. • In Japan the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Internal Affairs and Communications, the Ministry of Economy, Trade and Industry, etc. are implementing demonstration experiments, etc. in various regions	deployment, and succession • Sustainable operational structures • Ensuring security • Advance project collaboration by the relevant offices, ministries, and agencies and cross-sectional data federation, etc. to deploy projects under the common basis nationwide • Through a framework, etc. for international collaboration, share the experiences of cities around the world to promote international collaboration and cooperation • Encouragement to take up the subject of a city OS, and of commercialization and industrialization • Response to international standardization • Support for new technologies that have been practically applied
• **Individual fields**					

[35] International Telecommunication Union

Mobility	○ Realize smooth movement of people and goods through a combination of automated driving, sharing, and public transportation [MaaS Global (Finland)] ① Owner cars: high-speed (level 4 (*)) ② Transportation services: limited regions (level 4) ③ Logistics services: high-speed trucks (level 4) (*) This equates to level five driving automation level as defined by the SAE (Society of Automotive Engineers) International, a standardization organization in the United States, on a six-level scale from level 0 to level 5, at which the automated driving systems execute all dynamic driving tasks (these are operational and tactical functions which are necessary when operating a vehicle in real time; however, strategic functions such as journey planning, etc. are excluded) and response in the case that	① FY2025 ② FY2020 ③ FY2025 onwards (Public-Private ITS Initiative/ Roadmaps 2019)	• Under SIP II, promoted the building of an architecture in the automated driving field pertaining to geographical data based on Society 5.0 while taking into account the issues and direction of initiatives regarding new mobility services such as MaaS, etc. to promote initiatives concerning collaboration with other fields, international standardization, etc. utilizing geographical data through collaboration with the measures of each office, ministry, and agency • The Public-Private ITS Initiative/Roadmaps 2019 of the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society summarizes the issues and direction of	• In SIP and the demonstration experiments for automated driving by each headquarters, ministry, and agency, vehicle performance, technical issues, service content and operation are being verified • In addition, local governments, companies, universities, etc. are implementing demonstration experiments for automatic travelling • The Charter for Improvement of Legal System and Environment for Automated Driving Systems decided in April 2018 clearly presented the method of proceeding toward the revision of systems pertaining to automated driving, etc., and as a result great progress going forward is expected • From April 2019 the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism started a new project called Smart	• Boost the dissemination of MaaS that contributes to the solution of regional issues, through data exchange of multiple means of transportation and peripheral services such as tourism, medical care, nursing, education, etc., and through infrastructure development in physical space, such as transportation nodes, etc. • Concerning new mobility services such as MaaS, etc. offered by regions and companies, etc., summarize the commercial viability, social acceptability, impact on the regional economy, systemic issues, etc. in the region and develop the business environment • Promote demonstration experiments, etc. concerning infrastructure coordinated-type automated driving, including utilization of geographical data at the Tokyo waterfront, etc. • Realization of traffic volume management and parking lot management through data utilization

	continuation of operation is difficult, within limited domains. In contrast to levels 0 to 2 in which the driver executes some or all dynamic driving tasks, level 3 and above are predicated on the automated driving systems (when operating) executing all of the dynamic driving tasks.		initiatives regarding mobility services such as automated driving, MaaS, etc. and was decided in June 2019 • With the objectives of holding discussions in the MaaS-Related Data Investigative Commission so that the exchange of MaaS-related data is carried out smoothly, the Guidelines on the Exchange of MaaS-Related Data, Ver.1.0, which present the matters the related people should refer to when carrying out data exchange, have been formulated by the national government for the first time	Mobility Challenge, which supports regions and companies challenging themselves to solve transportation issues and revitalize their regions through the social implementation of new mobility services • The Ministry of Economy, Trade and Industry is implementing the formulation of business plans and the analyses of business effects, etc. together with the areas that are engaging in pioneering social implementation of new mobility services (Project for the Analysis of Pilot Areas) • The Ministry of Land, Infrastructure, Transport and Tourism support demonstration experiments for new mobility services such as MaaS, etc. in regions nationwide in order to carry out model building for the solution of transportation services issues in the regions (Project for the Promotion	

				of New Mobility Services)	
Health and medical care and nursing	○ Extend the health and longevity of citizens by actively utilizing ICT data in the field of health and medical care and nursing ① Provision of services that can confirm the health information history of individuals such as baby and infant health checkups, immunizations, etc. centrally ② Mechanisms that can confirm public health medical care information in medical institutions, etc. nationwide ③ Gather data for scientific analysis of nursing to provide optimal services ○ Promotion of the utilization of anonymized medical data that contributes to research and development of the medical care field	① to ③ FY2020 (Growth strategy follow-up)	• Full-scale operation from October 2020 of consolidated analyses of the National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB) and the Long-term Care Insurance Comprehensive Database (Nursing DB) • Regarding baby and infant health checkups and pregnant woman health checkups, carry out the necessary legal revisions, and formulate the data standards layout and the renovation of systems in municipalities based on the My Number system, and start provision from June 2020 in Mynaportal. • Put into operation the mechanisms that can confirm the public health medical care information	• In order to promote mechanisms that can confirm other data items at medical institutions, etc., currently summarizing the issues and verifying the necessity of information collaboration, technology trends, and cost-effectiveness, taking into account previous demonstration results, etc. concerning the public health medical care information network • In SIP, develop “AI hospital systems” utilizing AI, the IoT, and big data technologies (building of a highly secure medical care information database, creation of a medical care glossary, automation of records at the time of a health checkup, bidirectional communication at the time of informed consent,	• Develop an environment for realization of other local government health checkups, etc. as well, based on the progress schedule formulated in the summer of 2020, so that provision can be started by about 2022. • Forms, etc. of the managing entities and cost burdens • Analyze the database to present to citizens the services that have been scientifically corroborated as having the effect of supporting independence, etc. • Creation of new services such as an AI hospital, online (remote) health checkups, pharmaceutical delivery, etc. • Multitiered development and promotion of the integration of the life data, health checkup data, medical care information, research data, etc. of daily life

			of patients, namely the medical agent information and specific health checkups information based on receipts, with the patients themselves and at nationwide medical institutions, etc., from about March 2021 in the case of specific health checkups information and from about October 2021 for medical agent information. Moreover, expand the information that is covered, such as information about surgeries, and ensure that it can be confirmed by about the summer of 2022. • Develop the database in FY2019, and start operating it from FY2020	building of an AI platform for implementing an AI hospital, development of support systems for the selection, etc. of diagnostics, monitoring, and medical treatments (including medical drugs) which apply AI technologies based on the patients' biological information, etc., development of highly safe medical equipment, etc.)	
Infrastructure and disaster prevention	○ Realization of improvement of fundamental productivity through digital transformation of the infrastructure field ○ Realize alleviation of the	① FY2022 (AI Strategy) ② FY2022 (SIP II)	• Currently promoting the building of an infrastructure and data platform through PRISM • In order to execute large-scale disaster response operations, currently	• Build the environment necessary for realizing across-the-board digitalization of the construction production process with BIM/CIM utilization as the starting	• Encourage further expansion of utilization of BIM/CIM in public projects • Aggregate and manage three-dimensional data and real data, and promote worksite demonstration and technology

	harm from disaster and improvement of productivity through realization of data exchange across normal times/times of disaster by aiming for exchange between the Land, Infrastructure, Transport and Tourism Data Platform and the foundational disaster prevention information distribution network (SIP4D) ○ Realize evacuations to protect the lives of individual citizens, the early restoration of wide-area economic activities, and strengthening of the disaster response capacity of municipalities ① Build a data infrastructure that connects the construction production process overall using three-dimensional data, ties the obtained data to the position information, and centrally		promoting research and development utilizing the latest science and technology, such as satellites, AI, big data, etc.	point • Implement demonstration experiments in SIP4D information linkages and promote research and development through dynamic social exclusion • Information generation and operation of systems that distribute to handheld information terminals and SIP4D for automatic alerts to railways about sudden winds such as tornadoes, etc. • The ISUT[36] that started full-scale operation from FY2019 utilized SIP4D in the 2019 Boso Peninsula Typhoon, the 2019 East Japan Typhoon, etc.; furthermore, it implemented provision of satellite analysis images • Plan to provide forecast information immediately before heavy rain in the Tokyo 2020 Games • Implement demonstration experiments of the research results in local government	development of new technologies utilizing these data, human resources development, etc. • Regarding the Land, Infrastructure, Transport and Tourism Data Platform, promote the improvement of functions, expansion of exchange with data held by other ministries and agencies and the private sector, etc., and the creation of use cases. • Link SIP4D and the L-Alert, etc. to enhance disaster information that can be shared. Promote the strengthening of functions and rulemaking so that the information can be utilized by local governments and the private sector as well • Consolidation and integration of infrastructure data with local governments and the private sector • Enhancement of SIP4D disaster information and provision of disaster information in a form that can be utilized easily by local governments and the private sector

[36] Information Support Team

	manages it (the Land, Infrastructure, Transport and Tourism Data Platform) ② Build information systems to support the decision-making of the national government and the municipalities at times of large-scale disasters*			disaster prevention drills, etc.	• Building of mechanisms with which data acquired with satellites is utilized
Agriculture	○ Build smart food chain systems with the Agricultural Data Collaboration Platform at their core that flexibly meet the needs of domestic and overseas markets and consumers ○ Utilize diverse information through digitalization that includes diverse procedures ① Reduction of food loss by 10% and reduction of working hours on production worksites by 30%*	① FY2022 (SIP II)	• Implement the building of a smart food chain under SIP	• Promote research and demonstration experiments for smart agriculture, etc. using AI and big data in SIP and also each ministry	• Expand the functions of the Agricultural Data Collaboration Platform (hereinafter referred to as "WAGRI") from production to processing, distribution, and consumption, and build smart food chain systems by FY2022 • Deployment of smart agriculture technologies and smart food chain systems utilizing sensing data, etc. • Capture the world market through the deployment of smart agriculture technologies
Logistics and commercial distributi	○ Build an infrastructure for data concerning logistics and commercial distribution (production and purchasing data,	① FY2022 (SIP II) ② FY2020	• Build a data infrastructure, etc. for accumulating, analyzing, sharing, and utilizing the data of logistics and	• In SIP, promote research and development for building the data infrastructure, etc. of logistics and commercial	• Build a port-related data exchange platform and realize information collaboration, the sharing of procedures, data standardization, etc. by the end

on	acceptance or delivery data, loading data, etc.) to collaborate with data infrastructures in other fields, and realize dramatic improvement in productivity in the supply chain overall by promoting automation, etc. in the logistics field ① Realize the building of a base that can utilize data beyond the barriers of individual companies and industries and the visualization of cargo information and merchandise information* ② Building of a port-related data exchange platform	(Declaration to Be the World's Most Advanced IT Nation and Basic Plan for the Advancement of Public and Private Sector Data Utilization)	commercial distribution using SIP beyond the barriers of individual companies and industries • Demonstration of trade procedures data exchange systems • The Cabinet Secretariat, National Strategy office of Information and Communication Technology and the Ministry of Land, Infrastructure, Transport and Tourism have established a promotion committee and an investigation working group pertaining to the building of a "port-related data exchange platform" and have implemented the systems design. Currently implementing the investigation and coordination for building the systems	distribution • The Ministry of Land, Infrastructure, Transport and Tourism is implementing demonstration experiments of cargo deliveries utilizing drones in mountainous areas, etc. and of the introduction of the IoT to marine industries	of 2020 • Develop logistics and commercial distribution data infrastructure by FY2022 • Provision of new services using data consolidation of the overall movement of goods, including drone deliveries, etc. utilizing automated deliveries • Development of support systems utilizing fiscal loans for the introduction of logistics facilities and equipment, etc. contributing to the conversion to data and automatic gathering of logistics information and labor-saving, etc. by using the IoT, AI, etc. • Response to the international logistics network (computerization of trade procedures, etc.)
Energy	○ Realization of energy management systems that enable optimal utilization of diverse energy sources ○ Gather and analyze data	① FY2022 (SIP II) ② FY2021	• In the design of an energy system for an IoE society in the SIP's "Energy system for an IoE society," currently	• The Cabinet Office is implementing research and development concerning power electronics, which are fundamental	• Building of comprehensive systems for energy management including electricity, heat, hydrogen, etc. • Building of a new business model

	concerning the city environment and city sanitation (water supply, wastewater treatment, etc.) to streamline and improve the convenience of public services [France, the United Kingdom, etc.] ① Optimal conceptual design of new energy management systems based on data infrastructure in the environment and energy fields and utilization of that infrastructure* ② Commercialization of virtual power plants, the next-generation coordination capability utilizing the energy resources of combined heat and power (cogeneration), storage batteries, demand response, etc. and expansion of energy resources for which remote control using IoT technologies is possible	(Future Investment Strategy 2018)	investigating energy systems design techniques, etc. including architecture that incorporates cross-sectional data federation	technologies, and concerning wireless electricity transmission systems for practical applications. The Ministry of Economy, Trade and Industry, the Ministry of the Environment, etc. is implementing demonstrations of the building of energy management technologies • The Ministry of the Environment is gathering and analyzing data concerning energy consumption, and utilizing behavioral insights such as nudge and boost, etc. and AI/IoT (BI-Tech) to feedback personalized messages to each individual and implementing demonstration projects to encourage energy-saving behavior • The Ministry of the Environment implemented a demonstration of a platform for buying, selling, and trading the CO_2 reduction value of independently-dispersed	under which local governments and regional electricity business operators carry out the management and operation of distribution networks (including underground distribution networks) independently and autonomously • Promotion of initiatives for the System of Systems for realization of Society 5.0 in collaboration and cooperation with other systems

				and self-consumption-type renewable energy along with attribute information, and succeeded in recording the transfer of value using blockchain technologies • The Ministry of Economy, Trade and Industry and Ministry of the Environment is promoting sustainable, independent regional energy systems • The Ministry of the Environment is promoting building projects, etc. for decarbonized regional transportation models	
Earth environment	○ Enhance, accumulate, integrate, and analyze earth environment big data and real-time data, and provide such data to other Society 5.0-related systems ○ Build Hub, a platform that can respond to various impacts of climate change on social and economic activities, and return the results to society ① Advance development of analytical systems and applications that meet	① FY2025 ② FY2030 (Integrated Innovation Strategy)	• The Ministry of Education, Culture, Sports, Science and Technology is currently building an Earth Environmental Information Platform centered on DIAS	• The Ministry of Education, Culture, Sports, Science and Technology is currently demonstrating real-time river and dam management systems that use DIAS in the Shinanogawa river system • The Ministry of the Environment is enhancing information platforms in the fields of climate change adaptation, etc. (including plans)	• We will respond to rapidly-growing earth environment big data and real-time data using DIAS and advance the development of analytical systems and applications that meet diverse social needs to strengthen and upgrade infrastructure, including enhancement of the analytical environment, development of big data analytical technologies, etc., in order to encourage the development of use of the analytical systems and applications in new fields

	diverse needs to strengthen and upgrade the infrastructure ② Implement long-term and stable operation as important infrastructure for realizing continuous data accumulation and return of data to society				• Furthermore, we will implement long-term and stable operation as important infrastructure for continuous accumulation of earth environment big data, etc. and for converting that data into information that can be used for a variety of decision-making and returning it to society
Environment and trash	○ Share the information for engaging in environmentally-friendly consumption and the information necessary for proper resources circulation among the related people, and aim for thorough resources circulation to ensure that problems related to environmental conservation do not arise ① Upgrading of the monitoring of proper treatment processes and labor-saving, etc. ○ Building of a recycling society with high resource productivity	① About 2030 (Fundamental Plan for Establishing a Sound Material-Cycle Society, Promotion Strategy for Environmental Research and Environmental Technology Development)	• The Ministry of the Environment plans to promote research and development concerning the upgrading of resources circulation and proper treatment utilizing AI/IoT technologies, including data exchange	• The Ministry of the Environment plans to promote research and development concerning the upgrading of resources circulation and proper treatment utilizing AI/IoT technologies	• Ensuring proper treatment and the upgrading of resources circulation

“Monozukuri” (Manufacturing)	○ Through the digitalization of production and distribution processes, greatly increase automation and virtualization, minimize production and distribution costs, and improve productivity ① Realize inverse problem MI* • Reduce materials development costs to 50% or less and reduce the materials development period to 50% or less, and demonstrate the effectiveness of that approach • Use inverse problem MI from the required performance of the actual materials in the environment and energy industries, such as electricity-generating plants, and the aircraft industry, etc., to develop cutting-edge processes, etc. for composite materials and heat-resistant alloys with a	② FY2022 (SIP II)	• The Ministry of Education, Culture, Sports, Science and Technology is building a data platform integrating materials information • The Ministry of Economy, Trade and Industry is encouraging data sharing in cooperative domains of the priority industrial fields • Developing inverse problem MI to design processes and materials from the required performance in SIP	• The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry is implementing research and development, demonstration experiments, encouragement of dissemination, and human resources development for technologies pertaining to productivity improvement utilizing the IoT • Regarding the mechanism for distributing data beyond the barriers of companies which domestic organizations and companies cooperated to build by FY2019 in order to fully utilize the valuable data generated in manufacturing worksites, the Ministry of Economy, Trade and Industry will carry out demonstration experiments, etc. and start actual operation by FY2021.	• Collaborate with the investigation of architecture in the five priority fields under Connected Industries, to build architecture which has mutual operability • Building of data exchange mechanisms that connect the platforms of each company horizontally • Improvement of security and usability for social implementation of MI systems. • Build a database fully utilizing an information engineering framework, and investigation of open-and-closed strategies for data. • Investigation of the creation of uniform evaluation techniques used in common by domestic institutions when building materials properties databases for the purpose of acquiring authentication. Preliminary materials and manufacturing process experiments and database building.
			<SIP II: A materials revolution through an integrated materials development system> • Build an integrated materials development system aimed		

	high degree of design freedom		at the realization of Society 5.0. Deploying this in the cutting-edge structural materials and processes in which Japan has strengths and which will be increasingly important going forward will enable the structures and properties of the materials that are necessary based on the desired performance to be proposed and feasible processes to be presented. • Utilize the integrated materials development system to develop technologies related to the properties and productivity improvement of carbon fiber reinforced plastic composites, which are being increasingly used as materials for light structures. Based on those results, lead the world in the development of transportation equipment such as aircraft, etc. • Regarding the heat-resistant alloy powder process, for which there is fierce competition over development, and ceramic-based composites, which are materials resistant to super-hot temperatures for use in next-generation transportation and energy equipment, realize innovative materials and processes utilizing the integrated materials development system, and aim to strengthen the industrial competitiveness of Japan.		
Finance	○ Realization of a cashless society using FinTech,[37] and completion of transactions digitally ○ Upgrading of the consumer lives of individuals, enhancement of assets formation, improvement of the	① FY2025 (Cashless Vision)		• The Ministry of Internal Affairs and Communications is implementing the nationwide deployment of the unified QR “JPQR” to promote the shift to a cashless society	• Development of the data environment that is a precondition for FinTech • Promotion of collaboration between financial institutions and FinTech companies • Encouragement of the dissemination of cashless settlement based on the

[37] A coined word combining “finance” and “technology.”

	earning power of companies [South Korea] ① Cashless settlement ratio of 40%				Cashless Vision, etc.
Ocean	○ Gather and analyze data concerning the ocean and provide it to other Society 5.0-related systems ① Building of an industrialization model and extraction of issues for ocean minerals and deep-sea resources*	① FY2022 (SIP II)	• The Cabinet Office's National Ocean Policy Secretariat and the Japan Coast Guard have started operation of a maritime condition display system to encourage the aggregation and sharing of information	• Establish and demonstrate technologies for survey and collection for marine mineral resources in SIP	• As a part of the strengthening of the capability of MDA, improve the visualization of the ocean by encouraging the gathering and sharing of information using advanced information sharing systems, the strengthening of structures for gathering information, including the development of automatic observation technologies such as AUV, etc. • Development of marine mineral resources survey and development technologies • Response to new environmental issues such as plastic trash in the ocean, etc. • Expansion of data utilization through collaboration with the systems possessed by local governments and the private sector, etc. and collaboration with the systems of other fields, etc. • Investigation on utilization of Minamitorishima Island and discussion on commercialization

					models for of the marine environment survey and the marine geological surveys using AUV developed in SIP II in collaboration with related ministries and insituttions
Space	○ Use space systems to gather and analyze data, and provide it to other Society 5.0-related systems [Copernicus DIAS (Europe), etc.] ① Approximately 16,000 user registrations in the government satellite data platform (Tellus) that the Ministry of Economy, Trade and Industry is developing	① FY2020 (Objectives of budget projects)	• In collaboration with the Cabinet Office's National Space Policy Secretariat, the Ministry of Economy, Trade and Industry is promoting a project to develop an environment for opening and using government satellite data. The general release of the prototype of the government satellite data platform (Tellus) was in February 2019 • The ministry is continuing data contests, user training, etc. in order to develop human resources who can analyze satellite data	• Provide data from remote sensing satellites • Promote demonstration experiments concerning utilization of the Quasi-Zenith Satellite System in SIP and the relevant offices, ministries and agencies • Automated driving (expansion of systems and services) • Smart biotechnology for industry and agriculture • Enhancement of national resilience (disaster prevention and reduction)	• In order to advance the establishment of principles for the use of satellite data for the streamlining and upgrading of the operations of the national government and local governments, establish the Task Force on the Use of Satellite Remote Sensing Data (provisional name) comprising the relevant offices and ministries during FY2020 • Promote a project to develop an environment for opening and using government satellite data • Expansion of data utilization through collaboration with other data platforms such as the data, etc. possessed by local governments and collaboration with the systems of other fields, etc. • Encourage utilization of satellite data in a variety of domestic and overseas business fields • Promote demonstration experiments concerning

					utilization of the Quasi-Zenith Satellite System in SIP and the relevant offices and ministries, and further accelerate social implementation through creation of an advanced use model
Digital government	○ The necessary services can be received in the optimal form regardless of time and place ○ Data and services are organically exchanged to create new innovation in both the public and private sectors [Estonia (e-Estonia)] ① 100% digitalization of administrative services ② Administration services data exchanged with private sector services, etc.	① FY2023 ② FY2023 (Digital Government Implementation Plan)	• Currently promoting the formulation of administration data exchange standards, the development of a common vocabulary base, the opening of administrative data, etc.	-	• Standardization and commonization of services and platforms in local governments
Education	○ Effectively utilize cutting-edge technologies as a tool for supporting teachers in school education, and realize meticulous instruction suitable for the school education of Japan and tailored to the capabilities and personalities of the pupils	Investigation taking into account the Measures to Utilize Cutting-Edge Technology to	• Currently investigating the utilization, etc. of big data (learning history and grade information of the pupils, records of pupil instruction, etc.) as a tool to support teachers for enhancement, etc. of instruction tailored to the capabilities,	• Implemented a demonstration project regarding the introduction of cutting-edge technologies that can be effectively utilized in school education • Implemented survey research for the introduction of online learning systems enabling	• Encouragement of development of an ICT environment for the realization of effective utilization of cutting-edge technologies • Investigation for both ensuring information security and utilizing data at the same time • Organization of the basic concepts concerning the utilization of cutting-edge

	[United States] • The definitions of terms and ID system from preschooler education to training inside companies is organized to standardize the learning data, and make data comparisons between states possible (CEDS: Common Education Data Standards) [Australia] • The data accumulated in each school is shared between schools, gathered and analyzed by the states, and used in comparisons by the federal government of the education situations of the states	Support Learning in a New Era (Final Version)	personalities, etc. of the pupils	learning and assessment using terminals in schools and households	technologies in schools and the utilization of education-related data (the forms of instruction utilizing cutting-edge technologies, the handling of personal information when handling the data of pupils, etc.)
Crime prevention and safety	○ Utilize cutting-edge technologies such as the utilization, etc. of AI, etc. to realize safe lifestyles [United States, United Kingdom, etc.] ① Upgrading and streamlining of police activities	① Aim for early implementation of AI based on demonstration experiments	• Currently promoting the opening of crime occurrence information and transportation accident statistics information	• Implemented demonstration experiments regarding the possibilities for the utilization of AI, etc. in police activities	• Expansion of the utilization of cutting-edge technologies in police activities

*: A research and development objective in the Cabinet Office's SIP project. Further policy measures, etc. are necessary for social implementation and general dissemination.

(3) Development and Global Deployment of Research Data Infrastructure

○ **Future Visions to be Pursued**

- Based on the national interest and the properties, etc. of the research fields, and taking into account the open-and-closed strategies, tackle the storage and management of research data[38] in cyberspace, and link with the research data infrastructure of foreign countries to build an enormous "source of knowledge," thus enabling all people to widely utilize the research results
- As a result, accelerate the creation of knowledge through new collaborations beyond the boundaries of the affiliated institutions, specialized fields, and national borders

○ **Objectives**

<Development of the Research Data Infrastructure and Repository[39]>

- Develop the NII Research Data Cloud (hereinafter referred to as the "Research Data Infrastructure System"), a system to encourage the management, release, and search of research data utilizing repositories, and start operation in FY2020
- ***Encouragement of advanced data management, including utilization of research data created by publicly-funded research activities***
- Promote strategic collaboration, including mutual operation, etc. of data with foreign governments, international institutions, etc., while also taking into account the open-and-closed strategies, for the building of an international research data infrastructure, in order to secure the autonomy of Japan's research and development activities and promote international open science

<Formulation of Policies and Plans for Management and Utilization of Research Data>

- Encourage the formulation of policies (data policies) and plans (data management plans)[40] for the management and utilization of research data as research results
- Encourage the release of publicly-funded research data using institutional repositories and other data infrastructure based on these policies and plans
- Ensure through data infrastructure the machine-readability and mutual operability of research data that is the result of publicly-funded research, and encourage collaboration with the research data infrastructure of foreign countries regarding research data that is released

<Development of Human Resources and Survey on the Utilization of Research Data>

- In order to achieve utilization of research data, encourage the utilization of teaching materials in training and improve the awareness of the research implementers and research support staff

[38] Including research data that provides the basis for research results (academic papers, etc.)

[39] A kind of data infrastructure, this is an archive system on the Internet to store and release electronic intellectual products.

[40] Policies for the management and utilization of research data will be established by national research and development agencies by the end of FY2020 and a system will be introduced to ministries and funding agencies by the solicitation of project proposals for the FY2021 budget to require research implementers using competitive research funds to formulate plans.

while also ascertaining the actual situation

① Implementation Status and Analysis of the Current Situation

To date we have formulated a range of guidelines and have carried out the development of the Research Data Infrastructure System. Furthermore, the Moonshot Research and Development Program carried out an investigation to promote advanced data management, for example, the early utilization of the Research Data Infrastructure System, and it reflected the investigation results in the operational and evaluation guidelines for the program.

<Development of the Research Data Infrastructure and Repository>

○ SINET, which is essential for the education and research of Japan, is operated as network infrastructure equipped with both high reliability and security which connects more than 900 universities, research institutions, etc. throughout Japan with a 100Gbps high-speed, dedicated line. Furthermore, regarding the Research Data Infrastructure System that encourages management, release and search of research data utilizing a repository (NII Research Data Cloud), the Ministry of Education, Culture, Sports, Science and Technology has taken the lead in advancing development toward full-scale operation within FY2020.

○ The Research Data Infrastructure Development and International Cooperation Working Group (hereinafter referred to as the "Research Data Infrastructure Development and International Cooperation WG") investigated the short-term and medium- to long-term objectives pertaining to the development of research data infrastructure by 2025, such as building the sustainable structures of the Research Data Infrastructure System, promotion of advanced data management in the Moonshot Research and Development Program, etc., and released a report in October 2019.

○ The Moonshot Research and Development Program carried out an investigation to promote advanced data management, for example, the early utilization of the Research Data Infrastructure System, and it reflected the investigation results in operational and evaluation guidelines for the Program.

○ The Cabinet Office is advancing an investigation regarding collaboration with the Research Data Infrastructure System and other initiatives such as data exchange platforms, the Evidence System,[41] etc.

○ The Ministry of Education, Culture, Sports, Science and Technology has taken the lead in developing and releasing J-STAGE Data, a system that links to academic papers and research data printed in J-STAGE[42] and manages and releases the research data, during FY2019.

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[41] System that accumulates STI-related data (data about inputs (trends in funds, human resources, etc.), activities (the activities of universities, research and development agencies, etc.), outputs (academic papers, patents, etc.), and outcomes (trends in the economy, society, etc.)), enabling policy-makers and corporate managers to analyze them easily.

[42] The joint platform of electronic academic journals issued by domestic academic societies.

<Formulation of Policies and Plans for Management and Utilization of Research Data>

○ In the Cabinet Office (STI), the Research Data Infrastructure Development and International Cooperation WG conducted an investigation regarding the development content for the research data infrastructure and peripheral environment necessary for the appropriate management and utilization of research data and the general items of the data management plans, etc., and compiled a report in October 2019. Currently, the competitive research funding programs of six ministries and institutions[43] have introduced mechanisms requesting the submission of data management plans from research implementers.

○ Based on the Guidelines for Formulation of Data Policies in National Research and Development Agencies formulated in June 2018, national research and development agencies are advancing the formulation of data policies.[44] The Cabinet Office (STI) is regularly confirming the status of formulation and currently data policies have been formulated and released by ten agencies and one institution.[45]

○ In order to conduct an investigation for collaboration with the corresponding systems of the EU, etc., the Cabinet Office (STI) has introduced the initiatives of Japan and implemented information exchanges in workshops utilizing the G7 framework held in June 2019 and in international conferences in the United Nations and UNESCO.

○ In order to collaborate with investigations concerning the management and utilization of research data from the position of academia, the Cabinet Office (STI) has been carrying out information exchanges with the Science Council of Japan's Investigative Committee on the Deepening and Promotion of Open Science.

<Development of Human Resources and Survey on the Utilization of Research Data>

○ In the Cabinet Office (STI), the Research Data Infrastructure Development and International Cooperation WG conducted an investigation regarding the types of human resources required by research data management, and incentives, etc., and compiled a report in October 2019.

○ We produced online courses in research data management for research supporters and started test operation in August 2019.

○ The Ministry of Education, Culture, Sports, Science and Technology is taking the lead in continuously carrying out the gathering, etc. of domestic and overseas trend surveys and outstanding examples of research data utilization.

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[43] Six ministries and institutions: the Ministry of Education, Culture, Sports, Science and Technology, the Ministry of Economy, Trade and Industry, AMED, JST, JSPS, and NEDO.

[44] The aim is for all of the national research and development agencies (24 excluding AMED, JST, and NEDO, which are research funding agencies) to formulate data policies by FY2020.

[45] The ten institutes are NICT, NIMS, NIED, Riken, JAMSTEC, the National Agriculture and Food Research Organization, the Japan International Research Center for Agricultural Sciences, the Forest Research and Management Organization, the National Institute of Advanced Industrial Science and Technology, and NIES. JAXA has formulated and released its data policies through the Institute of Space and Astronautical Science, a laboratory inside JAXA.

② Measures and Solutions for Achieving the Objectives

<Development of the Research Data Infrastructure and Repository>

○ We recommend the development of a repository in each institution of the country, so that researchers are able to store and manage research data with confidence. [All offices, ministries, and agencies]

○ Regarding SINET, in addition to the upgrading of the network infrastructure for further improvement of the research environment, we will promote not only the gathering and forwarding of the data that is generated in diverse situations in research but also enhancement of the functions for an integrated platform that merges the Research Data Infrastructure System with the former network infrastructure including not only utilization for research at universities and research institutions but for industry and academia as well. [MEXT]

○ In order to encourage advanced data management, including utilization of research data created by publicly-funded research activities, the Moonshot Research and Development Program will promote advanced data management, for example, the early utilization of the Research Data Infrastructure System. [Cabinet Secretariat, STI, AMED, MEXT, MHLW, MAFF, METI]

○ Based on the findings of the advanced data management in the Moonshot Research and Development Program, we will implement an investigation for management and utilization of research data in other public funds through utilization, etc. of the Research Data Infrastructure System. [STI, MEXT]

○ For realization of collaboration with the cross-domain data exchange platform, in FY2020 we will commence formulation of a domain vocabulary in the research data infrastructure concerning the development of a common core vocabulary of the field. [STI]

○ In the development of J-STAGE Data, the Ministry of Education, Culture, Sports, Science and Technology will take the lead and cooperate with the academic societies, etc. using J-STAGE to enhance research data linked to academic papers printed in J-STAGE. [MEXT]

○ In order to contribute to a multifaceted analysis of research capacity by utilizing new techniques such as language processing, AI utilization, etc., we will conduct an investigation for the building of the infrastructure of the related data. [MEXT]

<Formulation of Policies and Plans for Management and Utilization of Research Data>

○ In order to encourage the utilization by private sector companies of research data generated by public funds, the Research Data Infrastructure Development and International Cooperation WG will advance an investigation into the anticipated issues and solutions, etc. [STI]

○ Based on the Guidelines for Formulation of Data Policies in National Research and Development Agencies, the national research and development agencies will promote the formulation of data polices taking into account the open-and-closed strategies. [All offices, ministries, and agencies]

○ We will formulate data polices at the national level, taking into account the grand design for

management, release, and search of the research data investigated in the Research Data Infrastructure Development and International Cooperation WG. [STI]

○ Each office, ministry, and agency and the competitive research funding programs under the jurisdiction of the research funding agencies will advance the introduction of mechanisms requiring research implementers to formulate data management plans. [All offices, ministries, and agencies]

○ We will utilize the G7 framework, etc. to carry out an investigation for collaboration with the corresponding systems of the EU. Furthermore, through international cooperation, we will investigate countermeasures for preventing harm to research and development activities caused by the overconcentration of academic papers and research data. [STI]

○ Regarding the management of the quality of information and sharing information among communities, etc. to contribute to the development of academia and improvement of the reproducibility of research results, etc., we will collaborate with an investigation from the position of academia concerning the direction of Japan, while taking into account the characteristics of the scholarly fields and international trends. [STI]

<Development of Human Resources and Survey on the Utilization of Research Data>

○ During FY2020 we will release teaching materials for research data management which are produced for researchers.

[MEXT]

○ We will continuously carry out surveys of the domestic and overseas trends in research data utilization and the gathering, etc. of outstanding examples.[46]

[STI, MEXT]

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[46] Outstanding examples to date include, for example, the following initiatives.
- An initiative that shared experimental data within a team comprising multiple universities and national research and development agencies to carry out research efficiently and achieve the objective of thermal efficiency of 50% in gasoline engines for automobiles (SIP, Innovative Combustion Technology, Gasoline Combustion Team)
- An initiative for building a shared data infrastructure based on the characteristics of each industry for the realization of open innovation, and building a data platform that enables utilization across industry, academia, and government, in order to develop innovative materials (NIMS)
- An initiative to use the Research Data Infrastructure System to share research data among researchers in order to clarify the pathogenic mechanism, etc. of epilepsy. (Synthetic analysis of the comprehensive epileptic network of the human brain using glia and neurons)
- Initiative to manage the data of different fields pertaining to the space and earth environment in one place and to encourage the sharing of the data among researchers (IUGONET (Inter-university Upper atmosphere Global Observation NETwork) project)

Other examples of management of research data have been released in the figures and charts of the report by the Research Data Infrastructure Development and International Cooperation WG in the Cabinet Office (October 2019 release)
(https://www8.cao.go.jp/cstp/tyousakai/kokusaiopen/zuhyou2.pdf).

(4) Evidence Based Policy Making/Promotion of University Corporation Management

○ **Future Visions to be Pursued**

• Contribute to innovation and economic growth by conducting EBPM accurately

• In particular, revitalize combined innovation by the public and private sectors, through evidence-based allocations of government research and development investment that prime private sector investment

• National universities and research and development agencies will improve management through EBMgt[47] to fully exercise their potential

○ **Objectives**

• We will tackle the expansion of the functions of the Evidence System[48] by aiming to consolidate it with other existing databases, and start using it within national universities and research and development agencies by FY2020

• We will utilize analyses using the Evidence System in the analysis, revision, and formulation of the policies of the government overall, and contribute to the evidence-based drafting of the Next Basic Plan

① Implementation Status and Analysis of the Current Situation

We built the Evidence System and started providing it inside the government in March 2020. Specifically, we have started provision of some of the functions established as the pillars of the constituent elements of the Evidence System, the functions regarding visualization of the science and technology-related budget, analysis of the research capacity of national universities, national research and development agencies, etc., analyses pertaining to the external funds and contributions acquisition of universities, national research and development agencies, etc., and visualization of the needs of the industrial world pertaining to human resources development.

<Utilization of Evidence Data in Policy-Making>

○ The Cabinet Office (STI) utilized the data obtained as a consequence of building the Evidence System in its review of the Fifth Basic Plan. Furthermore, it utilized this data as the base data for the formulation of the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers and the drafting of the Program to Support Emergent Research.

② Measures and Solutions for Achieving the Objectives

<Expansion of the Functions of Evidence System>

○ We will expand the functions of the Evidence System and start using it within national

[47] Evidence-based Management

[48] System that accumulates STI-related data (data about inputs (trends in funds, human resources, etc.), activities (the activities of universities, research and development agencies, etc.), outputs (academic papers, patents, etc.), and outcomes (trends in the economy, society, etc.)), enabling policy-makers and corporate managers to analyze them easily.

universities and research and development agencies by FY2020. Furthermore, in order to advance its use in policy-making by users and in the upgrading of corporation management, we will ensure that the analytical functions can be enhanced and provided, and investigate the strengthening of structures for continuously gathering data pertaining to the built functions and developing the data over time. [STI]

○ Regarding the visualization of the research capacity of national universities, national research and development agencies, etc., in addition to visualization of the relationship between the researcher attribute information in e-Rad and the academic paper information in bibliographic information databases, we will advance visualization of patent information. Furthermore, we will work to strengthen the functions so that visualization in the form incorporating not only English language academic paper information but also Japanese language academic paper information is possible. Moreover, in order to enable multifaceted analyses and evaluation of the research capacity of research institutions, in addition to the number of papers and number of citations previously used as output indicators, we will develop a tool that enables analyses of the depth of the researchers and analyses by domain, to build mechanisms that can share information among the related institutions. [STI]

○ We will use the funding data gathered based on the Guidelines concerning Promotion of Data Standardization that Contributes to the Analysis of Research Capacity to build mechanisms that visualize the cost-effectiveness of research funds, and add analytical functions pertaining to more appropriate forms of operation grants and competitive research funding, which are thought to be effective in improving the research capacity of Japan. [STI]

○ In order to grasp the research funds acquisition status and results status of researchers in a unified and efficient manner, we will expand the data gathering target of e-Rad from competitive funds to all public research funds and enhance its functions as a system contributing to the analysis of research capacity. Furthermore, we will ensure that duplicated data input by researchers can be avoided, by building functions that can electronically consolidate the funding data held by funding agencies in e-Rad. [STI]

○ In order to encourage the achievement of three times as much private sector research and development investment in universities, national research and development agencies, etc., we will build mechanisms that visualize the actual state of external funds acquisition in each institute, etc. and also visualize productivity pertaining to the acquisition of private sector funds, such as patent license income, joint research funding, etc., for each institution, and build mechanisms that can share information among the related institutions. [STI]

○ In order to advance investigation of the vision that the universities, etc. nationwide that are the core of innovation ecosystems should aim for going forward, we will build functions that visualize the potential research seeds of universities, etc. for each region and the human resources development supply and demand in the regions. [STI]

○ By advancing the utilization of the data gathered as a consequence of building the Evidence

System, we will strengthen collaboration with the relevant institutions possessing think tank functions in the science and technology policy field and strengthen the EBPM functions that support policy-making. Specifically, we will make more specific policy recommendations and lobby the related ministries and agencies, by implementing analyses combining the data gathered when building the Evidence System, such as the e-Rad data, funding data, human resources development needs data, etc., with the survey results for the academic paper production trends surveyed and analyzed at the related institutions. [STI]

<Further Utilization of Evidence Data in Policy-Making>

○ We will promote utilization of the Evidence System in order to achieve the greater penetration of EBPM into policy-making through further utilization in the related ministries and agencies and the related institutions. [All ministries and agencies]

○ In order to encourage use of the Evidence System, we will release the releasable parts of the system as a release site. Furthermore, on that site we will share examples of analyses using the evidence data in a comprehensible way, and regularly establish opportunities for each ministry and agency to give explanations pertaining to their utilization methods, and follow up on the utilization status of each ministry and agency. Moreover, we will advance further upgrading through exchanges of views with overseas government institutions and an investigation regarding the forms of international collaboration. [STI]

CHAPTER 2: Creation of Knowledge

(1) Strengthening Research Capacity, the Source of Value Creation (Support for the Challenges of Young Researchers, Further Promotion of Humanities and Social Sciences, etc.)

○ Future Visions to be Pursued

- ***Provide an appealing research environment to all motivated researchers, from young researchers to top researchers, in order to make "researcher" an appealing occupation, for sustainable maintenance and improvement of research capacity***

<Strengthening of Research Capacity and Support for Young Researchers>

- ***By deploying the right people in the right place, regardless of age or gender, after ensuring competitiveness, we will increase opportunities for outstanding young researchers to challenge themselves, and we will dramatically improve the research capacity of Japan through the realization of appealing doctoral courses and diverse career paths for research human resources, the encouragement of challenging research that contributes to the development of emerging and merged domains, and the development of an appealing research environment that enables dedication to research***

<Borderless Challenge (Globalization, Large-Scale Collaboration between Industry and Academia)>

- ***For the continuous creation of innovation using wide-ranging knowledge, perspectives, ideas, etc. beyond barriers such as national borders, industry, academia, and government, we will encourage international brain circulation and industry, academia, and government human resources flow, and realize many full-scale joint research projects, including international research cooperation, for which diverse, outstanding human resources such as young people, women, etc. from around the world gather in Japan***

<Promotion of Humanities and Social Sciences>

- ***Through the comprehensive and planned promotion of humanities and social sciences, the humanities and social sciences will contribute to the solution of issues including emerging infectious diseases such as the novel coronavirus disease, earth environmental problems, the population decrease and super-aging, destabilization of the society and economy as a consequence of globalization, etc., and to the solution of ethical, legal, and social issues for the social implementation of science and technology***

○ Objectives

<Strengthening of Research Capacity and Support for Young Researchers>

- By FY2020, for the realization of research productivity on a par with the major nations, increase the total number of papers and increase the proportion of the number of adjusted top 10% papers among the total number of papers to 10% or over. By FY2023, increase the number of papers

per teacher and the total number of papers in research universities while also increasing the proportion of the number of adjusted top 10% papers among the total number of papers to 12% or over

- By FY2023, the growth rate for the number of domains participating in the science map will surpass the growth rate of the world overall
- ***By FY2025, aim for teachers under 40 years old to account for 30% or more of the full-time university teachers of Japan in the future, and increase the number of full-time university teachers under 40 years old by approximately 10%***
- In the context of advancing an integrated revision of competitive research funding, by FY2023, we will make the ratio of young researchers in research projects adopted under Grants-in-Aid for Scientific Research ten percentage points higher than the ratio of young researchers in the research project applications
- ***To ensure that the second-stage doctoral course students that want it in the future can receive an amount approximately equivalent to their living expenses, for the time being aim to ensure that the number of students equivalent to approximately 50% of the students who go on to further study after their Master's course can receive that amount***
- ***By FY2025, realize diverse career paths for human resources with doctorates, and increase the employment rate of students who have completed second-stage doctoral courses to about the rate of people who have completed Master's courses (approximately 85%)***
- ***By FY2025, increase the number of holders of science or engineering doctoral degrees who are hired by the industrial world by approximately 1,000 people (approximately 65%)***
- ***By FY2025, halve the proportion of campus administration, etc. to ensure research time***
- ***By FY2025, establish shared-use structures for research facilities in universities, research institutions, etc.***

	(Baseline value)	(Current situation)	(Target value)
Proportion of the number of adjusted top 10% papers among the total number of papers	2004-2006	2014-2016	FY2020
	7.6%	8.5%[49]	10% or over
	2011-2013	—	FY2023

[49] Calculated using an integer count. The proportion of the number of adjusted top 10% papers among the total number of papers from 2014 to 2016: Japan: 8.5% (reference: China: 10.9%, Germany: 15.0%, the United States: 15.1%, and the United Kingdom: 17.3%) (Calculated in the National Institute of Science and Technology Policy based on the Japanese Science and Technology Indicators 2018 (August 2018) published by the National Institute of Science and Technology Policy).

	Proportion of the number of adjusted top 10% papers among the total number of papers of research universities	10.3%[50]	—	12% or over	
	Growth rate for the number of domains participating in the science map	2004 → 2014	2004 → 2016	FY2023	
		1.1-fold	1.2-fold[51]	Surpass the growth rate of the world overall	
	Number of university teachers under 40 years old	2013	2016	FY2025	
		43,763	43,153	48,700[52]	
	Proportion of full-time teachers under 40 years old at research universities	2013	May 2018	FY2025	
		27%	27%	30% or over	
	Difference between the ratio of young researchers in research projects adopted under Grants-in-Aid for Scientific Research, and the ratio of young researchers in the research project applications	FY2017	FY2019	FY2023	
		5.1 percentage points	10.6 percentage points[53]	At least 10 percentage points higher than the ratio of young researchers in the research project applications	
	Proportion of students going on to study a second-stage doctoral	—	—	Early achievement	
		—	—	Approximately 50%[54]	

[50] Calculated using the average value for 2011 to 2013 (integer count): 10.3% (collated by the National Institute of Science and Technology Policy using Japanese University Benchmarking Focused on Research Papers 2015 (December 2015) published by the National Institute of Science and Technology Policy, and similar databases).

[51] The growth rate of the number of participating domains from Science Map 2004 to Science Map 2016: world overall: 1.4-fold, Japan: 1.2-fold, the United States: 1.4-fold, the United Kingdom: 1.6-fold, Germany: 1.5-fold, China: 4.0-fold (Calculated in the National Institute of Science and Technology Policy based on the Science Map 2016 (October 2018) published by the National Institute of Science and Technology Policy).

[52] Provisional value in the case of making a provisional calculation in the same way as the Fifth Basic Plan using the most recent data, which is from FY2016. When investigating the Next Basic Plan, the investigation takes into account the latest data.

[53] Surveyed by the Ministry of Education, Culture, Sports, Science and Technology.

[54] When investigating the Next Basic Plan, the investigation takes into account the latest data. Of all second-stage doctoral course students (74,367 students in 2018) 10.4% received an amount equivalent to their living expenses (2015).

course after their Master's course who receive an amount equivalent to their living expenses			(Equivalent to about 20% of all second-stage doctoral course students)
Employment rate of students who have completed second-stage doctoral courses	FY2018 72.0%	FY2019 73.2%	FY2025 85%
Hiring of holders of science or engineering doctoral degrees by the industrial world	FY2014 1,257	FY2016 1,397	FY2025 Approximately 2,300
Proportion of campus administration, etc. for teachers in universities, etc.	FY2018 18.0%	— —	FY2025 Approximately 10%

* We have entered a dash ("—") under (Current situation) for those items where the (Baseline value) is the latest value. The same applies below.

<Borderless Challenge (Globalization, Large-Scale Collaboration between Industry and Academia)>

- By FY2023, increase the number of Japanese teachers who have obtained doctoral degrees and have experience of research and education activities at foreign universities by 30% over the FY2017 level in universities that are thoroughly advancing globalization[55]
- By FY2023, increase the number of graduate schools that students can complete in classes in the English language only to 300 or over
- By FY2023, make the rate of increase in the number of internationally co-authored papers among the number of adjusted top 10% papers equal to the level in Europe and the United States
- ***By FY2025, make the amount of investment by companies in universities, national research and development agencies, etc. three-fold the level of FY2014***

In the case that approximately 50% of students who go on to further study after their Master's course (approximately 30,000 students in 2018) can receive an amount equivalent to their living expenses, this is equivalent to about 20% of all second-stage doctoral course studnets.

[55] Universities that the Ministry of Education, Culture, Sports, Science and Technology is supporting with SGU which have been adopted as Type A universities (13 universities).

	(Baseline value)	(Current situation)	(Target value)
Number of Japanese teachers who have obtained doctoral degrees and have experience of research and education activities at foreign universities in universities that are thoroughly advancing globalization	FY2017	FY2018	FY2023
	1,308	1,344[56]	Approximately 1,700
Number of graduate schools that students can complete in classes in the English language only	FY2015	FY2017	FY2023
	222	252[57]	300 or over
Rate of increase in the number of internationally co-authored papers among the number of adjusted top 10% papers[58]	1999 → 2014	—	FY2023
	2.1-fold	—	Equal to the level in Europe and the United States
The amount of investment by companies in universities, national research and development agencies, etc.	FY2014	FY2017	FY2025
	115.1 billion yen	136.1 billion yen	Approximately 345 billion yen

<Promotion of Humanities and Social Sciences>

- ***Support research activities based on the inherent issue awareness of researchers, and anticipate various social issues to promote measures concerning the promotion of the humanities and social sciences in a comprehensive and planned way***

① Implementation Status and Analysis of the Current Situation

Regarding the strengthening of research capacity and support for young researchers, the CSTI

[56] Surveyed by the Ministry of Education, Culture, Sports, Science and Technology.
[57] Surveyed by the Ministry of Education, Culture, Sports, Science and Technology.
[58] Changes in the number of internationally co-authored papers in the number of adjusted top 10% papers (rate of increase from 1998~2000 to 2013~2015 (integer count)): Japan: 2.1-fold, the United States: 2.7-fold, France: 2.7-fold, Germany: 2.9-fold, the United Kingdom: 3.1-fold, China: 14.8-fold (Calculated in the Cabinet Office (STI) based on Scientific Research Benchmarking 2017 (August 2017) published by the National Institute of Science and Technology Policy).

formulated the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers in January 2020 in order to develop the Research Capacity Improvement Reforms 2019 by the Ministry of Education, Culture, Sports, Science and Technology and to comprehensively and fundamentally strengthen the research capacity of Japan through the triple reforms of human resources, funds, and the environment. For achievement of the objectives pertaining to the strengthening of research capacity and support for young researchers stated in the package, the government overall will tie the package to the enhancement of comprehensive and fundamental system reforms and measures.

Furthermore, in the investigation of the Next Basic Plan, we will further investigate the direction for addition and enhancement, etc. of the necessary measures concerning the strengthening of research capacity and support for young researchers, and the achievement objectives taking into account the latest data.

<Strengthening of Research Capacity and Support for Young Researchers>

○ In order to develop the Research Capacity Improvement Reforms 2019 formulated by the Ministry of Education, Culture, Sports, Science and Technology in April 2019 and comprehensively and fundamentally strengthen the research capacity of Japan through the triple reforms of human resources, funds, and the environment, the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry have collaborated to implement hearings for the frontline researchers and an investigation by CSTI executive members. Taking into account this investigation, the CSTI formulated the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers in January 2020.

[Direction of measures]

- Securing posts for and giving awards to outstanding young researchers
- Expansion of career paths for human resources with doctorates relying on diverse sources of finance (expansion of the number of paid interns, etc.), improvement of the treatment of graduate school second-stage doctoral course students, etc.
- For the seamless creation of research results, the “integrated revision of competitive research funding” to support the diverse and continuous challenges of researchers
- Establishment of mechanisms to provide long-term support for challenging research based on free-flowing thoughts and centered on young researchers
- Investigation of the revitalization of open innovation using externalization, etc. of the joint research functions of universities, etc.
- Establishment of the career paths of management human resources, URAs, engineers, etc. (URA certification systems, etc.)
- Encouragement of the development and sharing of research equipment and facilities (switch to core facilities), promotion of smart laboratories, etc.

<Borderless Challenge (Globalization, Large-Scale Collaboration between Industry and Academia)>

○ In order to strengthen international collaboration between industry and academia by universities, national research and development agencies, etc. and collaboration with domestic and overseas companies, the Cabinet Office (STI) formulated the Guidelines for universities and national R&D agencies on collaboration with foreign companies －Accelerate collaboration under appropriate approach －(interim report) in June 2019.

Furthermore, for encouragement of the mobility of innovation human resources and international brain circulation in industry, academia, and government, the Cabinet Office (STI) carried out a factor survey of the mobility of innovation human resources, and it made proposals for measures for the encouragement of mobility taking into account the results of questionnaires and domestic and overseas hearing surveys, and summarized and widely informed people about the good examples.

○ The Ministry of Education, Culture, Sports, Science and Technology has carried out the fundamental enhancement of opportunities to study and take on challenges overseas, including:

• Encouragement of the utilization of joint degrees[59] and double degrees;[60]

• Building and implementing educational exchange programs with overseas partner universities; and

• Establishing the Cross-border Postdoctoral Fellowship program, etc.

Furthermore, we utilized the hub formation-type industry, academia, and government collaboration systems that were generalized from FY2019 to start support of diverse hub formation based on the strategies of important fields such as quantum technologies, etc. and the characteristics and strengths of each university, national research and development agency, etc. from FY2020.

○ The Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Economy, Trade and Industry formulated the Guideline for Enhancing Industry-Academia-Government Collaboration Activities (Supplemental Version).

○ Concerning the promotion of collaboration between industry and academia and utilization of intellectual property in universities, etc., the amount of joint research funding received from private sector companies, the amount of income from intellectual property, etc., have been steadily growing in recent years, but the scale remains small compared to foreign countries, so it will continue to be necessary to promote the implementation of large joint research projects, the encouragement of open innovation, and the strategic utilization of intellectual property.

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[59] When a student has completed a single joint-education program offered among partnering universities, the said multiple partnering universities jointly confer a single degree.

[60] When a student has completed an education program among multiple partnering universities at the same degree level offered by each university and has satisfied the graduation requirements of each university, each university confers its respective degree on the said student.

Furthermore, in May 2020, NEDO compiled the issues, success factors, etc. apparent from the quantitative data related to open innovation and examples of its promotion by companies, etc. in the Open Innovation White Paper.

Moreover, we will promote organizations comprising universities, national research and development agencies, and private sector companies, and large industry and academia Co-Creation by the organizations, and in order to realize a virtuous cycle of knowledge and funds, the Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020, including clarification, etc. to the effect that joint research, etc. can be implemented in business operators that have received investments from research and development agencies.

<Promotion of Humanities and Social Sciences>

○ The humanities and social sciences not only play an important role as the intellectual assets of the nation; they also have the function of cultivating the soil for the learning and culture which comprises the foundation for a wide range of spiritual activities, and can be an important scale for measuring the intellectual and cultural maturity of the nation overall, so it is necessary to strategically emphasize this kind of perspective.

○ Taking this into account, to date we have promoted the humanities and social sciences from an academic perspective by offering dual support through competitive research funding such as Grants-in-Aid for Scientific Research, etc. and basis expenses such as the national university corporation operation grants, etc.[61]

○ Due to the fact that the progress of STI has become close and inseparable from the forms of humans and society, and the fact that it is important for the humanities and social sciences to play an active role in confronting various increasingly-complex modern issues, etc., the Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020, including adding science and technology pertaining to the cultural sciences[62] only to the items to be promoted by the Basic Act on Science and Technology.

② Measures and Solutions for Achieving the Objectives

Taking into account the above, from the perspective of aiming to strengthening research capacity, we will advance the building of an environment enabling a leap onto the path of research with dreams and hopes for the future, by implementing measures under the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers. Additionally, in the investigation of the Next Basic Plan, we will aim for the addition and

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[61] Of the FY2019 (newly) allocated amount of 64.7 billion yen (direct expenses) of Grants-in-Aid for Scientific Research, the amount allocated to major category A (related to the humanities and social sciences) was 9.7 billion yen (15.1%).

[62] For example, research pertaining to philosphy, law, history, classical literature, etc. qualifies as “cultural sciences” under the Basic Act on Science, Technology, and Innovation, so this is a concept that includes the humanities and social sciences. Note that the Integrated Innovation Strategy 2020 uses the expression “humanities and social sciences” ignoring the provisions of the law.

enhancement of the necessary measures.

Furthermore, regarding borderless challenge and human resources mobility, in order to develop and secure research human resources that can thrive on the global stage in an era of advancing globalization, we will aim to enhance the overseas study opportunities of graduate school second-stage doctoral course students and young researchers, and work to fundamentally strengthen international brain circulation under which outstanding researchers from throughout the world gather and thrive in Japan.

Regarding promotion of the humanities and social sciences, the humanities and social sciences will contribute to the solution of issues including emerging infectious diseases such as the novel coronavirus disease, earth environmental problems, the population decrease and super-aging, destabilization of the society and economy as a consequence of globalization, etc., and to the solution of ethical, legal, and social issues for the social implementation of science and technology, so we will support research activities based on the inherent issue awareness of researchers, and utilize the findings of the humanities and social sciences to promote initiatives to solve the specific issues in society.

<Strengthening of Research Capacity and Support for Young Researchers>

<<Implementation of the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers>>

(Expansion of posts for and provision of challenging research costs to young researchers)

○ We will urge the formulation of a "medium- to long-term personnel plan" by each national university, and allocate extra operation grants to universities taking measures to secure posts for young researchers. [MEXT]

○ For challenging research centered on young researchers, we will implement the Program to Support Emergent Research that offers support for a maximum of ten years while securing an environment in which researchers can dedicate themselves to their research without being bound by short-term results. [MEXT]

○ For the enhancement of priority support for young researchers and mid-career/senior researchers, and seamless support from basic research through to applications and practical application, we will conduct an investigation regarding integrated revision of competitive research funding.

[STI, MEXT, METI]

○ We will enhance and improve competitive research funding such as Grants-in-Aid for Scientific Research, JST Strategic Basic Research Programs, etc. for the encouragement of challenges in emerging and merged domains, the promotion of overseas challenges, and the strengthening of international joint research.

[MEXT]

○ We will expand the research opportunities of young researchers by enabling the allocation to

spontaneous research activities of a certain proportion of the effort of young researchers employed for implementing projects through competitive research funding.
[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

○ We will give priority to posts for young researchers through industry, academia, and government (the Leading Initiative for Excellent Young Researchers, etc.).
[MEXT]

(Realization of world-class treatment for outstanding researchers)

○ We will actively encourage mixed salaries (a mechanism for acquiring external funds to substantially raise salary levels) and diverse career paths by reinforcing the Basic Framework of the Cross-appointment System and Points to Note and informing people about good examples, etc. [MEXT, METI]

○ We will reinforce the personnel salaries management reform guidelines of national universities, etc. and thoroughly inform people about this, and provide incentives for mixed salaries, a greater number of posts for young researchers, and improvement of the environment in administrative divisions, including allocating extra operation grants to universities tackling reforms, etc. [MEXT]

○ We will carry out a systems revision to enable the implementation of joint research, etc. in business operators that have received investments from national university corporations, etc. We will apply an original salary structure commensurate to work duties and capabilities in the business operators that have received investments. [STI, MIC, MEXT, METI]

(Improvement of the treatment of second-stage doctoral course students)

○ We will encourage the enhancement of support such as campus scholarships, RAs, and fellowships (DC), etc. for outstanding second-stage doctoral course students, using diverse sources of funds including external funds, etc. [MEXT, METI]

○ To improve the treatment of second-stage doctoral course students, we will advance investigation of support measures for universities ensuring campus fellowships and career paths after completing doctoral courses in an integrated manner. [MEXT]

○ We will enhance overseas study opportunities for second-stage doctoral course students and young researchers. [MEXT]

○ We will promote the payment of proper compensation to RAs, etc., in competitive research funding and joint research funding.
[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

○ We will encourage the hiring of RAs, etc. for second-stage doctoral course students in national research and development agencies.
[Cabinet Secretariat, STI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ We will utilize commendation systems, etc. to encourage challenges by second-stage doctoral course students, etc. [STI]

(Expansion of career paths and mobility in the industrial world)

○ For the building, etc. of graduate school education that meets the needs of society through dialogue with the industrial world and universities, promote the building of education and research programs through collaboration between industry and academia and the development and education of excellent human resources with doctorates internationally, through implementation of the WISE Program (Doctoral Program for World-Leading Innovative & Smart Education), etc. and horizontal deployment, etc. of its results.

[STI, MEXT, METI]

○ Encourage the conversion of the long-term paid internships of doctoral course students into compulsory subjects that receive credits.

[MEXT, METI]

○ Regarding the situation with respect to the domestic and overseas hiring of doctoral degree holders as national public servants and in the industrial world, etc., and their work duties, treatment, etc., we will conduct surveys of the actual situation and needs, gather and carry out horizontal deployment of good examples, and investigate improvements to the treatment of doctoral degree holders in the national public service going forward, taking into account their specialist knowledge and research experience. [Cabinet Secretariat, NPA, STI, MEXT, METI, all offices, ministries, and agencies]

○ We will encourage the hiring, etc. in companies of outstanding young researchers, by encouraging the discovery of outstanding young researchers by companies and universities and matching through industry, academia, and government. [MEXT, METI]

○ We will formulate guidelines on improving the research capacity of postdoc students, etc. and supporting their career development, and deploy organized initiatives in universities, etc. [MEXT]

○ We will carry out a systems revision to enable the implementation of joint research, etc. in business operators that have received investments from national university corporations, etc., in order to encourage open innovation. [STI, MIC, MEXT, METI]

○ We will give priority to promoting support for ventures, etc. that are tackling innovation creation, by revising the Small Business Innovation Research (the Japanese version of the SBIR). [STI, METI]

○ For encouragement of the mobility of innovation human resources, inform the Leaders' Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS) and also universities, national research and development agencies, companies, etc. about the results of the factors survey pertaining to the mobility of innovation human resources, in order to contribute to investigation of the formation of a Forum for Co-Creation by industry, academia, and government, encouragement of joint research by open innovation, etc. [STI]

(Expansion of diversity)

○ We will investigate the building of a nationwide network to collaborate with institutions that are developing the research environment for women researchers and improving their research capacity, the enhancement of support for female students that are going on to further study in second-stage doctoral courses, and support measures for women researchers taking into account surveys and analyses of overseas examples. [MEXT]

○ In order to respond to the needs of researchers who are raising children, we will encourage the enhancement of campus childcare facilities and support systems, etc. [CCRA, MEXT, MHLW, METI]

(Enhancement of the research environment)

○ In order to ensure sufficient research hours for researchers, we will advance simplification of the application procedures, etc. through collaboration with the funding agencies. [Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

○ We will establish career paths for management human resources, URAs, engineers, etc.; for example, establishment of the quality assurance system for URAs and establishment of the Commendation by the Minister of Education, Culture, Sports, Science and Technology to commend the outstanding achievements of technical personnel. [MEXT]

○ We will encourage the development and sharing of research facilities and equipment (strengthening of core facilities and utilization of leases, etc.) by formulating, etc. guidelines/guidebooks for the sharing of research facilities and equipment. [MEXT]

○ We will promote the development and utilization of cutting-edge large research facilities and equipment, etc. such as specific advanced large research facilities (SPring-8/SACLA, the J-PARC neutron radiation facility), large projects leading the academic frontier of the world, etc., and the development of next-generation synchrotron radiation facilities. [MEXT]

○ We will aim to strengthen joint use and joint research structures through globalization, networking, etc. [MEXT]

○ We will advance networking of facilities and equipment and the building of a shared-use platform for securing access to the optimal research facilities and equipment, and encourage a shift to smart laboratories by utilizing AI, robots, etc. in research labs. [MEXT]

○ For the realization of an Innovation Commons as a Forum for Co-Creation, we will promote the introduction and expansion of open labs that can respond flexibly to cutting-edge research and new research themes, etc. and the strategic renovation of research facilities (improvement of decrepit areas and the strengthening of functions). [MEXT]

○ The publication and sharing of research results and data using preprints (academic papers before peer review) is spreading, so we will advance surveys and analyses of these new mechanisms, and advance investigations that lead to the enhancement of the national interests of Japan based on the open-and-closed strategies while ensuring quality and ensuring the rights and incentives

of individual researchers. [STI, MEXT]

○ In order to promote the development of the shared-use facilities and data exchange platforms of the universities, etc. conducting research and development at a level that compares favorably with anywhere in the world, and promote young human resources development, etc., we will establish funds on a scale that competes with the world's best in collaboration with universities, etc., and utilize their operational profits to realize mechanisms for building a global-level research base, taking into account investigations into the acceleration of university reforms, coordination with existing initiatives, collaboration with the private sector, etc.[63] [STI, MEXT]

(System improvements for the strengthening of research capacity)

○ In order to secure sufficient research hours, we will carry out a revision to enable the payment of outsourcing expenses other than research from the direct expenses of competitive research funding (a buyout system).

[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

○ We will carry out an investigation and revision to enable the payment of personnel costs from direct expenses to the research representatives in all competitive research funding, in addition to funds from companies, while also taking into account the character of the funding.

[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

○ In order to alleviate the administrative burden of research institutions and researchers, we will advance the commonalization of different effort management for each funding agency, and further streamline the application of competitive research funding such as improvement of e-Rad, etc. [Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD] [Restated]

○ Through the enhancement, etc. of the statement of the solicitation guidelines, etc. in competitive research funding, we will enhance investigations to ensure that appropriate salary levels are set commensurate with the nature and content of the research support operations in which RAs participate in research institutions.

[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD] [Restated]

○ For researchers active internationally, we will advance investigations for encouragement of responses in the English language, while also taking into account the character of competitive research funding.

[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

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[63] Regarding the funds of the major universities around the world, the total for universities in the United States (approximately 65 trillion yen) includes Harvard University (approximately 4.5 trillion yen), Yale University (approximately 3.3 trillion yen), Stanford University (approximately 3.1 trillion yen), etc. In addition, there is the University of Cambridge (approximately 1.0 trillion yen) and the University of Oxford (approximately 820 billion yen). * The figures for each university are 2019 figures but the total for universities in the United States is a 2017 figure (both are the latest figures).

<<Improvement of Procurement Systems>>

○ Regarding the exceptional negotiated contract system introduced for specified national research and development agencies based on the Basic Policy for Encouraging Research and Development, etc. by Specified National Research and Development Agencies (June 2016 Cabinet Decision), for early manifestation and improvement of research and development results, we will raise the upper limit amount for corporations that are already using the systems and expand the applicable corporations, etc., on the assumption that governance for ensuring the fairness of procurement is being steadily built and implemented by the corporations.

[Cabinet Secretariat, STI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]

<Borderless Challenge (Globalization, Large-Scale Collaboration between Industry and Academia)>

<<Promotion of Globalization>>

Due to the impact of the novel coronavirus disease, the situation in FY2020 is that we are being forced to reduce international exchange for the time being, but during this time we will implement international joint research in a form that does not entail overseas travel, and after the impact of the novel coronavirus disease has been brought under control we will advance the following initiatives so that international exchange activities can be revitalized rapidly and steadily.

○ In order to develop and secure research human resources that can thrive on the global stage in an era of advancing globalization, we will aim to enhance the overseas study opportunities of second-stage doctoral course students and young researchers. Specifically, we will carry out the following initiatives. [MEXT]

- Using priority allocations, etc. of budgets, we will enhance a range of programs providing overseas study opportunities for second-stage doctoral course students and young researchers.
- For the development of researchers with rich international perspectives and encouragement of research overseas, we will encourage the utilization of joint degrees and double degrees and the building and implementation of education exchange programs with overseas partner universities.

○ We will work for the fundamental strengthening of international brain circulation under which outstanding researchers from throughout the world gather and thrive in Japan. Specifically, we will advance systematic initiatives for increasing the incentives for reform in universities and research institutions, so that the range of findings and know-how, etc. cultivated through pioneering results such as SGU, WPI, etc. are widely introduced and utilized in domestic universities, etc. and their effective horizontal deployment is steadily advanced. [MEXT]

○ We will work for the further strengthening of international joint research. Specifically, we will carry out the following initiatives.

[STI, MEXT, relevant offices and ministries]

- Using priority allocations, etc. of budgets, we will work for the enhancement of international joint research programs in each office and ministry.
- Furthermore, regarding the research and development expenses that mainly anticipated domestic research and development until now, we will share and store the know-how of international collaboration while expanding in stages the international joint research utilizing the said research funding.

○ For the building of an environment in which outstanding researchers from overseas can thrive, we will expand international solicitation, strengthen our responses in the English language, enhance support for foreign researchers, etc.

[Cabinet Secretariat, STI, FSC, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

<<Strengthening of Joint Research Functions>>

○ We will promote organizations comprising universities, national research and development agencies, and private sector companies, and large industry and academia Co-Creation by the organizations, and we will carry out a systems revision to enable the implementation of joint research, etc. in business operators that have received investments from national university corporations, etc. and will reinforce, etc. the Guideline for Enhancing Industry-Academia-Government Collaboration Activities, so that the utilization of systems to realize a virtuous cycle of knowledge and funds makes progress. [STI, MIC, MEXT, METI]

○ From FY2021 we will carry out full-scale promotion of advanced initiatives combining industry and academia, through the utilization, etc. of a matching platform for the human resources who will be responsible for creating innovation. Furthermore, in order to encourage the global deployment and regional contribution of the selected regional open-innovation hubs, we will implement full-scale opening of new markets and the accompanying support from FY2021. The National Institute of Advanced Industrial Science and Technology will start initiatives for the strengthening of structures that offer specific technology needs support, including regional companies. [METI]

○ For the smooth implementation of collaboration between industry and academia, a source of innovation, we will raise awareness and the prioritizing of collaboration between industry and academia in universities and companies, and investigate the forms of intellectual property management that can appropriately evaluate and utilize inventions, etc. created in universities, etc., including strengthening and fully utilizing the functions of organizations collaborating between industry and academia, revision of the intellectual property strategy of universities responding to the value shift in the digital era, etc. [SIPSH, MEXT, METI]

<<Collaboration with Foreign Companies>>

○ In order to obtain overseas funds and encourage joint research between the universities and

national research and development agencies of Japan and foreign companies while considering security trade control, etc., we will support execution of the Guidelines for universities and national R&D agencies on collaboration with foreign companies that were formulated in FY2019, and conduct investigations of revisions as necessary. [STI]

<<Promotion of Open Innovation>>

○ We will promote the formation of diverse industry, academia, and government collaboration hubs based on the strategies of important fields and the characteristics and strengths of the universities, national research and development agencies, etc. that could become regional hubs, and we will promote the building of concentrated management structures for large joint research projects deeply involved in the business strategies of companies. [MEXT]

○ We will reinforce the Guideline for Enhancing Industry-Academia-Government Collaboration Activities and thoroughly inform people about it, and recommend the implementation of full-scale joint research. [MEXT, METI]

○ We will investigate the possibility of the "branding" of innovation companies with reference to the Action Guidelines for Japanese Companies' Management for Value Creation published in 2019. In the case that as a result of the investigation we are able to confirm the significance and effectiveness of the branding, we will advance its systems design. [METI]

○ In funding in NEDO, we will conduct an investigation regarding mechanisms under which initiatives taking into account the Guideline for Enhancing Industry-Academia-Government Collaboration Activities and the Action Guidelines for Japanese Companies' Management for Value Creation, etc. are encouraged. [METI]

○ We will start the Young Researcher Discovery and Support Project by the Public and Private Sectors from FY2020 under which the public and private sectors cooperate to discover promising young researchers and seeds research in universities, etc., carry out matching with companies, and support research funding. Furthermore, when adopting this project, we will work to strengthen functions for collaboration between industry and academia in companies and universities, by utilizing the Guideline for Enhancing Industry-Academia-Government Collaboration Activities and requiring the establishment of "response windows for collaboration between industry and academia" in both universities, etc. and companies, etc. Moreover, in order to create constant and sustainable innovation, we will establish a forum for industry, academia, and government dialogue in the Japan Open Innovation Council, and investigate measures for deepening collaboration between industry and academia. [METI]

○ In order to revitalize external collaboration by encouraging utilization of the CIP (Collaborative Innovation Partnership), we will clarify the matters pertaining to the establishment procedures and operation of the CIP under the Guidelines on the Establishment and Operation, etc. of the CIP (Collaborative Innovation Partnership), which were revised in April 2020. By FY2021, we

will further simplify and clarify the procedures, including the legislative response, to shorten the time from establishment permission to the creation of an operating company. [METI]

○ NEDO will ascertain the issues in open innovation through regularly-implemented fact-finding surveys, and will consolidate information for investigating specific measures. [METI]

○ Regarding the building of government-led international education and research hubs which gather together domestic and overseas human resources, the final summary of the Council of Advisors on an International Education and Research Hub in the Hamadori Region of Fukushima has been prepared, and the Reconstruction Agency is taking the lead in carrying out an investigation concerning this hub, while also collaborating with the related ministries and agencies and listening to the views of the related local governments, etc., and it plans to obtain a definite plan during this year. [Reconstruction]

○ We will encourage the participation of a wide range of operators of agriculture, forestry and fishery in the Field for Knowledge Integration and Innovation in the Council of Industry-Academia-Government Collaboration,[64] and we will collaborate with universities, etc. to promote open innovation that responds to regional issues. [MAFF]

○ We will advance the discovery of technical issues in agriculture, forestry, and fisheries and the food industry, etc. to hold forums for regular information exchanges with universities, VCs, financial institutions, etc. [MAFF]

○ Through utilization of the OILs[65] and Kammuri Labs[66] of the National Institute of Advanced Industrial Science and Technology, we will work to strengthen and deploy industry-academia collaboration platform functions to enable multiple research institutions and companies to collaborate. Furthermore, we will investigate structures to respond to the diversity of social issues and era changes and carry out research for the solution of issues across fields in the National Institute of Advanced Industrial Science and Technology. [METI]

○ We will tackle encouragement of the utilization, etc. of the diagnostic items list that clarifies the states of mind sought by managers and individuals,[67] to accelerate open innovation that has an impact socially. [SIPSH]

○ In the context of the fourth industrial revolution bringing about structural changes to the competition to gain added value, the issue is how company managers can fully utilize digitalization to create and gain added value.

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[64] Infrastructure of a mechanism for new industry-academia collaboration research (Field for Knowledge Integration and Innovation) that introduces the knowledge and technologies, etc. of different fields to the agriculture, forestry, and fisheries and food fields to generate innovative merchandise and services, and comprises diverse related people in private sector companies, producers, universities, research institutions, non-profit corporations, etc.

[65] An initiative to establish research hubs of the National Institute of Advanced Industrial Science and Technology on the sites of universities, etc., and carry out collaborative research merging the outstanding basic research seeds of each university with the objective basic research and applications research of the National Institute of Advanced Industrial Science and Technology. OIL is an initialism for Open Innovation Laboratory.

[66] An initiative to establish “collaborative research laboratories” or “collaborative research labs” named for a company (commonly called “Kammuri Labs”) inside the National Institute of Advanced Industrial Science and Technology to implement research and development that is more specialized for the needs of the partner companies.

[67] Refer to the people involved in open innovation (“Task Force for Value Co-Creation Report: Open Innovation that Starts with Me” by the Task Force for Value Co-Creation in the Intellectual Property Strategy Headquarters) (June 2019).

We will develop an environment for research and development of AI, the IoT, etc. in order to accelerate the initiatives by Japanese companies to utilize real data and knowledge in the actual world (physical space) in virtual space (cyberspace). [METI]

○ Regarding those important technologies for which continuing research in companies has become difficult and which it is highly necessary to preserve domestically, we will advance an investigation to ensure that the National Institute of Advanced Industrial Science and Technology can take the necessary measures, such as taking over the said research, etc. [METI]

<Promotion of Humanities and Social Sciences>

○ We will support research activities based on the inherent issue awareness of researchers in the humanities and social sciences through research funding measures such as the Grants-in-Aid for Scientific Research, etc. and the development of joint use and joint research structures, etc., and we will utilize the findings of the humanities and social sciences to promote the following initiatives to solve the specific issues in society. [MEXT]

- In conjunction with the revision of the Basic Act on Science and Technology, a law revising the Act on Japan Science and Technology Agency, National Research and Development Agency (the JST Act) and the Act on RIKEN, National Research and Development Institute (the RIKEN Act) was established. Taking this into account, both organizations will effectively advance the promotion of science and technology, including science and technology pertaining to the humanities and social sciences only, and initiatives for new merging of fields.
- JST Strategic Basic Research Programs, etc. will build cross-sectional research and development structures that include the humanities and social sciences from the initial stage of research and development, and effectively promote initiatives for developing emerging and merged fields, such as encouragement for the merging of the humanities and sciences, etc.
- WPI, a project that encourages the formation of international research hubs that merge fields, also covers initiatives for high-level hubs that merge fields, including cross-sectoral domains with the humanities and social sciences.
- For the solution of social issues, we will promote research and development led by researchers in the humanities and social sciences in the establishment of research and development themes and initiatives, etc. for ethical, legal, and social issues (ELSI) that take into consideration harmony between science/technology and society and the building of trust with society, and we will collaborate with stakeholders such as businesspeople, administrators, entrepreneurs, etc. to lead to the creation of new value by STI based on a wide range of “knowledge” in academia including universities, etc.

(2) Creation of Innovation Ecosystems through University Reforms, etc.

○ **Future Visions to be Pursued**

- ***Universities and national research and development agencies improve and strengthen their organizations and management through their own efforts, and become the core of innovation ecosystems generating knowledge-intensive industries***
- ***Strengthen governance based on university president leadership and realize the strengthening and efficient management of the management infrastructure, including diversification of the sources of funds, linkage and reorganization of universities, etc.***
- ***Consider universities and national research and development agencies to be the drivers of new value creation, and build a mechanism enabling the value of the "knowledge" universities and national research and development agencies possess to be evaluated appropriately to realize large industry and academia Co-Creation between organizations, attract large private sector investment, and reinvest some of that in the improvement of basic research capacity and human resources development, as "core collaboration hubs for the circulation of knowledge among the sectors of industry, academia, and government"***

○ **Objectives**

- ***Develop an environment to encourage the expansion of investment and donations from companies for joint research, etc. and then in addition to the self-help efforts of universities, national research and development agencies, etc., we will promote reforms of support measures and operation grants for universities, national research and development agencies, etc. making those efforts, and foster a donation culture to increase the amount of investment by companies in universities, national research and development agencies, etc. to three times the level in FY2014 by FY2025***

	(Baseline value)	(Current situation)	(Target value)
	FY2014	FY2017	FY2025
The amount of investment by companies in universities, national research and development agencies, etc.[68]	115.1 billion yen	136.1 billion yen	Approximately 345 billion yen

① Implementation Status and Analysis of the Current Situation

[68] Established in the Japan Revitalization Strategy 2016: Toward the Fourth Inustrial Revolution (June 2016 Cabinet Decision).

In order to support the management reforms of the universities, we will ascertain the needs of industry and academia in the Leaders' Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS) and formulate national university corporation governance codes, and in order to create, etc. opportunities for young researchers to thrive, we formulated the Comprehensive Package to Strengthen Research Capacity and Support Young Researchers, including initiatives, etc. to encourage the formulation of medium- to long-term personnel plans in national universities.

Furthermore, in order to realize a virtuous cycle of knowledge and funds, the Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020, including clarification, etc. to the effect that joint research, etc. can be implemented in business operators that have received investments from research and development agencies.

<Improvement of the Management Environment of Universities, etc.>

○ We improved the environment for universities to collaborate with the industrial world to strengthen their management infrastructure and support efficient management, through the parties in industry, academia, and government deepening their discussions in the Leaders' Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS), etc. Furthermore, the momentum toward the industrial world expanding investment in universities is growing.

○ In the FY2020 national university corporation operation grants, we evaluated the following issues and reflected the evaluation in the allocations of the operation grants.

- The ratio of young researchers
- Status of reforms of management of personnel salaries
- Status of reforms of accounting management
- Amount received for commissions, joint research, etc. per full-time teacher
- Number of top 10% papers per cost, such as operation grants, etc.

Furthermore, we started the Project for Strengthening the Innovation Creation Environment in National Universities, which gives incentives based on the track record of obtaining external funds, etc. Due to these projects, the environment supporting reforms concerning funds to national universities and the diversification of sources of funds improved.

○ Under the revision of the National University Corporation Act, the single corporation, multiple universities system was introduced, enabling effective and efficient allocation and use, etc. of the education and research resources of multiple universities. In April 2020 the Tokai National Higher Education and Research System, a national university corporation, was established through the corporate integration of Nagoya University, a national university corporation, and Gifu University, a national university corporation.

<Building of Core Collaboration Hubs for Circulation of Knowledge>

○ We will promote organizations comprising universities, national research and development agencies, and private sector companies, and large industry and academia Co-Creation by the organizations, and in order to realize a virtuous cycle of knowledge and funds, the Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020, including clarification, etc. to the effect that joint research, etc. can be implemented in business operators that have received investments from research and development agencies.

② Measures and Solutions for Achieving the Objectives

In order to continue supporting the management reforms of the universities, we will ascertain and investigate proposals to relax regulations, etc. through the Leaders' Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS), etc., and tie the proposals to the necessary policies, and we will promote the operation of national university corporation governance codes and reforms of national university corporation operation grants.

Furthermore, we will promote organizations comprising universities, national research and development agencies, and private sector companies, and large industry and academia Co-Creation by the organizations, and will develop the relevant provisions, reinforce the Guideline for Enhancing Industry-Academia-Government Collaboration Activities, and thoroughly inform people about it, so that the utilization of systems to realize a virtuous cycle of knowledge and funds makes progress.

<Improvement of the Management Environment of Universities, etc.>

<<Encouragement of Strategic Management in National Universities>>

○ For the 4th term medium-term objectives period of the national university corporations, we will conduct investigations specifically about the forms, etc. of finance and accounting in order to advance strategic management. [STI, MEXT]

○ For the operation of the National University Corporation Governance Codes formulated in FY2019, a tripartite council comprising the Ministry of Education, Culture, Sports, Science and Technology, the Cabinet Office (STI) and the Japan Association of National Universities, a general incorporated association, carries out investigations specifically regarding the method of reporting the status of compliance with the codes (timing, format, etc.). Furthermore, regarding reporting of the status of compliance, etc. announced by each national university corporation, the Ministry of Education, Culture, Sports, Science and Technology will confirm the status of compliance taking into account the views of a council comprising external knowledgeable persons. Moreover, we will constantly carry out revisions of the codes based on the necessity of updates, including changes to the forms of university governance in the world, modifications to systems in response to investigations of the forms of university management, etc. [STI, MEXT]

○ We will aggregate information concerning management and education and research inside

universities, and encourage the visualization, etc. of the seeds possessed by universities (promotion of the so-called “university version of IR”). [MEXT]

○ Regarding national university corporations and national research and development agencies, we will investigate the measures necessary for the encouragement of large joint research projects, the strengthening of the fiscal infrastructure by gaining diverse funds, including the expansion of donations, etc.

[Cabinet Secretariat, STI, MIC, MOF, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ We will carry out an investigation for realizing the strategic management of national university corporations, such as relaxing regulations to strengthen the strategic university management and management infrastructure of national university corporations. [MEXT]

<<Reforms of the National University Corporation Operation Grants, etc.>>

○ For the 4th term medium-term objectives period of the national university corporations, during FY2021 we will investigate the mechanisms of allocation based on the results of education and research during the period, and draw a conclusion, so that the universities can tackle reforms based on consistent evaluation indicators regarding the operation grants overall. [STI, MEXT]

○ We will promote the ascertaining and visualization of the costs and results of education and research for each department, which is necessary for carrying out funds allocations based on evaluations of education and research in each national university. [MEXT]

○ We will allocate operation grants based on their track record of obtaining external funds, etc., and give priority allocations under the Project for Strengthening the Innovation Creation Environment in National Universities to national university corporations. Furthermore, we will work for the horizontal deployment of good examples of gaining private sector funds in national research and development agencies. [Cabinet Secretariat, STI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ Under the national university management reform promotion project started from FY2018, we will implement support for eager and forward-looking initiatives that carry out management reforms with a sense of urgency, in conjunction with the expenses at the discretion of the university president.

[STI, MEXT]

<<Leaders’ Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS)>>

○ The Leaders’ Forum on Promoting the Evolution of Academia for Knowledge Society (PEAKS), which comprises university officials, the industrial world and government, holds specific discussions about management issues and solutions, etc. in universities, and advances horizontal deployment of good examples leading to innovation creation, investigations of the relaxation of regulations, etc., and the development of the university managers. The government

rapidly investigates proposals from worksites to relax regulations, etc., and executes the necessary policies.

[STI, MEXT, METI]

<Building of Core Collaboration Hubs for Circulation of Knowledge>

○ We will promote organizations comprising universities, national research and development agencies, and private sector companies, and large industry and academia Co-Creation by the organizations, and we will carry out a systems revision to enable the implementation of joint research, etc. in business operators that have received investments from national university corporations, etc. and will reinforce, etc. the Guideline for Enhancing Industry-Academia-Government Collaboration Activities, so that the utilization of systems to realize a virtuous cycle of knowledge and funds makes progress.

[STI, MIC, MEXT, METI] [Restated]

(3) Strategic Research and Development for the Solution of Social Issues (Research and Development Pursuing Social Implementation and Research and Development Pursuing Disruptive Innovation)

○ **Future Visions to be Pursued**

• Realize the repeated creation of knowledge and sustainable creation of innovation by driving research and development for solving a variety of issues in the economy and society under decisive management (research and development pursuing social implementation) and research and development that boldly takes on the challenge of future industry creation and social transformation (research and development pursuing disruptive innovation) in a well-balanced way like the two wheels of a car

○ **Objectives**

• Accelerate the creation of innovation by establishing research and development objectives which take into account global benchmarks, etc. and are backcast from the industrial and social aims, in order to strategically implement research and development

<Research and Development Pursuing Social Implementation>

(SIP and PRISM)

• Regarding SIP I (FY2014 to FY2018), realize the early social implementation of the results

• Regarding SIP II (FY2018 to FY2022), advance selection and concentration through the implementation of strict evaluation, application of stage-gates, and thorough implementation of office and ministry collaboration, while improving SIP to be a research and development program which places greater importance on the social implementation of the results

• Regarding PRISM, in technology domains based on the range of strategies, etc. formulated by the CSTI, aim for integrated operation with the SIP of research and development that contributes to the inducement of private sector research and development investment or the streamlining of fiscal expenditure, while offering flexible support under office and ministry collaboration

(ImPACT)

• Connect the innovative research results obtained from ImPACT to the next development and social implementation

<Research and Development Pursuing Disruptive Innovation>

(Moonshot Research and Development Program)

• Through the project formation that introduced innovative goals and innovative management systems, realize a dramatic improvement in Japan's basic research capacity and future industry creation and social transformation

① Implementation Status and Analysis of the Current Situation

In SIP I, regarding disaster prevention and reduction, increasing the service life of infrastructure, the promotion of automatic travelling and next-generation agriculture, etc., we realized the social implementation of results contributing to the solution of the social issues faced by Japan and the

strengthening of industrial competitiveness. Going forward, we will follow up on the status of the continuation of research and development of the individual research themes and the status of the creation and market launch of products, and for at least three years after the end of SIP I we will endeavor to ascertain the status of results deployment.

Furthermore, in SIP II, we will carry out a revision of systems aspects, and strengthen issues management for social implementation of the results while promoting research and development.

In PRISM, we will continue promoting expansion of the research and development investment of the public and private sectors through acceleration, etc. of the projects of each office, ministry, and agency, taking into account the range of strategies, etc. formulated by the CSTI.

Regarding Moonshot Research and Development Program, we decided six Moonshot Goals that are difficult but are expected to have a big impact if the projects are realized.

<Research and Development Pursuing Social Implementation>

○ In SIP I, for example, we realized social implementation of results of the kind that greatly contribute to the strengthening of industrial competitiveness and the solution of social issues, such as the following.

- Development of advanced software groups, etc. that exceeded expectations, including the domestically-made combustion analysis software HINOCA
- Development and commercialization of high-precision 3D maps as infrastructure necessary for the realization of automatic travelling
- Development of technologies that can realize highly efficiently and for a fair price a variety of infrastructure fields such as wall thickness measurements of metallic structures, etc. for which testing was difficult previously
- Utilization of SIP4D from the research and development stage at sites of disasters such as the heavy rains in July 2018 and the Hokkaido Eastern Iburi Earthquake, etc.
- Market launch of smart agricultural equipment such as automatically-travelling tractors, etc.
- Development of agricultural crops using genome editing technologies (high-GABA tomatoes)
- Building of WAGRI to enable the exchange, sharing, etc. of a variety of data in the agriculture field

○ For the steady social implementation of the results of SIP I, initiatives for the continuation of research and development by the institutions participating in SIP I and social implementation in the related ministries and agencies are proceeding. In order to ascertain the status of social implementation of the research results of SIP I and the status of initiatives after the ending of SIP by the institutions participating in SIP I, we are implementing follow-up surveys. In FY2020, in order to ascertain the situation in greater detail, we will make improvements such as further enhancing the institutions covered by the surveys, etc. and then continue implementing the follow-up surveys.

○ In SIP II, we implemented a strict issues evaluation placing the priority on the degree of achievement of the objectives at the end of FY2019, and sought improvement so that each issue

(program) better matched the purpose of SIP, and based on the said evaluation results we implemented well-balanced budget allocations.

○ PRISM was established in FY2018 for the purpose of leading the measures of each office, ministry, and agency to domains in which there is a strong inducement effect from private sector research and development investment and domains in which it is expected that the utilization of research results will contribute to the streamlining of government expenditure, etc. Regarding the additional allocations in FY2019, based on the range of strategies, etc. formulated by the CSTI, priority was given to allocations for the establishment, etc. of data exchange platforms for infrastructure, drug discovery, agriculture, etc.

Specifically, budget allocations have been made in order to carry out the following:

• Through i-Construction initiatives to fundamentally improve the productivity of construction worksites, the building of an "infrastructure and data platform" for exchanging and sharing the data obtained in the construction and production process overall (from surveying to design, construction, maintenance and management)

• Upgrading by enabling the exchange of the information possessed by the SIP4D developed in SIP I and by the private sector, etc.

• In the agriculture field and drug discovery field, incorporation of cutting-edge technologies (sensors, AI, etc.) in the initiatives of the offices and ministries with jurisdiction over projects, for improvement of their productivity and acceleration of the projects

etc.

○ ImPACT worked to achieve ground-breaking research results and to practically apply and commercialize them. These results include:

• Development of the world's first tough polymer that is light and possesses resilience equal to that of ferrous materials, anticipating the conversion of automobiles to EVs[69]

• Development of a new model of computer that can utilize the quantum effect of light to process complex combinatorial problems at the fastest speed in the world

• Development of the world's smallest synthetic aperture radar satellite capable of instant observations on a global scale regardless of the weather conditions or whether it is day or night

etc.

○ As a result of the evaluation when ImPACT ended, the following issues were indicated:

• Commercialization was seen in individual programs, but the value demonstration and ascertaining of issues for social implementation were insufficient, and the path leading to social transformation was not clear

• The definition of failure and the mechanisms for evaluating management that does not fear failure are not clear, so program managers could not be led to take on bold challenges that permit failure

[69] Electric Vehicles

etc.

○ The main management results for social implementation obtained as a result of implementation of SIP I and ImPACT are as follows.

- Establishment of ultimate goals, including social implementation, and clarification of the schedule
- The commitment of users in both the public and private sectors. Collaboration with stakeholders such as users, financial institutions, regulatory authorities, standardization institutions, etc. from the beginning of research and development
- Research and development advanced simultaneously and in parallel with investigations of regulations, standardization, etc.
- Establishment of venture companies, etc. for the practical application of results
- Gaining of users through the wide release of results and utilization for free or for a charge
- Collaboration with not only related domestic institutions (universities, companies, public institutions, etc.) but also with overseas institutions

○ Note that the issue titles, objectives, progress and issues, etc. of SIP II are as in <Attached Table 2>.

○ The interim report of the R&D and Innovation Subcommittee in the Committee on Industrial Science and Technology Policy and Environment of the Ministry of Economy, Trade and Industry's Industrial Structure Council (June 11, 2019) pointed out the necessity of a vision describing the future directions of research and development for groups of important technologies to which Japan should intensively input resources toward the medium- to long-term (2025 and 2050), and taking this into account the Ministry of Economy, Trade and Industry formulated the Industrial Technology Vision 2020 (May 29, 2020).

<Research and Development Pursuing Disruptive Innovation>

Europe, the United States, and China are aiming for leadership in the creation of disruptive innovation, presenting more ambitious concepts and issues that are difficult to solve, and moving in the direction of hoarding top researchers from around the world and accelerating challenging research and development. Furthermore, under clear open-and-closed strategies, they are actively proceeding with international collaboration from the research and development stage; moreover, private sector investment that promptly introduces those research results to entrepreneurship and startups is gaining momentum.

Taking into account these recent domestic and overseas situations, the progress of social issues, and the above evaluation when ImPACT ended, etc., a systematic framework continuously and stably promoting challenging research and development is strongly expected by the citizens, so we established the Moonshot Research and Development Program which the relevant offices, ministries and agencies are uniting to promote, and the CSTI incorporated the findings and ideas of domestic and overseas knowledgeable persons and experts to decide six Moonshot Goals that

anticipate future society and target social issues, etc. that are difficult to solve but are expected to have a big impact if the projects are successful. We will promote Moonshot Research and Development Program, including the goals in the health and medical care field decided in the Headquarters for Healthcare Policy.

Moonshot Goals

Goal 1: Realization of a society in which human beings can be free from limitations of body, brain, space, and time by 2050

Goal 2: Realization of ultra-early disease prediction and intervention by 2050

Goal 3: Realization of AI robots that autonomously learn, adapt to their environment, evolve in intelligence, and act alongside human beings, by 2050

Goal 4: Realization of sustainable resource circulation to recover the global environment by 2050

Goal 5: Creation of the industry that enables sustainable global food supply by exploiting unused biological resources by 2050

Goal 6: Realization of a fault-tolerant universal quantum computer that will revolutionize economy, industry, and security by 2050

② Measures and Solutions for Achieving the Objectives

Regarding the results of SIP I and ImPACT, we will advance further social implementation, and based on these results and reflections we will promote SIP II and Moonshot Research and Development Program .

<Research and Development Pursuing Social Implementation>

○ In conjunction with the evaluation of the issues in the SIP II interim evaluation in FY2020, we will implement a systems evaluation, and coordinate with the relevant offices, ministries, and agencies and related institutions, etc. to reflect the results of the evaluations in the SIP II systems from FY2021 onwards.

[STI]

○ Regarding SIP II, we will further increase the level of objectivity and expertise in the peer reviews of the management corporations in each issue. Furthermore, we will enhance the visits by the governing board and external experts, etc. to the sites for each issue, implement interim evaluations of the issues to carefully determine the research and development themes that we should continue to implement as SIP, and carry out flexible revisions of the research and development structures and budget allocations, etc. in accordance with the evaluation results.

[STI]

○ We will summarize and classify the good examples, including initiatives such as regulatory reforms and standardization, etc. for social implementation, and then horizontally deploy them in the research and development by the government which intends to achieve social

implementation. We will steadily advance the social implementation of technologies developed in SIP, including initiatives implemented in each ministry and agency.

[STI, related ministries and agencies]

○ We will continue implementing follow-up surveys after the research and development has ended, and horizontally deploy those mechanisms in the research and development of the government which intends to achieve newly-started social implementation. [STI]

○ We will operate SIP and PRISM in an integrated manner. Furthermore, about PRISM in particular, we will continue promoting expansion of the research and development investment of the public and private sectors through acceleration, etc. of the projects of each office, ministry, and agency, taking into account the range of strategies, etc. formulated by the CSTI. [STI]

○ In PRISM, for each project to which a budget has been allocated, we will carry out follow-up on the status of progress of the project and the positioning, etc. for realization of the range of strategies, etc., and implement evaluation of the results, etc. of the projects every fiscal year. Moreover, in addition to the effectiveness verifications every fiscal year, we will implement follow-up evaluations after the project ends. Furthermore, regarding projects that seek continued budget allocations over multiple fiscal years, we will evaluate the results, etc. of the project for each fiscal year in the PRISM Review Board. [STI]

○ In the Industrial Standardization Act brought into force on July 1, 2019, provisions were newly developed which impose a duty on national research and development agencies, etc. to independently tackle activities concerning industrial standardization and international standardization, and to endeavor to ensure appropriate treatment for the people involved in the relevant operations. Taking this into account, we collaborated with the relevant offices, ministries, and agencies to raise the level of standardization activities in research and development by sharing specific examples of standardization activities and techniques among national research and development agencies, for example, research and development management techniques utilizing the NEDO Standardization Management Guidelines, and ascertained the actual state of the standardization activities of some national research and development agencies through hearings, etc. [METI]

○ Based on the Industrial Technology Vision 2020 (May 29, 2020 Decision), which presented a medium- to long-term vision for strategically tying the industrial technologies of Japan to competitiveness, during FY2020 we will formulate the individual technology strategies pertaining to the group of key technologies that will constitute the infrastructure of Society 5.0 (computing technologies based on new principles, human augmentation technologies, etc.), and we will give priority to promoting research and development; for example, we will investigate the development of a next-generation computing hub with the National Institute of Advanced Industrial Science and Technology at its core by about FY2021. [METI]

○ In diverse fields, we will advance the establishment of research themes suitable for award-type

research and development and investigations of implementation rules. [METI]

<Research and Development Pursuing Disruptive Innovation>

○ Under promotion structures in which the relevant offices, ministries, and agencies work together, we will incorporate the following kinds of elements to promote Moonshot Research and Development Program. [Cabinet Secretariat, STI, AMED, MEXT, MHLW, MAFF, METI]

- We will lead cutting-edge research and promote research and development by program directors (PDs) who have an international track record of success
- We will fully draw out the findings and ideas in the basic research stage to tackle challenging research without fear of failure and discover and develop innovative research results
- Anticipating social implementation in the future, we will investigate open-and-closed strategies that involve the industrial world from the research and development stage, to actively lead the utilization of private sector funds and the spin-out of the derived research results
- We will build a portfolio for soliciting and employing project managers (PMs), pooling the wisdom of researchers from throughout the world, and achieving the Moonshot Goals
- We will reorganize portfolios based on the status of progress of projects, and promote research and development based on operational and evaluation guidelines stipulating research support systems, data management, etc.
- Going forward, in cases recognized to be necessary based on changes to the social environment and the progress of science and technology, etc., we will carry out evaluations of technical feasibility, and carry out additions, modifications, etc. of the Moonshot Goals after listening to domestic and overseas views.
- In addition, we will improve and strengthen ImPACT and other advanced and pioneering research and development techniques, and disseminate and entrench them in the relevant offices, ministries, and agencies, enabling the achievement of research and development for which failure is permitted, which enables the researchers to tackle bold challenges, and also enabling the continuous promotion of human resources development

○ Through the INNO-vation Program, we will support extraordinarily ambitious technological ideas with great possibilities that create disruptive global value. In artificial intelligence, we will support the global deployment of human resources who continue to challenge themselves to achieve unique and diverse disruptive innovation of the kind that cannot be predicted, “to create something from nothing,” and we will tackle the development of human resources with unusual talents through a nationwide network. [MIC]

Overview of SIP II

<Attached Table 2>

Theme title	Objectives	Initiatives going forward
Big-data and AI-enabled Cyberspace Technologies	• For the purpose of maintaining and strengthening international competitiveness of technologies in this field, develop the world's most advanced human interaction technology (sensing/cognitive technologies) by incorporating linguistic and non-linguistic information in real space to establish a data collaborative platform and collaborations with AI, and put it into social implementation.	• Taking into account the matters pointed out in the evaluation of the issues, we will advance the strengthening of promotion structures for social implementation, the investigation of understandable use cases taking into account the originality and superiority of Japan, and the investigation of evaluation indicators taking into account social and economic needs, to steadily promote research and development.
Intelligent Knowledge Processing Infrastructure Integrating Physical and Virtual Domains	• For the purpose of maintaining and strengthening international competitiveness of technologies in this field, develop the world's most-advanced basic technology allowing high-functioning sensing, highly efficient data processing and a strong collaboration with the cyber side, and put it into social implementation.	• Regarding the validity and encouragement of the dissemination of Edge PF technological elements and implementation examples (use cases), we will accelerate well-balanced operation while incorporating the opinions of third parties. • We will implement steady results creation for each research and development project, encouragement of collaboration among themes for practical application, encouragement of dissemination of the results, and mutual supplementation of missing parts through collaboration with other SIP projects.
Cyber Physical Security for IoT Society	• In addition to strengthening the collaborations with western countries to advance international standardization and social implementation, develop the world's most-advanced "Cyber Physical Security Measures Base" capable of being utilized for protecting supply chains as a whole, including small and medium-sized enterprises, for securing various IoT devices and establishing the safety and security of the whole of society towards realizing a secure Society 5.0.	• Taking into account the matters pointed out in the evaluation of the issues, we will collaborate with the relevant offices, ministries, and agencies to implement social implementation measures in the priority fields. We will develop prototype systems that can be used in demonstration experiments, and steadily promote the preparations for the start of the demonstration experiments in specified fields in the second half of FY2020.

SIP Automated Driving for Universal Services (SIP-adus)	• For joining as a main player in the intensified global competition over automated driving technologies, develop the world's most-advanced core technology (collecting and distributing road traffic information including signal and probe data) as a cooperative area among automobile manufacturers, for establishing a platform to realize automated driving on general public roads (level 3), and put it into social implementation.	• Taking into account the matters pointed out in the evaluation of the issues, such as how to foster the social acceptability of automated driving, and the fact that those measures should be investigated and implemented steadily, etc., we will present an overall vision of automated driving, including the risks, while utilizing the opportunity of the Tokyo 2020 Games to implement citizen-participation-type demonstration experiments, etc. on the Tokyo waterfront, etc., and promote activities to encourage correct understanding of automated driving. • We will build public and private sector research and development structures, including the stakeholders responsible for ultimate goals, while advancing automated driving system demonstration experiments in the Tokyo waterfront demonstration experiments, etc. and fundamental technology development, and promoting initiatives to foster social acceptability and for international collaboration.
"Materials Integration" for revolutionary design system of structural materials	• To maintain and develop the strength of Japan in materials development with the aim of significantly reducing costs and development periods, develop the world's most advanced materials integration for inverse design, which can propose optimized materials, processes, and structures for required performances, and for social implementations, leading to the development of super high performance structural materials while establishing reliability evaluation techniques.	• Responding to and taking into account the facts that a certain number of results have been obtained in the evaluations of individual research tasks while it has also been indicated that the exit strategies of the MI systems are unclear, we will implement revisions of the research and development plans and promote initiatives for social implementation of MI systems. • We will advance initiatives for building inverse problem MI while implementing hearings with respect to the research plan of each team, and implementing site visits to the research implementing institutions.
Photonics and Quantum Technology for Society 5.0	• To further improve international competitiveness of our strength in photonics and quantum technology, which is one of the most important basic technologies for	• Taking into account the matter pointed out in the evaluation of the issues, that specialist functions for social implementation should be added in order to

	realizing Society 5.0, develop the world's most advanced processing (laser), information processing (photoelectron) and communications (quantum cryptography) utilizing photonics and quantum technology, and put them into social implementation.	steadily advance social implementation early, we will implement revisions of the research and development plans. • We will newly launch social implementation acceleration projects and build CPS conversion platforms, etc., to utilize domestic and overseas corporate networks, test platforms, etc. while promoting large-scale social implementation of the research results.
Technologies for smart bio-industry and agriculture	• With the aim of sustainable growth of Japan's bio economy, demonstrate the food value chain models utilizing the "bio and digital" features in the value chain of the food industry, ranging from food production/distribution to recycling focusing on agriculture, for achieving export expansion of agricultural/processed products, strengthening production sites (improvement of productivity and labor load reduction) and reducing the environmental load that includes the "venous industries" such as container and packaging recycling as the target.	• Taking into account the matters pointed out in the evaluation of the issues; for example, the fact that priority should be boldly given to the sub-themes and research and development themes essential for achievement of the objectives under these issues, we will implement revisions of the research and development plans. • We will promote effectiveness verification using demonstration experiments, including the building of smart food chain systems, and production, distribution, and consumption.
Energy systems for IoE Society	• For the purpose of realizing social implementation of IoE in the era of Society 5.0, provide a conceptual design for energy management systems that contributes to optimization of energy supply and demand while conducting development of common basic technologies (power electronics) and R&D for their practical application (wireless power transfer system), and putting them into social implementation.	• Taking into account the matters pointed out in the evaluation of the issues; for example, enhancement of initiatives concerning the conceptual design of energy management systems, development of IoE common fundamental technologies, and clarification of the relationship to wireless power transfer systems aiming for IoE applications and practical application, we will implement revisions of the research and development plans.
Enhancement of National Resilience against Natural Disasters	• We will utilize the latest science and technology such as satellites, AI, and big data to build an information system to support the decision-making of the national government and municipalities at the time of large-scale disasters, and put it into social implementation.	• Taking into account the matters pointed out in the evaluation of the issues; for example, the need to advance revisions of the intellectual property strategy and international standardization strategy, we will implement revisions of the research and development

		plans. We will take a bird's eye view of the overall vision of research and development in the disaster prevention field, and then implement an investigation of measures to promote research and development that responds to new social needs in the disaster prevention field. • We will promote development of evacuation guidance technologies, etc. using AI, etc. that contribute to the solution of the issue of providing understandable disaster prevention information for evaluation at the time of a disaster
Innovative AI Hospital System	• Develop a system called the "AI Hospital" using AI, IoT, and big data to provide advanced and leading-edge medical services and improve effectiveness in medical institutions (drastically reducing the burden of doctors and nurses), and put it into social implementation.	• Taking into account the matters pointed out in the evaluation of the issues as issues for social implementation going forward; for example, the handling of medical data and personal information, and investigation of a response taking into account the status of regulations pertaining to rights, etc. in the case that utilization is carried out through integration with existing intellectual property, we will implement revisions of the research and development plans. • We will promote the creation of a medical care glossary, which includes regional dialects, for natural language processing and its application in those emergency situations. • We will start the building of an AI platform anticipating the time after the end of the projects and predicated on utilization of various kinds of AI tools, and start the utilization of an operation model that enables their autonomous operation. • We will develop a novel coronavirus disease consultation assistance system using artificial intelligence avatars, and in addition build data exchange platforms that contribute to the development of medical drugs and

		vaccines.
Smart Logistics Service	• To dramatically improve productivity in the whole supply chain and compete in global markets, develop a logistics and commercial distribution data infrastructure to enable utilization of a full range of relevant data handled in production, distribution, sales and consumption, and put it into social implementation.	• We will steadily advance the building of logistics and commercial distribution data infrastructure, and, taking into account the matter pointed out in the evaluation of the issues that it is necessary to take into consideration the relationship with original initiatives by the private sector to further strengthen the promotion structures for advancing research and development, we will implement revisions of the research and development plans. • In order to steadily advance the building of the logistics and commercial distribution data infrastructure, we will build the prototype data infrastructure of multiple fields and measure the effects using demonstration experiments while advancing expansion to other fields.
Development of Innovative Technologies for Exploration of Deep-Sea Resources	• With the aim of utilizing abundant marine mineral resources in Japan's EEZ, establish and demonstrate technologies for deep-sea resources surveys at a depth of more than 2,000m ahead of the world to further reinforce and improve Japan’s survey technology and increase productivity in this field, and put it into social implementation.	• Taking into account the matters pointed out in the evaluation WG; which is, for example, clarification of the needs of users, we will implement revisions of the research and development plans. • In cooperation with the related ministries and institutions, we will investigate utilization of Minamitorishima Island, and discuss on commercialization models for the marine environment surveys and marine geological surveys using AUV developed in SIP II. • We will continue to implement basic surveys such as collection and analysis of specimens in the targeted ocean areas, and technology developments of highly efficient survey and production systems for marine mineral resources which are estimated to exist at a depth of more than 2,000m.

(4) Development of Innovation Human Resources

○ Future Visions to be Pursued

- ***Anticipating the Society 5.0 era, provide opportunities for education to a variety of generations, including recurrent education, to generate high-quality science, technology, and innovation human resources.***

<Promotion of STEAM and AI Literacy Education, etc. Centered on the Elementary and Middle Education Stages>

- ***Respond to the grand transformation of industrial structure, the flood of information, and the growing importance of software aspects such as knowledge and services, to develop human resources who can individually think, make their own judgments, and create by themselves***

<Development of Leaders of Innovation, including Recurrent Education that Meets the Requirements of the Society 5.0 Era>

- ***In order to realize a world-leading Society 5.0, Japan will take into account the changes in society while developing innovation human resources who open up the next generation and are capable of responding flexibly***

○ Objectives

<Promotion of STEAM and AI Literacy Education, etc. Centered on the Elementary and Middle Education Stages>

- ***Promote education reforms with an awareness of the new basic knowledge infrastructure going forward while also taking into account the continuity and universality of education. For example, all high school graduates (approximately 1 million people/year) obtain basic literacy concerning "mathematics, data science, and AI"***

<Development of Leaders of Innovation, including Recurrent Education that Meets the Requirements of the Society 5.0 Era>

- ***In order to improve the quality of science, technology, and innovation human resources who can thrive as the right people at the right time in diverse situations in society, promote the development of an environment, including relearning for adults (recurrent education), and university education reforms. For example, implement recurrent education covering mathematics, data science, and AI for many adults (approximately 1 million people/year)***

① Implementation Status and Analysis of the Current Situation

To date we have developed an environment in which ICT and EdTech can be fully utilized in learning in the elementary and middle education stages, and implemented recurrent education that responds to social needs and development of a base for the development of human resources who can make innovation happen.

<Promotion of STEAM and AI Literacy Education, etc. Centered on the Elementary and

Middle Education Stages>

○ In a data-driven society, knowledge and grounding pertaining to mathematics, data science, and AI has become extremely important in the same way as "reading, writing, arithmetic," which are the basic grounding of social life, so at a time when STI is increasing inclusiveness with society, we have commenced reforms for education in Japan going forward.

<Development of Leaders of Innovation, including Recurrent Education that Meets the Requirements of the Society 5.0 Era>

○ Producing human resources who possess the ability to analyze and utilize enormous amounts of data and possess wide-ranging education and deep expertise transcending fields is extremely important for responding flexibly to changes in society going forward, so we are advancing the development of an environment in which the development and relearning of human resources who can make innovation happen in the real world are possible.

② Measures and Solutions for Achieving the Objectives

We will advance education reforms and environment development concerning data and AI literacy, etc., from the elementary and middle education stages through to the university and graduate school education stages, from the perspective of developing innovation human resources who can respond to the Society 5.0 era. Furthermore, at a time when the industrial structure is changing rapidly, we will develop an environment in which relearning of new knowledge to realize knowledge-intensive value is possible.

<Promotion of STEAM and AI Literacy Education, etc. Centered on the Elementary and Middle Education Stages>

<<Promotion of STEAM Education, etc.>>

○ For development of the strength necessary to live in society going forward, we will promote STEAM education, which is education across subjects, etc., for utilizing the learning in each subject for the solution of issues in the real world, and ensure an environment for learning tied to specific social issues.

[MIC, MEXT, METI]

○ In light of the situation that there is a great lack of resources such as content, etc. for giving instruction, we will build an online library of STEAM education content, obtain the cooperation of universities, research institutions, companies, etc., form a pool of external human resources and a remote education network, and ensure an environment in which the implementation of classes and smooth collaboration in schools is possible through SINET, etc. [MEXT, METI]

○ We will encourage initiatives to get unusual talents to blossom. Furthermore, we will put in place sustainable promotion structures for the nationwide implementation of education in which students can experience the fun of "creating new things," fully appreciate the importance of "respecting created things" and develop these capabilities, and work to encourage the

development of education programs and improve their convenience. [SIPSH]

○ Regarding the local ICT clubs which provide forums for studying STEAM education in the regions, we will gather, share, etc. good examples to encourage their dissemination in accordance with the actual circumstances of the regions. [MIC]

<<Promotion and Development of an Environment for Data and AI Literacy Education, etc.>>

○ We will provide opportunities for learning to currently-employed teachers to improve their mathematics, data science, and AI literacy. [MEXT]

○ When implementing the new government curriculum guidelines across the board, we will promote teacher training, recurrent education of currently-employed teachers, and the appointment of external human resources (diverse human resources in society such as doctoral course students, postdoc human resources, engineers, data scientists, etc., and human resources well-versed in ICT, etc.), so that programming education in elementary and intermediate schools and information subjects education in high schools can be reliably implemented nationwide.

[MEXT, METI]

○ We will carry out environment development through fundamental expansion of universities adopting "Information I" in their entrance exams in all academic fields, such as humanities, sciences, etc., and through prioritization of the private school subsidies for that expansion. [MEXT]

○ Keeping in mind the connection to mathematics and data science education in universities, etc., we will create teaching materials to ensure that the knowledge which forms the basis of probability, statistics, linear algebra, etc. can be mastered at the high school stage, and give instruction centered on pupils that will go on to further studies at universities, etc. [MEXT, METI]

○ In the environment to be realized by the GIGA school project, we will develop an environment to create opportunities for as many pupils as possible to utilize ICT and EdTech and to learn the knowledge, skills, thinking ability, judgment ability, expressive ability, etc. that are necessary in the real world. [Cabinet Secretariat, MIC, MEXT, METI]

○ In all academic fields, such as humanities, sciences, etc., we will develop an environment in which learning and study of mathematics, data science, and AI at the literacy level and applied basic level can be experienced (including model curriculum and teaching materials development, utilization and enhancement of MOOC,[70] utilization of systems under which the acquisition of degrees such as double majors in AI and a specialized field, etc. is possible). [MEXT]

○ Based on the "Future Study Building Package," we will build a utilization model for cutting-

[70] Massive Open Online Course. An initiative to enable anyone to attend university lectures for free through the Internet.

edge communications technologies (5G) in order to realize individually optimal and effective study and instruction with no time or distance constraints.

[MIC]

<Development of Leaders of Innovation, including Recurrent Education that Meets the Requirements of the Society 5.0 Era>

<<Development of Deeply Diverse Human Resources that Drive Innovation>>

○ We will promote recurrent education in universities, junior colleges, and KOSENs through the Brush up Program for Professionals (BP) under which the Minister of Education, Culture, Sports, Science and Technology certifies practical and specialist programs tailored to the needs of adults and companies, etc. and in vocational schools through the Career Formation Encouragement Program under which the Minister of Education, Culture, Sports, Science and Technology certifies short-term programs offering structured education for adults. [MEXT]

○ In order for both industry and academia to independently participate in human resources development and build human resources development systems that can meet the demands of society in the medium- to long-term and sustainably, we will carry out development, implementation, etc. of programs to develop the practicing teachers essential for the implementation of practical industry and academia joint education, etc. [MEXT]

○ We will promote the enhancement of applied basic education for regional hub human resources using public tests, national research and development agencies, etc. and human resources development in the regions with the said human resources at its core. [MIC, MAFF, METI]

○ In order to build innovation ecosystems with local universities at their core and realize vitalization of the regions, we will strengthen initiatives for the development of STEAM human resources and field-merging education and research in local universities, and for social implementation of the results, etc. In conjunction with this, we will investigate the strengthening of functions, including the handling of the capacities of local national universities carrying out those kinds of initiatives contributing to the promotion of the regions. [MEXT]

○ In FY2020, we will establish a forum for discussions about specific initiatives for presenting needs, such as a vision of the necessary human resources with doctorates from the industrial world, etc., sharing these with the university world, and then collaborating on the human resources development, etc. that should be tackled. Specifically, we will carry out fact-finding surveys to ascertain overall trends and issues, including specification of the important fields from the perspective of the industrial world and investigation of the forms of recurrent education in universities in each field, etc., inform people about the best practices, and investigate specific measures. [STI, MEXT, METI]

○ We will encourage active utilization of degree program systems that can establish curricula beyond the framework of faculties, graduate schools, etc. In conjunction with this, in order to broadly realize liberal arts education across the humanities and sciences in university education, we will build multiple new types of education programs (late specialization programs, etc.) that

utilize the said systems to offer both breadth and depth at the same time from university-wide common education to graduate school education. [MEXT]

○ In order to develop top human resources who will drive the world, we will advance the building of an education program to draw out the "outstanding people" who will realize individually optimal study from an early stage through early admission, etc. [MEXT]

○ We will foster a spirit of confronting a variety of difficulties and transformations not only with the given environment but also by taking action beyond one's own boundaries to generate new value (entrepreneurship) in Japan overall, and for the development of human resources aimed at entrepreneurship and new project creation based on research results, etc., we will promote entrepreneurship education and network building through learning and practice for students and young researchers, etc. in universities, etc. [MEXT]

○ Through the INNO-vation Program, we will support extraordinarily ambitious technological ideas with great possibilities that create disruptive global value. In artificial intelligence, we will support the global deployment of human resources who continue to challenge themselves to achieve unique and diverse disruptive innovation of the kind that cannot be predicted, "to create something from nothing," and we will tackle the development of human resources with unusual talents through a nationwide network. [MIC] [Restated]

<<Human Resources Development Taking into Account the Needs of a Digital Society>>

○ We will operate a system under which the government certifies the mathematics, data science, and AI education recognized as graduation credits of universities and KOSENs which consists of outstanding education programs at the literacy level, and also newly investigate the forms of the certification systems at the applied basic level, and then start operating them. [STI, MEXT, METI]

○ We will investigate and implement measures for encouraging the collaboration and cooperation of the industrial world so that the certification systems of the mathematics, data science, and AI education programs of universities and KOSENs are operated and disseminated as programs that contribute to the industrial world. [METI]

○ We will develop an environment to learn the knowledge, skills, thinking ability, judgment ability, expressive ability, etc. that are necessary in the real world (including utilization of EdTech, etc.). [MEXT, METI]

○ In order to respond to the upgrading of information technologies, we will promote the development of practical information technology human resources such as project-based learning (PBL), etc. through collaboration between industry and academia, and we will tackle the strengthening of education for Society 5.0 in universities, etc. by promoting the improvement of classes utilizing information technologies. [MEXT]

○ We will tackle the development of human resources who build practical education networks through industry-government-academia collaboration, apply and deploy data science in a

variety of fields, create value from data, and produce answers for business issues. [MEXT]

○ We will expand the base of cybersecurity human resources development by making it possible to utilize the cybersecurity exercise infrastructure built in NICT in education institutions, etc. as well. [MIC]

○ For the development of human infrastructure concerning smart ““Monozukuri” (Manufacturing),” including software, we will create opportunities for active learning and practice through “Monozukuri” (Manufacturing) that solve the various issues of the regions using wireless technologies. [MIC]

CHAPTER 3: Social Implementation of Knowledge
(1) Implementation of Society 5.0 (Smart Cities)

○ ***Future Visions to be Pursued***

- ***Smart cities as places for the advanced realization of Society 5.0 will be realized domestically, and the basic concept, success examples, etc. for data exchange platforms will be shared with smart cities in countries around the world with the objective of solving the issues the cities and regions in those countries face, so collaboration and cooperation on a global scale will progress***

○ ***Objectives***

- ***In the smart city-related projects of the relevant offices, ministries, and agencies, utilize the smart city reference architecture and the Smart City Public-Private Partnership Platform, etc. to promote data exchange across fields and companies, deployment to other cities and regions, international standardization, the ensuring of security, the ensuring of a startup environment, etc.***
- ***Make smart cities utilizing new technologies such as the IoT, etc. the basis for urban renewal, and have the relevant offices, ministries, and agencies collaborate to strategically promote convenient and comfortable urban renewal anticipating the future***
- ***Through the concentrated investment, etc. of the projects of the relevant offices, ministries, and agencies, promote the early implementation of super cities equipped with data exchange platforms***
- ***In the Osaka, Kansai World Exposition to be held in 2025, actively communicate a vision of a society that achieves the solutions of issues (the economy and society, etc. after the overcoming of the coronavirus) through the implementation of Society 5.0***
- ***Through the activities, etc. of the Global Smart Cities Alliance, advance the sharing of the examples of success in each country, and investigate, agree on, and implement the common policies and norms in smart cities***
- ***Communicate the concept of smart cities that Japan is promoting overseas while also utilizing international frameworks***
- ***Utilize Japan's experience of developing city infrastructure and data management know-how to promote the overseas deployment of smart cities through collaboration between the public and private sectors***
- ***Build a sharing economy model from Japan that has the strengths of safety and reliability, and accelerate its dissemination in regions throughout Japan. Furthermore, communicate Japan's initiatives in international forums***

① Necessity and Importance of Smart Cities in Innovation

○ Smart cities are initiatives that aim to solve the issues of cities and regions utilizing cutting-edge technologies, and create new value, and are places for the advanced realization of Society 5.0.

Around the world, a variety of smart city projects have been proposed for the solution of issues pertaining to energy and the environment, transportation, health and medical care, education, natural disasters, etc. caused by the concentration of populations in cities, resources and energy consumption, and greenhouse gas emissions, and demonstration and implementation of these projects is proceeding in each region. In particular in emerging countries, projects to construct large-scale smart cities have been announced in recent years as a set with plans to disperse and transfer the functions of the capital.[71]

○ On the other hand, in Japan, as a consequence of aging and population stabilization and decrease, economic disparities between urban areas and rural areas, and the decrease in the services and information provided to residents, business opportunities, etc. have become social issues, and due to these issues hopes have been pinned on revitalization through the introduction of cutting-edge technologies to the regions.

○ Furthermore, the concept of a Regional Circular and Ecological Sphere, etc. which solves the various issues of a region through the utilization of cutting-edge technologies has been proposed by the relevant offices, ministries, and agencies.

② Recognition of the Current Situation

<Project Promotion through Office, Ministry, and Agency Collaboration>

○ To ensure that Japan keeps pace with the global trend toward the introduction of smart cities, it is important for the entire government to work together to implement initiatives with implementation as the ultimate goal. In particular, acceleration of the digitalization and strengthening of social and economic functions is required as a response to the novel coronavirus disease, and introducing the concepts of health and well-being, comfort, maintenance of culture, social inclusion, etc. to smart cities taking into account the diverse values of the residents is important. Furthermore, it is necessary to advance IT utilization in smart cities while organizing the ownership of personal information, the forms of management, the relationships to the rights and obligations of the residents, etc. in order to take care to form a social consensus.

○ For this reason, in FY2019 the offices and ministries implementing smart city-related projects (the Cabinet Office, the Ministry of Internal Affairs and Communications, the Ministry of Economy, Trade and Industry, and the Ministry of Land, Infrastructure, Transport and Tourism) utilized SIP to organize and structure the demonstration projects, the domestic and overseas use cases, and the related standards, specifications, and data, etc. in diverse fields related to smart cities, in order to jointly design and build the reference architecture of smart cities. Furthermore, in each project of FY2020, they agreed to refer to the said reference architecture to implement

[71] The new capital on Kalimantan Island (Indonesia), New Clark City (the Philippines), the new industrial city NEOM (Saudi Arabia), and the suburbs of Cairo (Egypt), etc.

the project in line with the common basic policy.[72] Going forward, it is necessary to strongly promote project collaboration by the relevant offices, ministries, and agencies and data exchange, etc. among fields in line with this agreement, and to expand and develop smart cities as places for the advanced realization of Society 5.0.

<Super Cities>

○ Moves toward city design of the kind that utilizes cutting-edge technologies to fundamentally change the forms of societies are progressing rapidly worldwide. When revising the Act on National Strategic Special Zones[73] that was passed and established by the 201st ordinary session of the Diet, we presented the "super cities" initiative aiming for a "future city" that will be the first to utilize AI and big data, etc. to realize a world-leading future life. In this initiative, it is important for multiple cutting-edge services to be implemented in people's lives, and those services to realize synergistic effects through data exchange platforms to increase resident satisfaction. For that reason, together with bold regulatory reforms, it connects the initiatives in multiple fields such as travel, logistics, payment, administration, medical care and nursing, education, energy, the environment, crime prevention, disaster prevention, etc. to one data exchange platform and aims for the solution of social issues in the regions, in order to be first to comprehensively realize a better future society in which citizens want to live and better lives. Moreover, from the perspective of contributing to "new lifestyles" to adapt to the novel coronavirus disease, it is necessary to work on the development of an environment in which the implementation of online medical care and remote education is possible.

○ Taking into account the investigation results of the Investigative Commission on the Mutual Operability of Super Cities/Smart Cities implemented in FY2019, it is necessary to create the rules for the release of the APIs that are necessary when a variety of cutting-edge services in the super cities are mutually connected, to ensure that all systems are in a state in which they can be connected to each other if desired.

<Global Deployment>

○ In the cyber world, cutthroat competition over data platforms is occurring, but smart cities are a field merging the cyber and the physical, so there is a possibility that a similar kind of situation will occur. It is necessary for the city data and city OS supporting smart cities to be broadly opened to the local residents and new businesses, etc. predicated on the assumptions of ensuring security and the appropriate handling of personal information, without monopolization by limited people.

○ Against the background of these kinds of trends, in recent years multiple cities around the world aiming to be smart cities have formed federations such as the Global Smart Cities Alliance with

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[72] About the Common Policy in Government Smart City-related Projects in FY2020 (March 24, 2020 Task Force for Smart Cities agreement)

[73] Act on Partial Revision of the Act on National Strategic Special Zones (Act No. 34 of 2020)

the objectives of sharing the information and examples of success of each city, data exchange among the cities, and commonalization of the architecture, and have started activities to foster a common perception contributing to the effective and efficient operation of smart cities. For example, we will investigate the principles that form the common guidelines for networking and sharing experiences among cities and the governance of data and digital technologies in cities (the common core guiding principles), and will promote the adoption of common guidelines in each city, etc.

○ The 44th Ministerial Meeting on Strategy relating to Infrastructure Export and Economic Cooperation (October 2019) decided to add elements of overseas deployment to the Task Force for Smart Cities for the government's domestic and overseas deployment departments to cross-sectorally handle encouragement of the overseas deployment of smart cities. Furthermore, in January 2020 we established the Smart Cities Overseas Deployment Task Force across offices, ministries, and agencies to develop a structure for consulting on technical possibilities such as the use of digital technologies, AI, big data, etc. in overseas smart city development projects, and systemic issues, etc.

○ In advance of this initiative, the Ministry of Land, Infrastructure, Transport and Tourism collaborated with the ASEAN countries to hold the ASEAN Smart Cities Network High Level Meeting in Yokohama (October 2019). Furthermore, we established the Japan Association for Smart Cities in ASEAN (JASCA) with the relevant offices, ministries, and agencies serving as the joint secretariat, and it is working on centralization of the response window of the offices, ministries, and agencies for the private sector, surveys and information provision concerning the partner cities, and matching support for the products and services of Japan, etc. We have formed a project team inside JASCA for each city or country, and during FY2019 we dispatched local survey missions to five cities, including Siem Reap Province, Cambodia, and we formed a project team inside JASCA to hold a local meeting in Makassar City, Indonesia.

③ Measures and Solutions for Achieving the Objectives

<Project Promotion through Office, Ministry, and Agency Collaboration>

○ Under a united government infrastructure, we will promote initiatives for implementation of smart cities. In August 2019 we established the Smart City Public-Private Partnership Platform with the Cabinet Office, the Ministry of Internal Affairs and Communications, the Ministry of Economy, Trade and Industry, and the Ministry of Land, Infrastructure, Transport and Tourism as the secretariat, and based on this platform comprising a total of 484 organizations (as of March 2020) including companies, universities and research institutions, local governments, the relevant offices, ministries and agencies, etc., the public and private sectors will work together to strongly promote smart city-related projects in regions nationwide. Specifically, we will provide hands-on support, matching support, etc. Furthermore, we will apply the common policy in the smart city projects of the relevant offices, ministries, and agencies to specific projects. (Specifically, regarding the smart city-related projects of the relevant offices,

ministries, and agencies, we will improve the interconnectivity of data by advancing the standardization and release of the APIs of data infrastructure in each region, predicated on the assumption of making reference to the reference architecture, etc.) We will demonstrate nationwide the smart city projects functioning on the common infrastructure, and work for horizontal deployment through the Public-Private Partnership Platform. [Cabinet Secretariat, STI, OPDVLE, MIC, METI, MLIT]

○ In order to follow up as appropriate on the implementation status of model projects, etc. to solve systemic and operational issues, the relevant offices, ministries, and agencies will collaborate to promote initiatives pertaining to the dissemination and expansion of smart cities, including the formulation of guidelines, etc. (promotion of horizontal deployment and collaboration among cities through the modulization and packaging of the range of functions of smart cities, etc.). Furthermore, we will strengthen support structures, including utilization of the human resources and know-how, etc. of the local agencies of the national government, incorporated administrative agencies, etc. [Cabinet Secretariat, STI, OPDVLE, MIC, METI, MLIT]

○ Concerning smart city model initiatives by local governments, etc., the relevant offices, ministries, and agencies will collaborate to implement support measures for development of the necessary technological foundation and infrastructure, such as the building of a 3D city model, etc. [STI, OPDVLE, MIC, METI, MLIT, MOE]

○ Based on the Act on the Promotion, Etc. of Information and Communications Technology in Administrative Procedures (the Digital Procedures Act), we will promote initiatives for digital first (individual procedures and services are consistently completed digitally), once only (information that has been submitted once does not need to be submitted a second time), and connected, one stop (multiple procedures and services are realized at one window, including the private sector's services). [Cabinet Secretariat]

<Super Cities>

○ Based on the revision of the Act on National Strategic Special Zones, during FY2020 we will advance solicitation and selection of the target cities, development of data exchange platforms, concentrated investment in the projects of the relevant offices, ministries, and agencies, and the investigation, etc. of bold regulatory reforms, in order to advance early implementation of the super cities. Regarding the development of data exchange platforms, we will promptly implement surveys and design, the building of systems, smooth operational support, etc. In conjunction with this, in order to deploy those results in other cities, we will make it mandatory to release APIs for the data exchange platforms in the cities selected as super cities. Regarding regulatory reforms, we will utilize the demand for development of the special measures of new regulations incorporated in the revised Act to boost the investigations by the relevant offices, ministries, and agencies so that they proceed simultaneously, in an integrated manner, and comprehensively. [Cabinet Secretariat, STI, OPDVLE, MIC, METI, MLIT, MOE]

<Global Deployment>

○ We will utilize the forum of the Global Smart Cities Alliance proposed and established in the G20 to promote cooperation with the cities of the world based on a common perception of free and open smart cities. In each region, under common guidelines, the city stakeholders (local governments, central governments, private sector partners, city residents, etc.) will collaborate and cooperate to advance the implementation of smart city technologies, and improve the transparency and openness of smart cities and the mutual operability of their systems. Furthermore, we will provide tools to each city for efficiently utilizing and managing smart city technologies for the public good. [STI, MIC, METI, MLIT]

○ Regarding smart cities in ASEAN, we will form a project team inside JASCA for each city or country to advance matching and project composition among offices, ministries, and agencies and through public-private partnership. Furthermore, at international conferences, such as the next high-level meeting, etc., we will transmit information about the smart cities of Japan, etc., and introduce the specific progress of Japan's cooperation, such as JASCA activities, etc. Furthermore, we will advance business environment development and responses to partner country needs, etc. through bilateral city development and real estate development platforms, etc.

[Cabinet Secretariat, STI, MIC, MOFA, METI, MLIT, MOE]

○ We will establish the Public-Private Partnership Council for Overseas Deployment (provisional name), stipulate the concept of Japan's smart cities, and communicate Japan's smart city initiatives overseas. Firstly, in promising cities in emerging countries, primarily in Asia, the relevant offices, ministries, and agencies will collaborate and utilize the smart city-related city infrastructure development experience and data management know-how that has been built up by Japan to take support measures for the concentrated demonstration and implementation of smart city-related technologies.

[Cabinet Secretariat, STI, MIC, MOFA, METI, MLIT, MOE]

○ Through the Global Technology Governance Summit which is scheduled to be held in Japan in 2021 and the consultations, etc. with each country in the G20 under the presidency of Saudi Arabia, we will continuously advance international collaboration for smart cities. [Cabinet Secretariat, STI, MIC, MOFA, METI, MLIT]

<Sharing Economy>

○ For improvement of the safety and reliability of the sharing economy, we will present the basic matters that the providers of services should comply with, and in FY2020 we will start training and certification systems for expansion of the base of share workers, improvement of their skills, and improvement of the quality of the services. [Cabinet Secretariat]

○ We will provide support for the model initiatives of the sharing economy for the solution of regional issues, and also collaborate with the Sharing City Promotion Council, etc. under the leadership of private sector organizations to encourage utilization of the sharing economy for

the smooth provision of new public services through Co-Creation and mutual assistance at times of emergency, etc. [Cabinet Secretariat, MIC]

(2) Startups

○ **Future Visions to be Pursued**

• We will form hubs that compete with the world's best and realize a society in which research and development results lead to social implementation, by building Japan-style startup ecosystems, in particular research and development startups that utilize the outstanding human resources, research and development capacity, funds, etc. of large companies, universities, etc., which are the strengths of Japan

○ **Objectives**

• Develop the environment for launching the research and development startups of Japan to the level of the United States and China, countries which are at the highest level in the world

<Startup Awareness>

• Double the number of establishments of ventures originating from universities, etc. and the number of establishments of ventures originating from research and development agencies from the numbers in FY2016[74]

	FY2016	FY2017	FY2018	(Objective)
Cumulative total number of establishments of ventures originating from universities, etc.	2,706 companies	2,912 companies	3,097 companies	Double
	FY2016	FY2017	FY2018	(Objective)
Cumulative total number of establishments of ventures originating from research and development agencies	207 companies	221 companies	—	Double

<Funds>

• Improve the ratio of the venture investment amount with respect to nominal GDP to the highest level in the world[75]

	2016	2017	2018	(Objective)

[74] Cumulative total number of establishments of ventures originating from universities, etc. (2018): 3,097 companies (Calculated in the Cabinet Office (STI) based on About the Status of Implementation of Collaboration between Industry and Academia, etc. in Universities, etc. in FY2018 (January 2020) by the Ministry of Education, Culture, Sports, Science and Technology).

[75] The ratio of the venture investment amount with respect to nominal GDP (2018 data as of December 2019): Japan: 0.051%, the United States: 0.633%, China: 0.231% (Calculated in the Cabinet Office (STI) based on VEC YEARBOOK 2019 (November 2019)).

Ratio of the venture investment amount with respect to nominal GDP	0.028%	0.036%	0.051%	The highest level in the world

<Growth>

• Create 20 unlisted venture companies with a corporate value or market capitalization of one billion dollars or over (unicorns)[76] or listed venture companies[77] by 2023

	2018	2019	2020	(Objective) 2023
Unicorns or listed venture companies	—	7 companies	16 companies	20 companies

[76] Number of unicorn companies: the United States: 221 companies, China: 109 companies (CB Insights, as of March 2020). Japan has eight companies (Calculated in the Cabinet Office (STI) based on the JAPAN STARTUP FINANCE REPORT 2018 and 2019).

[77] Covers companies that have not been launched or were launched fewer than ten years ago as of the beginning of FY2018.

① Implementation Status and Analysis of the Current Situation

Japan's startup procurement amount has been rapidly growing since 2014, and in 2018 it increased by 40% compared to 2017. Furthermore, the number of startup companies with a corporate value or market capitalization of one billion dollars or over (so-called unicorns) doubled from 2019 to 2020.[78] On the other hand, the economic activities of startups are still very minor, and they have not been able to become an engine of innovation creation. Around the world, and particularly in the United States and China, many unicorns have been created from startup ecosystems centered on cities. Taking into account this kind of situation, Japan has also decided to accelerate the creation and growth of further startups by selecting the cities that will be the hubs for the formation of ecosystems that compete with the world's best and providing concentrated support through the public and private sectors for acceleration of the creation of startups in universities, the strengthening of accelerator functions, gap funding, etc. Going forward it is necessary to continue to steadily execute these measures, and to investigate startup ecosystems taking into account the characteristics of the regions in regions other than startup cities as well.

Furthermore, in order to encourage social implementation of research and development results through startups, it is necessary for all of the ministries and agencies to utilize their expertise in their respective domains and collaborate with industry while supporting the creation and growth of startups, so we have decided to carry out a review of the Japanese version of the SBIR which aims for the creation of innovation by startups from that perspective, and to aim to improve its effectiveness.

<Creation of Startup Ecosystem to Compete with the world top ecosystems>

○ We will implement a survey of the potential of startup ecosystems in major domestic cities. While also taking into account these results, we selected global startup cities and promotion startup cities as startup ecosystem startup cities (consortiums comprising local governments, universities, and private sector organizations). Going forward, we will provide concentrated support through the public and private sectors, including strengthening of the acceleration functions and Gap Fund, etc. in the chosen startup cities.

<Strengthening of Startup Ecosystems Centered on Universities, etc.>

○ In EDGE-NEXT,[79] we will investigate the establishment of communities for entrepreneur education in which nationwide universities, etc. can participate.

○ In JST SCORE,[80] we started a new framework that supports the building and promotion of entrepreneurship support programs for the departments in charge of entrepreneurship support, etc. in universities.

○ The Global Science Campus is being implemented in 14 institutions as of FY2020 and currently

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[78] JAPAN STARTUP FINANCE REPORT 2019 (as of April 2020)
[79] Exploration and Development of Global Entrepreneurship for NEXT generation
[80] Program of Start-up incubation from Core Research

we are soliciting new institutions to implement it in FY2020.

○ There are 217 schools which have been designated Super Science High Schools as of FY2020.

○ The Act on Partial Revision of the Basic Act on Science and Technology, etc. was established and promulgated in June 2020. It included expansion of the number of research and development agencies that can invest in venture companies, etc. that utilize results from 22 institutes to 27 institutes, and other changes.

<Provision of Acceleration Programs that Compete with the World's Best>

○ In order to develop startups that spread their wings around the world, connect the top players in the world to startup support organizations, and transfer know-how in global startup cities, we are advancing investigation about implementation of overseas top accelerator programs.

<Encouragement of Funds Procurement, etc. for Research and Development Startups (Gap Fund)>

○ Concerning research and development startup support carried out after obtaining the commitment of VCs, etc., we have made a review of the certified VCs. Furthermore, in order to realize effective support for startups that bring about solutions to social issues and change the game in the market, we have carried out a significant strengthening of the Gap Fund. It is necessary to continue the investigation about utilization of the risk money supply from the Development Bank of Japan and public-private investment funds.

○ In order to carry out an investigation of revision of the Japanese version of the SBIR to strengthen initiatives for improving the effectiveness of systems for innovation creation through collaboration between ministries and agencies and with the Cabinet Office as the control tower, we have implemented a revision of the basis law from the Act for Strengthening the Management of SMEs, etc. to the Law on the Revitalization of Science, Technology and Innovation Creation.

<Strengthening of Public Procurement for Research and Development Startups>

○ We are implementing the Cabinet Office Open Innovation Challenge 2019.[81] We recruited proposals for startups tackling the issues faced by each ministry and agency and local governments, etc. and certified 11 startups. We are matching with large companies, etc. and providing entry support for demonstration and experimental introduction in institutions that are proposing issues, etc.

<Strengthening of the Formation of "Connections" between Ecosystems, Fostering of Trends>

○ We integrated the Council on Science & Innovations Integration (S&II Council) with the Japan

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[81] Cabinet Office Open Innovation Challenge 2019 (https://open-innovation-challenge.go.jp/)

Open Innovation Council (JOIC) to strengthen the network with universities, research institutions, etc. We implemented pitches, etc. in special features combining ventures originating in universities and health tech.

○ In the Japan Open Innovation Prize,[82] we selected and gave awards to projects that were role models for open innovation and fostered momentum for the horizontal deployment of good examples and open innovation.

<Encouragement of the Mobility of Human Resources in Research and Development, etc.>

○ We will implement surveys of the mobility of research and development human resources and human resources in large companies and of the increase in the supply of human resources to startups. We will continue encouraging the mobility of research and development human resources.

<Strengthening of Concentrated Support through the J-Startup Program>

○ In June 2019 we selected 49 new J-Startup companies. We have provided support for exhibiting in overseas exhibitions such as CES, support for overseas deployment utilizing the Global Acceleration Hub, and public relations support, etc.

② Measures and Solutions for Achieving the Objectives

From the perspective of comprehensively improving the startup environment while taking into account global and domestic developments, we will continue deepening the collaboration of the relevant offices, ministries, and agencies to provide concentrated support to the startup cities, and in addition strengthen startup communities in regions other than startup cities.

Furthermore, regarding the new Japanese version of the SBIR, we will strongly promote innovation creation utilizing startups; for example, investigating the establishment of issues contributing to innovation creation and the introduction of unified rules across ministries and agencies based on multiple stage selection in the research and development projects for startups utilizing the expertise of the ministries and agencies in their respective domains.

<Creation of Startup Ecosystem to Compete with the world top ecosystems>

○ In order to create many startups with high growth potential rooted in outstanding technologies and research in the startup cities of startup ecosystems, we will carry out seed discovery through collaboration between industry and academia and provide funds support using the Gap Fund. In conjunction with this, we will provide support for the overseas deployment of startups and for attracting overseas startups in order to strengthen the global connections of startup cities. Furthermore, in order to encourage the creation of startups to solve social issues in regions other than startup cities, we will strengthen startup communities based on regional universities and

[82] Japan Open Innovation Prize (https://www8.cao.go.jp/cstp/openinnovation/prize/index.html)

core companies, and encourage the supply of funds and human resources to startups which have a social impact. Through these initiatives, we will promote startup measures in an integrated manner.

[STI, MIC, MEXT, METI, MLIT]

<Strengthening of Startup Ecosystems Centered on Universities>

○ We will promote entrepreneurship education through investigation of curriculum reforms and through learning and practice, and strengthen support for practical entrepreneurship activities using START,[83] SCORE, etc. Furthermore, we will promote initiatives for faculty development of university teachers, etc. who contribute to entrepreneurship education and startup creation support, the utilization of external human resources, encouragement of the hackathons, boot camps, etc. of the campus and university collaboration consortiums, and the fostering of creativity in the elementary and middle education stages. [STI, MEXT]

○ From the perspective of encouraging the practical application of research and development results, we will carry out organization and investigation of the investment target range of national university corporations, etc. about whether to enable direct investment in ventures originating from the said corporations, etc.

[MIC, MEXT]

[83] Program for Creating STart-ups from Advanced Research and Technology

<Provision of Acceleration Programs that Compete with the World's Best>

○ We will strengthen the acceleration functions of Japan through collaboration, etc. with global top accelerators, and encourage the strengthening and establishment of acceleration programs for each field. [STI, METI]

<Encouragement of Funds Procurement, etc. for Research and Development Startups (Gap Fund)>

○ We will work on research and development support such as large-scale funds support (Gap Fund supply), etc. by research funding agencies, etc. Furthermore, we will utilize the risk money supply from the Development Bank of Japan and public-private investment funds. We will encourage social implementation of research and development projects implemented by the government.

[Cabinet Secretariat, STI, MIC, MOF, MEXT, MHLW, METI]

○ In the new Japanese version of the SBIR, we will investigate formulation of a policy with the objective of paying a certain proportion of the fixed research and development budget for each ministry to startups, etc. that carry out innovative research and development, while also taking into account the characteristics, etc. of research and development, and we will investigate the formulation of operation guidelines incorporating the establishment of issues, the designation of the subsidies, etc. of each ministry aiming for innovation creation using unified rules based on constant support using multiple stage selection, the deployment of program managers who have technical knowledge and experience when executing and operating the subsidies, etc., in order to promote programs utilizing the strengths of each ministry and agency in an integrated manner, thereby improving their effect.

[STI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]

<Strengthening of Public Procurement for Research and Development Startups>

○ We will promote project deployment through encouragement, etc. of the procurement of cutting-edge technology products with an awareness of needs and technology seeds and utilization of a trial ordering system by local governments, and in addition, in the new Japanese version of the SBIR, we will investigate measures for linking the establishment of issues based on policy issues to the government procurement of results. [All offices, ministries, and agencies]

<Strengthening of the Formation of "Connections" between Ecosystems, Fostering of Trends>

○ In order to realize the formation of startup ecosystems, we will strengthen the collaboration of the relevant offices, ministries, and agencies, and aim for the establishment of a framework for startup support institutions to collaborate more than they have previously to concentratedly and efficiently support high-quality startups. [All offices, ministries, and agencies]

○ In JOIC, we will strengthen and promote a range of initiatives that promote open innovation in the relevant offices, ministrie,s and agencies, such as working to switch functions to the support platforms of open innovation-related organizations, strengthening the encouragement of open innovation by ventures, large companies, universities, etc. Furthermore, we will deploy good examples and strengthen the collaboration of startup-related events through the strengthening and awarding of the networks and collaborations of the industrial world, governmental institutions (in particular, research funding agencies and venture support institutions), public-private investment funds, the Development Bank of Japan, etc.

[All offices, ministries, and agencies]

○ In order to encourage the collaboration between operating companies and research and development startup companies that is necessary for open innovation, we will create handbooks with understandable explanations of the points that require care when engaging in contract negotiations and model contracts (contract boilerplates) tailored for the collaboration processes and industry types. [METI]

<Encouragement of the Mobility of Human Resources in Research and Development, etc.>

○ In order to encourage the inflow of outstanding research and development human resources into startups, the relevant offices, ministries, and agencies will investigate support for initiatives pertaining to human resources mobility, and support the mobility of human resources supporting startups in order to encourage the mobility of research and development human resources. [All offices, ministries, and agencies]

○ Regarding human resources managing startups, we will create an environment under which candidates to be management human resources can change their job to work at promising startups where growth is being hindered by a lack of management human resources, by eliminating the factors hindering the candidates to be human resources managing startups among workers at large companies from changing their job to work at startups, and by developing the environment necessary for efficient job change mediation to be carried out. [METI]

<Strengthening of Concentrated Support through the J-Startup Program>

○ With the objective of creating startups that grow globally, we will provide concentrated support through the J-Startup program to startups with limited management resources to further strengthen the startup ecosystems of Japan, including matching the domestic and overseas VCs and accelerators, and providing support for the establishment of ecosystem hubs in the regions, etc. [STI, METI]

(3) Promotion of Greater Innovation in Government Projects and Systems

○ **Future Visions to be Pursued**

• Build mechanisms so that greater innovation in government projects and systems is carried out permanently, including comparative investigations of government projects and systems with respect to advanced examples in foreign countries, active utilization of new technologies, including cutting-edge technologies, systems development to encourage the creation of innovation, reforms of the regulations that are factors hindering that development, etc.

• ***In particular we will take care to ensure that there is no delay in the recovery of research and development investment by the private sector due to the impact of the novel coronavirus disease compared to foreign countries, while inducing the development and introduction of cutting-edge technologies, etc. and expansion of investment in the private sector, through these kinds of government initiatives for productivity improvement, etc.***

○ **Objectives**

<Encouragement of Research and Development Investment>

• Achievement of the government research and development investment objective (1% relative to GDP (in the case that the nominal growth rate of GDP during the period of the Fifth Basic Plan is projected based on the Economic Revitalization Case in the Economic and Fiscal Projections for Medium and Long Term (submitted to the Council on Economic and Fiscal Policy on July 22, 2015) at the time of the formulation of the Fifth Basic Plan, the scale of the total amount of government research and development investment that is necessary during the period is approximately 26 trillion yen)) and the public and private sector research and development investment objective (4% or over relative to GDP[84])

Government research and development investment during the period of the Fifth Basic Plan	FY2017	FY2018	FY2019	(Objective) FY2020
	Approximately 8.9 trillion yen	Approximately 13.7 trillion yen	Approximately 19.4 trillion yen	Total amount of approximately 26 trillion yen
	FY2016	FY2017	FY2018	(Objective) FY2020

[84] Taking into account the Fifth Basic Plan, we will set the objective of combined public and private sector research and development investment of 4% or over relative to GDP, and ensure the consistency of government research and development investment with the Economic and Fiscal Recovery Plan in the Basic Policies for Economic and Fiscal Management and Reform, while aiming for 1% relative to GDP. Note that the industrial world has declared that it will in response to the moves by the government to achieve research and development investment objectives by aiming for research and development investment by private companies that is 3% of GDP and will coordinate with the government in its efforts to increase the amount of investment.

Public and private sector research and development investment objectives relative to GDP	3.43%	3.48%	3.56%	4%

<Realization of the World's Most Innovation-Friendly Country>

• Fundamentally improve the innovation environment through a revision of government projects and systems (with regards to the World Bank's business environment rankings,[85] improve to be among the top three of the 35 OECD countries by 2020)

	2018 (October 2017 announcement)	2019 (October 2018 announcement)	2020 (October 2019 announcement)	(Objective) 2020
Business environment ranking	24th	25th	18th	3rd

<Top Productivity Growth Rate Attained among World's Advanced Nations>

• Doubling Japan's productivity[86] growth rate in 2020 (the annual growth ratio to be increased to 2% from the median rate of 0.9 % for 5 years ended 2015).

	2016	2017	2018	(Objective) 2020
Growth of productivity	1.0%	0.5%	±0.0%	2%

① Implementation Status and Analysis of the Current Situation

In addition to leadership of greater innovation by CSTI and the expansion of initiatives by each office, ministry, and agency, for the encouragement of the social implementation, etc. of cutting-edge technologies domestically and overseas we advanced greater innovation in government projects and systems, including implementing the aggregation, analysis, etc. of information pertaining to greater innovation, certifying proposals for startups tackling the issues faced by each office, ministry, and agency and local governments, etc., and providing entry support for demonstration and experimental introduction, etc.

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[85] The rankings are prepared every year by analyzing ten items, such as the funds procurement environment, the tax system, etc. https://www.doingbusiness.org/en/rankings

[86] Real GDP per capita per hour.

Regarding the government's science and technology-related budget, at a time when the major countries such as the United States, China, Germany, and the United Kingdom are greatly increasing their government budgets, Japan has also increased its government budget over the past few years.[87] The FY2020 science and technology-related budget is approximately 5.2 trillion yen,[88] and the cumulative total government research and development investment during the period of the Fifth Basic Plan finalized in June 2020 was approximately 24.6 trillion yen.[89] For the achievement of each objective, we will continue to promote initiatives, etc. for greater innovation in government projects and systems, and tackle prioritization of the necessary budget.

In particular, there are concerns that research and development investment in the private sector will decline to some extent in the short term due to the impact of the novel coronavirus disease, so we will advance initiatives for its recovery in order to avoid a decline in innovation creation.

<Greater Innovation in Government Projects and Systems>

○ Regarding the projects of each office, ministry, and agency, we presented examples of utilization of cutting-edge technologies, etc. while working on greater innovation in FY2020 government projects under cooperation with each office, ministry, and agency; for example, encouraging the offices, ministries, and agencies with jurisdiction over the projects to introduce greater innovation to the said projects.

○ For the encouragement of the social implementation, etc. of cutting-edge technologies domestically and overseas, we started the aggregation, analysis, etc. of information pertaining to greater innovation from FY2019.

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[87] The FY2019 science and technology-related budget is approximately 5.2 trillion yen when the initial and supplementary budgets are combined, 20% higher than in the previous fiscal year.

[88] The total of the science and technology-related budget amount of 4.4 trillion yen in the FY2020 initial budget and the science and technology-related budget amount of 772.7 billion yen in the first supplementary budget and the second supplementary budget.

[89] Including a science and technology-related budget amount of 4.2 billion yen in the FY2019 budget contingency funds. The cumulative total government research and development investment during the period of the Fifth Basic Plan includes the initial budget, first supplementary budget, and second supplementary budget in FY2020 and we plan to record the portion for the local governments going forward.

<Strengthening of Public Procurement for Research and Development Startups>

○ We are implementing the Cabinet Office Open Innovation Challenge 2019. We recruited proposals for startups tackling the issues faced by each ministry and agency and local governments, etc. and certified 11 startups. We are matching with large companies, etc. and providing entry support for demonstration and experimental introduction in institutions that are proposing issues, etc.

② Measures and Solutions for Achieving the Objectives

The CSTI is collaborating with the Ministry of Finance so ensure that priority is placed on the budget compilation process with respect to initiatives pertaining to greater innovation.

<Expansion of Innovation in Government Projects and Systems>

○ In order to promote initiatives for greater innovation in government projects and systems under collaboration with each office, ministry, and agency, we will continue the aggregation, analysis, etc. of information pertaining to greater innovation, and make proposals for revisions of the projects and systems, etc. under the jurisdiction of each office, ministry, and agency in order to encourage the social implementation, etc. of cutting-edge technologies domestically and overseas. [STI]

○ We will actively advance the expansion of initiatives for greater innovation in projects and systems, etc. that have been advanced to date and the incorporation of pioneering initiatives in other offices, ministries, and agencies, etc., and we will collaborate with the CSTI for further promotion of greater innovation in government projects and systems. [All offices, ministries and agencies]

<Strengthening of Public Procurement for Research and Development Startups>

○ We will promote project deployment through encouragement, etc. of the procurement of cutting-edge technology products with an awareness of needs and technology seeds and utilization of a trial ordering system by local governments, and in addition, in the new Japanese version of the SBIR, we will investigate measures for linking the establishment of issues based on policy issues to the government procurement of results. [All offices, ministries and agencies] [Restated]

<Give Priority to Promotion of Investment in Anticipation of Future Needs>

○ Through principles and guidelines, etc., we will encourage behavioral transformations such as innovation management, industry and academia commercialization collaboration, and proper open innovation with startups, etc. Furthermore, it is essential to provide support for market creation in an integrated manner for the dissemination of research and development results, so in research and development projects, we will provide a full range of support anticipating social

implementation and commercialization, by carrying out planning, formulation, and management with an awareness of industrialization scenarios and creating initial demand through the establishment of introduction objectives and public procurement, etc. [METI]

<Encouragement of Private Sector Research and Development Investment>

○ For the encouragement of the social implementation, etc. of cutting-edge technologies, we will investigate revisions of related systems, etc. that support the research and development investment of the private sector, in order to strengthen research and development of software such as AI, etc. and the social implementation of new services utilizing that software. [METI]

(4) Utilization of Strategic Standards

○ **Future Visions to be Pursued**

• The penetration of the perspective of "utilization of strategic standards" (conceiving of the value provided to society in innovation ecosystems (the solution of social issues) and then investigating the design of the overall measures (architecture) and what kinds of "standards" are necessary for realization systems based on the architecture, and forming a consortium, etc. of the related people to judge what kinds of "standard" techniques and forums to utilize, including the rapid formation of standards, etc.) and ideas into the public and private sectors

• ***Encourage the monetization and social implementation of the technologies of Japan and ensure that Japan has the initiative in the realization of Society 5.0, etc. using the "utilization of strategic standards" through the strengthening, etc. of structures tackling flexible and strategic international standardization of cutting-edge technologies, systems, etc. based on collaboration by the public and private sectors***

○ **Objectives**

<Building and Implementation of Control Tower Functions>

• Ensure organic collaboration among government organizations and related institutions that have become vertically-divided by field and a wide range of related people including private sector companies, and build and implement control tower functions (platforms) to support the "utilization of strategic standards" from the perspective of overall optimization, including analyses of the global developments and trends, design of the architecture, etc.

<Strategic Standards and Intellectual Property Initiatives in Emerging Technologies, etc.>

• Compile the policies, etc. and build the required structures to promote initiatives concerning strategic standards and intellectual property in the emerging technologies that are important for strengthening the international competitiveness of Japan and the intellectual infrastructure that contributes to the solution of social issues

① Analysis of the Current Situation

<Changes in the Environment Surrounding Standards>

○ At a time when consumer needs are switching from "goods" to "services" and a dynamic market environment is being formed, for example the rise of platformers in the upper layer, we have reached a situation which should be perceived as the pivot having shifted to the cross-sectoral themes of systems, services, and data in circumstances under which the strategic utilization of standards is required.

○ Digital innovation has shortened the period for the social implementation of new technologies, so the speed necessary for new standards and the speed with which existing standards are overridden by new standards are accelerating rapidly.

○ In companies in the United States, Europe, and China, moves to utilize standards optimized from

a global perspective (example: the adoption of domestic and overseas cutting-edge technologies in the procurement criteria), moves to neutralize the competitiveness of advanced companies through the utilization of strategic standards, etc., are being seen.

<Response to Cross-Sectoral Themes>

○ Most Japanese companies have a strong tendency to advance their investigations of strategies with the technology seeds they possess themselves as the starting point, and research institutions in each field and ministries and agencies are advancing their investigations in each of their respective domains, so there are not enough investigations from panoramic and multifaceted perspectives by diverse related people. As a result, individual demonstrations only are proceeding, without any portrayal of a vision for a market that aims for creation.

<Responding to Agile Ideas and the Sense of Urgency>

○ Anxiety grows when engaging in advanced actions with uncertain outcomes while being cautious of the risk of failure and criticism. As a result, the speed of response to change is slow compared to Europe and the United States, which take action while engaging in agile activities to respond to the situation at any given time. Furthermore, there is a competitive environment which makes it difficult for companies to exercise leadership to encourage other companies in the same industry to formulate standards, so it takes time to form a consensus within an industry or among industries, and flexibility in international negotiations is lost.

② Measures and Solutions for Achieving the Objectives

<Utilization of Strategic Standards>

○ The National Institute of Advanced Industrial Science and Technology established the Standardization Promotion Center in July 2020, and it will strengthen initiatives such as putting in structures for external consultations and the coordination of cross-domain themes. NEDO will implement investigations involving experts in the field of standards, etc. in its new projects in the current fiscal year, and will work on activities with an awareness of the utilization of strategic standards. Furthermore, it will collaborate with the related ministries and agencies on these activities and share the specific techniques and examples of the standardization activities among the national research and development agencies. [SIPSH, METI]

○ In order to encourage understanding of importance (value and risk) in management concerning OSS and improve awareness of the utilization of OSS, we will implement dissemination of and education about the results compiled in the Survey Research on Intellectual Property Risks, etc. Pertaining to Open-source Software in the Era of Digitalization and the IoT (April 2020, Japan Patent Office). [SIPSH, METI]

○ In the fields of AI, Beyond 5G, smart agriculture, etc., we will utilize the functions of the related ministries and agencies and the related institutions (research and development agencies such as

the National Institute of Advanced Industrial Science and Technology (Standardization Promotion Center/Digital Architecture Promotion Center), NICT, AMED, the National Agriculture and Food Research Organization, etc., and the IPA (Digital Architecture Design Center)) to experimentally support utilization of strategic standards in companies, etc. and identify good examples and issues in national projects, etc. Moreover, for the building of control tower functions and structures to think about the form that the overall structure of society should take from a panoramic perspective and formulate the measures to realize that form, during FY2020 we will compile the initiatives and policies going forward for demonstrating platforms to support the utilization of standards. [SIPSH, MIC, MAFF, METI, relevant offices and ministries]

○ Regarding original standardization activities by small and medium-sized enterprises, etc. that are not via industrial organizations, we will implement support for standardization with a strengthened perspective of business strategy from FY2020 so that a greater project expansion effect can be obtained. [METI]

<Development of Strategic Intellectual Infrastructure>

○ In order to strengthen the international competitiveness of and sustainably develop the highly-reliable "Monozukuri" (Manufacturing) industries that are a pillar of Japanese industry and high-quality and very safe infrastructure and service industries, etc. such as medical care, transportation, and to encourage innovation that supports the safety and security of citizens, we will steadily develop intellectual infrastructure for research materials, standards of measurement, and information concerning science and technology, etc. pertaining to the three particularly important fields of "measurement standards," "microorganism genetic resources," and "geological information," based on the Intellectual Infrastructure Development Plan (Stage 2). Furthermore, taking into account the changes in the situation of the economy and society, in particular the progress of Society 5.0, technological innovation, and the status of achievement of the Intellectual Infrastructure Development Plan (Stage 2), etc., we will broadly collaborate with local research institutions, etc. to formulate a new plan by about the spring of 2021 to promote the steady development of intellectual infrastructure that contributes to the solution of social issues. [METI]

<Initiatives for Strategic Standards and Intellectual Property for Emerging Technologies>

○ In the information and communications field, 5G and Beyond 5G, the next-generation communications standard, are expected to become the core social and economic infrastructure that supports Society 5.0. For this reason, during FY2020 we will organize the direction going forward of global and strategic deployment of standardization and intellectual property activities pertaining to promotion of Beyond 5G through the following initiatives, for the strengthening of Japan's digital competitiveness through the early establishment and

dissemination of fundamental technologies.

① Establishment of strategic standardization and intellectual property objectives

② Strengthening of collaboration with strategic partners, including the enhancement of international joint research, the strengthening of collaboration structures with influential standardization institutions overseas, etc.

③ Development and utilization of functions as a standardization and intellectual property hub of Japan pertaining to the promotion of Beyond 5G

[SIPSH, MIC]

○ In recent years, technology development is progressing in fields merging agriculture and industry as a consequence of the application and penetration of industrial technologies in the agriculture, forestry, and fisheries and food fields, such as smart agriculture, etc. Furthermore, initiatives for expansion of exports based on the government's export expansion strategy for agriculture, forestry, and fisheries products and food are being advanced.

In order for Japan's outstanding technologies and quality to be evaluated correctly, strategic standardization is necessary and essential, and the importance of strengthening initiatives for standardization in the agriculture, forestry, and fisheries and food fields is growing. For this reason, the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Economy, Trade and Industry will collaborate and cooperate to strongly promote strategic standardization activities in the agriculture, forestry, and fisheries and food fields together with the relevant incorporated administrative agencies, etc.

In the agriculture, forestry, and fisheries and food fields, initiatives suited to the characteristics of the regions are important. For this reason, we will build liaison, information sharing, and consultation structures within the horizontal connections between the related institutions at the regional level and the vertical connections within organizations such as the headquarters, branches, etc. of the related incorporated administrative agencies, in order to ensure that standardization needs in the regions lead appropriately to standardization. [MAFF, METI]

CHAPTER 4: Global Deployment of Knowledge

(1) Promotion of Science, Technology and Innovation for Achieving SDGs (STI for SDGs)

○ **Future Visions to be Pursued**

- Promote initiatives at the highest level in the world to utilize the STI necessary for the realization of Society 5.0 for the achievement of the 17 SDGs stipulated by the United Nations
- Globally deploy the STI of Japan to drive forward global “STI for SDGs” activities

○ **Objectives**

- Utilize the STI of Japan to achieve the 17 SDGs by 2030, and continue further initiatives thereafter to set an example to the world
- For that purpose, formulate a world-leading STI for SDGs Roadmap (hereinafter referred to as the “Roadmap”) and present it to the international community in order to support the formulation of a roadmap in each country
- Advance initiatives for building an STI for SDGs Platform (hereinafter referred to as the “Platform”) to match the intellectual assets of Japan, such as technology seeds, etc., with domestic and overseas needs, promote independent initiatives by the private sector companies, etc. of Japan for international contributions utilizing STI, and drive forward the building of a sustainable international community from 2030 onwards as well

① Implementation Status and Analysis of the Current Situation

Regarding the Roadmap, we have led international discussions, in particular the sharing of the basic concept in the G20, etc. Furthermore, through participation in United Nations programs and collaboration, etc. with international institutions, we have started initiatives for roadmap formulation and execution support in each country.

Regarding the Platform, we will start trials of prototype development and initiatives, and advance the strengthening of collaboration with stakeholders both online and offline.

<Formulation and Implementation of a Roadmap>

○ In the Meeting of the SDGs Promotion Headquarters in December 2017, the Prime Minister issued an instruction to promote initiatives involving the public and private sectors, formulate the Roadmap, etc. In response to this, the Cabinet Office collaborated with the relevant offices and ministries to formulate a Roadmap for Japan concerning AI, energy and the environment, and agriculture.

○ The Guiding Principles for the Development of STI for SDGs Roadmaps proposed by Japan were approved at the G20 Osaka Summit.
○ A United Nations task team (UN-IATT[90]) started a pilot program (the Global Pilot Programme on Science, Technology and Innovation for SDGs Roadmaps), with several developing countries, etc. as the pilot countries, in order to promote the formulation of a roadmap in each country. Japan is also participating in this pilot program and in order to support roadmap formulation and execution, etc. in the pilot countries of India and Kenya in particular, Japan is advancing consultations with the related people in both countries and United Nations agencies.

<Reflection in Plans and Strategies of the Government>

○ Specific initiatives concerning STI for SDGs were stated in the SDGs Action Plan 2020 compiled by the SDGs Promotion Headquarters.

<Investigation of a Platform for the Global Deployment of STI>

○ Intellectual assets such as STI seeds, etc. that contribute to the achievement of the SDGs exist in Japan, but they are not tied sufficiently to the SDGs-related needs of each country. It is necessary to globally deploy Japan's intellectual assets such as STI seeds, etc. to contribute to the world's achievement of the SDGs.
○ For this reason, we carried out matching with domestic and overseas SDGs needs and implemented creation and trial demonstrations, etc. of surveys and prototypes for the building of a platform to support project creation.
○ We launched and introduced the prototype of the SDGs Solution Hub, an online system in conjunction with TICAD 7.
○ For the full-scale building of the platform, we held meetings gathering together the relevant offices, ministries, agencies, government institutions, private sector companies, academia, international institutions, etc. and we are advancing consultations.

② Measures and Solutions for Achieving the Objectives

In order to utilize Japan's outstanding science and technology to contribute to the world's achievement of the SDGs, we will also utilize ESG investment[91] to boost the creation of innovation, and we will implement the following initiatives.

<Formulation and Implementation of a Roadmap>

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[90] United Nations Inter-Agency Task Team
[91] Investment that takes into account Environmental, Social, and Governance elements, not only financial information as previously

○ In the United Nations Pilot Program, we collaborate with the World Bank, etc. and United Nations agencies, etc. to provide support for formulation and execution of roadmaps in India and Kenya through the holding of workshops, etc. Furthermore, we will share the examples of roadmaps in Japan and the findings obtained from formulation of the roadmaps, etc. [STI]

<Reflection in Plans and Strategies of the Government>

○ In the plans and strategies of the government related to the SDGs that will be formulated and revised going forward, such as the Next Basic Plan, etc., we will ensure the “visualization” of matters concerning the SDGs and incorporate specific paths and objectives focused on Japan’s achievement of the SDGs, and we will conduct an investigation about cooperation with other countries for the world’s achievement of the SDGs. In this way, we will globally deploy beyond national borders, scale up, and aim for the global deployment of science and technology utilizing the strengths of Japan and the opening up of the international market. [All offices, ministries, and agencies]

<Investigation of a Platform for the Global Deployment of STI>

○ Keeping in mind future independent operation by the private sector, etc., we will carry out surveys and analyses and consultations with domestic and overseas stakeholders for the full-scale building and refinement of a “platform,” globally deploy Japan’s intellectual assets such as STI seeds, etc., and carry out trial demonstrations to tie them to the SDGs needs of the world. [STI, SIPSH]

○ While utilizing the said platform, we will encourage collaboration and cooperation with diverse domestic and overseas stakeholders and encourage the creation of innovation for the achievement of the SDGs.

[STI, SIPSH, MOFA, MEXT, METI, MOE]

(2) Strengthening of an International Network

○ **Future Visions to be Pursued**

- Respond to the progress of globalization of society, the economy, funds and people, ensure that Japan's universities, national research and development agencies, etc. occupy a major position in international brain circulation, and strengthen the international network in research and development and the accumulation of researchers[92]
- Due to international joint research and international collaboration with overseas universities, research institutions, etc. and the resulting increase in internationally co-authored academic papers, Japan's competitiveness will improve and the overseas deployment of technologies will accelerate
- Japan will collaborate and cooperate with the related countries and related institutions to lead the creation of international standards and rulemaking concerning ELSI, etc. for the creation of science, technology, and innovation

○ **Objectives**

- By FY2023, increase the number of Japanese teachers who have obtained doctoral degrees and have experience of research and education activities at foreign universities by 30% over the FY2017 level in universities that are thoroughly advancing globalization [Restated]
- By FY2020, expand new initiatives for enhancing opportunities for young researchers to study overseas
- By FY2023, increase the number of graduate schools that students can complete in classes in the English language only to 300 or over [Restated]
- By FY2023, make the rate of increase in the number of internationally co-authored papers among the number of adjusted top 10% papers equal to the level in Europe and the United States [Restated]

	FY2017	FY2018	(Objective) FY2023
Number of Japanese teachers who have obtained doctoral degrees and have experience of research and education activities at foreign universities	1,308	1,344	Approximately 1,700

[92] The proportion of foreign researchers in universities and national research and development agencies: universities: 5.6% and national research and development agencies: 8.8% (Survey on International Research Exchange by the Ministry of Education, Culture, Sports, Science and Technology (September 2019)).

in universities that are thoroughly advancing globalization			
	FY2015	FY2017	(Objective) FY2023
Number of graduate schools that students can complete in classes in the English language only	222	252	300 or over
	1999 → 2014	—	FY2023
Rate of increase in the number of internationally co-authored papers among the number of adjusted top 10% papers[93]	2.1-fold	—	Equal to the level in Europe and the United States

① Necessity and Importance of Strengthening International Networks in Innovation

○ Globally, cutthroat competition is unfolding in the areas of research and development and innovation. Taking into account the situation that expectations from foreign countries with respect to the outstanding research capacity of Japan have been growing in recent years, the acceleration of international collaboration is essential in basic research and in applied research.

○ On the other hand, caution and moves to strengthen management with respect to technology leakage from the perspective of security risks are emerging around the world.

○ In this context, it is necessary to strengthen international networks in order to strengthen Japan's basic research capacity and competitiveness, secure the safety and security of our nation and its citizens, promote social implementation, and contribute to global issues such as earth environmental problems. Due to this, fundamental strengthening of international collaboration in all forums, including the G7, the G20, TICAD, the United Nations, bilateral collaboration, etc., is an urgent issue in

[93] Changes in the number of internationally co-authored papers in the number of adjusted top 10% papers (rate of increase from 1998~2000 to 2013~2015 (integer count)): Japan: 2.1-fold, the United States: 2.7-fold, France: 2.7-fold, Germany: 2.9-fold, the United Kingdom: 3.1-fold, China: 14.8-fold (Calculated in the Cabinet Office (STI) based on Scientific Research Benchmarking 2017).

order to attract outstanding “human resources” and “science and technology” and “funds” from around the world, and furthermore in order to contribute to the international community in the building of a human-centered society using STI.

② Analysis of the Current Situation

The relevant offices, ministries and agencies and Japan’s universities, national research and development agencies, etc. are making efforts to strengthen the international networks through the following initiatives, etc. such as development of an international research and development hub by WPI. However, there are issues including:

- There are few Japanese teachers who have obtained doctoral degrees at foreign universities. Furthermore, there are far fewer Japanese international students than international students from China, South Korea, etc. in the United States.[94]
- The number of international students, mainly from Asian countries, being accepted into the universities, etc. of Japan is on an increasing trend, but the acceptance of outstanding international students who can be responsible for international research activities is insufficient due to the fact that the number of graduate schools in which students can study in the English language only is limited, etc. Furthermore, it is thought that the difficulty of planning career paths such as places of employment in Japan, etc. is also one factor.
- The scale of the amount and implementation status of international joint research in the universities, national research and development agencies, and funding agencies of Japan[95] is small compared to domestic joint research, so even if there are offers for appealing joint research from overseas there are cases in which they cannot be accepted. Universities, etc. have concluded many memorandums of understanding, etc. concerning international joint research, but it cannot be concluded that they are being implemented very actively.[96]

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[94] Number of foreign graduate school students in the science and engineering fields enrolled in graduate schools in the United States (2017): China (1st): approximately 80,000, India (2nd): approximately 78,000, Iran (3rd): approximately 8,000, South Korea (4th): approximately 7,000, Japan (19th) approximately 1,000. (Japanese Science and Technology Indicators 2018 published by the National Institute of Science and Technology Policy (August 2018))

[95] The main international joint research programs implemented by funds allocations institutions under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology (FY2020 budget amount)

• JST: Strategic International Collaborative Research Program (SICORP): approximately 1.1 billion yen; collaborations with about 20 countries

• AMED: Strategic International Collaborative Research Program (SICORP): approximately 300 million yen; collaborations with about seven countries

• JSPS: JSPS International Joint Research Program: approximately 500 million yen; collaborations with about five countries

[96] Number of universities and research institutions in Japan which have concluded agreements concerning research with

Furthermore, Japan is leading international rulemaking concerning AI social principles, etc., but it is necessary to expand these kinds of attempts going forward.

Moreover, when strengthening the international network, ensuring the soundness and fairness of the research ("research integrity") is important.

<Promotion of International Joint Research, Globalization of Universities, etc.>

○ In order to enhance opportunities to build up study and take on challenges overseas, the Ministry of Education, Culture, Sports, Science and Technology has encouraged the utilization of joint degrees and double degrees and has enhanced the Overseas Research Fellowships program and the Cross-border Postdoctoral Fellowship program, etc. However, it cannot be concluded that there are sufficient opportunities to study and take on challenges overseas even now.[97]

○ We have worked on the steady strengthening of international joint research, including research solicitation and adoption using the lead agency method[98] between funding agencies under the jurisdiction of the Ministry of Education, Culture, Sports, Science and Technology and the funding agencies of the United Kingdom, etc., but international joint research is still limited even now.

○ With the objective of strengthening international collaboration between industry and academia by universities, national research and development agencies, etc. and collaboration with domestic and overseas companies, the Cabinet Office (STI) has advanced the formulation of the Guidelines for universities and national R&D agencies on collaboration with foreign companies.

○ In the JST Strategic Basic Research Programs, we have been implementing joint solicitation with France in some research domains since FY2018, and in addition in FY2019 we implemented joint solicitation between Japan, Germany, and France for

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overseas universities and research institutions (including memorandums of understanding) and the number of research agreements (FY2017): 566 institutions, 25,630 research agreements (Survey on International Research Exchange by the Ministry of Education, Culture, Sports, Science and Technology (September 2019))

[97] The current status of the initiatives is as follows:
- Number of joint degree programs offered (as of April 2020): 22 (Surveyed by the Ministry of Education, Culture, Sports, Science and Technology)
- Number of double degree programs (FY2017): 1,196 (The Status of Reforms of Educational Content, etc. in Universities (FY2017) by the Ministry of Education, Culture, Sports, Science and Technology * This is the number of inter-university exchange agreements with overseas universities which include matters pertaining to double degrees)
- Overseas Research Fellowships program (number of new people to be included in the program in FY2020): about 172
- Cross-border Postdoctoral Fellowship program (number of new people to be included in the program in FY2020): about 14

[98] The lead agency method is one of the methods used in international joint research support when screening joint research proposals by researchers from two countries, which delegates the screening to the institution on one side (the institution that is leading). It is necessary for there to be an ongoing prospect of being able to provide support and for a relationship of mutual trust to be fostered, including the quality of the screening. Its introduction is being seen primarily in Europe and the United States as one simple screening method.

the purpose of supporting joint research among the top researchers in the AI field in those three countries.

<Development of International Research Hubs>

○ Regarding the development of international research hubs, the Ministry of Education, Culture, Sports, Science and Technology is implementing SGU, WPI, etc. and there are examples of it producing outstanding results. However, even now horizontal deployment is not sufficient. There is a need to encourage the horizontal deployment of those results, of course within organizations, but also within universities across departments and to other universities and research institutions, in order to strengthen administrative functions and support structures pertaining to education and research in domestic universities, etc., including the deployment of human resources possessing advanced expertise, etc.

○ In conjunction with this, it is necessary to advance systemic initiatives to increase reform incentives in universities, etc., such as appropriately and actively incorporating the perspectives of globalization and systems reforms for administrative functions and research support structures when evaluating universities, etc. and allocating resources based on the evaluations, so that the findings, know-how, etc. cultivated through these pioneering results are widely introduced to and utilized in domestic universities, etc. and their effective horizontal deployment is steadily advanced.

○ The United States, Europe, China, etc. are working on the enhancement of research and development investment and the formation of research and development hubs, etc. concerning AI, biotechnology, and quantum technologies, positioning them as important technologies in their national strategies. Japan is advancing initiatives for the formation of core hubs for the research and development of biotechnology, quantum technologies, etc.

<Leadership of International Standardization and International Rulemaking>

○ The Industrial Standardization Act stipulates that the national government, national research and development agencies, universities, business operators, etc. shall tackle the encouragement of international standardization, etc.

○ Forums such as the G20, etc. are implementing initiatives for fostering and sharing understanding of the Social Principles of Human-centric AI.

○ In the Open Science WG of the G7 Science and Technology Ministers' Meeting, Japan is leading discussions aimed at building a global open science environment.

③ Measures and Solutions for Achieving the Objectives

We will strengthen the international network in research and development for

improving the research capacity of Japan, etc., and in order to lead international collaboration concerning STI we will strongly promote the following measures concerning i) the promotion of international joint research in universities, etc. and the globalization of universities, ii) the development of international research hubs in cutting-edge research and development fields, and iii) the leadership of international standardization and international rulemaking.

<Promotion of International Joint Research, Globalization of Universities, etc.>

○ For the development of researchers with rich international perspectives and encouragement of research overseas, we will encourage the utilization of joint degrees and double degrees and the building and implementation of education exchange programs with overseas partner universities. [MEXT] [Restated]

○ We will work for the further strengthening of international joint research. Specifically, we will carry out the following initiatives.

[STI, MEXT, relevant offices, ministries, and agencies] [Restated]

- Using priority allocations, etc. of budgets, we will work for the enhancement of international joint research programs in each office and ministry.
- Furthermore, regarding the research and development expenses that mainly anticipated domestic research and development until now, we will share and store the know-how of international collaboration while expanding in stages the international joint research utilizing the said research funding.

○ We will build a portfolio for pooling the wisdom of researchers from throughout the world, and achieving the Moonshot Goals. [STI, MEXT, MAFF, METI] [Restated]

○ We will utilize the forum of the Global Smart Cities Alliance proposed and established in the G20 to promote cooperation with the cities of the world based on a common perception of free and open smart cities. [STI, MIC, METI, MLIT] [Restated]

○ In order to obtain overseas funds and encourage joint research between the universities and national research and development agencies of Japan and foreign companies while considering security trade control, etc., we will support execution of the Guidelines for universities and national R&D agencies on collaboration with foreign companies that were formulated in FY2019, and conduct investigations of revisions as necessary. [STI] [Restated]

○ Concerning big science, we will strategically promote initiatives regarding the ITER[99] plan, etc. in the thermonuclear field and large international joint research projects in the space and oceanic fields, etc. while also taking a long-term perspective, so that research and development results commensurate with the investment can be obtained.

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[99] International Thermonuclear Experimental Reactor

[STI, Space, Ocean, MEXT]

○ In order to promote initiatives for overseas deployment of the research results generated from the Field for Knowledge Integration and Innovation, we will promote information transmission to overseas universities and research institutions and collaboration through matching, etc.

[MAFF]

○ Initiatives that autonomously ensure the soundness and fairness of research (“research integrity”) will be important, so we will implement investigations and lobbying for the creation of reports, etc. so that a common understanding among research communities can be reached regarding the clarification of problems and response measures thereof.

[STI, MEXT]

<Development of International Research Hubs>

○ WPI, a project that encourages the formation of international research hubs that merge fields, also covers initiatives for high-level hubs that merge fields, including cross-sectoral domains with the humanities and social sciences. [MEXT] [Restated]

○ For the globalization of universities, etc., we will horizontally deploy the results of reforms through initiatives such as SGU and WPI, etc. within organizations and to other universities and national research and development agencies. [MEXT]

○ From FY2020 we will commence full-scale formation of the Quantum Technologies Innovation Hub (International Hub). Furthermore, we will carry out formation of an international biocommunity zone at an early stage. [STI, MIC, MEXT, MAFF, METI]

<Leadership of International Standardization and International Rulemaking>

○ Based on the Industrial Standardization Act, we will strengthen activities concerning international standardization in the national government, national research and development agencies and universities, and encourage initiatives in business operators. Specifically, the Ministry of Economy, Trade and Industry will collaborate with the relevant offices, ministries, and agencies to raise the level of standardization activities in research and development by sharing specific examples of standardization activities and techniques among national research and development agencies, for example, research and development management techniques utilizing the NEDO Standardization Management Guidelines. [METI, relevant offices, ministries and agencies]

○ We will propose international standards concerning the life cycle of AI and AI quality assurance, including the guaranteeing of data quality. [METI]

○ Under a multilateral framework built concerning AI social principles, we will lead and promote discussion concerning implementation of the principles. [STI, PPC, MIC, MOFA, MEXT, MHLW, METI]

○ We will investigate trial implementation of funding for theme establishment-type ELSI research targeting themes with a high level of social interest, such as implementation in the SIP project of ELSI research concerning encouragement of social acceptance and citizen understanding of genome editing, etc. [STI, MEXT, MHLW, MAFF, METI]

○ We will continue the discussions, covering both basic research on the use of genome modification techniques and other technologies on human fertilized embryos and the institutional framework including the legal regulations for their clinical use, in cooperation with the international society. Based on “Second Report on the revision of the ‘Basic Principles on the Handling of Human Embryos’”, we will continue the necessary discussions including basic research of genetic and congenital diseases using genome modification techniques and other technologies on human embryos created for research purposes. [STI, MEXT, MHLW]

○ For the building of an international research data infrastructure, we will take into account open-and-closed strategies while utilizing the G7 framework, etc. to carry out investigations into sharing of good practices and ensuring the mutual operability of research data, etc., and we will carry out development of the Research Data Infrastructure System incorporating the perspective of the distribution of international research data. [STI, MEXT]

CHAPTER 5: Fundamental Technologies that Should be Tackled Strategically
(1) AI Technologies

○ **Future Visions to be Pursued**

• In the process of full-scale deployment of AI in the real world, establish the following vision of the future which has the basic principles of a society in which the dignity of human beings is respected (Dignity), a society in which people from diverse backgrounds can pursue diverse forms of happiness (Diversity & Inclusion), and a sustainable society (Sustainability)

- For Japan to develop a base of human resources which, in proportion to population, leads the world in being aligned with the needs of the AI era, and to become a country that attracts human resources from around the world. In addition, to build a mechanism to achieve this objective on a sustainable basis.
- For Japan to become a frontrunner in the application of AI to real-world industry and to achieve strengthened industrial competitiveness
- For a series of technology systems to be established in Japan that will realize a "sustainable society that incorporates diversity," and to implement a mechanism to operate them
- For Japan to take a leadership role in building international research, education, and social infrastructure networks in the AI field, and to accelerate AI-related R&D, human resource development, achievement of the SDGs, etc.

○ **Objectives**

• The following goals are set keeping in mind their realization by 2025, with the aim for human resources to be active in all fields of society and for all citizens to cultivate the capability to participate in creating a sustainable society, which includes the knowledge and skills related to "Mathematics, Data Science, and AI" as the basic knowledge of the digital society (like the so-called "Reading, Writing, Abacus" basics), and the basic skills necessary to design new forms of society, products and services:

- For all senior high school graduates (approximately 1 million people/year) to acquire basic literacy in "Mathematics, Data Science, and AI". In addition, to foster creativity through the experience such as problem discovery and solving for designing new forms of society, products and services
- Cultivating human resources who understand data science/AI and can apply such understanding in their respective specialized fields (approx. 250,000 people/year)
- Identifying and training world-class human resources who can create innovations that fully exploit data science and AI (approximately 2,000 people/year, among whom approximately 100 people/year are classified as top class)
- Conducting of recurrent education for many members of society to foster mathematics, data science, and AI (approximately 1 million people/year)
- Promotion of learning opportunities for international students in fields such as data science and AI

- ***Promotion of the adoption of appealing AI research hubs as chosen by world researchers, with the AI Japan R&D Network at their core***
- ***World-leading realization of AI social implementation with ① health and medical care and nursing, ② agriculture, ③ national resilience, ④ transportation infrastructure and logistics, ⑤ vitalization of the regions (smart cities), and ⑥ "Monozukuri" (Manufacturing) as the priority fields***

① Implementation Status and Analysis of the Current Situation

○ The utilization of artificial intelligence (AI) is progressing widely in society and the United States, China, and other foreign countries have formulated national strategies concerning AI, and are engaging in fierce competition to lead the world.

○ In this context, AI brings enormous benefits to society while on the other hand we perceive that appropriate development and social implementation of AI is required because its influence is so large, so in light of the importance of being able to use AI effectively and safely so that society overall enjoys the maximum benefits from AI, Japan formulated the Social Principles of Human-centric AI (Integrated Innovation Strategy Promotion Council Decision; hereinafter referred to as the "AI Social Principles") in March 2019. Furthermore, in the G20 Osaka Summit held in June 2019 the G20 AI Principles were agreed in the form of an Annex to the Leaders' Declaration.

○ Furthermore, Japan will contribute to the solution of global scale issues taking into account the AI Social Principles and through the realization of Society 5.0, and in order to overcome the social issues of Japan itself, and moreover to improve the industrial competitiveness of Japan after that, in June 2019 Japan formulated the AI Strategy 2019 (Integrated Innovation Strategy Promotion Council decision) to disseminate "AI for Everyone: People, Industries, Regions and Governments."

○ This AI Strategy 2019 presents specific objectives concerning education reform, reconstruction of the research system, social implementation, development of data-related infrastructure, ethics, etc., and presents the measures that the national government should tackle independently, and the relevant offices, ministries and agencies, etc. are promoting their own initiatives in order to realize the said objectives.

○ However, the initiatives based on the strategy of Japan have still only just been started, and at a time when research and development and social implementation of AI is showing more and more progress in foreign countries, further strengthening of the initiatives is necessary.

○ In particular, the question of how to ensure the fairness, transparency, explainability, etc. of AI, and the conducting of an investigation regarding the forms of that response are important for influencing the degree of progress of social implementation of AI going forward.

○ We have incorporated the status of progress, etc. of the initiatives to date, including these points, to compile the AI Strategy 2019 Follow-Up in the AI strategy expert meeting in June 2020.

② Measures and Solutions for Achieving the Objectives

○ In order to achieve the above objectives, we will implement measures and solutions, including the following, in accordance with the AI Strategy 2019 and its follow-up. [All offices, ministries, and agencies]

<Education Reforms>

○ We will provide opportunities for learning to currently-employed teachers to improve their mathematics, data science, and AI literacy, and investigate and implement the introduction, etc. of mathematics, data science, and AI education-related curriculums in teacher training. [MEXT]

○ Taking into account the implementation of Information I, etc. and the establishment of mathematics, data science, and AI education program certification systems (literacy levels), we will carry out a revision of the questions in IT passport tests, etc., and encourage their utilization in high schools, KOSENs, universities, etc. [MEXT, METI]

○ When tackling across-the-board implementation of the new government curriculum guidelines, we will enhance the teacher training courses and the training of currently-employed teachers, so that programming education in elementary and intermediate schools and information subject education in high schools can be implemented reliably nationwide. [MEXT]

○ We will investigate introducing questions about Information I in the Common Test for University Admissions from FY2024, and anticipating that conclusions will be drawn during FY2021, etc., we will urgently investigate and implement nationwide support measures such as securing high-quality teachers, including the training of specialist teachers in high schools and the utilization of external human resources. [MEXT, METI]

○ Keeping in mind connections with mathematics and data science education in universities, etc., we will create teaching materials to provide instruction primarily to pupils who go on to further studies at universities, etc., so that the knowledge that forms the basis of probability, statistics, linear algebra, etc. can be mastered at the high school stage. [MEXT, METI]

○ We will promote vocational training for acquiring the ability to understand and utilize IT. [MHLW, METI]

○ We will advance learning logs that save the records of the study and projects of pupils inside and outside schools and standardization and utilization enabling continuous data exchange and analysis regarding state of health, etc. of a pupil regardless of whether the pupil transfers schools or goes on to further studies, etc., and accelerate the presentation of basic policies about the development of an ICT environment based on cloud utilization, personal information protection, etc.
[Cabinet Secretariat, PPC, MIC, MEXT, METI]

○ In the environment realized by the GIGA school project, we will develop an

environment to create opportunities for as many pupils as possible to utilize ICT and EdTech and to learn the knowledge, skills, thinking ability, judgment ability, expressive ability, etc. that are necessary in the real world. [Cabinet Secretariat, MIC, MEXT, METI]

○ For realization of the GIGA school project, we will advance optical fiber development in regions with schools in which optical fiber has not been developed. [MIC]

○ We will carry out environment development through fundamental expansion of universities adopting Information I in their entrance exams in all academic fields, such as humanities, sciences, etc., and through prioritization of the private school subsidies for that expansion. [MEXT]

○ We will ensure an environment in which all students of universities and KOSENs can take mathematics, data science, and AI education programs with an outstanding literacy level (including enhancement of the utilization of MOOC and the Open University of Japan, etc.). [MEXT]

○ We will provide active support through the prioritization of operation grants and private school subsidies, etc. for universities and KOSENs taking into account the status, etc. of initiatives such as introducing mathematics, data science, and AI education into the curriculum, etc. [MEXT]

○ We will develop an environment in which students can experience learning and study at the applied basic level of mathematics, data science, and AI in their own specialized fields in all academic fields, such as humanities, sciences, etc. (including development of a model curriculum and teaching materials at the applied basic level, utilization and enhancement of MOOC including utilization of the excellent teaching materials of foreign countries, and utilization of systems under which students can obtain degrees such as double majors in AI and a specialized field, etc.) [MEXT]

○ We will work on the investigation, implementation, and global deployment of issue solution-type AI human resources development systems, centered on PBL, which apply mathematics, data science, and AI to discover and solve problems. [METI]

○ We will build specialist teacher training systems for the science of statistics, etc., including data analysis, in order to support mathematics, data science, and AI education. [MEXT]

○ We will start operation of a system under which the government certifies the mathematics, data science, and AI education recognized as graduation credits of universities and colleges of technology that consists of education programs with an outstanding literacy level, and we will investigate the forms of certification of the applied basic level.

[STI, MEXT, METI]

○ We will investigate and implement measures for encouragement of collaboration and cooperation by the industrial world so that the certification systems for the mathematics, data science, and AI education programs of universities and KOSENs are operated and disseminated as systems that contribute to the industrial world. [METI]

○ We will build an online library on the theme of global social issues and consisting of STEAM education content from collaboration between industry and academia. [MEXT, METI]

○ We will promote the enhancement of applied basic education for regional hub human resources using public tests and national research and development agencies, etc. and the expansion of recurrent education for members of society responsible for the regions with the said human resources at its core. [MIC, MEXT, MAFF, METI]

<Research and Development>

○ We will implement enhancement of institutions participating in the AI Japan R&D Network, the encouragement of unified information transmission, and the promotion, etc. of international collaboration. [STI, MIC, MEXT, METI]

○ Centered on the AI Japan R&D Network, we will investigate and implement the securing and development of high-quality researchers who will lead the world, the encouragement of international student exchanges, the expansion of opportunities for young researchers to take on overseas challenges, and measures to pool the wisdom of researchers around the world. [STI, MIC, MEXT, METI]

○ We will strengthen the secretariat functions of the AI Japan R&D Network. [METI]

○ We will promote innovative, fundamental, and merged research and development of AI, and in order to realize the technologies and systems that guarantee the explainability, safety, fairness, etc. necessary for utilizing research results in society rapidly, we will promote research and development merging humanities and social sciences with mathematics and information science, such as research and development and ethics, etc. concerning fundamental technologies for ensuring the evolution and reliability of AI going forward. [STI, MIC, MEXT, METI]

○ We will build a framework to share the latest domestic and overseas trends in research and development into the trust of AI and hold discussions by knowledgeable persons in order to investigate the direction of initiatives concerning research and development into the trust of AI that Japan should work towards. [STI, MIC, MEXT, METI]

○ We will start the shared use of the Fugaku supercomputer early, during FY2021, carry out initiatives pertaining to encouragement of its use in universities, national research and development agencies, and the industrial world, and promote the solution of social and scientific issues and the strengthening of industrial competitiveness, etc. through further encouragement of the merging, etc. of data science and computational science. [MEXT]

○ For the creation of AI research hubs at the world's top level, we will upgrade the computer equipment, etc. possessed by the National Institute of Advanced Industrial Science and Technology, etc. [MIC, MEXT, METI]

<Social Implementation, etc.>

○ With the objectives of improving the level of medical care and nursing and improving

the working environment of the relevant professionals, we will accelerate the development and social implementation of AI technology through the design of a cross-sectional information infrastructure for the health, medical care, and nursing fields, collection of a full range of data, building of an AI data infrastructure, development of medical equipment and technologies for the early detection and diagnosis of diseases utilizing AI, and promotion of AI education.

[Cabinet Secretariat, MEXT, MHLW, METI]

○ We will clarify the agricultural management advantages of smart agriculture utilizing cutting-edge technologies such as AI, etc. and accelerate its demonstration and implementation. [MAFF]

○ We will develop a trusted network by developing a 5G network utilizing traffic lights, for the utilization of traffic lights as a trust information hub.

[Cabinet Secretariat, NPA, MIC]

○ We will advance the building of data infrastructure and the utilization of AI technologies, etc. in the infrastructure, transportation and logistics, and marine and oceanic fields, and we will advance the building of synthetic data infrastructure for our national territory and transportation that recreates events in the real world in cyberspace, through data exchange with other fields.

[STI, MLIT]

○ We will gather and analyze data about energy consumption, and use a combination of behavioral insights such as nudge and boost, etc. and cutting-edge technologies such as AI/IoT, etc. (BI-Tech) to feedback personalized messages to each individual to encourage energy-saving behavior. [MOE]

○ We will support the capital investment necessary for the innovative services development and production process improvements, etc. carried out by small and medium companies, etc., research and development for upgrading “Monozukuri” (Manufacturing) fundamental technologies, and projects that aim to share data and information to newly improve added value. [METI]

○ We will support the handing down and efficient utilization of the tacit knowledge accumulated in “Monozukuri” (Manufacturing) worksites (experience and intuition) in order to implement the development of AI technologies that improve productivity and the development of data infrastructure systems which carry out the automatic handling, processing, analysis, and management of large volumes of data for use in materials and informatics. [METI]

<Development of Data-Related Infrastructure>

○ We will work to upgrade and ensure the safety and reliability of the network infrastructure for the utilization of AI, through quality confirmation and assurance for the gathered data, the building of trust data exchange platforms, and nationwide development of 5G and optical fiber, etc. [Cabinet Secretariat, STI, MIC, MEXT, METI]

○ We will propose international standards concerning the life cycle of AI and AI quality assurance, including the guaranteeing of data quality. [METI] [Restated]

<Digital Government>

○ In administrative institutions, we will deploy staff who have expertise in data science, the science of statistics, and AI, and encourage data gathering and analysis and AI applications while at the same time vesting them with the authority to be able to guarantee data integrity. [Cabinet Secretariat, MIC]

○ We will carry out the standardization of AI services that local governments can use with security and the implementation of AI and RPA[100] in local government administration, and build a platform to enable multiple small and medium-scale local governments to jointly introduce AI while keeping down costs. [Cabinet Secretariat, MIC]

<Ethics>

○ Under a multilateral framework built concerning AI Social Principles, we will lead and promote discussion concerning implementation of the principles. [STI, PPC, MIC, MOFA, MEXT, MHLW, METI] [Restated]

○ For the implementation of AI Social Principles, we will anticipate domestic and overseas trends while investigating the strengthening of the industrial competitiveness of Japan and the forms of AI governance, such as regulations, standardization, guidelines, audits, etc. that contribute to the improvement of the social acceptance of AI. [STI, MIC, METI]

[100] Robotic Process Automation

(2) Biotechnology

○ **Future Visions to be Pursued**

• In order to realize Society 5.0 through sustainable production and recycling, think about what can be done with bio, realize a society that can initiate action, and form appealing communities of the type that become a catalyst for global data, human resources, investment, and research based on international collaboration, the merging of fields, and open innovation

• Realize the world's most advanced bioeconomy and society by making the bio-digital integration the entire foundation and building a data infrastructure, including the conversion of biological activities into data, etc., and fully utilizing that infrastructure to develop industries and research

○ **Objectives**

<Overall Objective>

• Realizing the world's most advanced bioeconomy and society by 2030

<Introduction of Data Infrastructure and AI and Formation of a Biocommunity>

• ***Formulation of the Guidelines concerning Biodata Exchange and Utilization (provisional name) in FY2022***

• ***Formation of the world's most advanced global biocommunity and regional biocommunities in 2030***

① Implementation Status and Analysis of the Current Situation

○ As the first phase of a comprehensive policy package with the objective of "realizing the world's most advanced bioeconomy and society by 2030," we formulated Bio Strategy 2019 in June 2019, which presented the grand design for the formulation of a market domain roadmap, the merging of bio and digital, the formation of a biocommunity, etc.

○ Subsequently, political interest in the bioeconomy increased more and more throughout the world. For example, in the United States, the White House hosted the Bioeconomy Summit and an investigation of health and medical care, ICT, agriculture, industry, security, etc. was carried out by industry, academia, and government, and in Germany a new bioeconomy strategy was formulated.

○ In Japan, we will obtain the participation of many industrial organizations, companies, etc. to advance investigations for a market domain roadmap and formation of a biocommunity, and we invested approximately 6.2 billion yen of the FY2019 government budget to advance the demonstration and investigation of data exchange utilizing SIP and PRISM and the development of technologies for the demonstration of biomanufacturing, etc.

○ On the other hand, the spread of infection by the novel coronavirus disease is having an enormous impact on economic and social activities, including a rapid economic

slowdown, supply constraints due to the severing of the supply chain, etc., so it is necessary for the market domain roadmap that we planned to formulate at the end of the previous fiscal year to take into account the impact of this, and promotion of the bioeconomy is growing in importance both for the response for bringing the infectious disease under control and for a rapid economic recovery after it is brought under control.

○ Taking into account this situation, and anticipating the responses such as research and development, etc. for bringing the spread of the infectious disease under control that should be tackled immediately, and the rapid economic recovery after the infectious disease is brought under control, we compiled the fundamental measures that should be tackled without delay in accordance with Bio Strategy 2019 to formulate Bio Strategy 2020 (Fundamental Measures) in June 2020.

○ Regarding the measures overall taking into account the market domain roadmap, after taking into account this change in the situation, we decided to respond by formulating Bio Strategy 2020 (the final version of the market domain measures) by about winter 2020.

○ Note that the response as a biostrategy for research and development, etc. that should be tackled immediately for bringing the spread of the infectious disease under control is included in the measures in PART II.

② Measures and Solutions for Achieving the Objectives

○ In order to achieve the above objectives, we will implement measures and solutions, including the following, in accordance with the Bio Strategy. [All offices, ministries, and agencies]

<Initiatives in the Market Domain>

○ Taking into account the recent economic and social situation, we will formulate the market domain roadmap, including the 2030 market-scale objectives, by about the winter of 2020. [Cabinet Secretariat, STI, CAA, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ Regarding bio-derived products that contribute to alleviating the environmental load, and the bio-related analysis, measurement, and experiment systems that form the infrastructure of all bioindustries, we will promote the following initiatives as fundamental measures in order to capture domestic and overseas markets.[101] [STI, MAFF, METI, MOE]

[101] We will promote them coordinated with the Roadmap for the Introduction of Bioplastics which we plan to formulate based on the Resource Circulation Strategy for Plastics.

- We will gather the needs of the industrial world and develop domestic and overseas data gathering and a big data utilization platform for a recycling society.
- In the global biocommunity candidate regions,[102] from FY2021 we will start full-scale support for development of a biomanufacturing demonstration and human resources development hub that develops genetic modification technologies and innovative biomanufacturing technologies in an integrated manner that is led by the private sector and achieved through collaboration between industry and academia.
- In order to encourage the switch to bio-derived products that contribute to alleviating the environmental load of “Monozukuri” (Manufacturing), we will provide support for funds procurement using green bonds, etc. and provide support for capital investment.
- Regarding bio-related analysis, measurement, and experiment systems, during FY2020 we will start investigations for the formation of a consortium that clarifies the development hub.
- In order to encourage fully domestic production of bio-derived products, we will promote consistent research and development from the supply of raw materials through to the manufacturing process and creation of products.
- We will implement strengthening taking into account the market situation, etc., such as the criteria, etc. for making judgments concerning the blending ratio of the biomass materials in the designated procurement items of the Green Purchase Act.
- We will carry out investigations aimed at the introduction in the middle of the 2020s of labels for bio-derived products that alleviate the environmental load, and investigations of demand stimulus measures pertaining to bio-derived products with reference to the Green Purchase Act, etc.[103]
- In order to encourage expansion of the use of bioplastics in bags for combustible trash, we will formulate guidelines to encourage the introduction of bioplastics for municipalities, and we will also add a statement related to bioplastics to the Handbook on the Introduction of Charges for General Waste Disposal by about FY2020.
- We will aim for an international standardization proposal for evaluation of marine biodegradable plastics at the beginning of the 2020s in order to support the development of evaluation techniques.
- We will collaborate with the Intellectual Infrastructure Development Plan to promote the development and enhancement of domestic biological resources, and the development of safety management structures and improvement of safety

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[102] The Tokyo zone and the Kansai zone. Refer to Bio Strategy 2020 (Fundamental Measures).

[103] For example, Europe has excluded products containing a certain proportion of bio-derived plastic from the disposable plastic regulations and the United States has introduced demand stimulus measures under the BioPreferred Program; namely, labels for bio-derived products and imposition of a public procurement obligation on the federal government, etc. to procure products that have received that label.

management technologies for contaminating microorganisms, etc. at the time of product manufacturing.

○ Regarding sustainable primary production systems that contribute to the stable supply of food, alleviation of the environmental load, etc., we will promote the following initiatives as fundamental measures in order to capture domestic and overseas markets.

[STI, MAFF]

- We will develop a smart breeding platform utilizing breeding big data infrastructure and AI with the aim of test operation by about 2023.
- We will promote enhancement of the soil-related database and soil microorganisms-related research with the aim of starting provision of soil-related data through data exchange platforms by about 2023.
- We will promote the acceleration of the development of high-added-value cultured varieties, smart farming, and the development of innovative farming feed through the encouragement, etc. of data exchange in the fisheries field.
- We will build a joint private-public agricultural biohub to be the hub for development, etc. of sustainable primary production systems.
- We will promote the protection of intellectual property and genetic resources through measures for the prevention of unfair overseas leakages of genetic resources based on the revision of the Plant Variety Protection and Seed Act and the post-revision Act on Improvement and Increased Production of Livestock and Act on the Prevention of Unfair Competition pertaining to Livestock Genetic Resources.

○ Regarding industries related to biopharmaceuticals, regenerative medicine, etc. such as lifestyle modification health care, etc., we will promote the following initiatives as fundamental measures in order to capture domestic and overseas markets.

[Cabinet Secretariat, OSSTNS, STI, CAA, MIC, MEXT, MHLW, MAFF, METI, MOE]

- Regarding matters for the promotion of PHRs[104] such as the computerization, etc. of data pertaining to health checkups and medical examinations, we will advance discussions in an investigative commission comprising knowledgeable persons in order to investigate the forms, etc. of the rules necessary for API collaboration and private sector business operators.
- The implementing entity, such as the healthy cohort, etc. collaborate to verify sufficient scale, etc. as infrastructure to support international competitiveness while aiming to take steps to build a large-scale healthy cohort and biobank.[105] Regarding the

[104] Personal Health Records

[105] Regarding the scale, the recommendation “For the Implementation of a Cohort Study of the Genomes of One Million People” (July 26, 2013 Science Council of Japan) stipulates “establishment in one million people enabling the identification of the causes of many serious diseases based on the current disease onset rate in Japan,” the United States is aiming for the participation of more than one million people, and the United Kingdom announced in 2018 that it will carry out genome analyses of five million people over the next five years.

disease cohort, we will investigate utilization of a control group while incorporating whole-genome analysis, etc. to accelerate and strengthen those initiatives to promote comparative analyses with the healthy cohort, etc.

- We will develop the results of the Tohoku Medical Megabank Project, the basis of the genomic data infrastructure that is important as personalized health care infrastructure.
- We will utilize SIP and PRISM to demonstrate results creation examples through data exchange by about FY2021.
- Industry, academia, and government will collaborate to investigate and implement the initiatives necessary for development of the international development and manufacturing demonstration hubs agglomerated domestically and from overseas, including industries related to the CRO,[106] the CDMO,[107] etc. which support the supply chain of development, manufacturing, etc., and for development, etc. of data utilization infrastructure for research and development.
- Concerning the genetic testing business for consumers, in FY2020 we will develop a guidance compiling the matters with which consumer-facing business operators should comply.
- We will implement the necessary initiatives for technology development, standards infrastructure, etc., that contribute to the realization of medical treatments and health care using microbiomes.
- We will advance the accumulation of findings about foods with function claims, etc. in order to realize new labels in public health applications through improvement, etc. of immune functioning.

○ Regarding large architecture that utilizes timber and smart forestry, we will promote the following initiatives as fundamental measures in order to capture domestic and overseas markets. [MAFF, MLIT]

- We will promote smart forestry, including encouragement of the introduction of forest clouds compatible with standard specifications, ICT production management systems, etc.
- We will promote architecture demonstration, human resources development, etc. through pioneering architecture, etc. using CLT,[108] etc. for the dissemination of large architecture utilizing timber.
- We will implement the development, etc. of standard techniques for design and construction and stable supply structures for wooden building materials with reliable quality and performance, aiming for realization by about 2024.

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[106] Contract Research Organization
[107] Contract Development and Manufacturing Organization
[108] Cross-Laminated-Timber

- We will promote the development of design and construction technologies for buildings with mixed structures and design criteria for mid-to-high-rise buildings with laminated timber structures, etc.
- We will develop and disseminate fire-resistant wooden members and high-endurance, high-durability members, etc.
- We will gather information such as the laws, regulations, standards, etc. in the export destination countries.

<Merging of Bio and Digital (Building of Data Infrastructure)>

○ Regarding the Guidelines concerning Biodata Exchange and Utilization (provisional name), we will compile the interim version by the middle of 2021, and formulate it during FY2022 while giving demonstrations based on the interim version.
[Cabinet Secretariat, STI, MEXT, MHLW, MAFF, METI, MOE]

○ Regarding health, medical care, and nursing information, we will promote its utilization as big data, including interlinked analyses[109] of the public database. [Cabinet Secretariat, STI, MEXT, MHLW, METI]

<Encouragement of Formation of and Investment in a Biocommunity>

○ We will conduct a prior survey and take into account its content, etc. to certify a global biocommunity[110] (about two regions) and regional biocommunities (several cities) (trial operation in 2021 and full-scale operation in 2022), and by FY2030 the related ministries and agencies will collaborate to strengthen the collaboration of the related ministries and agencies, including for funding support such as loans, etc., regulatory reforms, commercialization support, domestic and overseas information transmission, etc. while also offering the comprehensive support[111] necessary for the priming of private investment, and compiling and announcing the implementation status of the support.
[Cabinet Secretariat, STI, MEXT, MHLW, MAFF, METI, MOE]

<Research and Development and Human Resources>

○ We will back-cast from the development of market domains to promote steady research and development in accordance with the formulated market domain roadmap for the fields in which innovation due to the utilization of biotechnology is particularly expected.[112] [Cabinet Secretariat, STI, MEXT, MHLW, MAFF, METI, MOE]

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[109] We will investigate their necessity and start with realization of analyses for which the legal and technical issues can be solved.
[110] This indicates the “international biocommunity zone” in the Integrated Innovation Strategy 2019.
[111] Promoted while strengthening the collaboration of the existing related measures.
[112] The quantum technologies field, the nanotechnology and materials field, the environment and energy field, the breeding field, and the biological function use and synthetic biology field.

○ Regarding the bio data scientists responsible for the merging of bio and digital, by FY2021 we will build structures to establish the visions of the human resources that are necessary and the development objectives in accordance with those visions of human resources [113] and to train the human resources in biomanufacturing demonstration and human resources development hubs, etc. [STI, MEXT, METI]

<Utilization of Data, Intellectual Property, and Genetic Resources[114]>

○ We will investigate the full range of data that should be accumulated domestically, in particular the human genome (its nature, scope, etc.) and compile the results by about FY2020.

[Cabinet Secretariat, STI, PPC, MEXT, MHLW]

○ From the perspective of the growth of the market domain, we will carry out an investigation about the forms of strategic utilization and protection of data, intellectual property, and genetic resources, and compile measures by about FY2020.

[Cabinet Secretariat, STI, SIPSH, MEXT, MHLW, MAFF, METI, MLIT, MOE]

○ Regarding the handling of intellectual property in collaboration between industry and academia taking into account the characteristics of biofields, we will establish a forum for investigation in industry, academia, and government during FY2020. [STI, SIPSH, MEXT, METI]

<Response to ELSI>

○ We will investigate trial implementation of funding for theme establishment-type ELSI research targeting themes with a high level of social interest, such as implementation in the SIP project of ELSI research concerning encouragement of social acceptance and citizen understanding of genome editing, etc. [STI, MEXT, MHLW, MAFF, METI] [Restated]

○ We will continue the discussions, covering both basic research on the use of genome modification techniques and other technologies on human fertilized embryos and the institutional framework including the legal regulations for their clinical use, in cooperation with the international society. Based on “Second Report on the revision of the ‘Basic Principles on the Handling of Human Embryos’”, we will continue the necessary discussions including basic research of genetic and congenital diseases using genome modification techniques and other technologies on human embryos created for research purposes. [STI, MEXT, MHLW] [Restated]

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[113] After ascertaining and taking into account the supply and demand balance of the anticipated human resources, we will establish a scale of the number of people that is deemed necessary in accordance with the respective visions of human resources.

[114] In the definition of the Intellectual Property Basic Act, data and genetic resources are included in intellectual property, but they are listed in light of their importance.

○ We will ensure the implementation of proper animal experiments, etc. in accordance with the basic guidelines, etc. about animal experiments, etc.

[FSC, NPA, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]

<Control Tower Functions of the Strategy>

○ We will obtain the participation of the industrial world, universities, etc. to carry out in an integrated manner implementation and follow-up of the strategies such as the following initiatives, etc., based on domestic and overseas situation analyses. [All offices, ministries, and agencies]

- We will evaluate the quantitative objectives and qualitative objectives and investigate solutions taking into account that evaluation
- Follow-up and revisions of the market domain roadmap
- Establishment and revisions of the certification requirements, etc. for the biocommunity
- Formulation and revisions of the necessary guidelines

(3) Quantum Technologies

○ **Future Visions to be Pursued**

- ***Through the utilization of quantum technologies, realize dramatic innovations in realization of a productivity revolution, realization of a healthy and long-lived society, and securing of the safety and security of our nation and its citizens, the three visions of society for which Japan should aim***

○ **Objectives**

<Promotion of the Quantum Technology Innovation Strategy>

- ***After clearly establishing a vision of the future society made possible by quantum technologies, deploy strategic initiatives with a strong national commitment through collaboration and cooperation between the government, academia, and the industrial world and based on the Quantum Technology Innovation Strategy which paints the broader picture for the nation overall***

<Technology Development, Hub Development, etc.>

- ***Give priority to the strengthening and promotion of research and development, etc. in important technological domains that will be key for the realization of the vision of society (from FY2020)***
- ***For the fundamental strengthening of international competitiveness, commence full-scale formation of an international research and development hub comprising industry, academia, and government, the Quantum Technologies Innovation Hub (International Hub), etc. (sequentially from FY2020)***
- ***Regarding cutting-edge quantum technologies over which there is fierce international competition, encourage the strategic acquisition of rights and utilization of intellectual property based on open-and-closed strategies, and promote strategic international standardization, etc.***

<International Cooperation>

- Newly develop and build government-level multilateral and bilateral cooperation frameworks concerning quantum technologies, centered on Europe and the United States (by about FY2024)

<Developing and Securing Human Resources>

- ***Form a human resources development hub for quantum technologies (from FY2020) and develop and utilize a common education program in order to develop and strengthen high-level human resources for quantum technologies***

① Necessity and Importance of Quantum Technologies in Innovation

○ Currently, we are in the middle of a global paradigm shift in economic and social structures, and at a time when AI and data exchange platforms are extremely important for the switch to a knowledge-intensive economy and society, quantum technologies are being positioned as the fundamental technologies which are the key to that switch.

○ For example, expectations are rising of quantum computers and quantum measurement and sensing, quantum communications and cryptography, quantum materials and other quantum technologies as technological systems that will bring about dramatic innovations in realization of a productivity revolution in Japan, realization of a healthy and long-lived society, and in securing the safety and security of our nation and its citizens.

○ For this reason, it is necessary and essential for the national government to anticipate future changes in industries and business structures, etc. and then implement strategic and comprehensive initiatives from the medium- to long-term perspective of 10–20 years, keeping in mind industries and innovation, for the realization of the vision of society for which Japan should aim.

② Recognition of the Current Situation

○ Foreign countries, particularly the United States, European countries, and China, are positioning quantum technologies as important technologies in their national strategies for bringing about future transformations of their economies and societies, and they are rapidly deploying strategic initiatives for the formulation of national strategies, the enhancement of research and development investment, and hub formation, etc.

○ Japan has accumulated basic research over many years and has outstanding research results, but it does not have a medium- to long-term strategy by the nation overall concerning quantum technologies or any research and development hubs, etc. visible to the world; Japan has not progressed beyond the relevant offices, ministries, and agencies and companies carrying out initiatives for research and development, etc. individually. Therefore, Japan clearly established a vision of the future society made possible by quantum technologies in order to compete with the best in foreign countries in the development of quantum technologies while securing the future growth of our nation and safety and security of our nation and its citizens, and then newly formulated the Quantum Technology Innovation Strategy in January 2020 as the first national strategy which paints the broader picture for the nation overall.

③ Measures and Solutions for Achieving the Objectives

<Promotion of the Quantum Technology Innovation Strategy>

○ Based on the Quantum Technology Innovation Strategy, we will strongly promote comprehensive and strategic initiatives concerning quantum technologies innovation with a strong national commitment.
[Cabinet Secretariat, STI, SIPSH, Space, Ocean, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOD]

<Technology Development, Hub Development, etc.>

○ Based on the Quantum Technology Innovation Strategy, from FY2020 we will commence full-scale formation of the Quantum Technologies Innovation Hub (International Hub) for industry, academia, and government to tackle a full range of tasks from basic research to technology demonstrations, open innovation, intellectual property management, and human resources development, etc. Regarding the said hub, in addition to the utilization of a variety of support, we will develop measures to attract investment from domestic and overseas companies, etc. [STI, MIC, MEXT, METI]

○ We will promote and enhance priority support for the major technology domains (in particular the priority technical issues) and domains merging quantum technologies and innovation established in the Quantum Technology Innovation Strategy, through research and development projects, etc. using industry, academia, and government collaboration and based on the respective roadmaps, etc. Furthermore, from a medium- to long-term perspective, we will promote funding and research institution initiatives with respect to basic fundamental research. [STI, MIC, MEXT, METI]

○ We will promote research and development of the related technologies and peripheral technologies that support quantum technologies such as microstructural analysis and microfabrication technologies, light wave control and optical device technologies, semiconductor technologies, cooling technologies such as dilution refrigerators, etc., cryogenic electronics, analysis and evaluation technologies, high-density mounting technologies, etc., and we will promote the development and sharing of infrastructure facilities and equipment, etc. for the advanced instruments, etc. that realize those technologies. [STI, MIC, MEXT, METI]

○ We will promote matching of the seeds pertaining to promising quantum technologies possessed by universities, research institutions, etc. with the needs of companies and ventures, etc., and encourage commercialization and bridge-building, etc. in universities and companies, etc.
[STI, MIC, MEXT, METI]

○ Regarding the results, etc. of research and development concerning quantum technologies in universities, research institutions, etc., we will encourage flexible

acquisition of rights and utilization, etc., including the related technologies, based on open-and-closed strategies. [STI, SIPSH, MIC, MEXT, METI]

○ We will collaborate with universities, research institutions, etc. to specify the quantum technology domains in which Japan possesses strengths and big economic ripple effects, etc. are expected, and support the acquisition of integrated international standards from the research and development stage. [STI, SIPSH, MIC, MEXT, METI]

<International Cooperation>

○ Based on our order of priorities, sequentially from FY2020 we will develop and build multitiered multilateral and bilateral cooperation frameworks concerning quantum technologies, centered on the United States and European countries, between the governments and research institutions, etc. [STI, MIC, MOFA, MEXT, METI]

○ The governments and research institutions, etc. will promote the development of joint funding mechanisms and holding of joint symposiums for international joint research with the United States and European countries, etc.

[Cabinet Secretariat, STI, MIC, MOFA, MEXT, METI]

<Developing and Securing Human Resources>

○ We will investigate roadmaps, etc. for strategically developing and securing researchers and technicians in the field of quantum technologies, and support the development and securing of human resources in universities, etc. [STI, MIC, MEXT, METI]

○ We will collaborate and cooperate with universities, inter-university research institutes, etc. to develop a human resources development hub related to quantum technologies from FY2020, and we will develop a systematic and common education program and encourage its utilization and implementation in undergraduate and graduate school education, etc. in each university. [STI, MIC, MEXT, METI]

○ We will enhance math and science education such as mathematics, physics, etc. in high schools, KOSENs, etc., and we will promote the provision, etc. of opportunities to learn about cutting-edge research related to quantum technologies.

[STI, MIC, MEXT, METI]

(4) Materials

○ Future Visions to be Pursued

- ***Strengthen Japan's ability to create materials innovation, its "materials innovation capacity," and ensure that Japan becomes***
  - ***"a country that drives forward industries using materials and exercises leadership in the world;"***
  - ***"a country that attracts outstanding researchers from around the world through the appeal of its materials;" and***
  - ***"a country that can use materials to generate new value and industries and contribute to the world."***
- ***Specifically,***

  — Ensure that the materials companies of Japan acquire a high level of competitiveness and reliability in the international market, expand the scale of exports of materials products, and improve the international competitiveness of Japan's user companies which use those materials products

  — Create a global research and innovation hub which gathers together outstanding domestic and overseas researchers, and improve the research capacity and secure outstanding human resources in the materials-related fields

  — Ensure that knowledge of materials is implemented with a high probability and a sense of urgency to accelerate the realization of the important government strategies of AI, bio, quantum technologies, and the environment, and to contribute to the solution of important issues domestically and overseas, and ensure that new value, research domains, and industrial domains are created from materials originating from Japan
- ***In the context of the digital revolution, and furthermore in the context that the world is aiming to build resilient societies and industries going forward, Japan will acquire world leadership by accelerating the digital transformation (DX) of materials research and development and by carrying out the world-leading establishment and presentation of the "Japan model" of data utilization from the materials domain***

○ Objectives

<Strategy Formulation>

- ***Formulate a government strategy for strengthening "materials innovation capacity" under a common vision with the related people in industry, academia, and government***

<Realization of the Data-Based Materials DX Platform (Provisional Name)>

- ***For the realization of an industry, academia, and government platform that greatly strengthens materials research and development capacity and creates,***

shares, stores, distributes, and utilizes high-quality materials data sustainably and effectively throughout Japan, conceive and promote the platform through cooperation with industry, academia, and government

<Strategic Promotion of Important Technologies and Implementation Domains>

- ***Clarify the social implementation domains in which materials bring about big value (realization of an Eco-Society 5.0 driven by ultra-low power consumption, substantial switch from a country dependent on overseas resources to a resources-producing country, etc.) and the important technology domains for realizing these, and then strategically promote research and development through cooperation by industry, academia, and government***

① Implementation Status and Analysis of the Current Situation

○ The merging of virtual and real and digital and materials innovation are essential for the realization of Society 5.0, but in recent years in the context of global business centered on “Kotozukuri” (Value Creation), the necessity of following digital innovation with materials innovation has been indicated in particular.

○ Materials innovation is decisively important for the solution of social issues, such as the strengthening of advanced technology fields such as AI, bio, quantum, etc., achievement of the SDGs, achievement of the long-term objectives of the Paris Agreement, overcoming of resources and environmental constraints, and realization of a safe and secure society and a healthy and long-lived society.

○ In recent years, big changes have occurred in the global materials supply chain as a consequence of trade friction between the United States and China and other factors, and the risk of breakdowns in the supply chain as a consequence of global outbreaks of the novel coronavirus disease, etc. has emerged. Materials innovation is required for alleviating Japan’s risks from the perspective of economic security.

○ The development of AI and big data greatly changes materials research and development techniques, and initiatives aiming to shorten the period and lower the costs of research and development are progressing globally. If Japan, which possesses the good-quality materials data of industry, academia, and government, is able to get a head start in building a mechanism that can strategically gather and utilize data to realize overwhelming productivity improvements and new value creation, then it is possible that Japan will greatly lead the industries and innovation of the world based on materials. As a consequence of the occurrence and spread of the novel coronavirus disease, the activities pertaining to materials research and development of industry, academia, and government have stagnated while on the other hand changes in the values and forms of behavior of people are appearing, so there is an opportunity to quickly accelerate the digital transformation (DX) of research and

development worksites.

○ Materials is a technology domain which possesses great strength in Japan, so it can be said that the current situation, in which the importance of materials is growing, is a big opportunity. On the other hand, that strength is being lost. The main situation regarding Japan's strengths and issues in the field of materials can be summarized as follows from the three perspectives of "industries," "the foundation," and "merging."

(i) Perspective of Industries

- Together with automobiles, materials are an essential export industry of Japan,[115] which has many materials products which account for more than a half share of the world market. The strength of the integral-type materials industry has become a lifeline for the industrial competitiveness of Japan.
- Japan is losing market share for combination-type products such as batteries, etc. and markets are being taken away in cases in which materials invented in Japan can be imitated easily, or open-and-closed strategies are not sufficient, etc. Innovation ecosystems tailored to diversifying and shortening user needs have not been built sufficiently; for example, the growth of materials-type ventures has been low compared to other domains.[116]

(ii) Perspective of the Foundation

- The materials-related fields drive forward the academic paper production of Japan overall,[117] and research hubs and high-quality researchers that can compete with the world exist in Japan. The existence of research facilities and equipment at the highest level in the world and high-quality materials data has also become a big strength of Japan.
- Over the last ten years, the number of papers in materials-related fields has seen a large fall in international share from both qualitative and quantitative perspectives.[118] Concerns about a lack of young human resources exists at research worksites such as universities, etc.

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[115] Japan's total exports in 2018 were approximately 81 trillion yen and industrial materials accounted for approximately 22% (approximately 18 trillion yen) of those exports (Trade Statistics of Japan from the Ministry of Finance)

[116] The number of ventures originating from universities in natural science fields such as chemistry, materials, etc. is 178 in FY2016, 209 in FY2017, and 216 in FY2018 (Surveyed by the Ministry of Economy, Trade and Industry)

[117] Of the academic papers in the natural science fields recorded in Clarivate Analytics' Web of Science (2015-2017 average, fractional counting method), academic papers in the chemistry and materials science fields accounted for approximately 21% of the total number of papers, approximately 22% of the number of adjusted top 10% papers, and approximately 28% of the number of adjusted top 1% papers (Surveyed by the National Institute of Science and Technology Policy)

[118] Comparing Japan's number of papers from 2005 to 2007 and Japan's number of papers from 2015 to 2017, as recorded in Clarivate Analytics' Web of Science (both using the fractional counting method), the total number of papers, the number of adjusted top 10% papers, and the number of adjusted top 1% papers have all declined in both the chemical field and the materials science field and their international share has also greatly declined (Surveyed by the National Institute of Science and Technology Policy)

(iii) Perspective of Merging

- In the materials-related fields, the relationships between industry, academia, and government are closer compared to other fields, and opportunities are being provided for doctoral degree holders to be active in companies. As represented by lithium-ion batteries, blue LEDs, and neodymium magnets, materials originating from Japan have driven forward many social transformations to date and have been highly evaluated by the world.
- In comparison to foreign countries, in Japan the opening up of merged and emerging domains is not sufficient, and there are concerns that the knowledge of diverse materials is not necessarily being sufficiently tied to social implementation in a form commensurate to its value.

○ At a time when initiatives to boost materials innovation are proceeding in the countries of the world, policies across offices and ministries targeting the materials domain in the government of Japan have not been formulated since the Sectoral Promotion Strategy (for nanotechnology and materials) was formulated along with the Third Science and Technology Basic Plan in March 2006. The time has come when we should take into account the above issues and then present a government strategy based on the remaining “strengths” of Japan in order to accelerate initiatives carried out by industry, academia, and government together.

② Measures and Solutions for Achieving the Objectives

<Strategy Formulation>

○ We will formulate a government strategy for strengthening “materials innovation capacity,” which is the ability to create materials innovation (potential), under a common vision with the related people in industry, academia, and government, as one important strategy following on from AI, bio, quantum technologies, and the environment.

[Cabinet Secretariat, STI, MEXT, MAFF, METI, MLIT]

<Realization of the Data-Based Materials DX Platform (Provisional Name)>

○ We will cooperate with industry, academia, and government to advance the investigation of concepts regarding a platform for Japan overall which enables the high-quality materials data of industry, academia, and government to be strategically gathered, stored, distributed, and utilized, and in addition has a mechanism enabling that good-quality data to be created and shared efficiently and continuously from industry, academia, and government based on the strengths of the facilities and

equipment, etc. of Japan, and we will make the decisions by about the end of 2020. [MEXT, METI]

○ In order to formulate common guidelines concerning handling of the materials data of industry, academia, and government, during the first half of FY2020 we will hold an investigative commission comprising experts to sequentially advance investigations concerning the desirable handling of data, the development of a common data format, etc. while taking into account the characteristics of the field, with the open data of patents and academic papers, etc. and the shared closed data which should be shared strategically among limited related people as the main targets. [MEXT, METI]

○ During 2020 we will start an investigation into creating a database so that the release information for patents and academic papers, etc. can be learned using AI. [METI]

○ In order to form a core hub and network for materials data, which will be the infrastructure for data-driven research and development, we will promptly implement the initiatives necessary to advance investigations regarding the forms of the hubs to store and manage the materials data and the data structure in a secure environment for open data and shared closed data, through collaboration and cooperation with the Research Data Infrastructure System of Japan overall, from FY2020. [MEXT, METI]

○ In order for Japan overall to develop shared-use facilities and equipment groups that industry, academia, and government can use to create high-quality data and data structures, we will advance investigations regarding forms of data acquisition-type shared-use infrastructure development from FY2020 and promptly implement the necessary initiatives. When doing so, we will advance the investigation keeping in mind effective utilization of the results of the Nanotechnology Platform project which is scheduled to end at the end of FY2021. Furthermore, we will advance investigations regarding measures to upgrade shared-use infrastructure through the development of next-generation research equipment, and measures to encourage the development of human resources who can design data structures. [MEXT, METI]

○ We will develop a common format for measurement and analysis data which differs for each equipment manufacturer and type of equipment, and we will establish a JIS drafting committee during 2020 with the aim of switching to JIS early. [METI]

○ Regarding strategic research and development projects merging data gathering and utilization and theory, computations, and experiments and aiming for important technologies and implementation domains with the purpose of using high-quality materials data to create outstanding research results, we will advance investigations from FY2020 and promptly implement the necessary initiatives. We will also conduct an investigation regarding measures to promote smart laboratories and work for deployment of the measures through projects, etc. [MEXT, METI]

○ We will fully utilize supercomputers such as the Fugaku supercomputer, etc. to promote

materials analysis and development that merges simulations with AI and data science. [MEXT]

○ We will promote data-driven research and development at the research and development worksites of industry, academia, and government, starting with the development of an inverse problem response-type MI which designs the actual materials and processes based on the performance wanted by SIP. [STI, MEXT, METI]

<Strategic Promotion of Important Technologies and Implementation Domains>

○ Social implementation domains in which materials bring about big value (future vision) include:

• Realization of an Eco-Society 5.0 driven by ultra-low power consumption
• Substantial switch from a country dependent on overseas resources to a resources-producing country
• Realization of the world's most safe and resilient nation
• Realization of sustainable industries and lives that do not depend on fossil resources
• Realization of research and development and manufacturing worksites that have the world's greatest creativity, productivity, and resilience

Furthermore, important technology domains for realizing these include:

• Materials that enable the manifestation of advanced device functions
• Technologies for the advanced circulation of materials
• Materials possessing extreme functions
• Multi-material conversion technologies
• Design and control technologies for substances and functions

In the discussion of government strategies for strengthening materials innovation capacity, we will clarify the important materials technologies and implementation domains, including these ones. [MEXT, MAFF, METI, MLIT]

○ We will implement and accelerate research and development projects and hub formation (including network-type hubs) for promoting important technologies and implementation domains. We will appropriately conceive the objectives, the mechanisms for industry, academia, and government collaboration and the merging of different fields, the measures for strengthening of the process technologies and process science, the measures for introduction of data creation and utilization in collaboration with the Materials DX Platform (provisional name), appropriate intellectual property management, and the method of advancing international cooperation, etc. in accordance with the technologies and implementation domains. When promoting the important technologies and implementation domains, we will strengthen collaboration with the relevant offices and ministries, funding agencies, etc.

[MEXT, MAFF, METI, MLIT]

○ We will strengthen the functions of and strengthen collaboration with the CRDS in JST and the TSC in NEDO and encourage their activities as science and technology intelligence agencies at the world's top level. [MEXT, METI]

<Building of Materials and Innovation Ecosystems, Development and Securing of Human Resources>

○ We will conduct investigations concerning the building of materials innovation ecosystems in which diverse stakeholders in industry, academia, and government participate and merge, and concerning the development of an environment to enable Japanese companies to strategically acquire international markets, and we will sequentially implement the necessary initiatives. [MEXT, METI]

○ In relation to innovation ecosystems, we will provide seamless support for materials from research and development to implementation, to build a process innovation hub comprehensively possessing functions such as shared use of process devices and analytical equipment groups, a materials prototype foundry, coordination connecting diverse seeds and needs, human resources development, etc., and we will implement pilot research to discover and develop high-risk, high-impact innovative seeds. [METI]

○ In relation to environment development, in order for the materials research results of Japan to be appropriately evaluated and utilized in the global market, we will implement joint research, etc. with the research institutions, etc. of Europe and the United States, etc. regarding the measurement methods and specifications, etc. for the materials, and lead international standardization while aiming for formation of an international consensus. [METI]

○ Through the full-scale cooperation of industry, academia, and government, we will conduct investigations concerning measures for the development of human resources merging "materials and digital skills" and for appropriately developing and securing researchers and technicians in the materials-related fields for Japan overall, and we will sequentially implement the necessary initiatives. [MEXT, METI]

CHAPTER 6: Applied Fields that Should be Tackled Strategically

(1) Safety and Security (Realization of Comprehensive Security with Respect to a Wide Range of Threats, such as Large-Scale Natural Disasters, Global Outbreaks of Infectious Diseases, etc.)

○ **Future Visions to be Pursued**

• As the security environment surrounding Japan grows increasingly testing, realize comprehensive security with respect to a wide range of threats to people's lives and social and economic activities, including large-scale natural disasters, global outbreaks of infectious diseases, decrepit infrastructure, international terrorism and crimes, attacks in new domains such as cyberspace, etc.

• In order to maintain the peace of Japan and secure the safety and security of our citizens through the realization of comprehensive security, the relevant offices, ministries, and agencies, industry, academia, and government will collaborate to pool the advanced scientific and technological capabilities of Japan

• At a time when the problem of leakages of science and technology information is emerging internationally, further enhance comprehensive technology Control initiatives in Japan while advancing outstanding science and technology research and development and social implementation in Japan to secure and maintain technological superiority while realizing a society which can broadly utilize this to secure safety and security

○ **Objectives**

<Know>

• Take a panoramic overview of the scien

ce and technology of Japan to identify the fields to be promoted, the fields to be supplemented, and the fields to be properly managed from the perspectives of safety and security

<Develop>

• Prioritize the allocation of budgets and resources including humans to the fields identified in the process of <Know> in order to strongly develop science and technology that contributes to safety and security

< Protect>

• Countering leakages of science and technology information from the perspective of securing and maintaining the technological superiority of Japan and the perspective of preventing the diversion of research and development results to weapons of mass destruction, etc. and voluntarily securing the soundness and fairness of the research ("research integrity")

<Utilize>

• Secure the safety and security of our nation and its citizens through executing social implementation of the results obtained through the initiatives in <Know>, <Develop>, and <Protect>

① Implementation Status and Analysis of the Current Situation

○ Concerning the trends in science and technology pertaining to the realization of safety and security in recent years, at a time when each country's struggle for supremacy in innovation is intensifying, each country is engaging in fierce competition over cutting-edge basic research and its practical application directly leading to safety and security.

○ Furthermore, at a time when the security environment is becoming more severe, people's lives and social and economic activities in Japan are being exposed to a wide range of threats, including natural disasters that are on a larger scale, last longer, and are more serious, global outbreaks of infectious diseases, international terrorism and crimes, and cyber attacks.

In this way, with respect to the threats to people's lives and social and economic activities which are currently becoming more serious, it is necessary to prioritize the allocation of budgets and resources including humans to important technology fields for securing safety and security, and necessary for the relevant offices, ministries, and agencies and national research and development agencies, etc. to further strengthen collaboration to effectively promote the necessary research and development by mobilizing the scientific and technological capabilities of Japan.

○ In Japan as well, the Integrated Innovation Strategy Promotion Council formulated "The Direction of Science, Technology, and Innovation for Realization of 'Safety and Security'" stipulating the direction of STI policy going forward from a longer-term and more comprehensive perspective in January 2020.

As an initiative based on this, since March 2020 we have been holding the Working Group to Investigate Think Tank Functions in order to consider institutionalization, including think tank functions, that are necessary for the utilization of science and technology for securing the safety and security of our nation and its citizens.

○ In order to maintain the peace of Japan and secure the safety and security of our nation and its citizens through the realization of comprehensive security with respect to a wide range of threats, it is necessary to widely utilize the outstanding science and technology of Japan in the response to threats in a variety of domains.

For the realization of the safety and security of our nation and its citizens, the relevant offices, ministries and agencies and national research and development agencies, etc. are further strengthening their collaboration while promoting research and development and initiatives for social implementation of the results of the research and development. Specifically, advancing the initiatives for social implementation of the results of research and development of the SIP I, we are promoting research and development, etc. into fundamental technologies, infrastructure maintenance and management, disaster prevention and reduction, and cybersecurity, pertaining to SIP II.

○ Moreover, in the context of the international situation in recent years, international terrorism and crimes, cyber attacks, etc. have become more diverse and sophisticated, and concerns are growing that cutting-edge technologies will pose a wide range of

threats to people's lives, etc.

At a time when information gathering by each country concerning cutting-edge technology fields is actually becoming more active and leakage of technical information and technical human resources are already occurring, as initiatives to protect technologies in Japan, we have implemented briefings, etc. about compliance with laws and regulations for universities, research institutions, etc. in order to thoroughly implement security trade control, and we have revised the Foreign Exchange and Foreign Trade Act in order to respond appropriately to investment which could harm the safety, etc. of our nation.

② Measures and Solutions for Achieving the Objectives

○ In order to respond to domestic and overseas environmental changes surrounding safety and security, we will deploy concrete measures taking into account "The Direction of Science, Technology, and Innovation for Realization of 'Safety and Security'".

○ As the secutity environment surrounding Japan grows increasingly testing, it is necessary to enhance observation, forecasting, analysis, etc. to accurately "know" the threats themselves and to "know" the technologies that can counter the threats and the technologies that can become threats.

From this perspective, we will carry out the identification and sharing of technology needs, ascertaining of domestic and overseas research and development trends, gathering of information on technology seeds from industry, academia, and government and matching of technology seeds and technology needs, and advance the building of a path toward identification clarification of the important technology issues that should be strategically developed in Japan and the social implementation of those research and development results.

We will consider institutionalization, including new think tank functions, that will support this process.

○ Regarding the important technologies for the realization of safety and security, the relevant offices, ministries, and agencies, industry, academia, and government will collaborate to tackle the promotion of research and development programs that include social implementation objectives, and to build a roadmap from research and development to social implementation, etc. as initiatives to "develop" and "utilize" these technologies.

Furthermore, we will advance initiatives for steady social implementation of research and development results pertaining to disaster prevention and reduction, etc. in the national government and local governments, and in addition we will proceed with verifications of systematic factors that are hindering social implementation and as necessary investigate revisions to systems and operations such as public procurement and standards, etc.

○ While building and maintaining a research and development environment in Japan which creates outstanding results, the relevant offices, ministries, and agencies will collaborate to tackle investigations of technology leakage prevention countermeasures responding to a variety of leakage channels, including systems aspects, as an initiative to “protect” technologies which should be prevented leakage.

In addition to the previous initiatives, we will further advance information gathering about measures, etc. pertaining to technology control and results publication in foreign countries, while also summarizing the issues in initiatives in Japan going forward to advance investigations about the necessity, effectiveness, etc. of the measures and advance the building, etc. of a specific measures framework, and reliably take the structural measures, etc. necessary for realization of this policy.

i) Know

○ In order to secure safety and security, through collaboration with the relevant offices, ministries, and agencies, industry, academia, and government, we will take a panoramic overview of and ascertain cutting-edge domestic and overseas science and technology research and development trends to identify the fields that Japan should develop, the fields that it should supplement, and the fields that it should appropriately manage.

[Cabinet Secretariat, STI, Disaster, Space, Ocean, NPA, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

- The relevant offices, ministries, and agencies will collaborate to investigate institutionalization equipped with new think tank functions to carry out the identification and sharing of technology needs, centralized surveying and gathering of domestic and overseas technology seeds information, the matching of technology needs and technology seeds by well-versed human resources, identification of important technical issues based on analyses of the domestic and overseas situations, etc.

  Furthermore, we will select the fields taking into account the trends in social threats in recent years and then commence the investigation process for identification of the important technical issues.
- We will increase exchanges of people and information among the relevant offices, ministries, and agencies and national research and development agencies, etc. and deepen their mutual understanding, and work for the expansion of personal networking to develop human resources who are well-versed in science and technology.

ii) Develop

○ While taking into account the implementation status of matching of technology needs and technology seeds, we will priolitize the allocation of budgets and resources

including humans to research and development of important technology fields and technology issues that secure safety and security.

Furthermore, we will enhance systems to promote cutting-edge basic research and challenging and innovative research and development to strongly develop the science and technology necessary to secure safety and security.

[Cabinet Secretariat, STI, Disaster, Space, Ocean, NPA, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

- We will create a roadmap for research and development and social implementation taking into account the results of matching.
- Taking into account the threats of increasingly serious natural disasters and global disease outbreaks of infectious diseases, we will ascertain the domestic and overseas research and development trends pertaining to disaster prevention science and technology and the technologies related to public health countermeasures, and then extract the important research and development issues taking into account the situation in recent years.
- In order to secure safety and security, we will prioritize the allocation of budgets and resources including humans to the following fundamental technologies and other important technology fields, to strengthen the scientific and technological capacities which will become the infrastructure for comprehensive security.

(a) Fundamental technologies

Fundamental technologies that are expected to be utilized in a wide range of domains in the future (for example, AI technologies, biotechnology, quantum information processing, quantum technologies and materials, etc. that will realize quantum cryptography, etc.)

(b) Technologies that contribute to extending service life for efficient, effective infrastructure

From the perspective of greater national resilience, the technologies that contribute to securing the soundness of efficient, effective public infrastructure under fiscal constraints (for example, the implementation technologies, etc. for compact, high-powered lasers that enable efficient and effective testing of the condition of infrastructure, and compact sensors that enable situation monitoring over a long period).

(c) Technologies that contribute to responses, etc. to a wide range of threats such as natural disasters, infectious diseases, etc.

For the strengthening of national resilience, we will improve our forecasting and observation capacity in order to correctly know the threats and improve our prevention capacity for disaster prevention and reduction in advance, and in addition, we will pool cutting-edge technology seeds such as ICT and AI,

quantum technologies, etc. cross-sectionally to prioritize to the promotion of research and development that contributes to rapid information sharing and information transmission, etc., for the strengthening of our response capacity when disasters occur in particular.

Technologies that quickly and precisely ascertain the warning signs and occurrence status of natural disasters, etc., and rapidly and accurately carry out forecasting of natural disasters, etc. and damage forecasting to prevent natural disasters, etc. and minimize the damage caused by disasters (for example, ocean survey technologies based on the utilization, etc. of highly-reliable subsea robots which can function through multiple linkages or alone in the deep-sea over long distances with remote sensing data, etc., sensing technologies and seafloor observation network-related technologies that ascertain the status of major trench-type earthquakes, etc., technologies related to satellites, space exploration, and rocket launches to ascertain the status of natural disasters using remote sensing from space and to ensure the safe use of outer space, high-speed aircraft propulsion technologies for ascertaining the situation over a wide range, high-precision technologies utilizing simulations to forecast climate change and its impact, carbon recycling technologies and electricity supply and demand balance coordination technologies that contribute to decarbonization and resilience strengthening, quantum measurement and sensing technologies that realize measurements with a precision and sensitivity that surpasses conventional technologies, prevention, early detection, and rapid response technologies for serious public health threats such as the novel coronavirus disease, etc.)

Technologies that enable human lives to be saved and energy to be supplied and that realize rapid restoration even in harsh environments in disaster-stricken areas, etc. (for example, remote autonomous robot technologies that can exercise their capabilities even in an extreme environment when there is a disaster, autonomized next-generation unattended construction technologies, brain information and communications technologies that also contribute to robot remote control, the power storage and power source technologies capable of meeting the diverse electricity demand required to enable the long continuous use of electrical energy and rapid restoration work even when there is a natural disaster, cognitive communications technologies for communications network restoration, etc.)

Technologies that contribute to rapid and precise information sharing in disaster response institutions, the provision of information to residents for evacuation, etc. when a disaster occurs, etc. (systems that utilize AI to carry out information transmission, etc. to the residents of a disaster-stricken area (disaster prevention chatbots), etc.).

(d) Technologies that contribute to ensuring cybersecurity

Technologies for monitoring, analysis, response, and information sharing regarding cyber attacks and for protecting important social infrastructure, IoT systems and services, and the supply chains in economic activities, etc. from cyber attacks, and technologies for the restoration response after damage has occurred (for example, attack warning sign detection and analysis technologies, security countermeasures automation technologies, automatic restoration technologies, etc.)

○ In order to effectively advance research and development in important technology fields and challenging and innovative research and development, the national research and development agencies that play an important role in developing science and technology, in light of their public interest nature, are actively collaborating with the relevant offices, ministries, and agencies to develop science and technology that contributes to safety and security in a variety of domains, namely disaster prevention and reduction, space, and the ocean, within the scope of the purpose of their establishment and in accordance with the actual circumstances of each institution.

[Cabinet Secretariat, STI, Disaster, Space, Ocean, NPA, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

- The relevant offices, ministries and agencies and national research and development agencies will carry out information exchanges about science and technology that contributes to safety and security, and will efficiently and effectively promote important technology fields and challenging and innovative research and development through research cooperation such as joint research, etc.
- We will build mechanism for effectively advancing international collaboration and international joint research in the research and development of cutting-edge technologies, and we will actively utilize international funding, etc. in research and development.
- We will maintain science and technology, and industrial competitiveness at cutting-edge levels and, taking into account the perspective of smoothly promoting international joint research to secure and maintain the technological supriority of Japan, we will investigate forms of granting qualifications to people who handle important technical information in a form in which collaboration with foreign countries is possible.

○ In promoting these initiatives, it is extremely important to take into account the ambiguity of science and technology while encouraging the understanding of general society, including the related people involved, regarding the importance of safety and security research and development and its social implementation, so the government will strengthen wide-ranging information transmission about the results, etc. of research and development that contributes to safety and security, and will foster an

environment for motivated research and development entities to easily participate in these kinds of research and development.

[Cabinet Secretariat, STI, Disaster, Space, Ocean, NPA, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOD]

iii) Protect

○ Taking into account the situation that the problem of technology leakage is becoming apparent internationally, we will counter science and technology information leakage countermeasures from the perspective of securing and maintaining the technological superiority of Japan and the perspective of preventing the diversion of research and development results to weapons of mass destruction, etc. and voluntarily securing the soundness and fairness of the research (“research integrity”).

To achieve this, firstly it is necessary to ensure that each individual researcher recognizes the concerns about leakages of science and technology information, and for the universities and research institutions to which the researchers are affiliated, companies including the small and medium companies in the supply chain, etc. to take the appropriate steps to protect science and technology information as organizations.

In particular, at a time when the importance of technology control is growing internationally, we will advance initiatives to share the perception among industry, academia, and government that universities, research institutions, companies, etc. complying with laws and regulations and taking measures for preventing actual technology leakage in advance and alleviating risk leads to build of relationships of trust with overseas joint research partners and to strengthen collaboration.

Furthermore, when advancing the initiatives, we will take care to ensure their consistency with the principle of open science which encourages communication of research results and with the science and technology promotion policy based on the encouragement of overseas joint research, and also will make the initiatives predictable, to ensure that the researchers do not shurink back.

[Cabinet Secretariat, STI, Disaster, SIPSH, Space, Ocean, NPA, MIC, MOJ, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOD]

- Regarding technology leakage to foreign countries, etc., such as the movement of international students and researchers, etc. as a consequence of the globalization of research and corporate activities, corporate acquisitions, information theft in cyberspace, etc., the relevant offices, ministries, and agencies will gather and share information to promote collaborative countermeasures while taking care noting the policies of foreign countries regarding sensitive technology control, etc.
- Needless to say, guaranteeing the openness of research results is important as a basis for the development of science and technology, but in order to secure or prevent technology leakage from leading to security concerns, we will take into account of the situation, etc. in foreign countries while working for both the

demands for innovation encouragement, etc., and security at the same time. In addition to that, concerning the handling of the release or non-release of research results, regarding the results into which government funds have been invested, taking into account the fact that appropriate technology control should be implemented from the perspective of accountability to taxpayers, the government institutions (funding agencies) will investigate specific measures for a framework regarding the forms of that release which can effectively make cross-government judgements, including the characteristics of the project and technical viewpoints, and will take the necessary measures.

- Of the research and development results, regarding the handling of patents, we will promote investigations concerning publication of patent applications and granted patents, including the systems aspects, keeping in mind consistency and balance with measures for responding to technology leakage through other media such as academic papers, academic conference presentations, publishing on web sites, etc. and the forms of patent systems in each country, and giving consideration to the burden on users, while ensuring that both the encouragement of innovation and the prevention of technology leakage can be achieved at the same time.
- Because it is important for research communities to undertake initiatives that autonomously ensure the soundness and fairness of research (”research integrity”) upon recognizing concerns that the outstanding research activities of Japan and the values of openness and transparency which constitute the basis of the research environment will be lost due to under influences from foreign countries, we will implement investigations and lobbying for the creation of reports, etc. so that a common understanding among research communities can be reached regarding the clarification of those problems and response measures.
- Regarding the acceptance of funds from foreign countries, we will make information disclosure of the situation, etc. as a requirement at the time of a research funds application to seek transparency and accountability from government-funded research, and we will investigate specific measures regarding the framework and take the required measures, such as cancelation of the funds allocation decision when false declarations, etc. are discovered, etc.
- Taking into account the point that the importance of technology control is growing internationally, it is important for universities, research institutions, and companies, etc. to comply with laws and regulations and tackle measures for preventing technology leakage and risk alleviation in advance, so when accepting international students and foreign researchers, etc., we will promote initiatives by industry, academia, and government to ensure that internal management structures such as management of access to sensitive technical information in universities, research institutions, and companies, etc. and enhancement of management divisions, etc., are further strengthened. The government will

enhance the necessary awareness education and support to improve effectiveness while also tackling the alleviation of the burden of universities, companies, etc.

- We will work on informing people about the Guidelines on the Collaboration of Universities and National Research and Development Agencies with Foreign Companies (formulated in FY2019), which presents the laws and regulations with which to comply, the risk management measures, and practical matters to note, etc., and we will implement revisions as necessary taking into account the implementation of measures pertaining to “protecting” technologies.
- In order to achieve border management with more effective prevention of technology leakage, we will promote initiatives for strengthening the screening of international students and researchers, etc. and the development, etc. of the IT environment for that purpose, including the investigation of the forms of immigration management and visa issuance through the collaboration of the relevant offices, ministries, and agencies.
- In order to raise awareness of the problem among companies, etc. including small and medium companies in the supply chain, the relevant offices, ministries, and agencies will collaborate to promote initiatives for awareness education and information sharing concerning the risk of technology leakage, including brain drain.
- We will carry out a detailed examination of the government research and development projects that should manage technologies appropriately based on aspects, etc. of security trade control, and take into account the characteristics of the projects while expanding the covered projects, such as making security trade control a requirement, etc., and in addition the executing institutions of the covered projects will operate the covered projects appropriately so that the research and development entities carry out the necessary technology control.
- In order to prevent technology leakage using reverse engineering, etc., we will create a handbook pertaining to the prevention of technology leakage utilizing the results of the technology surveys and experiments, etc. that we have been implementing since FY2018, in order to promote discussions about the necessary structures and rules, etc. that Japan should develop.

iv) Utilize

○ In order to achieve steady social implementation of research and development results that contribute to the realization of safety and security, from the perspective of science and technology policy, when building a roadmap from research and development to social implementation we will advance the implementation of research and development programs that include social implementation objectives, and verifications, etc. of the systematic aspects of the factors that are hindering social implementation.

[Cabinet Secretariat, STI, Disaster, Space, Ocean, NPA, MIC, MOFA, MEXT, MHLW, MAFF, METI, MLIT, MOE, MOD]

- We will expand initiatives to identify the ultimate goal at an early stage to steadily lead to social implementation, through the active involvement of the relevant offices, ministries, and agencies that possess technology needs in discovered and specified specific research and development, using the newly-built matching mechanism operated by well-versed human resources.
- In order to steadily promote government plans concerning disaster prevention and reduction, and national resilience such as the Fundamental Plan for National Resilience, etc., in SIP II, based on the research and development objectives and social implementation objectives, we promote coordination, etc. toward research and development and social implementation for the building of information systems to support for the decision-making of the national government and the municipalities utilizing the latest science and technology such as satellites, AI, big data analysis, etc.
- Through SIP4D, we will advance further enhancement of the data exchange among offices, ministries, and fields that is necessary for disaster prevention, promotion of automatic linkages with prefectural disaster prevention information systems, etc. in order to promote the building of a disaster information network in Japan.
- In order to realize a Sophisticated Utilization of Geospatial Information Society (G Spatial Society), for the social implementation of a G Spatial Project by the entire government, regarding the field of disaster prevention, we will promote the building of integrated G spatial disaster prevention and reduction systems for organic collaboration among the relevant offices and ministries on initiatives utilizing technologies that contribute to disaster prevention and reduction through sophisticated utilization of geospatial information.
- We will promote utilization in disaster-prevention agencies and local governments of the “Satellite Safety Confirmation Service” which gathers information concerning the damage situation of and necessary supplies for disaster-stricken areas via a quasi-zenith satellite and the “Disaster and Crisis Management Service” which distributes information about tsunamis and landslide disasters, etc. via a quasi-zenith satellite, with both services able to function even in the case that the ground communications infrastructure has been interrupted.
- We will utilize satellite positioning data and remote sensing data to implement new model demonstrations and research that contribute to disaster countermeasures and national resilience.
- Regarding disaster prevention and reduction technologies, we will contribute to global disaster prevention and reduction through accumulation and global deployment of technologies taking into account experience of disasters. Furthermore, we will promote the introduction of the L-Alert advance system and G-space disaster prevention system for enhancement of local disaster prevention in 15 prefectures and 100 local governments, respectively, by FY2020.

- From the perspective of prior disaster prevention and reduction countermeasures in preparation for times of disaster or securing the sustainable safety and security of people's lives, for the securing of soundness of public infrastructure using steady maintenance and management, etc., we will promote initiatives such as revision of the criteria, etc. for technology development, utilization, and dissemination pertaining to public infrastructure inspection, diagnostics, and measures.
- In order to contribute to the promotion of i-Construction and securing, etc. the soundness of cross-sectional infrastructure in preparation for times of disaster, etc., and moreover from the perspective of innovation creation using data exchange with a variety of fields other than infrastructure, we will promote the building of the Land, Infrastructure, Transport and Tourism Data Platform and the Field Collaboration-Type Infrastructure and Data Platform through collaboration between the public and private sectors.

(2) Environment and Energy

○ **Future Visions to be Pursued**

- Realization of the world's most advanced energy management system[119] for the realization of Society 5.0
- Lead the world, strengthen the industrial competitiveness of Japan, and contribute to climate change measures and energy security by deploying the decarbonizing infrastructure technologies of Japan domestically and overseas to contribute to the reduction of global CO_2 emissions consistently with the long-term objectives of the Paris Agreement
- ***Establish innovative technologies that enable the carbon-neutrality of the world and CO_2 reduction on a past stock basis (beyond zero) by 2050***
- Utilize the energy carrier technologies, etc. of Japan to lead the world in realizing a hydrogen society by building an international supply chain, etc., including the importing of CO_2-free hydrogen, etc.
- ***Through the above initiatives, etc., achieve the Paris Agreement "2°C objective" and contribute to the "1.5°C objective"[120] as one member of the international community, to realize a "decarbonized society"[121] as close as possible to 2050***

○ **Objectives**

<Energy Management System>

- Implement the conceptual design of the new energy management system through the data infrastructure in this field and its utilization by FY2020

<Creating Energy[122] and Storing Energy>

- For making renewable energy a major power source, we will reduce the power generation costs of renewable energy to a globally competitive level, further incorporating the perspective of overseas deployment of the related technologies, etc.[123]

<Hydrogen>

- Realizing the world's first hydrogen society
  i) Introduction quantity of hydrogen to be 5~10 million tons +α in 2050, introduction quantity of ammonia to be three million tons in 2030

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[119] This is a system to optimally utilize energy between the networks set up at regional or inter-regional levels irrespective of whether such energy is in the form of electricity, heat, chemical energy, etc.

[120] Holding the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

[121] This means to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century (carbon-neutrality in the world overall).

[122] To utilize renewable energy such as solar power, wind power, etc. and cogeneration systems, etc. to create energy.

[123] Examples of benchmark objectives: 2030 solar power generation cost: 3.3 yen/kWh (the United States), 2030 ocean wind power generation cost: 9.45yen/kWh (Europe), 2030 geothermal power generation cost: 6.6 yen/kWh (the United States), 2030 ocean energy power generation cost: 13.5 yen/kWh (Europe).

ii) Hydrogen power generation cost to be made substantially equal to that of fossil fuel in 2050
iii) Hydrogen manufacturing costs at 10% or less of their current level in 2050

① Implementation Status and Analysis of the Current Situation

○ In order to investigate an innovation strategy anticipating the practical application and dissemination of technologies in the energy and the environment field, in August 2019 we launched the Progressive Environment Innovation Strategy Investigative Commission and it carried out an investigation regarding specific measures for technical and systemic issues and social implementation and the clear objectives, etc. regarding costs, etc. and formulated the Progressive Environment Innovation Strategy in the Integrated Innovation Strategy Promotion Council in January 2020. It is necessary to advance reliable execution of this strategy.

○ The IPCC 1.5°C Special Report concerning the impact due to global warming of 1.5°C from pre-industrial levels and the related global greenhouse gas emission channels was announced by the IPCC in October 2018. The necessity of innovation creation and social implementation in this field is growing more and more; for example, at COP25 which was held in December 2019, a statement urging the state parties to undertake ambitious climate change measures was incorporated in the decision document.

○ In addition to the building of the world's most advanced energy management system and the technologies for creating energy and storing energy, in order to promote the overseas deployment of decarbonizing infrastructure technologies, realize a hydrogen society that leads the world, and furthermore to realize a decarbonized society, it is necessary to establish objectives with a global perspective, and to build a path to their achievement and for the relevant offices, ministries, and agencies, industry, academia, and government to collaborate on the implementation of consistent initiatives from research and development through to social implementation.

○ There is a need to respond to the long-term issues of inexpensive and stable electricity supply and global warming; therefore, it is necessary to advance comprehensive and responsible initiatives with respect to a variety of issues. For example, we will stably advance the use of nuclear power, but only if we can acquire the social trust of the citizens and secure its safety.

<Energy Management System>

○ We have gathered and organized literature data pertaining to demonstration projects in each region concerning the data infrastructure for the environment and energy fields.

○ In SIP's Energy system for an IoE society, we carried out an investigation concerning the conceptual design of the electricity and gas (hydrogen) management module and the thermal management module, including transportation systems embedded with energy data infrastructure.

○ The creation of new added value in a wide range of fields is expected from the utilization of electricity data, such as the upgrading of the disaster prevention plans and evacuation plans of local governments, the protection of elderly people, etc., so the revised Electricity Business Act[124] was established and promulgated in June 2020 to enable these kinds of utilization of electricity data.

○ A maximum of 14.5% energy-saving and CO_2 saving effects have been confirmed using eco drive nudges utilizing smartphone applications and GPS sensors, and a sustained average of 2% energy-saving and CO_2 saving effects have been confirmed using energy-saving nudges that sent reports concerning energy-saving continuously for two years.

○ Regarding the power electronics technologies which are essential for thoroughly alleviating the electricity supply and electricity transmission loss and demand-side electricity loss caused by non-fossil energy, research and development to improve their performance and lower their costs is important, so the relevant offices and ministries have collaborated to advance consistent initiatives from research and development through to social implementation[125] of total systems design, including the elemental technologies and peripheral equipment of next-generation semiconductors, etc.

<Creating Energy and Storing Energy>

○ We have advanced initiatives for the realization of the price targets of a "power generation cost of 7 yen/kWh by 2025" for commercial solar power and a "power generation cost of 8 to 9 yen/kWh by 2030" for onshore wind power and bottom-mounted offshore wind power.

○ The Progressive Environment Innovation Strategy presented technology development roadmaps for solar power generation, wind power generation, and geothermal power generation, and advanced investigations for international standardization. Furthermore, we implemented technology development for overcoming area constraints, etc. such as power generation efficiency and weight saving.

<Hydrogen>

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[124] Act No. 170 of 1964

[125] The world's first electric vehicle driven by power electronics utilizing gallium nitride, an innovative energy-saving technology (AGV: All GaN Vehicle), was exhibited at the Tokyo Motor Show 2019.

○ We have implemented the demonstration project for manufacturing clean hydrogen from renewable energy electricity and water using water electrolysis technologies in Fukushima Prefecture and Yamanashi Prefecture, the supply chain demonstration project utilizing low-carbon hydrogen from unused resources in each region of Japan in the regions, the demonstration project for technologies for manufacturing hydrogen from lignite in liquified hydrogen supply chain demonstrations between Japan and Australia, the hydrogen supply chain demonstration project using organic highland between Japan and Brunei, fundamental technology development for the upgrading of water electrolysis, and research and development of fundamental technologies for CO_2-free hydrogen manufacturing.

○ In April 2019 we established the Green Ammonia Consortium, which builds CO_2-free ammonia value chains from the perspective of innovation. For example, it converts the world's renewable energy into ammonia and imports it to Japan.

<CCUS/Carbon Recycling>

○ We have advanced research and development, etc. based on the Roadmap for Carbon Recycling Technologies formulated and announced in June 2019, which summarized the research and development fields, issues, and schedule. We held the International Conference on Carbon Recycling, the world's first international conference specializing in carbon recycling, in Tokyo. Twenty countries and institutions participated, and they announced the Carbon Recycling 3C Initiative which presents promotion of mutual exchange, establishment of R&D and demonstration base and promotion of international joint research.

○ Regarding CCUS, we have advanced commercial scale demonstrations and technology development, projects for cyclic use of carbon, demonstrations of negative emissions technologies that capture and store exhaust gases accompanying the combustion of biomass resources, etc., and have advanced technology development and social implementation for DAC (Direct Air Capture) which directly captures CO_2 from the air and uses it effectively.

<Implementation of R&D Evaluation for Achieving the Goals>

○ Concerning national research and development agencies promoting research and development, when we ascertained the status of initiatives applying the PDCA cycle, we confirmed that the introduction of follow-up evaluation is becoming better understood, and that initiatives are proceeding to evaluate and apply the PDCA cycle from the perspective of the achievement of the innovation objectives to the practical application and commercialization status of the research and development results.

<Promotion of Energy/Climate Change Diplomacy from the Perspective of Innovation>

- ○ At the G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth we held as the G20 president in June 2019, all of the G20 members agreed to the concept of a “virtuous cycle of environment and growth“ and the importance of the three pillars of actions to achieve the concept, namely: (i) innovation, (ii) mobilization of finance, and (iii) improvement of business environments. Regarding the energy field, they shared awareness concerning the significance of innovation as a driving force for energy transitions and the significance of promoting innovation in diverse areas, such as hydrogen, Carbon dioxide Capture, Utilization and Storage (CCUS), and Carbon Recycling. Furthermore, they agreed on the G20 Karuizawa Innovation Action Plan, which clearly stated specific actions for the realization of the “virtuous cycle of environment and growth.”
- ○ In September 2019 we held the Second Hydrogen Energy Ministerial Meeting, which shared findings pertaining to innovation promotion and confirmed the importance of international cooperation. Furthermore, in October 2019 we invited to Japan the leaders of the top research institutions in the clean energy technology field in the G20 to hold the First Research and Development 20 for Clean Energy Technologies (RD20) international conference, in order to lead international cooperation for groundbreaking innovation.
- ○ The 27th Meeting of International Energy Agency (IEA) Governing Board at Ministerial Level in December 2019 agreed on a communiqué stating that clean energy transitions were necessary for the building of sustainable energy systems, and that all energy sources and technological innovation were important, etc.
- ○ The session of the International Renewable Energy Agency (IRENA[126]) Assembly in January 2020 appealed to the importance of the utilization of hydrogen technologies and the importance of mass disposal of renewable energy equipment that is nearing the end of its service life.

<Earth Observations>

- ○ In a revision by the IPCC of the guidelines showing the methodology for estimating greenhouse gas emissions and removals in May 2019, a new statement was added to the effect that satellite observation data (the GOSAT series, ALOS-2, etc.) could be effective information for verification of the calculations. Furthermore, the GEO[127] Ministerial Summit in November 2019 reaffirmed the importance of sustainable earth

[126] International Renewable Energy Agency
[127] Group on Earth Observations

observations and data sharing, and confirmed their further utilization in climate change, disaster prevention, and sustainable development and economic activities.

○ In order to enhance and maintain effective greenhouse gas observation, we will continue observations using GOSAT and GOSAT-2 based on the Basic Plan for Space Policy, and we have advanced development with the aim of launching the Global Observation SATellite for Greenhouse gases and Water cycle (GOSAT-GW) equipped with the Thermal And Near infrared Sensor for carbon Observations 3 (TANSO-3) and the Advanced Microwave Scanning Radiometer-3 (AMSR3), which will progressively succeed to these missions from FY2023.

○ We will utilize private sector aircraft and private sector ships to dramatically increase the observation data on greenhouse gases in the sky and observation data on greenhouse gases in the air above the oceans and carbon dioxide partial pressure in the surface seawater, data which are extremely lacking in the world. Regarding ground observations, we will regularly carry out air sampling observations not only in Japan but also in six countries mainly in Asia and in Siberia, to contribute to data storage in gap areas. We strengthened the observations for emissions estimates from large urban areas, which are big emissions sources.

<Reflection in the Plan and Strategy>

○ Based on the Long-Term Strategy as a Growth Strategy Under the Paris Agreement (formulated in June 2019), we formulated the Progressive Environment Innovation Strategy in January 2020. This strategy clearly stated the specific cost objectives, etc. for five fields and 16 technical challenges as Innovation Action Plans, and incorporated research structures, measures to encourage investment, and mechanisms for Co-Creation with the international community to boost the realization of these technologies.

② Measures and Solutions for Achieving the Objectives

We will implement the following initiatives taking into account the implementation status and situation changes, etc.

<Energy Management System>

○ Taking into account the introduction of power sources with variable output and situation changes including the technological progress in the world, for the realization of not only Society 5.0 but also the Regional Circular and Ecological Sphere and “zero-carbon cities,”[128] we will advance the conceptual design of energy management systems that

[128] Local governments that have declared “substantially zero carbon dioxide emissions by 2050.” One hundred and one local governments had made this declaration as of the end of June 2020, which in terms of population size is one half of the total population.

reduce CO_2 through data exchange among fields. [Cabinet Secretariat, STI, MIC, MEXT, MAFF, METI, MLIT, MOE]

○ Taking into account the content of the revised Electricity Business Act which was established and promulgated in June 2020, we will advance the detailed systems design for steadily advancing initiatives by business operators who want to utilize electricity data. Note that we will implement meticulous measures for personal information protection and information security when advancing the detailed design. [METI]

○ For the building of a resilient electricity network and establishment of green mobility utilizing digital technologies, we will advance the development of highly-efficient, low-cost power electronics technologies, etc. utilizing next-generation semiconductors such as gallium nitride semiconductors, etc., and aim to disseminate and expand the technologies by 2050.

[STI, MEXT, METI, MOE]

○ We will combine analyses using satellite data and ground observation data with analyses of the amount of activity utilizing IoT data and big data with a high temporal-spatial resolution to investigate improvements to the precision of estimates of greenhouse gas emissions. [MOE] [Restated]

○ We will gather and analyze data about energy consumption, and use a combination of behavioral insights such as nudge and boost, etc. and cutting-edge technologies such as AI/IoT, etc. (BI-Tech) to feedback personalized messages to each individual to encourage energy-saving behavior. [MOE] [Restated]

○ To ensure that environmental value in small and medium companies and households, etc. can be traded and utilized with a small time-lag through trades of environmental value using the J-Credit Scheme, etc., we will advance the computerization of the procedures and an investigation into the creation of a market that utilizes digital technologies such as blockchain, etc., with the aim of starting operation in FY2022 at the earliest.

[MAFF, METI, MOE]

<Creating Energy and Storing Energy>

○ We will make sure to realize the FY2030 energy mix[129] and for making renewable energy a major power source, we will establish objectives such as reducing the power generation costs of renewable energies to a globally competitive level while further incorporating the perspective of overseas deployment of the related technologies,[130] etc. Furthermore, in order to build a path toward achievement of those objectives, we will implement investigations, etc. of revisions of roadmaps[131] and promote international standardization of the related technologies. [MEXT, METI, MLIT, MOE]

○ We will implement investigations for further introduction of renewable energy in the future, for overcoming area constraints, etc., such as power generation efficiency improvement and weight saving. [MEXT, METI, MLIT, MOE]

○ We will promote lower costs for innovative solar power, onshore wind power, and bottom-mounted offshore wind power that can overcome establishment constraints. Regarding floating offshore wind power generation, which has great potential in Japan where there are many deep-water sea areas, we will aim for the establishment and dissemination of world-leading floating offshore wind turbine technologies. [MEXT, METI, MLIT, MOE]

○ We will promote initiatives to make renewable energy a major power source in the regions through visualization of the areas suitable for renewable energy introduction, utilization of direct current power-feeding systems, the building of energy self-sufficient areas, etc. [MOE]

<Hydrogen>

○ We will implement an investigation for realization of hydrogen manufacturing costs 10% or less of their current level by 2050.

[MEXT, METI, MLIT, MOE]

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[129] Long-term Energy Supply and Demand Outlook (July 2015 Ministry of Economy, Trade and Industry Decision). This document stipulates that the ratio of renewable energy in the power source mix will be 22% to 24% by FY2030.

[130] Examples of benchmark objectives:
• 2030 solar power generation cost: 3.3 yen/kWh (US, utility scale)
(United States Department of Energy “Sunshot 2030” (November 2016))
• 2030 ocean wind power generation cost: 9.45 yen/kWh (Europe, fixed type)
(European Commission “Transforming the European Energy System through INNOVATION” (September 2015))
• 2030 geothermal power generation cost: 6.6 yen/kWh (United States, Enhanced Geothermal Systems)
(United States Department of Energy “2016–2020 STRATEGIC PLAN and Implementing Framework” (November 2015))
• 2030 ocean energy power generation cost: 13.5 yen/kWh (Europe, tidal power generation)
(European Commission “SET Plan – Declaration of Intent on Strategic Targets in the context of an Initiative for Global Leadership in Ocean Energy” (September 2016))
(One dollar converted at ¥110. One Euro converted at ¥135)).

[131] Roadmaps for energy-related technology development.

○ We will aim for the urgent building of an international supply chain utilizing energy carriers, etc., and implement an investigation of the potential for introduction and feasibility of social implementation, etc.

[MEXT, METI, MLIT]

○ We will advance investigations for reducing the costs of hydrogen derived from renewable energy, etc. and actualizing its environmental value, while promoting dissemination of regional low-carbon-hydrogen supply chains in regions nationwide.

[MOE]

○ Centered on the Green Ammonia Consortium, we will implement investigations for the building of a CO_2-free ammonia value chain from the perspective of innovation, for example by converting the world's renewable energy into ammonia and importing it to Japan. [METI]

<CCUS[132]/Carbon Recycling>

○ We will implement demonstrations of and research and development, etc. into CCUS/carbon recycling for full-scale social implementation from 2030 onwards, and aim to establish the first CCU technologies on a commercializable scale by 2023.

[STI, MEXT, MAFF, METI, MOE]

<Resources Circulation>

○ For the realization of a recycling economy utilizing the strengths of Japan, we will tackle the creation and dissemination of innovative resources circulation businesses utilizing digital technologies, etc. such as the building of an information platform concerning resources circulation, etc., and the research and development, demonstration and social implementation, etc. of innovative technologies such as substitute materials, next-generation recycling, etc. [METI, MOE]

○ For the solution of the problem of plastic trash in the ocean, we will tackle technology development for ascertaining the actual state of pollution and the research and development, etc. of techniques for evaluation of impacts on the ecosystem, and we will advance harmonization of the distribution of plastic trash in the ocean, including microplastics, with monitoring techniques and global data aggregation, estimates of generation sources and emissions, and survey research on biological impacts. Furthermore, we will implement development of resources circulation industries through innovation concerning substitute materials such as ocean-biodegradable plastics, etc. and the strengthening of recycling, treatment, and reduction of the amount

[132] Including negative emissions technologies

of trash washed ashore, and the initiatives presented in the framework for international collaborations which was a result of the G20 Osaka Summit. [MEXT, METI, MOE]

○ In order to encourage expansion of the use of bioplastics in bags for combustible trash, we will formulate guidelines to encourage the introduction of bioplastics for municipalities, and we will also add a statement related to bioplastics to the Handbook on the Introduction of Charges for General Waste Disposal by about FY2020. [MOE] [Restated]

○ In order to encourage the resources circulation of plastics, we will carry out research and development, introduction, dissemination, etc. for the realization of advanced recycling, such as chemical recycling technologies, etc. that can manufacture recycled materials with properties that are not inferior in any way to plastic raw materials. [METI]

<Promotion of Climate Change Response Research in the Agriculture, Forestry, and Fisheries Fields>

○ We will aim to build local-production-for-local-consumption energy systems suitable for rural areas, and we will carry out development, etc. of technologies that utilize the renewable energy available in rural areas at a low cost and efficiently. [MAFF]

○ We will develop materials to reduce methane emissions derived from cropland soil and livestock, and in order to reduce the CO_2 that results from fuel combustion in agricultural production, we will develop technologies such as electrification of agricultural machinery, conversion to fuel cells, etc. [MAFF, METI]

○ We will develop materials that increase the carbon storage of cropland soil by injecting biochar, and high-performance lignin bioplastic materials extracted from woody biomass, and we will promote development of blue carbon evaluation technologies. Furthermore, in order to encourage carbon fixation in forests, we will carry out development and dissemination, etc. of varieties, etc. of fast-growing trees and elite trees. [MAFF, MLIT]

○ We will advance the development of technologies that reduce the generation of greenhouse gasses derived from cropland soil, and fully utilize the functions of microorganisms by elucidating the functions of soil microorganisms, etc. [MAFF]

<Nuclear Power>

○ In addition to the further improvement of safety, reliability, and efficiency, the perspective of encouraging innovation in nuclear power-related technologies anticipating the growth of diverse societal demands such as coexistence with renewable energy, hydrogen manufacturing, and the use of heat is important. Based

on the Strategic Energy Plan, etc., and also taking into account the initiatives of the United States and Europe which are advancing the development of innovative nuclear reactors, we will secure strategic flexibility, and to work towards 2050 we will immediately commence the strengthening of human resources, technologies, and the industrial infrastructure, pursue reactors that offer outstanding safety, economic performance, and mobility, and advance technology development for the solution of back-end problems. [STI, MEXT, METI]

<Implementation of R&D Evaluation>

○ We will establish the Green Innovation Strategy Meeting as the control tower advancing research and development in the environment and energy fields, and through collaboration with each ministry we will strongly boost the realization of the strategy, including the progress management, communication, etc. of the existing projects. [STI, MEXT, MAFF, METI, MLIT, MOE]

<Promotion of Initiatives for Decarbonization, etc. through Collaboration with Universities, etc.>

○ In order to accelerate our response to the global issues of decarbonization, etc. of the country and regions, we will pool the capabilities of universities, etc. possessing comprehensive knowledge and diverse networks to promote field-merging research that ties the research results of universities, etc. to the social implementation of specific policies and technologies of the country and regions, and build the database that will be the infrastructure for promotion of the said research and the strategic collaboration of industry, academia, government, and financial institutions, etc.

[MEXT, MOE]

<Promotion of Energy/Climate Change Diplomacy from the Perspective of Innovation>

○ In order to contribute to reduction of global CO_2 emissions consistently with the long-term objectives of the Paris Agreement, we will utilize the wide-ranging technologies and experience of Japan and take into account the variety of needs in each country to support the energy transitions and decarbonization of each country in terms of building of infrastructure and human resources in order to lead global economic growth and decarbonization. In particular, through the overseas deployment of decarbonizing infrastructure technologies, including renewable energy, individual technologies such as hydrogen, etc., and systems technologies for energy management, etc., we will support the initiatives of each country for achievement of the SDGs, and in fields in which Japan has technological advantages we will promote energy and climate change

diplomacy from the perspective of innovation that contributes to strengthening the industrial competitiveness, climate change measures, and energy security of Japan, such as supporting the policy and systems building of each country through public-private partnerships, encouraging development of the business environment, etc.

[STI, MOFA, MEXT, METI, MOE]

○ In 2020 we will hold an international meeting (RD20) in which the leaders of the top research institutions in the clean energy technology field in the world's major countries (the G20) will participate. We are aiming to hold this meeting continuously in order to lead international cooperation for groundbreaking innovation. Furthermore, we will utilize the alliance in RD20 to carry out international joint research and development of innovative clean energy technologies based on Japanese research institutions, etc. collaborating with the cutting-edge technologies and research resources possessed by research institutions, etc. in foreign countries. [STI, MEXT, METI, MOE]

○ When promoting renewable energy, anticipating the mass disposal of renewable energy equipment such as future solar panels, etc., we will advance communication, etc. with the international community concerning the importance of responding to that issue.

[MOFA]

<Earth Observations>

○ We will enhance and maintain effective greenhouse gas observation, and by 2023 we will gather greenhouse gas observation data as rapidly as possible to implement proper quality management. In conjunction with this, we will promote initiatives contributing to a Global Stocktake,[133] etc. based on the Paris Agreement and utilizing greenhouse gas observation data, etc. by developing techniques that are integrated with advanced analysis systems. [MEXT, MOE]

○ As the common infrastructure of Society 5.0, and in order to continuously acquire over the long term the earth environment big data that is important as the scientific basis for a variety of decision-making, we will pool diverse observation tools and the research capabilities of a wide range of fields, and continuously upgrade observation technologies such as earth observation satellites, etc. to implement observations. Furthermore, in order to respond to diverse needs, we will strengthen the core data infrastructure for utilizing earth observation big data (real-time processing, etc.).

[STI, MIC, MOFA, MEXT, MAFF, METI, MLIT, MOE]

<Execution of the Plan and Strategy>

[133] A mechanism to confirm the status of progress of warming countermeasures in the world overall.

○ In order to steadily execute the Progressive Environment Innovation Strategy, we will establish an innovation dashboard enabling the issues and status of progress regarding the 39 technological themes set out in the strategy to be viewed, and we will announce the dashboard as occasion demands. Moreover, through the National Institute of Advanced Industrial Science and Technology's Global Zero Emission Research Center (GZR) and next-generation energy infrastructure research hubs, the Tokyo Bay coastal innovation area, etc., we will strengthen the collaboration of domestic and overseas research institutions, the private sector, etc. We will create the Progressive Environment Innovation Strategy Progress Report compiling the status of progress of these initiatives every year, and show the effectiveness of innovation by communicating domestically and overseas through international conferences, etc., and encourage the expansion, etc. of private sector investment in innovative technology development. [STI, MEXT, MAFF, METI, MOE]

(3) Health and Medical Care

○ **Future Visions to be Pursued**

- ***Promote consistent research and development from basic research and development to research and development for practical application in research and development in the medical care field, and contribute to the provision of medical care at the highest level in the world through the smooth practical application of the results of the research and development***
- ***Contribute to improving the quality of medical care overseas while also contributing to the growth of the Japanese economy, through the creation of industrial activities that contribute to the formation of a healthy and long-lived society, the encouragement of the deployment of these industries overseas, and other revitalization***

○ **Objectives**

<Overall Objectives>

- ***Aim to extend the healthy lifespans of men and women by three years or more to over 75 years old by 2040 and extend them by one year or more by the end of FY2024***

<Research and Development in the Medical Care Field>

- ***Promote consistent research and development from basic research to practical application through industry, academia, and government collaboration with support by AMED at its core, including the promotion of integration projects, etc. and work for practical application of the results of the research and development, and achieve the results objectives (KPIs) stipulated in the healthcare and medical strategy[134] by the end of FY2024***

<Creation and Global Deployment of New Industries>

- ***Work for the building of preventative, disease progression suppressing, and symbiotic health and medical care systems through the revitalization of the health care industry outside public insurance and the strengthening of collaboration with public insurance services, and working for the global deployment of health and medical care-related industries in Asia and Africa, in order to achieve the results objectives (KPIs) stipulated in the healthcare and medical strategy by the end of FY2024***

① Implementation Status and Analysis of the Current Situation

○ The healthy lifespan is growing steadily and in 2016 it reached 72.14 years for men and 74.79 years for women, but the difference between the healthy lifespan and the average lifespan remains nearly ten years, so initiatives to shorten this further are

[134] March 27, 2020 Cabinet Decision

desired.

○ Looking at the disease structure of Japan, not only single-target diseases such as infectious diseases and genetic diseases, etc. but also multiple-factor diseases, including so-called lifestyle-related diseases and diseases resulting from aging are having a big impact on our citizens. At a time when responding to these kinds of diseases is a challenge to overcome in order to further expand the healthy lifespan, the importance of prevention will increase in addition to diagnostics and medical treatments, and it is desired to take initiatives for living with disease as two halves of the whole.

○ Research and development in the medical care field and life sciences fields is accelerating globally, and we are going through the fourth industrial revolution, so the utilization of digital technologies and data such as AI, robots, big data, etc. is continuing to have a big impact on the industrial structure and economic and social systems overall. Going forward, it is expected that innovation in these fields will accelerate, the elucidation of disease mechanisms, the development of new diagnostics and medical treatment methods, research and development such as drug discovery, etc. utilizing AI, big data, etc., and personalized medical care and precision medical care tailored to the physical condition of individuals, etc. will make progress.

○ In July 2014 we formulated the healthcare and medical strategy for the initial period, and in April 2015 we established AMED to centralize the research and development budget in the medical care field which had previously been operated by the Ministry of Health, Labor and Welfare, the Ministry of Education, Culture, Sports, Science and Technology, and the Ministry of Economy, Trade and Industry, respectively, and organized a total of nine integration projects including the cross-disease type and the disease-specific type, and built structures to promote consistent research and development from basic research to practical application, including the development of research and development management structures through the deployment of PDs, etc. In this way, many outstanding research and development results were created, such as the seeds of academia reaching practical application, etc.

○ On the other hand, issues regarding the integration projects include the fact that originally development of the modalities that can be utilized across diseases (technologies and techniques), etc. is divided into specific diseases in disease-specific integration projects, so disease-specific integration projects are only deployed for the specified diseases, etc.

○ In order to create new health care industries, we have promoted initiatives contributing to expansion of the demand for health care services, such as the establishment of mechanisms which evaluate companies that make investments in health, etc., and we have advanced the development of the supply environment, including compiling

guidelines showing the forms of industry authentication, etc.

○ We will compile the Basic Principles of the Asia Health and Wellbeing Initiative[135] and the Basic Principles of the Africa Health and Wellbeing Initiative[136] and advance the deployment of the health care services of Japan to these regions.

○ Taking into account the above situation, we formulated the healthcare and medical strategy for the second period targeting the period from FY2020 to FY2024 and the Plan for Promotion of Research and Development in the Medical Care Field[137] in March 2020.

② Measures and Solutions for Achieving the Objectives

<Promotion of Research and Development in the Medical Care Field>

○ We will also collaborate with other funding agencies, in-house research institutions, and private sector companies while promoting in an integrated manner consistent research and development from basic research to practical application in the medical care field with support by AMED at its core. [Cabinet Secretariat, MIC, MEXT, MHLW, METI]

○ We will reorganize the integration projects into the following six projects based on modalities, etc. to promote research and development with support by AMED at its core.

1) Pharmaceutical project

In order to promote the practical application of pharmaceuticals that meet the needs of medical settings, we will carry out research and development taking into account the characteristics and nature of the modality, from searching for drug discovery targets to clinical research.

[STI, MEXT, MHLW, METI]

2) Medical equipment and health care project

We will utilize AI and IoT technologies, measurement technologies, and robotics technologies, etc. merged together to carry out research and development concerning medical equipment and health care that contributes to the upgrading of diagnostics and medical treatments, and improvements in QOL[138] and prevention, etc. [MIC, MEXT, MHLW, METI]

3) Regenerative and cellular medicine and gene treatments project

For the practical application of regenerative and cellular medicine and gene treatments, we will carry out basic research, non-clinical and clinical research, applied research, and building of the necessary infrastructure while promoting field-

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[135] July 29, 2016 Headquarters for Healthcare Policy Decision (revised July 25, 2018)
[136] June 20, 2019 Headquarters for Healthcare Policy Decision
[137] March 27, 2020 Headquarters for Healthcare Policy Decision
[138] Quality of Life

merging research and development.

[STI, MEXT, MHLW, METI]

4) Genomic data infrastructure project

Aiming for the realization of genomic medicine and personalized medical care, we will promote research and development that contributes to prevention of the onset and worsening of diseases, diagnostics, and medical treatments, etc. while taking a panoramic view of the life stages, by implementing and utilizing action plans for the building of the genomic data infrastructure, whole-genome analysis, etc.

[STI, MIC, MEXT, MHLW, METI]

5) Basic disease research project

Aiming for applications in the research and development of the medical care field, we will carry out basic research and development for elucidation of the functions of vital phenomena such as brain functions, immunity, aging, etc. and elucidation of disease mechanisms for a variety of diseases, etc. [MEXT, MHLW]

6) Seed development and research base project

We will promote basic research and international joint research, such as creation and development, etc. of groundbreaking seeds, for the creation of new modalities. Furthermore, in bridge-building research support hubs and clinical research core hospitals we will develop structures and mechanisms for the discovery and transfer of seeds and implementation of high-quality clinical research and clinical trials.

[MEXT, MHLW, METI]

○ We will promote disease research so that it can be managed flexibly in AMED in a form that covers all of the above integration projects. Regarding disease fields that are social issues in Japan (cancer, lifestyle-related diseases, psychiatric and neurological diseases, geriatrics and dementia, intractable diseases, child health and development, infectious diseases, etc.), we will constantly secure sufficient collaboration among projects concerning specific diseases, and make external announcements after ascertaining the size of the budget and the status of the research and development, etc. Furthermore, regarding the disease fields of intractable diseases and cancer, etc., we will promote consistent research and development from basic research to the practical application of pharmaceuticals, etc., and regarding particularly intractable diseases, we will take into account their characteristics, and ascertain the actual state of the patients while mutually collaborating on and seamlessly promoting all of the research from the survey research of the Ministry of Health, Labor and Welfare to the research of AMED aimed at the practical application.

[Cabinet Secretariat, MIC, MEXT, MHLW, METI]

○ Regarding medical care field research and development in AMED and in-house

research institutions, the Headquarters for Healthcare Policy will carry out centralized budget request allocation coordination. Furthermore, concerning the in-house research and development of the medical care field, during FY2020 we will investigate and compile the research and development themes that we should give priority to tackling going forward and the forms of collaboration and division of labor with, etc.

[Cabinet Secretariat, MEXT, MHLW, METI]

<Development of an Environment for Research and Development in the Medical Care Field>

○ In order to seamlessly achieve the practical application of seeds based on the outstanding research results of academia, we will develop bridge-building research support hubs and clinical research core hospitals, further strengthen collaboration with universities, etc. outside the related fields and hubs, and improve seed discovery and evaluation functions. [MEXT, MHLW]

○ Taking into account the issues summarized in the investigations to date, we will urgently investigate the forms of organization of the national R&D centers as clinical research hubs in Japan.

[Cabinet Secretariat, MHLW]

○ We will promote the development and securing, etc. of expert human resources such as biostatisticians, etc. and experts in regulatory science, and promote the education for researchers necessary for practical application of regulatory science and intellectual property, etc. [MEXT, MHLW, METI]

○ In order to work for further improvement in the trust of the citizens with respect to the clinical research of Japan and promote research, we will appropriately operate the Clinical Trials Act[139] and revise it as necessary taking into account the status of its enforcement, etc. [MHLW]

○ We will carry out the necessary operational improvements to the regulatory science strategy consultation system and priority clinical trial consultation system, etc. of the Pharmaceuticals and Medical Devices Agency (PMDA) and work for rapid practical application of innovative pharmaceuticals, etc. so that research and development results can be connected efficiently to pharmaceutical approval. [MHLW]

○ We will disseminate and enhance regulatory science in research and development, through support for research concerning the quality, effectiveness, and safety of pharmaceuticals, etc. predicated on harmonization with international regulations, the development of screening guidelines, and the improvement of the specialist knowledge of screeners, etc. [MHLW]

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[139] Act No. 16 of 2017

<Creation and Global Deployment of New Industries>

○ In order to encourage, etc. health care industries other than public insurance, we will carry out promotion of health management, promotion of regional and occupational collaboration, and the encouragement of initiatives to improve the health of individuals, etc. Furthermore, to develop an environment for providing proper health care services, we will tackle initiatives to evaluate the quality of health care services, collaboration between public insurance services and services other than public insurance, etc. [MIC, MHLW, METI]

○ We will promote initiatives for funds support by public-private investment funds, etc., information transmission using a one-stop window, consultation support and network support with support institutions, etc. to strengthen innovation ecosystems for the creation of new industries in the health and medical care field. [REVIC, MEXT, MHLW, METI]

○ With a focus on contributing to the achievement of universal health coverage, under the Asia Health and Wellbeing Initiative and the Africa Health and Wellbeing Initiative, we will aim to contribute to the autonomous industry promotion in each country and the broad-based health and medical care field, and we will promote global deployment of the health and medical care-related industries of Japan. Regarding the covered fields, we will deploy not only medical care and nursing but also all services including broad-based health care services as a package. [Cabinet Secretariat, MIC, MOJ, MOFA, MOF, MEXT, MHLW, MAFF, METI, MLIT]

(4) Space

○ Future Visions to be Pursued

- ***Strengthen the independence of the space activities of Japan and the industrial, scientific, and technological foundations that support it, and expand the use of space for security, disaster countermeasures and national resilience, contributions to global issues, the new creation of knowledge, and the realization of economic growth and innovation, etc.***
- ***Aim to become an independent superpower of space use by realizing a virtuous cycle of "expansion of use" and "strengthening of infrastructure" under which the expansion of space use encourages further strengthening of the industrial, scientific, and technological foundations***

○ Objectives

<Ensure Space Security>

- ***Secure space security by strengthening, etc. our capability to secure the sustainable and stable use of outer space and to secure advantages in the use of space***

<Contribution to Disaster Countermeasures, National Resilience, and the Solution of Global Issues>

- ***Promote disaster countermeasures and national resilience by strengthening space systems and using them in our responses to large-scale disasters and the maintenance and management, etc. of infrastructure***
- ***Furthermore, through cooperation with the international community, Japan will exercise leadership to contribute to the solution of global issues and contribute to the achievement of the SDGs***

<Creation of New Knowledge Using Space Science and Exploration>

- ***Regarding our space science and exploration, which has received a high evaluation internationally and has greatly contributed to securing the presence of Japan in the international community, strengthen initiatives such as leading international collaborations, etc. and create global results leading to the new creation of knowledge***

<Realization of Economic Growth and Innovation with Space as the Driving Force>

- ***In order to respond to the growing dependence of the economy and society on space systems and the further expansion of the domain of activities of the human race, work for the further strengthening and expanded use of space systems, which are important infrastructure, and with this as the driver, fully utilize space systems in the economic growth and innovation of Japan***

<Strengthening of the Comprehensive Foundations Supporting the Space Activities of Japan, Starting with the Industrial, Scientific, and Technological Foundations>

- ***In order to achieve the above, strengthen the comprehensive foundations supporting the space activities of Japan, such as the industrial, scientific, and technological foundations, etc.***

① Implementation Status and Analysis of the Current Situation

○ Today, the role of space systems in the security, economy, and society of Japan is getting larger, and it is expected that this trend will strengthen further. In this context, space activities are moving away from the previous public sector-led approach into an era of public and private sector Co-Creation, and the revitalization of industries through the use of space is being attempted in a wide range of fields.

○ Moreover, due to the progress of space exploration, the domain of activities of the human race has gone beyond the Earth's orbit and is expanding to the surface of the Moon and even further into deep space. Space is becoming more important as a frontier of science and technology and also as a driver of economic growth. Space can also become a large driver for the economic growth of Japan.

○ On the other hand, at a time when the growth of threats in outer space is being indicated, in particular the development of diverse tools for disruption that go beyond the destruction of satellites using missiles, etc. discussed previously, momentum toward positioning space as a "warfighting domain" and an "operational domain" is growing in the United States and other countries, and space security has become an urgent issue.

○ Furthermore, the building of constellations of small and ultra-small satellites is proceeding, which is changing the game in the space industry. The space equipment industry of Japan is lagging behind with respect to this development, and at a time when the relevant technologies are rapidly progressing, the reinforcement of industry and the science and technology infrastructure is an urgent issue for the maintenance of the independence in the space activities Japan built up after the war.

○ In June 2020 we compiled the new Basic Plan for Space Policy as the basic guidelines for a ten-year space policy, recognizing this huge potential of space and the severe situation Japan is currently facing, and anticipating the next 20 years.

② Measures and Solutions for Achieving the Objectives

In order to achieve the above objectives, we will implement measures and solutions, including the following, in accordance with the new Basic Plan for Space Policy.

<Quasi-Zenith Satellite System>

○ Regarding the quasi-zenith satellite system Michibiki which started service in November 2018, we will establish a 7-satellite constellation by about FY2023 and steadily carry out the development, maintenance, and strengthening of the security of the ground equipment needed for this structure, and strategically and continuously advance the upgrading of positioning technologies, including the improvement of precision and reliability and the strengthening of survivability, etc. We will also collaborate with the G Spatial Project to expand the use of Michibiki in a variety of fields such as disaster prevention, logistics, railroads, automated driving, automatically-operating ships, agriculture, etc. through support, etc. for the dissemination of demonstration projects and compatible receivers, and furthermore carry out initiatives incorporating the perspective of overseas deployment.

[Cabinet Secretariat, Space, MIC, MEXT, MAFF, METI, MLIT]

<Information-Gathering Satellites>

○ We will steadily increase the number of satellites with temporal axis diversification satellites and data relay satellites added to four optical and radar satellites (mission-critical satellites) to work for the improvement of instantaneousness and readiness through the establishment of a 10-satellite constellation, and we will enhance and strengthen functions and improve the quality of information through research and development, etc. of cutting-edge technologies.

[Cabinet Secretariat]

<Participation in International Space Exploration>

○ Regarding the international space exploration proposed by the United States (the Artemis program), taking into account the fact that it has a different character from previous space science and exploration in the sense that it is aiming for sustainable activities on the Moon, etc., the entire government will advance investigations including of involvement from perspectives other than space science and exploration, such as economic activities, diplomacy, and security, etc., and we shall participate in a way that ensures the independence of Japan. When participating in international space exploration, we will sufficiently exercise the presence of Japan as a developed space country, for example by securing opportunities for Japanese astronauts to be involved, etc., while the entire government will strategically and efficiently advance initiatives that are significant for Japan. For that purpose, we will participate in the sharing of data about the surface of the Moon, through areas in which Japan possesses strength such as manned stay technologies, supplying, and landing on and exploring the surface of the Moon, and we will tackle the building of the systems that are essential for activities on the surface of the Moon, including means of moving on the surface of the Moon.

Furthermore, we will collaborate with universities and private sector projects, etc. while advancing the development and upgrading of the fundamental technologies necessary for sustainable exploration activities on the Moon and further away than the Moon. [Space, MEXT, relevant offices, ministries, and agencies]

○ Regarding the International Space Station (ISS) program, we will advance further streamlining of operation, and utilize it to acquire, strengthen, etc. the capability necessary for exploration of the Moon and Mars. [MEXT]

<Space Science and Exploration>

○ We will continue to tackle space science and exploration with a long-term perspective and the track record and technological capability of Japan which has received a high evaluation globally, in particular the original deep space exploration technologies cultivated using Hayabusa 2, etc. as its foundation, to lead to the further improvement of the presence of Japan, and we will make efforts such as actively advancing derivations to terrestrial technologies, etc. For this reason, we will secure and promote funds on a certain scale while referencing JAXA's Space Science/Exploration Roadmap, with a bottom-up approach based on proposals from researchers as its foundation. [MEXT]

<Space Transportation Systems>

○ For securing the independence of the space activities of Japan, we will continuously advance the development and upgrading, etc. of mainstay rockets, including newly positioning H3 rockets as mainstay rockets and completing the H3 rockets, and we will take into account the trends in the competitive environment of the rocket launch market, etc. while taking the measures necessary for the effective and efficient maintenance of mainstay rockets. [MEXT]

○ In order to continuously secure the independence of the space transportation systems of Japan and strengthen competitiveness in the future market, we will take into account the business models of domestic private-sector launch business operators and the significance, etc. with respect to the space transportation policies and security of foreign countries while investigating innovative future space transportation systems and technologies aiming for fundamental cost reductions, etc. (reuse technologies, innovative materials technologies, propulsion system technologies (LNG,[140] air breathing), reliability improvement technologies contributing to manned transportation, etc.) and formulating specific roadmaps clearly stating the earliest times they can be realized. In conjunction with this, under continuous promotion structures in which

[140] Liquified Natural Gas

industry, academia, and government participated, including users, we will carry out appropriate progress management led by the government while implementing challenging research and development. [MEXT, relevant offices, ministries and agencies]

<Building of a Framework to Strategically Promote Satellite Development and Demonstration (a Satellite Development and Demonstration Platform)>

○ For securing the independence and strengthening the competitiveness of satellites for positioning, communications, earth observations, information gathering, etc., we will newly build structures comprising key industry, academia, and government entities, including the users of satellites, and equipped with functions and strong leadership for continuous surveys and analyses and strategy drafting in the areas of domestic and overseas technologies and markets and policies. In these structures, we will rally the related institutions to establish development themes for innovative and ambitious satellite technologies anticipating the exit and preceding future user needs, in order to draft and promote the projects systematically.

We will utilize the above framework to tackle the development and demonstration of innovative fundamental technologies related to satellites, such as technologies, etc. pertaining to quantum cryptography communications, space optical communications, the flexibilization of satellites, digitalization, and satellite constellations. Furthermore, we will promote the provision, etc. of opportunities for building the Technology Renewal Satellite Program which carries out the development of engineering test satellites and agile development and demonstrations using small and ultra-small satellites, and opportunities for demonstrations in orbit of space parts and components utilizing ultra-small satellites, and demonstrations for universities and research institutions, etc. of new elemental technologies utilizing ultra-small satellites, etc.

[Space, MIC, MEXT, MAFF, METI, MLIT, MOE, MOD, relevant offices, ministries, and agencies]

<Satellite Development that Contributes to Disaster Countermeasures, National Resilience, and the Solution of Global Issues>

○ We will advance the development of meteorological satellites, greenhouse gas observation technology satellites, and advanced optical and radar satellites, and we will promote the continuous upgrading of mission-critical satellite technologies such as radar and microwave radiometers, etc. and the strengthening of the information infrastructure (DIAS), etc. [MEXT, MLIT, MOE]

<Expansion of Satellite Data Use>

○ In order for the private sector to take the lead in advancing the appropriate utilization of satellites for the streamlining and upgrading of the operations of the national government and local governments, the relevant offices and ministries will investigate the possibilities for the use of satellite remote sensing data in their respective operations, and in cases where it is reasonable will make the use of this data a general principle. In order to advance these kinds of initiatives, during FY2020 we will establish the Task Force on the Use of Satellite Remote Sensing Data (provisional name) comprising the relevant offices and ministries. Furthermore, we will actively utilize small and ultra-small constellation satellites in information gathering.

[Space, MIC, MEXT, MAFF, METI, MLIT, MOE, MOD]

○ Geospatial information, including satellite remote sensing and positioning data, is the key to supporting the fourth industrial revolution, so we will promote projects in a wide range of fields such as disaster prevention, transportation and logistics, agriculture, forestry, and fisheries, the living environment, vitalization of the regions, and overseas deployment, in particular the symbolic projects in the Basic Plan for the Advancement of Utilizing Geospatial Information, and we will advance active utilization of the G-Spatial Information Center to work for realization of the Sophisticated Utilization of Geospatial Information Society (G Spatial Society).

[Cabinet Secretariat, STI, Disaster, Space, MIC, MEXT, MAFF, METI, MLIT, relevant offices, ministries and agencies]

○ We will utilize satellite positioning data and remote sensing data to implement new model demonstrations and research that contribute to disaster countermeasures and national resilience. Furthermore, in “Enhancement of national resilience (disaster prevention and disaster mitigation)” in SIP II, work for the utilization of satellite data in disaster countermeasures and greater national resilience through collaboration with the users in disaster prevention worksites, by developing and carrying out the social implementation by FY2022 of systems that utilize a full range of domestic and overseas remote sensing data to generate information products and analyze and share satellite data using SIP4D, etc., thereby enabling the rapid ascertaining of the status of the damage at the time of a disaster and ascertaining of the chronology of events.

[STI, Disaster, Space]

○ Regarding government satellite data with a strong public character, from the perspectives of the encouragement of satellite data utilization and the convenience of satellite data users, we will establish an “open & free” approach for free provision of data, excluding data about which there are security concerns, in a form in which the use of processing and analysis, etc. is easy at an internationally equal level. When doing so, we will take care not to hinder the satellite data sales businesses run by private sector business operators, etc. [Space, MEXT, METI, MLIT, MOE, relevant

offices, ministries and agencies]

○ Regarding the government satellite data platform Tellus, we will fully utilize private sector vitality while advancing data and analysis tool enhancement, etc. from FY2020 onwards as well. We will promote the utilization of satellite data through the active utilization, etc. of Tellus by government and public institutions (anchor tenancy) and advance the international sharing of satellite data in order to boost the creation of new businesses utilizing satellite data. [METI, relevant offices, ministries and agencies]

<Building Systems for the Provision of Space Status Assessment Services to Private Sector Business Operators>

○ For the building of systems that integrate and analyze space object observation data to provide space object orbit information to private sector business operators, etc. appropriately, we will build a unified investigative structure for the related government institutions, etc. by early FY2020. Under that structure, we will advance the development of the related systems while also taking into account the appropriate division of roles between the public and private sectors. [Space, MEXT, METI, MOD, relevant offices, ministries, and agencies]

<Expansion of Procurement from the Private Sector, such as Venture Companies, etc.>

○ Regarding projects by the national government, including by national research and development agencies such as JAXA, etc., we will adopt the basic approach of procuring from the private sector the items that the private sector can provide, and we will actively advance revisions to the methods of procurement and contracting by government institutions, including the utilization of a new SBIR system, the introduction of flexible contract types such as milestone payments, etc., and the acceleration of the release and provision of the required specifications for technologies and services, etc., in order to encourage venture companies, etc. to expand their procurement from the private sector and independent initiatives by the private sector.

[Space, MEXT, METI, relevant offices, ministries, and agencies]

<Institutional Environment Development>

○ We will accelerate the development of the institutional environment that will be necessary for the new space businesses for which growth is expected going forward. Regarding sub-orbital flight, which is being investigated for utilization in the air launch of small satellites and in space travel, etc., public and private sectors councils will take the lead to accelerate investigation of the development of an environment that contributes to future business expansion, while taking into account the status of

initiatives in domestic and overseas private sector business operators aiming for commercialization in the first half of the 2020s and international trends. Furthermore, we will take into account the trends, etc. in international discussions around resources exploration and development and activities in orbit by private sector business operators in outer space, including on the surface of the Moon, and space traffic management (STM), in order to build an investigative structure comprising the relevant offices and ministries early, investigate the necessary systems development, and take the necessary measures. [Space, MOFA, MEXT, METI, MLIT, relevant offices, ministries, and agencies]

<Space Debris Countermeasures>

○ We will promote specific initiatives regarding space debris countermeasures based on the proposals to the minister by the Task Force of the Relevant Offices and Ministries, etc. concerning Space Debris (May 2019). For example, we will steadily advance demonstrations of technologies to remove the debris starting in FY2020. [Space, MIC, MOFA, MEXT, METI, MLIT, MOE, MOD]

○ We will appropriate operate the Greenhouse gases Observing SATellite (GOSAT) and carry out an investigation and take the necessary measures to ensure that this satellite does not remain in space as space debris.

[MEXT, MOE]

<Monitoring of the Space Environment (Space Weather)>

○ In order to contribute to ascertaining the situation in space, the development and operation of satellites, communications and broadcasting on the ground, and the stable use of satellite positioning, etc., we will observe and analyze the ionosphere, magnetosphere, and solar activity in order to distribute space weather reports, and we will advance the upgrading, etc. of the relevant observation and analysis systems. [MIC]

<Strengthening of the Human Resources Basis that Supports Space Activities>

○ We will strengthen the development, etc. of next-generation human resources through human resources development linked to school education that anticipates expansion of the base of space-related people and through practical initiatives pertaining to space technologies targeting university students, etc., and we will advance the discovery and development of expert human resources who can build bridges to other fields and human resources possessing advanced knowledge in the humanities and social sciences. [MEXT]

(5) Food and Agriculture, Forestry, and Fisheries

○ **Future Visions to be Pursued**

- With the focus on diverse domestic and overseas needs, accelerate the nationwide deployment of smart agriculture that fully utilizes data to achieve income improvement, through service entities that carry out sharing, leasing, etc.
- Improve the brand power of Japanese agriculture and contribute to the realization of sustainable agriculture that responds to climate change, by deploying smart agriculture technologies and systems originating from Japan to the Asia-Pacific region, etc.
- ***Work for enhancement of the Agricultural Data Collaboration Platform (WAGRI) in order to deploy a smart food chain connected by data from production to distribution, processing, consumption, and exports. Private sector business operators to utilize WAGRI to realize efficient production and distribution and the provision of agricultural products and food that meticulously meet domestic and overseas consumer needs. Contribute to the achievement of new export objectives***
- ***Build made-to-order distribution systems for "delicious and healthy food" through the consolidation of WAGRI with big data about health care, etc. (Reiwa Era-style "a balanced diet leads to a healthy body")***
- ***Build the agri-biohub, a breeding platform that private sector companies, etc. can utilize for the development of varieties, and quickly develop agricultural crops, etc. matched to diverse needs***
- ***Promote initiatives for smart forestry and smart fisheries, implement new technologies such as ICT, AI, robot technologies, etc. in forestry and fisheries worksites, and contribute to turning forestry and fisheries into growth industries***

○ **Objectives**

As the labor force greatly shrinks due to the full-blown declining birthrate, aging population and population decrease going forward, in order to realize the above vision of the future, utilize the results of the SIP, etc. to create innovation in food and agriculture, forestry, and fisheries

<Social Implementation of Smart Agriculture>

- Having virtually all farmers practice data-utilizing agriculture by 2025

<Capturing the Global Market>

- ***Comprehensively advance initiatives to encourage exports of agriculture, forestry, and fisheries products and food in order to contribute to the objectives of raising exports to 2 trillion yen by 2025 and 5 trillion yen by 2030***

① Implementation Status and Analysis of the Current Situation

<Clarification of the Targets and Promotion of Development and Social Implementation of Technology with an Eye on the Global Market>

i) Promotion of smart agriculture

○ We have started agricultural ICT services in private sector companies that utilize WAGRI, which started operation in April 2019. Going forward, it is necessary to further implement open data, etc. in WAGRI in order to advance the development of an environment in which it is easy for private sector companies, etc. to develop and provide agricultural ICT services.

○ Furthermore, with the technologies of WAGRI as the infrastructure, we are building infrastructure capable of linking the information from production to processing, distribution, consumption, and exports, and we are advancing the development, etc. of data formats anticipating international collaboration.

○ Regarding demonstrations in production worksites in smart agriculture, we will take into account initiatives, etc. for new services contributing to the reduction of the cost of introduction in order to deploy demonstrations nationwide.

○ In order to support meticulous farming management based on data, we are updating the nationwide agricultural land block information (estate boundary polygon) to the latest information every year, and we are promoting initiatives to improve its precision.

ii) Response to climate change based on sustainable agriculture, forestry, and fisheries

○ The Progressive Environment Innovation Strategy was formulated in January 2020. In order to promote environment countermeasures such as the response to global warming, etc. positioned in the said strategy, it is necessary to develop technologies pertaining to climate change, etc. alleviation measures and adaptation measures in the agriculture, forestry, and fisheries fields as well.

iii) Utilization of biotechnologies in food and materials, etc.

○ For capturing the global market by utilizing cutting-edge biotechnologies, it is necessary to develop technologies pertaining to food and health, smart breeding, new materials utilizing biological functions, etc.

iv) Expansion of exports of agriculture, forestry, and fisheries products and food

○ Exports of agriculture, forestry, and fisheries products and food were 912.1 billion yen in 2019. Going forward, in order to further expand exports of agriculture, forestry, and fisheries products and food, it is necessary to develop technologies for realizing meticulous production that responds to the tastes and residual agricultural chemical standards, etc. of each export destination.

<Development of an Environment for Acceleration of Development and Social Implementation of Technology>

i) Development of an environment in the food and agriculture fields

○ In order to develop an environment in which agriculture-related people can provide data and know-how with peace of mind, we formulated the Contract Guidelines on AI and Data in the Agricultural Field in March 2020. Going forward, it is necessary to advance dissemination of and education about the guidelines.

○ For the dissemination and expansion of smart agriculture, it is necessary to tackle cost-benefit analyses taking into account the demonstration results, the formulation of a model for introduction based on the actual circumstances of the items and regions, the reduction of the costs of introduction of high-value smart agricultural equipment, etc.

○ Going forward, it is necessary to work for consolidation of the big data of different fields such as health care information, etc. while keeping WAGRI at its core, and promote innovation at the top level in the world; for example, development of made-to-order distribution systems for “delicious and healthy food.”

○ As a consequence of the application and penetration of industrial technologies in the agriculture, forestry, and fisheries and food fields, including smart agriculture, etc., technology development in fields merging agriculture and industry is progressing. In order for the outstanding technologies and quality in each region of Japan to be evaluated correctly internationally, it is necessary to strengthen initiatives for strategic standardization suitable for the characteristics of the regions.

ii) Development of an environment in the forestry and fisheries fields

○ In December 2019, we formulated the Program to Promote the Implementation of Forestry Innovation in Worksites, which has the purpose of effectively advancing initiatives from the development to the dissemination of new technologies in order to accelerate their introduction in forestry worksites, and going forward we will advance initiatives based on this.

○ In December 2019, we formulated the Program to Promote the Implementation of New Fisheries Technologies in Worksites, which has the purpose of the related people such as fishermen and companies, research institutions, administration, etc. collaborating with a common perception to accelerate the implementation of new technologies in fisheries worksites, and going forward we will advance initiatives based on this.

② Measures and Solutions for Achieving the Objectives

Based on the Agriculture, Forestry, and Fisheries Research Innovation Strategy 2020 (formulated in May 2020), we will accelerate innovation creation pertaining to food and agriculture, forestry, and fisheries.

<Clarification of the Targets and Promotion of Development and Social Implementation of Technology with an Eye on the Global Market>

i) Promotion of smart agriculture

○ For the realization of automation and unattended systems in agriculture, forestry, and fisheries, we will fully utilize cutting-edge technologies to develop remote monitoring technologies for work robots, etc. [STI, MAFF]

○ We will develop intelligent systems for production management based on cooperative work by harvesting robots and conveyance robots. [STI, MAFF]

○ In order to encourage the nationwide introduction of smart agriculture technologies to worksites, we will develop compact machinery equipped with special functions that can be applied to diverse items, mountainous regions, etc. [STI, MAFF]

○ We will develop data-driven agriculture, forestry, and fisheries technologies, such as disease and pest diagnostic technologies using advanced image analyses utilizing AI. [MAFF]

○ We will advance the building of a Smart Food Chain System, a platform that enables the sharing and utilizing of information from production to processing, distribution, consumption, and exports for optimization of the food chain overall, by FY2022. [Cabinet Secretariat, STI, MEXT, MAFF, METI, MLIT]

○ In particular, by FY2020 we will develop a prototype of the Smart Food Chain System that covers the food chain overall in order to contribute to the growth of added value for the expansion of exports, and demonstrate the prototype for each use case. [STI, MAFF, METI]

○ We will advance the development of technologies that enable high-precision growing and shipping coordination, supply and demand matching technologies utilizing AI, etc., and optimization technologies for new distribution. [STI, MAFF]

ii) Response to environmental problems such as climate change, etc. based on sustainable agriculture, forestry, and fisheries

○ We will aim to build local-production-for-local-consumption energy systems suitable for rural areas, and we will carry out development, etc. of technologies that utilize the renewable energy available in rural areas at a low cost and efficiently. [MAFF]

○ In order to reduce greenhouse gas emissions generated from food disposal, we will advance a survey toward the introduction of subcritical water processing technologies in order to promote the recycling of food waste downstream from food distribution, when sorting is difficult. [MAFF]

○ We will develop materials to reduce methane emissions derived from cropland soil and livestock, and in order to reduce the CO_2 that results from fuel combustion in agricultural production, we will develop technologies such as electrification of agricultural machinery, conversion to fuel cells, etc. [MAFF, METI]

○ We will develop materials that increase the carbon storage of cropland soil by injecting biochar, and we will promote development of blue carbon evaluation technologies. Furthermore, in order to encourage carbon fixation in forests, we will carry out

development and dissemination, etc. of varieties, etc. of fast-growing trees and elite trees. [MAFF, MLIT]

○ By elucidating the functions of soil microorganisms, we will develop food production technologies with a small environmental load that fully utilize the functions of microorganisms and do not depend on chemical fertilizers and agricultural chemicals. [STI, MAFF]

○ In order to alleviate the damage to the agriculture, forestry, and fisheries fields caused by climate change, we will evaluate the effectiveness of measures to adapt rice to climate change, and we will develop, etc. technologies pertaining to flood prevention that utilize the water-retaining functions of farmlands, etc. [STI, MAFF]

○ We will convert data about the nationwide climate, soil, items, technologies, production volumes, etc. into big data, and utilize AI, etc. to tackle production volume forecasting, etc. based on items and technologies, etc., with the aim of realization of the presentation of a production model that responds to climate change, including optimal items and technologies, etc. in FY2025. [MAFF]

iii) Utilization of biotechnologies in food and materials, etc.

○ We will scientifically elucidate the functions of gut flora and biomarkers, etc. to propose and provide delicious and healthy food based on the state of health and constitution, etc. of individuals (Reiwa Era-style “a balanced diet leads to a healthy body”). Furthermore, we will develop big data consolidated in different fields such as health care, etc., and realize more advanced agriculture production and distribution systems, such as “delicious and healthy food” production and distribution systems, etc. [Cabinet Secretariat, STI, MEXT, MAFF, METI]

○ When doing so, we will consolidate this big data with WAGRI to work for the building of an environment that can provide made-to-order food domestically and overseas. [STI, MAFF, METI, MLIT]

○ We will gather and analyze the evidence concerning the healthiness of Japanese food. [MAFF]

○ We will gather big data on breeding and genetic resources to build the agri-biohub, a breeding platform that the private sector, etc. can utilize for the development of varieties, and develop agricultural crops, etc. matched to diverse needs, such as varieties rich in functionality and varieties responding to climate change, etc. Moreover, through WAGRI, we will promote the development of varieties of agricultural crops, etc., by collaborating with breeding data and other agricultural data to create hubs in which multiple breeding institutions can collaborate. [STI, MEXT, MAFF]

○ We will develop high-quality lignin materials extracted from woody biomass, and we will carry out the technology development and demonstrations necessary for building

the manufacturing processes for manufacturing said materials, such as the optimal compounding of auxiliary materials and manufacturing processes, etc. [MAFF]

○ We will promote bio “Monozukuri” (Manufacturing) such as animal pharmaceuticals, etc. based on useful organisms with plants and food residue, etc. as their raw materials, and new biomaterials utilizing biomass resources, etc. [STI, MAFF, METI]

iv) Expansion of exports of agriculture, forestry, and fisheries products and food

○ For the achievement of new export objectives for agriculture, forestry, and fisheries products and food, in order to realize meticulous production that responds to the tastes and residual agricultural chemical standards, etc. of each export destination, we will promote productivity improvements through the acceleration, etc. of smart agriculture and in addition we will promote the development of varieties matching needs, the reduction of costs, and research and development of production technologies, etc. such as appropriate disease and pest elimination, etc. [MAFF]

○ We will advance the building of a Smart Food Chain System, a platform that enables the sharing and utilizing of information from production to processing, distribution, consumption, and exports for optimization of the food chain overall, by FY2022. [Cabinet Secretariat, STI, MEXT, MAFF, METI, MLIT] [Restated]

○ In particular, by FY2020 we will develop a prototype of the Smart Food Chain System that covers the food chain overall in order to contribute to the growth of added value for the expansion of exports, and demonstrate the prototype for each use case. [STI, MAFF, METI] [Restated]

○ We will advance the development of technologies that enable high-precision growing and shipping coordination, supply and demand matching technologies utilizing AI, etc., and optimization technologies for new distribution. [STI, MAFF] [Restated]

○ We will gather and analyze the evidence concerning the healthiness of Japanese food. [MAFF] [Restated]

<Development of an Environment for Acceleration of Development and Social Implementation of Technology>

i) Development of an environment in the food and agriculture fields

○ We will support research and development, etc. aiming for smart agriculture technologies and overseas deployment that responds to the gap domains in the research and development for the regions and items. Furthermore, through expert dispatches (hands-on support), etc., we will strongly advance social implementation of the research results created by collaboration between industry and academia. In conjunction with this, we will support the startups that will be responsible for this research and development and implementation. [MAFF]

○ Through the strengthening of exchanges and collaborations between production worksites and industry, academia, and government, and the encouragement of their

entry into different industry types, we will encourage the development of a new business model for sharing and leasing, etc. that reduces the costs of introducing smart agriculture, and the creation of agriculture support services. [MAFF]

○ By implementing the open data, etc. of the national government in WAGRI, we will put in place an environment to enhance the data that can be utilized in this infrastructure and encourage further creation of agricultural ICT services by the private sector. Furthermore, we will promote initiatives for data exchange among domestic companies through the utilization, etc. of WAGRI.

[Cabinet Secretariat, MAFF]

○ To ensure that smart agriculture is practiced in the major agricultural product items of each prefecture, we will work for the building and practice of a smart agriculture technology structure for each production region and item, taking into account the results of the demonstrations in each region. [MAFF]

○ Regarding the nationwide agricultural land block information (estate boundary polygon), we will demonstrate utilization in the automatic travelling of agricultural equipment, the visualization of the information and communications environment, utilization in soil analysis, etc. to promote the utilization of users practicing smart agriculture. [MAFF]

○ In order to support agriculture business management based on data, we will promote utilization of the results of agricultural management statistical surveys while anticipating collaborations, etc. with private sector management software for agricultural management. [MAFF]

○ We will advance use intention surveys concerning agriculture support services including services for the application of fertilizer and prevention of disease, etc. utilizing cutting-edge technologies such as drones and the IoT, etc., and services for harvesting work, etc. [MAFF]

○ We will establish data-driven smart agriculture technologies and systems with WAGRI at their core, and deploy them domestically and overseas. When doing so, we will take care to ensure that the strengths of Japanese agriculture, such as meticulous cultivation management, etc., are not lost. Moreover, we will move to the next step, the overseas deployment of the “healthy food” and systems of Japan, by building an environment in which made-to-order food can be provided.

[Cabinet Secretariat, STI, MAFF, METI, MLIT]

○ We will advance initiatives for optimization of transportation for overseas exports and for increasing the value of domestically-made agricultural products by utilizing international standards to share production information and distribution information among the related people, including the related people overseas.

[MAFF]

ii) Development of an environment in the forestry and fisheries fields

○ For improvement of the productivity, safety, and profitability of forestry, based on the Program to Promote the Implementation of Forestry Innovation in Worksites, we will promote forestry innovation through the promotion of smart forestry that utilizes ICT to carry out forest resources management and production management, expansion of the use of fast-growing trees, etc., and development of automated machinery and new wooden materials. [MAFF]

○ For improvement of productivity through the introduction of new technologies, based on the Program to Promote the Implementation of New Fisheries Technologies in Worksites, we will promote initiatives for smart fisheries, such as utilizing ICT to streamline operations and create higher added value from marine products, etc. [MAFF]

iii) Development of a cross-sectional environment

○ We will create matching opportunities with the diverse entities of different fields, etc. in order to strongly promote social implementation of the research results created by collaboration between industry and academia. In particular, regarding research results incorporating the perspective of the overseas market, we will encourage the transmission of information overseas and matching overseas. [MAFF]

○ In order to ensure that standardization needs in the regions lead appropriately to standardization, we will build a liaison, information sharing, and consultation structure together with the related incorporated administrative agencies, etc. in order to strongly promote strategic standardization activities in the agriculture, forestry, and fisheries and food fields, including the field merging agriculture and industry. [MAFF, METI]

(6) Other Important Fields

① Oceanic Field

For the solution of the problem of plastic trash in the ocean, we will tackle technology development for ascertaining the actual state of pollution and the research and development, etc. of techniques for evaluation of impacts on the ecosystem, and we will advance harmonization of the distribution of plastic trash in the ocean, including microplastics, with monitoring techniques and global data aggregation, estimates of generation sources and emissions, and survey research on biological impacts. Furthermore, we will implement development of resources circulation industries through innovation concerning substitute materials such as ocean-biodegradable plastics, etc. and the strengthening of recycling, treatment and reduction of the amount of trash washed ashore, and the initiatives presented in the framework for international collaborations which was a result of the G20 Osaka Summit.

Regarding ocean data, in order to expand the fields of use anticipating social implementation, as a part of the strengthening of the capability of MDA, we will implement the strengthening of functions anticipating further utilization of advanced information sharing systems, such as a DIAS that stores, integrates, and analyzes earth environment big data, a maritime condition display system that can display a variety of maritime information superimposed on a map, etc. Furthermore, in order to increase the enhancement of maritime information at an accelerating pace, we will strengthen collaboration with the systems possessed not only by government institutions but also the institutions of local governments, the private sector, foreign countries, etc. Moreover, in order to encourage the distribution and utilization of data, we will advance the development of the environment, including API collaboration and standardization of the necessary data, etc.

Furthermore, in order to effectively strengthen visualization of the ocean, as a means of obtaining the maritime information essential for making progress in the utilization of Japan's EEZ,[141] we will advance development and demonstration of the marine resource survey technologies in the Development of Innovative Technologies for Exploration of Deep Sea Resources of SIP II to tackle research and development of ocean observation technologies and next-generation unmanned probe systems including technologies for AUVs, such as multiple AUV operation and a terminal system for recharging AUV batteries in the deep sea.

At a time when developments concerning the Arctic are gathering pace, and keeping in mind our contribution to the Arctic Science Ministerial to be held in Japan, we perceive the size of the impact of the environmental changes in the Arctic region on the entire planet so we will tackle research and development for the observation and sustainable use of the Arctic region, starting with the steady promotion of initiatives concerning Arctic

[141] Exclusive Economic Zone

region research vessels.

We will appropriately operate the Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities, which was brought into force in April 2019 for encouragement of the introduction of offshore wind power generation, and we will tackle technology development, etc. for ocean energy such as offshore wind power generation and ocean current power generation, etc.

For the reduction of greenhouse gas (GHG) emissions from ships, we will tackle the development and practical application of low-carbon and decarbonizing technologies, etc., and the early building of international systems which encourage the replacement of old ships that produce a lot of GHG emissions with newly-built ships, etc. [Ocean and STI, MEXT, METI, MLIT, MOE]

② Radiation and Radioactive Isotopes Field

Radiation and radioactive isotopes (hereinafter referred to as “Radiation, etc.”) are used in a wide range of fields such as industry, medical care, agriculture, environmental conservation, etc., and the economic scale of their use is estimated to be 4.37 trillion yen (FY2015), etc., so they are broadly related to people’s lives, and this is a field that possesses scientific infrastructure in common with cutting-edge science and technology.

Radiation, etc. has beneficial properties that can be applied and used, such as substance permeance, the concentration of local energy, conversion of chemical substances, damage to bacteria and cells, etc. For example, diagnostics and cancer treatments utilizing radiation, in particular heavy particle radiation therapy and internal therapies, are contributing to maintaining the health of citizens. Apart from these examples, its social use is already established in multiple fields such as engineering, medicine, agronomics, science, etc. Going forward, there is a possibility that new domains merged across these domains will be created and technologies that can be further applied in society will appear.

In the United States, Australia, etc., the national government and research institutions are taking the lead in actively tackling the utilization of Radiation, etc. For example, they are opening up research facilities to the private sector and implementing human resources development programs, including programs for students. However, in Japan there is the issue that although there are many departments in charge of the measures in the government there are not sufficient initiatives for social implementation, etc.

For this reason, it is necessary for the relevant offices, ministries, and agencies to firstly spread the perception that the use of Radiation, etc. is contributing to the improvement of people’s lives and to clarify the issues to overcome to encourage the use of radiation. Furthermore, while giving priority to securing safety pertaining to radiation protection in all cases, going forward it will be required to strategically and effectively utilize Radiation, etc. by encouraging collaborations between fields such as

engineering, medicine, science, etc., and merging multiple specialized domains to tackle the challenges through an all-Japan structure involving collaboration with not only the national government, universities, and research institutions, but also private sector companies as well. [STI]

③ The field of “Monozukuri” (Manufacturing) and “Kotozukuri” (Value Creation) Using Data

In order to realize Connected Industries so that the manufacturing industries of Japan acquire new competitiveness, it is necessary to make ongoing improvements in manufacturing worksites in order to fully utilize the “valuable data” that is generated from the world’s best quality, and to strengthen the transformation ability (dynamic capability) of companies so that they can respond to the rise in uncertainty, in particular the trade friction between the United States and China and outbreaks of infectious diseases.

From this perspective, industry, academia, and government are working together to advance the building of a mechanism for AI and people to cooperate while realizing further improvement and evolution, which involves teaching AI the know-how and knowledge possessed by manufacturing worksites in order to support people (a digital triplet).

Furthermore, in order to fully utilize the valuable data generated from manufacturing worksites, domestic organizations and companies are cooperating to carry out demonstration experiments, etc. regarding the mechanisms for distributing data beyond the barriers of companies that had been built by FY2019, with the aim of starting actual operation by FY2021.

In order for Japan to promote these initiatives comprehensively and internationally, RRI[142] is taking the lead in advancing international standardization, etc. while also collaborating with Plattform Industrie 4.0, the parent organization promoting Industrie 4.0 in Germany, and other organizations.

Moreover, we will work toward the building of business structures for rapidly and flexibly rearranging the supply chain and the creation of technology development and prior examples for the full-scale utilization of information and communications technologies such as 5G, etc. in manufacturing worksites, by carrying out seamless data exchange utilizing digital technologies between manufacturing processes and companies positioned on the same supply chain. [MIC, METI]

Additionally, from the perspective of eliminating the “language barrier” to encourage global and free exchange, Japan is working on the development and dissemination of multi-lingual translation technologies, and they are being utilized in a variety of situations

[142] Robot Revolution & Industrial IoT Initiative

such as administrative procedures, medical care, transportation, tourism, etc. so this is also an important field from the perspective of meeting the needs of foreign nationals visiting Japan or foreign residents in Japan.

Going forward toward 2025, the dramatic development of multi-lingual translation technologies for strengthening of the business capacity needed for situations such as discussions and negotiations in business and international conferences, etc., realization of a symbiotic society against the background of the tourism strategy and policy for acceptance of foreign human resources being advanced by the whole government, and improvement of the presence of Japan in the World Exposition in Japan (the Osaka, Kansai World Exposition) is expected.

The Global Communication Plan 2025 was formulated from this kind of perspective in March 2020. In response to this plan, industry, academia, and government will collaborate and cooperate to advance the gathering and utilization of large amounts of high-quality language data, etc. anticipating applications in everything from research to industry, and will tackle research and development for the realization of “simultaneous interpreting” at a practical level and its precision improvement, etc., by working to further upgrade multi-lingual translation technologies. Through these initiatives, we will advance the implementation in society of systems combining simultaneous interpreting technologies and diverse ICT as the drivers of the digitalization of society, with the aim of contributing to social and economic activities. [MIC]

List of Abbreviations

Abbreviation	Formal name
AI	Artificial Intelligence
AMED	Japan Agency for Medical Research and Development
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
AUV	Autonomous Underwater Vehicle
BIM	Building Information Modeling
BSL	Biosafety Level
CCU	Carbon Capture and Utilization
CCUS	Carbon dioxide Capture, Utilization and Storage
CIM	Construction Information Modeling
CIP	Collaborative Innovation Partnership
COP25	The 25th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change
COP26	The 26th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change
CPU	Central Processing Unit
CPS	Cyber-Physical System
CSTI	Council for Science, Technology and Innovation
DFFT	Data Free Flow with Trust
DIAS	Data Integration and Analysis System
DX	Digital Transformation
EBPM	Evidence-based Policy Making
ELSI	Ethical, Legal and Social Issues
ESG	Environment, Social, Governance
e-Rad	The Cross-Ministerial Research and Development Management System
EU	European Union
FPGA	Field Programmable Gate Array
G-PON	Gigabit Passive Optical Network
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IMD	International Institute for Management Development

Abbreviation	Formal name
ImPACT	Impulsing PAradigm Change through disruptive Technologies Program
IoE	Internet of Energy
IoT	Internet of Things
IPA	Information-technology Promotion Agency, Japan
IPCC	Intergovernmental Panel on Climate Change
IR	Institutional Research
ISO	International Organization for Standardization
ITS	Intelligent Transport Systems
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JASCA	Japan Association for Smart Cities in ASEAN
JAXA	Japan Aerospace Exploration Agency
JIS	Japanese Industrial Standards
JOIC	Japan Open Innovation Council
JSPS	Japan Society for the Promotion of Science
JST	Japan Science and Technology Agency
MaaS	Mobility as a Service
MDA	Maritime Domain Awareness
MI	Materials Integration
MOOC	Massive Open Online Courses
NEDO	New Energy and Industrial Technology Development Organization
NICT	National Institute of Information and Communications Technology
NIED	National Research Institute for Earth Science and Disaster Resilience
NIES	National Institute for Environmental Studies
NII	National Institute of Informatics
NIMS	National Institute for Materials Science
NIST	National Institute of Standards and Technology
OECD	Organisation for Economic Co-operation and Development
OS	Operating System
OSS	Open-source software
PBL	Problem/Project Based Learning
PD	Program Director

Abbreviation	Formal name
PRISM	Public/Private R&D Investment Strategic Expansion PrograM
RA	Research Assistant
SBIR	Small Business Innovation Research
SCORE	Sentence Corpus of Remedial English
SDGs	Sustainable Development Goals
SGU	Super Global University Project
SINET	Science Information NETwork
SIP	Cross-ministerial Strategic Innovation Promotion Program
SIP4D	Shared Information Platform for Disaster Management
STEAM	Science, Technology, Engineering, Arts and Mathematics
STI	Science, Technology and Innovation
TFP	Total Factor Productivity
TICAD	Tokyo International Conference on African Development
TICAD7	The 7th Tokyo International Conference on African Development
URA	University Research Administrator
VC	Venture Capital
VEC	Venture Enterprise Center
WG	Working Group
WHO	World Health Organization
WPI	World Premier International Research Center Initiative
KAKENHI	Grants-in-Aid for Scientific Research
UN	The United Nations
JST	Japan Science and Technology Agency[143]
AI ST	National Institute of Advanced Industrial Science and Technology
CAO(STI)	Cabinet Office, Director General for Science, Technology, and Innovation
NARO	National Agriculture and Food Research Organization
RIKEN	Institute of Physical and Chemical Research

[143] An incorporated administrative agency provided for in the Act on General Rules for Incorporated Administrative Agencies (Act No. 103 of 1999), Article 2, Paragraph 3.

In particular, the abbreviations of the names of the offices, ministries, and agencies used inside square brackets ([]) in "② Measures and Solutions for Achieving the Objectives" and "③ Measures and Solutions for Achieving the Objectives" are as follows.

Abbreviation	Name of office, ministry, or agency		
NPA	National Personnel Authority		
Reconstruction	Reconstruction Agency		
OSSTNS	Cabinet Office	Office of the Social Security and Tax Number System in the Minister's Secretariat	
STI		Director General for Science, Technology and Innovation Policy	
Disaster		Director General for Disaster Management	
FSC		Food Safety Commission Secretariat	
OPDVLE		Office for the Promotion of Overcoming Population Decline and Vitalizing Local Economy in Japan	
SIPSH		Secretariat of the Intellectual Property Strategy Headquarters	
Space		National Space Policy Secretariat	
CCRA		Child and Child-Rearing Administration	
Ocean		National Ocean Policy Secretariat	
NPA		National Public Safety Commission	National Police Agency
PPC		Personal Information Protection Commission Secretariat	
FSA		Financial Service Agency	
CAA		Consumer Affairs Agency	
REVIC		Office for Regional Economy Vitalization Corporation of Japan	
AMED		Office for Japan Agency for Medical Research and Development (AMED) and Medical Information Infrastructure	
MIC	Ministry of Internal Affairs and Communications		
MOJ	Ministry of Justice		
MOFA	Ministry of Foreign Affairs		
MOF	Ministry of Finance		
MEXT	Ministry of Education, Culture, Sports, Science and Technology		
MHLW	Ministry of Health, Labor and Welfare		
MAFF	Ministry of Agriculture, Forestry and Fisheries		

METI	Ministry of Economy, Trade and Industry
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOE	Ministry of the Environment
MOD	Ministry of Defense