NISTEP REPORT No.164 Summary

The 10th Science and Technology Foresight

Scenario Planning from the Viewpoint of Globalization

- Summary Report -

September 2015

Science and Technology Foresight Center
National Institute of Science and Technology Policy
Ministry of Education, Culture, Sports, Science and Technology

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Contents

1. Structure of the study

The National Institute of Science and Technology Policy has carried out “The 10th Science and Technology Foresight”（hearafter referred to as ‘Foresight’）from the 2013 fiscal year. The Foresight consists of 3 parts; Part 1: Examining the Vision of Future Society; Part 2: Science and Technology Foresight by Field; and Part 3: Scenario Planning. This study falls under the final step of the whole process of the Foresight. Taking an international view in making predictions about the further development of globalization and being based on the previous report of Part 1 and Part 2 mentioned above, we predected the future society in 2030 and scenarios to realize this society.

(1) Part 1：“Examining the Vision of Future Society ”

As globalization and becoming connected including people and things are being advanced, we examined the future society and changes in values based on the shift in demographic composition and industrial structure. To be specific, we firstly extracted social trends from the magazine article database and structuralized the items of social changes. Secondly, we held the workshops to examine social structuration, to evaluate the impact of the items for social changes, and to discuss the measures. We developed the future vision based on these finding.

(2) Part 2：“Science and Technology Foresight by Field”

Having extracted science and technology, which is expected to be realized, we carried out a questionnaire to collect experts’ views on the importance, the global competitiveness, and the feasibility. To be specific, we first set up committees according to respective study field and examined the science and technology topics based on the measures for the social changes discussed through the Part 1. Secondly, we carried out a questionnaire for such experts as the members of Academic Societies to collect their views on science and technology topics and analyzed the direction of science and technology development.

(3) Part 3：“Scenario Planning” (this Study)

After examining the direction of each individual theme based on the results of Part1 and Part2, we consolidated the directions and created scenarios from the viewpoint of globalization. To be specific, we firstly extracted issues by theme and examined direction of their solutions, and reconstructed them to create scenarios by theme along with the viewpoint of Globalization. Secondly, we summarized the three integrated scenarios from the viewpoint of globalization by using the scenarios by theme as a basic intelligence.

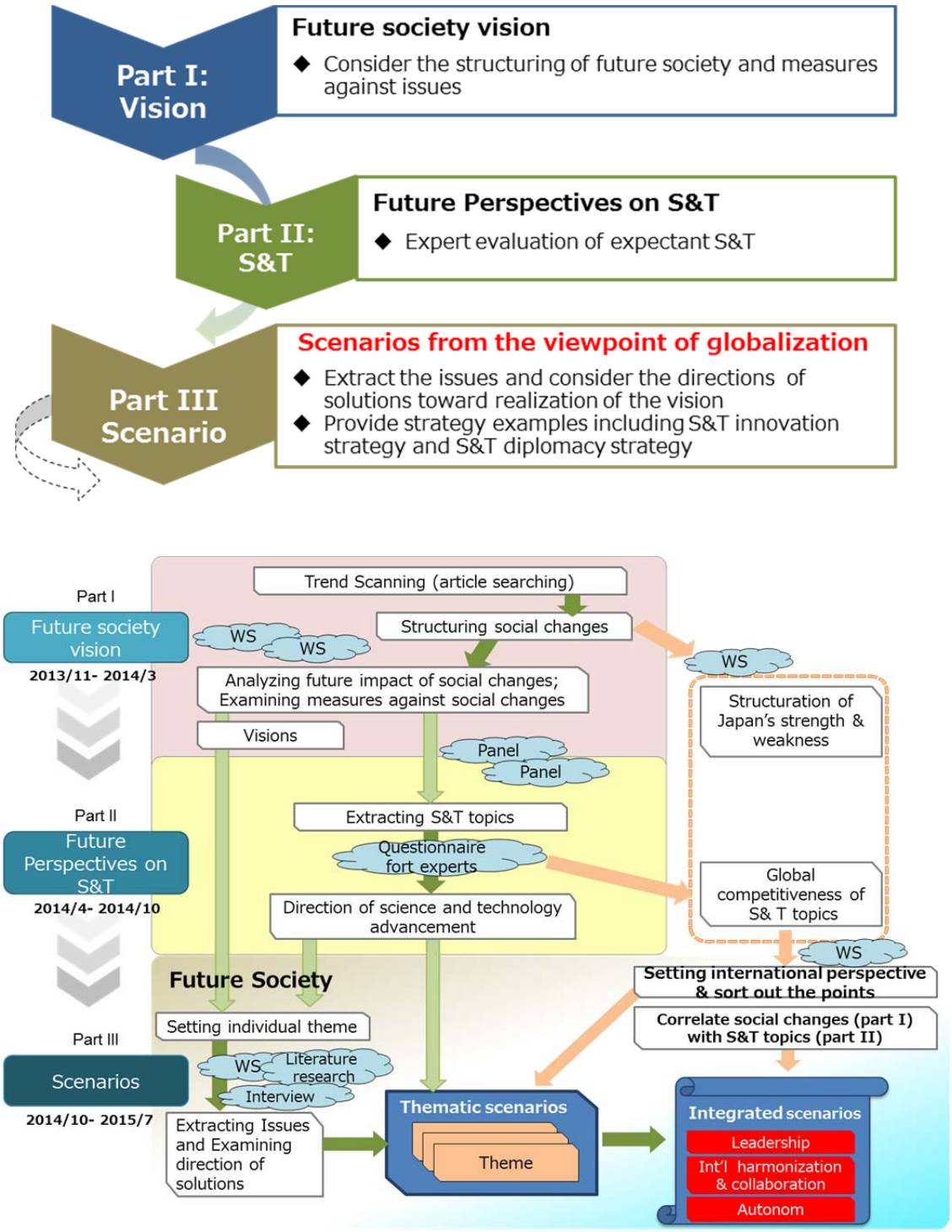


Figure 1: Structure and process of the study

2. Creating Scenarios

(1) Setting the Viewpoint of Globalization and Individual Theme

In this study, we set up the viewpoints of globalization from the aspects of Japan's positioning and role in the global world based on the self-recognition of our strengths and weaknesses, and created the integrated scenarios. The three set viewpoints include 'Leadership' as securing global competitiveness using the Japan's strengths, 'International Harmonization and Collaboration' as solving the global issues through international cooperation based on Japan's strengths, and 'Autonomy' as dealing autonomously with the issues relating to Japan's survival foundation). In addition, we referred to the results of "Examining the Vision of Future Society" (Part 1) and "Science and Technology Foresight by Field" (Part2) and set the individual theme to examine the creation of these three integrated scenarios.

(2) 'Scenarios' in the Study

The scenarios created in this study are composed of the future society in 2030, respective strategy by each body to actualize it, and points of attention when promoting the strategies. 'The society in 2030' is a possible future, which is positioned in between a desirable future (to be) and an extension of the current situation (as is). It is common in scenario planning to offer multiple independent cases as options by specifying axis and threshold. It shuld be noted that this study does not rely on one scenario and implement it but assume that each scenario would be realized under the most optimal environment in each situation and considering available resource restrictions.

3. Integrated Scenarios

We created the three integrated scenarios from the viewpoints of globalization as follows:

(1) Viewpoint 1: Leadership [Using the Japan's strengths to secur global competitiveness]

Leadership Scenario through Centralized Information Collection & Analysis based on "Manufacturing Capability"

The experts' recognition was indicated in the "Science and Technology Foresight by Field" (Part2) that Japan is superior to hardware but inferior to software, especially when using and systemizing mega data and the specialized human resources are short. We pictured Japan in the scenario as developing new industries and taking international leadership after leveraging hardware-aspect strengths such as device-related

technologies, collecting and analyzing life data in an integrated fashion, and resolving and overcoming the ethical problems. For the actualization of this scenario, it is considered to be important to design a system and set a policy associated with establishing and operating the infrastructure for utilizing information led by the national and local governments, and to promote research and development by universities and public research institutions including data analysis, security, and simulation.

(2) Viewpoint 2: International Harmonization & Collaboration [Using Japan's strengths to solve global issues through international cooperation]

International Harmonization & Collaboration Scenario to Solve Global Challenges

In dealing with the global issues such as climate change and infectious disease, we described a scenario under which Japan will play a major role in international engagement through ground and marine based observation. Japan will contribute by using its strengths which are technological and geographical conditions including marine resource management, sustainable agriculture, disaster prevention and reduction, and water treatment. It will further contribute to future design and safety of food by integrating food related technologies and ICT. Among those, the area where integrating satellite, marine, and ground data and solving global social issues by analysis and simulation is regarded as one of Japan's strongest areas to make an international contribution. To realize these scenarios, it is considered to be important for the government to have a major role to play in international activities and support to develop and disseminate the systems, legislative preparations, and adjustments among stakeholders. It is also expected to develop human resources and to build career path at the universities.

(3) Viewpoint 3: Autonomy [Dealing autonomously with the issues relating to Japan's survival foundation]

Autonomy Scenario to Maintain Japan's Vitality by Using Brain Big Data

We described a scenario in which Japan as an issue advanced country for such as an aging population with fewer children and deteriorated urban infrastructures is maintaining and improving the quality of life (QOL), securing safety and sustaining the vitality to be ahead of other countries in solving the issues. We brought up the challenges for people with mental disorder to return to social activities, for hilly and mountainous areas to be revitalized, and for urban function and its scenery including upgrading the infrastructure to be maintained and improved. Particularly, overcoming mental disorders is very critical for maintaining the QOL and restoring labors in a declining population era. To realize these scenarios, it will be important to improve the environment to implement in science and technology innovation by preparing regulations and guidelines, establishing business models, and developing human resources for management professionals.

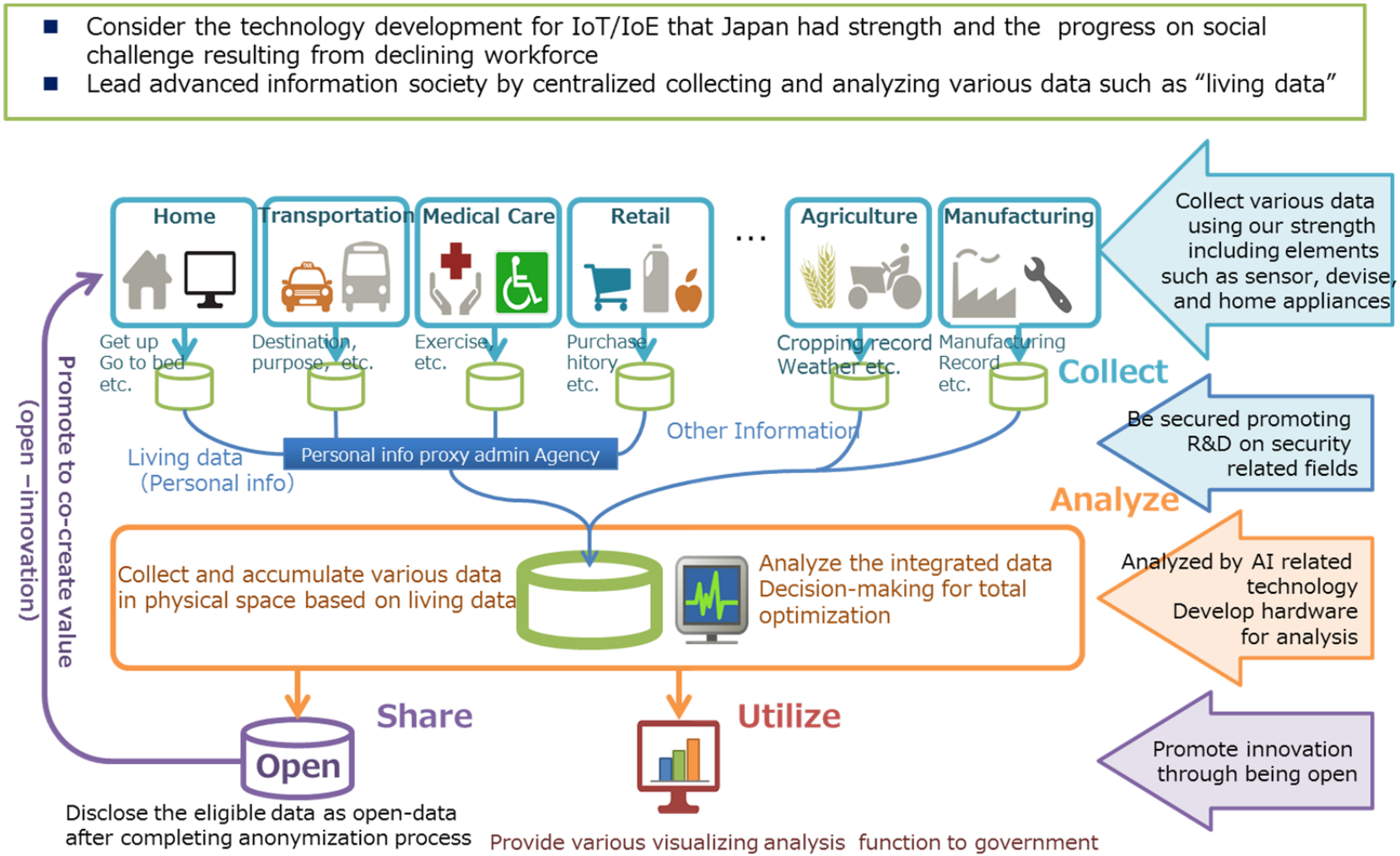


Figure 2-1: Leadership scenario - Overview

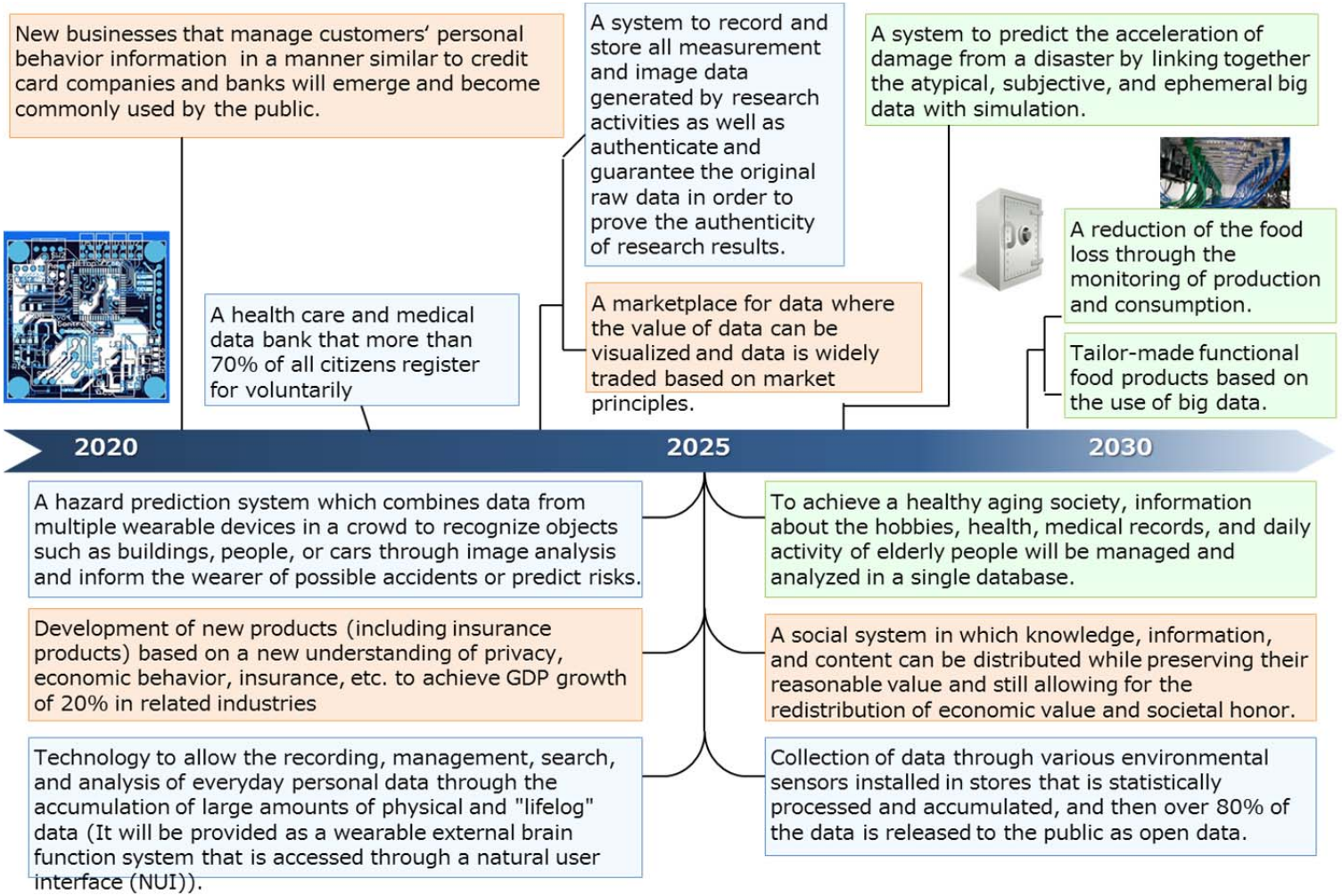
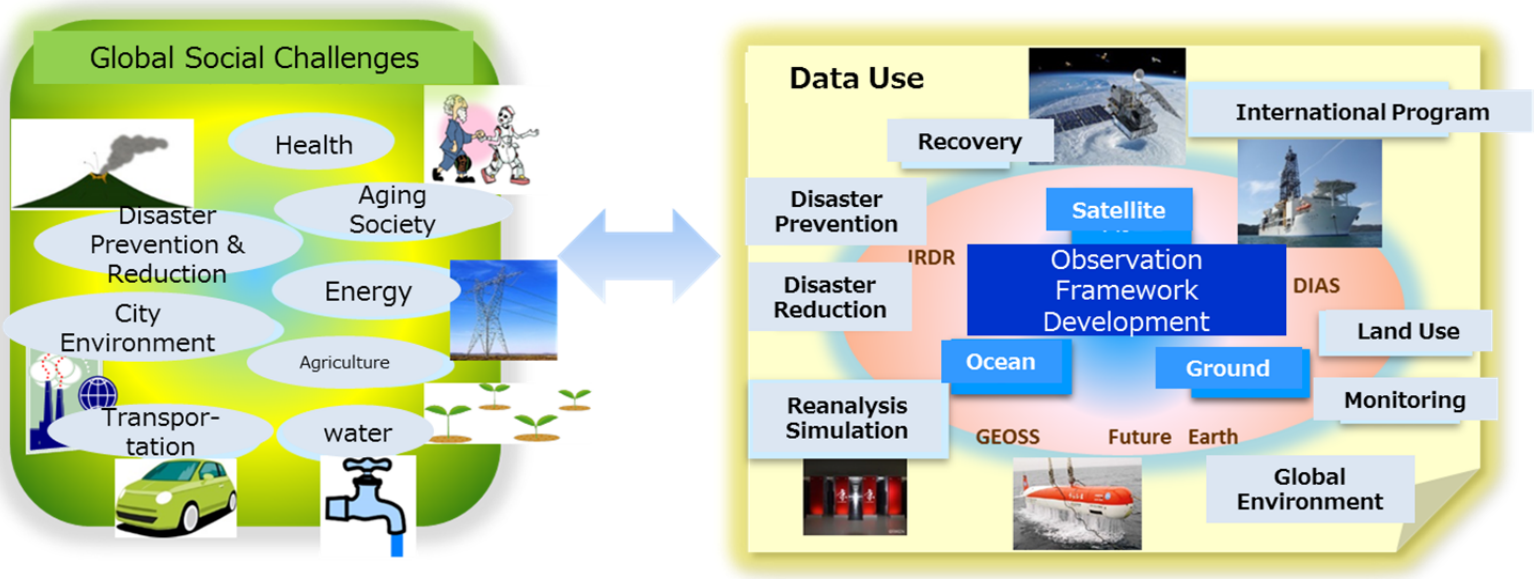


Figure 2-2: Leadership scenario - Related topics with forecasted years of their social implementation

■ Solve global social challenges including disaster prevention & reduction, city, transportation, environment, energy, health, aging society with fewer children by integrating sensing data of space, ocean, and grand based on advanced analysis and simulation technologies



- Solve diverse global challenges by integrating data from satellite, earth and ocean
- Show Japan's presence to international community in creating innovation by opening public data while making international contribution through international harmonization and collaboration
- Focusing on Japan's reliable space transport & satellite technology, ocean, and Earth Sensing Center, play a central role on disaster prevention and reduction in emergency situation including the time of natural disaster while trying to develop new innovation of data mainly obtained from observation for new fields such as agriculture, city environment, transportation, water, health and energy in normal

Figure 3-1: International harmonization & collaboration scenario - Overview

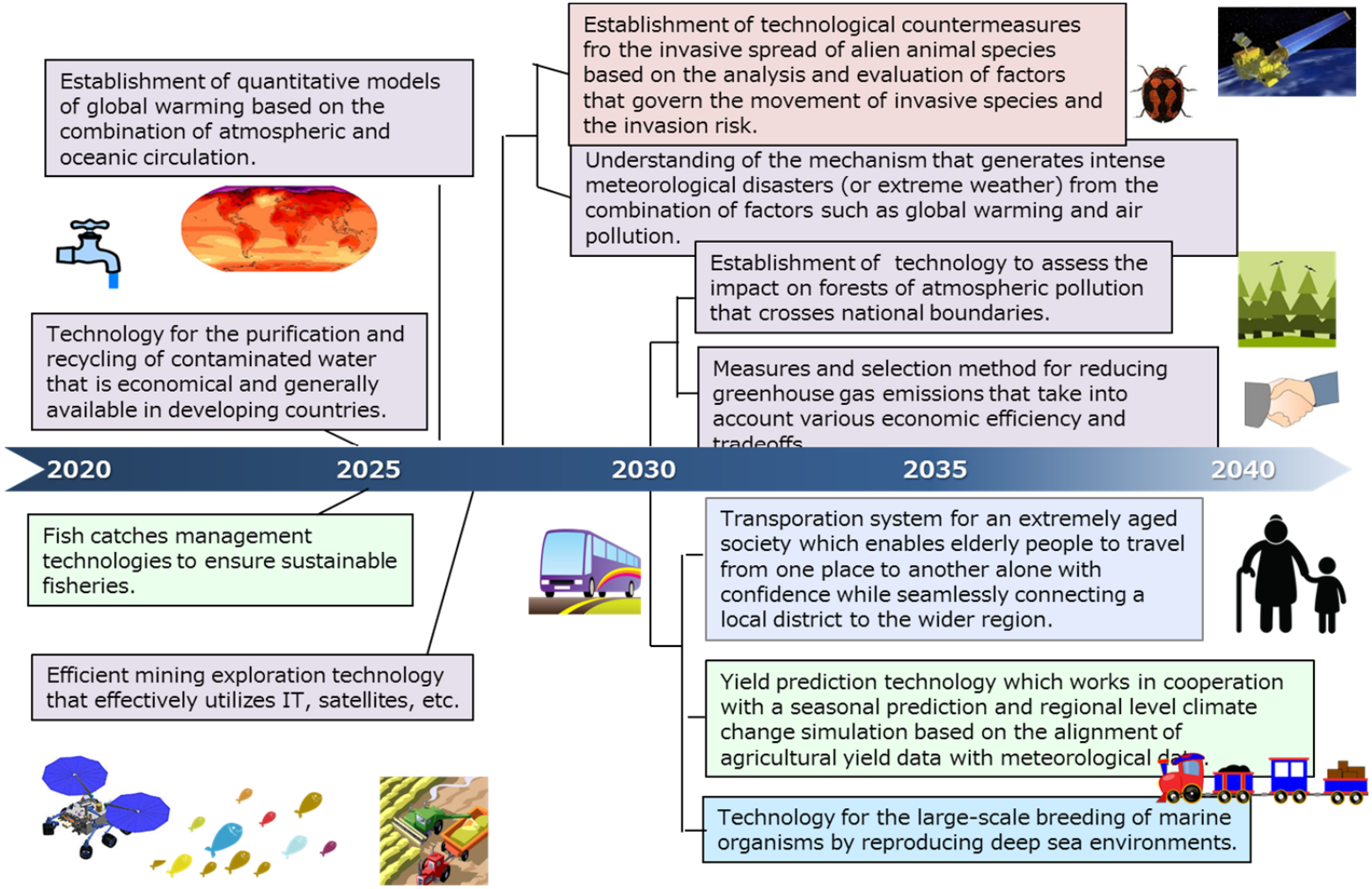
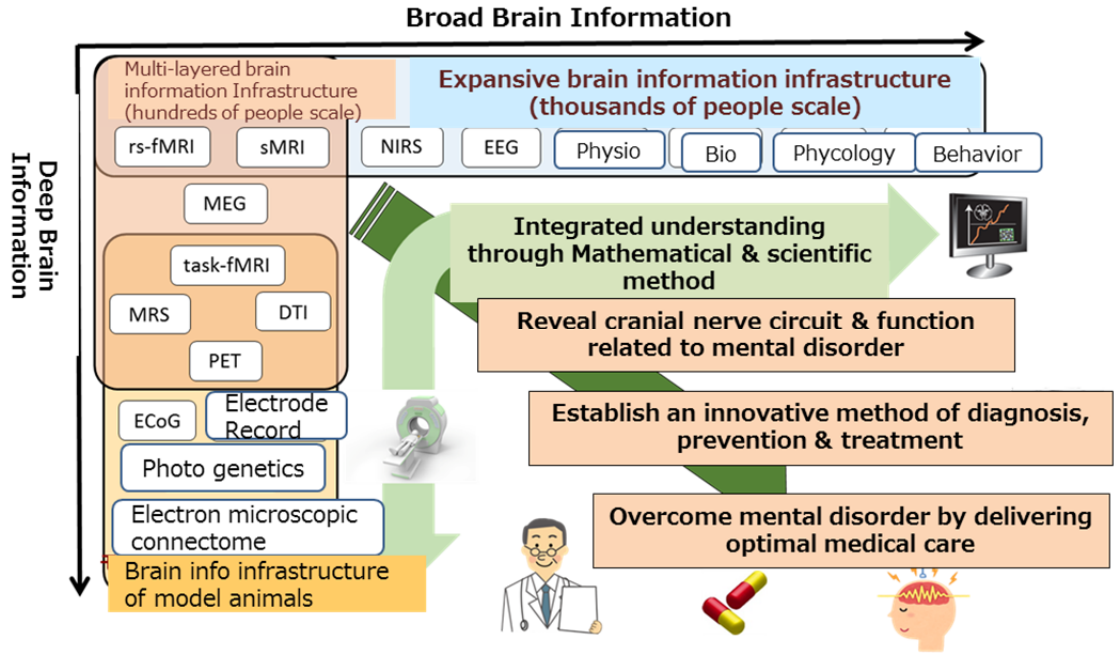


Figure 3-2: International harmonization & collaboration scenario
- Related topics with forecasted years of social implementation

- Quantify the qualitative diagnosis and establish a new method of treatment by turning not only behavior and psychological states but also information related to brain diagnosis into big data
- Improve health of labor force and secure QoL in a time of declining population and autonomously maintain our nation's vitality



As the absolute number of working age population (ages 16-64) is decreasing in 2030 while the society is aging further, the labor productivity per person is required to increase. Although the impact of disease on employment could be an issue, the impact of mental disorders including depression is greater than that of cancers among working age population. Patients with depression account for 6-7%. Overcoming depression is to secure workforce but also is very important to improve the person's QoL, which is thought to be most required to realize prosperous society. The society needs not only economical benefits but also spiritual benefits and a feeling of happiness.

Figure 4-1 : Autonomy scenario - Overview

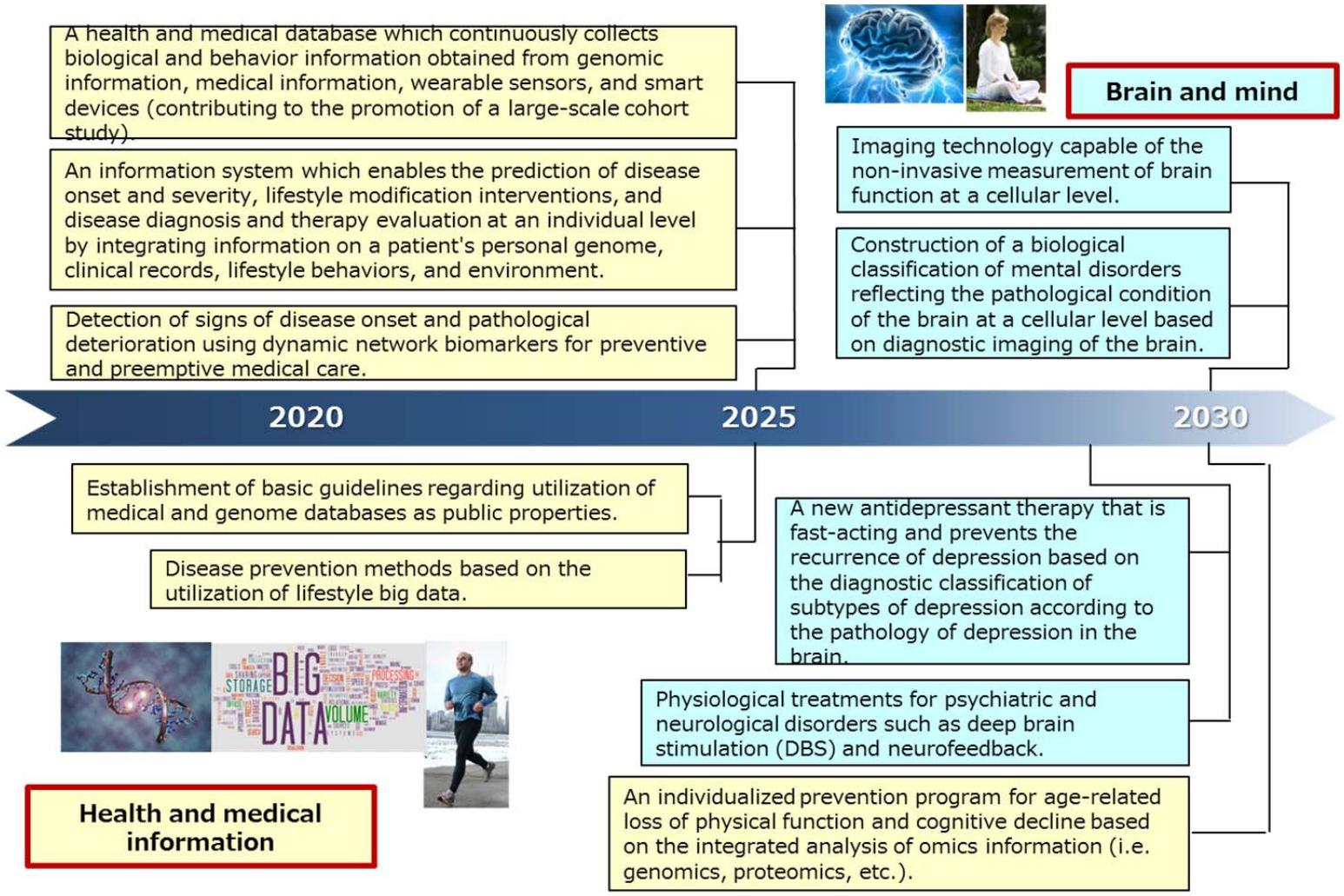


Figure 4-2: Autonomy scenario - Related topics with forecasted years of social implementation

Reference 1: Scenarios by Theme

<Manufacturing>
New Manufacturing Platform for Future Industrial Creation and Social Change

1. Background and Direction of the Examination

As commoditization of industrial products is advanced while emerging countries are gaining power, the environment surrounding ‘manufacturing’ industries which have been leading international competitiveness of Japan is dramatically changing where labor population is predicted to be decreasing because of an aging population with fewer children. Industry 4.0 and Industrial Internet are suggested, and R&D for new manufacturing using ICT (Information and Communication Technology) and IoT (Internet of Things) or robots and 3D printers is becoming active in developed countries to strengthen the industrial competitiveness.

This study covered the improvement of individual quality of life (QOL) and contributions to solving social issues evident in and outside of Japan by responding individual and societal needs as the crucial direction of ‘manufacturing’ to strengthen the international competitiveness of Japan’s industries and to realize sustainable growth toward the future.

As the ‘manufacturing’ is no longer able to respond to the diversified needs of individuals and societies only by technological advancement, it will be indispensable to utilize ICT and establish t a platform that takes advantage of Japan’s strength to maintain and improve its international competitiveness. This scenario exracted a future direction and strategies to be promoted after examining the future vision with considering global strategies targeting 2030 based on discussions at the joint workshop consisted of experts specializing in ICT, manufacturing and service sectors.

2. Society in 2030

(1) Viewpoint 1: Leadership

“Society where new manufacturing has been realized which responds to the diverse individual and social needs and is equipped with global competiveness”

The products and services responding sensitively to individual preference and diversified local and social needs are widely distributed, and individual quality of life (QOL) is dramatically improved. Both the advanced manufacturing systems with international standard in realizing the above and Japan-original products and services data basing and integrating Japan owned manufacturing and service know-how has been increasing demand for over the years even in the matured overseas market, which leads

Japan’s global competitiveness.

(2) Viewpoint 2：International Harmonization & Collaboration

“Society where manufacturing is contributing to use energy effectively and establish an environment-friendly global society”

The products and services including environment-friendly clean energy devices, nobilities, and traffic distribution systems are disseminated mainly to the urban areas, and the energy-saving urban model receives world’s attention and is widely expanded to overseas. Researcers from all over the world are attracted to the Basic Research Centers bolstering those, which contributes to the global human resource development.

(3) Viewpoint 3： Autonomy

“Society where manufacturing is contributing to advanced assistive devices and the usage environmental arrangement applicable to the needs of human behavior”

As Japan has promoted research and development of 3D designs & fabricated systems and wearable technologies as humans-to-things interface, wearable devices assisting the elderly and people in need of nursing care is disseminated, which is reducing a burden for the elderly and carer generations. Robots that can handle cumbersome work are disseminated to factories and operation fields, and the number of households with domestic robots is increasing. At the manufacturing of locally-specialized goods which maximize geographical characteristics, the assistive devices suitable for respective usage are developed and used, utilizing the digital fabrication hub.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing body	Leadership	Int'l harmonization&Collaboration	Autonomy
National/Local Government	● Suppor in local fabrication hubs ● Support in globalized/localized manufacturing and service networks	● Measures to disseminate renewable energy and energy saving devices ● Measures to disseminate direct current transmission and direct current smart grids ● Suppor of internationally contributing organizations	● Measures to disseminate assistive devices for people with disabilities and the elderly ● Support in local fabrication hubs (support in industrialization of primary industry and industrialization sevices)
Public research institution	● Managment and operation of open source systems ● R&D on quantification systems for human's values, emotion, and service ● R&D on advanced manufacturing, product service systems ● Support of global standardization for advanced manufacturing systems ● Establishment of material and process informatics ● R&D on value added manufacturing technologies and digital fabrication systems	● Research on innovative solar battery, storage battery, fuel cell and power devices ● R&D on next-generation mobility, traffic and distribution systems ● Research on wearable devices ● R&D on cyber security technologies ● Operational support for industry-academia collaborative research systems ● Preparation of international basic research hubs and systems, and operational supports	● R&D on 3D-CAD & fabrication systems ● R&D on AI robots ● R&D on systems for teleworks, remote medical cares and remote education
Corporation	● Development of IoT device and system, collecting, analyzing & utilizing big data. ● Proactive participation in global standardization for advanced manufacturing systems ● Technology development of High-mix low-volume production & mass customization production ● R&D of 3D printing materials, and establishment & implementation of digital fabrication business models	● Development of next generation mobility, logistic, and transportation systems ● Collection, analysis, and utilization of life-style monitoring data ● R&D on wearable devices and digital signage ● R&D on innovative solar batteries, storage batteries, fuel cells, power devices, & energy devices	● Development of universal 3D-CAD for wearable devices ● Development of industrial and domestic robots ● R&D on wearable devices and smart cloths ● R&D on systems for teleworks, remote medical cares & remote education ● Promotion of teleworks
Industry platform organization	● Establishment of global manufacturing and service networks	● Support to participate in global standardization for the environmental	● Support to participate in global standardization for wearable devices.

Implementing body	Leadership	Int'l harmonization&Collaboration	Autonomy
	● Support to participate in global standardization for advanced manufacturing systems	energy-related devices	
Academic society/ association	● Provision of opportunities for industry-academia collaborations	● Provision of opportunities for industry-academia collaborations	● Provision of opportunities for industry-academia collaborations
University	● Pioneering trial and implementation of digital fabrication ● Research onr manufacturing core technology such as creating materials, calculating and , measuring	● Basic research on environmental energy-related materials, devices, and wearable technologies ● Human resource development of simulation and informatics	● R&D on core technologies for wearable devices and robots such as materials, devices, and interfaces ● Advanced trial and implementation for digital fabrication
Other human development authority	● Practical education for digital fabrications	● Practical education for digital fabrications ● Primary and secondary education for environment	● Practical education for digital fabrications
Financial/ investing institution	● Support to establish glocal network for ventures and small- and medium-sized enterprizes	● Support for internationally-contributing companies.	● Development of financial products to purchase wearable devices
Citizen/ NPO	● Implementation of personal fabrications	● Contribution to measures for the global warming	● Burden reduction by installing nursing-care and domestic robots
Point to note in promoting strategies	■ Clarification of Japan's strategies towards establishment of advanced manufacturing systems and informatics	■ Promotion of unconventional basic research and establishment of efficient structure for industry-academia collaborations	■ Steadily promotion of development for 3D modelings and wearable technologies and related-materials.

<Service & ICT>

Shifting to Cloud Computing-Based Traffic adopting ICT and Creating New Services

1. Background and Direction of the Examination

As it is predicted that an aging population with fewer children trend in Japan will continue, declining population, particularly the increased number of people who need nursing care and the decreased number of labor population, is becoming urgent issues. Even at present, maintaining conventional public transportation systems such as route buses is getting more difficult especially in the rural areas even with subsidiary.

Based on this background, a virtual compact city will be achieved by increasing 'transportation convenience. At the same time, we look toward a new future in which multiple services are integrated based on traffic by re-examining the meaning of 'travelling' from a service-engineering point of view. Those are the new services cultivated only by ICT and aiming for the total optimization as the system is able to grasp diverse information in an integrated fashion. They havea character of treating an auto industry which Japan has advantages and research project outputs of ITS (Intelligent Transport Systems), further the life services without being closed in the automobiles in a unified manner.

2. Society in 2030

Through each theme, we suggested a service that does not require to think of 'how to go'（Mobility as a Service: MaaS）as minimum by dramatically reviewing the role of public transportation and making various transportation systems collaborated like cloud computing. Furthermore, as 'travelling' is fundamentally a method to achieve 'certain purpose' so that we are not treating 'transportation' as a mere travelling method but suggesting such services that are operated as 'service collaboration foundation'.

The core idea would be making public transportation to be on-demand by collecting and processing such demands of desires of when, from where, where to go and location-based information of buses and taxis in an integrated fashion. The point is the 'unified management of demand and vehicle' which enables not only an efficient operation closer to full optimization but also realizes virtual compact city by making outgoing be easier.

In each scenario, we described 'Autonomy' as a minimum plan as an example with minimum investment, 'Leadership' as an ideal plan as an example with sufficient investment and smooth social acceptance, and 'International Harmonization and Collaboration' as an intermediate of both plan and internationally executed plan. Therefore, we distinguish the above-mentioned services from each other whether they

are primitive, advanced, or enphasizingopen-oriented.

(1) Viewpoint 1：Leadership

“Cyber Physical System and Smart Compact City through cloud computing-based traffic”

Realizing smart compact city where different types of services are integrated through MaaS based on traffic

(2) Viewpoint 2 ：International Harmonization & Collaboration

“Service ecosystem driven by data enclosure achieved by exporting services”

Developing next-generation services by enclosing other countries’ data while contributing through exporting MaaS systems

(3) Viewpoint 3 ：Autonomy

“Resolving outing and shopping refugees’ issues and creating attractive and vigorous rural areas”

Vitalizing rural areas with virtual compact city by arranging the environment through MaaS where everyone can easily go out

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Strategies
National/Local Government	● Examination of the systems concerning indemnity for accidents and delays, Reform of the bus and taxi systems, Guaranteeing wage for existing business, Establishment of implementaion organizations and formulating the regulations, Fformulation and revision other systems
Public research institution	● Establishment of organizations for MaaS operation system , Evaluation of various values related to delays and other service levels, Development and revision of operational algorithms, Development of collaborative algorithms among services
Corporation	● Establishment of MaaS operational business enterprises
Industry platform organization	● Establishment of consortium for automobile companies and for business enterprises ● Adjustments among stakeholders mainly around the business enterprises
Academic society/ association	● Formulation of code of ethics related to collecting and using data on human behaviors ● Coordination of stakeholders mainly around the users
University	● Research activities for different simulations before installing MaaS as a core of a community
Other human development authority	● Enlightment and dissemination of MaaS and cultivation of user literacy
Financial/ investing institution	● Estimation of economic impacts by MaaS, Investment in new business enterprises based on the estimation, selling and promoting financial products including bonds for MssS subsidy and expanding various types of insurance
Citizen/ NPOs	● Accepting changes in patterns of public transportation usage, active involvment in service improvements, Acceptence inconvenience caused by advanced service cases
Point to note in promoting strategies	■ Changes in business models of automobile companies including autonomous driving, leasing parties, differentiation from other companies ■ Backlash from operational enterprizes for wage guarantee ■ Changes in users' lifestyles from following timetables to following demands ■ Revision of the Road Traffic Law and other related laws driven by collaboration with government offices ■ Establishment of agent organizations for collecting and managing data on behavior ,and socially accepting them ■ Formulation of service design and business models as diplomatic strategies ■ Service designs which effectively involve users ■ Reform and operation of the systems through cross collaborations among multiple government offices ■ Change in user awareness

*The basic frameworks are the same for all viewpoints in this theme although some differences are identified in the strategic depth and scope by viewpoint.

<Service&ICT>

Tourism and Disaster Prevention and Reduction Service based on collection and management foundation of service data

1. Background and Direction of the Examination

Japan is focusing on being a ‘tourism nation’, putting the 2020 Tokyo Olympic Games as its milestone. However, there are not enough efforts being made to understand the transportation in an integrated manner beyond local community and to mutually send visitors in other communities to each other. Even though each local community has sufficient tourism measures, there is not enough packaging among communities and nationwide so that they cannot generate a synergic effect. Looking at other aspects, Japan must be well prepared at any time for the natural disasters such as typhoon and earthquake. In the meantime, there are difficulties on those natural disasters as they are always fundamentally unexpected events and require huge resources to deal with once they occur so that many issues are left to attain effective preparation.

We are considering suitable services which can be offered in different shapes in both emergency situations and ordinary times. By having the services, we are able to avoid such problems as running-out of batteries during emergency situations, being difficult to use due to aging, outdated specification and loaded information, and accumulated various costs for the systems. This scenario gives a quick overview of the possible future taking ‘tourism’ as a service domain in ordinary times.

2. Society in 2030

The core idea and technology are ‘CPS(Cyber Physical Systems)’ in which different types of data firmly associated with individual lives called life data are collected including the activity logs through IoT (Internet of Things), and useful services for ordinary times and emergency circumstances are operated by using the collected information. For example, the activity logs could be used to carry out tourism planning, for customers to be mutually sent to each other across comminutes and for tourism navigation services in ordinary times. IN case of emergency, the logs are used to estimate the number of people who need rescue in the isolated local areas and to provide navigation services to the safe shelters. The point is to review and integrate values based on the information so that services for disasters which are hard to predict and are difficult to allocate financial and human resources in ordinary times could be converted into those which are more open and convenient.

In each scenario, we described ‘Autonomy’ as a minimum plan as an example with minimum investment, ‘Leadership’ as an ideal plan as an example with sufficient investment, and smooth social acceptance, and ‘International Harmonization and Collaboration’ as an intermediate of both plan and internationally executed plan.

Therefore, we distinguish the above-mentioned services from each other whether primitive, advanced, or emphasizing open-oriented.

(1) Viewpoint 1：Leadership

“Advanced tourism and disaster prevention and reduction cyber physical system achieved by using data on behaviors”

CPS realizing advanced tourism and disaster prevention and reduction by using data on behaviors

(2) Viewpoint 2 ：International Harmonization and Collaboration

“Realizing and providing an international natural disaster rescue platform through disaster prevention and reduction information cloud”

Realizing and providing an international natural disaster rescue platform through the disaster prevention and reduction information cloud

(3) Viewpoint 3：Autonomy

“Sustainable disaster prevention and reduction service ecosystem through the service collaboration”

Sustainable disaster prevention and reduction service ecosystem through the service collaboration

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Strategies
National/Local Government	● Designing systems for tourism and disaster prevention & reduction by using ICT, and enhancing measures for the different systems for collecting and utilizing personal data including incentives paid for risk management in case of information leakage ● Providing leadership under the international cooperation frameworks, designing the systems toward realizing disaster prevention & reduction service ecosystems, and establishment of international cooperation frameworks.
Public research institution	● Carrying out application research aiming for commercialization of personal information protection, analysis of time-series data including activity logs, high-speed and large-sized simulation in case of natural disasters, and evacuation navigator and optimized distribution of relief supplies
Corporation	● Straightening API (Application Programming Interface) for information disclosure in case of disasters, holding regularly organizing competitions, disclosing information corresponding to the standard for tourism and disaster prevention and reduction, commercialization of related services and disaster prevention & reduction cloud.
Industry platform organization	● Establishing business and business organization including consultants for using tourisme information and establishment of an international charter institution ● Providing publicly opened data available for disaster prevention & reductione
Academic society/ association	● Development and dissemination of tourisme informatics, establishing a code of ethics for personal information in tourism domain: Managment and operation system infrastructure for disaster prevention & reduction, and development of regional R&D based on large-scaled behavioral information.
University	● Carring out a basic research on forstering abilities in comprehension and utilization of data, personal information protection, time-series data analyses on activity logs, high-speed and large-scaled simulation for disasters, evacuation navigation & optimized distribution of relief supplies, real-time remote sensing and service designs
Other human development organization	● Information literacy Education, privacy education, tourism sommelier using ICT, cultivating regional leaders for disaster prevention and reduction
Financial/ investing institution	● Establishment of systems for personal (behavior) information management and operation related to financial and credit information system, development of financial commodities including behavioral information leakage insurance, and providing risk money for commercialization ● Prioritizing investment in infrastructure for disaster prevention & reduction, and development of insurance commodities to meet advanced disaster prevention & reduction

Implementing Body	Strategies
Citizens/ NPO	● Acceptance in use and application of behavioral information, and participation in international disaster prevention & reduction activities ● Utilization of disaster prevention & reduction activity for regional communities and vitalizion of regional community by utilizing tourism information
Point to note in promoting strategies	■ Information arrangement against the facts that information is not collected with a common format in an integrated fashion and information for shelters' capacity and stockpile is not in an electronic format, and information operative rule in emergency circumstances. ■ Promoting interregional collaboration with Government's binding power, literacy that enables to read collected user data and reflect to management measures, status where people pay attention as advanced case studies such as attainment of various conditions under leadership scenario, formulating international framework as to how to handle other countries' activity data ■ Restricting unintended use and scrap of data validation, operating manner under which information infrastructure such as smartphone is not sufficient, conversion mechanism when activity data format is different, localization of applications, service design well involving users, institutional reforms and operations through cross collaborations among multiple government offices, and changes in user awareness

*The basic frameworks are the same for all viewpoints in this theme although some differences are identified in the strategic depth and scope by viewpoint.

<Service&ICT>
Realization of Skill Succession Using ICT

1. Background and Direction of the Examination

The sources to make Japan attractive include the pop-culture such as cartoon films, comics and fashions, traditional arts and skills fostered in the history, and products aimed for applying advanced technologies to living environment. What makes these contents attractive are often generated in a labor-intensive manner depending on an individual expertise. However, there are quite a few issues from a mid to long term perspective due to aging of the experts and difficulties to succeed the skills.

Meanwhile, as the ICT-related technologies are being advanced, methods are going to be developed to formalize know-hows which have been traditionally considered to be difficult to acquire and to enable evaluation and replication of the acquired skills. It is expected to enable to succeed and develop the soft-power of Japan's contents.

Moreover, the ICT technologies applied to succeed and develop the power of contents are possibly available to disaster measures that are regarded as international issues, which is potentially capable of having positive impact over many fields.

2. Society in 2030

(1) Viewpoint 1：Leadership

"Developing creative economy by making contents-related skills smarter"

As clarification of principles of arts and handicraft creation is advanced, the know-hows are formalized, support for creation and skill succession becomes easier, and more human resources are quantitatively expanded and spilled over other fields.

The development of new picture expressions, based on the deeper understanding of characteristics of human's sensibility such as visual sense and tactile sense enables to present more dynamic and sensitive expression. New experiences are provided by using the real-time rendering and display devices.

(2) Viewpoint 2 ：International Harmonization and Collaboration

"Using ultra high resolution video, sensing technology and robot technologies for disaster measures"

Under the environment where earthquake and flooding severly damage buildings, it is required to acculately and promptly understands the situations at the affected areas in order to rescue the survivors and prevent secondary disasters. With Japan's initiative, digitalization of the cultural properties is being processed and with those experiences

know-hows to use wide-area 3D laser scanner has been accumulated. Using proactive sensing with Drones and Robots, ultrasound diagnosis, and small-sized radiation equipment together enables to quickly understand the situation and to make various decisions.

(3) Viewpoint 3：Autonomy

"Realizing regional industrial society driven by succeeding and developing skills through securing and storing global human resources'"

As it becomes easier to comprehend and succeed the implicit knowledge including know-hows, succession of small factories and skills to create traditional crafts are actualized all over the nation. As automatic interpreting devices are disseminated, multi-language communication become easier. As a result such case examples are increasing that the foreigners live in rural areas and succeed the above-mentioned skills. Mass individual production has become possible by quantitatively expanding skilled persons, which used to be thought difficult through small factories and traditional craftmans.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Leadership	Int'l Harmonization and Collaboration	Autonomy
National/Local Government	● Promotiion of skill succession	● Promotion of R&D on ultra-high definition images ● Promotion of R& D on the interface technologies and the tele-existence technologies	● Designation of the regionally specific skills and support to systematization of the know-hows
Public research institution	● Archiving master craftspersons' skills ● Promotion of research on social implementation of skill succession	● Developing operation technologies based on disaster management ● Reinforcement of dependability for robot technologies	● Archiving regionally-specific skills and estimation of know-hows
Corporation	● Enhancing sales of skillful products ● Development of new products by blending skills and advanced technologies	● ● Development of new products by blending skills and advanced technologies using ultra-high definition images	● Development of educational programs based on acquired know-hows
Industry platform organization	● Skill competition events among corporations and setting opportunities to share know-hows among businesses	● Formulating a standard for disaster management using spatial information	● Development of new business initiatives with master craftspersons
Academic society/ association	● Establishment of research organizations to solve skills	● Standardization of skills for sensing technologies ● Standardization of the spatial information utilization for disaster management	● Development of new products blending skills and advanced technologies
University	● Promotion of research to solve skills ● Cultivating new human resources equipped with both know-hows of skills and advanced manufacturing technologies	● Advancement of scanning (technologies for large-scaled scanning, technologies to rapidly reconstruct 3D model with urban scale) ● Developing basic diagnostic technologies applicable to disaster management	● Sharing experiences in pertaining skill succession
Other human development authority	● Succeeding skills	● Cultivating skilled persons in spatial information operation	● Establishment of research organizations to clarify know-hows on skills

Implementing Body	Leadership	Int'l Harmonization and Collaboration	Autonomy
Financial/ investing institution	● Providing risk money to create new contents	● Investment in businesses to use spatial information ● Financing for disaster-related social businesses	● Promotion research to clarify know-hows on skills
Citizens/ NPO	● Using new contents in social life	● Participation in volunteer activity in case of disasters	● Creating new technologies by blending acquired skills/know-hows and advanced technologies
Point to note in promoting strategies	■ AI technologies to extract information with higher-importance from the information acquired by precisely observing skilled persons and to structuralize the information ■ Distinguishing the know-hows between the one possible to formalize and the other impossible to formalize, and clarifying the approach for the latter one ■ Standardizing a method to archive skilled persons' skills, and to express the extracted know-hows	■ Building network technologies that enhance strength of the techniques up to the level at which they are available under disaster environment. ■ Deepening technologies to use spatial information and cultivating spatial information engineers	■ Establishing systems that enable to send forth or deploy practioners for skill succession ■ Measures to enhance regional entrepreneurial spirits ■ Promotion of exchange programs with overseas

<Health and Medical Information, and Brain and Mind>

Restoration of Mind and Body toward Realization of a Society of Health and Longevity"

1. Background and Direction of the Examination

Japan has been ahead in the world in the population aging rate so that is forced to respond to this unprecedented society. In regards, this theme focuses on lifetime health management and neuropsychiatric disorder, one which of the main causes of loss of the healthy life expectancy, from the viewpoint of securing labor resources in the super-aged society.

In order to solve those social issues, health and medical information and big data from the human brain are utilized. It is necessary to promote interdisciplinary research along with human resource development and ethical considerations. Through those activities, our country proactively proposes a model for super-aged society and creates new innovation.

We also cover the emerging and re-emerging infectious disease measures and research for intractable and rare diseases requiring international harmonization and collaboration.

2. Society in 2030

(1) Viewpoint 1：Leadership

"Using health and medical big data, to lead the world as a super-aged society model"

With the advancement of medical and health care and the enhancement of measures against the aged society, the term "the elderly" no longer has an implication for "the supported generation" used a decade ago. The elderly's labor participation rate which had been originally high is increasing more. The elderly's social participation in various settings brings to promote their health gradually and creates a positive cycle. Medicines, technologies for medical and caring devices, and living environment which contribute to social development under the super-aged situations have been disseminated to the world and have become the pillar of Japan's economy.

A 'large-scale long-term longitudinal research' which is an epidemiological study tracing wide variety of lifetime health-related information has become a foundation for diverse research including not only medical science but also education and economics. Using the health-related big data and bridiging research are contributing to formulate public policy and generat health industry, which also promote the efficiency of medical care.

Furthermore, the elderly's 'degree of functional health' is being extended from the coutcome of epidemiological study specializing on the elderly and intervention study on

life scene. A living labor where industry-government-academia collaboration can carry out various intervention studies together on cognitive frail (fragility) and physical frail has generated results, which lead to promote industries.

The social experiment was conducted to enhance the social capital as one of the factors for Japanese longevity which refers to human-to-human relationship at home, at work and in local community. And the effect was examined. The communities with affluent social capital attract the wealthy-elderly-classes in the world.

(2) Viewpoint 2 : International Harmonization and Collaboration

"International cooperation in countermeasures for emerging and re-emerging infectious disease and in research for intractable and rare diseases'

Influenza epidemic is dramatically reduced by the vaccine that enables the lifetime prevention from infection with a few injections. However, emerging and re-emerging infectious diseases occasionally have epidemic due to the influence of global warming and development of the transportation methods. Overseas travelers receive examination when return to Japan by ultra-light sensors that quickly detect and judge whether they are infected or not and the characteristics of the infectious disease. Unknown bioagents are also isolated and identified quickly

A forecast and warning of epidemic of infectious diseases through the comprehensive infectious disease surveillance system is functioned internationally, which is accurate. The influence to the human body is quantitatively forecasted and evaluated. Even against emerging infectious diseases, formulating strategy for medical and non-medical intervention is supported by using a real-time simulation system.

Falling into serious situation rarelly occuers by the mass-production technologies which promptly producing a neutralizing antibody against emerging pathogens. Vaccines and treatment drugs are provided to the regional areas in need through the international cooperation. In terms of intractable and rare disease, international collaboration has been enhanced in the epidemiology and clinical research to overcome the low number of the patient. The common platform of patient registration is in operation, and construction of intractable disease-specific genomic data base and analysis of pathogenesis are executed, through which many prevention and treatment methods have been developed.

(3) Viewpoint3 : Autonomy

"Restoration of brain and mind in super knowledge-based and super information-based society"

Those who could not cope with rapid changes in society, economy and ICT are forced to be maladjusted and suffer from depression. The structure that prevents people from having difficuluty to find employment and commiting suicide due to depression has become thoroughly entrenched in the society. Mental health problem had been a huge burden on a society, but it changed significantly. The Japan's happiness level is ranked in the top group.

Assistive technologies for stress control and rehabilitation system for mental disorders are being established for individuals. In terms of the social approach, an education system in which stress is intentionally applied to induce stress tolerance and social systems with little stress have been developed. An education system that nurtures tolerance to the diversity is led to build an organization containing unique people, which contribute to creating innovation.

There is no way to deny that depression is a prevailing disease, however, its treatment has become very effective. The biological classification of mental disorders is structured based on the neural circuit and molecular condition, so that treatment and prevention method corresponding to the characteristics of brain activities for individuals could be selected. Many of them are able to come back to the social activities immediately by the antidepressant treatment method with instant effect without recurrence. Furthermore, the physiologic treatment methods including brain-depth stimulation treatment method is being disseminated.

These have been developed based on big data of brain. The brain information obtained by various measurement technologies have been accumulated with the detailed clinical evaluation, and integrated organically with the brain information from the model animals. The 'deep brain information' in the individuals was compared with the 'broad brain data' derived from the massive number of samples with simple measurement technologies, and integrated analysis was conducted. Big data of brain has been practically used in diverse fields including society and education other than medical care.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Leadership	International Harmonization & Collaboration	Autonomy
National/Local Government	● Constructinn of infrastructure for large-scale & long-term longitudinal research and building the hubs	● Establishment of regulations and systems for health-medical personal information including genomes	● Preparation of institutions for employment system, education and ethics
Public research institution	● Construction of diverse data-set of health-related big data	● Construction of epidemic forecast and warning release systems	● Construction of infrastructure for big data of brain and accumulation of brain information.
Business	● Development of medicines and medical care equipments	● Quick preparation of antibodies and massively producing them	● Development of small-sized brain measurement devices
Industry platform organization	● Standardization of health and medical care information, and improvement of availabilities for data use	● International contribution for global health improvement (s providing free or low cost medicines for developing countries)	● Formulation of guidelines to reduce stresses in the office and standardizing brain measure data.
Academic society/ association	● Setting standard figures for the degree of functional health	● Updating and setting medical treatment guidelines	● Research on thr subtype classification of diagnostic treatment for mental disorder
University	● Development of medical related-human resources	● R & D of medical care treatments and prevention methods	● Research for deep brain simulation treatment methods
Other human development authority	● Education for the way of living to maintain and enhance the degree of functional health.	● Education for research ethics for handling data base	● Practice of education nurturing stress tolerance
Financial/ investing institution	● Financial support to businesses conducting helth related research and development	● Expanded investment for venture businesses developing health related technologies	● Expanding investment for venture businesses developing health related technologies
Citizens / NPO	● Building communities that maintain and enhance the degree of functional health	● Understanding for the handling of medical information	● Accepting education system nurturing stress tolerance
Point to note in promoting strategies	■ Using personal medical information and socially acceptance of brain and machine interface (BMI)	■ Social acceptance of the use of personal medical information	■ Using personal medical information and social acceptance of brain and machine interface (BMI)

<Regional Resource and, Agriculture and Food>
Food Production using Regional Resources and Conservation of Ecosystem Services

1. Background and Direction of the Examination

Regarding the topics of food, agriculture, forestry, and fisheries and community, we created a scenario referring the keywords of ICT-driven agriculture, vitalization of community , sustainability and human resource development, where necessary technologies and must-do research for Japan are examined based on the viewpoints of global warming and increasing population internationally whereas aging and fewer population society domestically.

2. Society in 2030

(1) Viewpoint 1：Leadership

“Practicing smart agriculture, forestry, and fisheries industry and globalizing Japanese food (WASHOKU)”

Smarter agriculture, forestry, and fisheries industry has been growing all over the world countries through ICT. For fisheries field, tunas and eels are fully farmed internationally. By using big data, prediction accuracy of food demand is improved so that food loss is significantly reduced. At the same time, the food production has been linked to distribution system, which resulted in shortening the lead-time from the production and processing to the consumers and in dramatically reducing food losses due to the quality loss and rotten food during transportation under heat environment. On the other hand, WASHOKU is globalized and the food-driven health longevity culuture has been globally disseminated.

(2) Viewpoint 2 ：International Harmonization and Collaboration

“Maintaining all-global ecosystem service”

The sustainable agriculture, forestry, and fisheries industry has practiced systematically. The amount of water utilization for agriculture is being controlled as minimum. The accuracy of component detection sensors for chemical fertilizer and agrochemical are highly improved and the sensors are being networked. Consequently, traceability of food distribution throughout the route is secured and the related-information is shared around the world. Regarding marine resources, under the international collaboration, highly-reliable resource amount evaluation system is establishedand thereby fisheries productivity has become improved dramatically. In

addition, a farming system considering marine environment and nitrogen and phosphorus circulation is established.

(3) Viewpoint 3: Autonomy

"Vigorous hilly and mountainous areas as a producing region of foods and energy resources"

Japan-made food productions are widely sold in the overseas market by using global forecasting of needs and advanced preservation and distribution technologies. The trading method of agriculture, forestry, and fisheries productions has completely been transited from the traditional face-to-face 'bid' style to the e-commerce. Investment in forests has become increased as understanding the functions of forests as disaster prevention, water-resource preservation and environmental maintenance as well as recognizing them as the renewable energy resource has been deeply developed. As a result, the economic conditions for maintenance and management are significantly improved. Strategic afforestation based on the warming rate prediction is practiced, the ICT are installed for forest management, and wood biomass is used effectively. In addition the market, which uses non-forest trees, for energy resources is generated while renewable energy use is expanding. On the other hand, in fisheries field, the plant based feed becomes required due to decreasing natural fish so that feeding crops are being cultivated all over the inland areas and usable plant are being cultivated in many lands.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Leadership	International Harmonization & Collaboration	Autonomy
National/Local Government	● Preparation of agricultural ICT infrastructure ● Development of international system for satellite data sharing ● Building international consensus for protecting and capturing species	● Establishment of international collaborative framework to promote sustainable agriculture ● Disclosing administrative data ● Building international agreement for sharing marine resource-related data	● Support for fresh foods to corresponding to international standard and brand protection ● Developing appropriate reservation and cultivation system for mountain forest ● E-commerce of agriculture, forestry, and fisheries products
Public research institution	● Construction of agricultural big data platform ● Correspondence to international standard of agricultural ICT systems	● Development of evaluation method for sustainable agriculture ● Development of evaluation method for marine resource amount ● Development of controlling method from diseases and harmful insects	● Establishment of environmental monitoring network from mountain forests to coastal areas. ● Risk assessment of new forest management methods using robots
Corporation	● Developing ready-to-use products for comprehensive ICT usage in agriculture ● Forecasting food consumption in the world ● Businesses to handle whole chains from farming and distribution to sales	● Operation of businesses to enable sustainable agriculture to actively practice ● Construction of market secured by food trace ability ● Marine resource forecasting businesses	● Businesses conduction research for needs of agricultural and fisheries products, and businesses operating from production & distribution to processing ● Mountain forest businesses
Industry platform organization	● Global establishment of agricultural and fisheries products brands	● Reinforement of fishery agreements ● Establishment of fisheries information network	● Creation and certification of regional brand products
Academic society/ association	● Collection and sharing of disease information	● Formulation of evaluation standard for sustainable agriculture	● Evaluation of asset valuse of forests

Implementing Body	Leadership	International Harmonization & Collaboration	Autonomy
University	● Accumulation of knowledge and experiences for information engineering ● Development of human resources in agricultural ICT ● Refining fish farming technologies and developing feeds ● Development of storage and logsticstechnologies	● Research on soil bacterium ● Development of various sensors for agricultural products ● Development of evaluation methods for marine resource amount ● Development of controlling methods for disease and harmful insects caused by global warming and sustainable agriculture	● Development of human resources for international strategy planning, and economic activity management in hilly and mountainous areas ● Development of environment monitoring methods ● Development of deforestation technology ● Establishing economic model in hilly and mountainous areas
Other human development authority	● Coordination of researchers , farmers and related enterprizes	● Promotion in understanding of sustainable agriculture	● Dissemination of agricultural ICT education and cultivation of human resources for international strategy planning in agriculture
Financial/ investing institution	● Investment on installing ICT infrastructure by agricultural businesses	● Investment on information platform ● Investment on marine resource amount forcasting businesses	● Development forest fund commodities
Citizen/ NPO	● Building consensus to maintain health through food	● Understanding importance of ecosystem services ● Providing information to database	● Development of system for mountain forest management
Point to note in promoting strategies	■ Impact on marine ecosystem along with expansion of farming industries ■ Limitation of accuracy for weather forecast ■ Maintenance cost for agricultural ICT infrastructure	■ Costs associated with sustainable agriculture ■ Shortage of food production amount occurred during transition period from high-environmental burden to environmentally low burden agriculuture	■ Speculative investment in hilly and mountainous areas ■ Shortage of human resource for forest management and forest value evaluation.

<Resilient Social Infrastructure>

Resilient Social Infrastructure dealing with Large-Scale Disasters and an aging population with Fewer Children

1. Background and Direction of the Examination

We examined the measures against such risks as the loss of capital functions triggered by large-scale disasters including the Nankai Mega thrust Earthquake, the diminishing labor population due to an aging population with fewer children, and the deteriorated infrastructures in disappearing rural areas. These are based on the lessons learned from the Great East Japan Earthquake. The focused directions are to deal with large-scale natural disasters based on the lessons learned, to organize the national-land surveillance system in view of national security, to develop long-lasting of infrastructures dealing with an aging population with a fewer children and to decentralize urban functions.

2. Society in 2030

(1) Viewpoint 1：Leadership

“Ensuring an education for disaster prevention and reduction and realizing simply and efficiently social infrastructure management”

Based on the lessons learned from the Great East Japan Earthquake in 2011, activities have been promoted to develop towns for residents to live safely and securely prepared for large scale disasters including earthquakes, volcanic eruptions, and tsunamis. The activies have expanded around the world as measures originated in Japan. In Japan, a wide-range of expertise has been efficiently accumulated and analyzed whenever natural disaster has occurred. On the other hand, research and development together with social implementation of technologies to improve the durability and to inspect and maintain constructions in considering the reality of social capital are conducted throughout Japan. These are the measures to tackle with the issues of huge cost to maintain and manage infrastructure. At the same time, safety and productivity including job efficiency of constructive production systems are to be maintained and improved, and informatized and unmanned operations are advanced with information-communication and robot technologies which enable a few people to do a lot of work. Consequently the construction period of infrastructures is dramatically shortened.

(2) Viewpoint 2 : International Harmonization and Collaboration ‘

“Realizing Observation Information Network providing usable information at times of disasters as well as at normal times”

As Global Observation Information Network has been established through an international framework, the number of dead and missing persons due to large scale natural disasters has been sharply decreased compared to that in the past. Not only the data obtained from international satellites but also that from globally developed ground and marine based multiple observation systems is distributed in this new information network. As the data is basically open, anyone could refer to it if they are connected to the network. Besides, the large amount of data is instantly processed and provided as usable information straight-away. Data distribution is diversified, the utilization of which is not limited to disaster measures, but is expanded to different fields.

(3) Viewpoint 3 : Autonomy

“Realizing elderly-friendly mobility and re-creation of communities”

Although Japan has become an aged society due to an unstoppable progressive decline in the number of children, mobility development is adapting to the situation. In addition, cities are becoming more compact through smart-shrink in response to the declining birthrate. As headquarters of large corporations are relocated to rural areas, our work-environment becomes enriched and the number of young people flowing into urban areas is decreasing. As a part of central-government functions, including legislative, administrative, and judicial branches of government has been relocated, the overconcentration in Tokyo has been resolved. Consequently, the risk of function loss caused by large-scale natural disasters is not regarded as a concern.

3. Strategies by Each Body for the Actualization and Point to Note in Promotiong

Implementing Body	Leadership	International Cooperation	Autonomy
National/Local Government	● Preparation of integrated management system for social infrastructure ● Storage of emergency supplies and establishment of consumption cycle ● Expanding observation points ● Development of legal institution	● Providing and preparing data among industry-government-academia groups. ● Promoting international cooperation for establishment of observation data infrastructure ● Preparing legal institution for data use ●	● Attracting large corporations to move to rural areas ● Partial relocation redundant desig of capital functions ● Measures for mobility sharing ● Preparing legal institution for re-development of urban areas （measures for unoccupied houses） ● Change of drivers licence system
Public research institution	● Improving durability of structures and R&D of inspection and monitoring technologies	● Preparation of various observation systems and collaboration and cooperation with domestic and international organizations ● Providing data and developing application	● Consideration of practical measures to realize smart-shrinking and compact cities
Corporation	● Improvement and dissemination of earthquake-proof and earthquake resistant technologies ● Maintainance and improvement of safety and productivity in construction production system ● Realization and dissemination of informatized technologies and automatic operations	● Consideration of business model for observation system operations ● Commercialization of applications extracting meaningful information from big data ● Providing data and evaluation of analysis	● Relocation of head-offices to rural areas ● Development and commercialization of various mobilities
Industry platform organization	● Improvement and deseminatoin of earthquake-proof and earthquake resistant technologies ● Maintainance and improvement of safety and productivity of construction production system ● Realization and dissemination of informatized technologies and automatic operations	● Standardization of inter-system interface	● Buiding consensus for mobility sharing

Implementing Body	Leadership	International Cooperation	Autonomy
Academic society/ association	● Establishment of information sharing system among industry-government-academia groups ● Expantion of observation points ● Research on disaster prediction and information communication	● Development of applications extracting meaningful information from big data ● Providing data ● Education for disaster prevention, disaster reduction, and information literacy	● R&D on autonomous driving and securing the safety
University	● Clarifocation of disaster occurrence mechanism ● Research on disaster forecast ● Research on informatized operaions and automatic operations	● Analyzation of big data and development of applications ● Providing data ● Education for disaster prevention, disaster reduction, information literacy	● R&D on autonomous driving and securing safety
Other human development authority	● Education for disaster prevention and reduction literacy	● Education for disaster prevention and reduction, and information literacy	● Education for traffic safety corresponding to various mobilities
Financial/ investing institution	● Re-examining fire and earthquake insurance ● Development of insurance on the adequacy in judgement (emergency evacuation orders)	● Development of insurance on the adequacy in judgement (emergency evacuation orders)	● Investment in preparing infrastructure ● Development of services to ptomote real estate exchange between suburbs and urban areas ● Development insurances for autonomous driving and the elderly's mobility
Citizen / NPO	● Confirming procedure in case of disasters (disaster drills) ● Education for disaster prevention and reduction literacy	● Providing data ● Education for disaster prevention and reduction and information literacy	● Development of attractive towns utilizing community characteristics ● Improvement of literacy for shifting to compact city
Point to note in promoting strategies	■ Selection of important measures and literacy education to cover the measures ■ Decreasing construction workers ■ Insufficient correspondence in case of disaster	■ Maintaining international cooperation ■ Promotion of openness and donation in data (balancing with laws and regulations under national security) ■ Formulation of APIs or standardization ■ Insufficience in data analysis	■ Selection of local cities as a leading model for compact city ■ Effective usage of the existing infrastructure ■ Selection of capital functions to be relocated ■ Selection of areas that would not be damaged by the Nankai Megathrust Earthquake simultaneously ■ Adequacy in autonomous driving ■ Shrinking market due to mobility sharing

<Energy, Environment, and Resources>

Energy, Environment, and Resources contributing to Establish Sustainable Future

1. Background and Direction of the Examination

As Japan is facing social changes due to declining and aging population and globalization, the need to dealing with conservation of natural environment inlcuing dealing with change in living environment is increasing. Therefore we examined energy, reources, and environment to contribute to the best mix of energies and to resolving the climate change issue. While setting energy from production, consumption, distribution, transduction, storage, and to transportation, we preferentially selected hydrogen which is aiming to be realized by 2020. For environmental field, we examined the need to deal with conservation of natural environment including coping with our living environment. In addition, risk management in tackling with the issues which are hard to be resolved only by technologies including evaluation and communication was examined. For resources, we covered mineral resources as well as unused waste heat and geothermal heat as resinal resource, and water processing-related technologies

2. Society in 2030

(1) Viewpoint 1：Leadership

“Promoting to develop the world’s leading technology in contributing to resolve global warming issues”

Japan’s manufacturing industries are maintaining the competitiveness through achieving simplification of technology and cost reduction so that technology development contributing to resolve global warming issues is to be realized. Consequently, Japan is leading the world in the environment and energy-related technologies. Japanese global observation technologies such as monitoring and clarifying the occurrence mechanism are contributing to resolve the global environmental problems, as being applied for mitigation of climate change, applied technologies to reduce natural disasters, and explication of the risk factors in the environment and ecosystem as well as appropriate measures for those.

(2) Viewpoint 2 ：International Harmonization and Collaboration

“Corresponding to global-scale issues and contributing to global development”

Regarding the forecast and management technologies of natural resource changes based on the impact assessment as to how the global warming influence on agriculture, forestry and fisheries resources, as well as observation and assessment technologies for

devastation prevention and revitalization of tropical forest, developing countries no longer receive as many economical aids as before. However, ASEAN countries are conducting technology development primarily in their own countries in collaboration with Japan. Eventually Japan is contributing to eliminate global poverty through global water business.

(3) Viewpoint 3：Autonomy

“Realizing systems considering total optimization”

Realization of the systems considering total optimization of infrastructures has made an impact on community vitalization and disaster measures. Different types of development have been advanced which are related to regionally oriented agriculture mainly for the local cities which continue to make self-help efforts in aiming for overseas expansion in conjunction with harmonizing with nature. The development has been conducted based on software development that enables individual element technology to be totally optimized for achieving business profitability as well as based on integrated system expansion. Those efforts are not only targeting domestic, but also being examined involving the viewpoints of migration and robots that are replacing human labors.

3. Strategies by Each Body for the Actualization and Point to Note in Promotiong

Implementing Body	Leadership	International Cooperation	Autonomy
National/Local Government	● Legal support of the energy best mix ● Revision of environmental tax system ● Supporting globalization ● Revision of the Ships Act ● Support to improve yield of waste collection	● Proposing a review of international laws ● Reviewing assistance to developing countries ● Correspondence to the declining and an aging population	● Establishment of unified development system ● Clarification of strategic courses ● Establishment of an opportunity to examine total optimization ● Harmnization to internationalization of human resources, organizations and institution ● Consideration of open government
Public research institution	● Research on smart community and social systems ● Clarification of risk factors in ecosystem ● Disseminatoin of monitoring systems	● Contribution to the international standard for quality of water ● Total management of risk information ● Development of measures against greenhouse gas emission and their selection methods ● Preparation of climate change-related data infrastructure under international framework ● Exploration of resources	● Promotion of international cooperation ● Development of total optimization system for elemental technology towards its installation and expansion ● Corresponding to climate changes ● System development for harmonization with nature toward overseas expansion
Corporation	● Research on saving energy, resources and related areas ● Development and implementaion of management to developing countries	● Strategies to create new market ● Development of economically efficient technologies to clean up and reuse contaminated water	● Internationalization of human resources, organizations and institution ● Realization of highly productive agriculture ● Energy saved and low cost cultivated breeding
Industry platform organization	● Formation of utilization and framework of raw materials considering biodiversity framework ● Collaboratoin with other industries	● Development of risk management methods ● Assessment of the impact of cross-border air pollution ● Comprehensive water management technologies	● Consideration of open government ● Optimization of cultivation system ● Cool (remarkable) farm management

Implementing Body	Leadership	International Cooperation	Autonomy
Academic society/ association	● Development of human resources through industry-academia collaboration ● Collaboration among academic societies examining best balances between energy and environment	● Development of human resources familiar with energy management ● Development of disaster rescue robots	● Energy-related measures and technology development corresponding to global warming ● Cultivating agriculture workers
University	● Research on the energy best mix ● Clarification of abnormal weather occurrence mechanisms ● Human resource development through in-school collaboration	● Development of energy including social systems, environmental technologies, and human resources	● Energy-related R&D considering global warming ● Education of management
Other human development authority	● Making environment education compulsory from primary education	● Risk management education from primary education ● Efforts towards consensus making	● Dissemination of energy and environment education
Financial/ investing institution	● Establishment of the new FIT system ● Support to emission trading	● New investment scheme ● Foreign Direct Investment	● Needs to achieve business profitability
Citizen/ NPO	● Cooperation for waste retrieval ● Accumulation of correct knowledge about warming	● Consensus making among stakeholders participating in risks	● Dissemination of energy and environment education
Point to note in promoting strategies	Difficulties in continuing the FIT system due to decrease of tax revenueGetting difficult to continue ■ Destruction of environment by increaseing introduced species ■ Energy peaks due to urban concentration ■ Weakening manufacturing due to technology transfer	■ Changes in international framework, especially those in ASEAN and APEC ■ Increasing damages from cross-border environmental pollution ■ Declination of local economies ■ Water shortage around the world due to deteriorated climate change ■ Decreasing number of researchers	■ Immiguration policy ■ Risk management ■ Relocation of central government offices to rural areas ■ Detrioration of climate change ■ Declination of labor population

Reference2: Integrated Scenarios

Viewpoint 1：Leadership

Leadership Scenario through Centralized Information Collection & Analysis based on "Manufacturing Capability"

1. Background of Study and its Direction

As Japan's trends in an aging population with fewer children is forecasted to continue, the declining population, particularly increasing number of people who need nursing care and declining labor population, has become an urgent issue. As a result, many findings showed that Japan's potential growth rate will continue to be up to 1% in the future. In terms of international affairs, it is foreseen that 'the expansion of individual power', 'the spread of power' and 'the population issue' would result in destabilization of different fields including economy and military. Consequently, the forward looking strategic measures are required.

From those sets of background, we summarized strategies that Japan should take as a "Japanese information umblella" from the viewpoint of the soft-power including economy.

This aims for the Japan's position in ICT field as 'Switzerland and Singapore in finance domain' and will pursue comprehensive solutions to diverse issues such as public diplomacy and national security while using our strengths fostered by 'manufacturing'. To be specific, the platform to accumulate, analyze, visualize, and disclose massive data such as life data that gathered hereafter mainly from physical space through Iot (Internet of Things) and IoE (Internet of Everything) will be built and operated while secureing some transparency. We are promoting open innovation by utilizing the accumulated data and aiming for sustainable economic growth together with recharging Japan's basic power and international contribution

2. Society in 2030

As mentioned in the last section, we described a future society enabled by centralized collection and analysis of life data gathered mainly from physical space with IoT and CPS（Cyber Physical Systems）in mind. The precondition here is that information value is increasingly improved and information hoarding is developed.

To be specific, it is assumed to collect life data by installing sensing devices into

life environment based on ‘manufacturing’, a Japan’s strength, especially a full-stuck ‘power of manufacturing’ from sensor elements to home electronics. Furthermore, we aim to expand the collected data into various services by integrating and analyzing with using artificial intelligence. For example, the exisiting government statistics and the analyzed and visualized platform linked with them including confirmation of tax payment are provided for government. Also the anonymized and statistically processed data will be opend, which enhance open innovation.

Those frameworks are not only available for Japan but also provide a sort of cloud services to developing countries. This is to provide an “information umbrella” in the daily life, similar to what the United States uses in its military domain. We provide different information by “information umbrella” with security and transparency for operation and analysis. The image is aiming for the positioning as ‘Switzerland and Singapore in the finance domain’ and trying to acquire an international presence by establishing ‘safety and security’ as public diplomacy.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	Strategies
National/Local Government	● Building consensus of information collection at a national level, Design of systems to establish and operate platform, Formulation of couses for information utilization, Establishment of the agencies for development, collection, and manegement
Public research institution	● Protection of personal information, Methods to detect and block domestic and international illegal access, Analyzion of time-series data including activity logs, Methods to integrate different types of data, Application research including large-scaled simulation
Corporation	● Development of highly-reliable hardware and software for basic systems, Embedment of sensing devices to various products, Development of high value-add services using sensing data
Industry platform organization	● Formulation industry standard and promotion of built-in of life data, promoting built-in, Promotion of efforts by all-Japan Makers opened for all manufacturers and industries
Academic society/ association	● Creation and monitoring appropriate use and application of life data, Operation and managment of open data platform for public disclosure
University	● Basic research on material development, security, data analysis and data use, Basic research on ethical and social influence of using life data
Other human development authority	● Iinformation literacy education , Privacy education, Data science literacy education, Service design education
Financial/ investing institution	● Establishment of agent operation organization for personal information, Planning and Development information asset managedproducts, Development of insurance system for information leakage, Exemption rule to promote investment into information systems

Implementing Body	Strategies
Citizen / NPO	● Acceptance in using activity information, Monitoring and Regulation of appropriate use of information
Point to note in promoting strategies	■ Understanding in collection and use of personal information ■ Formulation of courses for information usage with safty, transparency and strategies

Viewpoint 2 : International Harmonization and Collaboration
"Harmonization & Collaboration Scenario to Solve Global Challenges"

1. Background of Study and its Direction

Environmental issues including climate change and conservation of ecosystem as well as food and energy concerned in the world are provided as globally important issues that all the countries of the world should make efforts for cooperatively. We described a future in contributing to resolve global issues by actively and creatively using Japan's strength in science and technology as well as that in making international contribution through software efforts including education, which are out of the challenges that Japan should tackle with based on the social issues. The social issues include declining and aging population that we are facing ahead of other countries in the world.

2. Society in 2030

"Efforts for common problems in international society including climate change and infectious disease"

Japan is contributing to long-term observation of climate changes and disaster prevantion by clarifying the occurrence mechanism for abnormal weather, establishing technologies of impact assessment of cross-border air pollution, integrating mitigation and adaptation technologies for climate change and disasters based on the ecosystem function, and developing ground and marine based multiple observation systems expanded globally to manage the risks of food, water, and disaster . Eventually, Japan is making international contribution not only by providing technologies, but also by offering environmental education and realizing continuous monitoring technologies for pathogenic microbe and economical technologies to clean up and reuse contaminated water that could be commonly used in the developing countries.

“Contributing to the establishment of resilient societies as Japan-originated technologies are disseminated globally”

Japan is actively making international contributions from many sides to relief damages of natural disasters all over the world. At the scene of the natural disaster, disaster-relief robots are in operation and evacuation activities are smoothly conducted by installing navigation systems using personal mobile terminals. Together with immediate response right after the disaster occurs, software-aspect approaches such as collecting and selecting information required for response in accordance with time passing and taking feedback from the site for implementing outcomes from research and development have contributed to reduce the damage of disasters around the world. In addition, recognizing the gap between simulation and reality and taking educational measures to keep it firmly in mind that no two disasters are the same have become helpful to reduce the effects of disasters around the world.

“Future food design and contribution to needs of safety for diversified food”

Crop growth prediction and diagnosis systems by integrating short to mid-term weather forecasts and crop models as well as yield prediction technologies in collaboration with regional level simulation of climate change and seasonal prediction based on matching of yield data and climate data have begun to be disseminated and be improving. The fact that an enormous amount of information was provided has significantly contributed to improvement, which include fishery yield management technologies securing sustainable fishery industry, detailed climate data in each community as well as monitoring results for ingredients of crops. Traceability throughout entire distribution route is now secured by IoT. Traceable systems and monitoring of shipping and consumption amount is contributing to reduce discarded food in the logistics process. Further more information is transfered to the data base in order to be shared by countries around the world. Consequently, the research and development platform which could be openly used has begun to be implemented.

3. Strategies by Each Body for Actualization and Point to Note in Promotion

Implementing Body	Strategies
National/Local Government	● Supportive activities related to climate change including IPCC ● Coordination of stakeholders ● Legally support in the energy best mix ● Support to dissemination of optimally balanced energy supply systems ● Measures for international diffusion of energy-saving products ● Reexamination of international law for marine vessels ● Establishment of international charter systems ● Preparation of legal systems to accept foreign workers in medical and nursing care fields in Japan ● Establishment of international information collection system and standardization of the quality of collected data
Public research institution	● Research on smart communities and social systems ● Dissemination of monitoring systems ● Examination of social systems realizing low-carbon societies
Corporation	● Development and dissemination of management to developing countries ● Dissemination of business in ecologically conciousness services ● Dissemination of remote medical treatments ● Establishment of common platform securing interoperability of data
Industry platform organization	● Utilization and formation of framework of raw materials regarding biodiversity ● Collaboration with other industries ● Preparation of ethical regulation for R&D
Academic society/ association	● Collaboration among academic societies to examine the most appropriate balance between energy and environment
University	● Human resource development for in-school collaboration and cooperative research with other faculties
Other human development authority	● Making environment education compulsory from primary education ● Literacy education
Financial/ investing institution	● Support in emission trading ● Establishment of funds ● Cultivation of community leaders
Citizen/ NPO	● Acceptance and understanding of risks ● Understanding in different cultures ● Accumulation of correct knowledge of warming
Point to note in promoting strategies	■ Correspondence to climate change ■ Reexamination of international law ■ Religious issues ■ Protection of personal information ■ Participation in efforts for ecosystem services ■ Increasing people who have problems in human interactions as the progress of the network society

Viewpoint 3：Autonomy

“Autonomy Scenario to Maintain Japan’s Vitality by Using Brain Big Data”

1. Background of Study and its Direction

As Japan’s population will be aging and with fewer children in the future, declining population and a shortage of labor are predicted. Consequently, it is required to sustain high standard of science and technology in order to maintain international competitiveness of products and services which secures a stable economic growth. At the same time, Japan needs to increase its own value based on the traditional and cultural background and to stay to be internationally an attractive country, which could become requirements to gain the trust from the international society in a forum for dialogue of the issues that should besolved through international cooperation.

It is important to create a living and social environment as a foundation to foster tradition, culuture, and science and technology and to maintain underlying natural environment and the urban functions in sustaining our country’s vitalization and protecting our national land and citizens., which will result in enhancing Japan’s brand image.

In creating a scenario from those viewpoints, we focused on ‘a society with high quality of life (QOL) where positive circle of living and work is actualized’, ‘hilly and mountainous areas with vitalities where natural environment and food production are harmonized’, and ‘maintenance of the function and the scenery of such large cities as Tokyo.

2. Society in 2030

“A society with high quality of life (QOL) where positive circle of living and work is actualized”

Revolutional innovation in mental health including medical treatment with ICT, new orgamizational management method, and treatment by using brain big data have made it easier for those who are in their most productive age but had departed from employment opportunity due to mental disorder caused by complicated human relations to return to social activities, which is contributing to maintain Japan’s vitality.

Furthermore, while a way of belonging to a group in urban and regional areas and in community has been changed, systems to understand individual and group situations in real time by analyzing social media data and to offer appropriate advice and present risks including crime forcast and cnsumer’s purchase behavior prediction have pervaded

our society through the advanced technology to manage privacy.

"Vigorous hilly and mountainous areas harmonizing natural environment and food production"

It is rediscovered that devastated forests in the hilly and mountainous areas are valuable from such viewpoints as the measures against global warming, conservation of ecosystem, reduction of natural disasters and maintenance of water resources. Timbers planted and logged for the purpose of maintaining natural environment at hilly and mountainous areas are utilized as renewable energy resources. Besides, hilly and mountainous areas are becoming the hubs of food production by using the areas for plant factories. In addition, the rich natural environment has also been for tourism resources.

"Maintenance of urban function and scenery by using autonomous technologies"

Tokyo and other urban cities which being compact by smart-shrink still hold considerable populations, and have many inbound tourists as there are many cultural heritage sites constructed through the historical development process. Whilst dealing with an aging social infrastructure and maintaining urban scenery, the infrastructure is maintained by improving construction and production systems such as information-driven and unmanned construction using ICT and robot technologies.

3. Strategies by Each Body for the Actualization and Point to Note in Promotion

Implementing Body	**Strategies**
National/Local Government	● Preparation of insitututions for employment and education systems ● Preparation of institutions for comprehensive conservation of the natural environment ● Preparation of institutions towards re-development of urban areas
Public research institution	● Preparation of infrastructure for big data ● Establishment of monitoring network for the natural environment ● Examination of courses towards smart-shrinked and compact cities
Corporation	● Establishment of organization management to maximize individual abilities ● Establishment of business models at hilly and mountainous areas ● Relocation of head offices to rural areas
Industry platform organization	● Formulation of guidelines to reduce in-office stress ● Creation and certification of branding for local-sourced productions ● Formulation of standards and guidelines for automated construction

Implementing Body	Strategies
Academic society/ association	● Re-examination and creation of medical care guidelines ● Evaluation of asset values of forests ● Preparation of guidelines for auto-inspection of infrastructures
University	● Creation of research fields for organization management and development of human resources ● Development of human resources to manage economic activities at hilly and mountainous areas ● R&D on safety and productivity for construction and production systems
Other human development authority	● Cultivation of experts to remove stress in organizations assisting medical doctors ● Dissemination of ICT education
Financial/ investing institution	● Investment in infrastructure meintenance
Civil/ NPO	● Promotion of understanding in social implementation
Point to note in promoting strategies	■ Utilization of individual medical information ■ Securing human resources with high specialty meintenance ■ Responding to restore complicated system troubles ■ Securing resources for concentrated of transportation and information traffic ■ Social Acceptance

I. Outline of the 10th Foresight

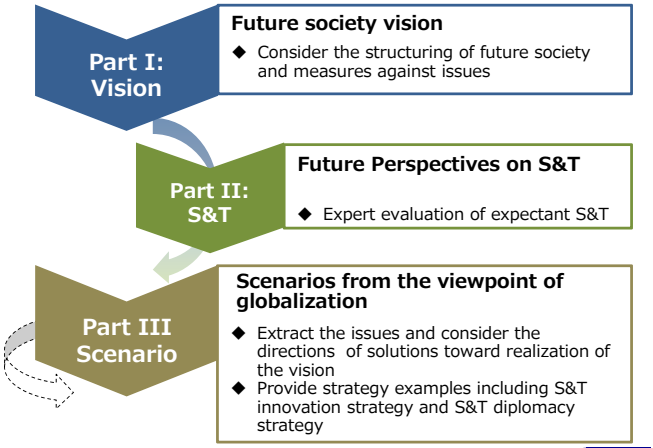
Scenarios based on future vision

Outline of the 10th S&T Foresight

Outline

- **Background**
  - In Japan, a large-scale S&T Foresight has been carried out every 5 years since 1971, to overlook the med- to long-term S&T development. NISTEP has become the implementing entity of the survey since the 5th survey (1992).
  - The 10th S&T Foresight was started in 2013, envisaging the science and technology development spanning to 2050, with year 2030 being the midpoint.

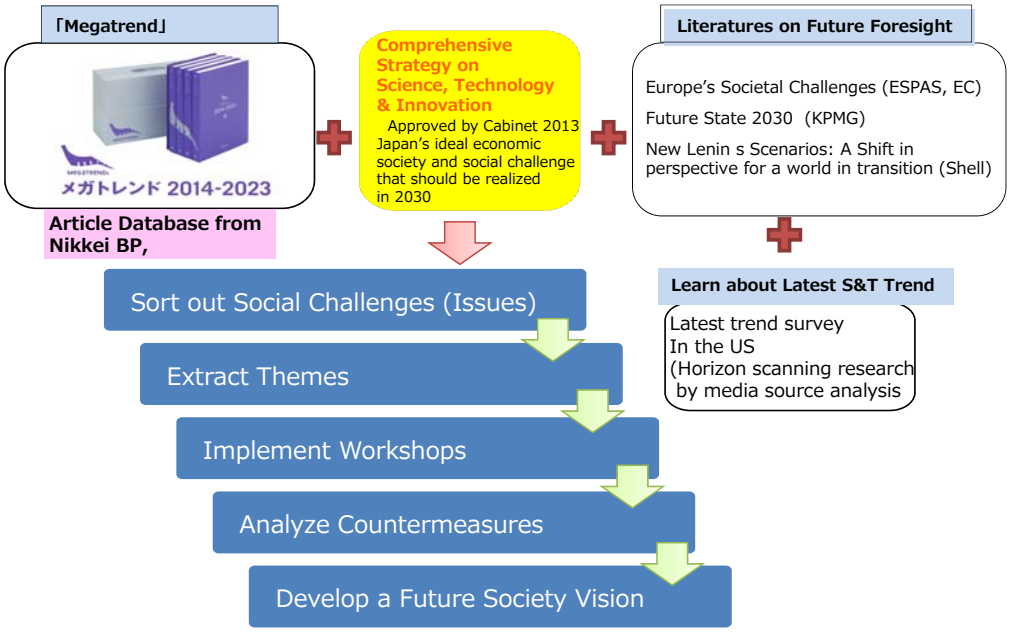
- **Outline of latest survey**
  - To contribute to deliberations on S&T innovation policies and strategies, consider the development of S&T towards realizing the vision.
  - Carry out (I) Consideration on future society vision from the social perspective and (II) S&T foresight by field from the S&T perspective. Consolidate the results of (I) and (II), and (III) Extract the issues in the future society and consider the directions of solutions.



Part I: Future Society Vision

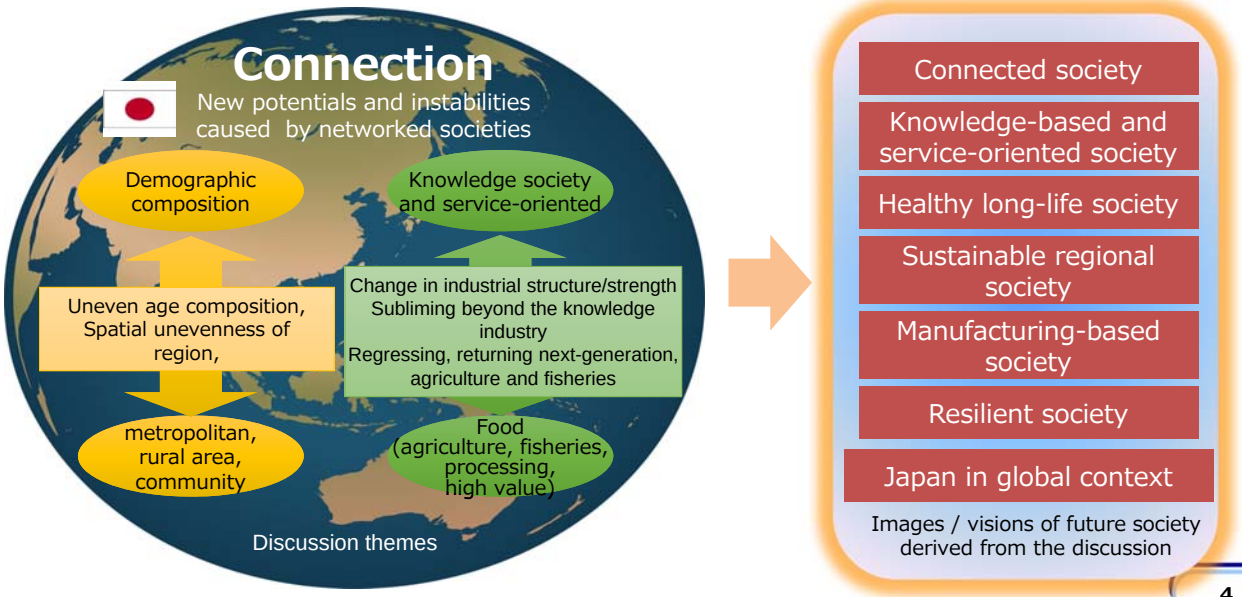
Outline

- Factors for future foresight of social challenges in Japan from 2030 to 2050 are separated into macro changes that will certainly happen including demographic changes and shift to service economy and uncertain changes including small social and technological changes that are happening, are discussed in workshop, and put together into future society vision.



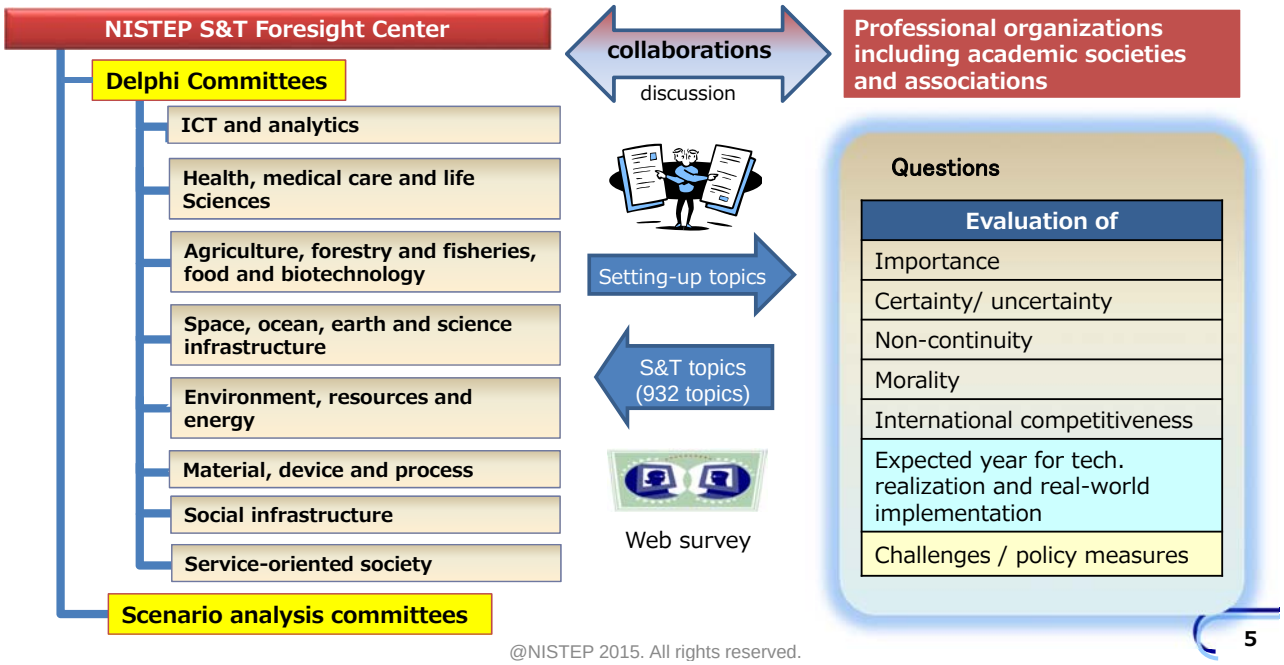
Part I: Future Society Vision
Directionality of the future society

- **Discuss the directionality of the future society based on the matters below that are expected to change drastically in the future**
  - From the viewpoint of
    - globalization: "Japan in the world" ,
    - rapid advancement in networking: "Connection",
    - human distribution: "Population composition" "City, region, community"
    - industrial strength: "Knowledge society and service-oriented" "Food"



Part II: Future Perspectives on S&T

- **Opinions of experts were collected and analyzed on the directions of mid- to long-term S&T development (to 2050).**
  - A committee was established for each subject field, and S&T that have high potential in making a major impact on the future economic society or S&T development were set as "S&T issues (topics)" (8 fields, 932 topics).
  - Under cooperation by relevant academic societies, associations, etc., questionnaire was carried out on the R&D traits, feasibility prospect, etc. on the topics. 4309 people responded.



Part II: Future Perspectives on S&T
Questions

Outline

[R&D Characteristics]

Variables	Definitions	Options
Importance	Comprehensive importance from both S&T and societal perspectives	Select one from: Very High / High / Low / Very Low * Responses are coded as Very High=4, High=3, Low=2, Very Low=1
Uncertainty	Involving many stochastic elements and needing methods to tolerating failures and multiple approaches to be considered during R&D	
Discontinuity	The result of R&D is not merely an extension of current state but is market-destructive and innovative	
Morality	Needing to consider morality and societal acceptance during R&D	
Global competitiveness	Enabling Japan to have global competitiveness over other countries	

[Predicted Timing of Realization]

Variables	Definitions	Options
Technological realization	When technology is expected to be achieved (somewhere in the world including Japan) When technological environment is ready such as achievement of anticipated performance. (e.g., when prospect of technology development becomes clear in stage of R&D in a lab) When a theory or phenomenon becomes scientifically established in case of fundamental science	Select one from: Achieved / Achievable / Not Achieved/ Not Sure If "Achievable" selected, additional question will be asked to identify the year that will be achieved between 2015 and 2050
Real-world implementation	When it's applied in the Japanese society or internationally led by Japan When achieved technology is available to be used as a product or service (or when it's diffused widely) When a framework, ethical standard, values, or societal consensus is established in case of non-S&T topics	

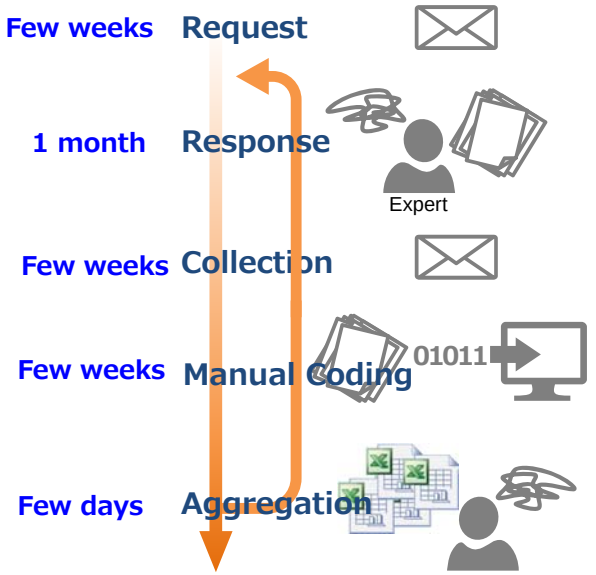
[Policy Priority]

Variables	Options
Policy that need to be focused for technology achievement	Select one from: Human resource strategy / Resource allocation / Internal and external collaboration and cooperation/ Environment enhancement/ Other
Policy that need to be focused for real-world implementation	

Transition to Online Delphi Questionnaire

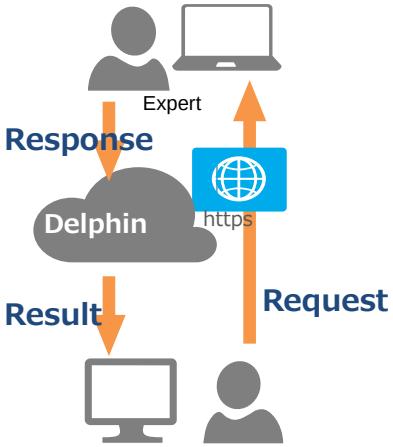
- **Migration of Delphi survey from printed material (sent via postal mail) to online form allowed us to reduce many aspects of operational cost.**

Previous method (via postal mail)



It took months excluding response period
Working on Excel was very cumbersome.

Current method（Online）

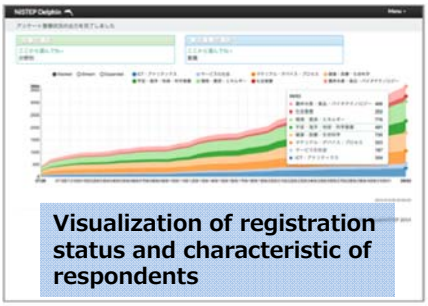


Most of processes, except those expected by respondents, requires only few seconds and progress can be tracked anytime.

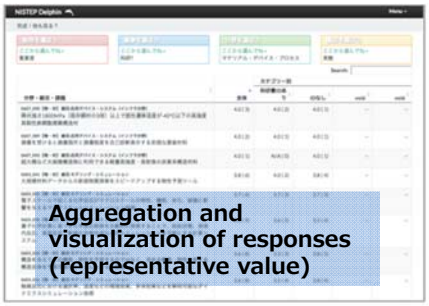
Online-base Delphi Analysis System: “Delphin©”

- **Possible to store mass data from questionnaires through online digitalization**
- **Developed a framework called Delphin which can process (analyze and visualize) mass data efficiently**

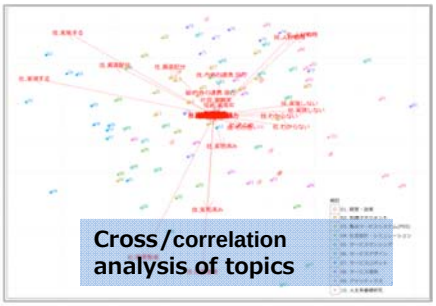
* Delphin©: Visualization tool which based on relationship between each Delphi topics



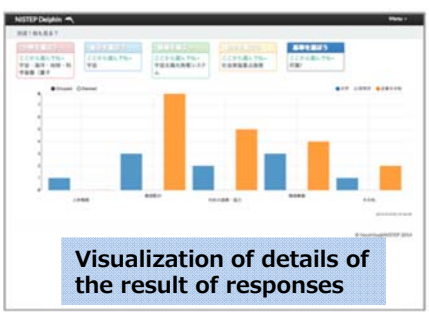
Visualization of registration status and characteristic of respondents



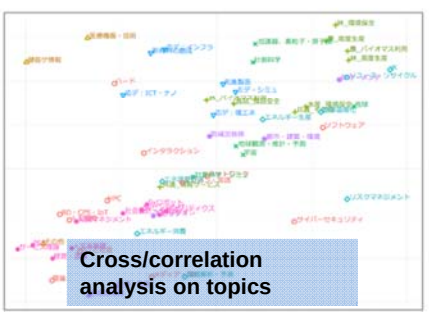
Aggregation and visualization of responses (representative value)



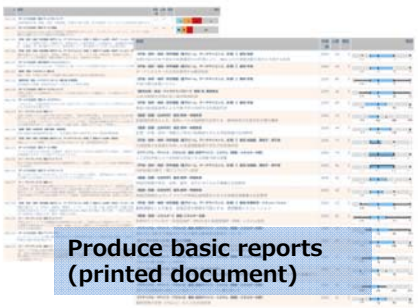
Cross/correlation analysis of topics



Visualization of details of the result of responses



Cross/correlation analysis on topics



Produce basic reports (printed document)

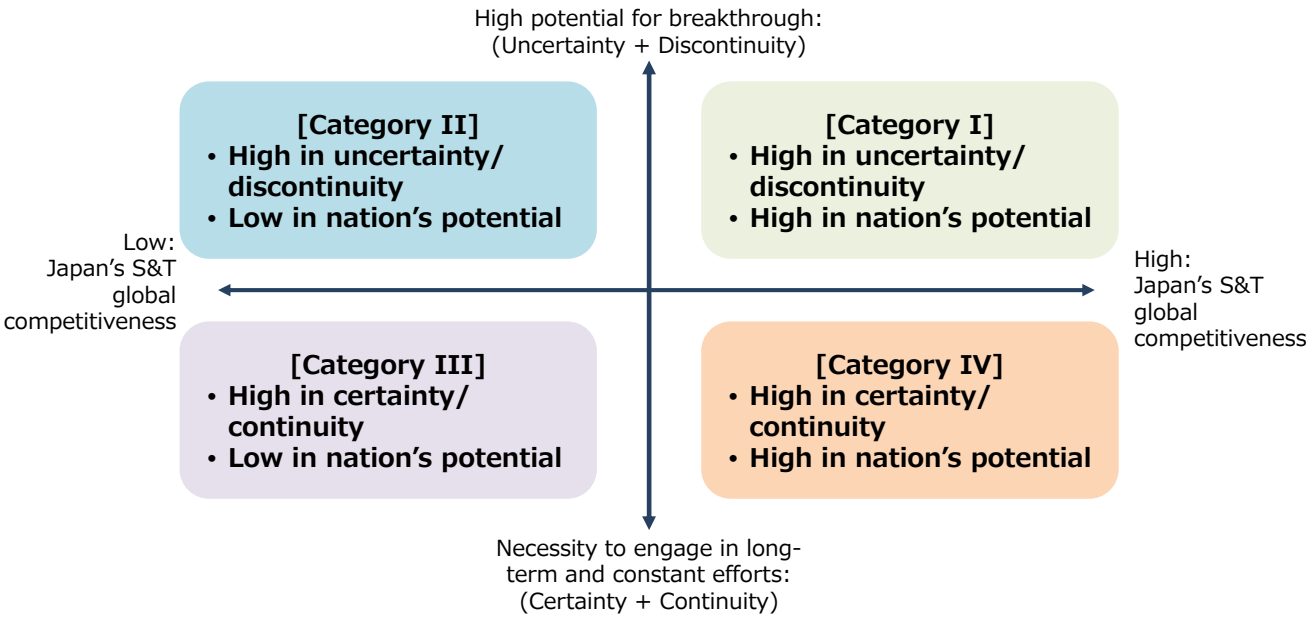
Example of Top 100 Topics with High Importance

Field	Topic
ICT	Development of data utilization techniques with theoretically guaranteed preservation of privacy
ICT	Technology to develop software without security holes which allow remote exploitation
ICT	Technology to improve performance to power ratio of super-large-scale supercomputers and big data IDC systems with more than one million nodes by a factor of 100 compared to current systems
ICT	A low cost, easy-to-use, secure personal authentication system which can be used with confidence even when accessing many different websites over a long period of time
ICT	A health care system that monitors the condition of patients in real time to provide optimal nursing or medical care at a low cost
Health	A cheap, easy-to-introduce dementia care assistance system
Health	Medical technology to regenerate auditory and visual functions
Health	Preventative medicines which inhibit the development of carcinogenesis from a precancerous state
Agriculture, forestry and fisheries	Crops that can be expected to produce a good harvest even in environments generally unsuitable for farming such as deserts (arid regions), etc.
Agriculture, forestry and fisheries	Technology to predict the variation in sardines, tuna, and other major fishery resources under different harvesting and long-term environmental conditions, as well as technology for the proper management of fishery resources based on this prediction technology
Agriculture, forestry and fisheries	Technology to remove radioactive substances in order to revitalize fishing in coastal areas
Frontier	Urgency assessments for all active volcanoes to identify the volcano or volcanoes most likely to erupt in the near future

Field	Topic
Frontier	Technology to observe local structure and electron state information essential to understanding the mechanisms for the functional expression of physical characteristics in functional materials and the control of such properties at the nanometer-scale and femtosecond order
Frontier	Technology to predict the local occurrence of heavy rain, tornadoes, hail storms, lightning strikes, and snow which will occur several hours in the future at a spatial resolution of less than 100m using a high-resolution simulation and data assimilation
Environment and resources	Mineral extraction and mining technology needed for extracting ocean mineral resources
Environment and resources	Predictive technology to assess the impact of global climate change on food production
Environment and resources	Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries
Material	A rechargeable automotive battery capable of a range of 500km while maintaining the size and weight of current batteries
Material	Integrated circuit technology to realize the performance level similar to the existing super computer with one chip by improving the information processing ability without increasing the electricity consumption per unit area
Material	Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs
Social infrastructure	Low-emission and energy efficient aircraft to realize reducing noise at the takeoff and landing as well as the emission gas during the flight, and to achieve lowering the frictional resistance on the body and improving the combustion efficiency of the engine
Social infrastructure	Establishment of decommissioning and radioactive waste disposal technology for 1 million KW-class nuclear reactors.
Service	The generalization of robot inspection technology to inspect buildings or infrastructures that would be more dangerous or costly for humans to inspect.

Classification of Topics with High Importance

- **Examined 312 items with high importance (top 1/3 items on importance score)**
- **Combined scores for uncertainty and discontinuity to extract items within top 10% (30 items) and bottom 10% (30 items)**
- **Global competitiveness was then taken into account to finalize the ranking of top 10% and bottom 10%**



Scale: Responses are coded (Very High=4, High=3, Low=2, Very low=1)

Classification of Topics: Category I

- **Category I: High in uncertainty and discontinuity as well as nation's potential.**
  - Regenerative medicine, fuel cell and rechargeable battery for automobiles, earthquake forecasting, etc.

Field	Topics	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	A network node that uses technology such as nanophotonics to reduce the electricity consumed per unit of data transferred to 1/1000 of the current consumption level	3.5	3.0	2.9	3.2	2025 2030
Health, medical care and life sciences	A comprehensive understanding of the reprogramming mechanism of differentiated cells	3.5	2.9	2.9	3.4	2023 2025
Health, medical care and life sciences	Technology to create stem cells such as iPS cells from differentiated cells regardless of genetic transfer	3.5	3.0	2.9	3.2	2020 2025
Agriculture, forestry and fisheries, food and biotechnology	Technology to preserve perishable goods for about one week without refrigeration for use in logistics	3.6	3.0	2.8	3.3	2023 2025
Space, ocean, earth and science infrastructure	Prediction technologies for the timing (within a one year horizon), scale, affected regions, and damage of earthquakes greater than magnitude 7 on the Richter scale	3.5	3.6	2.9	3.1	2030 2032
Space, ocean, earth and science infrastructure	Technology to predict the occurrence of large-scale earthquakes greater than magnitude 8 on the Richter scale through the analysis of strain distribution on the Earth's crust and the history of past earthquakes.	3.5	3.5	2.7	3.2	2030 2030
Material, device and process	Room-temperature superconducting materials that make use of strongly-correlated electron systems	3.4	3.4	3.4	3.2	2030 2040
Material, device and process	Solar cell with a conversion efficiency of more than 50%	3.5	3.0	2.8	3.1	2025 2030
Material, device and process	A rechargeable automotive battery capable of a range of 500km (energy density of more than 1kWh/kg, and specific power of more than 1kW/kg) while maintaining the size and weight of current batteries	3.6	2.8	2.9	3.3	2025 2030
Material, device and process	High-efficiency fuel cells for motor vehicles which do not use rare metals	3.6	3.0	3.0	3.3	2025 2030

*Top=Technological realization
Bottom=Real-world implementation

Classification of Topics: Category II

- **Category II: High in uncertainty and discontinuity; low in nation's potential**
  - -Cybersecurity, mental disease, infectious disease, etc.

Field	Topic	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems as the foundation for construction of a realistic and marginal problem solving platform	3.5	3.0	3.0	2.9	2027 2035
ICT and analytics	Defense technology that recognizes dynamic changes in the pattern of an attacker's attacks and automatically implements the most effective defense	3.6	3.0	2.9	2.7	2020 2022
ICT and analytics	Technology to prevent illegal activities by people who are authorized to access to a specific system	3.6	3.1	2.8	2.7	2020 2024
Health, medical care and life sciences	Pharmaceuticals based on new functional molecules to follow after pharmaceuticals based on low molecular weight compounds, antibodies, and nucleic acids	3.5	3.0	3.0	2.8	2024 2025
Health, medical care and life sciences	A new antipsychotic drug based on the pathogenesis of schizophrenia in the brain that has fewer side effects than current drugs and leads to the social reintegration of patients	3.5	3.0	2.8	2.7	2027 2031
Health, medical care and life sciences	A new antidepressant therapy that is fast-acting and prevents the recurrence of depression based on the diagnostic classification of subtypes of depression according to the pathology of depression in the brain	3.5	3.0	3.0	2.7	2025 2029
Health, medical care and life sciences	A new mood stabilizer based on the pathogenesis of bipolar disorder in the brain with fewer side effects than current drugs and the possibility of preventing the recurrence of symptoms	3.5	3.0	2.8	2.8	2028 2030
Health, medical care and life sciences	Therapies and intervention methods based on the pathogenesis of autistic spectrum disorders in the brain that enable an independent social life	3.4	3.1	2.9	2.6	2025 2030
Health, medical care and life sciences	Flu vaccines which don't cause antigenic variations in the virus and can provide lifelong protection against infection through only a few vaccinations	3.4	3.3	3.0	2.5	2025 2030
Material, device and process	Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs	3.5	3.0	2.9	2.9	2025 2030

*Top=Technological realization Bottom=Real-world implementation

Classification of Topics: Category III

- **Category III: High in certainty and continuity; low in nation's potential**
  - Network technology, utilization of medical data, forestry, surveillance, etc.

Field	Topic	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
ICT and analytics	Automatic configuration technology for integrated wired/wireless networks that provides uninterrupted access to a network without the user being aware of configuration changes as the status of the network changes over time	3.4	2.3	2.3	2.9	2020 2022
ICT and analytics	A highly reliable network which provides services without disruption by using network virtualization technology that dynamically adjusts based on operating conditions internal and external to the system	3.4	2.3	2.4	2.9	2020 2020
Health, medical care and life sciences	Disease preventation methods based on the utilization of big data methods to analyze lifestyle data	3.4	2.3	2.3	2.7	2020 2025
Health, medical care and life sciences	A prediction and alert system for infectious disease epidemics based on a comprehensive infectious disease surveillance system that utilizes medical data such as EMR system data, test results, and prescription records along with various kinds of web data	3.5	2.3	2.2	2.5	2020 2022
Health, medical care and life sciences	Technology for the separation and identification of unknown pathogens by utilizing a pathogen database	3.5	2.4	2.3	2.7	2022 2025
Agriculture, forestry and fisheries, food and biotechnology	Establishment of methods for assessing the safety of genetically-modified crops and animals	3.6	2.3	2.3	2.7	2024 2025
Agriculture, forestry and fisheries, food and biotechnology	Woodland creation technology corresponding to the period from forest thinning to final clear cutting to ensure the reproduction of the forest following the harvest	3.5	2.3	2.0	2.3	2021 2025
Agriculture, forestry and fisheries, food and biotechnology	Development of high strength wood members and fire resistant wood structures for the construction of low-rise and high-rise wooden buildings such as office buildings	3.4	2.2	2.3	2.6	2020 2025
Space, ocean, earth and science infrastructure	A 24-hour high precision homeland monitoring system based on satellites to ensure public safety and security and provide data for industrial use	3.5	2.2	2.2	2.9	2025 2025
Social infrastructure	Unmanned aircraft for low-attitude autonomous flight to be used for surveillance of territorial waters, disaster monitoring, and rescue support	3.4	2.3	2.3	2.9	2020 2025

*Top=Technological realization
Bottom=Real-world implementation

Classification of Topics: Category IV

- **Classification IV: High in certainty and continuity as well as nation's potential.**
  - -Beam application (material, treatment), highly-efficient power generation, recycling of resources, etc.

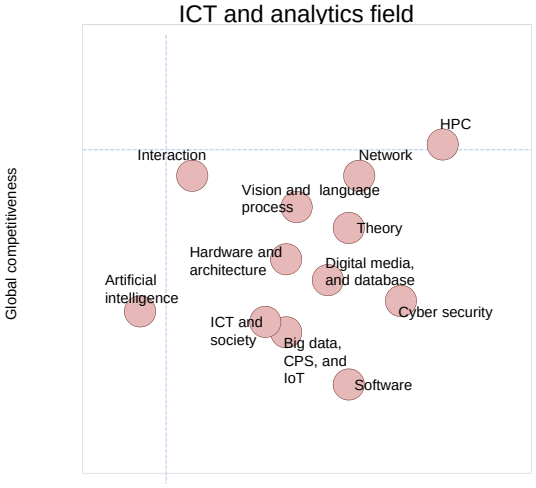
Field	Items	Importance	Uncertainty	Discontinuity	Competitiveness	When to be achieved*
Health, medical care and life sciences	Radiation therapies to enable cancer treatment within a short period without disturbing daily life by using a small system for irradiation of intensity modulated particle beam	3.5	2.2	2.2	3.3	2025 2030
Space, ocean, earth and science infrastructure	Buoy-type technology to observe crustal deformation and tsunami formation at sea without laying submarine cables	3.5	2.2	2.3	3.4	2020 2025
Space, ocean, earth and science infrastructure	A medium-size high-intensity synchrotron radiation facility surpassing Spring-8 in the soft X-ray area (electron energy 3 GeV, horizontal emittance of 1.2nmrad or less, brilliance of 10^20 phs/s/mm^2/mrad^2/0.1%BW or more).	3.6	2.0	2.6	3.4	2020 2020
Space, ocean, earth and science infrastructure	Technology for the in situ observation of functional materials and structural materials using neutrons and X-rays to visualize the three-dimensional stress and strain distribution of the materials during the production process	3.5	2.2	2.4	3.2	2020 2022
Space, ocean, earth and science infrastructure	Communications and networking technologies based on fiberoptic network and frequency link technologies with high-precision standards, reference signals, location information, etc. that works equally well in remote areas (i.e. optical carrier frequency fiber link technology, optical comb transmission technology, high stability GPS technology through timing synchronization, and ultra-high-precision technology, etc.)	3.4	2.2	2.4	3.2	2021 2025
Environment, resources and energy	720℃ level supercritical pressure thermal power generation that can achieve 46% efficiency (HHV standard)	3.4	2.4	2.2	3.3	2022 2025
Environment, resources and energy	Large-scale combined power generation with high efficiency, large-scale gas turbines (inlet temperature of over 1700℃)	3.4	2.3	2.2	3.2	2021 2025
Environment, resources and energy	Technology for the rational recovery and utilization of rare metals from sewage, sludge, incinerator fly ash, waste, and small electronic devices	3.4	2.4	2.2	3.2	2022 2026
Environment, resources and energy	Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries	3.6	2.3	2.1	3.2	2020 2025
Service-oriented society	Popularization of supervision terminal technology that can be worn naturally by general consumers to monitor people such as dementia sufferers who might wander off	3.5	2.2	2.3	3.2	2020 2022

*Top=Technological realization
Bottom=Real-world implementation

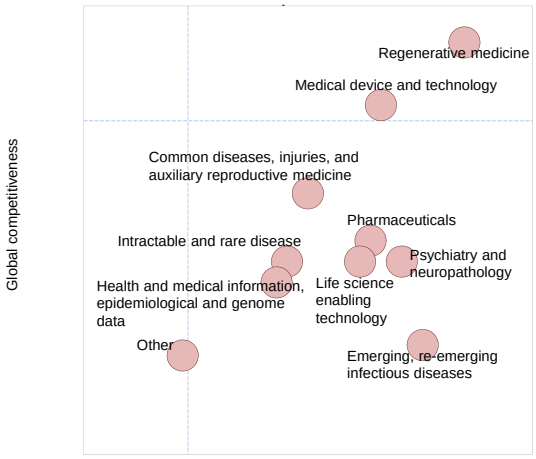
Importance and Global Competitiveness

- **Characteristics of "ICT and analytics" and "Health, medical care and life sciences" that show high importance and low global competitiveness**
  - ICT and analytics
    - Topics in "HPC": High importance, high global competitiveness
    - Topics in "Cyber security" and "Software": High importance, low global competitiveness
  - Health, medical care, and life sciences
    - Topics in "Regenerative medicine": High importance, high global competitiveness
    - Topics in "Emerging and re-emerging infectious diseases": High importance, low global competitiveness

ICT and analytics field



Health, medical care and life sciences field



Top-rated Topics in "Policy: Human Resource Strategy" (Real-world Implementation)

- **Software and theory in ICT field as well as modeling and simulation in material field. Half of topics overwrap with technological achievement.**

Field	Topic	Selection ratio*1	Importance *2	When to be achieved*3
ICT	Software development technology that reduces the frequency of bugs occurring in code to less than one per million lines of code	52% (57%)	3.4	2025 2025
ICT	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems (i.e. interactive computing, quantum computing, probabilistic proof verification model, etc.) as the foundation for construction of a realistic and marginal problem solving platform (including theoretical exploration of innovative model building)	47% (80%)	3.5	2027 2035
ICT	Technology which automatically inspects and fixes minor bugs in large-scale software	47% (58%)	3.5	2024 2025
Material	Dynamic simulation technology that allows for the analysis of the selection rates, environmental effects (temperature, etc.), and many-body effects in catalytic reactions	47% (65%)	3.3	2025 2029
ICT	Technology which ensures that widely used compilers, OSes, or basic libraries operate in accordance with specifications	47% (55%)	3.5	2025 2029
Environment and resource	Establishment of a two-way risk communication process to enable consensus on energy supply technologies and systems	46% (44%)	3.4	2022 2025
Material	Technology to estimate the structure or creation process of materials through materials science inverse problems by applying statistical mechanics techniques for information such as Bayesian estimation and neural networks	46% (56%)	3.2	2025 2029
Material	Multiscale simulation technology to project how chemical reactions at the electron-scale affect macro-scale physical properties, functions, degradation, and destruction of substances	44% (57%)	3.4	2025 2030
Agriculture, forestry and fisheries	Evaluation of toxicity caused by the interaction of multiple harmful factors in food	44% (31%)	3.4	2020 2023
ICT	Improved scalability of the problem-solving paradigm using mathematical programming (Developing mathematical programming technology to solve global-level optimization problems in real time)	43% (65%)	3.5	2022 2025

*1: Parentheses represent percentages for selecting "human resource strategy" as a policy focus for technology achievement
*2: Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
*3: Top=Technological realization, Bottom=Real-world implementation

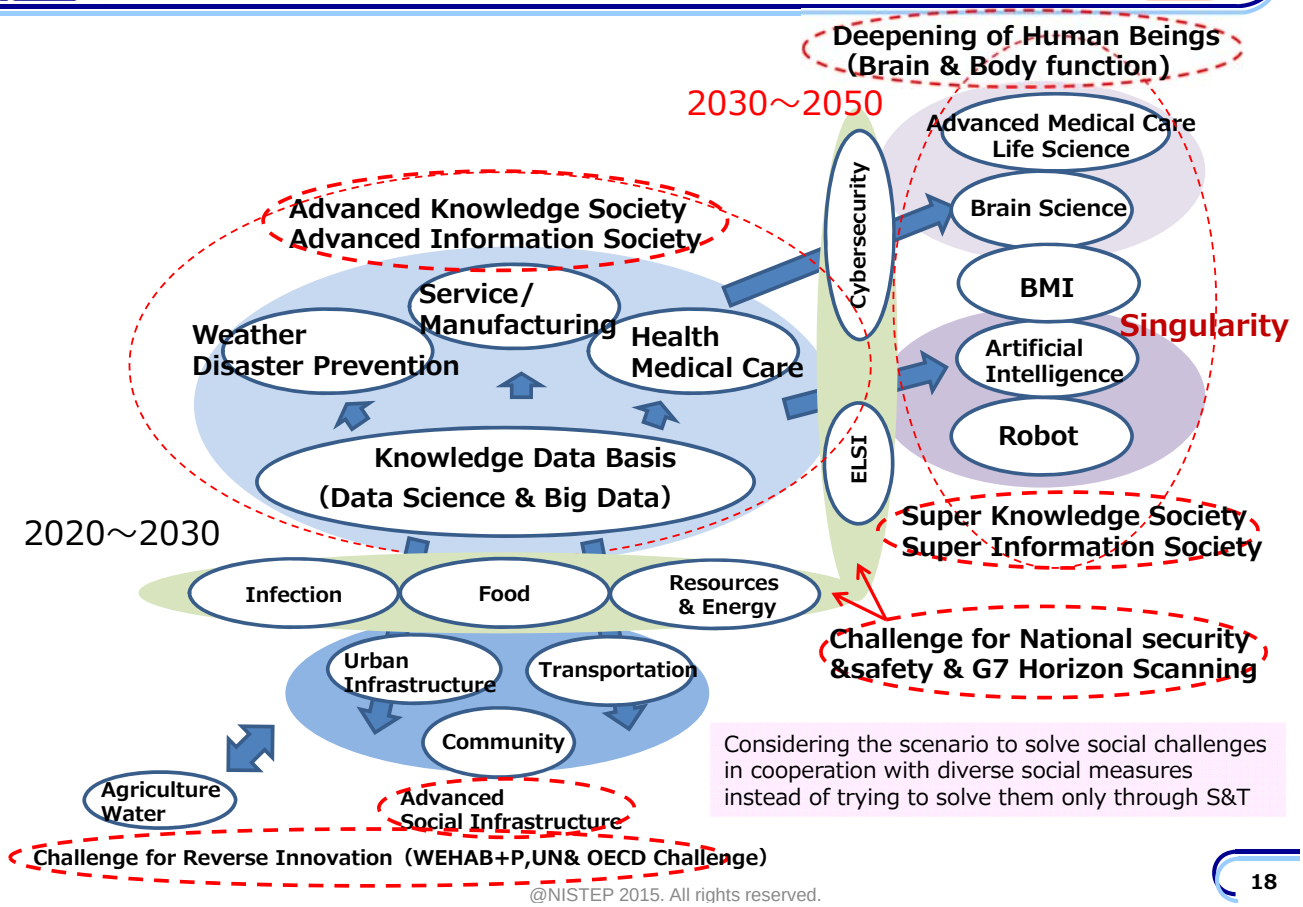
Top-Rated Topics in "Morality"

- **Top topics come from "ICT and analytics", "Health, medical care and life sciences", and "Service-oriented society".**

Field	Topic	Morality	Importance	When to be achieved
Health	An infertility treatment that uses reproductive cells that have been induced to differentiate from human iPS cells	3.9	2.9	2025 2036
Service	To achieve a healthy aging society, information about the hobbies, health, medical records, and daily activity of elderly people will be managed and analyzed in a single database	3.7	3.3	2020 2025
Service	Development of a system that can automatically determine the relationships between employees from their behavioral histories	3.7	2.5	2025 2026
Service	New businesses that manage customers' personal behavior information in a manner similar to credit card companies and banks will emerge and become commonly used by the public.	3.6	2.6	2018 2021
Health	An artificial uterus which enables the growth of a fetus	3.6	2.8	2030 2040
Health	Organs for transplant derived from human stem cells but produced by animal embryos (in other words, produced from chimeric embryos based on animal embryos injected with human cells)	3.6	3.0	2022 2032
Health	Regenerative medicine technologies using the transplantation of embryonic stem cells	3.6	3.0	2020 2025
ICT	A service to provide predictive and preventive medicine based on analysis of various personal data such as health, diet, and exercise	3.5	3.5	2021 2025
ICT	Technology that integrates evidential information such as provenance into data utilized for big data analytics to allow for safe analysis and the protection of personal data	3.5	3.6	2020 2024
ICT	Social consensus about the relationship between machines (e.g. robots) and humans (By establishing a new "three laws of robotics", legal developments will proceed, and we will achieve a stable society and economy where humans and robots cooperatively coexist). As a result, the contribution of robots to the economy will reach 40%	3.5	3.4	2025 2030

* Morality/Importance: Responses are coded (Very high=4, High=3, Low=2, Very low=1)
* When to be achieved: Top=Technological realization, Bottom=Real-world implementation

Changes over Science and Technology

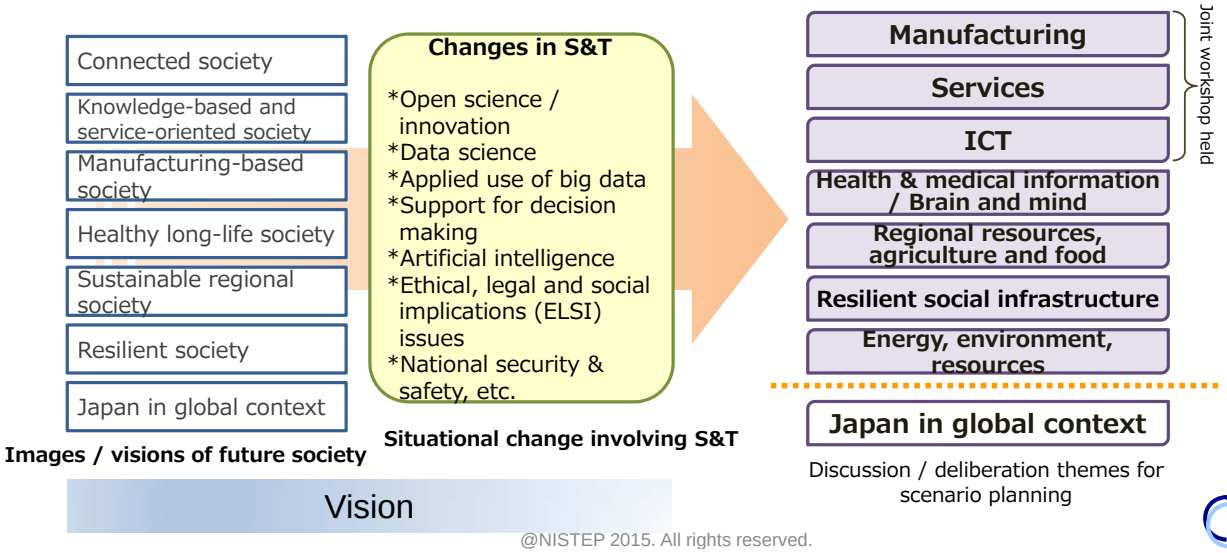


Considering the scenario to solve social challenges in cooperation with diverse social measures instead of trying to solve them only through S&T

Part III. Scenarios from the viewpoint of globalizaiton

Outline

- **Based on the change in the society and the directionality of S&T development in the future, identifying future issues, strategies and precautions for solving them, etc.**
  - Consider relevant policies and strategies, images of the future society derived from the vision survey and situational changes involving S&T derived from S&T foresight by field, determine the consideration themes from the viewpoint of their long-term nature, fusion of fields, and interdisciplinary nature.
  - Gather information through foresight workshops, interviews, literature reviews, etc., and analyze and summarize them at NISTEP.
  - Towards overall integration of thematic scenarios, hold "Japan in global context" workshop to deliberate on S&T- triggered scenarios from the viewpoint of placement of Japan in global context.



Part III. Scenarios
Main Points from International Perspectives

Summary

- Our country's advantages and disadvantages that serve as the basic information for reviewing strategies are organized based on the results of the "Study on the Future Vision of Our Society"(Part1) and "Foresight in Science and Technology for Each Field"(Part 2).
- We had a workshop titled, "Japan in the World—Consider Japan's Role in the World" where the main points were picked up from international perspectives (in terms of: leadership, international harmonization and collaboration, and autonomy).
- Given below are the points brought out in discussions that were based on the direction of science diplomacy.

1. Points Related to "Leadership"
- A scenario in which Japan will have a strong ability to make proposals based on not only the technological strength that provides greater international competitiveness but also the cultural advantages including Japanese-style hospitality, the so-called "O-Mo-Te-Na-Shi"
- A scenario in which Japan, as a developed country facing many serious challenges including aging society issues, will present an exciting field for research, form an international hub to attract superb researchers and companies, and lead technological innovation

2. Points Related to "International harmonization and collaboration"
- A scenario in which Japan will make great contributions to resolving global challenges related to disasters, the environment or energy
- A scenario in which multinational harmonization and collaboration will facilitate in resolving challenges such as measures against intractable/infectious diseases
- A scenario in which the best response to the challenge Japan or a counterpart faces will be made under bilateral harmonization and collaboration.

3. Points Related to "Autonomy"(a foundation for surviving in our society/daily life in this country)
- A scenario that contributes to resolving the issue of decreased production/consumption associated with a decrease in population
- A scenario that responds to urban and regional challenges that arise as a result of a decrease in population (including aging infrastructures, depopulation of hilly/mountainous regions, etc.)
- A scenario that contributes to the improvement of QOL and mental benefits

＊"Scenarios" in this study are implemented not by exclusively selecting one of those scenarios, but by assuming that the individual scenarios will be achieved in a proper balance that corresponds to the situations we face, in consideration of, for example, the limitation of available resources.

Thematic Scenarios

Advanced manufacturing platform towards future industry creation and societal reform
Consider advanced manufacturing platforms through advanced fusion with ICT and services that contribute to "future industry creation and societal reform".

Future co-creating services
Consider service innovations that construct various elements and co-create new values and services that meet the user's requests.

Improvement of physical and mental health towards realization of a society with healthy long-life
Disease control towards sustainment of work force in a super aged society, and health improvement and functional expansion of brain and mind.

Maintaining food production and ecosystem services using regional resources
Cross-field activities, consider based on "food, sustainability and human resources development

Resilient social infrastructure to respond to large scale disasters and an aging population with fewer children
Consider from the viewpoint of response to large-scale natural disasters, land monitoring and integrated social infrastructure management.

Energy, environment and resources that contribute to building a sustainable future
Consider energy, environ. and resources that contribute to the best energy mix and solving climate change issues.

Japan in global context

- Leadership
- Int'l harmonization & collaboration
- Autonomy

II. Thematic Scenarios

Theme 1: Advanced Manufacturing Platform towards Future Industry Creation and Social Reform

Overview

- Examine social challenges involved with “manufacturing” in 2030 from the aspects of economy, population and region.
  - Shifting industrial products to commodities
  - Decreasing workforce due to an aging population with fewer children
  - Declining rural areas
- Consider the important directions of “manufacturing” in order to strengthen the international competitiveness of Japanese industries and realize sustainable development for the future.
  - Improve individual QoL by meeting diverse individual and societal needs and contribute to solve social challenges that could become evident domestically and internationally.

Focused Directionalities

- New “manufacturing” which meets diversifying needs and is equipped with international competitiveness
- Contributions to use energy effectively and establish an environment-friendly international society
- Contributions to prepare advanced support equipment and working environment applicable to the needs of human behavior

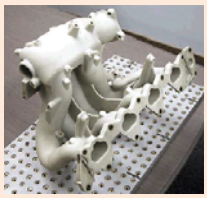
Theme 1:Advanced Manufacturing Platform

Scenarios

Leadership

Society where new manufacturing has been realized which meets diverse individual and societal needs and is equipped with international competitiveness

New manufacturing could be realized which meets domestic and international diverse individual and societal needs and is equipped with international competitiveness by adding high value by highly integrating with services and establishing effective digital processing system with advanced use of ICT including design, manufacturing, distribution, sales and services.



Int’l Harmonization & Collaboration

Society where manufacturing contributes to use energy effectively and establish an environment friendly international society

Manufacturing is contributing to use energy effectively and establish an environment friendly international society, which has been realized by systematizing with advanced use of ICT and promoting basic research for simulating measurement of material creation based on technologies with high international competitiveness including mobility with low environmental impact and material/device supporting renewable and saving energy.

Autonomy

Society where manufacturing contributes to prepare advanced support equipment and operating environment applicable to the needs of human behavior

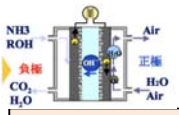
Manufacturing is contributing to solve social challenges that could become evident in Japan and other countries including an aging population with fewer children and food issues by preparing research and development on and operating environment for the equipment (robots in a broad sense) enabling complicated work operations required for various life scenes by highly integrating with ICT.

Solar cell with a conversion efficiency of more than 50%.

A rechargeable automotive battery capable of a range of 500km

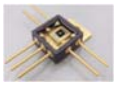
High-efficiency fuel cells for motor vehicles which do not use rare metals.

Lightweight carbon-based structural materials with high strength and corrosion resistance appropriate for use in large-scale structures such as super-large bridges.

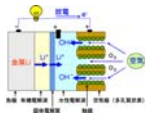


Air batteries with high energy density that use metals like magnesium and are easy to regenerate or recycle.

Practical power semiconductors for electrical use which have lower losses than SiC or GaN



Integrated circuit technology to that improves processing power without increasing the power consumption per unit area, enabling the creation of a single chip capable of approximating the performance of a current supercomputer.

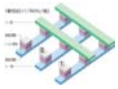


2025 2030 2035 2040

Structural health monitoring technology for buildings which is small, lightweight, and can be operated by a single person.

Memory that operates with 100 times the memory bandwidth and 1/100 the power consumption of current DRAM.

Simulation technology that integrates synthesis process simulation, fabrication process simulation, and function prediction abilities.



Multiscale simulation technology to project how chemical reactions at the electron-scale affect macro-scale physical properties, functions, degradation, and destruction of substances.

Multiphysics material simulation technology for multiple scales including electronic scale, atomic scale, mesostructured scale, macrostructure scale, and industrial material scale.

Multiphysics simulation technology to clarify the impact of various physical factors such as friction, shock, stress, fluid, electric fields, heat, light, etc. on chemical reactions that occur on surface of or interface between materials.

Artificial photosynthesis technology with with the equivalent efficiency of plants (more than 1%).

Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs.

Theme 1: Advanced Manufacturing Platform
Related Topics with Years of Their Real-World Implementation
Manufacturing

Digital fabrication (3D printing)

A system to facilitate the inheritance of skills from artisans (skilled workers, craftsmen, etc.) through the measurement and modeling of such skills and the archiving of the implicit knowledge involved.

Personal manufacturing of parts or products with the same precision and quality of mass-produced goods and similar items.

Mass customization production methods for making parts with different shapes (multiproduct mass production on the scale of 100,000 or more products).

Innovative production technology to directly build a three-dimensional solid shape from a liquid substrate without a template.

Application of metamaterials to consumer products through additive manufacturing technologies.

Manufacturing of replacement organs through bio-printing.

On-demand production of maintenance parts for consumer products.

2025 2030 2035 2040

A physical property prediction tool that increases the speed of searching for new substances in large-scale materials data.

Model optimization technology that connects the local and macro physical properties of materials by assimilating simulation data and measured data to achieve more precisely predictive models.

Technology to estimate the structure or creation process of materials through materials science inverse problems by applying statistical mechanics techniques for information such as Bayesian estimation and neural networks.

Development structural and functional materials through 3D modeling utilizing material informatics.

Material informatics

Theme 2: Future Co-creating services

Services

Overview

- Essence of service* lies in manifestation of values, which is a wider concept including so-called “products”.
- One of the tasks is how to create “values” by combining various elements. Additionally, values are to be integrally “co-created” with the recipients instead of being one-sidedly specified by the provider.
- There are many themes where “values” cannot be specified in advance from the viewpoint of “co-creation”. Here, considerations will be given to the overall perspective and the typical examples of field fusion by picking up themes that will solve social problems and become plausible only by multiple fields fusing and cooperating.

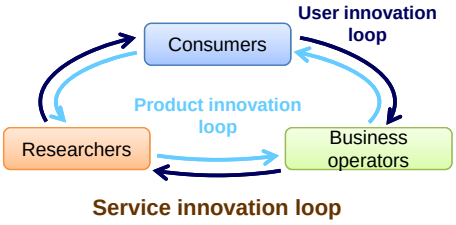
* “service” refers to “Service Science”

Focused Directionalities

- Co-creation of new values through “service”: Service innovation (overall perspective)

Examples

- Clouding of transportation and creation of new service by utilizing ICT
- Tourism and disaster prevention/mitigation services by service data collection and management infrastructure



Created by NISTEP based on the figure in CSTI-WG material (by Member Ueda)

Theme 2:Future Co-creating Services
Scenarios

Services

Leadership

Realizing Smart Compact City by moving transportation to cloud computing

- Could go out without thinking transportation by cloud computing transportation
- Realize local economic revitalization through making virtual compact city by improving traffic convenience
- Cooperate with different services such as transportation with visiting hospitals

Int’l Harmonization & Collaboration

Realizing Service Ecosystem by accumulating and using data through exporting services

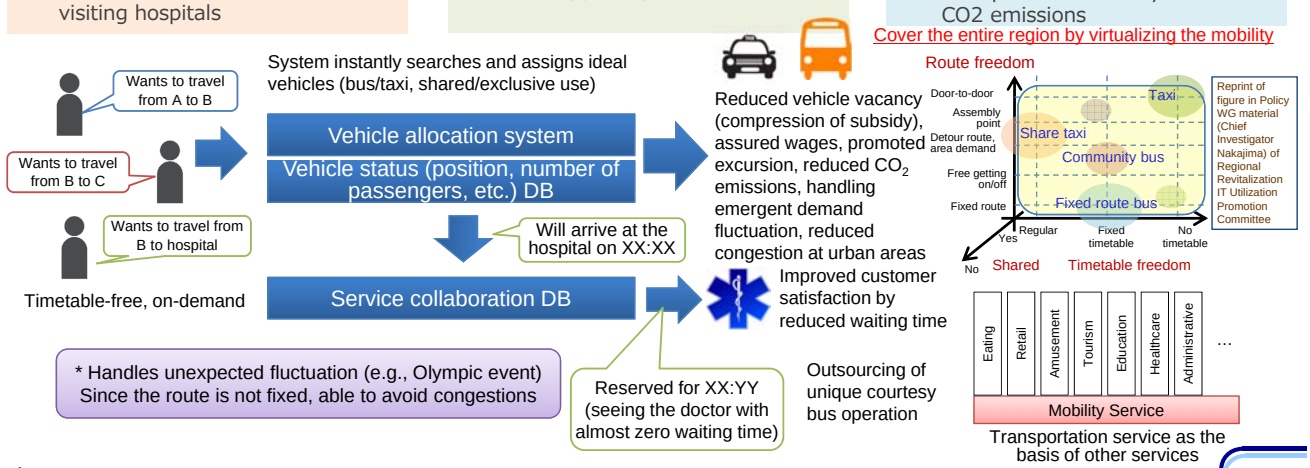
- Export on-demand transportation service
- Collect, accumulate and analyze life data in other countries through transportation
- Realize creation of business opportunity such as localizing and suggesting services

Autonomy

Resolve going-out and shopping refugee issues and create attractive and vigorous rural areas

Address the challenges of declining regions associated with declining public transportation

- Promote going out through flexible transportation system such as door- to door and timetable free services
- Contribute to compress transportation subsidy and reduce CO2 emissions



(Targeting 2030)

Theme 2: Future Co-Creating Services
Related topics with years of their real-world implementation

Services

Virtualization of public transportation, enabling users to select the optimal transportation method by only indicating their destination (more than navigation, it includes transportation mode matching based on current levels of demand).

A traffic control service system that dynamically uses big data collected from vehicles and road infrastructure such as traffic lights.

Centralized network control and operation technology which manages information from a large number of moving vehicles (automobiles, bullet trains, airplanes, ships, etc.) to contribute to the reduction of the load on the environment.

A mobility management system designed to accommodate several hundred thousand people to ensure the smooth movement of people during emergency situations (such as interruptions caused by disasters or malfunctions).

Cooperative transportation system which supports communication between humans and vehicles so that all traffic signals can be eliminated.

2020 2025 2030

A system to halve the time, cost, and environmental impact of cargo transportation by creating road+railway, road+port/airport, and railway+port/airport transportation nodes to improve the efficiency of transportation between cities.

A system for comprehensively optimizing an entire road network to reduce social impacts including traffic congestion, environmental impacts, and the cost of road management.

A transportation system for an extremely aged society which enables elderly people to travel from one place to another alone with confidence while seamlessly connecting a local district to the wider region.

Theme 3: Improvement of Physical and Mental Health towards Realization of a Healthy Longevity Society

Health

Overview

- Japan stays ahead of the world in the population aging rate and is forced to respond to an unprecedented society.
- For sustainable and stable economic development, it is essential to secure workforce and is necessary to encourage the elderly to participate in society and extend their healthy life expectancy and avoid declining workforce associated with mental disorders in the general workforce.

Focused Directionalities

- Focused on lifetime health management and mental and neurological disorders which are the leading causes of loss in healthy life expectancy along with cancer and cardiovascular disease in terms of securing workforce in the super aged society.
- Undertook the measures against emerging and re-emerging infectious diseases and the research on intractable and rare diseases which require international harmonization and collaboration.

- Use health and medical information and big data for brain to solve these social challenges.
- To do so, it is necessary to promote research on different areas associated with human resource development and ethical consideration.

- Through these approaches, Japan with most increasing longevity in the world will take the lead to propose a model for the super aged society and will create new innovation.

(Targeting 2030)

Theme 3: Improvement of Physical and Mental Health
Scenarios

Health

Leadership

Japan takes a lead in the world as a model for the super aged society by using a big data for health and medical care

- Improve medical and health care and strengthen the measures against aged society
  - Improve the labor participation ratio of the elderly
  - Elderly's social participation contributes to health promotion
  - Disseminate various technologies for drugs, medical and nursing care equipment and living environment
  - **A large-scale long-term longitudinal study** has developed tracking diverse health related information for a lifetime
  - Developed into diverse research infrastructure not only for medicine but also education and economics
  - Using health related big data and bridging research contribute to formulate public policy and to create health industry.
  - Contribute to improve the efficiency of medical care

(Targeting 2030)

Int'l Harmonization & Collaboration

International cooperation in the measures against emerging and re-emerging infectious diseases and the research on intractable and rare diseases

- Detect infection and isolate and identify unknown pathogen by ultralight sensor to detect and determine the characteristics of infections promptly
- Forecast and alarm the epidemics of infection through international and exhaustive infection surveillance system
- Various measures against emerging infectious disease
  - Support to develop strategy by real-time simulation including medical and non-medical intervention
  - Rapid supply system through neutralizing antibody production, mass production, and delivery technology
- Operate a common platform for intractable and rare disease patient registration
  - Create refractory disease specific genome database and analyze the pathogenesis

Autonomy

Healthy brain and mind in the super knowledge and super information society

- Develop a system to prevent mental disorders caused by social maladjustment and improve Japan's happiness ranking
  - Establish technology to support stress defense and a rehabilitation system for mental disorder
  - Secure diversity by cultivating education for a tolerance to diversity and promote innovation
- Develop biological taxonomy for mental disorder based on neural circuit and molecular conditions on depression
- Clinical medicine developed by using brain big data infrastructure
  - "Deep brain information" in individuals" is corresponded with wide brain information" obtained from large number of people through simple measurement technology

Theme 3: Improvement of Physical and Mental Health
Related topics with years of their real-world implementation

Health

A health and medical database which continuously collects biological and behavior information obtained from genomic information, medical information, wearable sensors, and smart devices (contributing to the promotion of a large-scale cohort study).

An information system which enables the prediction of disease onset and severity, lifestyle modification interventions, and disease diagnosis and therapy evaluation at an individual level by integrating information on a patient's personal genome, clinical records, lifestyle behaviors, and environment.

Detection of signs of disease onset and pathological deterioration using dynamic network biomarkers for preventive and preemptive medical care.

Brain and mind

Imaging technology capable of the non-invasive measurement of brain function at a cellular level.

Construction of a biological classification of mental disorders reflecting the pathological condition of the brain at a cellular level based on diagnostic imaging of the brain.

2020 | **2025** | **2030**

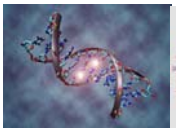
Establishment of basic guidelines regarding utilization of medical and genome databases as public properties.

Disease prevention methods based on the utilization of lifestyle big data.

A new antidepressant therapy that is fast-acting and prevents the recurrence of depression based on the diagnostic classification of subtypes of depression according to the pathology of depression in the brain.

Physiological treatments for psychiatric and neurological disorders such as deep brain stimulation (DBS) and neurofeedback.

An individualized prevention program for age-related loss of physical function and cognitive decline based on the integrated analysis of omics information (i.e. genomics, proteomics, etc.).



Health and medical information

Theme 4: Maintenance of Food Production and Ecosystem Services by Using Regional Resources

Regional Resource

Overview

- For the topics in social challenges of food and Agriculture, Forestry and Fisheries, and regions, consider the technologies that Japan needs and the research that Japan should conduct on the premise of global warming and increasing world population as international challenges and an aging society with fewer children as domestic challenges, and create scenarios including agriculture to ICT, revitalizing regions, sustainability, and human resource development as keywords

Focused Directionalities

- **Rich and varied food by using reginal resources**
  - Export "safe and delicious" food from Japan to the world with competitive agricultural, forestry and fishery products via smart distribution
- **High productivity and sustainable vitality of the regions**
  - Realize sustainable and high efficient agricultural, forestry and fishery industries and develop a system to attract people to the regions
- **Human resource development to support the regions**
  - Foster human resources equipped with diverse knowledge including ICT, infrastructure, economics and business administration to connect the regions

Theme 4: Food Production and Ecosystem Scenarios

Regional Resource

	Leadership	Int'l harmonization & collaboration	Autonomy
	Implement smart agricultural, forestry and fishery industries and globalize Japanese food	**Maintain global ecosystem services**	**Vibrant hilly and mountainous areas as energy and food producing regions**
Scenario	• ICT agriculture is disseminated all over the world • Fully cultured eel and tuna are launched globally • Food waste is decreased • WASHOKU is globalized	• Disseminate sustainable agricultural, forestry and fishery industries to the world • Secure food traceability • International agricultural information database	• Produce competitive food • Use wood as renewable energy • Increasing forest asset value • Local production for local consumption of energy
Technical Factor	• Fam field, forest, & breeding environment sensor • Crop Quality Monitoring (non-destructive) • Livestock condition sensor (non-invasive) • IoT Distribution • Plant-based feed for culturing development • food demand forecast • Taste database • Understanding food culture in different countries	• Using Bacillus thuringiensis • Minor component detection technology • Crop breeding for global warming • More efficient irrigation • IoT Distribution • Understanding marine resources	• Advanced food preservation and distribution skills • Economic model using wood biomass focusing on renewable energy in hilly and mountainous areas • Establish environmental monitoring network • Develop low-cot and safe tree cutting technology at hilly land
Necessary HR	HR using ICT	HR for Global strategy	HR to connect regions

(Targeting2030)

Theme 4: Food Production and Ecosystem Services
Related topics with years of their real-world implementation

地域資源

Realization of an automatic home delivery system for food and groceries based on household food stock estimation and customer preference estimates.

A sensor which recognizes the five senses such as smell or taste and can reproduce the results for display.

Breeding of crops which can be cultivated with less labor and at lower costs (including GMO)

Technology for the large-scale breeding of marine organisms by reproducing deep sea environments.

Observation and data-processing systems to discover underground and marine resources using satellites and marine/underwater sensors.

2025 **2030** **2035**

Advanced teleoperation that enables people to receive services including medical care from remote locations such as isolated islands.

Telexistence technology which enables the elderly and people with disabilities to perform physical work such as farming remotely while staying at home.

Fish catches management technologies to ensure sustainable fisheries.

Technology to artificially fertilize, farm and ship in large quantities of unagi (Japanese fresh water eels).

Development of market-based approaches (such as mitigation banking, environmental offset banking*, etc.) for the comprehensive management of the conservation and restoration of rural communities and the environmental burdens posed by urban areas.

Evaluation technology to quantitatively predict the impact of development activities on the natural world and simulate the effects by taking into account the regeneration speed of nature

Theme 5 : Resilient Social Infrastructure Addressing Large Scale Natural Disaster and the Aging Population with Fewer Children

Infrastructure

Overview

- Consider establishment of resilient infrastructure that addresses the national security and large-scale natural disaster preparedness based on the lessons learnt from the Great East Japan Earthquake.
- Carry out considerations that contribute to solving global problems, including the climate change, disaster prevention and mitigation, water/food issues, and the conservation of ecosystem, through the establishment of social infrastructure where observation information is efficiently collected and utilized.
- Consider establishment of infrastructure that addresses matters including the preparedness for potential large scale disasters (e.g., Nankai megathrust earthquakes) and loss of cities, reduction in the work force due to the aging population with fewer children, and potential loss of regions.
- Focusing on the extension of service life of infrastructure and decentralization of urban functions, build a resilient society that realizes compact cities (with maintaining the living standards) through smooth social implementation of the technical R&D outcome and smart shrinking, by establishing integrated social infrastructure management systems.

Focused Directionalities

- Preparing for large-scale natural disasters based on lessons learnt from the Great East Japan Earthquake
- Extension of service life of infrastructure and decentralization of urban functions in response to the aged society with fewer children
- The establishment of land monitoring systems viewing the national security

Scenarios

Leadership

Realize a thorough disaster prevention education and simple and efficient social infrastructure management

- Disseminate "activities to develop towns where residents could live safely and securely " from Japan to the world
- Accumulate a wide range of know-how on disaster prevention and reduction and disseminate disaster prevention and reduction education with hardware and software aspects based on the know-how
- Promote the efficiency of infrastructure management through R&D and social implementation on the enhancement technology on durability of structures and the inspection and monitoring technology
- Shorten construction period significantly by maintenance and enhancement of construction production system safety and productivity and by unattended and informatized construction

Int'l Harmonization & Collaboration

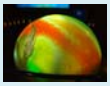
Realize observation information service network providing the merits at the time of disaster and at normal time

- Realize assessing disaster affected situations accurately and dramatically decrease the number of dead and missing by the observation information service network developed under international framework
- Address the diverse risks at the time of disaster in public and commercial facilities and in transportation infrastructure including airports, seaports, and railways which combine observed and simulation data with big data such as people's moves
- Expand the network use in various fields other than disaster control by opening the data and generalizing the commercial use


Autonomy

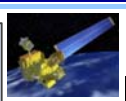
Realize the elderly friendly mobility and the recreation of regions

- Develop the mobility to respond to the aged society
- Advance compact city through smart shrink responding to declining population
- Recreate rural areas by attracting big firms and relocating some capital functions to rural areas


Related Topics with Years of Their Real-World Implementation

A disaster prevention system which measures changes in the shape and topography of steep slopes and large-scale structures in mountainous areas using satellites.



A mobility management system designed to accommodate several hundred thousand people to ensure the smooth movement of people during emergency situations.

Accurate and rapid detection system for extremely minute amounts of explosives, narcotics, radioactive materials, and infectious microorganisms in public infrastructure facilities where the public gathers such as airports, seaports, and railroads.

A real time damage analysis and extent prediction system for effective emergency response in the case of large-scale disasters.

A national airspace, maritime zone, and land territory observation system to enable warning, evacuation, and coordination based on the advanced prediction of a disaster (about 1 hour prior notice).

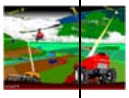
Establishment of quantitative models of global warming based on the combination of atmospheric and oceanic circulation.

Innovating through the application of Exabyte- to Zettabyte-scale, high performance computing and big data analytics technologies to social phenomena, science, and advanced production.

A prediction and diagnosis system for the growth of crops by integration of short- and medium-term weather forecast and crop growth models.

2025 **2030** **2035**

Technology to predict the local occurrence of heavy rain, tornadoes, hail storms, lightning strikes, and snow which will occur several hours in the future at a spatial resolution of less than 100m using a high-resolution simulation and data assimilation.



An integrated real-time delivery system of oceanic survey, fishery survey, and monitoring results to society.

A yield prediction technology, which works in cooperation with a seasonal prediction and regional level climate change simulation based on the alignment of agricultural yield data with meteorological data.

Wide area monitoring system for agricultural, forestry and fishery resources through the use of remote sensing and network technologies

Real-time mountain weather forecast and disaster risk assessment using data from satellites, meteorological observations, etc.

An evacuation instruction system to work in conjunction with the immediate evaluation of an incoming tsunami.

Theme 6: Energy, Environment and Resources that Contribute to Building a Sustainable Future

Energy

Outline

- Consider energy, environment and resources for contributing to the **best energy mix** and solving **the climate change** issue.
- Placing special priority on **hydrogen**, which is to be realized by 2020.
- For the environment field, focusing on the necessity for taking actions on **natural environment preservation**, including addressing the **changes in living environment** due to **social changes** arising from population decline, aging population, globalization, etc.
- For resources, focusing on **geothermal** as **an unused waste heat** and **regional resource**, as well as the world's top level **water treatment** technologies.
- Consider **risk management** for addressing the issues that are difficult to be solved only by technologies, including assessment and communications

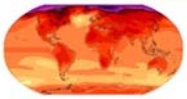
Focused directionalities

Energy
Best mix of energy taking into account LCA (including distribution, conversion, storage and transport) from production through to consumption

Resources
Effective utilization of mineral resources, unused heat and water by recycling and reusing them

Environment
Technologies on global warming countermeasures, environmental conservation, analysis and prediction, environment creation, risk management related to all of them, and on solving global and regionally characteristic problems







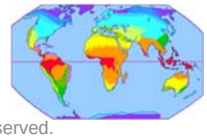
Theme 6: Energy, Environment and Resources Scenarios

Energy

	Leadership	Int'l Harmonization & Collaboration	Autonomy
	Promote world leading technology development contributing to solve global warming issues	**Address global issues and contribute to global development**	**Realize a system considering total optimization**
Society in 2030	• Best mix of optimal control energy • Advanced energy saving technology • Reuse 100% of waste including rare metal and waste heat by resource recovery management • Clarify earth observation technology, monitoring and generating mechanism • Determine risk factors in environment and ecosystem and take appropriate measures	• Establish a quantitative model for global warming and evaluate the influence • Disseminate natural energy and CO_2 recovery technology • Import food and mineral resources by Clean Ship • Resolve poverty issues in the world by securing water resources and through the world top level water related technology • Contribute to disaster reduction in the world	• Revitalize rural areas by energy saving and best mix of energy • Expand a smart energy system across the country by advanced ICT technology • Disseminate an optimized system for open-field and plant cultures responding flexibly to climate changes • Have an immigration program and use robots to tackle labor shortage
Strategy	• Legal support to best mix of energy • Support for energy saving products to expand internationally • Create a system for raw materials considering biodiversity and cooperate with other industries	• Develop new creation of a market • Foster human resources specializing in energy management • Develop technologies considering economic and environmental influence	• Develop software and integrated system considering total optimization • Policies to support business profitability • Agriculture, forestry, and fisheries technology considering the harmonization with nature





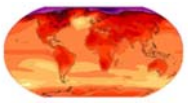

(Targeting 2030)

Environmental Issues

Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries.

An understanding of the mechanism that generates intense meteorological disasters (or extreme weather) from the combination of factors such as global warming and air pollution.

Establishment of technology to assess the impact on forests of atmospheric pollution that crosses national boundaries.



Establishment of technological countermeasures fro the invasive spread of alien animal species based on the analysis and evaluation of factors that govern the movement of invasive species and the invasion risk.

Measures and selection method for reducing greenhouse gas emissions that take into account various economic efficiency and tradeoffs.

2025 2030 2035 2040

Combined cycle power generation using low grade fossil fuels such as lignite and a CO2 recovery-type gasification process.

Establishment of consensus formation methods regarding the risk of low dosages of radiation.

Efficient mining exploration technology that effectively utilizes IT, satellites, etc.

Achievement of energy self-sufficiency and a complete closed-loop resource circulation system in small cities with populations under 100,000 (integrating sources such as fuel cells, biogas, natural energy, rain water, etc.).

Hydrogen production technology utilizing solar heat.

An automobile engine with 50% energy efficiency.

Next generation long life battery for the stabilization of grid interconnections on the MW scale (Cycle life: more than 20 years at a cost of 15,000 yen ($130) per kWh or less).

Technology to dramatically reduce the amount of radioactive isotopes contained in high-level radioactive waste through transmutation using a particle accelerator.

Energy Systems

III. Integrated Scenarios from the Viewpoint of Globalization

Leadership Scenario through Centralized Information Collection and Analysis based on "Manufacturing Ability"

Leadership

(Targeting 2030)

Overview

Have centralized information collection based on Japan's strengths of devise technology in IoT/IoE and take a lead internationally in the advanced information society

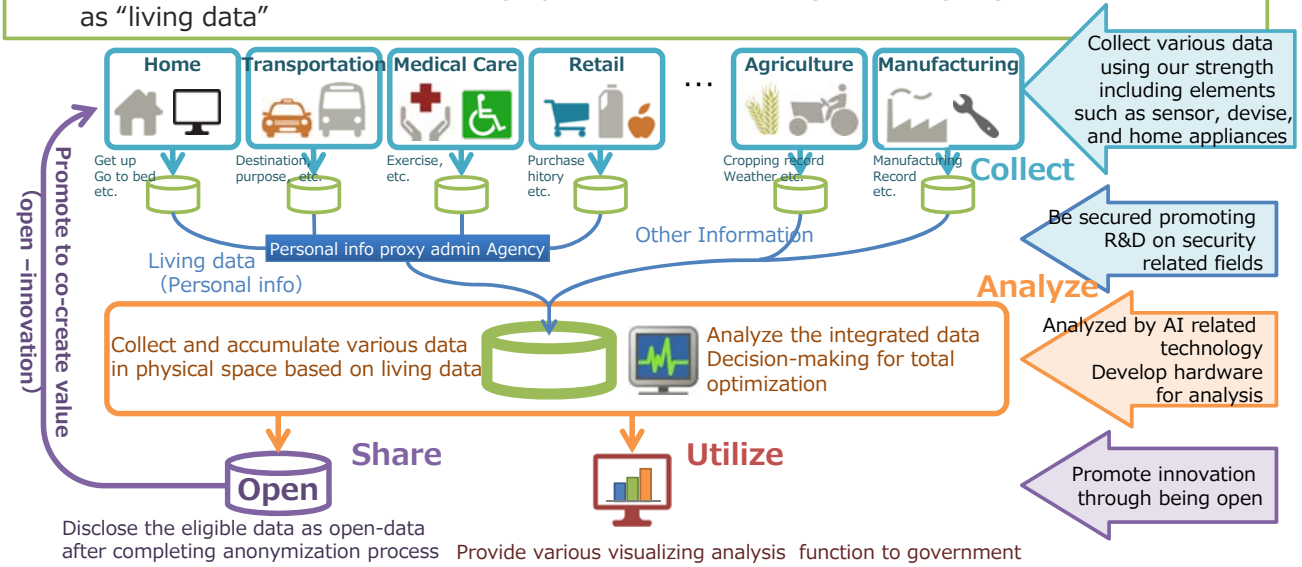
Focused Directionalities

- **Social challenges associated with the aging population with fewer children and social environment changes including an increase in data asset value**
- **Building on the strength of data collection in life scenes**
  - Build on the strength that fostered in the traditional "manufacturing" oriented countries which have advanced sensing element devise related technology and many global "home appliance" manufacturers
- **Integrating data collected at individual domains**
  - Aggregate and integrate various data which had been collected by specific models, manufactures and industries into one place and analyze them
    - ▶ Realize total optimization of those which had accomplished only individual and local optimization
    - ▶ Promote a co-creation (open-innovation) of services starting with cross industrial exchanges
    - ▶ Use the data for other purposes including refinement of government statistics and administrative efficiency
- **Promoting the shift to a knowledge based industrial structure**
  - Establish a place as the information hub as Singapore and Switzerland and pursue the stable economic growth and the acquisition of foreign currency even under the aging population with fewer children

Leadership Scenario through Centralized Information Collection and Analysis based on "Manufacturing Ability" (Targeting 2030)

Leadership

- Consider the technology development for IoT/IoE that Japan had strength and the progress on social challenge resulting from declining workforce
- Lead advanced information society by centralized collecting and analyzing various data such as "living data"



Aim&Effect

Properly address Heavy rain on information

Decision making on Overlooking a whole

Shift from labor intensive industrial structure to Knowledge intensive industrial stricture

Cultivate new industrial fields

International Harmonization & Collaboration Scenarios to Solve Global Challenges (Targeting 2030)

Collaboration

Overview



- **Address declining population and aging**
- **Overview globally not only addressing changes on social structure but also on living environment**
- **Address social changes not only form hard side such as dealing with the infrastructure development toward the 2020 Olympics but also from soft side such as risk management**
- **Address the best mix of energy and important global challenges that could not be solved by Japan alone**
  - Policies to optimize mineral resources and natural energy efficiently
  - Addressing energy, ecosystem preservation and food fully considering climate change
  - Prevention of infectious diseases and cyberterrorism and disaster reduction and prevention



Focused Directionalities

Approaches to common issues in international community including climate change and infectious disease

- Leverage the strengths in S&T assertively and creatively and clarify our intention to build an open, liberal, peaceful and prosperous world through S&T Diplomacy that Japan could show a leadership

International contribution to solve global challenges through S&T

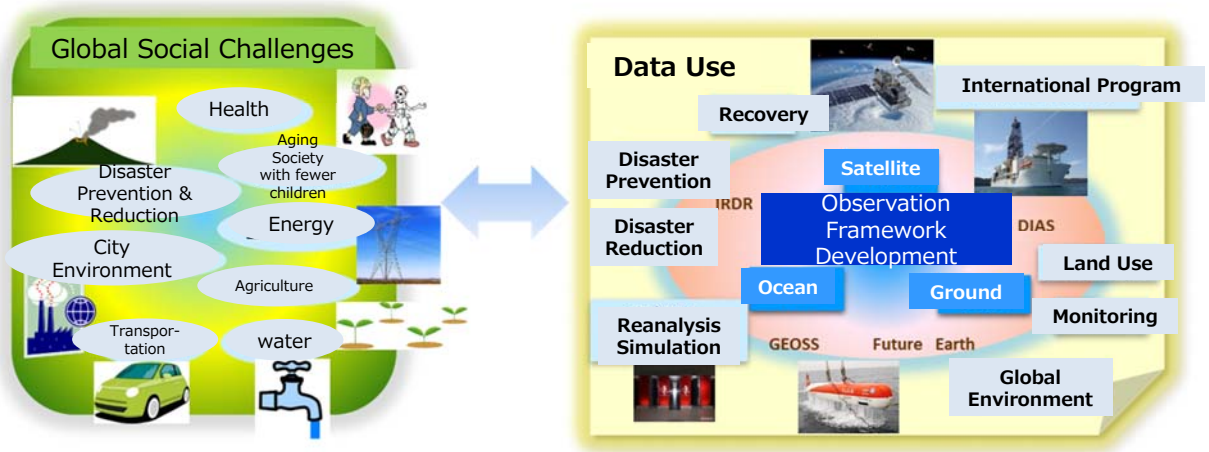
- A situation where Japanese technology internationally plays an important role or Japan benefits from it
- Promote diplomatic activities directly encouraging citizens in foreign countries and public opinion through PR and cultural exchange in cooperation with private sectors instead of government to government
- Aim to improve Japan's presence in the world by appealing its charm including manners, values, and culture that we should be proud of



International Harmonization & Collaboration Scenarios to Solve Global Challenges (Targeting 2030)

Collaboration

- Solve global social challenges including disaster prevention & reduction, city, transportation, environment, energy, health, aging society with fewer children by integrating sensing data of space, ocean, and grand based on advanced analysis and simulation technologies



- Solve diverse global challenges by integrating data from satellite, earth and ocean
- Show Japan's presence to international community in creating innovation by opening public data while making international contribution through international harmonization and collaboration
- Focusing on Japan's reliable space transport & satellite technology, ocean, and Earth Sensing Center, play a central role on disaster prevention and reduction in emergency situation including the time of natural disaster while trying to develop new innovation of data mainly obtained from observation for new fields such as agriculture, city environment, transportation, water, health and energy in normal

Autonomy Scenarios Related to Infrastructure for Life and Social Existence in Japan (Targeting 2030)

Autonomy

Overview

- Address workforce shortage associated with an aging society with fewer children and declining population
- Enhance the image of Japanese brands with traditional and cultural background while maintaining its international competitiveness for services and products
- Maintain our natural environment and city function that underline the foundation of life and social environment

Focused Directionalities

Society with high QoL where virtuous cycle is achieved

- Support the rehabilitation of persons with difficulty in employment due to mental disorder with the progress in mental health and innovation within organizational society
- Understand individuals and groups' situations in real time through SNSs
  - Maintain social vitality
  - System offering appropriate advise and risks is penetrating the society

Vibrant hilly and mountainous areas in harmony with natural environment and food production

- Rediscover the natural environmental sustainability functions of hilly and mountainous areas, accounting for 70% of the national land
  (Reducing natural disaster, maintaining water resources, and stabilizing renewable energy
  - Ecosystem conservation of river basin/coast, food production hub by local production for local consumption energy, and tourism resources

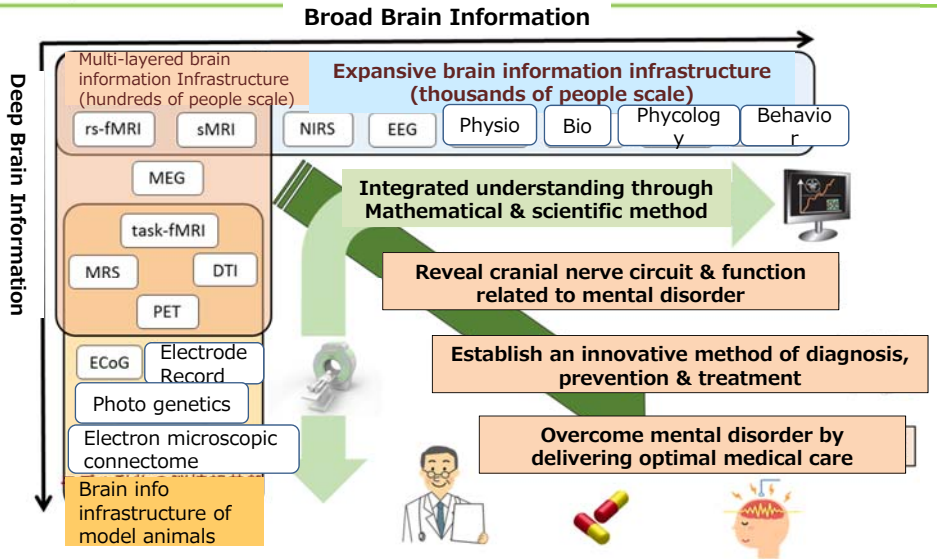
Maintenance of city function landscape by using automation technology

- Activities toward sustainable social economic development and policies to turn our culture into tourism resources
  - Expand the use of ICT to maintain and manage city landscape and social infrastructure and the use of automation technology by robots

Autonomy Scenarios to Maintain Japan's Vitality by Using Brain Big Data (targeting 2030)

Autonomy

- Quantify the qualitative diagnosis and establish a new method of treatment by turning not only behavior and psychological states but also information related to brain diagnosis into big data
- Improve health of labor force and secure QoL in a time of declining population and autonomously maintain our nation's vitality



As the absolute number of working age population (ages 16-64) is decreasing in 2030 while the society is aging further, the labor productivity per person is required to increase. Although the impact of disease on employment could be an issue, the impact of mental disorders including depression is greater than that of cancers among working age population. Patients with depression account for 6-7%. Overcoming depression is to secure workforce but also is very important to improve the person's QoL, which is thought to be most required to realize prosperous society. The society needs not only economical benefits but also spiritual benefits and a feeling of happiness.

Reference 4: S&T Topics and forecasted year of their realization

<Fields >

1 ICT and analytics
2 Health, medical care and life Sciences
3 Agriculture, forestry and fisheries, food and biotechnology
4 Space, ocean, earth and science infrastructure
5 Environment, resources and energy
6 Material, device and process
7 Social infrastructure
8 Service-oriented society

<Year>

Forecasted year of technological realization / Forecasted year of social implementation

Technological realization:

When technology is expected to be achieved (somewhere in the world including Japan).
When technological environment is ready such as achievement of anticipated performance. (e.g., when prospect of technology development becomes clear in stage of R&D in a lab)
When a theory or phenomenon becomes scientifically established in case of fundamental science

Social implementation:

When it's applied in the Japanese society or internationally led by Japan
When achieved technology is available to be used as a product or service (or when it's diffused widely)
When a framework, ethical standard, values, or societal consensus is established in case of non-S&T topics

Source: "Future Persiepctives on Science and Technology by Field, Research Material No. 240, September 2015

F No.	Sub Field	Topic	Year
1	Artificial intelligence	Artificial Intelligence capable of operating as a referee at sporting events such as soccer games	2022 / 2025
		A robot which conducts dangerous work such as road, railroad, or electrical maintenance in cooperation with workers with specialized knowledge and skills	2023 / 2025
		Support system for the elderly and people with disabilities to enable a daily life without human assistance	2025 / 2028
		Artificial Intelligence capable of listening to parties engaged in civil lawsuits and suggesting mediation proposals	2025 / 2030
		Artificial Intelligence capable of teaching foreign languages at language schools	2025 / 2026
		Skill duplication system which first studies as a trainee under a human to develop a highly qualified expertise such as animal husbandry then improves to become a master.	2025 / 2030
		A robot which first possesses infant-level intelligence, physical, and learning abilities, then through human education and external information develops until it obtains adult-level work skills.	2030 / 2037
		Artfificial intelligence technology that enables understanding more than 90 percent of scenes in typical TV shows.	2023 / 2025
		A virtual actor who understands a director's intentions and represents them in its performance.	2025 / 2030
1	Vision and language processing	High-speed object recognition technology that can be applied to blurred images	2020 / 2025
		A hazard prediction system which combines data from multiple wearable devices in a crowd to recognize objects such as buildings, people, or cars through image analysis and inform the wearer of possible accidents or predict risks	2020 / 2025
		Speech synthesis technology which can express different subtle nuances and human emotions.	2020 / 2025
		Artificial Intelligence capable of understanding conversation and the relationship between speakers so that it is able to participate in the conversation naturally.	2025 / 2030
		Real-time speech translation device which operates as a simultaneous interpreter in international trade situations.	2025 / 2030
		Network technology which makes it possible to watch TV shows from all over the world without language barriers.	2025 / 2030
		A system to collect, interpret, and summarize online opinions and claims in multiple languages from around the world using machine translation and deep analysis of intentions (including semantic analysis).	2025 / 2030
1	Digital media and database	Technology which provides the most suitable search results and suggestions based on information about a user’s interests, skills, or current situation collected by various sensors and the sophistication of the user’s access request. This technology could, for example, be used when a user searches for related information while viewing a video.	2020 / 2023
		Technology to allow the recording, management, search, and analysis of everyday personal data through the accumulation of large amounts of physical and "lifelog" data (It will be provided as a wearable external brain function system that is accessed through a natural user interface (NUI)).	2020 / 2025
		Automatic metadata generation system which creates metadata for image, video, and audio data by combining media recognition technology and human-based “social annotation”.	2020 / 2021
		Technology that archives high-quality image, video, audio, and text data previously delivered via broadcasting, telecommunications, or mass media while enabling search, analysis, distribution, and utilization of the stored data.	2020 / 2020
		Technology which provides highly precise and reproducible search results and recommendations based on the situation, intended use, or socially defined information instead of searching based on keywords.	2020 / 2025
		A system which is capable of integrating data obtained from a variety of sensors that are deployed in large numbers throughout society as a result of the progress of the Internet of Things (IoT) to perform search and analysis.	2020 / 2025
		A system which analyzes data from social media sites and predicts human behavior	2020 / 2022
		Technology to analyze the credibility and reliability of information obtained from websites or social media or through data mining (including the authenticity of digital images).	2020 / 2023
		Technology that integrates evidential information such as provenance into data utilized for big data analytics to allow for safe analysis and the protection of personal data.	2020 / 2024
1	Hardware and architecture	A logic LSI circuit that integrates MOS transistors using 5nm technology.	2022 / 2025
		An LSI circuit which integrates more than 10 heterogeneous chips such as CPU, memory, sensors, etc. using stacked 3D stacking technology.	2020 / 2023
		A System on Chip (SOC) LSI circuit which can operate semipermanently by converting thermal or vibrational energy (e.g. energy harvesting).	2020 / 2024
		An LSI circuit which is capable of transferring large volumes of data between on-chip processors or with external hardware using on-chip optical interconnects.	2022 / 2025
		A logic LSI circuit which processes information based on the concept of spintronics.	2024 / 2025
		A fault-tolerant logic LSI circuit which has various self-repair functions.	2020 / 2020
		A wearable computer based on a contact lens with built-in display and camera.	2022 / 2025
		A microscopic medical computer system capable of travelling in the blood stream.	2023 / 2025

F No.	Sub Field	Topic	Year
		A neurosynaptic system with ten billion neurons and one hundred trillion synapses with an information processing capability equivalent to a human brain.	2024 / 2030
		A gate-type quantum computer that can achieve coherence across 10,000 qubits to solve problems difficult for conventional computation methods at high speed.	2030 / 2038
	Interaction	Technology to operate a computer by understanding the user's intentions based on information obtained from wearable biosignal sensors.	2020 / 2023
		A sensor which recognizes the five senses such as smell or taste and can reproduce the results for display.	2020 / 2025
		Telexistence technology which enables the elderly and people with disabilities to perform physical work such as farming remotely while staying at home.	2023 / 2025
		A portable communication device that makes it possible for animals or people who can't speak to understand language or express one's own intentions in words.	2025 / 2029
		A 3D video display device which can be viewed without the use of 3D glasses and does not cause image distortion even if the viewer changes their position or moves naturally.	2022 / 2025
		Technology which enables general users lacking specialized knowledge to design and manufacture advanced items such as cars or houses by selecting functional elements from an existing library.	2022 / 2025
		Technology to solve complicated problems collaboratively by collecting knowledge from many users connected to a network	2020 / 2025
		A small wearable device which increases the user's physical and intellectual capabilities, such as the senses of sight, smell or touch, or abilities like memory or strength, in a natural way	2021 / 2025
		A medium that allows for the recording, transfer, experience, and sharing of individual experiences, going beyond visual information to include sensory information such as smell and temperature as well as the individual's psychological state to capture the raw state of experience.	2027 / 2030
		Interactive virtual agents whose expression, movement and feelings are very realistic and cannot be distinguished from human. They can operate as receptionists or guides to interact naturally with people for a few minutes	2022 / 2025
1	Network	Petabit-level fiber-optic communication technology and terabit-level frame multiplex communication technology	2020 / 2024
		Optoelectronic circuits that allow for freely switching between core transmission and core switch networks without depending on the scale, speed, or distance specifications or hierarchy of the network.	2022 / 2025
		Wireless network technology which guarantees QoE (Quality of Experience) and can be used for 8K UHD online meetings or distance learning using portable terminals.	2020 / 2023
		Wireless communication technology which enable users to access a network without congestion in areas of dense user concentration by installing more than 100 antennas in the base station and allowing users' devices to dynamically cooperate with other devices in the vicinity.	2020 / 2022
		Wide area wireless network technology with ultra-low-latency times of less than 1 millisecond	2020 / 2025
		Automatic configuration technology for integrated wired/wireless networks that provides uninterrupted access to a network without the user being aware of configuration changes as the status of the network changes over time.	2020 / 2022
		Technology that enables an entire network to avoid communications interruptions by enabling massive cooperation between diverse information and communication devices based on the concept of self-organization.	2021 / 2025
		Flexible network and mobile terminal technology which normally works to ease congestion and improve the fault tolerance of the network, but when a disaster strikes it isimmediately expanded in disaster areas, supporting rescue operations and enabling people to use voice, video, and packet communications without interruption.	2020 / 2022
		A content distribution system which enables the caching and processing of data by routers or switches within a network based on the name of the information (in URI form).	2020 / 2022
		A highly reliable network which provides services without disruption by using network virtualization technology that dynamically adjusts based on operating conditions internal and external to the system.	2020 / 2020
		A network node that uses technology such as nanophotonics to reduce the electricity consumed per unit of data transferred to 1/1000 of the current consumption level.	2025 / 2030
		A backbone router which reduces the electricity consumed per unit of data transferred to 1/10 of the the current consumption level.	2020 / 2023
1	Software	Technology which automatically creates mashup software for personal use.	2020 / 2025
		Technology which assists average developers to write comprehensive specifications for large-scale software and provides error-free code validation.	2025 / 2025
		Technology which automatically inspects and fixes minor bugs in large-scale software.	2024 / 2025
		Software development technology that reduces the frequency of bugs occurring in code to less than one per million lines of code.	2025 / 2025

F No.	Sub Field	Topic	Year
		Technology to develop and operate software which achieves 99.9999% of service availability (approximately 5 minutes of downtime per 10 years) without significantly increasing cost in situations where hardware failure or changes to the runtime environment are inevitable.	2025 / 2026
		Technology to develop software without security holes which allow remote exploitation.	2025 / 2026
		Technology which ensures that widely used compilers, OSes, or basic libraries operate in accordance with specifications.	2025 / 2029
		Technology to ensure that critical systems which could malfunction and endanger people's lives or health operate safely by analyzing their software.	2025 / 2030
		Technology to analyze software used in critical infrastructure (such as finance, communication, transportation, and energy) to ensure they operate in compliance with the law	2025 / 2030
		Verification technology which can be used for large-scale software and takes into account stochastic behavior	2024 / 2030
1	HPC	True portable artificial intelligence enabled by high performance computer technology that can be used in machines such as robots.	2025 / 2030
		Innovation through the application of exabyte- to zettabyte-scale high performance computing and big data analytics technologies to social phenomena, science, and advanced production.	2022 / 2025
		Co-design and integration of high performance computing and big data methods to increase the speed and scale of data processing by a factor of 100 in order to analyze big data at the exabyte- to zettabyte-scale.	2021 / 2025
		New computation algorithms, programming methods, and performance evaluation methods for 10 million- to 1 billion-scale parallelism	2022 / 2025
		Robust fault-tolerance and self-recovery technology for super-large-scale supercomputers and big data analytics data center systems with more than one million nodes.	2022 / 2025
		Technology to improve performance to power ratio of super-large-scale supercomputers and big data IDC systems with more than one million nodes by a factor of 100 compared to current systems.	2021 / 2025
		A post-Moore era exascale supercomputer utilizing advanced devices: Movement away from current supercomputers which focus on the optimization of the processing speed of the CPU towards supercomputer architectures which focus on optimization of the energy consumption of data transfer and processing and achieving a performance to power ratio 100 times better than current systems through the use of next-generation devices.	2024 / 2026
		Next-generation HPC accelerator technology which that can be quickly custom-designed at a low cost and achieve significant acceleration, shortening the time-to-solution by a factor of 100	2020 / 2024
		Post-John von Neumann HPC: Development of superconductive single-flux quantum circuits (SFQ), carbon nanotube and spintronics devices, and post-sillicon devices such as memristors, and the use of these items to enable new processor architechture technologies, the application of quantum computers to HPC computing (targetting uses such as molecular orbital calculation, combinatorial optimization, etc.), and the establishment of computing utilizing models that mimic the neuron model of human brain function (neuromorphic computing).	2026 / 2033
1	Theory	Development of a new computation model to understand the difficulty of calculations: A theoretically solvable model for computationally difficult problems as the foundation for construction of a realistic and marginal problem solving platform.	2027 / 2035
		Development of a theoretical foundation for control techniques to allow individuals' to behave freely while still allowing the smooth function of society as whole	2022 / 2028
		A theoretical base for functional compression technology which allows users to have the advantages of big data analytics in a portable device which can be carried on their person	2020 / 2025
		Development of data utilization techniques with theoretically guaranteed preservation of privacy	2020 / 2025
		Development of structural models of the knowledge contained within data to develop decision making support algorithms and achieve the creation of a “virtual consultant”.	2023 / 2027
		Development of high-quality data sorting and organizing methods which integrate data from various formats such as text, video, and data collected through sensors and sorts and manages the data based on the semantic specifics of the concepts expressed	2020 / 2025
		Clarification of the human brain's capability through the theoretical understanding and modeling of the brain's intellectual processing capabilities	2025 / 2032
		An understanding of maintenance systems found in living organisms based on information theory and the application of such knowledge	2025 / 2030
		Development of the algorithmic theory for computing systems which learn from their own experiences.	2025 / 2030
		Systematization of massively parallel and distributed computing theories for practical computation systems	2021 / 2025
		Improved scalability of the problem-solving paradigm using mathematical programming	2022 / 2025

F No.	Sub Field	Topic	Year
1	Cyber security	Quantitative risk evaluation technology to evaluate the costs and derived risk for planning and designing security systems.	2020 / 2022
		A low cost, easy-to-use, secure personal authentication system which can be used with confidence even when accessing many different websites over a long period of time.	2020 / 2020
		Application-specific quantum cryptographic communication technology which can be used between cities that are 100 km away from each other	2023 / 2029
		Defense technology that recognizes dynamic changes in the pattern of an attacker's attacks and automatically implements the most effective defense	2020 / 2022
		Technology to prevent unauthorized intrusion to the control systems of devices such as cars	2020 / 2024
		A system which automatically changes related programs when new vulnerabilities are discovered.	2021 / 2025
		Technology to prevent illegal activities by people who are authorized to access to a specific system	2020 / 2024
1	Big data, CPS and IoT	Low cost sensor nodes which enable anyone to manufacture and deploy them within one hour by downloading purpose-specific hardware and software plans from the internet and fabricating them with a 3D printer.	2020 / 2023
		Privacy management technology which manages the identity of sensors and enables users to know how and by whom their actions are being monitored, in order to flexibly balance privacy and convenience.	2020 / 2025
		Positioning technology which has 1 centimeter spatial resolution and 100 millisecond temporal resolution that works as a substitute for GPS	2025 / 2025
		A platform which can store 1 zettabyte (2^70 byte) of data and search for and retrieve data within a practical amount of time.	2023 / 2025
		A marketplace for data where the value of data can be visualized and data is widely traded based on market principles.	2020 / 2024
		A service to provide predictive and preventive medicine based on analysis of various personal data such as health, diet, and exercise.	2021 / 2025
		An educational system that provides the most optimal education approach to individuals based on their interests, abilities and available time while adjusting by looking at the biological reactions of the learner	2023 / 2025
		Cooperative transportation system which supports communication between humans and vehicles so that all traffic signals can be eliminated.	2025 / 2030
		A framework for science and big data analytics which make all experiments and observations trackable online and allows cooperation and sharing of data that is generated and analyzed by scientific research in fields such space science, life science, etc.	2022 / 2025
	ICT and Society	Communication technology that enables communication with people with mental illnesses such as autism, dementia, or social withdrawal	2025 / 2030
		Systems that understand the circumstances of individuals or groups in real-time and present appropriate advice or potential risks	2025 / 2030
		Development of new products based on a new understanding of privacy, economic behavior, insurance, etc. to achieve GDP growth of 20% in related industries	2024 / 2025
		A health care system that monitors the condition of patients in real time to provide optimal nursing or medical care at a low cost.	2021 / 2025
		Social consensus about the relationship between machines (e.g. robots) and humans . As a result, the contribution of robots to the economy will reach 40%.	2025 / 2030
		Social infrastructure that can monitor public costs in real-time and visualize, predict, and optimize operations.	2021 / 2025
		Technology that enables people to communicate and learn without distance barriers .	2025 / 2026
		A social system in which knowledge, information, and content can be distributed while preserving their reasonable value and still allowing for the redistribution of economic value and societal honor.	2025 / 2025
		Technology to identify and understand ideas, ,systems and expressions of indigenous cultures and languages.	2030 / 2032
		Technology which evaluates the validity of research papers by checking against a research paper data base.	2020 / 2025
		Systems that certify and guarantee the original data by recording and saving all measured data and image data that are produced during research in order to prove the validity of research results.	2020 / 2024
2	Pharmaceuticals	Drug therapies based on the systematic understanding of the pathology of chronic diseases.	2025 / 2025
		Antibody drugs that act on intracellular targets.	2020 / 2025
		Pharmaceuticals based on new functional molecules to follow after pharmaceuticals based on low molecular weight compounds, antibodies, and nucleic acids.	2024 / 2025
		Antiviral agents which demonstrate effectiveness on related viruses by inhibiting the movement of virions and viral structural elements between organelles within infected cells.	2022 / 2026
		Technology to design compounds that inhibit protein-protein interactions (PPI).	2020 / 2025

F No.	Sub Field	Topic	Year
		In silico drug discovery using biological response and molecular behavior simulation technology running on a post-K next generation supercomputer.	2025 / 2025
		Artificial organs derived from pluripotent stem cells which imitates the functions of the original organs from a living body and can be used to evaluate the efficacies and safety of pharmaceuticals.	2025 / 2025
		Nucleic acid medicines based on siRNA, antisense RNA, etc. which can be used to treat diseases in organs or tissues other than the liver through systemic administration.	2020 / 2025
		Molecular design technology for pharamaceuticals based on the prediction of allosteric binding sites.	2024 / 2025
		Compound synthesis technology that does not use a solvent.	2025 / 2025
		A drug delivery system (DDS) which reliably delivers componds with problems related to absorbability, metabolic stability, and solubility to targeted disease sites.	2023 / 2025
		A nanocarrier system which uses MEMS (microelectromechanical systems) technology, external energy control (e.g electromagnetic induction), and a mesoscale control system (approximately 3-300nm precise artificial control system) to deliver medicines or genetic material to a specific site within a target cell.	2025 / 2030
		High-throughput screening (HTS) technology to measure drug responsiveness that makes use of differentiated cells derived from stem cells such as iPS cells.	2020 / 2023
2	Medical device and technology	Technology to detect tumor tissue 1mm or less in size at any arbitrary location in the human body.	2020 / 2025
		A capsule endoscope capable of moving freely in the human body by external control.	2020 / 2025
		Risk indicators for the progression and rupture of a cerebral aneurysm based on computational fluid dynamics.	2023 / 2025
		An anatomical model of the human body for surgical simulation which faithfully reproduces the body's physical properties such as the texture based on three dimensional imaging.	2020 / 2024
		A painless microneedle as thin as a mosquito's proboscis (~50μm in diameter).	2020 / 2020
		Disposable plastic scissors (surgical scissors) with sharpness equivalent to stainless steel scissors.	2020 / 2022
		A wearable dialysis machine capable of maintaining renal function without disturbing the patient's daily life.	2025 / 2028
		Polymer medical materials capable of selectively enveloping and treating cancer tissues when they are administered.	2020 / 2025
		A surgical support device that compensates for a surgeon's level of experience and enables the smooth anastomosis of blood vessels smaller than 1mm in diameter.	2020 / 2025
		Minimally invasive surgery that does not leave a lasting scar by using ultra-slender endoscopes and endoscopic surgical devices smaller than 2mm in diameter.	2022 / 2025
		A surgical robot which transmits the texture of tissues and organs to the hand of the operator through high sensitivity haptic detection and feedback functions.	2022 / 2025
		An intraoperative surgical diagnostic device to visualize lesions deep within organs in 3D in real-time.	2022 / 2025
		A surgical support system for intraoperative navigation that uses augmented reality (AR) technology to accurately present information on the patient's internal body with an error of less than 1mm.	2021 / 2025
		Treatments for restoring lower limb functions that were lost due to spinal cord injuries by using walking-support robots.	2020 / 2025
		An artificial arm which enables the user to perceive the full range of cutaneous sensations such as warmth, coldness, pain, and touch .	2025 / 2030
		An intention communication device (brain machine interface, or BMI) that directly reflects brain activity to support the daily activities of patients suffering from severe motor function disability due to amyotrophic lateral sclerosis (ALS).	2025 / 2025
		Robots that provide complementary motor functions to support the daily activities of patients suffering from severe motor function disability due to amyotrophic lateral sclerosis (ALS) by directly reflecting the patient's brain activity (via brain machine interface, or BMI).	2025 / 2029
		An inexpensive, easy-to-introduce dementia care assistance system (for instance, the cost of adoption is less than 100,000 yen (approx. $1,000), the monthly cost for maintenance is less than 1,000 yen (approx. $10), and the system can be installed in a one bedroom apartment).	2022 / 2025
2	Regenerative medicine	A comprehensive understanding of the reprogramming mechanism of differentiated cells.	2023 / 2025
		Technology to create stem cells such as iPS cells from differentiated cells other than gene transfer.	2020 / 2025
		Large-scale culture technology for hematopoietic stem cells which enables their use in regenerative medical treatments.	2020 / 2025
		Technology to selectively remove undifferentiated stem cells which are resistant to differentiation and to purify the differentiated cells derived from stem cells such as iPS cells.	2020 / 2023
		Technology to detect tumors among cells transplanted as part of regenerative medical procedures utilizing stem cells such as iPS cells.	2020 / 2024

F No.	Sub Field	Topic	Year
		Treatments for dysfunction of the central neural network（e.g Parkinson's disease and ALS) based on the stem cell transplantation.	2024 / 2025
		Regenerative medicine technologies using the transplantation of embryonic stem cells.	2020 / 2025
		Technology to activate stem cells in situ in a living body.	2023 / 2025
		Regenerative medical technology which promotes the autonomous proliferation and differentiation of stem cells transplanted into a living body.	2023 / 2029
		Allogeneic regenerative medical technologies and products to ensure safety being completely free of immune rejection.	2022 / 2025
		Technolgy for the preservation and transportation of regenerative medicine products over long periods of time (at least two weeks).	2020 / 2020
		A scaffolding material for regenerative medicine which has biological tissue functions and allows for the control of the shape in three dimensions.	2020 / 2025
		Fabrication technology to produce an organ-like structure (organ mock-up) through cellular printing technology.	2020 / 2025
		Medical technology to regenerate auditory and visual functions.	2025 / 2025
		A spinal cord injury treatment that can achieve the reconstruction of the human neural network.	2025 / 2027
		Organs for transplant derived from human stem cells, produced from animal-human chimeric embryos (chimeric embryos based on animal embryos injected with human cells).	2022 / 2032
		Therapies to recover physical functions by injecting partially differentiated cells or cells commtted to a specific kind of differentiation at a treatment site to regenerate tissue at the site.	2022 / 2027
2	Common disease	Disease preventation methods based on the utilization of lifestyle big data.	2020 / 2025
		Preventative medicines which inhibit the development of carcinogenesis from a precancerous state.	2025 / 2030
		A diagnostic method for the risk of developing cancer and intractable diseases by monitoring the epigenetic regulation of gene expression.	2025 / 2030
		A selection method for cancer treatment based on liquid biopsies as a substitute for cell tissue examination.	2020 / 2025
		Personalized cancer care based on integrated analysis of omics information (i.e. genomic, proteomic, etc.).	2023 / 2025
		Therapeutic medicines for refractory cancer which target cancer stem cells.	2022 / 2025
		Cancer treatment based on immune system control technology that works against the majority of solid cancers.	2025 / 2028
		Clarification of the impact that the autonomic nervous system, psychological stress, and depression have on lifestyle-related diseases and the mechanism for such effects.	2023 / 2025
		Preventative and therapeutic medicines for lifestyle-related diseases which act on epigenetic changes caused by environmental factors from the fetal period through early childhood.	2025 / 2030
		Therapeutic methods for lifestyle-related diseases such as diabetes, hypertension, and arteriosclerotic disease based on etiological and pathological classification by integrated omics (i.e. genomic, proteomic, etc.) analysis.	2024 / 2025
		An individualized prevention program for age-related loss of physical function and cognitive decline based on the integrated analysis of omics information (i.e. genomics, proteomics, etc.).	2025 / 2030
		New anti-fibrosis drugs which enable the recovery of organ function.	2025 / 2028
		The extension of healthy life expectancy by administering factors that induce rejuvenation or suppressing substances that induce aging.	2027 / 2035
		The extension of healthy life expectancy by reconstructing the intestinal microbiota.	2025 / 2025
		Nutritional and dietary therapies for lifestyle-related diseases based on an integrated understanding of the effects that each nutrient has on homeostasis in the human body.	2022 / 2025
		An early diagnostic method for chronic inflammation which uses functional RNA such as miRNA.	2021 / 2025
		Technology for the prediction of the risk of cardiovascular and cerebrovascular events through quantitative analysis of biomarker and bioimaging information.	2021 / 2025
		Effective prevention methods for locomotive syndrome based on clarification of the mechanism underlying sarcopenia.	2022 / 2025
		Therapeutic medicines for lifestyle-related diseases which replicate the effects of exercise so that people with movement difficulties such as the elderly and people with disabilities can also use them.	2020 / 2030
		Drug therapies that can completely repair atherosclerotic lesions.	2030 / 2033
		Drugs to cure diabetes by regenerating and increasing the number of pancreatic β cells.	2025 / 2030
		Immunomodulator drugs which work for specific allergic diseases and don't affect other biological defense mechanisms.	2025 / 2035
		Elucidation of the pathogenesis of osteoarthritis and identification of new therapeutic target molecules.	2025 / 2029
		Elucidation of the disease suppression and aging mechanisms through the genetic analysis of centenarians (people over 100 years old).	2025 / 2029

F No.	Sub Field	Topic	Year
		Radiation therapies to enable cancer treatment within a short period without disturbing daily life by using a small system for irradiation of intensity modulated particle beam.	2025 / 2030
		Boron Neutron Capture Therapy (BNCT) which aims to treat aggressive cancers (eg brain tumor) where cancer cells and normal cells are mixed.	2023 / 2027
		Radiation therapy technology for internal use (i.e. drugs which incorporate radioactive substances) which aims to treat metastatic cancer.	2024 / 2032
		Development of molecular targeted drugs based on an understanding of the pathogenesis of chronic pain.	2025 / 2028
		Preventive and therapeutic treatments for chewing or swallowing dysfunctions associated with aging.	2020 / 2024
		Artificial red blood cells which can be used for massive emergency blood transfusions.	2020 / 2025
		Recovery of visual function from traumatic ocular injuries through full eye ball transplants.	2025 / 2030
		Allotransplantation technology which doesn't require an immunosuppressant.	2025 / 2029
		An infertility treatment that uses reproductive cells that have been induced to differentiate from human iPS cells.	2025 / 2035
		An artificial uterus which enables the growth of a fetus.	2030 / 2040
		Ovulation regulation for infertility treatment via an intradermal embedded microchip which enables the delivery of hormones at the optimal time.	2020 / 2030
		Preventive and therapeutic treatments for infertility through the prevention of aging or functional rejuvenation of egg cells (i.e. preservation of ovarian functions, anti-aging drugs, etc.).	2025 / 2031
2	Intractable and rare disease	Methods to understand the risk of developing intractable diseases (i.e. ALS, Crohn's disease, etc.) and select the optimal treatment through the use of a biochip.	2025 / 2030
		Construction of a disease-specific genome database for intractable diseases and methods of analysis for the pathogenesis of those diseases using a next-generation DNA sequencer.	2023 / 2025
		A method to prevent the onset of idiopathic hematopoietic disorders (eg aplastic anemia, myelodysplastic syndrome).	2023 / 2030
		Gene therapies for almost all single gene disorders.	2025 / 2030
		Gene therapy for intractable and rare diseases based on editing of the genome or epigenome of a specifically targeted tissue.	2025 / 2029
		Muscle regeneration for those suffering from muscular dystrophy through stem cell transplantation.	2023 / 2030
		Regeneration of lymphoid organs including the thymus through an understanding of the control mechanism of the human immune system.	2030 / 2032
		Prevention and cure of autoimmune diseases based on the regeneration of immune organs.	2025 / 2032
		Preventive and therapeutic treatments for intractable diseases (i.e. ulcerative colitis, Crohn's disease, etc.) based on the reconstruction of intestinal microbiota.	2020 / 2029
		Preventive and therapeutic treatments for congenital metabolic disorders (i.e. lysosomal storage diseases) based on inhibiting the intracellular accumulation of lipids, proteins, etc.	2025 / 2025
		Therapies for prion diseases based on inhibiting the intracellular accumulation of proteins.	2025 / 2035
		Therapies to prevent the onset and delay the progression of progressive neuromuscular diseases (eg mitochondrial disease) based on inhibiting the intracellular accumulation of lipids, proteins, etc.	2020 / 2027
		Development of biomarkers for assessing the prognosis of neurodegenerative diseases (eg ALS), muscular dystrophy, and rare muscular diseases by using a national database based on the Japanese law regarding measures to deal with intractable diseases.	2024 / 2026
2	Psychiatry and neuropathology	A comprehensive understanding of the molecular mechanisms governing the development, maturation, maintenance, and aging of human neural networks.	2030 / 2035
		A comprehensive understanding of the information processing mechanism neurotransmitters mediate in neural networks and synapses.	2030 / 2035
		A comprehensive understanding of the molecular mechanisms involved in interactions between neurons and glial cells.	2025 / 2030
		A comprehensive understanding of the neural basis for supporting specific brain functions such as memory, learning, cognition, and emotion.	2030 / 2035
		A comprehensive understanding of the neural basis for higher mental functions such as consciousness, socialness, and creativity.	2035 / 2040
		The discovery of biomarkers which reflect the pathological progression of neurodegenerative diseases (eg ALS).	2025 / 2030
		Construction of a biological classification of mental disorders reflecting the pathological condition of the brain at a cellular level based on diagnostic imaging of the brain.	2030 / 2030
		Preemptive medical care which leads to the prevention of the onset of dementia based on biomarkers detected prior to its onset.	2025 / 2030
		A new antipsychotic drug based on the pathogenesis of schizophrenia in the brain that has fewer side effects than current drugs and leads to the social reintegration of patients.	2027 / 2031

F No.	Sub Field	Topic	Year
		A new antidepressant therapy that is fast-acting and prevents the recurrence of depression based on the diagnostic classification of subtypes of depression according to the pathology of depression in the brain.	2025 / 2029
		A new mood stabilizer based on the pathogenesis of bipolar disorder in the brain with fewer side effects than current drugs, which can prevent the recurrence of symptoms.	2028 / 2030
		Methods to prevent addiction and relapses into addiction based on the elucidation of common pathological conditions in the brain caused by addiction (i.e. addiction to alcohol, drugs, etc.).	2028 / 2030
		Therapies and intervention methods based on the pathogenesis of autistic spectrum disorders in the brain that enable an independent social life.	2025 / 2030
		Treatments for and methods to prevent the onset of neurodegenerative diseases (eg Alzheimer's disease) based on inhibiting the formation of intracellular aggregates in such diseases.	2025 / 2030
		Physiological treatments for psyciatric and neurological disorders such as deep brain stimulation (DBS) and neurofeedback.	2024 / 2029
		New diagnostic and treatment methods for those suffering from neuromuscular diseases (eg ALS) based on whole genome analysis using next-generation DNA sequencers.	2024 / 2025
		Development of appropriate treatments for epilepsy through the construction of typological classifications of the forms of the disease.	2025 / 2030
		New therapies for psychiatric symptoms and sleep disorders seen in neurological disease patients through the elucidation of the onset mechanisms.	2025 / 2030
2	Emerging and re-emerging infectious disease	Curative treatment for choronic viral infections (i.e. HIV/AIDS, chronic hepatitis, etc.).	2025 / 2030
		An efficient development and supply system for diagnostic methods, vaccines, and pharmaceuticals against infectious diseases which social willingness to invest in is low due to low incidence or other reasons (i.e. drug resistant bacteria, neglected tropical diseases, etc,).	2025 / 2030
		Flu vaccines which can provide lifelong protection against infection through only a few vaccinations regardless of antigenic variations in the virus.	2025 / 2030
		Ultra-lightweight sensors that can be used in contaminated areas and aircraft to quickly detect and determine the presence or absence of a particular infectious disease, the infectiousness of an infected person to others, and the susceptibility of non-infected people to the disease.	2025 / 2026
		Methods to test the effectiveness and side effects of therapeutic agents being developed for infectious diseases using cells derived from stem cells like iPS cells as an alternative to using animal models.	2023 / 2025
		A prediction and alert system for infectious disease epidemics based on a comprehensive infectious disease surveillance system that utilizes medical data such as EMR system data, test results, and prescription records along with various kinds of web data.	2020 / 2022
		Technology for the isolation and identification of unknown pathogens by utilizing a pathogen database.	2022 / 2025
		A quantitative prediction and evaluation system that comprehensively takes into account environmental, pathogenic, and host factors to determine the impact of emerging infectious diseases on humans	2023 / 2025
		A real-time simulation system which supports the formulation of strategies to respond to emerging infectious diseases where the rapid development of vaccines and pharmaceuticals is difficult.	2025 / 2028
		A system to control the development and spread of drug-resistant infectious diseases.	2025 / 2028
		Disinfection technology which can be used for anything including living bodies (eg mucous membranes) and is capable of sterilization regardless of the target object, such as even spores.	2025 / 2030
		Technology to rapidly prepare neutralizing antibodies for new pathogens and then mass produce them.	2025 / 2030
2	Health/medical information and epidemiology	Remote medical care based around disease management at home using biosensors to relieve the need for patients with chronic diseases such as diabetes and hypertension to visit the hospital regularly.	2020 / 2023
		An EMR system with a navigation function which enables medical staff to provide medical care in compliance with clinical practice guidelines for each and every patient.	2020 / 2022
		An information system which accumulates and shares the use history of OTC medicines and health suppliments in real-time to assist with clinical evaluations.	2020 / 2022
		An algorithm and database for the automatic calculation of clinical quality indicators for the purpose of health care quality management.	2020 / 2023
		A system for the immediate and thorough multidimensional aggregation of disease, treatment, and outcome events based on a national-scale database of medical activities and results created by integrating receipt information and EMR information.	2020 / 2022
		A health care and medical data bank that more than 70% of all citizens register for voluntarily .	2020 / 2023

F No.	Sub Field	Topic	Year
		A management system for personal medical histories, medication records, and genomic information based on a storage medium such as an insurance card with an embedded IC chip to contribute to the implementation of personalized medicine and improvement of medical care quality.	2020 / 2024
		A health and medical database which continuously collects biological and behavior information obtained from genomic information, medical information, wearable sensors, and smart devices .	2020 / 2025
		An information sytem which enables the prediction of disease onset and severity, lifestyle modification interventions, and disease diagnosis and therapy evaulation at an individual level by integrating information on a patient's personal genome, clinical records, lifestyle behaviors, and environment.	2023 / 2025
		An automatic medical chart recording system which automatically recognizes conversations between medical staff and patients in examination rooms and records information as well-formed sentences.	2023 / 2025
		A system which automatically detect important clinical events from computerized nursing and medical records and generates a health summary for medical staff.	2022 / 2024
		A system capable of quantifying, collecting and analyzing personal observational data (i.e. complexion, walking gait, speech patterns, etc.), currently evaluated based on doctor's experience, through the use of sensors and data processing technologies.	2023 / 2025
		An automatic initial diagnostic system for use by primary care physicians based on medical artificial intelligence.	2024 / 2026
		An information sytem which can automatically store the majority of nursing care records as EMR records through almost certain voice input methods.	2022 / 2025
		A monitoring system that utilizes behavior identification sensors for nursing care to ensure safe, high quality home nursing care.	2024 / 2025
		A system which uses a high-precision set of bedside sensors or wearable sensors mounted on the patient to detect actions that will lead to the fall or collapse of a hospitalized patient with over 90% accuracy and immediately alert nursing staff or caregivers.	2020 / 2021
		Detection of vascular events such as cerebrovascular disease, myocardial infarction, and life-threatening arrhythmia through sensing of a patient's living conditions and lifelogging sensing, and an emergency medical information system based on such detection.	2020 / 2025
		A medical information system equipped with intelligent alert and decision making support functions which aimed at eliminating medical malpractice due to causes such as the incorrect operation of medical equipment and systems or the use of equipment settings that do not match the condition of the patient.	2023 / 2025
		A computer system (or virtual medical staff) with consultation functions to assist patients with making informed choices or decisions and counsel patients on their health.	2022 / 2025
		An information system that implements an intelligent reasoning algorithm to determine the individualized risk of side effects from medicines based on knowledge of molecular pharmacology, biomolecular interactions, and information about a patient's genome.	2022 / 2025
		Testing technology to monitor genome and omics data (specifically from the epigenome, proteome, and metabolome) that produces results within a few hours at a cost of less than 10,000 yen (approx. $100) from a sample of body fluid.	2020 / 2025
		Introduction of EMR systems that enable the electronic storage and use of the majority of medical records across all domestic medical institutions.	2022 / 2025
		Digitization of all medical data (including paper medical records) stored by all domestic medical institutions.	2020 / 2025
		A multilingual medical information system equipped with information processing functions including automatic translation of medical terms between languages with the aim of promoting medical tourism and the overseas development of medical technologies.	2022 / 2025
		Construction of an epidemiological database for understanding the actual condition of radiation exposure associated with medical activities and protection from such exposures.	2020 / 2025
2	Enabling technology	Construction of equations for quantitative relationships that describe biofunctions in terms of various many-body molecular systems.	2025 / 2028
		Production of artificial cells derived from an understanding of the operating principles governing the creation of biological systems stemming from the cooperation of a large number of varied types of biomolecules.	2027 / 2035
		Detection of signs of disease onset and pathological deterioration using dynamic network biomarkers for preventive and preemptive medical care.	2023 / 2025
		Imaging technology capable of the non-invasive measurement of brain function at a cellular level.	2025 / 2030
		A minimally invasive real-time monitoring system for biopolymers and small molecules circulating in bodily fluids.	2022 / 2025
		Proteomic analysis at the level of a single cell.	2020 / 2025
		Acquisition of genomic information of all organisms which humans can come into contact with (including plants, single-cell eukaryotes, and prokaryotes) and creation of a database of that information.	2025 / 2025

F No.	Sub Field	Topic	Year
		Technology to predict interactions between proteins and a variety of substances (protein/protein, protein/DNA or RNA, or protein/compound) from information on the primary and higher-order structures of proteins.	2025 / 2025
		Technology to estimate the dynamic conformation of a protein in an active state from the primary structure information of the protein and the three-dimensional structural information of substances acting on that protein.	2025 / 2029
		Functional elucidation of more than 50% of the non-coding regions of the genome.	2025 / 2030
2	others	A cost-effectiveness evaluation system to contribute to the review of pharmaceuticals and medical devices.	2020 / 2024
		Remedies for bullying and truancy based on a comprehensive understanding of brain functions such as emotions.	2024 / 2026
		Devices which can measure the stress level of athletes on the playing field remotely and without requiring direct contact.	2025 / 2028
		Mental control methods to help athletes perform at their full potential under intense stress.	2021 / 2024
		A system to record and store all measurement and image data generated by research activities as well as authenticate and guarantee the original raw data in order to prove the authenticity of research results.	2020 / 2022
		Food safety inspections (i.e. toxicity tests, microorganism tests, etc.) that allow for 100% inspection of imported foods.	2025 / 2028
		Formation of a social consensus on the utilization of genetically modified foods.	2025 / 2025
		Establishment of basic guidelines regarding utilization of medical and genome databases as public properties.	2020 / 2025
		Establishment of national ethical guidelines regarding brain machine interface (BMI) technologies.	2021 / 2026
3	Agriculture: Advanced production	Improved productivity of non-ruminant animals through control of intestinal bacteria.	2022 / 2025
		Technology which enables the commercial cultivation and distribution of tropical and subtropical fruits in Japan, by taking advantage of global warming.	2025 / 2030
		Technology which allows the overall control of the quality and taste of fruits such as citrus, apples, and pears through the use of "omics" techniques (i.e. genomics, proteomics, etc.).	2025 / 2030
		Application of the technology that uses endophytes (symbiotic plant bacteria or fungi) to enhance crop production.	2025 / 2025
		Highly productive paddy field agriculture which integrates groundwater level control systems and diverse crop rotation and ICT.	2020 / 2025
		Biological crop protection methods such as phages, plant activators, natural enemies, pheromones, and allelopathy, to reduce the synthetic chemical input by half.	2025 / 2026
		Technology for the production of transgenic cattle that can efficiently secrete bioactive substances such as antibacterial proteins and blood coagulation factors as part of their milk.	2025 / 2030
		Optimization system for outdoor and indoor agriculture which can felxibly adapt to climate change.	2024 / 2025
3	Agriculture: Crop development	Breeding of crops which can be cultivated with less labor and at lower costs (including GMO).	2025 / 2029
		Technology to selectively impart one of a pair of specific homologous chromosomes in a gamete.	2025 / 2030
		Technology for the control of color, shape, and scent of ornamental plants.	2020 / 2025
		Technology to control the aging of ornamental plants.	2021 / 2025
		Technology for the efficient production and storage of germ cells for the preservation and maintenance of endangered species.	2025 / 2030
		Genetically modified plants which have no effect on the environment.	2025 / 2029
		Technology to improve photosynthetic functions to increase food production and improve environmental conservation.	2025 / 2030
		Development of genetically modified rice plants capable of C4 carbon fixation and nitrogen fixation.	2027 / 2035
		Crops that can produce a good harvest even in environments generally unsuitable for farming such as deserts (arid regions), etc.	2025 / 2033
		Identification of the gene network controlling plant growth.	2025 / 2030
		Identification of the signal transmission pathway via receptor and the biosynthesis and transport mechanism of growth regulators in plants.	2025 / 2030
			2024 / 2026
		Creation of plants with the ability of nitrogen fixation in the air, utilization of phosphoric acid from the soil, etc. from biotechnology.	2025 / 2030
		Production of biomass crops with a dry matter yeild of over 50t/ha/year.	2025 / 2030
		Development of crops which are less susceptible to global warming and pests	2025 / 2035
		Development of expressed genetic markers which can predict various kinds of agricultural traits by using all of the infromation regarding gene expression of crops	2025 / 2030
		Predictive simulation of the phenotypic variation expected from the breeding of two arbitrary hybrid populations and selection of individuals with optimal genotypes.	2025 / 2030

F No.	Sub Field	Topic	Year
		Technology for the production of high-quality and high-yield agricultural crops through genome editing.	2025 / 2029
		Development of a genome atlas of natural and spontaneous mutations that affect agricultural character of crops.	2025 / 2030
		Technology for the efficient production of pharmaceutical compounds and functional polymers in the edible part of plants, silkworms, or the milk of cows and goats.	2025 / 2030
		Molecular control technology which enables chromosomal transfer in arbitrary genomic regions of plants.	2029 / 2030
		Identification of the mechanisms behind hybrid vigor in cattle and the creation of a system for production of livestock based on strains which contain such attributes.	2027 / 2035
		Identification of the molecular genetic basis of hybrid vigor and inbreeding depression in crops.	2025 / 2030
		Breeding of animals based on genomic information contained in gametes or reproductive germ cells.	2020 / 2023
		Development of a desease-model swine capable of xenotransplantation through the use of genetic modification technology.	2025 / 2030
3	Agriculture: Disease control	Completely pesticide-free production system for high-quality fruits such as oranges and apples	2028 / 2030
		Insect control technology through ultrasonic waves, vibrations, etc.	2025 / 2030
		Technology which eliminate zoonotic pathogen from the body of animals.	2025 / 2027
		A sustainable and holistic cultivation technology focused on the use of the agricultural ecosystem for pest control.	2025 / 2030
3	Agriculture: Biomass utilization	Industrial manufacturing technology for enzymes to improve the function of microorganisms.	2020 / 2025
		Decomposition and utilization technology for vegetable fibers through the use of artificial proteins to mitigate the degree of crystallinity of cellulose.	2023 / 2027
		Development of a "one-stop" biomass fermentation technology using a microbial consortia.	2023 / 2025
		A cooperative production system between the livestock and crop farming sectors mediated by fetilizor production that utilizes methane fermentation digested liquid.	2022 / 2025
		Technology to assess the vitality, social impact, and environmental impact of a society where renewable energy such as biomass is used.	2020 / 2025
			2025 / 2030
3	Agriculture:Environmental conservation	Technology which shifts from production-centered agriculture to agriculture which mitigates environmental burdens through measures such as consideration of timing to reduce the application of pesticides, controls on the emission of methane and nitrous oxide, etc.	2024 / 2025
		Technology which helps to maintain biodiversity among crop monocultures.	2025 / 2027
		Monitoring system of toxic chemical and radioactive substances in the environment, identification of the uptake mechanisms of them by plants, and estabulishment of safety standards.	2024 / 2025
3	Food: Advanced production	Technology for the production of edible and fuel oils using heterotrophic microorganisms such as yeast and filamentous fungi.	2022 / 2028
3	Food: Distribution and processing	Practical robot technology for completely deboning edible fish.	2020 / 2020
		Flexible cooking appliances capable of supporting a variety of menus for restaurant use.	2021 / 2024
		Technology to detect organic matter (such as hair) contamination in a food production line.	2020 / 2022
		Technology to preserve perishable goods for about one week without refrigeration for use in logistics.	2023 / 2025
3	Food: Food safety	Sequencing technology to identify an entire DNA or RNA base sequence within a minute from very small samples from tissue taken during the grwoth process or final products to enhance food traceability.	2020 / 2025
		Evaluation of toxicity caused by the interaction of multiple harmful factors in food.	2020 / 2023
		Analysis technology based on genetic information from poison producing marine organisms that cause food poisoning.	2022 / 2026
		Establishment of methods for assessing the safety of genetically-modified crops and animals.	2024 / 2025
		A food defence system targeting the food chain to prevent contamination by hazardous substances, bacteria, etc. to achieve food safety and security.	2020 / 2020
		A mobile analysis system using omics (i.e. genomics, proteomics, etc.) and chemical analysis for on the spot verification of the quality of raw agricultural products.	2020 / 2025
3	Food: Food functionality	Technology to produce hypo-allergic food based on allergen measurement technology.	2022 / 2025
		Food which supports a healthy aging society by preventing the decrease in anti-oxidative function particular to elderly people.	2021 / 2025
		A diet which supports a healthy aging society by preventing the deterioration of brain and masticatory functions particular to elderly people.	2023 / 2025
		Tailor-made functional food products based on the use of big data.	2025 / 2028
		Development of various kinds of functional food products based on foodomics.	2025 / 2025
		Functional food products for the prevention of lifestyle-related diseases according to the individual consumer's constitution.	2022 / 2025

F No.	Sub Field	Topic	Year
3	Fishery: Resource conservation	Permanent preservation of genetic resources through the construction of a bank of reproductive germ cells targeting major species for fishing and aquaculture.	2020 / 2025
		Construction of a database of seaweed and marine plant resources suitable for coastal area environments (including islands) for sustainable use of such resources.	2023 / 2025
		Technology to predict the variation in sardines, tuna, and other major fishery resources under different harvesting and long-term environmental conditions, as well as technology for the proper management of fishery resources based on this prediction technology.	2025 / 2026
		Technology to assess the variety and abundance of marine resources through a highly accurate fish finder system (capable of distinguishing the size and species of fish).	2025 / 2030
		Logging of fishery resources for their entire lifetimes through the implantation of ultra-small electronic chips.	2020 / 2022
		Creation of non-invasive acoustic measurement technology and a voice recognition database for fish and marine mammals.	2022 / 2025
		Fish catches management technologies to ensure sustainable fisheries.	2025 / 2025
3	Fishery: Breeding and production	Technology to artificially fertilize, farm and ship in large quantities of unagi (Japanese fresh water eels).	2023 / 2025
		Creation of aquatic life such as salmon, trout, tilapia, tiger puffer fish, etc. with superior properties added via transduction using developmental engineering technology.	2020 / 2025
		Development of aquaculture factories such as onshore recirculation systems where an optimum environment is managed by using a broad range of engineering technologies based on biological and other technologies.	2023 / 2025
		Technology to prevent infectious diseases based on an understanding of a fish's immune system and its control agents.	2021 / 2025
		Fish farming using plant material to reduce environmental burdens.	2022 / 2024
		Development and promotion of the use of completely infertile cultured fish.	2025 / 2030
		Foreign gene expression technology for organisms insusceptible to transformation by full control of activated recombinants (eukaryotic plants, eukaryotic algae, etc.).	2020 / 2025
3	Fishery: Environmental conservation	Commercialization of inexpensive fishing materials and containers made of biodegradable materials.	2023 / 2022
		Observation and prediction technology of sudden coastal waves and high tides that can damage fishing facilities.	2025 / 2026
		A 3D image analysis system which can recognize microscopic marine organisms (plankton, microorganisms, etc.).	2020 / 2025
		Coastal environmental remediation technologies such as seagrass beds, tidal flats, etc. based on an understanding of the material circulation system that connects the land, rivers, and coastal areas.	2025 / 2025
		Water environment purification and chemical/biofuel coproduction system by aquatic biomass plantations.	2025 / 2025
		Installation and use of renewable energy facilities using wave power, tides, tidal currents, etc. in the ocean.	2024 / 2029
		Technology to remove radioactive substances in order to revitalize fishing in coastal areas.	2025 / 2027
3	Forestry: Advanced production	New technology for cutting, transport, and processing of large-diameter trees to achieve the policy objective of 50% self-sufficiency rate in lumber.	2020 / 2025
		Woodland creation technology to ensure the reproduction of the forest following final clear cutting .	2021 / 2025
		Technology to freee the worker in the forestry industry (including timber production, forest development, and management of forestry resources) from heavy physical labor in a society where the population has been declining.	2025 / 2025
		Development of super trees by employing a high-speed breeding technology which uses the genomic information of trees such as Japanese cedar and hinoki cypress.	2025 / 2030
3	Forestry: Biomass utilization	Development of high strength wood members and and fire resistant wood structures for the construction of low-rise and high-rise wooden buildings such as office buildings.	2020 / 2025
		Development of highly durable lumber which can be used outside for about 50 years to satisfy increasing demand in civil enginerring and other fields.	2020 / 2025
		Decomposition technology which breaks down a large amount of lignin (approximately one ton per month) to vanillin and syringaldehyde in a highly efficient manner (takes about a minute by using supercritical water decomposition).	2025 / 2025
		A gasification power generator that utilizes waste and unused biomass.	2024 / 2025
		A highly efficient synthetic fuel production system that utilizes waste and unused biomass.	2023 / 2025
		Advanced utilization technology that relies on a biofinery to take advantage of the properties of bamboo (for fiber materials, building materials, etc.).	2021 / 2025
3	Forestry: Environmental conservation	Efficient capture and distribution technology which prevents damage caused by wild animals by managing their populations while utilizing their meat for consumption.	2025 / 2025
		Observation and evaluation technology for to prevent the destruction of rainforests and assist related reforestation activities.	2024 / 2027
		An understanding of the regional genetic divisions between populations of major tree species used in commerce based on molecular markers for the analysis of regional differentiation and genetic diversity.	2025 / 2025

F No.	Sub Field	Topic	Year
		Complete control of pine wilt disease in Japan.	2025 / 2030
		Forestry management technology to prevent landslides before they occur.	2030 / 2032
3	Common: Information service	Wide area monitoring system for agricultural, forestry and fishery resources through the use of remote sensing and network technologies.	2022 / 2025
		High-throughput phenotype measurement system for crops using ICT and a microminiature optical device capable of sensing a wide spectrum of EM radiation from the X-ray to the terahertz range.	2025 / 2028
		A system that provides information on insect pest countermeasures, pesticides that can be used, etc. based on a wearable computer system (an ultra-small computer that can be worn on the body) that allows access to computers and the internet even during farmwork and has a system to automatically track production history information.	2021 / 2025
		A sensor network which monitors real-time environment and biological information in the farm field, livestock barn, and aquaculture pond to detect growth disuorders, pests, and infectious diseases such as bird flu.	2024 / 2030
		A monitoring system using a global sensor network to track the circulation of major chemical elements and substances (including nitrogen and carbon) in agricultural and marine ecosystems.	2025 / 2030
		A system which proposes an optimum food (including necessary ingredients and cooking method) based on an individual's health condition and matching his/her taste.	2020 / 2025
		A prediction and diagnosis sytem for the growth of crops by integration of short- and medium-term wether forcast and crop growth models.	2025 / 2030
		Establishment of a quality management technology database for crops through the use of symbiotic microorganisms and the natural immune systems of plants.	2026 / 2026
		Creation of a medium- and long-term forecast system based on a database of the use of microbial communities in soil, compost, and organic fertilizer.	2027 / 2030
		Creation of a global grid database of agricultural data collected by remote sensing technology for understanding various kinds of information related to agriculture, forestry, and fisheries (grid spacing: 1 square km).	2025 / 2030
		Yield prediction technology which works in cooperation with a seasonal prediction and regional level climate change simulation based on the alignment of agricultural yield data with meteorological data.	2025 / 2030
		Establishment of a database and optimization platform regarding variety, production, processing, and cooking characteristics of agricultural and marine products, as well as information on nutrition, functionality, and taste, for the prevention of the frailty cycle in aging adults.	2020 / 2025
		Creation of a international database of research results that integrate cognitive science, linguistics, and chemistry considering taste, scent and texture, for the expression of taste.	2025 / 2030
		Construction of big data infrastructure for agriculture by digitizing legacy data recorded on paper.	2022 / 2027
		Systematization of component technologies for the establishment of smart villages that take advantage of local resources (Example: Towns and villages based on natural energy that conduct sustainable initiatives through the vertical integration of primary, secondary, and tertiary economic activities, such as agricultural production based on scientific techniques and advanced cultivation facilities, combined with the development of processed foods and dining menus that contribute to the regional health strategy and maintain regional health while also being connected to health care facilities where nursing-care and hospital meals are provided).	2025 / 2025
		A system to quantitatively analyze the quality of fruits (including ingredients, physical properties, and the degree of ripeness) on site in real-time.	2020 / 2025
		An integrated real-time delivery system of oceanic survey, fishery survey, and monitoring results to society .	2024 / 2025
		Technology for resource change prediction and management based on the assessment of climate change's impacts on agricultural, forestry, and fishery resources.	2025 / 2030
		A portable biological information monitoring system to understand the health condition of crops in the field.	2020 / 2025
		Establishment of a deep-ocen information and communication network.	2025 / 2030
		Real-time mountain weather forecast and disaster risk assessment using data from satellites, meteorological observations, etc.	2025 / 2032
3	Common:Others	Strategic maintenance and renewal of technology for main irrigation facilities through asset management (such as non-destructive and contactless inspection and diagnosis technology for structures).	2021 / 2026
		Resilient disaster prevention and reduction technology which can be used for reservoirs mainly in rural areas	2023 / 2029
		Production improvement technology that reduces the stress of livestock and farm-raised fish based on animal welfare.	2020 / 2025
		Robotic technology to automate farm work completely.	2021 / 2028
		Formation of an understanding and consensus by the general public about genetically modified plants and food.	2025 / 2030

F No.	Sub Field	Topic	Year
		Recycling-oriented local commuties where cities and villages cooperate to make the nitrogen cycle work effectively and reduce nitorogen's impact on the watershed.	2025 / 2032
		Forest therapy based on physiological identification of the comfort enhancing effects that types of wood and forests have.	2024 / 2027
		Factory production of more than half of agricultural products and assurance of traceability following production.	2025 / 2029
		Development of food demand prediction system which takes into account trends in the increase of the global population, economic development, and crop production technologies.	2025 / 2028
		Establishment and demonstration of a market-oriented business model for sustainable agriculture through the vertical integration of primary, secondary, and tertiary industries to generate added value and growth for the agricultural, forestry, and fisheries industries.	2020 / 2025
		Technology which removes and extracts dioxins, heavy metals, and rare metals from the soil effectively by using plants and microoganisms.	2022 / 2030
		A reduction of the food loss through the monitoring of production and consumption.	2024 / 2028
4	Space	A system to acheive access to space at a low cost	2025 / 2030
		Construction of a permanent manned operating base on an extraterrestrial body (i.e. the Moon or Mars) for the purpose of scientific observation, resource use, etc.	2035 / 2040
		Technology to explore extraterrestrial life on astronomical bodies via direct exploration by satellite.	2030 / 2030
		A space debris removing system for the safe use of space.	2025 / 2030
		A space elevator connecting a ground (or offshore) station with a station in geostionary orbit.	2040 / 2040
		A space-based solar power generation system.	2030 / 2035
		A 24-hour high precision homeland monitoring system based on satellites to ensure public safety and security and provide data for industrial use.	2025 / 2025
		A highly accurate and precise positioning technology based on satellites that provides accurate position information in realtime with an error range of only a few centimeters in order to improve the productivity of unmanned or automated agricultural production and management (including improvement of atomic clocks).	2025 / 2025
		A convenient all-purpose spacecraft control system for the smooth promotion of the commercial use of the space (e.g. crewed space flights, microsatellites, etc.).	2025 / 2026
		Observation technology to verify the cosmic inflation hypothesis.	2025 / 2025
		Technology to detect dark matter particles based on the hypothesis that dark matter is an unknown type of particle.	2025 / 2027
		Observation technology to clarify the identity of dark energy.	2030 / 2031
		Technology to directly observe gravitational waves.	2025 / 2030
		Imaging technology that utilizes cosmic ray muons.	2026 / 2025
4	Ocean	Sensors capable of measuring the carbon dioxide levels from the surface of the sea to the seafloor.	2020 / 2025
		Manned submersibles capable of descending to 11,000m.	2024 / 2025
		Technology to measure absolute position while underwater without additional assistance from other vessels such as a mother ship (e.g. undersea loran, undersea GPS, etc.).	2023 / 2025
		High-speed communication technology which exceeds a 100kbps data transfer rate at a distance of 10,000 meters under the ocean.	2025 / 2030
		Technology to conduct fully automated long-term (i.e. for several months) oceanographic surveys via autonomous unmanned vehicle (AUV).	2025 / 2025
		Technology to enable multiple autonomous unmanned vehicles (AUVs) to work together with each other in a coordinated manner.	2025 / 2025
		Technology for marine environment monitoring and seabed resource exploration in ice bound sea areas .	2025 / 2025
		Technology for fixed-point time series observations at sea without using berthing ropes.	2025 / 2025
		Bio-logging technology for use at sea (including deep sea depths) using technologies such as microelectronic chip embedding.	2020 / 2025
		in situ genetic analysis technology for marine microorganisms (up to 1 mm in size).	2023 / 2025
		Technology for the large-scale breeding of marine organisms by reproducing deep sea environments.	2025 / 2030
		Technology for the economical harvesting of methane hydrate.	2025 / 2030
		Technologies for the exploration and mining of deepwater rare earth and minor metals within a country's excusive economic zone.	2025 / 2030
4	Earth	Scientific drilling technologies suitable for extreme depths to obtain deep earth substances without pollution.	2025 / 2030
		Observation and data-processing systems to discover underground and marine resources using satellites and marine/underwater sensors.	2025 / 2030
		Urgency assessments for all active volcanoes to identify the volcano or volcanoes most likely to erupt in the near future.	2025 / 2030
		Prediction technology based on the mountain landslide generation mechanism.	2025 / 2030
		Technology to improve the dating accuracy during the period between 50 and 100 thousand years ago to unravel the history of volcanic eruptions.	2025 / 2025

F No.	Sub Field	Topic	Year
		Prediction and assessment technologies for the occurrence of disasters such as tsunamis and massive snowmelts accompanying volcanic eruptions.	2025 / 2030
		Prediction technologies for the timing (within a one year horizon), scale, affected regions, and damage of earthquakes greater than magnitude 7 on the Richter scale.	2030 / 2032
		Technology to predict the occurrence of large-scale earthquakes greater than magnitude 8 on the Richter scale through the analysis of strain distribution on the Earth's crust and the history of past earthquakes.	2030 / 2030
		Technology to measure the regional stress field within the Earth's crust at the seismogenic zone-scale	2025 / 2030
		Buoy-type technology to observe crustal deformation and tsunami formation at sea without laying submarine cables.	2020 / 2025
		Technology to explore the inside of the Earth utilizing neutrinos occuring in the Earth's interior.	2025 / 2030
		Seafloor geodetic surveying technology.	2025 / 2025
4	Earth observation and prediction	Technology to observe atmospheric conditions such as water vapor, precipitation, cloud aerosols, etc. with high precision and high sensitivity at a global-scale via satellites (with GCOM-C, resolution of 250 meters and a swath width of 1,000 kilometers; with GCOM-W, swath width of 1,450 kilometers).	2021 / 2025
		A system to monitor trace atmospheric components using imaging spectrometer technology based on satellites.	2022 / 2025
		A system to understand vegetative enviroments using Lidar technology based on satellites.	2023 / 2024
		Technology to constantly observe the land and coastal areas of East Asia, Southeast Asia, and Australia at a spatial resolution of 30 meters using geostationary satellites to support risk management related to food, water, and disasters in those regions.	2025 / 2025
		A real-time oceanic condition monitoring system to track sea ice, ocean surface temperature, waves, ocean currents, and chlorophyll globally via satellites for use in the fisheries industry.	2021 / 2025
		Highly accurate automatic measuring technology for the measurement of water temperature, salinity, dissolved oxygen, nutrient salts, and total carbonic acid from the ocean surface to the ocean floorat a grid interval of 30 kilometers.	2025 / 2029
		A highly precise sealevel observation system based on interferometric synthetic aperture radar (SAR) technology to track global hydrographic conditions and seafloor topographic, including coastal regions and marginal seas.	2023 / 2025
		Technology to predict the scale of snow and ice disasters and the degree of risks across a wide area using technologies to monitor chages in the characteristics of snowfall and the snowpack over time and snow and ice disaster models.	2023 / 2026
		Technology to predict the local occurrence of heavy rain, tornadoes, hail storms, lightning strikes, and snow which will occur several hours in the future at a spatial resolution of less than 100m using a high-resolution simulation and data assimilation.	2025 / 2025
		A seamless prediction technology capable of dealing with everything from short-term weather forecasts to long-term climate change estimates using a single model framework.	2025 / 2025
		A technology to improve the accuracy of weather forecasting by assimilating data on the oxygen isotope ratio in the upper atmosphere as measured by sensors on satellites into a quantitiative model of the atmoshpere.	2025 / 2030
4	Accelerator, elementary particle and atomic nucleus	New X-ray optical elements utilizing non-linear phenomena such as wavelength conversion and non-linear refractive index changes.	2022 / 2025
		A new X-ray light source that saves energy and reduces maintenance requirements by 70% compared to current models.	2022 / 2028
		EUV lithography light sources based on industrial free electron lasers (FEL).	2020 / 2025
		New particle acceleration technology that improves acceleration gradient remarkably by utilizing a laser-driven or beam-driven plasma or dielectric wakefield (leading to the development of small and portable accelerators and free electron lasers, afterburner technologies, and/or high energy colliders).	2025 / 2030
		Accelerator-driven nuclear reactor and transmutation technology using a high intensity proton accelerator.	2030 / 2035
		Compact and portable accelerator for contactless, non-destructive in-situ measurement of 3D stress and strain distribution in underground and above ground structures and structural machine components using neutron beams and X-rays.	2025 / 2025
		Technology to generate and process light in the soft X-ray and X-ray regions of the spectrum for the development of diffraction-limited imaging technologies to utilize for materials and life science research.	2022 / 2025
		Technology to generate atto-second pulses of synchrotron radiation by using the interaction between an electron beam and laser light.	2022 / 2025
		Positron research facility providing beams with the highest intensity (>109 e+/sec) in the world	2025 / 2026

F No.	Sub Field	Topic	Year
		Pulsed ultra-cold neutron source and high-intensity neutron research reactor (neutron flux 5x1014n/cm2/sec) combined with neutron focusing measurement technologies (e.g. neutron microbeam, polarized neutron microscope, etc.) for materials science and biochemical research extending to non-periodic systems hereby contributing to expand industrial application.	2025 / 2030
		Coherent coupling technology for higher stability, higher endurance, higher reliability, and miniaturization of laser equipment across the range from high average power lasers to terawatt/petawatt-class high peak power lasers.	2025 / 2030
		TeV-class electron-positron collider technology.	2025 / 2028
		100 TeV-class proton-proton collider technology.	2030 / 2040
		High-intensity neutrino beam generation technology and large-scale neutrino detector technology to help explain CP asymmetry and the mass hierarchy of neutrinos.	2025 / 2028
		Large-scale detector technology to examine if neutrinos and antineutrinos are the same or different particles.	2025 / 2025
		Acceleration and measurement technologies to study the differences between normal hadrons composed of three quarks or a quark/anti-quark pair and exotic hadrons.	2025 / 2025
		A method to unravel the structure of hadrons and the interactions among hadrons by using first-principle calculations and supercomputers (optimization of the computer technology and the computational physics).	2025 / 2027
4	Beam application: synchrotron radiation	A medium-size high-intensity synchrotron radiation facility surpassing Spring-8 in the soft X-ray area (electron energy 3 GeV, horizontal emmitance of 1.2nmrad or less, brilliance of 10^20 phs/s/mm^2/mrad^2/0.1%BW or more).	2020 / 2020
		A foundation for high-speed (ps/fs-order resolution) synchrotron radiation analysis for the direct visualization of the kinetics of chemical reactions, the internal dynamics of materials, and the operation of electronic devices.	2020 / 2021
		Next-generation cost reducing, super high-brightness radiation light sources based on ultra-low emmitance storage rings.	2020 / 2022
		Technology to observe local structure and electron state information essential to understanding the mechanisms for the functional expression of physical characteristics in functional materials (e.g. electronic materials, magnetic materials, catalyst materials, and battery materials) and the control of such properties at the nanometer-scale and femtosecond order.	2020 / 2022
		Next-generation X-ray microscopes with a nano-resolution sensitivity and a visual field on the micron order enabling the 3D-imaging of the chemical-bonding state of each element being examined.	2020 / 2023
		Synchrotron radiation imaging technology for analyzing the structure, chemical state, and electronic state of samples with continuous variable magnification from sub-nanometer resolution to micrometer resolution.	2020 / 2023
		Structural imaging analysis using highly coherent synchrotron radiation to analyze the structure of non-periodic functional materials such as cells, glasses, polymer molecules, surfaces, interfaces, etc.	2020 / 2023
		Analysis technology such as ultra-high-speed, high-resolution X-ray microscopy technology based on advanced quantum beams (including synchrotron radiation, laser plasma X-rays) and coherent X-ray imaging technology to make it possible to visualize protein supramolecules at the nanometer-scale for pharmaceutical research and the study of the origin of life.	2020 / 2025
		Time-division protein analysis technologies to understand the reaction mechanism of enzymes.	2020 / 2024
		X-ray diffraction technology to analyze the structure of a sample protein molecule.	2024 / 2025
		In-situ time-resolved measurement and analysis technology for materials during laser processing based on high-energy synchrotron radiation with micrometer-order spatial resolution and temporal resolution of less than a microsecond.	2020 / 2021
		Technology to analyze the structure and chemical state of highly radioactive substances or samples under highly radioactive environment necessary for the development of hydroprocessing catalysts for improving nuclear safety and composition and state analysis of fuel debris for reactor decomissioning.	2020 / 2022
		Low-dose diagnostic technology through improvements in the speed, size, and resolution of 2-dimensional X-ray detectors capable of detecting single photons.	2020 / 2024
4	Beam application: neutron, muon, charged particle etc.	Technology to polarize neutron spin and control the polarized neutrons for the precise measurement of the local magnetic structure and magnetic excitation in magnetic substances.	2020 / 2025
		Technology for the in situ observation of functional materials and structural materials using neutrons and X-rays to visualize the three-dimensional stress and strain distribution of the materials during the production process.	2020 / 2022
		Technique to generate and control ultraslow muons and technology to analyze the depth profile of magnetic state with a nanometer-scale by the ultraslow muons.	2020 / 2021
		Technology to generate and control spin-polarized positron beam to observe the spin-polarized electron density of state associated with the first surface layer and the ferromagnetic band structures without using models.	2020 / 2023

F No.	Sub Field	Topic	Year
		Multilateral and precise analysis and observation technologies for a composite approach to atomic structure, electronic structure, and transient phenomena in highly complex systems and highly domain-dependent substances by exposing the same location of a sample to multiple quantum beams (e.g. neutron, radiation, positron, laser, ion, etc.) either simultanously or sequentially with a good ability to reproduce the same target location.	2025 / 2025
		Fabrication and control technology for material's structures and functions in a wide scale range (nano- to mili- meter) by complimental usages of multiple quantum beams (e.g. neutron, radiation, positron, laser, ion, etc.).	2020 / 2025
		Production technology by using neutron and/or ion beams in order to stably supply large amount of radioisotopes such as At-211 necessary for the development of novel radiopharmaceuticals which enables precise diagnosis and highly efficient therapy.	2020 / 2025
		Technology to reveal the characteristics of mutations induced by quantum beams such as ion beams and gamma rays with comprehensive molecular information and to reliably achieve intended mutations with the revealed characteristics.	2025 / 2030
		Measurement and analysis technologies to measure the structure of nano-scale materials at the atomic level using synchrotron radiation, lasers or other quantum beams under the actual conditions in which the nano-scale materials are manufactured or used such as during crystal growth and device operation.	2021 / 2025
		Microbeam technology for the accurate local irradiation of cells withion living tissue, and technology for the accurate measurement or estimation of the local dose imparted in three dimensions.	2020 / 2025
		Function creation by a single ion track and micro-fabrication/surface functionalization based on the multiple charged particle irradiation (envisioning applications to high performance reaction/separation membranes, single photon emitting quantum devices, diagnostic chips, regenerative medical devices, etc.).	2025 / 2030
		Measurement technology based on the sophistication of high-intensity neutron imaging technology for local metal composition analysis and the 3D visualization of fine structures in metal parts.	2020 / 2024
		New material separation methods (isotope-selective heating) based on quantum control technology using high-intensity THz wave pulses to separate the Cesium isotopes to render radioactive waste harmless by using transmutation technology on the long-lived radionuclide Cs-135.	2025 / 2030
		Technology to enable the acquisition of nuclear data in unexplored areas of research by producing short-lived super-heavy elements and eliciting specific ionic states at the same time through the fusion of ion accelerators and the high-intensity lasers.	2025 / 2030
4	Computational sciences and simulation	A global environment prediction model for the composition of the oceans and atmosphere, ecosystems, material cycles, etc. by introducing techniques such as data assimilation and parameter optimization.	2025 / 2028
		Prediction of changes in the water cycle and water sediment disasters through the development of modeling and simulation technologies for large-scale systems such as ecosystems and the environment.	2025 / 2028
		A numerical simulation of global climate change from the early 20th century to the end of the 21st century using an ultra-high-resolution atmospheric general circulation model with a 1km resolution.	2025 / 2030
		A system that estimates the balance of energy, water, and materials (i.e. CO2, etc.) on all the continents until the end of the 21st century to make clear future issues of concern regarding resources (such as renewable energy, food, and water), human health, and ecosystem services at 1km ultra-high-resolution.	2027 / 2030
		A system for wide-area estimation of the water level and flow rate of rivers on a global-scale through reverse analysis using a numerical model and measurements of water surface elevation and flood areas from satellites.	2025 / 2030
		Technology for the prediction of global floods and droughts from several hours to several days in advance through a simulation using a terrestrial surface water circulation model based on satellite and ground-based observations that also takes into consideration human activities.	2025 / 2030
		Coastal hazard assessment technology that integrates and addresses the inland and coastal water flooding associated with storm surges, high waves, and rainfall occurring during a typhoon.	2025 / 2026
		Earthquake simulation using big data-based data assimilation.	2025 / 2030
		A wide-area complex disaster prediction system that includes prediction of damage due to structural collapse, fires, ground liquefaction, flotsam, etc. in addition to the direct damage caused by earthquake-related seismic motion and tsunamis.	2025 / 2027
		A simulation which is faithful to reality and enables the design and development of cars and large manufactured products with minimal prototyping.	2025 / 2025
		A pharmacokinetic simulation which enables to the development of cosmetics and medicines without animal testing.	2030 / 2035
		Degradation analysis technology and high-sensitivity non-destructive diagnostic technology that simulates large industrial products (i.e. turbines, plants, bridges, etc.) to avoid accidents caused by deterioration.	2025 / 2030

F No.	Sub Field	Topic	Year
		Inverse problem-specific material development to adapt the characteristics of most materials (about 90% of target materials for development) to a requested value.	2030 / 2035
4	Mathematical sciences and big data	A real-time navigation system based on a mathematical-scientific traffic congestion prediction model that doesn't generate traffic congestion in the metropolitan area.	2020 / 2025
		A system to enable proactive measures related to roads, traffic, power, agricultural facilities, etc. based on the prediction of snow and ice disasters up to several weeks in advance.	2023 / 2025
		A method to assess the vulnerability of city functions and the regional economy to ash falla caused by a large-scale volcanic eruption.	2025 / 2026
		A social impact simulation of human behaviors that occur in the event of a disaster (i.e. evacuation congestion, panic, hoarding, false rumors, etc.).	2020 / 2025
		An evacuation instruction system to work in conjunction with the immediate evaluation of an incoming tsunami.	2020 / 2025
		A system that can be used to derive the appropriate evacuation site by integrating large amounts of formal and informal information on the disaster situation (current and predicted) in the current location and evacuation routes.	2020 / 2025
		A system to predict the acceleration of damage from a disaster by linking together the atypical, subjective, and ephemeral big data with simulation.	2025 / 2026
		A system to understand the occurrence of natural disasters and the state of damage by integrating observation data, sensor data, social media data, etc.	2022 / 2025
		An integrated safety assessment system that uses data from previous accidents and disasters and meteorological disaster simulation results to enable the reliable design of large transport equipment (i.e. ships, trains, aircraft, etc.).	2025 / 2028
		A system to support public policy decision-making through simulation using a social mathematical model based on the mathematical analysis of future social activities.	2025 / 2030
		A supercomputer with a computing speed exceeding 10 exaflops (10^19 operations per second).	2022 / 2025
		Network infrastructure with a data transmission speed of 1Tbps available even in private homes.	2022 / 2025
		Search technology which enables a search through 1 exabyte of data in one second.	2025 / 2025
		Technology to record and store the 1 exabyte of scientific experimental data generated each year and provide it for the use of the researchers at universities and research institutes throughout the world through a 1 Tbps-class network.	2025 / 2027
4	Measurement infrastructure	Broadband coherent frequency link technology making use of the EM spectrum from the radio range through terahertz, infrared light, visible light, UV, all the way to the X-ray range.	2024 / 2030
		Technology for measurement and materials science to generate an arbitrary waveform by freely manipulating and controlling all the parameters of the light wave to suit the individual application needs such as broadband spectrum generation, phase level timing control, and precise mode manipulation, utilization, and synthesis.	2025 / 2030
		A high-precision optical lattice clock with an accuracy of 10^-18 seconds using techniques such as supression of blackbody radiation shift that is precise enough to be applied to geoid measurement.	2022 / 2026
		Technology for the measurement of extremely small masses and forces based on the precise measurement of the fundamental phsyical constants using the momentum of the photon as a unit.	2025 / 2030
		Communications and networking technologies based on fiberoptic network and frequency link technologies with high-precision standards, reference signals, location information, etc. that works equally well in remote areas	2021 / 2025
		Technology to correct for fluctuating variables using objective measurement to freely, instantaneously, and precisely correspond to changes in the object of measurement, environment, and general conditions across a wide range of variables.	2022 / 2025
		The creation of microsystems and microchips integrating light sources and measuring devices.	2022 / 2025
		Technology to deploy in imaging with high-speed, high-precision multi-point measurement of any arbitrary shape beginning with objects with a high aspect ratio such as industrial products with deep holes.	2020 / 2025
		A measurement control system that adaptively accomodates everything from measurement, transmission, and data processing to action optically.	2025 / 2027
		Long distance absolute measurement technology (sub-micrometer accuracy at a range of over 100 meters with prolonged stability).	2020 / 2025
		Absolute displacement measurement of microscopic regions for device integration (picometer accuracy, millimeter range, in both vacuum and air).	2020 / 2025
		A sensor based on principles and with capabilities difficult to imagine in regular-sized equipment based on the interactions between light and matter only possible through the extreme microfabrication of semiconductors.	2025 / 2030
		A measurement technology with absolute accuracy based on ultra-wideband precision spectroscopy technology for EM radiation ranging from radio waves through light to the X-ray region for applications such as astronomy (astro-comb), spectroscopic databases, environmental analysis, and medical diagnostics.	2025 / 2030

F No.	Sub Field	Topic	Year
		In situ analysis technology for aerosol-mixed gases containing volatile organic compounds (VOCs) using wavelengths in the infrared to terahertz range (detection sensitivity of 10ppm to 1% depending on the chemical species of gas).	2020 / 2025
		3D imaging technology capable of degradation diagnosis and non-destructive inspection of materials (such as soft materials, etc.) that are difficult to measure using conventional methods (with a 3D spatial resolution of 100 micrometers in the terahertz range, and sub-micrometer resolution in the visible light range).	2021 / 2025
5	Energy production	Hydrogen production technology utilizing solar heat.	2025 / 2030
		Hydrogen production technology that uses microbial fermentation to split water molecules.	2025 / 2030
		Technology for the co-production of energy and useful substances from biomass.	2024 / 2025
		Energy technology based on the use of sodium and magnesium.	2025 / 2030
		Combined cycle power generation using low grade fossil fuels such as lignite and a CO2 recovery-type gasification process.	2022 / 2025
		720℃ level supercritical pressure thermal power generation that can achieve 46% efficiency (HHV standard).	2022 / 2025
		Large-scale combined power generation with high efficiency, large-scale gas turbines (inlet temperature of over 1700℃).	2021 / 2025
		Widespread power generation using geothermal energy at hot spring areas in Japan.	2022 / 2025
		1MW-class low temperature geothermal resource use technology through the use of solutions such as binary power generation and heat pumps.	2022 / 2025
		10MW-class offshore floating wind power generation.	2020 / 2025
		Power generation technology using ocean power sources such as waves, tides, tidal currents, and ocean thermal energy conversion to generate power at the megawatt level or higher.	2024 / 2030
		Space solar power generation system (a system that generates power from solar radiation in space and transmits electricity to earth).	2030 / 2038
		Nuclear fusion power generation.	2040 / 2050
		Fast breeder reactor (FBR) system technology, including the entire nuclear fuel cycle and integral fast reactor (IFR).	2030 / 2035
		Next generation standardized light water reactor technology with special characteristics such as the ability to use enriched fuel at concentrations of over 5%, a plant operational life of 80 years, and no location siting criteria.	2030 / 2030
5	Energy consumption	Adoption of residential use fuel cell systems in over 10% of newly constructed homes.	2025 / 2025
		Fuel cell vehicles account for over 10% of new car sales.	2025 / 2030
		An industrial use heat pump capable of generating steam at temperatures in excess of 200℃.	2022 / 2025
		Ultra high efficiency heat pump for consumer use (for air conditioning use COP≧12; for hot water supply COP≧8).	2025 / 2030
		General purpose building energy managements systems (BEMS) and home energy management systems (HEMS) system that expand in use to reach over 30% of new construction projects.	2020 / 2025
		A simplified version of a smart grid control system that can help realize convert small cities (population under 100,000) into smart cities powered by 100% renewable energy.	2025 / 2028
		Achievement of energy self-sufficiency and a complete closed-loop resource circulation system in small cities with populations under 100,000 (integrating sources such as fuel cells, biogas, natural energy, rain water, etc.).	2025 / 2030
		A system able to control electricity supply and distribution for households and consumers using fuel cells and storage batteries installed in automobiles.	2020 / 2025
		An automobile engine with 50% energy efficiency.	2025 / 2030
		A process for manufacturing ammonia that consumes less energy to replace the Haber-Bosch process that accounts for 10% of current world energy consumption.	2025 / 2030
5	Energy distribution, transformation, storage and transportation	A 1000kV direct current power transmission system.	2024 / 2029
		A 66-77kV superconducting power transmission cable with the same capacity as current 275kV CV power cables (crosslinked, polyethylene-insulated, PVC-sheathed cable).	2025 / 2025
		Technology for contactless charging of automobiles while in motion.	2023 / 2028
		New hydrogen storage material technology (hydrogen storage capacity over 10% by weight and release temperature approximately 100℃).	2025 / 2030
		Hydrogen supply infrastructure network for fuel cell vehicles (5000 hydrogen station locations).	2025 / 2028
		A power recovery system based on a Stirling engine which utilizes unused CO2-free heat sources.	2025 / 2028
		Superconducting flywheel for 1 MW, 50 kWh class power storage.	2024 / 2030
		A superconducting magnetic energy storage system on the scale of several kWh to several tens of kWh for improved power stability.	2024 / 2025
		Construction of a forest production system to improve the economics of wood-based biomass power generation.	2025 / 2027
		GTL (Gas To Liquid) technology utilizing biotechnology.	2025 / 2030

F No.	Sub Field	Topic	Year
		Next generation long life battery for the stabilization of grid interconnections on the MW scale (Cycle life: more than 20 years at a cost of 15,000 yen ($130) per kWh or less).	2025 / 2030
5	Resources	Efficient mining exploration technology that effectively utilizes IT, satellites, etc.	2025 / 2028
		Mineral extraction and mining technology needed for extracting ocean mineral resources.	2025 / 2030
		Shale gas drilling technology that doesn't pollute the environment.	2025 / 2028
		Technology to smelt titanium at less than 50% of the cost of current methods.	2025 / 2030
		Arsenic treatment and containment technology for copper mining.	2025 / 2025
		Methane hydrate extraction and utilization technology.	2025 / 2030
		Technology to recover rare metals such as uranium economically from seawater.	2026 / 2035
		Ultra deep excavation technology with capable of operating at depths of 15km and temperatures of 400℃ as basic specifications.	2030 / 2034
		Economical harvesting technology for mineral resources from hydrothermal deposits on the deep sea floor.	2030 / 2035
5	Reuse and recycle	Technology for recovering helium effectively from the air.	2026 / 2031
		Technology for the economical separation and recovery of useful metals even from sources such as used specialty steel products containing low grade rare metals.	2025 / 2030
		Technology for the rational recovery and utilization of rare metals from sewage, sludge, incinerator fly ash, waste, and small electronic devices.	2022 / 2026
		More than 50% of the required amount of most rare metals will be provided by urban mines.	2025 / 2030
		Achievement of the creation of biomass refineries capable of producing a variety of basic industrial products.	2025 / 2031
		Sorting sensor technology for improved refuse sorting and separation systems.	2020 / 2025
		Technology to dramatically reduce the amount of radioactive isotopes contained in high-level radioactive waste through transmutation using a particle accelerator.	2030 / 2040
5	Water	Making a national map of groundwater based on the effective integration of satellite and ground observations that is available for general use.	2025 / 2026
		Technology for real-time, continuous monitoring of bodies of water through continuous non-contact sensing of water quality.	2025 / 2025
		Integrated water management technology to deal with urban flooding, storm surges, land subsidence, etc. in areas with densely populated areas.	2025 / 2025
		Technology that provides information based on snowfall and climate models and observations to enable the effective use of snow as a resource (at intervals of six months, three months, weekly, etc.).	2025 / 2027
		Continuous monitoring technology to detect infectious microorganisms and trace amounts of harmful chemicals in the water supply.	2020 / 2025
		Technology to remove antibiotic substances during sewage treatment.	2024 / 2025
		Technology to recover energy and resources during sewage treatment.	2025 / 2029
		Reverse osmosis water purification technology with over 50% improved energy efficiency.	2022 / 2025
		Technology for the purification and recycling of contaminated water that is economical and generally available in developing countries.	2020 / 2025
		Effective use of ballast water.	2022 / 2025
		Establishment of an integrated water quality index to evaluate water quality replacing BOD, COD, TN, and others.	2022 / 2025
5	Global warming	Airplanes and ships that do not use fossil fuels.	2030 / 2035
		An understanding of the mechanism that generates intense meteorological disasters (or extreme weather) from the combination of factors such as global warming and air pollution.	2025 / 2028
		Measures and selection method for reducing greenhouse gas emissions that take into account various economic efficiency and tradeoffs.	2025 / 2030
		Technology to investigate the impact of ocean acidification on biological diversity, especially fishery resources.	2025 / 2030
		Predictive technology to assess the impact of global climate change on food production.	2025 / 2027
		Technology to predict sudden, localized rainstorms (precipitation of 100mm of rain per hour called "guerrilla rainstorms" in Japan) with a 100m mesh observation network.	2022 / 2025
		Establishment of quantitative models of global warming based on the combination of atmospheric and oceanic circulation.	2025 / 2026
5	Environmental conservation	Development of technology for the quick and simple recovery of salt-damaged farmland soil.	2023 / 2025
		Technology to remove mercury from the exhaust gas of coal combustion, taking into account the movement, diffusion, and accumulation of the exhaust gas within the environment.	2021 / 2025
		Technology to use predatory microorganisms and bacteria to control aquatic plants that cause outbreaks of red tide and blue-green algae.	2025 / 2028
		Reliable decontamination technology for removing radioactive materials from soil and water.	2025 / 2029

F No.	Sub Field	Topic	Year
5	Environment analysis and forecasting	Accurate and rapid detection system for extremely minute amounts of explosives, narcotics, radioactive materials, and infectious microorganisms in public infrastructure facilities where the public gathers such as airports, seaports, and railroads.	2020 / 2030
		Establishment of technological countermeasures fro the invasive spread of alien animal species based on the analysis and evaluation of factors that govern the movement of invasive species and the invasion risk.	2025 / 2030
		Establishment of technology to assess the impact on forests of atmospheric pollution that crosses national boundaries.	2023 / 2030
		Smart city system design methodology based on risk assessments of material and energy flows.	2020 / 2025
		A vegetation distribution and ecosystem function monitoring system based on the application of big data analytics to data from portable information terminals, remote sensing, etc.	2020 / 2025
5	Environment creation	Establishment of environmental impact assessment techniques that rely on changes in familiar, everyday environments to indicate the ecological state.	2025 / 2026
		Integrated technology for adaptation to and mitigation of climate change and disasters based on ecosystem functions.	2030 / 2030
		Infrastructure maintenance technology capable of maintaining both healthy biological habitat environments and proper water circulation.	2025 / 2030
		Technology to restore and protect the genetic diversity of endangered species.	2025 / 2030
		Development of market-based approaches (such as mitigation banking, environmental offset banking, etc.) for the comprehensive management of the conservation and restoration of rural communities and the environmental burdens posed by urban areas.	2025 / 2033
		Technology for regenerating the ecosystem and biological diversity of wetlands.	2025 / 2030
		Technology for mitigating heat island effects, desertification, and habitat loss.	2026 / 2030
		Technology to manage the reproduction and maintenance of vegetation in arid and desert areas.	2028 / 2033
		An integrated system to maintain the preservation of both woodland and urban infrastructure functions.	2030 / 2035
5	Risk management	Establishment of a two-way risk communication process to enable consensus on energy supply technologies and systems.	2022 / 2025
		Establishment of safety standards regarding the use of nano particles in consumer goods such as foods, cosmetics, etc.	2024 / 2025
		Technology for reducing and managing the risk of chemical substances that are long-term hazards to human health, agricultural production, and natural ecosystems.	2025 / 2030
		Establishment of consensus formation methods regarding the risk of low dosages of radiation.	2025 / 2027
		Evaluation technology to quantitatively predict the impact of development activities on the natural world and simulate the effects by taking into account the regeneration speed of nature.	2025 / 2030
6	Creation of new substance, material and function	Heat-resistant inorganic materials with a suitability for plastic working comparable to polymers.	2025 / 2027
		Practical power semiconductors for electrical use which have lower losses than silicon carbide (SiC) or gallium nitride (GaN).	2024 / 2025
		Thermoelectric elements which can be in place of products such as water-cooled radiators, etc.	2025 / 2029
		Recyclable cross-linkable resins.	2024 / 2027
		Self-organizing hybrid materials of combining polymers and inorganic materials.	2020 / 2025
		Polymer materials with the electrical conductivity and environmental durability of copper and similar metals at room temeprature.	2025 / 2030
		Low-cost, flexible organic semiconductor transistors with stable mobility through monocrystalline silicon level printability that can be attached to curved surfaces or moving parts.	2025 / 2028
		A novel high-electron-mobility transistor utilizing high-quality interfaces based on van der Waals forces.	2025 / 2030
		Phosphorescent materials capable of providing enough brightness for practical lighting use continuously for eight hours.	2025 / 2026
		Technology to artificially create bulk semiconductors based on the desired energy band obtained through calculations.	2025 / 2030
		Optical elements that make use of metamaterials with fine geometric structures on the order of nanometers to impart any of the following characteristics: polarization, relative permatittivity, or magnetic permeability.	2025 / 2029
		A semiconductor laser array which allows the free control of the emission direction of the laser beam without using a mirror.	2023 / 2027
		Optical technology to freely control and measure the placement and movement of microscopic objects such as biological molecules and micro/nanomachines in the region of a few hundred nanometers in size by generating small forces on the order of piconewtons (pN) to nanonewtons (nN) for non-contact, high-precision applications.	2024 / 2028

F No.	Sub Field	Topic	Year
		Reflectors which can confine electromagnetic waves like light and prevent the majority from escaping.	2025 / 2030
		Self-repairing materials which can maintain the structural functions of buildings, etc.	2025 / 2030
		Room-temperature superconducting materials that make use of strongly-correlated electron systems.	2030 / 2040
		Development of surface modification tribology to produce ultra-long life parts (more than double the lifespan of current parts being produced).	2025 / 2030
6	Advanced manufacturing	On-demand production of maintenance parts for consumer products.	2020 / 2025
		Manufacturing of replacement organs through bio-printing.	2025 / 2035
		Mass customization production methods for making parts with different shapes (multiproduct mass production on the scale of 100,000 or more products).	2021 / 2025
		Application of metamaterials to consumer products through additive manufacturing technologies.	2021 / 2026
		Personal manufacturing of parts or products with the same precision and quality of mass-produced goods and similar items.	2020 / 2025
		Net shape fabrication technology which does not use cutting at less than 1m machining accuracy.	2025 / 2030
		A fab system which is capable of producing a large variety of semiconductor devices or integrated circuit chips in small production volumes on-demand within a short period of time.	2020 / 2025
		Ultraprecise process technology (including manufacturing, analysis, testing, and in-situ monitoring) on the angstrom order of size due to the advances in the sophistication of beam technology (such as ion, electron or laser), equipment control technology, and sensor technology.	2025 / 2030
		A low-cost mass production technique to produce edible amylose or sugar from cellulose found in wood, paper, etc.	2024 / 2028
		A technique to insert a substance with an attoliter order volume into a picoliter order closed space.	2022 / 2028
		Innovative production technology to directly build a three-dimensional solid shape from a liquid substrate without a template.	2025 / 2025
		A system to facilitate the inheritance of skills from artisans (skilled workers, craftsmen, etc.) through the measurment and modeling of such skills and the archiving of the implicit knowledge involved.	2023 / 2025
		Refining technologies with a reduced ecological footprint through the construction of new manufacturing systems such as direct reduction, etc.	2025 / 2030
6	Modelling and simulation	Multiphysics simulation technology to clarify the impact of various physical factors such as friction, shock, stress, fluid, electric fields, heat, light, etc. on chemical reactions that occur on surface of or interface between materials.	2025 / 2030
		Multiscale simulation technology to project how chemical reactions at the electron-scale affect macro-scale physical properties, functions, degradation, and destruction of substances.	2025 / 2030
		Simulation technology that integrates synthesis process simulation, fabrication process simulation, and function prediction abilities.	2025 / 2029
		Simulation technology that does not predict functions and physical properties based on structural information but rather predicts the structure itself using the desired functions and physical properties as inputs.	2025 / 2030
		Simulation technology not only for material design but also dynamic process design that is based on quantum theory.	2025 / 2030
		Dynamic simulation technology that allows for the analysis of the selection rates, environmental effects (temperature, etc.), and many-body effects in catalytic reactions.	2025 / 2029
		Multiphysics material simulation technology for multiple scales including electronic scale, atomic scale, mesostructure scale, macrostructure scale, and industrial material scale.	2025 / 2030
		A computing system that enablesthe simulation of excited states, reactions in solution, surface reactions, or the synthesis of new compounds by automatically searching for chemical reaction pathways using quantum chemical calculations.	2025 / 2029
		Model optimization technology that connects the local and macro physical properties of materials by assimilating simulation data and measured data to achieve more precisely predictive models.	2024 / 2030
		Technology to estimate the structure or creation process of materials through materials science inverse problems by applying statistical mechanics techniques for information such as Bayesian estimation and neural networks.	2025 / 2029
		A physical property prediction tool that increases the speed of searching for new substances in large-scale materials data.	2023 / 2025
		Development structural and functional materials through 3D modeling utilizing material informatics.	2025 / 2028
6	Measurement and analysis method of advanced material and	Spacial and temporal decomposition analysis technologies for carrier movement in light-energy conversion materials.	2022 / 2025
		Real-time three-dimentional visualization technology for examining mass transfer and mass change inside of batteries while charging and discharging.	2020 / 2025

F No.	Sub Field	Topic	Year
	device	Ultra-high sensitivity technology to perform non-destructive, in-situ detection and analysis of defects in solid objects.	2022 / 2025
		Technology to analyze the fluctuation of materials in a supercritical state or undergoing a phase transition.	2020 / 2025
		Operand analysis through multichannel, simultaneous measurements of catalysts.	2020 / 2025
		Real-time tracking of the elementary processes of catalytic reactions.	2021 / 2025
		Technology to estimate the physiological safety of nanomaterials.	2020 / 2025
		Automatic injection of proteins or fluorescent substances into cells with a survival probability of over 10%.	2021 / 2027
		Measurement technology with the ability to track molecular intracellular dynamics with a temporal resolution of less than one microsecond.	2020 / 2025
		An electron microscope with a low acceleration voltage of under 100V that can achieve atomic-level resolution.	2025 / 2025
		Electron microscopy technology to observe catalysts, metals, molten salts, etc. in extreme environmental conditions such as extreme heat (more than 800°C) and high-pressure reactions (more than 3kPa).	2025 / 2029
		Technology to generate, control, and detect polarized neutrons at a wide range of energies (wavelengths) in order to analyze the functions of high-temperature superconductors, spintronic materials, etc.	2025 / 2030
6	Application device and system in the fields of ICT	Printable LSI circuits based on high-performance organic semiconductors that are suitable for use as logic circuits for sensors and make possible high-mix, low-volume production at a low cost.	2020 / 2025
		A thin electronic device production platform in which sensors, integrated circuits, etc. are physically and functionally integrated (printed system-on-plastic).	2020 / 2025
		A flexible man-machine interface constructed with low-cost devices that can be attached to large curved surfaces and can be used in mobile living spaces such as vehicles of the near future.	2022 / 2025
		A nanomechanical system that operates based on molecular forces, mimicking biomolecular motors.	2024 / 2030
		Development of process and integration technologies to produce devices based on two-dimensional semiconductors such as single layer graphene devices.	2025 / 2030
		Integrated circuit technology to that improves processing power without increasing the power consunption per unit area, enabling the creation of a single chip capable of approximating the performance of a current supercomputer.	2025 / 2030
		A display which can only be viewed by specific people.	2021 / 2026
		Ultra-high-density recording technology which eliminates the dilemma posed by the degradation of digital data over time.	2025 / 2030
		Memory that operates with 100 times the memory bandwidth and 1/100 the power consumption of current DRAM.	2025 / 2028
		Information elements that use a single spin as an information carrier andsurpass the performance of CMOS devices.	2030 / 2035
		New devices that can emit single photons on-demand for communication based on quantum cryptography.	2025 / 2030
		Storage technology that stores 1 bit of data as a single atom or molecule and is capable of high-speed storage and retrieval of large amounts of data.	2028 / 2035
6	Application device and system in the fields of nanotechnology environment and energy	Thermoelectric conversion devices with a conversion efficiency of more than 40%.	2025 / 2030
		Refrigeration devices with high energy consumption efficiency to enable the practical use of superconducting power transmisson.	2025 / 2030
		Solar cell with a conversion efficiency of more than 50%.	2025 / 2030
		Replacement of more than 80% of the national power transmission and distribution network with a direct current smart grid system.	2030 / 2035
		A low-temperature hot water power generation system which is capable of generating electricity with 40°C to 100°C water.	2025 / 2030
		A wind power system capable of generating electricity from typhoons or high altitude prevailing winds such as the westerlies.	2025 / 2030
		Technology to create plastic using CO2.	2025 / 2030
		A portable device which can reduce radioactivity through artificial transmutation.	2030 / 2035
		Technology to exterminate pests and exotic species using specific drugs to target genetic markings.	2025 / 2035
		High-efficiency energy harvesting technology that generates more than a few watts of electricity.	2025 / 2030
		A rechargeable automotive battery capable of a range of 500km (energy density of more than 1kWh/kg, and specific power of more than 1kW/kg) while maintaining the size and weight of current batteries.	2025 / 2030
		Air batteries with high energy density that use metals like magnesium and are easy to regenerate or recycle.	2026 / 2031
		Carbonaceous capacitors for electric cars which enables to continuously run from Tokyo to Osaka	2030 / 2035
		High-efficiency fuel cells for motor vehicles which do not use rare metals.	2025 / 2030
		Fuel cells capable of using low concentrations of NOx as an oxidizing agent.	2025 / 2031

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		High-density hydrogen storage materials with a gravimetric hydrogen storage capacity of more than 10wt% and a release temperature of less than 100°C.	2025 / 2030
		A practical photocatalyst that can split water using sunlight.	2025 / 2030
		Artificial photosynthesis technology with with the equivalent efficiency of plants (more than 1%).	2030 / 2040
		Conversion of CO2 into fuel through the use of a photochemical reduction catalyst.	2030 / 2035
		Devices with low environmental impacts enabled by the use of graphene and carbon nanotubes instead of metals.	2025 / 2030
		Membrane separation technology to produce hydrogen from coal without the release of CO2.	2025 / 2030
6	Application device and system in the fields of nfrastructure	Structural health monitoring technology for buildings which is small, lightweight, and can be operated by a single person.	2020 / 2025
		Inexpensive coating materials which allow the self-diagnostic display of damaged areas and the degree of damage they have received.	2020 / 2025
		Tough, high-strength ferrous building materials with a yield strength of over 1,800MPa (three times that of existing steel) and a ductile-brittle transition temperature of below -40℃.	2025 / 2030
		Ferrous materials which can bond directly to ceramics without intermediate buffer layers.	2024 / 2025
		Lightweight carbon-based structural materials with high strength and corrosion resistance appropriate for use in large-scale structures such as super-large bridges.	2025 / 2030
7	Land development and conservation	Intelligent robots to work on construction sites instead of humans.	2020 / 2025
		Floating structures compatible with protection of the marine environment (to be used for transportation, communciation, production, a base of operations, etc).	2025 / 2025
		Sewage treatment technology for the recovery of energy and resources.	2020 / 2025
		Estimation technology for ground water quality and flow observation.	2025 / 2025
		Technology which enables the recovery of hydroelectric productivity by returning sediment deposited against the existing dam to the river channel with a low environmental impact together with recovery of the river and coastal environment.	2025 / 2025
		Estimates of the amount of global groundwater (fossil water) reserves that are not replenishable to enable proper international management	2025 / 2027
		Technology to provide advance warning of breaks in dikes which combines forecasts and observations.	2025 / 2027
		Construction technology for closing a dike breach in an emergency.	2024 / 2026
		River channel design technology which integrates long-term environmental protection and maintenance management.	2025 / 2028
7	City, architecture and environment	A fireless construction method utilizing adhesive technology with high strength and durability as an alternative to welding in large-scale and heavy construction.	2020 / 2025
		Greatly streamlined steel frame construction through the application of adhesives for steel with improved durability and fire resistance to new construction.	2023 / 2024
		Housing incorporating robots and other equipment to help elderly people and the handicapped eat, bathe, use the bathroom, and enjoy recreation on their own without the help of a caregiver.	2025 / 2025
		Indoor environment control technology with sensor functions corresponding not only to temperature and humidity control but infection prevention as well.	2020 / 2025
		Design technology (construction methods) and demolition technology to facilitate the dismantling of reinforced concrete skyscrapers.	2020 / 2025
		Technology for detached housing which enables the systematic use of natural energy, rainwater, and groud water.	2020 / 2024
		Positioning technology which measures location information seemlessly regardless of being indoors or outdoors.	2020 / 2024
		Sensor and information network technology to protect the health and safety of residents through centralized management of water and energy supply systems and drainage, garbage, human waste processing, and reclamation equipment distributed across individual households.	2021 / 2029
		Development of a predivtive model of urban environmental change reflecting changes in demographic composition, the progression of an aging society, and the deteriortation of buildings and infrastructure.	2020 / 2025
		As evacuation behavior model for disasters occuring at a terminal station, an underground shopping area, or a complex large-scale venue.	2020 / 2024
		Efficient commercial agriculture which enables Japan to produce more than half its crops domestically.	2025 / 2025
		Quantitative assessment technology for the regeneration of agriculture and forestry and natural management over broad areas.	2024 / 2025
7	Infrastructure management and maintenance	Technology to refurbish major structures such as bridges, dams, and tunnels while maintaining service.	2023 / 2025
		Life support robots which provide users with disaster prevention, crime prevention, and nursing support functions.	2025 / 2030
		Technology to detect and automatically repair damaged areas of facilities to require fewer personnel to maintain infrastructure equipment.	2025 / 2025

F No.	Sub Field	Topic	Year
		Diagnostic technology for typical structures using sensors suitable for long-term use to monitor environmental factors involved in the degradation or deterioration of the structure, the history of external forces acting on the structure, and changes in the state of the structure.	2024 / 2025
7	Transportation and distribution infrastructures	A navigation system which provides elderly people and the disabled (especially visually impared people) with information allowing them to act freely and independently.	2022 / 2025
		Centralized network control and operation technology which manages information from a large number of moving vehicles (automobiles, bullet trains, airplanes, ships, etc.) to contribute to the reduction of the load on the environment.	2021 / 2025
		A transporation system for an extremely aged society which enables elderly people to travel from one place to another alone with confidence while seamlessly connecting a local district to the wider region.	2023 / 2030
		A system to halve the time, cost, and environmental impact of cargo transportation by creating road+railway, road+port/airport, and railway+port/airport transportation nodes to improve the efficiency of transportation between cities.	2025 / 2029
		A mobility management system designed to accommodate several hundred thousand people to ensure the smooth movement of people during emergency situations (such as interruptions caused by disasters or malfunctions).	2025 / 2027
		Ships and airplanes that do not use fossil fuels.	2025 / 2030
		An easy-to-fold bike that takes up less than half of its usual space when folded as well as a highly efficient share cycle system (including bike depot design and redeployment methods) using such folding bikes.	2020 / 2022
		A system for comprehensively optimizing an entire road network to reduce social impacts including traffic congestion, environmental impacts, and the cost of road management.	2022 / 2029
		A system that uses probe data collected by automobiles for the maintenance of road infrastructre.	2020 / 2025
		Nondestructive inspection technology available for on-site use to improve reliability and reduce the burden of infrastructure inspection and diagnostics.	2023 / 2025
		A system which measures temperature, shock, and composition changes in items during intermodal transportation, capable of tracing the item through production, transpotration, storage, use, and disposal.	2024 / 2025
7	Automobile, rail, vessel and aviation	Pavement technology using new materials to reduce road traffic noise to a level below environmental standards.	2020 / 2025
		Contactless charging infrastructure technology which enables the successive charging of electric and hybrid cars while they are stopped or parked at a public parking lot or intersection.	2020 / 2025
		Infrastructure technology which enables power to be supplied to electric and hybrid vehicles while operating on the highway.	2025 / 2026
		A system to prevent accidents at places such as intersections using vehicle-to-infrastructure (V2I) and vehicle-to-vehicle (V2V) communications.	2020 / 2023
		A traffic control service system that dynamically uses big data collected from vehicles and road infrastructure such as traffic lights.	2020 / 2025
		Installation of hydrogen supply stations for fuel cell vehicles at 5,000 locations.	2020 / 2025
		A navigation system which provides elderly and disabled people (especially visually impared people) with information to help them act freely and with a sense of safety in public urban spaces.	2022 / 2025
		Automated driving, supervised by drivers, on roads where certain conditions are in place.	2020 / 2025
		Centralized network control and operation technology which manages information from a large number of moving vehicles (automobiles, bullet trains, airplanes, ships, etc.) to contribute to the reduction of the load on the environment.	2020 / 2025
		Multilingualization of urban information (such as roads, traffic signs, guidance displays, signage, etc.) via wearable or mobile terminals.	2020 / 2022
		A road usage fee system where a fee is charged based on the location of the road and time of usage (or the state of congestion).	2020 / 2025
		Accident prevention systems utilizing vehicle-to-vehicle (V2V) communication systems to avoid accidents such as when one car passes another (including both vehicle and infrastructure elements).	2020 / 2025
		A public transportation system (such as demand buses) where elderly people can use when they need.	2020 / 2025
		Bullet train technology which satisfies environmental standards for noise (below 70dBA in residential areas) while continuously operating at speeds of 350kph through technological improvements to the vehicle structure and the use of new materials or structural elements.	2022 / 2025
		A safety system using ITS which reduces traffic congestion on surrounding roads due to rail crossings whose gates remain closed for long periods and halves the number of accidents caused by motor vehicles entering the crossing.	2020 / 2025
		High-speed rail system (conventional type rail) that does not require a pantograph due to contactless charging.	2023 / 2025

F No.	Sub Field	Topic	Year
		High-speed sealift ships capable of operating at a speed of 50 to 60 knots at an equivalent cost to currently existing ships.	2027 / 2030
		Merchant icebreaker ships capable of navigating waters such as the Arctic Ocean.	2021 / 2025
		Clean ships that cut CO2 emissions in half and reduce NOx emissions to 20% of existing emissions.	2025 / 2028
		Frictional drag reduction technology for ships which reduces required horsepower by 20%.	2025 / 2025
		Flight trafic control operations technology allowing the control of twice the current volume of air traffic by using a high-precision navigation system for both sircraft and air traffic control.	2024 / 2026
		Airplanes which save energy by changing the shape of their wings at will like a bird's wing by leveraging smart composite materials and morphing technology.	2025 / 2032
		Safe aircraft that can prevent crashes during takeoff and landing by automatically restoring the aircraft to its original position in the unlikely event the aircraft falls into an abnormal orientation.	2025 / 2031
		Spaceplanes that reduce our impact on the environment.	2030 / 2035
		Low-emission, energy efficient airplanes that achieve lower noise during takeoff and landing and reduced emissions during flight through an airframe with low frictional drag and engines with improved combustion efficiency (noise level reduced by 90% and fuel cost reduced by 50%).	2030 / 2035
		A passenger aircraft flight control system capable of being operated by a single person.	2025 / 2030
		Maintenance system to reduce aircraft maintenance costs by detecting or predicting equipment malfunctions based on the information from each aircraft.	2025 / 2030
7	Technology for disaster prevention and reduction	Unmanned aircraft for low-attitude autonomous flight to be used for surveillance of territorial waters, disaster monitoring, and rescue support.	2020 / 2025
		High-altitude unmanned aircraft capable of flying through the stratosphere and within the control zone of manned aircraft for communication and observation for disaster mitigation and security issues.	2025 / 2025
		Liquefaction countermeasure technology using a database of disaster records and land information.	2023 / 2025
		Sewater flow control technology to prevent the occurrence of large-scale environmental hypoxia in inner bays and other bodies of water.	2030 / 2035
		Rescue equipment (such as a "flying platform", etc.) and evacuation equipment (such as a "wing suit" for building evacuation, etc.) which can be used by people in need of rescue in locations that are difficult to approach or reach using equipment such as ladder trucks, such as sandbars in the middle of rivers or cliffs.	2025 / 2026
		Robots capable of successfully rescuing people from rubble or providing emergency transport inside buildings.	2024 / 2025
		Work clothes clolored based on radiation intensity to be used during work involving radiation.	2020 / 2025
		Technology to dampen or control the direction of propagation of a tsunami.	2025 / 2030
		Fluorocarbon-free fire extinguishing agents to extinguish fires where water-soluble agents can not be used.	2021 / 2025
		Housing that minimizes damage to residents by controlling the expansion of fire and the flow of smoke in advance when a fire occurs.	2023 / 2025
		Disaster relief robots to identify and rescue survivors at disaster sites.	2025 / 2029
		Robots which clear snow from roofs, around houses, and on roads safely and efficiently.	2025 / 2028
		Real-time water management analysis technology utilizing groups of reservoirs for disaster prevention and reduction.	2023 / 2025
		Development of high-strength wood materials for medium- and high-rise wooden buildings.	2021 / 2025
		A decision-making support system which automatically formulates a plan for rapid recovery and reconstruction in the event of a disaster.	2025 / 2026
		Establishment of decommissioning and radioactive waste disposal technology for 1 million KW-class nuclear reactors.	2029 / 2035
7	Information of disaster prevention and reduction	Embeddable sensor technology to inform of landslides, mountain slope collapses, and embankment destabilization in advance and an alarm and evacuation support system to make use of the data.	2020 / 2025
		A disaster prevention system which measures change in the shape and topography of steep slopes and large-scale structures in mountainous areas using satellites.	2020 / 2025
		An information-sharing system to reduce risk by integrating accident records and geographic information.	2020 / 2025
		A realtime damage analysis and extent prediction system for effective emergency response in the case of large-scale disasters.	2021 / 2025
		A radio communication system capable of video communication without causing congestion that is not disrupted in the event of a disaster.	2020 / 2025
		A risk prediction, warning, and prevention system to reduce the occurrence of marine accidents such as capsizing, collisions, and running aground.	2025 / 2027

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		A quick and precise detection system for minute amounts of explosives and drugs in public areas, facilities that attract many people, ports, airports, and transport infrastructure such as railways.	2020 / 2025
		A quick and precise detection system for radioactive substances in public areas, facilities that attract many people, ports, airports, and transport infrastructure such as railways.	2020 / 2025
		A quick and precise detection system for pathogenic microbes in public areas, facilities that attract many people, ports, airports, and transport infrastructure such as railways.	2025 / 2027
		A navigation system using personal portable terminals to conduct rescue and evacuation activities smoothly.	2020 / 2021
		A system using social networking services to collect highly accurate evacuation information.	2020 / 2020
		A national airspace, maritime zone, and land territory observation system to enable warning, evacuation, and coordination based on the advanced prediction of a disaster (about 1 hour prior notice).	2025 / 2029
		Flooding and flood damage damage prediction systems which take into account the specifications and usage of individual buildings and structures.	2020 / 2025
		Fault displacement measurement technology for linear structures (such as tunnels and shafts).	2022 / 2025
8	Management and policy	As developed countries progress to the BOP (Base of the Economic Pyramid) market, the market transitions from a necessities-focus to a services-focus, resulting in a global improvement in quality of life.	2025 / 2025
		Construction of a system to check whether proposed services are comform to laws of each country and specify the conditions for providing services by country based on legal information searches.	2024 / 2025
		A detailed framework to resolve issues related to the legal and commercial handling of intellectual property will spread, and it will reach more than 20% of new products and services that enter the market through open innovation.	2023 / 2025
		Values that are difficult to measure numerically for inclusion in financial statements and securities reports, such as the emotional perspective of customers and employees or a knowledge and skills perspective of a company, will be described in some form of uniform standards and become generalized as one of the fundamental criteria for corporate evaluation.	2023 / 2025
		Intangible values (including the accumulation of information on customers, happiness level of employees, etc.) will be used as important items to when banks evaluate the risk of making a loan to a company or perform due diligence (such as company evaluation before M&A).	2025 / 2025
		A mechanism will be developed to allow customers themselves to decide the amount of resources to be provided for the production of a given service and determines a price based on the amount specified.	2025 / 2025
		In addition to traditional statistical data, policymakers come to use the results of data mining technology such as big data analysis utilizing machine learning to assist decision making.	2020 / 2025
		Stock analysts shift from a focus in corporate evaluations on short-term, economic performance indicators towards long-term, social value-oriented indicators. More specifically, evaluations progress to the level of evaluating internal and external services provided.	2021 / 2025
		More than half of all companies start using a new index to evaluate their employees which takes into account their long-term relationship with customers and their contributions to customer lifetime value or to society.	2024 / 2025
8	Knowledge management	Utilization of a cultural and technological inheritance system that archives both explicit and tacit knowledge by measuring and modeling great artists' performances and artisans' (such as skilled technicians') techniques.	2024 / 2025
		Establishment of an education system to improve the quality and efficiency of services by retrospective analysis based on service log data that is automatically collected with the aid of various sensors.	2020 / 2025
		As research into the feelings of pleasure, discomfort, love, hate, etc. progress, techniques to directly analyze, measure, and evaluate the feelings of consumers will be developed, and using those techniques R&D, marketing, sales, etc. methods for goods and services will be established.	2024 / 2025
		Various knowledge about related to health care and nursing services for the elderly will be systemized and then utilized as a common language for various multidisciplinary service providers involved.	2021 / 2025
		The mechanism underlying 'hospitality' in providing services will be understood, and robots and computer systems possessing "hospitality" will be used at actual service sites.	2025 / 2025
		Service related knowledge will be put into a database, leading to the development of navigation tools to support the provision of services while adapting to changing conditions in real-time.	2020 / 2025

F No.	Sub Field	Topic	Year
		A database accumulating the best practices for services in each industry will be built, and education and human resource development will generally be performed based on those cases.	2020 / 2025
		Content and tools that teach the basic principles, designs, and management techniques of product service systems (PPS) will be developed and become widely used regardless of industry.	2021 / 2025
		Methods to evaluate service providers' skills (the service sector equivalent of IT skill evaluation) will be established and become used as indicators in the education and training processes in several industries.	2020 / 2025
		In addition to traditional school-type lessons carried out at pre-decided times and pre-decided places, education will also incorporate a new lesson system using ICT which allows people to study at the time and pace of their choosing.	2020 / 2021
		A hybrid service education system combining on-the-job training and e-learning will become widespread that enables the learning of implicit knowledge such as "hospitality".	2020 / 2025
8	Product Service Systems (PSS)	As personal fabrication becomes widespread, more products will be made by amateurs or jointly produced by several people. As a result, amendment of corresponding laws on product liability and new forms of property insurance will be developed.	2020 / 2025
		Development of a practical design navigation tool that consistently guides the product design service system from upstream to downstream elements.	2020 / 2025
		A method for constructing business models is established that maximizes the utility value derived by beneficiaries of deals such as PFI (Private Finance Initiatives), PBL (Performance Based Logistics), and partnering.	2020 / 2028
		The design for an additional energy management system will be established that can incorporate pre-existing home appliances and audiovisual equipment just by adding an attachment to them, even without a home energy management system constructed from the top-down like HEMS.	2020 / 2025
		A digital pipeline will be developed by computerizing the entire design, development, production, quality control, and manufacturing process, and the unified format will intensify open innovation both inside and outside companies.	2025 / 2026
		A support method for life cycle design targetting the product service system will be developed and put into use in many industries.	2022 / 2025
		Development and maintenance of business scenario planning methods that enable the prediction of product service system growth scenarios using a backcasting approach to logically configure medium- to long-term business plans based on future expectations of customer values and social conditions.	2022 / 2025
		Contract design methods and contract design support tools that support various forms of contracts between service providers and recipients through a product service system will be developed and maintained.	2020 / 2025
		Business Case Analysis for product service system providers and comprehensive risk management methods based on the results will be maintained.	2022 / 2028
8	Society design and simulation	It will become possible to complete one million simulation cases involving the flow of 100,000 people in the vicinity (about 5 square km) of a large-scale terminal station for six hours, including simulation of the effectiveness of various forms of information provision and individual assessments of the situation, in approximately one month.	2020 / 2022
		To achieve a healthy aging society, information about the hobbies, health, medical records, and daily activity of elderly people will be managed and analyzed in a single database.	2020 / 2025
		Virtualization of public transportation, enabling users to select the optimal transportation method by only indicating their destination (more than navigation, it includes transportation mode matching based on current levels of demand).	2020 / 2025
		Establishment of design support technology that determines the optimal arrangement of wireless charging infrastructure for small mobile objects and robots operating in a given region.	2020 / 2025
		Establishment of advanced residential building design technology that enables the elderly and people with disabilities to have a 'natural life,' in which barrier-free design is improved and made compatible with coexisting with robots.	2025 / 2030
		Highly precise electricity consumption prediction at the micro-scale (HEMS level) and macro-scale (regional level) will be developed, and the flexible trading of electricity will take place. For example, electricity stored in the battery of an electric car can be sold at a destination location (such as a commuter's work place).	2021 / 2026
		The current structure in which neighbors cooperate to solve local issues will be expanded and become more open, allowing people from outside the region with consciousness of a problem to volunteer to help resolve the problem through social networking sites as part of a lifestyle assistance system.	2021 / 2025
		Establishment of simulation technology that can realistically reproduce real world society over a network constituted of an extremely large number of nodes (i.e. individuals)..	2025 / 2030
8	Service sensing	Collection of data through various environmental sensors installed in stores that is statistically processed and accumulated, and then over 80% of the data is released to the public as open data.	2020 / 2025

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		Popularization of supervision terminal technology that can be worn naturally by general consumers to monitor people such as dementia sufferers who might wander off.	2020 / 2022
		People will manage personal profiles including individual sensor data, and by carrying their profiles in portable terminals they will be able to receive some degree of customized service even when they visit a store for the first time.	2019 / 2020
		New businesses that manage customers' personal behavior information (such as sensor information and purchase histories)in a manner similar to credit card companies and banks will emerge and become commonly used by the public.	2018 / 2021
		Service quality measurement technology that considers the subjectivity and diversity of customers is established and put into use in many industries.	2021 / 2025
		Establishment of technology to estimate an individual's mood and emotional state and predict emotional transitions based on data, such as data on facial expressions, which is naturally and continuously recorded in daily life (technology for consideration and empathy).	2020 / 2025
		Widespread use of biological information that can be collected through sensors such as measuring of brain activity or gaze in order to analyze consumer trends and consumer satisfaction.	2022 / 2025
		A system that collects and uses data on the 'awareness' of service staff using various kinds of sensors will be used at more than 30% of service establishments.	2020 / 2025
		Open and low-cost M2M (Machine to Machine) platforms which connect all the devices through a network will become available for service locations.	2020 / 2025
		Matchmaking services that assist people in meeting others while pretending it was a natural encounter by using data from sensors worn by people or deployed around town will spread.	2019 / 2023
		Development of technology to measure customers' activities (such as gaze, facial expression, route, time spent at each section, purchased goods, etc.) in store in real-time.	2020 / 2025
8	Service Design	Establishment of a description method for service processes to clearly express the context of providing services that are highly dependent on the specific culture, such as the form of "hospitality".	2020 / 2024
		Development of technologies and tools with versatility to improve the reliability of services, such as service fault diagnosis or risk aversion techniques.	2020 / 2025
		New UX (user experience) design for big life purchases such as automobiles and school education that have so far been primarily performed offline in consideration that even these purchases will be performed via the internet.	2024 / 2025
		Service design techniques will become industry standards, like UML did in software design, and serve as a shared language.	2020 / 2025
		Service design techniques will be established and become part of the general education core curriculum in universities.	2020 / 2025
		Establishment of technology to qualitatively and quantitatively simulate service systems from economical, technical, and social points of view before they are implemented within society.	2020 / 2025
		As design support tools using information technology are improved and 3D printers become widespread, goods and services that allow users themselves to customize and re-design them become commonplace.	2020 / 2023
		Establishment of methods to measure and evaluate productivity in the case of intellectual work such as design and creative problem solving and contributions to cooperative intellectual activities.	2025 / 2030
		Service process design support techniques and tools, such as service blueprinting, experience oriented approach tables, scenario modeling, context modeling, etc., will be integrated and used in the industrial field.	2020 / 2025
		A method for the optimal allocation of human and product resources when providing service systems including services and products will be established and used by more than 20% of companies.	2022 / 2030
8	Service Robots	Introduction of technologies to communication and nursing care robots that both ensure human safety and shorten the amount of time humans and robots are in contact during operations.	2020 / 2025
		It will be common for service robots or electronically simulated humans to provide services or sell products to humans at shops except for special cases of selling luxury goods.	2021 / 2025
		Development of a hazard prediction system that aggregates sensor information collected from sensors throughout a living space and information from the network will be developed, encouraging the elderly to go out and participate in society (Improving quality of life for the elderly).	2021 / 2025
		The generalization of robot inspection technology to inspect buildings or infrastructures that would be more dangerous or costly for humans to inspect.	2020 / 2025
		Life size personal robots or telepresence robots which serve as proxies for humans will be developed, and it will be common for people to use them to go shopping or to meet other people.	2025 / 2028

F No.	Sub Field	Topic	Year
		Automatic driving technology becomes widespread and the number of roads on which people do not have to drive manually increase, resulting in dramatically improved logistical efficiency.	2020 / 2028
		Intelligent robots (able to recognizeand avoid danger without input from an external operator) that can be remotely controlled by family members in order to provide lifestyle support to elderly and mildly disabled people living in remote areas becomes widespread.	2025 / 2030
		Development of a robot chef who can cook more than 20 meals on a menu and perform more than 80% of cooking tasks in the kitchen as a substitute for a human.	2024 / 2027
		Advanced teleoperation that enables people to receive services including medical care from remote locations such as isolated islands.	2025 / 2025
		Development of robots to take over supplemental duties in the service industry such as restocking products at convenience stores.	2024 / 2025
		Cases wherer HCIs (Human-Computer Interfaces) are used in the health care industry increase, leading to improved service productivity in the health care sector.	2020 / 2025
		Laws on agricultural corporations will be amended, opening the door to the creation of new agricultural businesses such as fully automated robot farm work (return of domestic agriculture to ensure food safety).	2022 / 2025
8	Service theory	Theories that view goods and services as dichotomous entities will be theoretically outdated, and a new theory of "service dominant logic" fusing together ideas about goods and services will become the generally accepted social paradigm.	2020 / 2025
		A value model will be established describing the feeling of value people receive from service in mathematical terms, enabling the design of services that maximize value based on a mathematical approach.	2020 / 2029
		As the servitization of the manufacturing industry increases, the utility of distinctions between "manufacturing" and "services" industry classifications decreases and a new system of industrial classification emerges.	2024 / 2025
		Modeling of how human emotions vary depending on context and the structure of those emotional variations when receiving interpersonal services (such as aspects that do or do not vary based on the context, the degree of influence of different contexts, types of emotion that result from certain contexts, etc.).	2025 / 2030
		Creating shared value (CSV) theory will continue to be developed and specific measurement methods are developed and become widespread.	2025 / 2030
		The process of collaborative creation of value in services, and the effective combination of resources provided by service providers and recipients and the dynamism of their interaction will be theorized.	2020 / 2030
		The nature of value produced by co-creation is clarified, leading to the theorization of a specific measurement scale for the co-creation of value.	2022 / 2025
		Development of a framework to achieve efficiency without sacrificing quality when services are provided by IT or robots in the service industry.	2025 / 2030
		Techniques to construct a system are put in place that cultivate the service competency and service literacy of service providers and recipients step by step based on Service Dominant Logic.	2022 / 2028
		The definition of marketing used by one of the global leading marketing-related organizations such as the AMA (American Marketing Association) will be revised to make the co-creation of value in services one of the principle components.	2020 / 2025
8	Analytics	Establishment of technology to make high-precision prediction of an individual's movement in space (prediction of where they will go) will be developed that uses real-time edge heavy data (data that arises at the edge of networks such as from sensors).	2020 / 2030
		Establishment of technology to make real-time prediction of customers' activity (prediction of what they will do) in large amusement parks and shopping malls using edge-heavy data (data that arises at the edge of networks such as from sensors).	2020 / 2024
		Establishment of simultaneous recommendation technology that is based on real-time tracking of purchased goods.	2019 / 2020
		Establishment of technology to integrate online and brick and mortar store data as a basis for understanding consumer behaviors such as "webrooming" and "showrooming" (purchasing a product online after checking it out at a physical store or vice versa).	2020 / 2025
		Machine learning technology to automatically forecast trends based on nonstructured big data collected through social networking services (such as Twitter, Facebook, and blogs) will be established.	2020 / 2022
		Realization of highly accurate real-time customer behavior prediction by integrating techniques (data assimilation) from deductive reasoning (simulation) and inductive inference (statistical modeling).	2020 / 2023
		Bayesian forecasting of individual household demand using large-scale data will be established.	2022 / 2025
		Realization of an automatic home delivery system for food and groceries based on household food stock estimation and customer preference estimates.	2019 / 2025
		Establishment of real-time statistical technology to estimate the highly complex models (models with a very large number of parameters in excess of several million) which are necessary in order to support individualized services targetting a large number of customers.	2020 / 2025

F No.	Sub Field	Topic	Year
		Establishment of statictical techniques to evaluate the heterogeneous and dynamic mechanisms underlying consumer behavior such as shopping behavior in the supermarket or information-seeking behavior on the web.	2023 / 2025
8	Basic research in humanities	The thinking processes and techniques of creators that forms their "implicit knowledge" will become archivable as "explicit knowledge" that will be applied to the development of education and idea support systems.	2025 / 2030
		Technology for finding the "optimal learning method" for an individual based on knowledge of neuroscience and cognitive science is established, improving learning productivity.	2025 / 2030
		As an algorithm for customers' evaluation of 'employee failures' that occur in service establishments becomes apparent, and information on failure cases accumulates and social consensus about them forms, it will be possible to evaluate the economic consequences and predict the risks associated with every failure.	2025 / 2028
		Generalization of aptitude tests for employees that enable employees to comfortably accept their position within the comapny.	2025 / 2025
		Establishment of a methodology for constructing models describing human behavior.	2025 / 2030
		Development of a mechanism to model different cultural differences by country and region and adapt the service level of an establishment accordingly.	2025 / 2030
		Discovery of an algorithm explaining the relationship between a service and a particular customer's satisfaction level (similar to a utility function).	2025 / 2027
		Discovery of the cognitive mechanism that makes a person happy when someone says "thank you" or remembers their face.	2020 / 2025
		Development of a system that can automatically determine the relationships between employees from their behavioral histories.	2025 / 2026
		The ability to classify the desirability of a given service for a particular customer based on a simple question (experiment) for a variety of different types of services.	2024 / 2025
		Development of participatory simulation technology to explore problem solving taking into account the unique culture and climate at each of the community, local government, national, and global levels of organization.	2025 / 2027

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