Chapter 3 Response to Critical Issues Facing Japan

Section 1 Promotion of Measures for Solving Critical Issues

1 Assuring Safety, Affluence and High Quality of Life

Under the 4th Basic Plan, one goal is for Japan to become "a nation that affords its citizens safety, fulfillment and high quality of life". To assure safety, fulfillment and a high quality of life for years to come, measures should be taken to enhance security by protecting people from large-scale natural disasters, serious accidents and terrorism and ensuring a stable supply of food and water. Efforts are also needed to help people enrich themselves mentally and cultivate themselves in terms of sensibility.

(1) Enhancement of safety and convenience of life

Authorities have been advancing efforts as described, toward the following objectives: ensuring safety against natural disasters, accidents and crime; protecting human health and conserving ecosystems; and achieving a good balance between safety enhancements and increases in comfort and convenience.

1) Surveys, observations and predictions of earthquakes, volcanoes, tsunamis, high waves and storm surges, wind damages, flooding and landslide, and R&D to improve disaster prevention, mitigation and response capabilities

In FY 2014, Japan was affected by various natural disasters such as the landslides in Hiroshima in August, the Mount Ontake eruption in September and earthquakes in northern Nagano prefecture in November to name but a few. Overseas, natural disasters caused tremendous damage in many parts of the world, such as large-scale landslides in Afghanistan in May the same fiscal year. To mitigate damage caused by natural disasters, it is important to advance R&D of science and technology (S&T) contributing to the reduction of various types of disasters.

(i) Promotion of seismological R&D (MEXT)

Under the Headquarters for Earthquake Research Promotion (Director: the Minister of Education, Culture, Sports, Science and Technology), administrative agencies are working in close cooperation on seismological investigations and research.

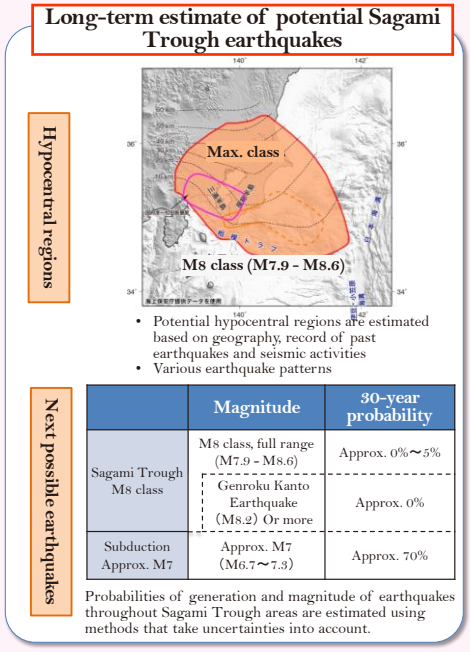
The "Program for comprehensive earthquake research and observation" was reviewed in August 2014 and adapted to the progress of New Comprehensive Basic Policy[1] and observation and research projects.

Because the long-term evaluations of the probability and scales of earthquakes conducted by the Headquarters for Earthquake Research Promotion did not cover massive multi-segment earthquakes such as the 2011 Off the Pacific Coast of Tohoku Earthquake, conventional evaluation methods have been

1 "New Promotion of Earthquake Research - Comprehensive Basic Policies for the Promotion of Seismic Research through the Observation, Measurement, and Survey -" (September 2014) http://www.jishin.go.jp/main/w_030_f-e.htm

reviewed to discuss the renewal of evaluation methods. In April 2014, the "Long-term Evaluation of Sagami Trough Earthquakes (2nd edition)" was published (Figure 2-3-1).

■ **Figure 2-3-1 / Long-term Evaluation of Sagami Trough Earthquake Activities (2nd edition)**



Source: Created by MEXT

Universities and research institutions dealing with seismic and volcanic observations and research not only predicted earthquakes and volcanic eruptions, but also conducted their study according to the "Promotion of Earthquake and Volcano Hazards Observation and Research Program for Mitigating Disasters (Proposal)" (drafted by MEXT in November 2013) covering strong ground motions, tsunamis, volcanic ashes, molten lava and other factors causing disasters. The "Issues and Responses in Volcano Observation and Research in light of Mount Ontake eruption" (November 2014, Earthquake and Volcano WG of CST's Geodesy Subcommittee) was published urgently in the wake of the Mount Ontake eruption to indicate the direction of future volcanic observation and development of human resources for volcanic research. This report contains a couple of suggestions, including a change in the number of volcanic mountains to observe from conventional 16 to 25, including Mount Ontake, and reinforcement of studies on the precursors of hydrovolcanic explosions. Consequently, MEXT requested about 2.1 billion yen as necessary funding to strengthen volcanic observation and research in the supplementary budget for FY 2014.

MEXT has conducted investigation and research into potential earthquakes which may cause tremendous social and economic damage, including the "Special Project for the Mitigation of Great Disasters which the Vulnerability of Cities Causes" for earthquakes directly beneath the Tokyo Metropolitan Area and the "Research Project for Compound Disaster Mitigation on the Great Earthquakes and Tsunamis around the Nankai Trough Region" for Nankai Trough earthquakes. In the latter Nankai Trough Earthquake research project, an earthquake source model covering an area extending from the Nankai Trough to the Nansei Shoto Trench was developed to estimate potential damage from earthquakes and tsunamis and examine measures to prevent and mitigate such damage, as well as promote post-damage recovery and reconstruction. Efforts to enhance the use of research results specific to this region include research into the following: disaster prevention and mitigation measures, structural exploration, dense seismic observation, tsunamis in recorded history and simulations. In the Project for Investigations of Earthquakes and Tsunamis in the Sea of Japan, controlled-source surveying and investigations of tsunami deposits were conducted to advance research on an earthquake source fault model and a tsunami source model that would be applicable to the Sea of Japan and its coast. This is because earthquake source faults and tsunami sources there are less understood that those in the Pacific Ocean and on its coastline. In the Research Project for Supporting Regional Disaster-prevention Measures, a database was developed based on research for disaster prevention measures from universities nationwide. Additionally, the utilization of

research results in the formulation of regional anti-disaster measures was promoted.

After the Great Hanshin-Awaji Earthquake, earthquake observation networks were densely built in land areas. Although several sea-area observation networks have been built, including a Japan Meteorological Agency (JMA) cable network off Tokai/Tonankai for submarine earthquake observation, there are far fewer observation points in these networks than in land-based observation networks.

Accordingly, MEXT started the full-scale operation of a dense submarine network equipped with seismometers and hydraulic gauges for real-time seismic observation in the hypocentral region of the assumed Tonankai Earthquake. A similar system was developed in the hypocentral region of the assumed Nankai Earthquake. A cable network for submarine earthquake observation has also been developed in and around the hypocentral region of the 2011 Off the Pacific Coast of Tohoku Earthquake, because large aftershocks and tsunamis are likely to occur (see Section 1 1-(3), Chapter 2).

(ii) Promotion of S&T for disaster prevention (NIED)

The National Research Institute for Earth Science and Disaster Prevention (NIED) has been conducted the research project seismic engineering utilizing E-defense, studies on accurate predictions of rainfall and damage caused by landslides, windstorms and floods using next-generation high-performance radars and research contributing to the damage reduction caused by natural disasters such as volcanoes and heavy snow. NIED has also advanced the research to develop systems for integrating and utilizing information of various natural disasters. Its activities in FY 2014 include the estimation of the distribution of high-pressure volcanic fluid in the Japanese archipelago using a high-sensitivity seismograph network and R&D to observe the structure of cumulonimbus cloud system which caused the localized torrential rain and landslide in Hiroshima city using the observation data from MLIT's XRAIN[1].

(iii) Research on earthquake monitoring/forecasting, tsunami forecasting and earthquake early-warning (JMA)

JMA processes and analyzes the monitoring data collected at its earthquake monitoring facilities and related institutions and provides analytical results to the same institutions. JMA collaborates with NIED to conduct R&D and further advance technologies for the earthquake early-warning system.

The JMA Meteorological Research Institute researches the following topics: the development of tsunami forecasting technologies to mitigate damage by tsunamis based on offshore tsunami monitoring data and real-time earthquake intensity estimations after massive earthquakes; technologies for seismic intensity estimation that help improve the accuracy of earthquake early warnings; and technologies for monitoring and analyzing crustal movements that help improve the accuracy of predictions for the assumed Tokai Earthquake.

(iv) Improvement of technologies for monitoring and analyzing crustal movements (the Geospatial Information Authority of Japan: GSI)

GSI engages in R&D on technologies for the observation and analysis of crustal and plate movements through continuous GNSS[2] observation at electronic reference stations[1], through Very-Long-Baseline

1 X-band polarimetric (multi parameter) RAdar Information Network
2 Global Navigation Satellite System

Interferometry (VLBI[2]) and through SAR Interferometry[3]. Detailed monitoring of crustal movements in and around volcanoes has been implemented through integrated analysis of GNSS volcanic observation data, which have been collected in and around volcanoes by the JMA (since FY 2009), NIED (since FY 2010), the National Institute of Advanced Industrial Science and Technology (AIST) (since FY 2012) and the Hot Springs Research Institute of Kanagawa Prefecture (since FY 2012).

(v) Enhancement of surveys and observations of crustal movements on the sea-floor (Japan Coast Guard)

The Japan Coast Guard (JCG) has been advancing observations of crustal movements on the sea-floor[4] by means of GPS and echo ranging, as well as advancing surveys of submarine topography and active faults. In light of the 2011 Off the Pacific Coast of Tohoku Earthquake, the JCG has reinforced its system for observing crustal movements on the sea-floor in the Nankai Trough.

(vi) Geological surveys of volcanoes, active faults and tsunami deposits (AIST)

AIST conducts deposit surveys of active faults and tsunami sediment and geological surveys of active volcanoes to collect geological information useful for disaster prevention and publishes the results of these surveys.

Survey of tsunami deposits on the Sendai Plain (left); Collected deposits (right)
Source: AIST

Its geological surveys included seven major fault zones nationwide, five fault zones on land and two fault zones in nearshore seas to clarify the fault distribution and the history of fault activities. Surveys on underground mechanics were also continued by reanalyzing existing data on reflection seismic surveys over a wider area of Kanto Plain, including Fukaya and Ayasegawa Faults. For short-term predictions of Nankai Trough Great Earthquakes, AIST continued to operate its integrated groundwater observation points to measure groundwater levels (water pressures), groundwater temperatures, crustal strains and seismic waves. It also conducted geological surveys to understand the history of large-scale tsunamis and seismic activities causing such tsunamis in the Shimokita Peninsula, Sanriku Coast, Sendai Plain, Kujukurihama and the southern part of Boso Peninsula along the Sagami Trough and Shizuoka Prefecture, the Kii Peninsula and the coastal area of Shikoku along the Nankai Trough.

To further refine volcanic eruption scenarios, AIST conducted surveys on eruptive products, observations of ash fall and petrological analyses of Nishinoshima, Kuchinoerabu-jima, Mount Ontake and Mount Aso which erupted in 2013 and 2014 and Sakura-jima where increased activity was observed. It also

1 Electronic reference points numbered 1,276 as of the end of March 2014.
2 Very-Long-Baseline Interferometry: Technology that uses radio waves from quasars billions of light years away to obtain precise long-distance (i.e., several thousand kilometers) measurements on the Earth's surface within a tolerance of several millimeters.
3 Synthetic Aperture Radar: A form of radar hosted by satellites for monitoring the Earth's surface topography and its deformation. (The Advanced Land Observing Satellite "Daichi" stopped operating in May 2011.)
4 The location of each reference point on the seafloor is measured first by determining the precise location of a survey ship at sea through the use of GPS technology and then by using sound waves to measure the distance between the ship and each reference point.

investigated the history of eruptions of Mt. Fuji, Hachijo-jima and Esan.

(vii) R&D for the prevention and mitigation of damage from natural disasters as well as for the observation of waves and tidal levels (Ministry of Land, Infrastructure, Transport and Tourism: MLIT)

MLIT has been developing and operating the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS) in mutual cooperation with the Port and Airport Research Institute and other research institutions. Data on waves and tidal levels observed across Japan are collected through this network and details are published on MLIT's website in real time. In FY2014, MLIT increased the use of GPS wave gauges, which were also used for observing tsunamis in the event of earthquakes.

The National Institute for Land and Infrastructure Management (NILIM) of MLIT studies designs and plans measures for technical standards to prevent and mitigate natural disasters in collaboration with the MLIT departments concerned according to one of its targets, "disaster prevention and mitigation and risk management." For example, this includes "measures for extremely severe disasters" such as those for landslides and urban flooding due to sudden heavy rain and urban anti-inundation measures using flexible pump operations through ICT, road cleaning[1] and restoration of infrastructure immediately after disasters occur, using airborne portable SAR, existing camera sensors and other technologies, "faster initial response to large earthquakes" including R&D to support TEC-FORCE activities, "building a tsunami and fire-resistant towns" including developing buildings that can be continuously used from immediately after an earthquake, designing tsunami-resistant disaster centers and studying "preparations for high tides and tsunamis" to improve tsunamis and high tide observation technology.

(viii) Research on prevention, mitigation and early restoration in relation to natural disasters that have become increasingly severe and diverse (Public Works Research Institute: PWRI)

PWRI conducts R&D that contributes to the prevention and mitigation of damage caused by natural disasters (e.g., earthquakes, tsunamis, eruptions, windstorms, floods, landslides and snow and ice) and to early restoration after these disasters. In FY2013, for example, the PWRI engaged in research on technology for protecting river levees by combining measures to improve water resistance and measures for enhancing aseismic capacity.

1 Ensuring the passage of emergency vehicles by promptly removing the minimum required amount of debris and flattening the minimum required steps to open at least a single lane

ix) The collection and analysis of disaster information: The development of disaster drill systems (Fire and Disaster Management Agency)

Based on an understanding of problems with information gathering that were identified after the GEJE, the Fire and Disaster Management Agency (FDMA) experimentally developed a wide-area earthquake damage estimation system for test operation. This system helps officials responsible for emergency response to make appropriate decisions about the dispatch of emergency fire response teams and the like. To make use of experience gained in emergency response after the GEJE and large-scale flood disasters, the FDMA also developed an emergency response support system and a drill system for multiple simultaneous fires. These systems are useful for response team deployment in severe-disaster drills and for giving evacuation instructions to citizens.

On-screen display of simulated fire spreading
Source: the National Research Institute of Fires and Disasters

x) R&D of fire-fighting robots for large-scale fire disasters at petrochemical complexes, etc. (Fire and Disaster Management Agency)

Having experienced difficulties in extinguishing a fire and explosions at an LP gas holder yard during the GEJE, the Fire and Disaster Management Agency (FDMA) started R&D into a fire-fighting robotic system capable of autonomous actions through simple instructions from the fire-fighting force, which remains in a safe place. This robotic system comprises multiple robots operating in the air and on the ground by dispersing, cooperating, coordinating and sharing mutual information for fire-fighting and acquiring information required by the fire-fighting force. In FY 2014, the system configuration and design were completed.

2) The promotion of R&D on measures against fires, severe accidents and crime

The National Research Institute of Police Science specializes in research that helps to enhance criminal investigations, crime prevention and investigations of the causes of accidents. The following research subjects were dealt with in FY 2013: improvements to methods for scientific examinations in cannabis-related criminal investigations; the development of a system for visualizing age-related changes in facial appearance; Individual identification of biological data through haplotype analysis[1] to support criminal investigations; behavioral science regarding techniques for interviewing suspects and crime victims; the practical application of simulation techniques used for fire appraisal that is implemented to identify the causes of fire accidents as well as to establish the finding of arson; and the development of techniques for appraising crashes by vehicles against roadside structures to identify the causes of such crashes.

1 Analysis of a collection of specific alleles, or particular DNA sequences

In collaboration with ministries and agencies concerned, MEXT has been implementing the R&D Program for Implementation of Anti-Crime and Anti-Terrorism Technologies for a Safe and Secure Society, for the purpose of advancing R&D on S&T that helps to establish anti-crime and anti-terrorism measures and for the purpose of translating R&D results into applications based on the needs of public agencies as users of the developed S&T. This program was supported by Special Coordination Funds for Promoting Science and Technology between FY 2010 and FY 2012 and it has been a part of integrated implementation of social system reforms and R&D since FY 2013.

3) The promotion of R&D toward human health protection and ecosystem conservation

PWRI has been engaging in the research on risk assessment and management of and measures against, water pollutants, with the aim of protecting human health and conserving ecosystems.

For the purpose of preserving the maritime environment, the National Maritime Research Institute has been conducting research on key technologies that are useful for formulating environmental regulations which are socially rational and help to significantly reduce the environmental impacts of emissions, through efforts for attaining zero emissions.

4) Promoting R&D to enhance safety and increase comfort and convenience

(i) R&D on the advancement and safety evaluations of transportation systems

Because the safety and reliability of transportation systems, on which citizens depend every day, needs to be enhanced urgently for restoring the public confidence in these systems, priority should be given to the promotion of the use of new technologies that help to ensure traffic safety and accident prevention while increased demand for air traffic, human factors associated with the operators of transport facilities and the "discovery," "judgment" and "manipulation" of vehicle operators are taken into consideration.

The National Police Agency (NPA), Ministry of Internal Affairs and Communications (MIC) and MLIT have been promoting efforts for the practical application of Driving Safety Support Systems (DSSS) which utilize coordinated infrastructure and inter-vehicle communications.

To put the DSSS into practical use, MIC made it possible to introduce vehicle-to-vehicle and vehicle-to-infrastructure communications in the 700-MHz band across the nation in April 2013. MIC also completed R&D for the advancement of 79-GHz high-resolution radars in FY 2013. Amendments to rules and regulations necessary for securing pedestrian safety were made in December 2012.

MLIT installed about 1,600 ITS spots[1], mainly along expressways and started ITS spot service nationwide in 2011. In FY 2014, ETC2.0 started operating and as well as existing services, various new services will be incorporated using route information and driving history.

MLIT has also been enhancing R&D that helps to improve the safety of railway traffic, including by developing platform screen gates that are available to various train door positions relative to the platform and help reduce construction cost.

The National Maritime Research Institute has been implementing research that helps to realize a safe and secure society. Specifically, for the purpose of ensuring the safety of marine transportation, this institution is formulating safety regulations that are socially feasible and that help to substantially reduce

1 Intelligent Transport Systems

accidents at sea. Research is also being conducted on promoting modal shifts, increasing the efficiency of maritime transportation for better logistics and developing transportation systems.

For the purpose of ensuring safety and timely operation of air traffic, the Electronic Navigation Research Institute is focusing on the following R&D: the expansion of air traffic capacity and improvement of operation efficiency; the expansion of air traffic capacity at congested airports; and the development of technologies that connect air and ground for safe, efficient navigation.

In FY 2014, the National Research Institute of Police Science of NPA studied the safety of a smartphone car navigation system.

(ii) The promotion of R&D for the improvement of housing and social infrastructure that are aging, as well as for longer service life

PWRI is developing technologies for the efficient maintenance of aging social infrastructure and for the service life extension of social infrastructure while enhancing its function based on advances in materials technology.

MIC has conducted R&D into communication technologies for highly reliable and ultra-low power consuming, gathering and transmitting data on distortion and vibrations, etc. from sensors to achieve ICT-based effective and efficient maintenance of social infrastructure.

MLIT and Ministry of Economy, Trade and Industry (METI) have promoted the development and introduction of robots to maintain social infrastructure and implement anti-disaster measures more effectively and efficiently. In FY 2014, MLIT publicly sought robots in private companies and universities for use in five priority fields (bridges, tunnels and underwater for maintenance and surveys and emergency rehabilitation for disaster response) and evaluated 65 out of 101 technologies applied at direct MLIT controlled sites under the "Next-Generation Social Infrastructure Robot On-Site Verification Committee" comprising experts from industry, academia and government. METI launched the "System Development Project to Solve Social Problems for Infrastructure Maintenance and Renewal" to develop robots for priority fields.

The National Institute for Land and Infrastructure Management of MLIT selected "Maintenance of Infrastructure" as one of its major themes to address and has been engaged in studies, including developing technologies to maintain road structures, prompt, automated and low-cost sewerage line inspection, maintaining river structures, sea ports and airports and boosting efficiency for inspection, repair and renewal of an enormous amount of existing and aging housing and social capital stocks in cooperation with MLIT departments and agencies.

(2) R&D for securing stable supply of food, water, energy and other resources

Ministries and institutions concerned are engaging in the R&D described below for ensuring the stable, uninterrupted supply of food, water, energy and other resources that are indispensable for the lives of the nation, as well as engaging in the R&D described below for enhancing the safety of these supplies.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) is conducting research to develop super-high-yielding crop varieties, crops suitable for harsh environments, high-biomass crops, breeds of pigs with high feed utilization efficiency and highly reproductive breeds of cow. To help achieve Japan's food self-sufficiency target, the MAFF also works on developing food and feed crops that have novel

features in terms of quality and processing and on techniques for producing high-quality meat and other livestock products by using domestic feed.

Other R&D subjects that the MAFF has been dealing with include the following: enhancement of accuracy and efficiency in communicable disease control with the aim of lowering the risk of spreading of avian flu, foot-and-mouth disease and other livestock diseases and with the aim of reducing farmers' economic losses; technologies for reducing the risk posed by hazardous microbes and chemicals during the production, distribution and processing of farm products; techniques for finding scientific evidence of disease-prevention benefits in functional ingredients in farm/forestry/marine products and other food items and, thus, to support healthy longevity; the development of crop varieties containing functional ingredients in larger quantities and techniques for culturing these varieties; and systems for supplying functional food items and farm/forestry/marine products to individuals according to their health conditions.

With the aim of ensuring a stable supply of marine resources, MEXT has been promoting R&D for enhancing technologies for exploring ocean minerals and securing marine biological resources (see Section 1 4 (2), Chapter 3). Toward the realization of a low-carbon society, MEXT is also promoting R&D on innovative technologies for distributed energy systems and renewable energy that substantially help to create "green innovation" (see, Section 2, 1 (1) and (2), Chapter 2).

The National Maritime Research Institute is conducting research on the development and advancement of techniques for the safety evaluation of marine structures as well as for reducing their impacts on the marine environment, as these techniques underlie key technologies used for the development of marine resources and energy.

METI is promoting the establishment of recycling systems for used products, aiming at developing a sustainable recycling-based society that is environmentally sound and unaffected by resource constraints. Specifically, for enhancing the recycling of tungsten contained in cemented carbide tools that are indispensable for car manufacturing, grants were provided for the development and system demonstration of technologies for increasing the efficiency and reducing the cost of tungsten-derived alloy material production; and expansion of the recovery of used tools. To enhance the recycling of the lithium-ion batteries that are used in next-generation bicycles, grants were also provided for the development and demonstration of technologies for reducing the cost of cobalt extraction and recovery and the development of systems for collecting spent lithium-ion batteries.

(3) Increase of the affluence of lives of the people

To use science and technologies to improve quality of life, increasing affluence and helping to enrich people's minds and cultivate their sensibilities, efforts described below have been advanced by various ministries and institutions.

1) Efforts to improve quality of life and for increasing affluence

With the aim of promoting the use of information and communications technologies (ICT) at schools, MIC collaborated with MEXT in implementing the Future School Promotion Project, an empirical study for establishing low-cost educational ICT systems to provide continuous cloud-based learning, regardless of schools and houses, via various terminals. The project is currently conducted at 12 schools in three areas,

Shinchimachi in Fukushima prefecture, Arakawa Ward in Tokyo and Saga prefecture. Regarding R&D that benefits welfare, grants have been provided to R&D projects to defray the costs of R&D on technologies necessary for delivering more convenient communications and broadcasting services to elderly and/or disabled citizens. In medical care and nursing care, research has been conducted for verifying the usefulness and effectiveness Ubiquitous Net Technology[1] and demonstration tests have been implemented regarding a medical information linkage platform that is being used for facilitating the safe sharing of medical information by each local community. In the field of public administration, MIC has been promoting efforts to improve public services by utilizing ICT across Japan. MIC is also studying and verifying data items, data links and linkage methods for facilitating data linkages among public service authorities through cloud computing services.

2) Efforts toward helping people to enrich their minds and cultivate their sensibility

MIC has been promoting efforts to facilitate the handling of secondary-use rights, with the aims of developing an environment that supports the creation and distribution of broadcast content and of promoting the export of Japan's broadcast content.

■ Table2-3-2 / Major Projects for Realizing Safe and High-Quality Lives (FY2014)

Ministry /Agency	Implementation	Project
MIC	MIC	Establishment of an ICT platform for smart infrastructure maintenance
MEXT	MEXT	Seismic and tsunami investigations in the Sea of Japan
MAFF	MAFF	Improved food safety and animal health
		Promotion of research on S&T for agriculture, forestry, fisheries and the food industry
		The development of next-generation land-based farming technology
METI	METI	Development and Verification for Next Generation System of Surrounding Environment Recognition Technology
MLIT	MLIT	Study on development of plans and designs for harbor improvements
		Comprehensive R&D on construction technology (technical management) (flood control expenses)
		Comprehensive R&D on construction technology (technical management) (road improvement expenses)
		R&D on flood control projects
		Research on road technologies (ITS, etc.)
	GSI	Costs for improving basic map information
	JMA	Advancement of Earthquake Early Warning and tsunami observation information
	NILIM	Investigation into strategic priority evaluation methods for antiseismic sewerage structures
		Studies on new harbor planning methods to improve efficiency in international bulk cargo transport

1 Ubiquitous Net Technology is being used for automatically identifying and recording the medical practice of health-care professionals and patients' conditions by utilizing electronic tags and sensors attached to patients, medicinal products and medical devices.

2 Strengthening of Japan's Industrial Competitiveness

(1) Reinforcement of shared infrastructure, toward increasing Japan's industrial competitiveness

Japanese manufacturing is more globally competitive than other domestic industries, has major ripple effects on other industries and drives economic growth. Thus, the government of Japan has been taking measures to actively enhance manufacturing technologies. However, in the wake of the GEJE, R&D and production activities in the private sector have stagnated, thereby significantly affecting the supply chains of products, parts and materials. The recent rapid appreciation of the yen coupled with constraints on the procurement of raw materials, including rare-earth elements, has encouraged businesses to move their production bases abroad and the business environment in Japan has deteriorated. Consequently, people are increasingly worried about the hollowing of domestic industry and reductions in investment in R&D. In response, the government has been taking measures to enhance the competitive edge of Japanese industries, to achieve sustainable economic growth and to rebuild robust systems and infrastructure that can support manufacturing.

With the aim of creating new industries that utilize radio waves, MIC is conducting R&D on technologies that enhance the use efficiency of radio waves and that enable the use of higher frequencies, to meet the demand for newly available radio frequencies.

MEXT has been collaborating with industries and universities in promoting the development of the most advanced, unique technologies and instruments for measurement and analysis that serve the needs of world-leading researchers and manufacturers (see Section 1-5 (1), Chapter 3,).

Toward enhancing Japan's industrial competitiveness, METI has been promoting R&D on the topics stated below, to support the creation and growth of new industries by developing shared infrastructure for manufacturing.

1) Development of key technologies for manufacturing processes

The demand for light, high-strength carbon fiber, which is useful as a structural material for aircrafts and automobiles, is expected to expand significantly. In light of this, METI collaborated with universities and carbon fiber manufacturers to develop key technologies that are used in unconventional manufacturing processes. Through these processes, the production efficiency has significantly increased and CO2 emissions and other environmental impacts have been reduced.

Research was also conducted for translating these key technologies into basic manufacturing technologies.

2) Development of semiconductor technologies

METI has conducted R&D into 10 nm-level semiconductor micro-fabrication and manufacturing technologies to improve servers, computers and next-generation automobiles with low energy consumption and R&D of technologies for integrating next-generation semiconductor devices (see Section 2-1 (2), Chapter 2).

3) Support for reductions in use or nonuse of rare-earth metals

METI has conducted R&D into alternative materials and reductions in the use of rare-earth metals,

which are vital to manufacture high-performance motors for hybrid and electric vehicles and other value-added products but exposed to supply risk due to the increasing nationalism of producing countries.

In FY 2014, METI supported private companies using alternative and reduction technologies for rare-earth metals such as bismuth and lantern and promoted the development of magnetic materials which do not use rare-earth metals such as dysprosium, which are located highly eccentrically in cooperation with MEXT (see Section 2-1 (3), Chapter 2).

4) Promotion of R&D at small- to medium-sized enterprises

METI included the Project for Strategic Promotion of Advanced Basic Technologies in the budget for FY 2014 to support R&D by SMEs in collaboration with universities and public R&D institutes pursuant to the "Act on the Enhancement of Small and Medium-sized Enterprises' Core Manufacturing Technologies" (Act No. 33, 2006) ("The SME Technological Advancement Law").

In the 2014 Edition of the "Japan Revitalization Strategy", issued in June 2014, METI indicated "to review the support system such as adding design aspects to the technologies subject to the SME's Manufacturing Enhancement Act to promote industry-academia-government collaboration in product development based on the market-in concept," and appended "design development technology" to the Specific Core Manufacturing Technologies to reinforce the support for technologies improving the value of products (METI notification Nos. 13 and 14, 2015).

5) Development of innovative semiconductor manufacturing technology

METI has been conducting R&D on basic technologies for minimal fabrication, an innovative manufacturing process that eliminates the clean room; to save considerable energy in semiconductor production, reduce capital investment by using a set of smaller machines and allowing the production of a small quantity of semiconductors.

6) Promotion of regional open innovation

In line with the strategic field specified by regional industrial competitiveness councils, METI has introduced public R&D institutes to manufacturing facilities to assist in formulating a wide area support platform as an R&D center for SMEs.

7) Research support system for transferring technologies to SMEs

No matter how excellent the technologies owned by SMEs and venture companies, they remain insufficient for operational purposes. Accordingly, it is important for research institutions with outstanding basic technologies to transfer them to SMEs and venture companies to promote their commercialization. NEDO supports joint research projects by SMEs and venture companies using the bridging capability of institutions to commercialize innovative technological seeds.

8) Enhanced support for SMEs and venture companies specializing in R&D

Although many technological seeds are available in Japan, few are created or developed by SMEs and venture companies specializing in R&D.

To solve this problem, METI implemented a number of policies to invite foreign venture capital and

foster domestic venture capital to build a venture ecosystem in Japan, by combining policies to support R&D-oriented venture companies.

(2) The creation of industrial infrastructure by leveraging Japan's strengths

Against the backdrop of intensifying international competition in the markets for end-products such as machinery, automobiles and electrical/electronic equipment, the government has been promoting R&D on integrated systems consisting of smart grids, next-generation transportation systems and network infrastructure, as well as R&D on integrated services for the maintenance and operation of these systems. R&D for effective use of science and technology has been promoted to improve service industry productivity. Furthermore, with the aim of creating new industries and of improving the efficiency of the nation's socioeconomic system, the government has been promoting R&D on technologies for next-generation information and communications networks and R&D on ICT for highly reliable cloud computing. The use and application of these technologies are encouraged in a broad range of areas.

MIC has been promoting R&D on key technologies for realizing flexible network control and for increasing the network capacity in response to the diversification of network services and the expansion of wide-area cloud computing services. This includes R&D of communication platform technology for highly accurate and reliable remote control of various components in buildings and international standardization to achieve optimum regional energy management for smart grids. MIC has also promoted R&D and demonstration tests of new-generation network technologies and new applications using Japan Gigabit Network-eXtreme (JGN-X[1]), a new-generation network testbed developed and operated by the National Institute of Information and Communications Technology (NICT), to develop ICT human resources, revitalize the industry, improve the international competitiveness of Japan and accelerate international collaboration.

METI has been promoting R&D on technologies for increasing the efficiency of the nation's socioeconomic system. This includes developing and demonstrating technologies to create smart communities (see Section 2-1 (1), Chapter 2).

METI has also implemented development projects to create new added value and industries utilizing IT and data such as a diagnostic support system based on medical information and an effective crop cultivation system using environmental and ecological information.

■ Table 2-3-3 / Major Projects for Strengthening Japan's Industrial Competitiveness (FY 2014)

Ministry/ agency	Implementation	Project
Reconstruct-ion Agency	Reconstruction Agency	The development and promotion of a hub for safety evaluation of critical IT infrastructure to support restoration of the disaster-stricken Tohoku region
MIC	MIC	Costs required for R&D on technology using radio waves for radio use financial source
		technology test work for frequency shortage countermeasures

1 JGN-eXtreme

		R&D on technologies for using real-time information as part of the G-spatial platform development project
		ICT innovation (the "I-Challenge!" program)
		The demonstration of ICT for a next-generation ITS
MAFF	MAFF	Innovative technology creation promotion
		R&D for expanding demand frontier
		R&D for constructing value chains connected by technology
METI	METI	3D printer technology based manufacturing innovation program (part directly assigned to METI)
		High function JIS development project, etc.
		R&D project focused on basic fine bubble technology
		Research project to develop technology of clean diesel
		Innovation Network Corporation of Japan (INCJ)
		Project for developing a safety evaluation and dissemination center for important infrastructure technology for the recovery of Tohoku district
	NEDO	Programs for supporting Business Promotion for R&D oriented venture companies
		Monozukuri innovation program based on 3D modeling technology (part assigned to NEDO)
		The development of systems for responding to social issues, such as the maintenance and renewal of infrastructure (part assigned to NEDO)
		Laser Material Processing Technology Development Project *for* Next-generation Materials, etc.

3 Contributions to Solutions to Global Issues

(1) Promoting solution to global issues

As a country with relatively high S&T level, Japan has been focusing on R&D on technologies and measures for addressing various global issues, in cooperation with universities, public research institutions, industries, international organizations and other countries.

Toward adaptation to global climate change, Japan has been observing and predicting climate change globally and conducting impact assessment. R&D on measures against large-scale natural disasters has also been promoted. Additionally, Japan has been enhancing R&D on the following topics: the exploration of new resources, including energy sources and the cyclical use of such; the creation of alternative resources; the identification of pathogeneses of emerging and reemerging infectious diseases; and the prevention, diagnosis and treatment of these diseases.

1) R&D on climate change

(i) The promotion of Earth observation

To understand current global warming trends, many countries and organizations worldwide have been observing the Earth by satellite, ground-based and maritime observation systems. To enhance the effectiveness of global efforts for tackling climate change problems, Earth observation data should be integrated and analyzed through international collaborations, to accumulate useful scientific knowledge as a basis for policymaking in each country. It is also critical to develop the Global Earth Observation System

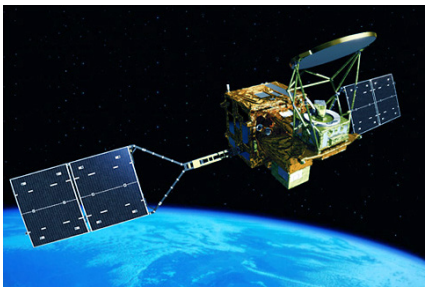
of Systems (GEOSS), which consists of multiple systems that facilitate access by many countries and institutions to observation and other scientific data. The intergovernmental Group on Earth Observations (GEO) was established as an international framework to promote the development of GEOSS. It has 184 countries and institutions as members as of February 2015. Japan has been playing a leading role on the GEO Executive Committee.

a) Satellite-based observation

Satellite-based Earth observation is effective in that it allows continuous collection of extensive information in a repeatable manner. Toward solving global environmental problems, Japan has been comprehensively promoting satellite-based observation in cooperation with domestic and overseas organizations.

Greenhouse gases observing satellite (GOSAT) "IBUKI" was launched in January 2009 to help promote measures against global warming. This satellite has been used for collecting observation data on global GHG concentration distributions and changes. The data are necessary to improve the estimation accuracy of GHG absorption and emission. GOSAT has been successfully clarifying the global concentration distributions of carbon dioxide and methane, as well as seasonal changes in these distributions. Based on GOSAT data, absorptions and emissions of CO2 and methane are estimated by month and by subcontinent and three-dimensional CO2 distribution data are estimated. These estimation results are made available to the public. In FY 2014, tendencies toward higher CO_2 concentrations in major global cities than surrounding circumstances would otherwise cause were revealed by analyzing observation data. In FY 2012, the development of a successor to GOSAT started, with the aim of further improving the observation accuracy. It is scheduled for launch in FY 2017. Multi-point observation data collected by the successor satellite will contribute to the science of climate change, global environmental monitoring and the formulation of measures against climate change. This satellite will be also used to collect data on CO_2 emissions by large cities or large-scale emission sources. MOE has promoted the observation of global carbon circulation in collaboration with related ministries and agencies to help clarify climate change and its effect. The ministry has also developed global CO_2 and methane observation technologies using GOSAT and continuously monitored greenhouse gases using airplanes and ships and in forests. The National Institute for Environmental Studies has constantly processed GOSAT data and distributed the result.

In May 2012, "SHIZUKU" (GCOM-W[1]) was launched for the purpose of elucidating the global mechanisms of climate change and water cycle. This satellite has been collecting data on changes in the global water cycle. The data have been provided to the numerical prediction systems of the JMA and are used to improve the accuracy of precipitation estimates. The data are used not only for research on climate change but also for various other purposes, including weather forecasting and fishing ground detection.



The "SHIZUKU" water cycle observation satellite (GCOM-W)
Source: JAXA

The JMA verified that the use of GCOM-W data has helped

1 Global Change Observation Mission-Water

to increase the accuracy of precipitation estimates in numerical weather prediction as well as the accuracy of analyses for sea surface temperature and sea ice. Since FY2013, the JMA has used the data from GCOM-W for a numerical weather prediction system that the JMA operates routinely and for analyzing sea surface temperatures and sea ice.

The Japan Aerospace Exploration Agency (JAXA) has performed observations with the Advanced Land Observing Satellite "DAICHI" (ALOS[1]) for research on the reduction of greenhouse gas emissions, which are increasing due to deforestation and forest degradation in developing countries (i.e., REDD+[2]). (The operation of this satellite ended in May 2011.) The 2nd advanced land observing satellite (ALOS-2) "DAICHI2" was launched in May 2014 and used for emergency observation of the landslide disaster in Hiroshima in August and eruption of Mount Ontake in September following a request from the Cabinet Office, MLIT and Coordinating Committee for Prediction of Volcanic Eruptions (in JMA), each responsible for relevant disaster prevention and response and providing image data to related agencies. ALOS-2 is a dramatically enhanced successor to the advanced land observing satellite (ALOS) "DAICHI" which ended its operation in May 2011. The satellite is expected to help prevent and manage disasters and solve global issues such as global warming in future through wide and detailed coverage of disaster-stricken areas and observation of forests. Processing and distributing data from Japan's improved version of high-performance microwave radiometer (AMSR-E[3]) installed in the U.S. global observational satellite (Aqua) and which terminated its operation in October 2011 were also provided. Satellite-based Earth observation has been continued to further contribute to increasing the accuracy of climate change prediction and fluctuating mechanism of clarifying water cycles through an international cooperation project, with the operation of a core satellite launched in February 2014 for Global Precipitation Measurement (GPM) operated by the National Aeronautics and Space Administration (NASA) in the U.S. and the R&D of Global Change Observation Mission-Climate (GCOM-C) satellite scheduled for launch in FY 2016.

b) Observation by electromagnetic wave sensing

MIC is conducting R&D on a cooperatively controlled radar system that consists of multiple transceiver, receiver and transmitter stations. This radar system enables high-accuracy 3D observations without the use of additional frequency bands. MIC and the NICT have been promoting R&D on an airborne polarimetric and interferometric synthetic aperture radar system (Pi-SAR2) that can detect ground surface situations in disaster-stricken areas as needed, regardless of weather conditions. In collaboration with JAXA, MIC developed the Superconducting, Submillimeter-Wave, Limb-Emission Sounder (SMILES[4]) and it was attached to a port of the Exposed Facility of KIBO (JEM) on the International Space Station. MIC has been analyzing the scientific data on atmospheric composition collected by SMILES, so as to continuously disclose the analysis results to the public[5]. MIC has implemented R&D regarding the

1 Advanced Land Observing Satellite
2 Reducing Emissions from Deforestation and Forest Degradation - Plus
3 Advanced Microwave Scanning Radiometer for EOS (Earth Observing System)
4 The Superconducting, Submillimeter-Wave, Limb-Emission Sounder: It observes ozone and other minor constituents by means of the most sensitive low-noise submillimeter receiver, which uses a superconducting sensor. The antenna is directed toward the edge of the atmosphere for receiving submillimeter waves emitted by trace gases. Submillimeter waves are radio waves with frequencies from 300 to 3,000 GHz. SMILES uses submillimeter waves with frequencies from 624 to 650 GHz.
5 http://smiles.nict.go.jp/pub/data/index-j.html

electromagnetic environment and the use of radio waves in geospace and has collected, managed, analyzed and distributed space/Earth observation data in an integrated manner. Additionally, the development of space environment informatics technology[1] has been promoted, with the aim of enhancing technologies for observation, sensing and numerical calculation and for the processing of large amounts of data.

c) Ground and oceanographic observations

Continuous oceanographic observation is necessary, because oceans are closely involved in environmental changes, such as global warming. The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has been promoting oceanographic observation throughout the world by utilizing buoys developed by JAMSTEC for observation. The observation results are used to research environmental forecasts and simulations. In FY 2013, JAMSTEC became the first global organization to obtain long-term observation data from profiling floats in the deep waters of the Antarctic Ocean. Until then, the deep-sea environment under the sea ice in winter had not been well known, due to the lack of sufficient observation data. JAMSTEC's success helped significantly advance research into the long-term changes of deep waters in the Arctic Sea, as well as on their warming mechanism, which significantly affects the global environment. MEXT and JMA are working on the maintenance of an advanced marine monitoring system (the Argo program) that continuously observes oceans around the world through international cooperation. The Argo program aims at real-time monitoring and evaluation of oceans worldwide. In the Argo program, a system for continuously observing oceans is being developed by deploying Argo floats globally. Currently, about 3,600 Argo floats have been deployed.

The JMA has been conducting observation and analysis of GHGs in the atmosphere and oceans, aerosols, ground-based emissions, the ozone layer and ultraviolet radiation. By collecting and analyzing various observation data from ships, Argo floats and satellites, the JMA provides information related to the global environment (see Section 2 1(3), Chapter 2).

(ii) Promotion of research that contributes to adaptation to climate change

The Meteorological Research Institute of the JMA has developed an Earth system model for global warming prediction that can simulate the effects of aerosols on clouds, changes in the ozone layer and the carbon cycle. Using this model, this institute is making near-future (i.e., about 10-year lead time) climate change predictions and long-term predictions based on IPCC emissions scenarios. The institute has also developed a sophisticated cloud-resolving regional climate model that has sufficient resolution to simulate Japan's unique local climatic phenomena. The aim is spatially detailed regional climate warming prediction.

MOE has been using the Environment Research and Technology Development Fund[2] and other funds for comprehensively advancing research on elucidation of phenomena, future predictions, impact assessment and countermeasures, for the purpose of assembling a picture of global warming and implementing adequate administrative measures based on scientific knowledge. The Environment

1 Space environment informatics technology: Technology for extracting information by processing large amounts of diverse data obtained through simulations and observation of the space environment.

2 In the light of the grave, significant effects that environmental problems can have on human survival, this policy-oriented, competitive fund was established for comprehensively promoting the investigation, research and development of technologies by uniting the capabilities of researchers in diverse fields from interdisciplinary and global perspectives. This fund aims at contributing to environmental conservation necessary for the realization of a sustainable society.

Research and Technology Development Fund was used for the following research:

- "Comprehensive research of global climate change risk management strategy" (FY 2010 - FY 2014) targeting a safer and more secure climate change adaptive society by predicting the influence of global warming on Japan and Asian nations in detail and taking measures to prevent or mitigate bad influence.
- "Comprehensive research for constructing global climate change risk management strategies" (FY 2012 - FY 2016) aiming to understand the risks of global warming which may occur in the world and Japan and uncertainties and providing a concept and options of scientifically and socially rational climate change risk management strategies among every layer of citizens and the international community.

In FY 2012, the MOE, MEXT and the JMA worked together for preparing and publishing the Integrated Report on the Observation, Prediction and Impact Evaluation of Climate Change, by collecting Japan's latest scientific knowledge about the impacts of global warming. This report aimed at supporting steady progress of measures for adapting to climate change in Japan. In July 2013, the Expert Committee on Climate Change Impact Assessment was established in the Global Environmental Subcommittee of the Central Environmental Council toward the development of an adaptation plan as a government-wide, integrated effort. This expert committee has been using existing studies for summarizing climate change projections and impact assessment and has been deliberating on the assessment of impacts on and risks for Japan. The deliberation results were consolidated into supplementary recommendations in March 2015. Based on the supplementary recommendations and other sources, an adaptation plan will be formulated around the summer of 2015.

To establish recycling-based food production systems in response to climate change, MAFF has promoted the following: the development of technologies for reducing GHG emissions and increasing GHG absorptions; production techniques that help realize low-input recycling-based agriculture; systems to support measures against deforestation and degradation in tropical forests in Asia; and technologies for creating new breeds and for the stable production of farm/forestry/marine products adapted to the progression of global warming.

NILIM of MLIT included disaster prevention and mitigation in its "disaster prevention, mitigation and risk management" issues to cope with a new stage of climatic changes, such as concentrated and regional heavy rainfall on the rise in recent days and is conducting research into anti-disaster measures for landslide and urban flooding caused by regional heavy rain, control of maximum possible river flooding and anti-inundation measures for cities through flexible ICT pump operation.

2) R&D on the stable supply of energy and resources

Toward the stable supply of energy and resources, the Japanese government has been promoting R&D that is useful for the exploration and cyclical use of new resources, including energy resources and for the creation of alternative resources (see Section 2 1 (1) and (3), Chapter 2 and Section 1 1(2), Chapter 3).

3) Research on emerging and reemerging infectious diseases

MEXT and the Ministry of Health, Labour and Welfare (MHLW) have been promoting research on the identification of the pathogenesis of emerging/reemerging infectious diseases and the prevention, diagnosis and treatment of these diseases (see Section 3 1-(1), Chapter 2).

■ **Table 2-3-4 / Key Projects to Help Solve Global Issues (FY2014)**

Ministry /Agency	Implementation	Project
MOE	MOE	Marine environment research for assessing CCS under the seabed
MLIT	NILIM	Development and introduction of observation, analysis and prediction technologies for flooding

4 Foundations of the State

To maintain Japan's leading global position and ensure the safe livelihood of its citizens, the government should engage in continuous, broad and long-term R&D concerning the foundations for the nation's existence and accumulate the results. Such R&D has been vigorously promoted as a means of determining the future of the nation. The National Security Strategy, approved by the Cabinet in December 2013, recognized "high technological strength of Japan as a valuable asset to underpin economical and defense capabilities and an image of Japan strongly sought by the international community. Accordingly, technological development, including dual-use technologies, shall be further promoted to improve the technological strength of Japan."

(1) Enhancement of national security and critical technologies

The government has been advancing R&D on technologies that help to enhance national security and the safe livelihood of the people. These included technologies for information collection, telecommunications, space transportation, satellite development and utilization, early detection of earthquakes and tsunamis and world's most advanced high-performance computing.

In relation to nuclear power, R&D has been implemented regarding nuclear decontamination and reactor decommissioning, toward promoting recovery from the nuclear disaster caused by TEPCO's Fukushima Daiichi Nuclear Power Station. The government is also promoting R&D on technologies for highly reliable information security systems.

1) The development and utilization of space technologies for space transportation and satellites

Space transportation technologies are essential for the utilization of space, because these are integral part of technologies for satellite launches. Technologies for sending satellites to their designated altitudes whenever needed are vital for autonomy of Japan's space activities. The active use of satellites for telecommunications, broadcasting and weather forecasting is expected to play a significant role in bringing more affluent living to citizens. A new Basic Plan on Space Policy was determined (approved by the Strategic Headquarters for Space Policy on January 9, 2015) as a 10-year, long-term and specific development plan with two decades vista, according to changes in the circumstances surrounding space policies, to sufficiently reflect new national security policies indicated in the National Security Strategy and increase the "predictability" of investment in industry to maintain or improve the industrial foundation. This plan sets out three goals for space policies; ensuring space security, promoting space utilization in the private sector and maintaining/strengthening the space industry and S&T infrastructure.

Column 2-2 New Basic Plan on Space Policy

A new Basic Plan on Space Policy was determined in January 2015 at the Strategic Headquarters for Space Policy (Director: Prime Minister Shinzo Abe). Since the Basic Act on Space had been enacted in May 2008, the Basic Plan on Space Policy was implemented twice in June 2009 and January 2013, respectively, to promote comprehensive and deliberate policies for space development and utilization. This is the third plan, which has been determined

The new Basic Plan on Space Policy is determined as a 10-year, long-term development plan with the continuation of two decades in mind to increase "predictability" of investment in the industry and strengthen the industrial infrastructure according to rapid changes in the circumstances relating to space policies in Japan, such as increases in the importance of space in national security and the need to reinforce space industry infrastructure. The plan sets out three new goals of space policies, "securing space security," "promoting space utilization in the private sector" and "maintaining/strengthening space industry and S&T infrastructure."

To ensure space security, the plan sets out requirements to improve the stable use of space, enhance the security capability, using space in which a space system for positioning, communication and information gathering is established and strengthening the Japan-U.S. alliance through space collaboration. To promote space utilization in the private sector, the plan focused on solving global issues such as strengthening land using space, achieving a safe, secure and affluent society and creating related new industries. To strengthen the industry and S&T, the plan emphasized collaboration between public and private sectors to develop domestic and foreign markets in the space industry and the collaboration of related agencies, including JAXA, to maintain and strengthen the industry and S&T infrastructure.

For example, the plan seeks to install a space system to solve energy, climate change, environment and other global issues as well as preventing and managing disasters through the seamless placement of optical and radar satellites such as advanced optical satellites that can be used for wide and detailed damage situation caused by natural disasters. Besides liquid fuel rockets HII-A/B and the Epsilon solid fuel rocket, flagship rockets for the space transport system in Japan, the Basic Plan also calls for the development of a "new flagship rocket" to replace HII-A/B and enhance the autonomous launch capabilities of Japan and international competitiveness of the launch service and prioritized use of this flagship rocket to launch government-owned satellites.

JAXA and public and private institutions are designated to maintain and strengthen the scientific and technological infrastructure by conducting joint R&D projects and proactively tackle, not only virtually complete S&T but also advanced R&D to create innovative technology seeds from a long-term perspective. In particular, it is important to promote the space science, space exploration and manned space activity continuously based on technological strength and achievements accumulated from various projects to date to ensure world-class achievements in space and the international standing of Japan. The International Space Station (ISS) Program must also be promoted to maintain the international standing of Japan in space science to expand the areas available for human activities in future and ensure the efficient and effective execution of strategic accumulation of technologies and wider utilization of technologies in the private sector while improving cost-benefit performance.

Science and technology play major roles in achieving the three goals set by the new Basic Plan on Space Policy to advance space development and utilization by Japan in future.

Basic Plan for Space Policy (Overview)

Environmental Awareness, Goals and Basic Stance

January 9, 2015
Strategic Headquarters for Space Policy

○ Based on changes in the circumstances surrounding space policies in Japan, establish a long-term and concrete public investment plan for next 10 years foreseeing coming 20 years to reflect the new security polies in the National Security Strategy (NSS) and to maintain and strengthen the space industrial base by improving "foreseeability" of investment in the industry,

1. Environmental Awareness surrounding space policy

❶ Change in the balance of power on space policy
- Transformation from the US-Soviet bipolar structure to a multi-polarized structure
- More countries involved in space activities and corresponding growth in the commercial space market.

❷ Growing importance of outer space for national security policy
- Necessity to utilize space proactively for the security area based on the National Security Strategy
- Advent of a new era for Japan-US space cooperation

❸ Growing risks against the stable use of outer space
- Increased volume of space debris and growing threats of ASAT attacks
- Necessity to cope with such risks sustainably and ensure the stable use of outer space

❹ Growing importance of the role of outer space to solve global challenges
- Global challenges such as energy, environment, food and natural disasters have come to the fore and pose severe threats to the international community
- The need to help solve global challenges using space systems

❺ Space industrial basis at stake
- An industrial basis is essential for conducting space activities autonomously
- Lack of foreseeability of investments led to continuous business withdrawals and stagnated new entries into the space industry

❻ Lack of organic cycles among science & technology, national security and industrial vitalization
- Insufficient R&D efforts in the use of space for security purpose and optimally exploiting R&D outcomes in civil space areas for industrial vitalization

2. Japan's space policy goals

❶ Ensuring space security
(1) Ensuring the stable use of outer space
(2) Strengthening security capabilities utilizing space
(3) Strengthening Japan-US alliance through space cooperation

❷ Promoting use of space in civil area
(1) Utilization of space for tackling with global challenges and realization of safe and affluent society (national resilience)
(2) Creation of new industries related to space (utilization of geospatial information)

❸ Maintaining and strengthening the industrial, science and technology basis
(1) Maintaining and strengthening the space industrial basis
(2) Maintaining and strengthening the science and technology basis which helps realize outcomes

3. Basic stance for fostering space policy

With shifts in the policy environment and the following three guidelines in mind, a greater emphasis is placed on "ensuring space security" among three space policy goals

❶ Prioritize the realization of outcomes from the use of space (exit strategy)
- Substantiate and clarify the needs for space use for purposes such as security and industrial promotion.
- Sufficiently considering the contribution of space and system to the specified needs.

❷ Prioritize the realization of policy outcomes that match budget allocations
- Set clear goals for outcomes for the next decade for each policy
- Fully enforcing prior consideration and post implementation assessment. Aiming to maximize policy effects through cycles of demonstration, assessment and improvement

❸ Rather than fixing rigid targets for each individual initiative, ensure targets are meaningful and aligned with environmental shifts
- Adjust policy targets flexibly in response to environmental changes and the results of examinations of progress status and introduce new policy measures accordingly.
- The Basic Plan on Space Policy comprises two parts ("Main Text" and "Implementation Schedule") with the Schedule revised annually by the Strategic Headquarters for Space Policy.

Basic Plan for Space Policy (Overview)

Policy framework, concrete approach

January 9, 2015
Strategic Headquarters for Space Policy

4. Concrete approach (1) Policy for framework to realize goals

❶ Ensuring space security
- Quasi-Zenith satellite - Japan-US cooperation for satellite positioning
- SSA - Japan-US cooperation for SSA
- Debris removal technology
- X-band satellite-based communication network
- Information-gathering satellite
- Responsive small satellite, early warning, Jana-US MDA cooperation
- Advanced optical, radar and data-relay communication satellites etc.

❷ Promoting the use of space in civil areas
- Geostationary meteorological satellites HIMAWARI
- GOSAT, environmental observation satellites
- QZSS, IGS
- Advanced optical, radar and optical data-relay satellites
- Automation, unmanned and labor-saving operations through GNSS and geospatial information
- Creation of new industries using satellite remote sensing data as big data etc.

❸ Maintaining and strengthening industrial and science & technology basis
- New-type core and Epsilon rockets
- Engineering test satellite
- The GOJ steadily takes steps according to the schedule Foster public-private efforts to achieve a cumulative market size of 5 trillion yen in 10 years
- Build organic cycles among science & technology, security and industrial promotion through R&D activities by JAXA, public and private institutions based on utilization needs on outer space.

4. Concrete approach (2) Concrete initiatives

Space projects to achieve space policy goals

Satellite Positioning
- Establish a 7-satellite QZSS constellation
  ⇒Begin project in around FY 2017 and start operation around FY 2023.

Space Transportation Systems
- New-type core rocket
  ⇒ Aim to launch the first rocket in FY 2020
- Epsilon rocket
  ⇒ Complete improvements and start the next step in FY 2015.
- Target range

Satellite Telecommunications and Broadcasting
- Next engineering test satellites
  ⇒ Target launch in around FY 2021.
- Data-relay communication satellite
  ⇒ Begin project in FY 2015 and launch it around FY 2019.
- 3rd X-band satellite-based defense communication network
  ⇒ Begin project in around FY 2015

Space Situational Awareness
- Construct SSA-related facilities and an operational framework required for space situational awareness
  ⇒ Complete project by around the early 2020s

Satellite Remote Sensing
- Consolidating and increasing information-gathering satellites
- Research studies on responsive small satellites
- Advance optical satellites
  ⇒ Begin project in around FY 2015 and start operation in around FY 2019.
- Advanced optical satellites (successor model)
  ⇒ Begin project in around FY 2022 and start operation in around FY 2026.
- Advanced radar satellites
  ⇒ Begin project in around FY 2016 and start operation in around FY 2020.
- Advanced radar satellites (successor model)
  ⇒ Begin project in around FY 2023 and start operation in around FY 2027.
- HIMAWARI 8 ⇒ Start operation in summer of 2015
- HIMAWARI 9 ⇒ Start operation in 2022
- HIMAWARI (successor model)
  ⇒ Begin project in around FY 2023 and start operation in around FY 2029
- Greenhouse gases observing satellite (GOSAT)
  ⇒ Launch GOSAT 2 in around FY 2017
  ⇒ Begin GOSAT 3 project in around FY 2017 and target launch in around FY 2022.

Maritime domain awareness (MDA)

Early warning functions, etc.

Improving the resiliency of space system

Space Science and Exploration, Manned Space Missions
- Launch 3 mid- & 3 small-sized spacecraft in the next decade in line with roadmap on space science and exploration.
- ISS: By 2020, cope with 2 HTVs and highly promising technology for future.
  As for the extension to 2024, consider cost-effectiveness etc. comprehensively, taking trends in other countries sufficiently into account.
- International manned space missions: Comprehensive examination by taking trends in other countries, diplomacy, industry and costs into account

Maintaining and Strengthening industrial and Science & Technology basis to support individual projects

Comprehensive initiatives aiming to encourage new entrants to the field and expand space utilization
- Law on space activities and law on satellite remote sensing
  ⇒ Aim to propose bills to the Diet in early 2016

Consolidation of the environment for steady supplies of essential parts and components for space systems
- Formulate a strategy on parts & components and reflect it in relevant plans.
- Demonstration experiments in orbit

Initiatives aiming to expand future space utilization
- Implementation of leading social demonstration experiments on space utilization in FY 2019 on the occasion of the 2020 Tokyo Olympics and Paralympics
- Demonstration experiments of LNG propulsion systems, R&D of reusable space transportation systems, space-based solar power systems, etc.

Strengthening of systems and frameworks for space development and utilization

Comprehensive enhancement of policy implementation frameworks

Strengthening of survey, analysis and strategy formulation functions

Enhancement of domestic human resources and promotion of public understanding

Establishment of legal institutions (Laws on space activities and remote sensing [again])

Advancement of space diplomacy and reinforcement of overseas development strategies related to the space field

Realization and strengthening of rules of law in outer space

Strengthening of international cooperation
- U.S., Europe, Australia, ASEAN, etc.

Establishment of "Taskforce on Space system overseas development" (provisional name)
- Establish a framework for joint public-private efforts to develop the international commercial space market in the first half of FY 2015.

(i) Space transportation systems

The H-IIA, H-IIB and Epsilon are Japan's flagship rockets. The successful liftoff of H-IIA rocket No. 28 in March 2015 marked 27 consecutive successful launches, with a success rate exceeding 96%. The development of a new flagship rocket was formally started in FY 2014 to expand Japan's autonomous space activities and ensure international competitiveness. The first new rocket is scheduled for launch in 2030.

Liftoff of H-IIA rocket No.26 (left) and Epsilon test rocket (right)
Source: JAXA

(ii) Satellite-based communications/broadcasting and observation/surveillance systems

MIC and MEXT have been collaboratively conducting experiments to develop and demonstrate large-scale satellite bus technology, large-scale deployable antennas and mobile satellite communications technology using Engineering Test Satellite-VIII, KIKU No. 8 (ETS-VIII[1]) and develop and demonstrate satellite-based gigabit-class Internet communications technology using ultra-fast Internet satellite Wideband Inter-Networking engineering tests and the Demonstration Satellite KIZUNA (WINDS[2]).

Regarding global positioning satellite systems, MIC, MEXT, METI and MLIT have been collaborated in demonstration experiments that utilize the Quasi-Zenith Satellite-1 "MICHIBIKI," which is available for high-precision positioning that is unaffected by mountains or tall buildings. The Cabinet Office launched the development of a practical positioning satellite system in FY2012.

Regarding satellite observation and monitoring systems, the Advanced Land Observing Satellite "DAICHI" (ALOS) was used for observing areas damaged by the GEJE and other large-scale natural disasters and for providing captured images of afflicted areas to disaster-prevention agencies. The DAICHI satellite was decommissioned in May 2011. R&D on the Advanced Land Observing Satellite-2 "DAICHI-2" (ALOS-2) was launched in May 2014 and started the normal distribution of data in November. For ensuring the stable operation of Japan's satellites, MEXT is working with the Cabinet Office and the Ministry of Defense (MOD) on research into the development of a space monitoring system that will be used for the ground-based monitoring of space debris. MEXT and the MOD will jointly study the application of sensitive infrared sensors to satellites. MEXT will also implement demonstration experiments of technologies for operating satellites at very low altitudes.

(iii) Efforts for enhancing the use of space

Although citizens are familiar with use of space in terms of satellite-based weather forecasting, telecommunications and broadcasting, space is not used sufficiently for other purposes or for people's livelihoods. In light of this, MEXT provided the commissioning expenses for promoting and coordinating

1 Engineering Test Satellite-VIII
2 Wideband Internetworking engineering test and Demonstration Satellite

space utilization in FY 2009 to establish a system for making best use of insight in the industry, academia and government. This funding allows continuous R&D for promoting space utilization in disaster prevention, agriculture, forestry and fisheries, medical, education and other areas with a view to create markets for the space utilization industry.

For the purpose of strengthening the infrastructure of Japan's space industry, METI has been promoting R&D on small ground systems and small high-performance satellites that provide performance comparable to that of large satellites but are built at lower cost in a shorter period of time. METI is also advancing the development of sensors for exploration of mineral resources using remote sensing technologies suing satellites and satellite-based technologies including data processing and analysis.

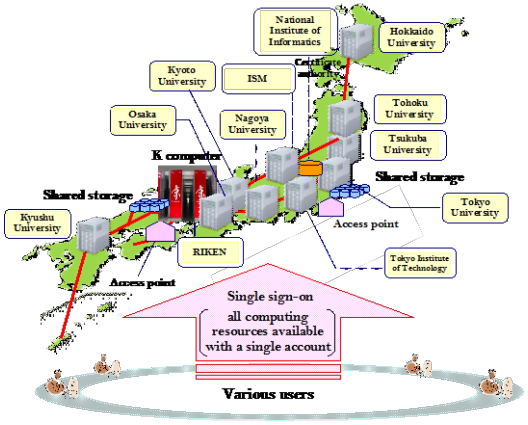
2) Technologies for sea-floor observation/monitoring directed toward the early detection of earthquakes and tsunamis

MEXT has been advancing the construction and operation of cable network systems for submarine earthquake/tsunami observation mainly in the potential hypocenters of the Nankai Trough earthquakes and the hypocenters of the Off the Pacific Coast of Tohoku Earthquake. MEXT is also working to improve technologies for the early detection of earthquakes and tsunamis by utilizing submarine observation network systems (see Section 1 (3), Chapter 2 and Section 1 (1), Chapter 3).

3) The development of Innovative, High-Performance Computing Infrastructure (HPCI)

Supercomputer simulations have become the third S&T approach, following theorization and experiments. They are indispensable for the most advanced S&T, for enhancing industrial competitiveness and for building a safe, secure nation. A supercomputer is capable of performing large amounts of calculations at great speed for various purposes and of simulating results that cannot be estimated by experiments, including damage caused by earthquakes, tsunamis and vehicle collisions.

MEXT has been advancing the plan for constructing an innovative high performance computing infrastructure (HPCI) by connecting domestic supercomputers and storages at universities and research institutions with high-speed networks around the core computer, K computer, which provides world's highest computing performance. Making maximal use of HPCI, MEXT intends to construct a system for promoting R&D and computing S&T in five strategic areas: 1) medical care and drug discovery, 2) materials and energy, 3) disaster prevention and mitigation, 4) next-generation manufacturing and 5) the origin and structure of matter and universe, for (i) achieving breakthrough results, (ii) developing human resources suitable for an advanced computational S&D environment and (iii) establishing an advanced computing research and education center.



Concept of the innovative High-Performance Computing Infrastructure (HPCI)
Source: Created by MEXT

Supercomputer "computer K"
Source: RIKEN

The K computer, officially made available for shared use in September 2012 pursuant to the Act on the Promotion of Shared Use of Specified Large-Scale High-Technology Research Facilities (Act No. 78, 1994) ("Shared Use Act"), is operated by the RIKEN Advanced Institute for Computational Science (in Kobe) in cooperation with the Research Organization for Information Science and Technology (RIST), which is the registered institution to support users and the HPCI Consortium, mainly comprising user communities and has produced breakthrough results in the abovementioned strategic areas.

For example, heart muscle movement was simulated on a molecular level for precisely reproducing cardiac motion. This simulation has helped elucidate the pathological condition of hypertrophic cardiomyopathy, an intractable cardiac disease and to rational therapies and drug efficacy evaluation for this disease. It was also demonstrated that the potential of the typhoon a couple of weeks later could be predicted by simulating a model capable of calculating details of the generation and extinction of clouds worldwide. This is expected to be tied to the prediction of typhoon. Expectations are high that the K computer will continue to produce world-leading, groundbreaking results in various fields and will help to advance new drug development processes, innovating manufacturing and the elucidation of the origin of matter and the universe.

The most advanced super computer has a decisive influence on national competitiveness in the progress of S&T and industry, hence competition is fierce.

In FY 2014, MEXT commenced a project to develop a world's top supercomputer and applications for solving synchronization problems, with an estimated 2020 completion date, to ensure they would help solve social and scientific issues faced by Japan. The basic design of system development was started and nine top priority issues, including health and longevity, disaster prevention and mitigation, energy and production, were selected to develop applications at expert meetings.

Continuous development of the system and applications while synchronizing and creating world-beating by satisfying social needs will help solve problems and create innovation.

4) R&D on nuclear power and fusion

Nuclear R&D was focused on radiation decontamination and reactor decommissioning to promote

recovery from the nuclear disaster caused by TEPCO's Fukushima Daiichi Nuclear Power Station. At the same time, MEXT was also engaged in R&D and developing human resources to support nuclear infrastructure and safety. High-level nuclear technologies and human resources are required to implement the Basic Energy Plan. To meet these needs, a "voluntary safety enhancement, technology and human resource working group" was formulated under the nuclear panel of Electricity and Gas Utilities Subcommittee at the Advisory Committee on Energy and Natural Resources, to create a roadmap to LWR safety technologies and human resources. Regarding Monju, issues to address, such as reconstruction of the implementation system, were discussed according to the Energy Basic Plan. Necessary measures were implemented for R&D on technologies for fusion and those for nuclear nonproliferation and nuclear security (refer to Section 2 1 (1), Chapter 2 for R&D on FBR cycle technologies and fusion and Section 3, 2 (2), Chapter 3 for R&D on technologies for nuclear nonproliferation and nuclear security).

5) Promotion of R&D on information security

R&D of information security technology and development of human resources responsible for R&D were promoted according to the "Cyber Security Strategy" (June 2013) and "Information Security R&D Strategy (revised)" (July 2014) determined at the Information Security Policy Council (ISPC, chaired by the Chief Cabinet Secretary), which was established to enhance information security measures through the united, cross-sectoral efforts of public and private sectors.

According to the Cyber Security Strategy, MIC has created international networks to gather intelligence on cyber attacks and malware with the help of Internet service providers and universities at home and abroad. MIC is also working on R&D and demonstration tests of technologies that enable the prediction of and prompt response to cyber attacks in collaboration with other countries. In response to recent increases in the numbers of cyber attacks targeting confidential information kept by government offices and companies, R&D has been implemented regarding technologies for detecting cyber attacks early based on analyses of communications on intranets and Internet user characteristics.

At the Control System Security Center, which has been operating since April 2013 in Tagajo City of Miyagi Prefecture, METI has been working on R&D, international standardization, the development of evaluation/accreditation systems, human resources development and promotional/educational activities. These efforts are continued for the purpose of evaluating and accrediting control equipment and technologies for enhanced security of control systems.

6) Development of technologies associated with the exploitation of ocean resources and energy

The growing global demand for energy has resulted in increases in oil and natural gas production at sea. Offshore and deep-water oil and gas exploration will increase in the future. Against this backdrop, growth is expected in markets for the floating structures that are necessary for offshore oil and gas exploitation. MLIT aims at expanding markets and meeting new demand for ocean resources development by providing support for the development of technologies for Floating Liquefied Natural Gas (FLNG) facilities and platforms for deep-water drilling.

The National Maritime Research Institute is conducting research on the development and improvement of techniques for safety evaluation of offshore structures and for reducing environmental impacts. These

techniques are the basis of key technologies for the exploitation of ocean resources and energy.

(2) Establishment of science and technology platforms for new knowledge frontier development

To establish S&T platforms to develop new knowledge frontiers through the elucidation and more comprehensive understanding of the universe, the earth and the oceans, the government has been advancing theoretical studies, experiments, surveys, observations and analyses on S&T topics.

1) The promotion of oceanographic R&D

Humans know little about the oceans, due to their vastness and inaccessibility. Driven by the intellectual desire to tackle the unknown, humans have conducted diverse investigations and studies of oceans. These efforts have resulted in discoveries of untapped energy and mineral resources and in the elucidation of the oceans' contributions to geoenvironmental, changes including climate change. Elucidation of oceanographic phenomena for building necessary technical platforms is important for solving issues critical to the development of humankind, including issues concerning global environment, responses to massive earthquakes in trenches and ocean resources exploitation. In view of this, in FY2013 the government deliberated on key ocean technologies that the entire nation should address. As the result of the deliberations, ministries and agencies started studies necessary for implementing projects related to key technologies of national importance, such as the project to develop a selected system for exploring next-generation ocean resources.

(i) R&D on deepening our understanding of phenomena at the deep ocean floor

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has been conducting research and surveys focusing on the seas around the Japanese archipelago and the entire Pacific Ocean. Specifically, crustal structures are explored by using research vessels, the manned research submersible SHINKAI 6500 and unmanned submersibles, toward deepening our understanding of phenomena at the deep ocean floor, such as tsunamis, volcanic eruptions and huge earthquakes that can cause devastating damage. In FY 2014, molecular biological and chemical analyses of seawater samples ranging from marine surface layer to near the ocean bottom (10,257 meters underwater), collected by the Automatic Bottom Inspection and Sampling Mobile (ABISMO[1]), revealed the first ever presence of a unique hadal and ocean trench life area in the hadopelagic zone (more than 6,000 meters deep) of Challenger Deep in the Mariana Trench, the deepest part of the world's oceans.

(ii) R&D on technologies for ocean resources exploration

MEXT has been developing advanced key technologies necessary for ocean resources exploration and is using these technologies for research and exploration. In the Program for Developing Technologies for Promoting the Use of Ocean Resources, MEXT started developing technologies for sensors in FY 2008. These sensors are based on scientific findings from academia and are used for efficiently and accurately understanding the abundance of ocean mineral resources in broader areas. In FY 2013, technologies that

1 Automatic Bottom Inspection and Sampling Mobile

had been verified as practical and effective for deep-sea exploration were transferred to the "Wide-area seafloor mineral resource exploration system development in the Marine Resource Utilization Promoting Technology Development Program," and R&D was continued.

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) started building a wide-area ocean floor research vessel for the purpose of accelerating research and exploration of untapped submarine resources around Japan. The vessel is capable of investigating submarine topography and structures under the sea-floor in a broad area, as well as of conducting detailed sea-floor surveys by operating multiple subsea robots, such as ROVs[1] and AUVS[2]. In FY 2014, JAMSTEC conducted at-sea test of offshore transponder (ASV[3]) which allows the operation of multiple AUVs. The ASV is required to monitor undersea AUVs from the surface and relay undersea information to the surface and land. The test result suggests the potential for efficient and wide-area search and to develop marine resources in future and would be useful for deep-sea R&D.

MIC started R&D for next-generation satellite communication technology for marine resource survey in FY 2014 to improve the efficiency of marine resource surveys, as well as technological development, including more compact Earth stations, energy saving techniques and automatic satellite guiding (anti-oscillation) systems.

(iii) R&D on exploration under the sea-floor

Aiming at elucidating the microbiosphere under the sea-floor and the seismogenic mechanisms in ocean trenches, JAMSTEC has been advancing the development of drilling techniques for the deep-sea drilling vessel CHIKYU as well as real-time observation techniques that rely on submarine cable networks. JAMSTEC is using these techniques for research and investigations. In FY 2014, it conducted a scientific drilling survey to study sea-floor ore deposits around the Iheya North hydrothermal vent field and the distribution of sea-floor hydrothermal areas as an indicator of deposits. The survey comprised drilling and inspection by attaching physical measurement sensors near to the end of the drilling pipe to measure various elements in the borehole, while the measurement results suggested the possibility of the largest hydrothermal pool ever found in the Okinawa sea. The survey team also successfully obtained samples of the mother body from the sea-floor hydrothermal deposit estimated from drilling and inspection data, which indicates the potential of the drilling and inspection procedure used to develop oil fields as a new tool applicable to developing sea-floor hydrothermal deposits. The results were used in the "Scientific study on origins of marine resources" in the "Next-generation Technology of Marine Resources Survey," a strategic innovation creation program implemented by the Cabinet Office.

(iv) R&D on technologies for securing marine biological resources

The adverse effects of global warming, ocean environmental degradation and overexploitation of marine species have become increasingly obvious. Conservation of marine biodiversity and sustainable use of marine biological resources are significant challenges for humans. In the Ocean Resource Use Promotion Technology Development Program, MEXT is implementing R&D for the purpose of realizing

1 Remotely Operated Vehicle
2 Autonomous Underwater Vehicle
3 Autonomous Surface Vehicle

innovative production based on an understanding of the physiology of marine species and for the purpose of comprehensively elucidating marine ecosystems. In the Strategic Basic Research Program of JST, R&D has been conducted regarding technologies for observation and monitoring of marine species.

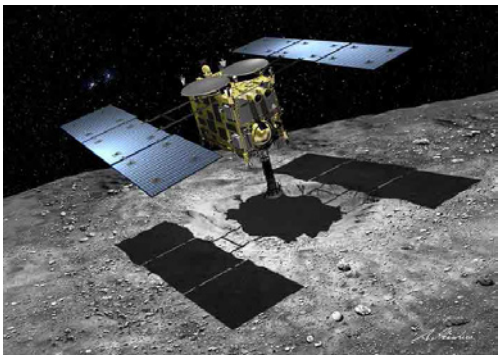
2) The promotion of R&D on space science

The quest for the unknown frontier is a highly advanced human intellectual activity to find the origin of the universe and the natural laws of the universe. This is the source of innovative and emerging technologies containing the possibilities of bringing new shoots in space development, and required as the support for the space development and utilization base in Japan.

New industries are expected to be developed from outcomes of research in space which is a special environment, new scientific insights, and technologies using these insights..

(i) Solar system exploration and astronomical observation in space

Regarding R&D in space science, JAXA has been playing a pivotal role. JAXA marked globally unrivaled results in X-ray and infrared astronomical observation, including developing and operating a world-first satellite for simultaneous X-ray photography and X-ray spectrography and collecting samples from a celestial body moving around the sun with the "Hayabusa" asteroid probe. "Hayabusa", which returned to Earth in June 2010, brought home tiny pieces of the near-Earth asteroid "Itokawa". An international call for proposals to research these pieces went out and excellent proposals were selected for advancing research. The "Hayabusa 2" was launched in December 2014. JAXA is also engaging in the development of an orbiter for the BepiColombo mission to Mercury, as a joint project with European Space Agency (ESA). Accordingly, JAXA has been helping enhance Japan's international standing in space exploration and engaging in R&D on technologies for space science that help expand the frontier of humans.



The "Hayabusa 2" asteroid explorer
Source: JAXA

(ii) The acquisition of space technologies for manned missions through the use of the International Space Station Program

The International Space Station (ISS) Program[1] is an international project collaboratively implemented by five parties: Japan, the U.S., Europe, Canada and Russia. Japan's role in this project is the development and operation of the KIBO (JEM) and the KONOTORI (HTV) automated cargo spacecraft. KIBO has been in service since its completion in July 2009 and KONOTORI has been used for resupplying KIBO and the ISS. Japanese astronauts have carried out long-stay missions aboard the International Space Station. The Japanese team has achieved various things so far, including acquiring manned and unmanned space technologies, establishing an international presence (international standing) of Japan, expanding the space industry and contributing to social benefits by using space social benefits (e.g. generating high-quality

1 An international joint project to construct, operate and utilize manned space stations in low-Earth orbit (about 400 km above ground) based on an inter-government agreement among Japan, the U.S., the EU, Canada and Russia.

protein crystals leading to drug discovery, acquiring medical knowledge, creating materials useful for next-generation semiconductors and launching ultra-small satellite) and educating young people. In August 2013, H-IIB Rocket No. 4 with KOUNOTORI 4 was launched and cargo was successfully delivered to the ISS. The Japanese astronaut Koichi Wakata was sent to the ISS on November 2013 on a long-stay mission. During his 6-month stay at the ISS, Wakata conducted various activities, including the capture and docking of a U.S. private-sector transfer vehicle with robotic arms, the orbital deployment of small satellites from KIBO, the filming of Comet ISON and aurora with a 4K high-resolution camera and the implementation of experiments in life science and astromedicine. In March 2014, Wakata became the first Japanese commander of the International Space Station, aboard which were two American crew members and three Russia crew members. In FY 2015, Kimiya Yui, another astronaut, is scheduled for dispatch to the ISS for a long-stay mission.

Astronaut Koichi Wakata (left): Change-of-Command Ceremony at the ISS (right: Astronaut Wakata is the second right astronaut)
Source: JAXA

International debate concerning sustainable international space exploration scenarios has been ongoing, mainly centering on national space agencies. These scenarios are based on optimally exploiting the ISS to reach Mars in several stages. For international collaboration in space, the U.S. Department of State hosted the International Space Exploration Forum (ISEF), a ministerial-level meeting, in Washington D.C. in January 2014. MEXT Minister Shimomura attended on behalf of the Japanese government. Representatives of 35 countries/regions and international organizations attended the ISEF to exchange views about international collaboration in future space exploration. Minister Shimomura noted that Japan would play an active role in building a framework for international collaborative space exploration and that Japan would actively help realize space exploration by utilizing unique Japanese technologies. Japan's offer to host the next meeting of the ISEF was kindly accepted.

■ Table 2-3-5 / Major Projects for Maintaining the Foundations of the State (FY 2014)

Ministry /Agency	Implementation	Project
Cabinet Secretariat	Cabinet Information Research Office	Information-Gathering Satellites
MIC	MIC	Program for promoting information security based on the ICT environmental changes
MEXT	MEXT	Financial contribution to the ITER's International Fusion Energy Organization
		The development of broad-area ocean mineral resource exploration systems
		The advanced use of high-performance computing infrastructure
		R&D for the establishment of high-performance computing infrastructure
		The development of next-generation ultra-fast electronic computing systems
		The promotion of use of specific advanced large research facilities (i.e., supercomputers)
		The operation of specific high-speed computer facilities
	JAXA	Advancement of Japan's primary rockets
		Grants for ISS development
	JAMSTEC	Shipbuilding grants by JAMSTEC
METI	METI	Costs for commissioning research on the standards for radioactive waste disposal
		R&D on technologies for the remote detection of oil resources
		R&D of hyper-spectral sensor
		Subsidies for surveying the strength of renewable energy power generation facilities
		R&D on technologies for solar-powered radio transmission and reception
		Commissioning expenses for research on next-generation reprocessing and vitrification technology base
	ANRE	R&D on technologies for mining submarine hydrothermal deposits
		Project for promoting the development of methane hydrates
		Subsidies for promoting coal production technologies
		Costs for commissioning research on technologies for safety measures for nuclear fuel cycle facilities
		Subsidies for the development of technologies to improve safety measures for nuclear reactors
		Costs for commissioning the development of technologies for fast reactors
		Sea-floor mineral resources survey project
		Commissioning expenses for surveys on geological disposal technology
		Commissioning expenses for research on next-generation reprocessing and vitrification technology base
MLIT	JCG	Promotion of marine research in EEZ of Japan
	GSI	Costs for surveying electronic reference stations
MOE	Nuclear Regulation Authority	Commissioning expenses to improve nuclear fuel research on technologies for safety measures for nuclear fuel cycle facilities
		Commissioning expenses for research into the safety of nuclear power generation facilities
		Development of Criticality Risk Evaluation Method (new)
		Commissioning expenses for research on earthquake and tsunami resistant safety design evaluation standard for nuclear facilities

5 Improvement and Enhancement of Common Science and Technology Infrastructure

To promote R&D effectively and efficiently toward solving diverse problems that Japan and the rest of the world are facing, it is necessary to promote R&D on science and technology that applies to multiple areas. Furthermore, common and fundamental facilities and equipment that are useful for diverse R&D activities need to be improved and enhanced and these facilities need to be networked.

Accordingly, the government has been giving priority to R&D on the facilities and equipment mentioned below, to respond to critical issues.

(1) The strengthening of cross-disciplinary science and technology

The government is promoting R&D of S&T that is useful across multiple disciplines and in cross-disciplinary fields. This S&T includes mathematical science, nanotechnology and technologies for advanced measurement and analysis, optical science, quantum science and information science.

1) The development of technologies and instruments for advanced measurement and analysis

Technologies and instruments for advanced measurement and analysis are indispensable for the advancement of S&T, as they form the basis for the world's most advanced, unique R&D results. Many Nobel laureates have won the prize for such R&D results.

According to the MEXT guidelines, Japan Science and Technology Agency (JST) has been implementing Industry-Academia Collaborative R&D Programs (for the Development of Advanced Measurement and Analysis Systems). In collaboration with industries and universities, this agency is promoting the development of the most advanced, unique instruments for measurement and analysis that serve the needs of world-leading researchers and manufacturers (Figure 2-3-6). As of the end of FY 2014, 50 prototypes had been developed and put into production. Various measurement and analytical technologies and equipment were developed in FY 2014, including those applied to social issues such as sustainable and clean energy by drastically improving photovoltaic cells, etc. as well as those for solving problems affecting the air, water and soil such as PM level 2.5 through study and monitoring of causes. Additionally, the development of technologies and instruments for radiation measurement was promoted and certified reference materials required for checking the validity of radioactivity analysis were developed. These efforts were made by capitalizing on the experience of technology/instrument development for the purpose of supporting reconstruction after the GEJE.

■ **Figure 2-3-6 / Examples of Technologies and Instruments for Advanced Measurement and Analysis**

Upper: Development of a fully automatic analytic system, including preprocessing of samples using ultra-critical fluid technology and fast and highly accurate isolation and analysis (significant reduction in the use of organic solvents, preprocessing of unstable samples without experience and skill and highly sensitive, fast and automatic processing, isolation and detection)

Lower: Certified reference material for radioactivity analysis (developed for radioactivity analysis of food items and used for checking the validity of radioactivity analysis of food as well as for the calibration of instruments. The photo shows certified reference material for radioactivity analysis of shiitake.)

Source: JST

2) R&D of nanotechnology

Nanotechnology/materials are the important technology seeds for the progress of S&T and solution of problems in life science, telecommunications and the environment, as well as achieving industrial growth, affluent lives, and safer, more secure and comfortable society.

MEXT has been promoting R&D on key technologies toward breakthroughs in environmental technology. For this purpose, the ministry launched the "Elements Strategy Initiative" for developing technologies to substitute or reduce the use of rare earth, rare metal and other scarce elements, and the "Development of Environmental Technology using Nanotechnology" for constructing a center for basic R&D of environmental technologies (see Section 2-1 (1) & (3), Chapter 2).

The National Institute for Materials Science (NIMS) has been developing advanced technologies commonly necessary for materials innovation. The following technologies have been included: the world's most advanced characterization technologies for comprehensive materials analyses; computational simulation techniques for precise prediction and analyses of materials properties; and novel design and processing for the fabrication of functional materials from composition elements such as particles and organic molecules. NIMS has also been creating new substances and materials by taking advantage of physical properties that are unique to nano-sized substances—either organic or inorganic—by manipulating and controlling atoms and molecules on the nano-level (one billionth or 10^{-9} meter). In response to the challenges shared by all humankind in terms of the solutions to environmental/energy/resource problems and the creation of safe, secure infrastructure, NIMS has been promoting R&D for advancing environmental/energy materials as well as for enhancing the safety and reliability of materials (see Section 2-1, Chapter 2).

The NICT of MIC has been promoting R&D with the aim of overcoming technological and performance limitations of ICT and for achieving dramatic advances in ICT. For this purpose, R&D on key technologies has been implemented by using new atomic, molecular or superconducting materials. These

key technologies include advanced quantum control, control of single-photon signals, utilization of unused frequency bands and control/utilization of atomic/molecular structure.

METI has been working on developing nanocarbon materials, such as high-purity single-wall carbon nanotubes, that enhance the strength and performance of transportation equipment and electronic components while also making them lighter.

METI has also been addressing the establishment of safety evaluation techniques that facilitate the development and application of nanomaterials critical for nanotechnology.

In Tsukuba, where world-class advanced nanotechnology research facilities and human resources are gathered, the Tsukuba Innovation Arena (TIA) comprising four core institutions was formulated as the center for industry-academia-government collaboration, with the support of MEXT and METI. TIA aims at serving as a global nanotechnology research center (see Section 4-1 (3), Chapter 2).

3) R&D on technologies for optical and quantum sciences

The excellent properties of quantum beams such as neutron or ion beams are used for fine observation, precision processing and the creation of substances. For example, lasers are used for the precision machining of semiconductors and radiation is used for the analysis of atomic structure.

As a result of remarkable advances in S&T, processing at the atomic/molecular level and detailed investigation of material structure, which were not possible before, are now required. Optical and quantum technologies are the key technologies that support a range of scientific research and industrial applications.

Thus, MEXT has been implementing a program for the development of key technologies toward the creation of an optical and quantum sciences R&D center since FY2008. This program aims at advancing R&D on optical and quantum sciences by using the potential of these sciences for satisfying the needs of various fields through collaboration by diverse researchers from industry, academia and government. The development of future scientists who can further advance these sciences is also promoted.

4) R&D on information science and technology

Information science and technology cover a wide area of basic technologies from science and technology, including life sciences, nanotechnology, the environment and manufacturing to social applications such as transportation, medical care, education, disaster prevention and energy. It will be more critical in future to boost the affluence of Japanese citizens and improve the industrial competitiveness of Japan in rapidly developing cyberspace through significant development and dissemination of information devices and sensor technology.

In the "R&D of ICT infrastructure for realizing a future society," MEXT has been enhancing the use of "big data" across different fields. For this purpose, MEXT conducts R&D into comprehensive analytical technology for real-time and automatic extraction and processing of meaningful information from an enormous volume (big data) in various fields and the use of "big data" for networking of human resources involved in innovations. MEXT is also implementing R&D on the following topics: solution-oriented integrated IT systems (i.e., advanced integrated systems that aggregate real-world information, derive solutions to problems or directions for necessary measures and provide society with feedback); and key technologies for spintronic materials and devices, as well as for highly functional and highly available storage, which help enhance IT systems in terms of their resistance to disasters, their data processing

capacity and their reduction of power consumption. MEXT is working on developing innovative High-Performance Computing Infrastructure (HPCI) for the purpose of advancing adequate scientific analysis, elucidation and prediction through use of information science and technology (see Section 1-4 (1), Chapter 3).

5) The creation of innovations through the application of math and mathematical sciences

As part of the activities for creating a framework that facilitates the use of knowledge of math and mathematical sciences in solving diverse problems in other scientific disciplines and industries and for creating new value (or mathematical innovation), in FY 2012 MEXT started a research promotion program for creating innovations through the collaboration of researchers in mathematics, mathematical sciences, other scientific disciplines and industry. In this program, issues that are expected to be solved through the application of math are chosen from among important topics, such as "big data" and mathematical optimization/control. Collaboration by researchers in math, mathematical sciences, other scientific disciplines and industry is enhanced through multiple opportunities that include workshops where these researchers discuss their availability for collaboration. Specific issues of science and industry are chosen and researchers specializing in these issues form study groups for intensive discussions. Additionally, tutorials on mathematical sciences are given to researchers in other sciences and industries.

(2) The upgrading and networking of common and basic facilities and equipment

As infrastructure to promote S&T, research facilities and equipment support a range of R&D, from basic research on S&T to the creation of innovations; thus, they need to be further advanced and to be used more efficiently and effectively. "Act on the Enhancement of Research and Development Capacity and Efficient Promotion, etc. of Research and Development, etc. by Advancement of Research and Development System Reform" (Act No. 63, 2008) ("R&D Enhancement Act") stipulates that the government shall take necessary measures to promote the shared use of research facilities and equipment owned by universities and independent administrative institutions.

Pursuant to the R&D Enhancement Act, the government has been promoting the effective use of key general facilities and equipment by industrial, academic and government research institutions for diverse R&D on science and technology. The government is also working on networking these facilities and equipment such that they will be available more conveniently in a mutually complementary manner and will be able to respond to emergencies.

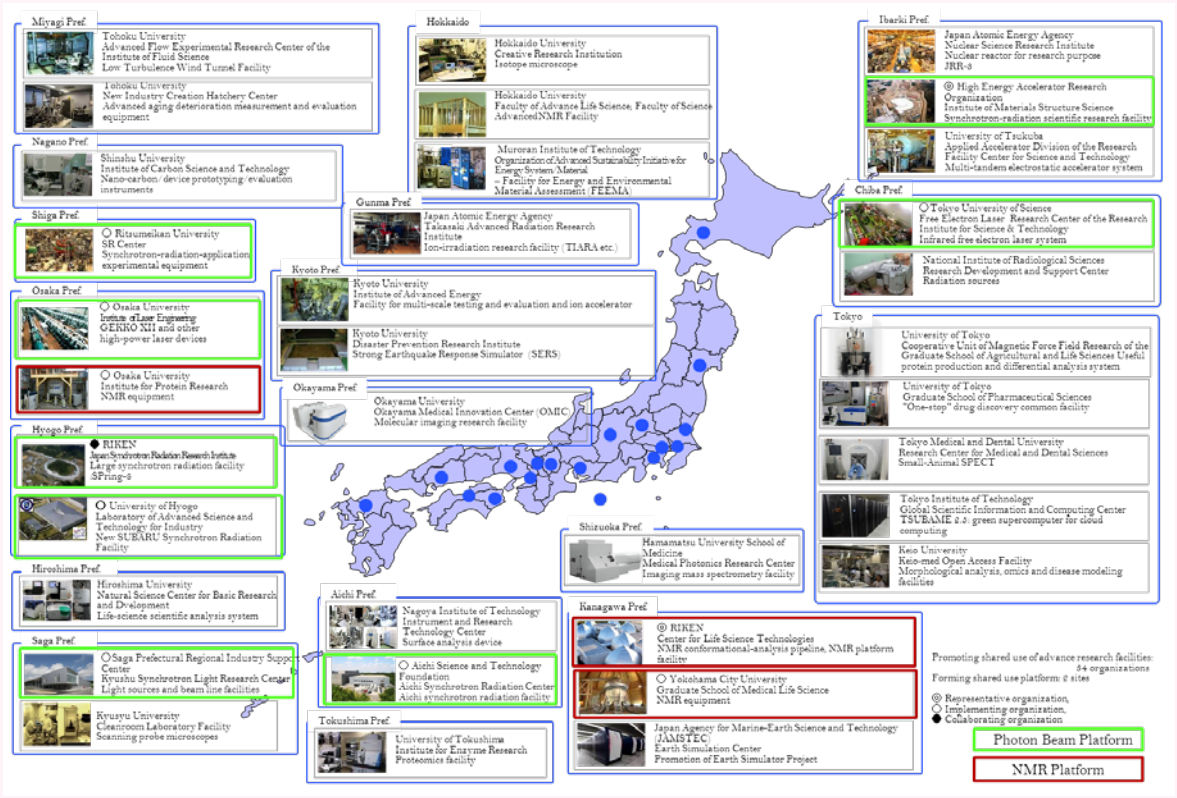
MEXT is also promoting the shared use of research facilities and equipment by researchers at industrial, academic and government research institutions. In this regard, the ministry is financially supporting these researchers for the expenses necessary to develop and share large-scale research facilities pursuant to the Shared Use Act.

MEXT has been implementing the "Program for the Creation of Research Platforms and Sharing of Advanced Research Facilities" (Figure 2-3-7). This program aims at enhancing the shared use of advanced research facilities and equipment, other than specified large-scale high-technology research facilities, which are owned by universities and incorporated administrative agency. Based on this program, networks of facilities and equipment will be built for various technological fields, so that research platforms will be created to effectively satisfy the diverse needs for these facilities and equipment. To facilitate shared use and

to help produce results from R&D conducted by utilizing facilities/equipment for shared use, the "Kyoyo Navi" website[1] was set up, to provide basic information online regarding locations, use applications, time availability, etc.

MEXT has established a nationwide, shared system that offers opportunities in using cutting-edge equipment and advanced technical support for users from industry, academia and government through the "Nanotechnology Platform" by collaborating closely with independent institutions. They own cutting-edge research facilities and equipment in nanotechnology and have the know-how necessary for using such research facilities and equipment.

■ Figure 2-3-7 / Universities & Institutions Participating in the Program for the Creation of Research Platforms and Sharing of Advanced Research Facilities



Source: Created by MEXT

1) Specified Large-Scale High-Technology Research Facilities

The Shared Use Act defines large-scale research facilities of special importance as Specified Large-Scale High-Technology Research Facilities. This act stipulates the need for the systematic development and operation of these facilities, as well as for shared use in a neutral and fair manner, so that investments in R&D are effectively and efficiently made and science, technology and innovation (STI) is enhanced in Japan.

1 http://kyoyonavi.mext.go.jp/

(i) Super Photon ring-8 GeV (SPring-8)

SPring-8 is a research facility that delivers the world's best performance in the analysis of atomic or molecular structure/function by using synchrotron radiation, the extremely bright light produced when electrons accelerated close to the speed of light are forced to travel in a curved path. Since entering service in 1997, this facility has been contributing to Life Innovation and Green Innovation in Japan and to innovative R&D in various fields of research that help boost Japan's economic growth.

Super Photon ring-8 GeV (SPring-8: the circular building on the, right) and XFEL facility (SACLA: the long, low building on the left)
Source: RIKEN

(ii) X-ray free-electron laser facility (SACLA)

SACLA is the world's most advanced research facility that generates unprecedented lights having both laser and synchrotron radiation characteristics and allows unprecedented analyses impossible with conventional methods. The shared use of the facility was started in March 2012. MEXT launched the "Priority Strategic Research Issues Using X-ray Free-Electron Lasers" program in FY 2012, to create leading, innovative R&D results that promote the development of pharmaceutical products and fuel cells and help elucidate photosynthesis mechanisms through the instantaneous measurement and analysis of ultrafine atomic structures and ultra-fast progress or changes in chemical reactions.

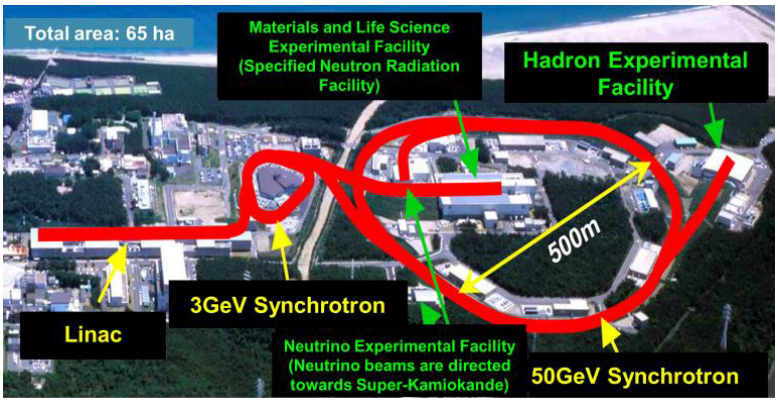
(iii) Supercomputer "K computer"

Supercomputer simulations have been crucial for cutting-edge S&T and improvements in industrial competitiveness as the third S&T approach, following theorization and experiments. The shared use of the "K computer" commenced at the end of September 2012 and has since underpinned breakthroughs in diverse fields, including advanced processes to develop new drugs, the development of next-generation semiconductors that help conserve energy, manufacturing innovations, mitigation of damage due to earthquakes and tsunamis and elucidation of the origin of matter and the universe.

Supercomputer "K computer"
Source: RIKEN

(iv) Japan Proton Accelerator Research Complex (J-PARC)

J-PARC has been contributing to a wide range of R&D, including basic research and industrial applications, by using secondary particle beams of neutrons and neutrinos[1] that are generated by a proton accelerator with the highest beam intensity in the world. The Specified Neutron Facility has been used for structural analyses which may spawn innovative materials and new drugs and numerous results have been achieved. The Shared Use Act is not applicable to the Nuclear and Particle Experimental Facility (Hadron Experimental Facility) and Neutrino Experimental Facility, but these facilities are used jointly by university researchers in Japan and abroad. Following the leak of radioactive materials at the Hadron Experimental Facility in May 2013, a new safety management system was established based on the post-accident comprehensive inspection and procedures to resume operation were started[2].



Japan Proton Accelerator Research Complex (J-PARC)
Source: J-PARC Center

■ **Table 2-3-8 / Key Facilities to Improve and Enhance Common S&T Infrastructure (FY 2014)**

Ministry /Agency	Operation	Facility
MEXT	MEXT	R&D on key technologies of ICT for future societies (formerly: R&D for next-generation IT infrastructure)
		Nanotechnology platform
		Program for the creation of research platforms and the sharing of advanced research facilities
		Program for the development of key technologies toward the creation of an optical and quantum sciences R&D center (Competitive funds)
	MEXT RIKEN Japan Synchrotron Radiation Research Institute	The development and sharing of Super Photon ring-8 GeV (SPring-8) and X-ray free-electron laser facility(SACRA)
	MEXT JAEA High Energy Accelerator Research Organization	The development and sharing of the Japan Proton Accelerator Research Complex (J-PARC)
	JST	The development of advanced measurement and analysis systems
METI	METI	The development of economic infrastructure for cyber security

1 A neutrino is an elementary particle that is the smallest unit of mass. Neutrinos are difficult to detect because they are electrically neutral and pass through ordinary matter. Many of their properties, including mass, are unknown.
2 Operation was resumed in April 2015.

Section 2 System Reforms toward Solution-oriented R&D

1 System Reforms for Promoting Solution-oriented R&D

To promote solution-oriented R&D in an efficient, effective manner, R&D projects need to be advanced systematically and comprehensively through industry-academia-government collaboration. In this regard, the government has been actively promoting the efforts stated in Section 4, Chapter 2.

2 The Establishment of Systems for Promoting R&D that should be led by the Government

R&D on technologies critical for the national security as well as on key facilities and equipment that are shared by multiple institutions across diverse fields are continuously advanced over a long period of time. Thus, under the government initiative, systems to promote R&D on these technologies/facilities/equipment are created by mobilizing available resources from industrial, academic and government research institutions. Additionally, projects are started for efficiently and effectively promoting the R&D.

One new R&D project started by METI is the "Pioneering Research for the Future" Project, in which a governing board is set up for each R&D topic and R&D projects are managed through industry-academia-government collaboration across ministries and agencies. Each R&D project is consistently implemented, from basic research through practical application. In other words, long-term projects that require 10 years or more for commercialization and, thus, that carry a relatively high risk are implemented under the government initiative. Investments focus on R&D for drastic measures for energy and environmental conservation. Furthermore, teams of excellent researchers from industrial, academic and government institutions are formed to implement internationally competitive R&D projects in terms of technologies and their commercialization. These teams work on the management of intellectual property and international standardization for enhancing the commercialization of technologies. (METI is studying the feasibility of foreign businesses taking part in these teams, on the condition that Japan's national interests are protected.)

R&D topics for the "Pioneering Research for the Future" Project are determined at a review meeting held jointly by MEXT and METI. R&D projects implemented through industry-university-government cooperation are supported, to help create world-leading innovations.

Section 3 Strategic Development of Global Activities in an International Context

The promotion of S&T diplomacy through the strategic development of global activities in an international context is important if Japan is to play an active role in the international community and further advance its S&T.

Thus, in accordance with the 4th Basic Plan, the government has been making efforts to strengthen international networks of research and scientists, to help solve global issues and to promote international strategic joint research projects, as well as exchanges of researchers. The government is also enhancing

arrangements necessary for increasing global activities that can support the abovementioned government efforts.

Priority issues regarding the international S&T and academic activities of Japan were discussed at the 7th international CST strategy committee to implement proactive STI policies under turbulent world affairs and "Ways to conduct international research collaboration and joint research" and "Basic concept of international strategy according to characteristics by countries" were documented in July 2014.

1 Promotion of R&D toward Solutions to Common Issues in Asia

For Japan to assume a leading role in solving global issues and to maintain a strong position in the world, the nation needs to strategically promote STI policies from the perspective of international cooperation. Japan's strength in S&T is especially useful for other Asian countries in solving many of their problems relating to the environment, energy, food, water, disasters and infectious diseases. By assuming a leading role in addressing problems common to Asian countries, Japan needs to build mutually beneficial relations with them based on mutual trust.

In June 2012, in cooperation with JST, MEXT started the e-ASIA Joint Research Program (e-ASIA JRP) with the aims of enhancing R&D capabilities by accelerating S&T research cooperation in East Asia and of conducting multilateral joint research for solving problems common to Asian countries. In October 2014, Japan, Thailand and the Philippines opted to collaborate on the project, "the development of nanocarbon based catalyst materials for using biomass as resources" and a total of six research subjects were supported in FY 2014.

MOE also supported the "Asia-Pacific Network for Global Change Research (APN)" to enhance researchers' capabilities in the Asia-Pacific region and held its 20th annual inter-government meeting in March 2015 under the cooperation of the Nepalese Ministry of Science, Technology and Environment. In November 2014, MOE hosted the 3rd annual meeting of the "Low-carbon Asia Research Network (LoCARNet)" to realize a low-carbon society in rapidly growing Asian countries.

2 New Developments in Science and Technology Diplomacy

(1) The development of international activities that capitalize on Japan's strengths

Japan leads the world in addressing various issues, including environmental and energy problems. The level of Japan's S&T is relatively high among the countries of the world. To achieve sustainable growth, Japan needs to promote the export of prescriptions for solving problems (i.e., export of systems developed based on Japanese S&T) and to create demand for these systems, especially in the rapidly growing Asian region. For this purpose, Japan has been using its strength in S&T to enhance the export of systems that help to bring social changes to emerging countries in Asia.

(Active efforts toward international standardization)

Based on the Intellectual Property Promotion Plan 2014, the government has been promoting an international standardization strategy as a joint effort of the public and private sectors to raise Japan's competitiveness in specific strategic S&T fields in which Japan excels. In addition, the "Japan Revitalization Strategy," revised in 2014, suggested the formulation of a "new market creation type standardizing system," for standardizing technologies which would be difficult to standardize using existing industries, such as

fusion technologies encompassing multiple scientific fields and advanced technologies owned by leading medium-sized firms and SMEs, which could facilitate entry to the world market.

MIC is actively and strategically promoting international standardization by focusing on the four major areas specified in the "Recommendations on Policies Regarding International Standardization of ICT (in response to Consultation No. 18 of 2011)" in 2012. With the aim of increasing the options available to users and enhancing the global competitiveness of Japan's ICT industries, MIC is also collaborating with de jure standardization organizations such as the ITU and de facto standardization organizations in the private sector in efforts to promote the international standardization of ICT that helps to reduce environmental impacts.

Specifically, a "New Market Creation type Standardization System" was established in July 2014 as a comprehensive system to reinforce public-private cooperation for prompt standardization of fusion technologies relating to multiple parties concerned or advanced technologies owned by specific firms, including SMEs. For developing a world-class domestic certification system in strategically important business areas with overseas business deployment in mind, construction of evaluation facilities for large power conditioners and storage batteries commenced under the Project to Develop Global Certification Infrastructure" to provide a certification infrastructure, for which certification or test results were internationally approved. Following Vietnam and India, a bilateral standardization and certification cooperation agreement was concluded with Indonesia in September 2014 to strengthen cooperation in Asian countries.

(2) The promotion of international activities regarding advanced science and technology

To further develop Japan's S&T and to bring about greater synergy between S&T and diplomacy, Japan needs to promote R&D activities concerning advanced S&T and to make active use of these activities in Japan's diplomacy, in cooperation with international organizations and other advanced nations. For this purpose, Japan is required to energetically advance the development of global networks of researchers and international activities regarding advanced S&T, while controlling the outflow of technologies.

1) The development of international networks of researchers

Japan needs to develop networks of researchers across diverse disciplines to connect Japanese R&D with R&D in other countries that have high S&T levels. It is also necessary to promote international cooperation concerning advanced S&T by utilizing excellent research resources overseas.

Currently, universities, research institutions and researchers are individually conducting exchanges with their counterparts abroad. To further advance Japan's S&T and scientific research, it is necessary to attract outstanding researchers from Japan and aboard to research institutions in Japan and to encourage Japanese researchers to develop through friendly competition with international researchers.

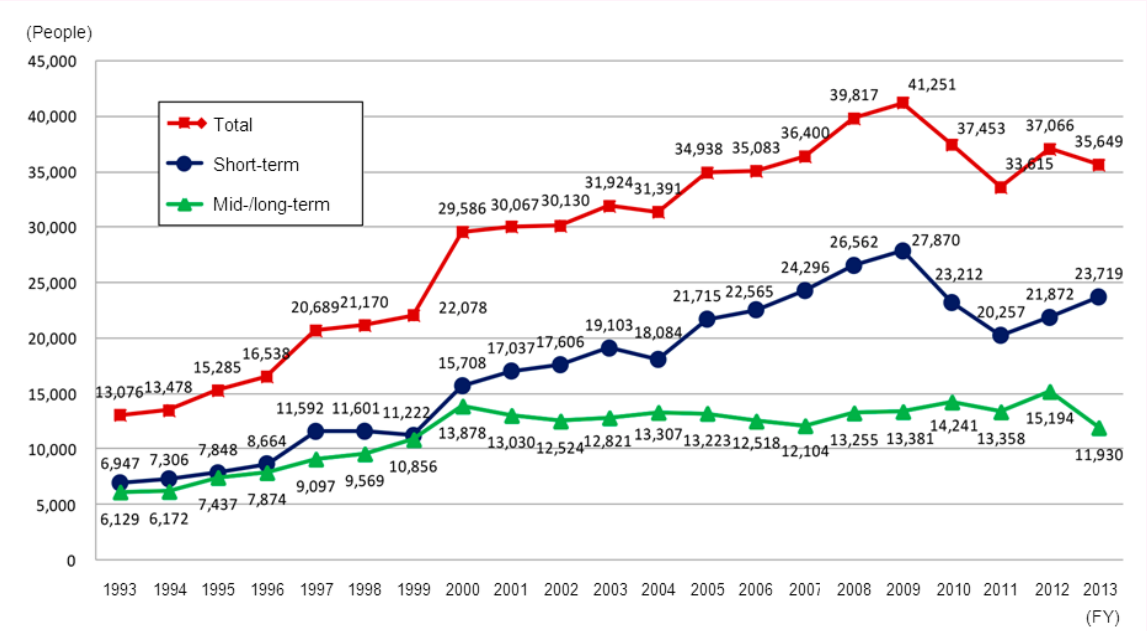
(i) International mobility of Japanese researchers

According to the "Survey on International Research Exchanges" in FY 2014, the total number of short-stay foreign researchers accepted by universities and independent administrative institutions in Japan showed a tendency to grow until FY 2009, while the number decreased in FY 2011 due to the effect of the Great East Japan Earthquake and then rebounded. The number of medium- to long-stay foreign

researchers varied between 12,000 and 15,000 for every year since FY 2000 (Figure 2-3-9). The decline in FY 2013 compared with the previous fiscal year may result from changes in the definition of accepted foreign researchers for this fiscal year.

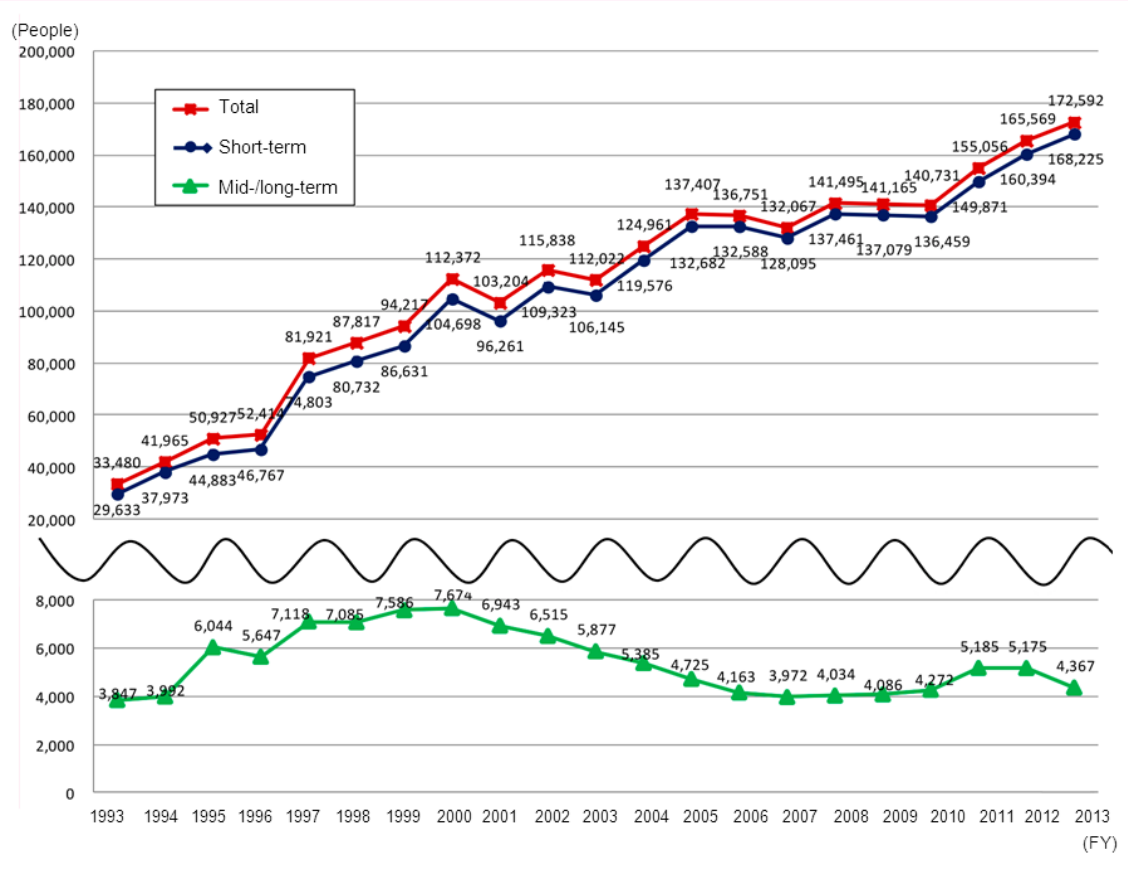
The total number of short-stay Japanese researchers overseas has tended to grow since the start of the survey and the number of medium- to long-stay Japanese researchers overseas has varied between 4,000 and 5,000 since FY 2008 (Figure 2-3-10).

■ Figure 2-3-9 / Changes in the Number of Foreign Researchers in Japan (Short-term Stay/ Medium- or Long-term Stay)



Note: 1: "Short-term" means 30 days or fewer; "medium- or long-term" means more than 30 days.
2: Postdocs and research fellows are included in the figures in and after FY2010.
3. Overlapped number of foreign researchers accepted in multiple institutions was eliminated from FY 2013.
Source: "Survey on International Research Exchanges," MEXT, March, 2015

■ **Figure 2-3-10 / Changes in the Number of Japanese Researchers Abroad (Short-term Stay/ Medium- or Long-term Stay)**



Note: 1. "Short-term" means 30 days or fewer; "medium- or long-term" means more than 30 days.
2. Postdocs are included in the figures in and after FY2008 and research fellows are also included in the figures in and after FY2010.

Source: "Survey on International Research Exchanges," MEXT, March, 2015

(ii) Efforts to promote international exchanges of researchers

In the midst of the globally accelerating brain circulation, Japan is making efforts to ensure that Japanese researchers and research teams can play a central role in networks of international research or researchers.

To foster young Japanese researchers who can play active roles internationally, the Japan Society for the Promotion of Science (JSPS) has provided various programs for sending young researchers abroad or inviting excellent researchers from other countries to Japan.

The "Strategic Young Researcher Overseas Visits Program for Accelerating Brain Circulation" is a JSPS program to support universities and other research institutions that exchange young researchers with overseas leading research institutions and enable domestic research groups with high potential to strategically formulate research networks in their specialties. The "JSPS Postdoctoral Fellowship for Research Abroad" and other programs are also provided to support individual researchers to go abroad and gain study opportunities in excellent research institutions or exchange with foreign researchers.

Invitation programs such as the "Postdoctoral Fellowship for Overseas Researchers" are provided to give outstanding foreign researchers opportunities to work in universities in Japan according to their diversified

career stages and purposes. In addition, the "Bilateral Exchange Program" supports a sustainable network between Japanese and foreign research teams.

To foster young scientists and build networks in the Asia-Pacific and Africa regions, HOPE Meetings have been organized by the JSPS to provide selected graduate students and young researchers from these regions with opportunities to engage in discussions with Nobel laureates and other distinguished researchers.

JST started the "Japan-Asia Young People Science Exchange Program" in FY 2014 to invite young people (high-school, undergraduate and graduate students and researchers aged under 40) from 14 Asian countries and regions for a short period (one to three weeks) in the hope of acquiring outstanding foreign human resources.

2) Large-scale international projects

In implementing large-scale international R&D projects or R&D that requires comprehensive databases, cooperation with other countries needs to be enhanced based on input from specific research communities. In this respect, the government takes into account Japan's global position in each S&T research area and provides support to Japanese researchers so that they can play leadership roles in R&D projects in the S&T fields in which Japan has strengths or is greatly interested.

(i) ITER (known as the international thermonuclear experimental reactor)

The ITER project is managed under the international cooperation of seven parties and Japan is promoting the production of superconductive coils, etc. (see Section 2-1 (1), Chapter 2).

(ii) International Space Station (ISS)

Japan operates the Japanese Experiment Module "KIBO" and the automated cargo spacecraft "KONOTORI" (HTV) in the ISS program (see Section 1-4 (2), Chapter 3).

(iii) International Ocean Discovery Program (IODP)

The International Ocean Discovery Program (IODP)[1] was launched in October 2013 to replace the Integrated Ocean Drilling Program (IODP[2] (2003 to 2013)). A group of drilling vessels, including "CHIKYU," a Japanese research vessel capable of drilling up to 7,000 m below the sea floor, a U.S. drilling vessel that is used as the principal vessel and ECORD's mission-specific platforms is also used to drill deep sea floors worldwide.

(iv) Large Hadron Collider (LHC)

In the Large Hadron Collider (LHC) project[3], the CERN member states, Japan and the U.S. collaborated to complete an accelerator in 2008 and now experiments are being performed.

1 International Ocean Discovery Program: A multilateral cooperation project involving 26 countries, led by the U.S. and Japan, to elucidate global environmental changes, the earth's internal structure and crustal life zones by drilling beneath the ocean floor.
2 Integrated Ocean Drilling Program
3 An experimental project for reproducing the beginning of the universe (immediately after big bang) using the giant circular accelerator owned by the European Organization for Nuclear Research (CERN) to discover unknown particles and search the most internal structure of matter.

(v) International Linear Collider (ILC)

A group of international researchers is planning to construct an "international Linear Collider (ILC) to investigate the properties of the Higgs Boson in more detail and an "ILC Technical Design Report" was published in June 2013. The Science Council of Japan (SCJ) announced the "The SCJ's view expressed in response to the MEXT request for deliberation on the International Linear Collider (ILC) Project" on September 30, 2013 followed by the English version to meet the high level of interest among research communities in Japan and abroad. It also hosted an academic forum – the "International Linear Collier (ILC) Program." Upon receipt of the reply from SCJ, MEXT founded an expert committee comprising external experts with two subcommittees in May 2014 to examine the scientific meanings to meet the enormous investment required and issues to determine the implementation of the program, including the costs and human resources indicated in the technical design report.

3) The collection and analysis of overseas science and technology information: Use of research centers abroad

For the purpose of referring to overseas information in formulating policies on S&T, a system needs to be created for continuously collecting, accumulating and analyzing overseas information in a structured and organized manner and for utilizing such information across multiple sectors and disciplines. MEXT and institutions have been working on this.

Specifically, the National Institute of Science and Technology Policy (NISTEP) collects data on current research activities regarding S&T and universities abroad and analyzes the data for comparison with the situation in Japan. The research and investigation conducted by NISTEP are based on objective and quantitative data, which is useful for enhancing Japan's S&T policies.

The Center for Research & Development Strategy (CRDS), JST is investigating and analyzing overseas trends to benefit the formulation of STI policies.

JSPS has liaison offices abroad. These offices collect information on trends in science and technology, support efforts by Japanese universities to expand their international bases and activities, collaborate with organizations engaging in promotion of sciences and hold symposiums.

4) Systematic efforts to promote international activities related to science and technology

(i) Utilization of international frameworks

a) Activities related to summit meetings

In 2008, the G8 Science and Technology Ministers' Meeting was held under the auspices of then Minister of State for Science and Technology Policy Fumio Kishida, according to a proposal made by Japan, which held the presidency at the time. Subsequently, meetings were held on an irregular basis and aimed to solve global issues using S&T via negotiations on policy adjustments between the Minister of State for Science, Technology and Innovation Policy and other ministers of countries and proactively contribute to international discussion concerning S&T policies in collaboration with other countries. The last meeting was held in the U.K. in 2013 and Yuko Harayama, an executive member of the CSTI (then CSTP) and Takashi Onishi, President of SCJ, representing Japan's science academies, attended the meeting.

The 5th Meeting of the Group of Senior Officials (GSO) on international research facilities, founded according to the discussion in the 2008 meeting, was held in Italy in December 2014 and discussions

included sharing information on international research facilities and international collaboration frameworks.

b) Asia-Pacific Economic Cooperation (APEC)

The APEC Industrial Science and Technology Working Group (ISTWG) had been holding meetings for the purpose of improving the levels of industrial S&T in the APEC member economies through joint projects and workshops. In 2012, Russia as the host economy proposed the reorganization of the ISTWG into the APEC Policy Partnership on Science, Technology and Innovation (PPSTI), which has had participation by industries and scientific communities to work on all kinds of innovations. The proposal was accepted at the 20th APEC Economic Leaders' Meeting in September 2012.

The 3rd and 4th meetings of the PPSTI were held in April and September 2014, with China as the host economy, to discuss PPSTI activities.

In August 2014, the 2nd APEC Chief Science Advisor Meeting was held in New Zealand to exchange opinions among science advisors or the equivalent in the APEC region concerning issues and opportunities related to scientific advice to the government. Yuko Harayama, an executive member of the CSTI, also attended the meeting.

c) Association of Southeast Asian Nations (ASEAN)

The ASEAN Committee on Science and Technology (COST) is working on S&T cooperation by COST+3, namely COST plus Japan, China and South Korea. MEXT is taking a leadership role in Japan's contribution to ASEAN COST+3. In January 2015, the 8th ASEAN COST+3 Meeting was held in Tokyo to exchange opinions on cooperation between ASEAN and the three countries. The ASEAN-Japan Cooperation Committee on Science and Technology (AJCCST) was founded in 2009 as a framework for cooperation between Japan and the ASEAN Committee for Science and Technology. The 5th ASEAN Cooperation Committee on Science and Technology was held in Indonesia in August 2014 and the 6th ASEAN Cooperation Committee on Science and Technology in Tokyo in January 2015 to exchange opinions about Japan and overall ASEAN scientific and technological cooperation in future.

d) Other

(Asia-Pacific Regional Space Agency Forum (APRSAF))

Since 1993, Japan has been hosting the annual APRSAF, the largest framework of space cooperation in the Asia-Pacific region. This forum has been used for exchanging information about space activities and utilization in the region as well as to promote multilateral cooperation. The 21st APRSAF meeting, held in Tokyo in December 2014, was attended by the largest number of participants, about 580 people from 33 countries and twelve international organizations. The number of participants is steadily expanding. One major achievement of the initiatives conducted by APRSAF is the Sentinel Asia Project. This project aims at reducing damage caused by natural disasters by sharing disaster-related information online, including Earth observation satellite images. As of January 2015, 81 institutions and 15 international organizations from 25 countries and regions were cooperating in the project. In 2014, a total of 18 emergency observations were provided, including observation images taken by ALOS-2 and offered by Japan for the landslide in the middle of Indonesia in December.

(International Space Exploration Forum (ISEF))

In January 2014, the ISEF was hosted by the U.S. Department of State in Washington, D.C. The Minister of Education, Culture, Sports, Science and Technology and others attended the forum from Japan. This was the first ministerial forum held to affirm political support for international cooperation in space exploration. The forum was attended by 35 countries/regions and international organizations. Views were exchanged regarding the meaning, significance and future directions of space exploration. At the opening ceremony of the ISEF, the Japanese Minister of Education, Culture, Sports, Science and Technology, representing Japan, stated that Japan was willing to actively contribute to international space exploration. A presidential advisor expressed the will of the U.S. to continue the operation of the ISS at least through 2024. It was the first time for the U.S. to make an official statement about the continuation of the ISS at an international meeting.

(Global Biodiversity Information Facility (GBIF))

The GBIF is an international organization that engages in the development of information infrastructure and data acquisition/analysis tools for the purpose of collecting data on biodiversity so that the data can be made available worldwide. The 21st meeting of the GBIF Governing Board was held in New Delhi in September 2014, with the participation of member countries and others, for approving a budget for 2015 and electing a Chair.

(The Global Earth Observation System of Systems (GEOSS))

GEOSS is a framework for comprehensive Earth observation for which diverse observation systems including artificial satellites and ground-based observation systems are linked to address nine areas of critical importance, such as disasters and climate (see Section 1-3(1), Chapter 3).

(Innovation for Cool Earth Forum (ICEF))

Suggested by Prime Minister Abe, the government decided to hold an annual international meeting, Innovation for the Cool Earth Forum (ICEF), in Tokyo every year as an international platform to promote discussion and cooperation among international academies, industries and governments to solve issues on climate change through energy and environmental innovations. At the 1st Annual Meeting held in October 2014, about 800 participants (including about 300 foreigners) from governments, companies and international institutions of about 80 countries joined the forum.

(ARGO Program)

MEXT and JMA joined an advanced ocean monitoring system (Argo Program) to understand the details of oceans worldwide and enhance the accuracy of climate change prediction (see Section 3-(1) of this chapter).

(ii) Utilization of international organizations

a) The United Nations System (U.N. System)

Japan has been participating and actively cooperating in various S&T projects and activities of the United Nations Educational, Scientific and Cultural Organization (UNESCO), a specialized agency of the

U.N.

In UNESCO bodies, such as the IOC, the International Hydrological Programme (IHP), the Man and the Biosphere Programme (MAB) and the International Bioethics Committee (IBC), international rules are formulated and projects are implemented for solving global-scale problems. Japan has established funds-in-trust at UNESCO for cooperating in S&T human resources development in the Asia-Pacific region. Japan also helps to promote UNESCO activities by sending experts to contribute to discussions at committees/commissions.

b) Organization for Economic Cooperation and Development (OECD)

The OECD engages in activities related to S&T through the creation of statistical data and exchanges of views, experience, information and human resources among the member countries at the following OECD bodies: the OECD Ministerial Council; the Committee for Scientific and Technological Policy (CSTP); the Committee for Information, Computer and Communications Policy (ICCP); the Committee on Industry, Innovation and Entrepreneurship (CIIE); the Committee for Agriculture (AGR); the Environmental Policy Committee (EPOC); the Nuclear Energy Agency (NEA); and the International Energy Agency (IEA).

At CSTP (the present CSTI), information and opinion concerning S&T policies were exchanged and roles of STI in economic growth, improvements in research organizations, roles of government and private sector in R&D and international collaboration in R&D were studied. In November 2014, an international symposium was held in Tokyo to discuss future STI policies and commemorate the 50th anniversary of Japan's participation in OECD.

CSTP contained six subgroups: the Global Science Forum (GSF); Research Institutions and Human Resources (RIHR); the Working Party on Innovation and Technology Policy (TIP); the Working Party on Biotechnology (WPB); the Working Party on Nanotechnology (WPN); and the Working Party of National Experts on Science and Technology Indicators (NESTI), but reorganization in 2015 integrated RIHR, TIP, WPB and WPN into single working groups, respectively. Typical activities led by Japan as Chair or Vice-Chair are as follows:

(Global Science Forum (GSF))

In 2014, new projects, including those for examining the new framework regarding the utilization of big data for social and economic studies and research ethics, were launched in GSF[1].

(Working Party of National Experts on Science and Technology Indicators (NESTI))

NESTI supervises, provides advice on and coordinates statistical work and contributes to the development of indicators and quantitative analysis helpful for the promotion of STI policies. Specifically, with regard to S&T indicators related to R&D spending, S&T human resources and the like, NESTI has been discussing and examining the development of indicators, methods for researching indicators and frameworks for international comparisons of indicators. Japan has delegated experts to the OECD

1 A place for promoting S&T cooperation by member nations, by exchanging information on national policies and making recommendations for the future, particularly on large-scale scientific R&D projects and research of global issues and for finding opportunities of new international cooperation in specific S&T fields, building an international framework for determining important scientific policies and utilizing scientific knowledge on global issues.

Secretariat, where they are working on developing new indicators. A decision was made at the FY 2012 annual meeting to start revising the Frascati Manual, the OECD guidelines for measuring R&D and a working group was organized in April 2013 for implementing the revision.

c) International Science and Technology Center (ISTC)

The ISTC is an international organization established by the four parties of Japan, the U.S.A., the EU and Russia in March 1994, with the aim of providing Russian and CIS former weapons scientists who had engaged in the development of weapons of mass destruction with opportunities to redirect their talents to R&D conducted for peaceful purposes. As of December 2014, the funds earmarked for approved projects amount to 884 million US dollars and cumulative researchers from Russia and the CIS who have engaged in these projects exceed 75,000.

(iii) Utilization of research institutions

(Economic Research Institute for ASEAN and East Asia (ERIA))

ERIA is an institution that provides policy analyses and recommendations toward East Asian economic integration. Under the three pillars of deepening economic integration, narrowing development gaps and achieving sustainable economic development, ERIA implements research, symposiums and human resources development in a wide range of areas, including innovation policies. In FY 2014, ERIA conducted research on the production and use of biomass as part of its efforts for the dissemination and promotion of S&T.

(iv) International research grant programs

(Human Frontier Science Program (HFSP))

The HFSP is an international research grant program first advocated by Japan at the summit at Venice in June 1987. This program aims at supporting international joint basic research on the complex mechanisms of living organisms. The HFSP is now operated by 14 parties (Japan, the U.S.A., France, Germany, the EU, the U.K., Switzerland, Canada, Italy, Australia, South Korea, New Zealand, India and Norway). Japan has been actively supporting the program since its establishment. This program provides grants for research expenses of international joint research teams, supports young researchers by covering the cost of traveling and staying abroad for research activities and holds HFSP awardees' meetings. The HFSP program has gained worldwide acclaim partly because 25 HFSP awardees had received Nobel Prizes as of FY 2014.

(v) Efforts by Japan's scientific institutions

(International activities by SCJ)

SCJ has been contributing to Japan's cooperation with other countries, by representing Japan for taking part in 45 international scientific organizations including the International Council for Science (ICSU) and the global network of science academies (IAP[1]).

1 IAP - the global network of science academies: Founded in 1995 as a forum for global science academies SCJ has been an IAP Executive Committee member from 2004 through 2009 and from 2013 through 2015.

Ahead of the Summit, science councils, including SCJ and other G7 science councils, made a joint statement to world leaders from scientific perspective.

At the G7 Science Council in Germany in February 2015, infectious diseases and the global environment were subject to discussion.

In May 2014, the 14th Science Council of Asia (SCA[1]) was held in Malaysia with the theme of "Future Earth: Studies on a comprehensive understanding of global sustainability and sustainable development of Asia" to urge Asian countries to collaborate and establish partnerships in scientific fields.

(vi) Efforts for peaceful use of nuclear energy

Japan concluded the Safeguards Agreement with the International Atomic Energy Agency (IAEA) in 1977 and signed the Additional Protocol in 1998. Pursuant to the agreement and the protocol, Japan has been complying with IAEA safeguards whereby the IAEA verifies that nuclear materials are used only for peaceful purposes and are not diverted or misused for nuclear weapons assembly. Thus, pursuant to the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (Law No. 166 of 1957) ("Nuclear Reactor Regulation Law"), Japan has been implementing a system of accounting for and controlling nuclear material, providing reports to the IAEA and accepting IAEA inspections. The IAEA evaluation has concluded every year that all the nuclear materials in Japan are used solely for peaceful purposes.

Japan has been working with the IAEA and the U.S in taking the leadership role in advancing international cooperation related to R&D on technologies for nuclear nonproliferation and nuclear security as well as related to human resources development. At the Nuclear Security Summit held in the U.S.A. in 2010, Japan expressed its intention to establish the Integrated Support Center for enhancing nuclear nonproliferation and nuclear security globally with a focus on Asia and to advance technologies for the measurement and detection of nuclear material as well as for nuclear forensics. After the summit, the Integrated Support Center for Nuclear Nonproliferation and Nuclear Security (ISCN) was established within JAEA. This center has provided training courses in nuclear nonproliferation and nuclear security to more than 2,100 officials and personnel from 49 countries, including Japan. In 2013, the ISCN made an arrangement with the IAEA regarding the development of human resources for nuclear security. Based on the arrangement, the ISCN and the IAEA have been jointly developing training programs and exchanging lecturers and information regarding human resources development. At the JAEA since 2011, Japan-U.S. joint efforts have been made in the demonstration of non-destructive assays of plutonium in spent fuel, the development of technology for nondestructive assays of fuel using nuclear resonance fluorescence, and the development of technology for nuclear forensics to identify the origin of illicitly trafficked nuclear materials. In 2014, the removal of all highly enriched uranium and plutonium fuel from the Fast Critical Assembly in JAEA to the United Sates was announced in a joint statement by the Leaders of Japan and the United States at the Nuclear Security Summit. Through these efforts, the Japanese government has been promoting international cooperation for the development of technologies and human resources in relation to nuclear nonproliferation and nuclear security, while also securing international trust in Japan's use of nuclear energy for peaceful purposes.

1 Science Council of Asia: Comprising 29 academic institutions from 17 countries

(vii) Other international efforts

In October 2014, the Cabinet Office held the Science and Technology Ministers' Roundtable Meeting, which was hosted by Shunichi Yamaguchi, Minister of State for Science and Technology Policy and attended by ministers responsible for science and technology policy, science advisors and others from 23 countries, to discuss the "Open and Transparent Science, Technology and Innovation Policies."

(3) The promotion of cooperation with developing countries on issues of global concern

To promote S&T cooperation with developing countries in Asia, Africa and Latin America, MEXT, JST, MOFA and JICA, which have necessary expertise, have been collaboratively implementing the Science and Technology Research Partnership for Sustainable Development (SATRPS[1]) program by utilizing Japan's advanced S&T and ODA. From FY 2008 through FY 2014, 87 SATREPS projects in 41 countries (including 47 projects in Asia and 20 projects in Africa) were adopted for implementation. These projects address issues relating to environment, energy, bioresources, natural disaster prevention and infectious diseases.

MEXT launched a program that combines international joint research with government scholarships for international students. Specifically, the government provides scholarships for international students who wish to study at the Japanese universities that are taking part in the SATREPS program. This program makes it possible for young researchers from countries participating in SATREPS joint research projects to earn degrees in Japan. Thus, MEXT is cooperating in many ways with other countries in developing their human resources.

MAFF is also providing support for the development of technologies and human resources in developing countries. MAFF supports agriculture, forestry and fisheries in these countries to address global-scale issues such as poverty reduction and climate change. For this purpose, assistance has been provided through international joint research projects to the development of crops resistant to drought and other environmental stress, technologies for reducing greenhouse gases from farmland and technologies for utilizing agricultural waste such as to mitigate global warming. Support is also provided through international agricultural research institutions to develop techniques for increasing the production of rice, root crops and legumes.

(4) Reinforcement of foundations for advancing international science and technology activities

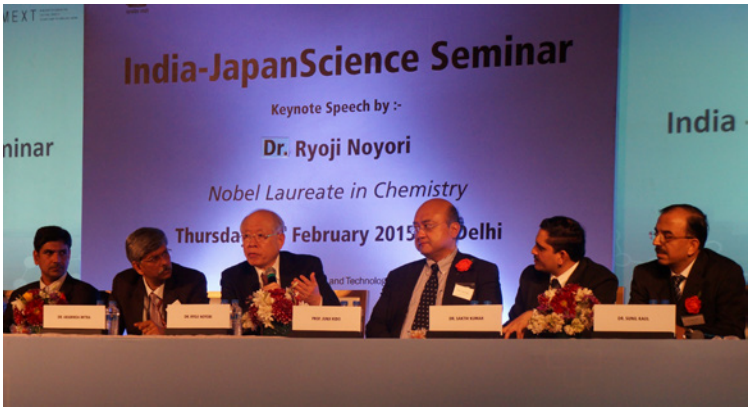
To strategically advance bilateral and multilateral cooperation in S&T, Japan needs to further promote intergovernmental dialog with other countries and to continuously collect and use information on overseas S&T trends. For this purpose, Japanese government is making efforts to strengthen the basis to develop international S&T activities.

1) Cooperation with other countries

(i) Cooperation with India and other emerging nations

1 Science and Technology Research Partnership for Sustainable Development

For cooperation with India, the 8th Joint Committee on Science and Technology Cooperation was held in Tokyo in October 2014 to discuss cooperation to date and in future. In February 2015, the Japan-India Science Seminar was held in Delhi to promote Japan-India cooperation and introduce enhanced S&T and features of universities and research institutions in Japan.



Panel discussion in Japan-India Science Seminar
Source: RIKEN

(ii) Cooperation with China, South Korea and other Asian countries

Within the framework of Japan-China-Korea trilateral cooperation, the Minister of Education, Culture, Sports, Science and Technology has attended the Japan-China-Korea Ministerial Meetings on Science and Technology Cooperation.

The Japan-China-Korea Ministerial Meeting on Science and Technology and the Trilateral Director-General's Meeting are held biennially and alternately and these meetings have resulted in support for research activities through the Japanese-Chinese-Korean Cooperative Joint Research Collaboration Program (JRCP) and Young Researchers' Workshops.

In addition to Japan-China-Korea trilateral cooperation, Japan is also promoting bilateral S&T cooperation with China and South Korea. For this purpose, the government has been exchanging information and researchers and supporting the implementation of bilateral joint research with China and South Korea.

JSPS supports exchange between research centers in Asia to establish scientific research networks and foster young researchers by launching the "A3 Foresight Program" and other activities.

A Joint Committee on Science and Technology Cooperation was also held with Vietnam in March 2015.

(iii) Cooperation with the U.S.A. and European countries

Japan has been actively advancing S&T cooperation with the U.S. and European countries in such advanced research areas as life sciences, nanotechnology, materials science, environmental sciences, nuclear technology and space exploration. Specifically, Japan has held meetings of joint committees on S&T cooperation based on bilateral S&T cooperation agreements, has been exchanging information and researchers with these countries and has been supporting the implementation of joint research.

In July 2014, the 14th meeting of the Japan-US Joint Working Level Committee was held in Tokyo to follow the Joint High-Level Committee on Science and Technology in 2013 and exchange opinions on various themes, including research collaboration in scientific fields. The 2nd Open Forum was held under the auspices of MOFA, MEXT and JST at the National Museum of Emerging Science and Innovation in cooperation with the U.S. Embassy. Participants from academies and industries in both countries discussed under the forum theme "Evolution to New Society - Utilization of Scientific Knowledge and Innovation."

Following consultations with the European Commission, Japan and the EU published the first

coordinated call for international joint research projects on ICT topics in October 2012 based on an agreement made with the European Commission. Joint ICT research started in 2013. In January 2014, the 2nd coordinated call was published and joint ICT research started in October.

In January 2011 through to December 2014, Japan took part in Connecting and Coordinating European Research and Technology Development with Japan (CONCERT-Japan), an international cooperation initiative funded under the 7th Framework Programme of the European Union (EU) for Research and Technological Development.

Japan also held the Joint Committee on Science and Technology Cooperation with Spain in September, with the U.K. in November, with Poland and Switzerland in December in 2014 and with Norway in February 2015.

In September 2014, the 4th Japan-U.S.-EU trilateral workshop on critical materials was held with attendance by government officials, materials engineers and other experts from Japan, the U.S. and Europe, urgently requiring rare-earth minerals. High-level government officials of the three economies participated in a workshop for cultivating a shared understanding of the global situation related to the supply of rare-earth minerals as well as for discussing strategic efforts required to ensure their stable supply.

When Prime Minister Abe visited France in May 2014, a cooperation agreement was signed between METI and MEXT in Japan and the Alternative Energies and Atomic Energy Commission (CEA) in France for the 4th generation sodium-cooled fast demonstration reactor (ASTRID) program, which is the sodium-cooled fast demonstration reactor R&D project in France and the development of sodium-cooled reactors. This agreement marked the start of Japan-France collaborative R&D. For this Japan-France ASTRID collaborative development, MEXT, METI, Federation of Electric Power Companies (FEPC), Japan Electrical Manufacturers' Association (JEMA), JAEA determined the development of key technologies for fast reactors useful for fast reactor demonstration technologies in Japan, proactive information gathering, including tank-type reactor design evaluation and technological knowledge by taking international trends into consideration, international trends in fast reactor development and technical investigation for quake resistance, safety, reliability, output level and economic efficiency, developing a system for efficient cooperation with France and investigating system development, including the international cooperation system in JAEA, which plays a central role in ASTRID collaborative development for the time being.

(iv) Cooperation with other countries

In March 2015, a Japan-Israel Joint Committee on Science and Technology Cooperation was held.

Japan is also promoting exchanges of information and researchers as well as the implementation of joint research with Russia, South Africa, Brazil and other countries, according to bilateral Science and Technology Cooperation Agreements.

Human resource development and exchange, as well as collaborative research are promoted for future with emerging countries.

2) Policy dialogs regarding science and technology initiated by the private sector

Based on the understanding that it is necessary to broaden the range of S&T diplomatic activities and to

ensure opportunities for constant dialogs among international stakeholders, in 2013 JST implemented the Program for the Promotion of International Policy Dialogs Contributing to the Development of Science and Technology Diplomacy, a program under the JST initiative for Infrastructure Development for Promoting International S&T Cooperation. This program supports organizers of international meetings that are held to provide a broad range of stakeholders, who are playing a leading role in advancing S&T in industry, academia and government globally, with opportunities to discuss the future direction of S&T.