"Michibiki" in FY 2010. In addition, for transportation of supplies to the International Space Station (ISS) by H-IIB rocket No.2 and as Japan's contributions to ISS program, an unmanned cargo transfer spacecraft H-II Transfer Vehicle "KOUNOTORI" No.2 (HTV 2) was successfully launched. As a result, it was the 14th consecutive success in launching large rockets, which include the H-II B rocket, leading to a launch success rate of 95%, which has earned high credibility.

(Telecommunication satellites systems, positioning, navigation and timing satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellite)

Utilization of satellites for communications, broadcasting, and other purposes offer a broad range of benefits in terms of wide-area use, broadcast simultaneity, durability following disasters, etc. To this end, the telecommunication satellites systems, positioning, navigation and timing (PNT) satellite system, satellite observation and monitoring system, and satellite sensor technology and fundamental technology of satellites have been selected as essential R&D issues.

In regards to the telecommunications satellite system, MEXT in cooperation with MIC, the experiments are being conducted by utilizing the Engineering Test Satellite-VIII "KIKU No.8" (ETS-VIII) to develop and demonstrate large-scale satellite bus technologies, large deployable antenna technologies and satellite mobile communication technologies, and the Wideband Inter-Networking Engineering Test and Demonstration Satellite "KIZUNA" (WINDS) to develop and demonstrate gigabit-class satellite internet communication technologies. As a part of this project, at the Great East Japan Earthquake, special disaster satellite communication lines to the affected areas by utilizing these satellites were temporarily provided. As for the PNT satellite system, MIC, MEXT, METI and MLIT are collaborating each other to launch the first quasi-zenith satellite (QZS) "Michibiki" which makes high-precision positioning, navigation and timing possible without being affected by mountain valleys or tall buildings in September 2010 and initiated technical and application demonstration in December of the same year. Explanation of the satellite observation and monitoring system is included in Part 2, Chapter 2, Section 2, 3 (1) and 7.

As for R&D regarding satellite sensor technology and fundamental technology of satellites, the "Program to Improve Reliability" (in relation to satellites) has been selected as a strategically prioritized S&T, and JAXA is working to improve the reliability of satellite bus technology and components. In "Research and Development of a Small-sized Advanced Space System," which was newly selected as strategically prioritized S&T, METI is promoting R&D of the small-sized high performance satellites to enhance their functionality to a level equivalent to that of larger satellites, lower their cost, and shorten delivery time.

As well as to promote the development of technologies of these satellites, under the policy established by the Strategic Headquarters for Space Policy directed by the Prime Minister, the government executed space diplomacy. In March 2011, Japanese satellite manufacturer accepted an order of two communication satellites from Turkey as a result of the collaboration between the government and the private sector.

(Promotion on use of space)

The use of space is very closely related to weather, telecommunications, broadcasting, etc. in people's

everyday lives, but the degree in which it is being applied in other fields pails in comparison to how commonly and widely it is being used in aforementioned ones. Considering such situations, Promotion of Space Usage Regulation Consignment Expenses was established in FY 2009 to utilize a wide range of knowledge possessed by industry, academia, and government for enhancing the use of space while seeking potential users and new applications for artificial satellites. As a result, R&D activities are continuously implemented to contribute to the promotion of the use of space to create the market in space industry in the various fields including disaster prevention, medical care, agriculture, forestry, and fisheries, and education.

(Acquisition of technologies for manned space activities based on the International Space Station Program)

The International Space Station (ISS) Program is an international collaborative program in which five parties including Japan, United States, Europe, Canada, and Russia. Japan participates in the program, through development and operation of the Japanese Experiment Module "Kibo" and "KOUNOTORI," an unmanned cargo transfer spacecraft H-II Transfer Vehicle (HTV). In August 2008, some scientific experiments in "Kibo" were started. These experiments including researches on drug development by crystallization of protein and prevention of bone loss and urinary stone, are showing great results in the field of preventative medicine concerning aging society. In April 2010, Astronaut Yamazaki completed her missions such as transporting supplies to the ISS successfully with Astronaut Noguchi who was on a long duration expedition on the ISS and was in charge of transportation of supplies. In February 2011, Astronaut Wakata announced his long duration expedition and being the first ever Japanese ISS commander (Captain), selected for the last half of the expedition period. In March of the same year, after "KOUNOTORI No.1" was launched in 2009, No.2 also completed the mission of material supplies to the ISS. Furthermore, these technologies and achievements were appraised and the "proximity communication system" (the main communication device for safe rendezvous docking and guiding space cargo transport vehicle to the ISS) that was installed on "KOUNOTORI" was adopted by unmanned spacecrafts being developed by the U.S.

(Solar system exploration and space astronomical observation)

JAXA serves as the center of space science in Japan by launching science-mission satellites and conducting R&D with the participation of researchers from various universities and academic institutes nationwide, and has made world-class achievements.

"HAYABUSA" Returning to the Earth
Photo: Provided by JAXA

Japan is promoting the scientific satellite project as one of the important R&D projects. In June 2010, asteroid explorer, the "Hayabusa" (Muses-C) has returned to the Earth and brought back some materials from celestial bodies other than the moon for the first time in history. JAXA is currently conducting analysis on minute particles extracted from the capsules. In addition, the Solar Physical Satellite "HINODE," (Solar-B) that is still continuing observation via international cooperation and X-ray

Astronomical Satellite "SUZAKU" (Astro-E II), are collecting observation data, and contributing to scientific research. The Venus Climate Orbiter "AKATSUKI" (Planet-C)that was launched in May 2010, has failed on entry into the orbit that goes around the Venus and while thorough investigation of the causes are conducted, JAXA is considering another Venus orbit entry. In addition, Interplanetary Kite-craft Accelerated by Radiation Of the Sun "IKAROS," a deep space solar sail demonstrator that was launched at the same time as "AKATSUKI," has proved the possibility of space navigation using solar power and expanding sails in deep space and acceleration using the sails were achieved successfully for the first time in history. Furthermore, Japan continuously promotes the development of projects, including the Mercury Exploration satellite (Bepi Colombo) under international cooperation with the European Space Agency.

(Promotion of international cooperation/collaboration)

To solve global issues, such as climate changes and large-scale natural disasters, the necessity of earth observation satellite technology and the importance of multinational cooperation and collaboration in space technology utilization are growing more than ever. Japan aims for further promotion of international cooperation in space area through the Asia-Pacific Regional Space Agency Forum (APRSAF), which Japan serves as a host country, as well as other international conferences such as the Committee on the Peaceful Uses of Outer Space (COPUOS) and the Committee on Earth Observation Satellites (CEOS). Especially in Asia, Japan promotes the Disaster Management Support System in the "Sentinel-Asia" project with the cooperation of 60 institutions in 24 countries/regions and 10 international organizations (as of January 2011) through the APRSAF. In addition, based on Japan's initiative, the Satellite Application for Environment (SAFE) project that monitors global environmental changes is being promoted under APRSAF.

In particular, MEXT has selected the APRSAF as one of the important pillars for the plans for promoting space diplomacy decided by Strategic Headquarters for Space Policy. In FY 2010 at 17th APRSAF, MEXT called for participation of the project together with the training of human resources for R&D on nano-satellite where universities took the initiative with the cooperation between space emerging countries in Asia.

(2) Ocean Development

(Promotion of R&D in frontier - oceans science)

The ocean is still a new frontier for human beings because of its vastness and difficulty to access. It has long been investigated and studied with the intellectual desire to clarify the unknown. Through these approaches, the existence of unused energy and mineral resources and the relation of the ocean to global environmental changes, including climate changes, have been made clear. Thus, pursuing and clarifying the principle of various phenomena in the ocean are necessary to address important issues closely related to human development, including the solution to global environmental problems, countermeasures for ocean-trench earthquakes, and the development of ocean resources.

MEXT has conducted a discussion on issues to be promoted in relation to marine science and technology in preparation for implementation of the "New Growth Strategy" in the CST's Subdivision on Ocean Development in FY 2010.

In the sectoral promotion strategy for the frontier (ocean) field in the 3rd Basic Plan, the

"Next-generation Ocean Exploration Technology" which constitutes the "Earth Observation and Ocean Exploration System" of the Key Technologies of National Importance, and the "Offshore Platform Technology" were chosen as strategically prioritized S&T. Furthermore, the important R&D issues in the following three domains were chosen.

(Deep sea and deep seabed exploration technology, technology to utilize marine resources)

MEXT is promoting the development of the advanced fundamental technology necessary for the observation/exploration of oceans by JAMSTEC. For example, in August 2010, as a part of key technologies of national importance "Next generation deep sea exploration technology [Literal translation]," R&D were promoted on small Lithium ion batteries for deep sea use that enables long time stable supply of electricity and developed new technologies such as highly functional imaging system that can record three-dimensional information and managed to successfully demonstrate in deep sea. Moreover, the deep-sea cruising AUV (Autonomous Underwater Vehicle)"URASHIMA," with the world record for the longest continuous autonomous cruise (317km), and the manned research submersible "SHINKAI 6500," with a world-class depth range (6,500m), are used for investigation, observation and research of the ocean. Concerning strategically prioritized S&T, "next-generation ocean exploration technology" was selected as one of the technologies to constitute the "Earth Observation and Ocean Exploration System" of the Key Technologies of National Importance. JAMSTEC promotes the development of the world's best technology for ocean riser drilling using the deep sea drilling vessel "CHIKYU," which was developed for drilling into the mantles previously untouched and for collecting useful microorganisms in the crust; the development of technology for a next-generation deep-sea cruising vessel; and the development of technology for a deep-sea high-performance unmanned vessel. These technologies enable surveys and observations in sea/hydrographic areas where investigation is difficult through conventional means, such as ships, and in the very deep-sea areas where heavy or precise work is required.

Furthermore, based on "Promotion on development and dissemination of marine resources and marine renewable energy", which was listed on the "Growth Strategic Execution Plan" of "New Growth Strategy," in order to promote the development of unused marine resources, such as sea-floor hydrothermal deposits, etc., at MEXT, the investigative commission of effective uses of marine resources in the CST's Subdivision on Ocean Development, held in August 2010, considered their position about future technological development, focusing on the development and operation of AUVs which are expected to play important roles in exploration of marine mineral resources and finalized a report titled, "About How to Conduct Demonstration of the Technologies for Marine Mineral Resources Exploration [literal translation]." In relation to the sensors and other exploration technologies, MEXT is implementing the "Program for the development of advanced sensor technologies to search for marine resources" [literal translation], aiming at promoting R&D for enabling effective exploration of marine resources such as sea-floor hydrothermal deposits in a broad area. In addition, in September 2010, deep sea drilling at Iheya-North hydrothermal area of Okinawa trough was implemented and various metal sulfides similar to that of black ore were extracted.

(Oceanic environment observation/forecasting technology, ocean usage technology, oceanic environment conservation technology)

JAMSTEC is promoting observation and simulation research on the global environment (observation of ocean, land and atmosphere and conducted around the world using observation facilities such as research vessels, buoys and terrestrial observation tools and prediction/simulation of climate changes, aiming to clarify global environmental changes including global warming). Furthermore, JAMSTEC analyzed the data obtained through observation and research by utilizing the supercomputer "Earth Simulator," which has the world's highest level of performance, and conducted modeling research for physical, chemical, and ecological programs of the global environment, thus contributing to improvement in prediction accuracy of phenomena that affect the climate on a global scale.

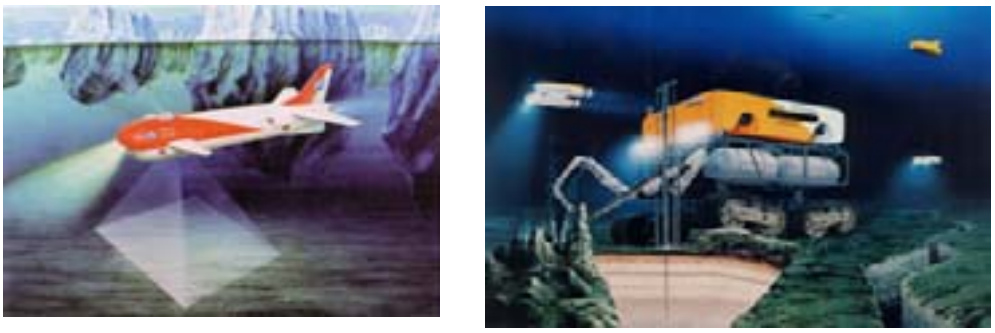
METI continues to implement surveys for reserves of oil and other resources in cooperation with Japan Oil, Gas and Metals National Corporation.

MLIT is working jointly with the Port and Airport Research Institute to improve the Nationwide Ocean Wave Information Network for Ports and Harbors (NOWPHAS).

JMA continuously implements surveys and research to improve monitoring and observation information of ocean phenomena and climate changes, including the observation of oceanic and maritime climatic phenomena and the clarification of the El Nino phenomenon.

JCG conducts R&D on oceanic surveying and observation technology as well as analysis technology.

The National Maritime Research Institute implements research on safety and environmental conservation in terms of ocean technology. In regards to the North-East Asian Regional Global Ocean Observing System (NEAR-GOOS project), JMA and JCG operate a system for promoting the exchange of oceanic data for NEAR-GOOS areas, further enhancing oceanographic research.



Conceptual diagram of the next generation deep-sea cruising AUV (left) and the deep-sea high-performance unmanned research vehicle (right) to be developed in the Next-generation Ocean Exploration Technology

Pictures: Japan Agency for Marine-Earth Science and Technology

(Research on clarification of the inner structure of the earth, lives within the earth's crust, undersea earthquakes and tsunami prevention technologies)

JAMSTEC is promoting research on the dynamics of the earth's interior including the dynamics analysis of ocean floor plates and the crustal structure exploration for continental shelf territorial delimitation are implemented using the remotely operated vehicle KAIKO 7000 and deep sea research vessels. For example, an ocean-floor observation system is being developed to monitor earthquakes, tsunamis and crustal movements in real-time at the source zone of the Tonankai and Nankai Earthquakes, which is predicted to

cause extensive damage to Japan. In addition, JAMSTEC promotes ocean drilling with the deep-sea drilling vessel "CHIKYU" in the Kumano Basin, off the Kii Peninsula under the framework of the Integrated Ocean Drilling Program (IODP), aiming at clarifying the mechanism of massive ocean-trench earthquakes and the biosphere under the ocean floor. In the FY 2010, JAMSTEC implemented scientific drilling in Nankai Trough to collect core samples, data through measurement of physical properties, and installation of long-term borehole measurement system for providing invaluable insights into the mechanism of great earthquakes. Furthermore, drilling expedition was carried out at the Iheya- North hydrothermal field in the Okinawa trough to obtain evidence for microbial communities, including their biomass and ecosystem roles and function.

Major research areas in frontier science implemented in FY 2010 are as shown on Table 2-2-11.

Table 2-2-11/Major Research Projects in Frontier Science (FY 2010)

Ministry	Research organization	Subject
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology	-Core technologies of satellite for disaster prevention measures and risk management
Ministry of Education, Culture, Sports, Science and Technology		- Infrastructural tool development program for marine resource applications
	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Next-generation ocean exploration technology -Development of the world's best deep sea riser drilling technology by CHIKYU -Development of technology for next-generation deep-sea cruising AUV -Development of technology for deep sea high performance unmanned research vehicles
	Japan Aerospace Exploration Agency	R&D on rockets -H-IIA /H-IIB rockets, solid rockets Promotion of Application and R&D on satellites -Land and sea observation, Earth environmental observation, advanced communication, accession Research on space science -X-ray, infrared rays, radio waves, Moon and planets, research on space engineering
Ministry of Economy, Trade and Industry		-R&D on remote sensing technology -Methane hydrate technology development
	National Institute of Advanced Industrial Science and Technology (AIST)	-Prediction of Earth and ocean environments based on geochemical and paleontological research of modern and past environments -Marine geological research and survey
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization (NEDO)	-Project on the development of fundamental technology for next generation transportation system design
	Japan Oil, Gas and Metals National Corporation (JOGMEC)	-Deep-sea mineral exploitation survey
Ministry of Land, Infrastructure, Transport and Tourism		-Research and development of offshore platform technologies
	Hydrographic and Oceanographic Department, Japan Coast Guard	-IOC Sub-Commission for the Western Pacific Region (WESTPAC)

[Transdisciplinary areas]

1 Key Technologies of National Importance

For Japan to achieve sustainable growth and lead the world amidst rapidly-changing conditions, such as tightening supplies of resources and energy, global warming and frequent occurrence of natural disasters, a long-term national strategy is vital, along with carefully-selected and promoted key technologies.

To this end, the government selected five Key Technologies of National Importance, namely "space transportation system," "earth observation and ocean exploration system," "FBR cycle technologies," "next-generation supercomputer," and "x-ray free electron laser" upon the formulation of the 3rd Basic Plan and sectoral promotion strategy.

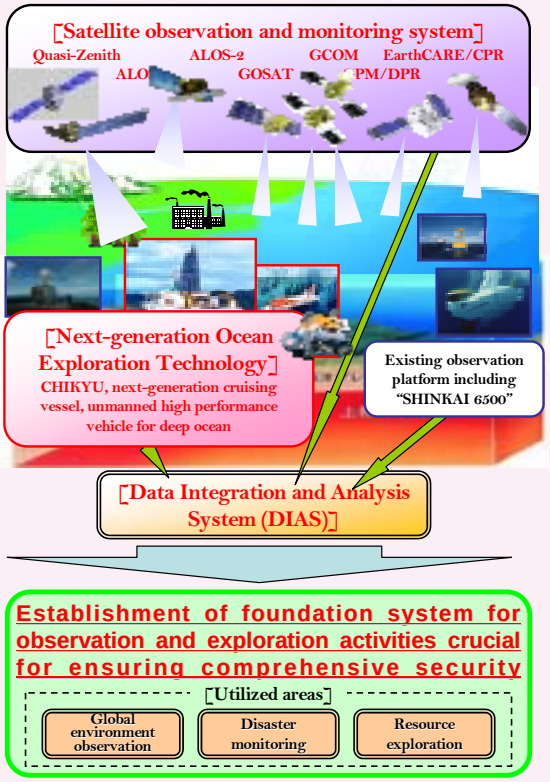
(1) Space transportation system technology

Refer to Part 2, Chapter 2, Section 2, 8 (1).

(2) Earth observation and ocean exploration system

In order to predict changes in the global environment, it is necessary to prepare a global observation network and to manage and share data derived from this network. In addition, detailed surveys of topographic features and exploration of resources in Japan's oceanic surroundings are necessary from the viewpoint of overall national security. In order to solve such issues, the earth observation and ocean exploration system aims to integrate, analyze, and provide data obtained from surveys of both ocean and space gathered to address such issues, and is comprised of three technologies: next-generation ocean exploration technology, satellite observation and monitoring system, and the data integration and analysis system (DIAS). The promotional framework for the entire system was evaluated by CSTP in FY 2006, with social contributions in the areas of global environmental observation, disaster monitoring and resource exploration anticipated in the future. In addition, to promote earth observation and ocean exploration, a forum is held every year for the purpose of understanding broad needs of users for observed data and of enhancing collaboration among concerned institutions and research disciplines. (Figure2-2-12)

Figure 2-2-12/ Conceptual Diagram of the Earth Observation and Ocean Exploration System

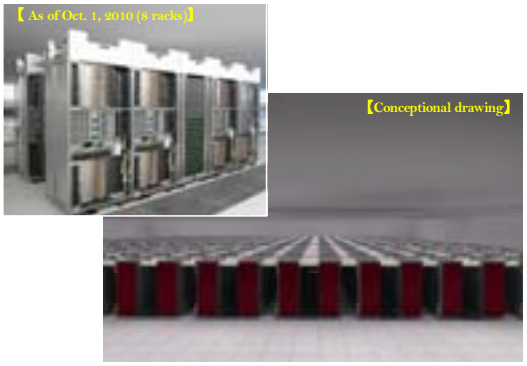


(3) FBR cycle technologies

Refer to Part 2, Chapter 2, Section 2, 5 (1).

(4) Next-generation supercomputer, "K"

Simulation using supercomputers is firmly establishing its position as the latest S&T technique, supplementing ongoing theoretical and experimental methods. Because supercomputers enable large-scale simulation at high speed, they are used for analysis of collisional damage of automobiles and to forecast typhoon paths, torrential rain, etc. In order for Japan to maintain its world-leading positions in a wide range of areas, such as science technology, academic research, industry, and medicine, MEXT is conducting the development and maintenance of a next generation supercomputer, "K", aiming to reach 10 Peta Flops[1] by June 2012 and to start the shared use by November of the same year. In FY 2010, MEXT has finished the detailed design, the prototype development, and the evaluation and initiated the manufacture of "K" and started the partial operation in the end of March 2011. (Refer to Part 2, Chapter 2, Section 2, 2.)



Next-Generation Supercomputer, "K"
Source: RIKEN AICS

1 10 Peta Flops: Calculation capability of ten thousand trillion per second

(5) X-ray free electron laser (XFEL)

The X-ray free electron laser (XFEL) facility is oscillating the ultimate light combining features of laser and radiation light, and is a world cutting-edge base research facility that makes it possible to carry out analysis that was impossible with conventional measures. The aforementioned facility will enable instantaneous measurement and analysis of ultra-microstructures at the atomic level and super-high-speed movement or changes in chemical reactions and is expected to offer innovative results in a wide range of research field including development of medical supplies and fuel cells, and clarification of mechanism of photosynthesis. The construction of XFEL has completed in September 2010 and conducting test operations for its shared use which is expected to start in March 2012. In addition, the name was decided as "SACLA" in March 2011. (Refer to Part 2, Chapter 2, Section 2, 4.)

X-ray Free Electron Laser (XFEL) facility [The rectangular-shaped building at left is XFEL. The circular-shaped building is the Super Photon ring-8 GeV (SPring-8)] (January 2009)

Source: RIKEN

2 S&T for Safety and Security

The 3rd Basic Plan posts "The world's safest country: making Japan the world's safest" as one of its goals, and promotes S&T approaches that contribute to the building of a safe and secure society in accordance with policies such as the "sectoral promotion strategy" and the "science and technology promotion strategy contributing to safety" [literal translation].

MEXT has implemented the "Project on Science and Technology for a Safety and Security" [literal translation] and is promoting R&D of important R&D issues including anti-terrorism measures and the safety and security of society, while enhancing opportunities to share knowledge and technology. In addition, it prepared the "promotion of R&D for safety and security" [literal translation] in FY 2009, and based on this promotion, started the "R&D Program for Implementation of Anti-Crime and Anti-Terrorism Technologies for a Safe and Secure Society" since FY 2010 in collaboration with concerned ministries.

International cooperation is executed mainly under the bilateral S&T cooperative agreements between Japan and the US. Concretely, cooperative activities are being actively promoted as part of the U.S.-Japan Framework Initiative for a Safe and Secure Society Initiative.

In addition, the Japan Science and Technology Agency (JST) promotes solution-oriented R&D grounded in on-site expertise and experience in the five areas of "A New Design for Aging Society created by the Community," "Community-based Actions against Global Warming and Environmental

Degradation," "Protection of Children from Crime," "Science Technology and Humanity," "Information Technology and Society," and implementing "Service Science, Solution and Foundation Integrated Research Program," utilizing knowledge not only in the area of the natural sciences, but also humanities and social sciences, with the objective of providing specific solutions to various social problems and contributing to a secure and stable society.