Table 2 2 7 Major Research Projects in Manufacturing Technology (FY 2009)

Ministry	Research organization	Subject
Ministry of Education, Culture, Sports, Science and Technology		- R&D on simulation software that becomes the base of innovation creation [literal translation]
	Japan Science and Technology Agency	- Project on acceleration of industry-academia collaboration [literal translation]
	RIKEN	- Research on the establishment of technology information integration system in advanced IT
Ministry of Economy, Trade and Industry	New Energy and Industrial Technology Development Organization (NEDO)	- Development of technologies for ultra-flexible display component [literal translation] - Development of technologies for super hybrid materials [literal translation] - Development of basic technologies for green sustainable chemical process [literal translation] - Technology for next-generation optical-wave control materials and elements [literal translation] - Technology for highly efficient manufacturing of three-dimensional optical device - Project to develop element technologies for strategic, cutting-edge robots - Project to develop manufacturing technology for next-generation devices combining different fields [literal translation]
Ministry of Land, Infrastructure, Transport and Tourism	National Institute for Land and Infrastructure Management	- Research on comprehensive evaluation methods and designing methods in relation to energy-saving functions in commercial construction [literal translation]

7 Social Infrastructure

Social infrastructure is a basic field that supports people's lives. In order to achieve a prosperous, secure, and safe society, R&D is being promoted to contribute to reducing the risks inherent in society and to improving public conveniences.

Disaster prevention

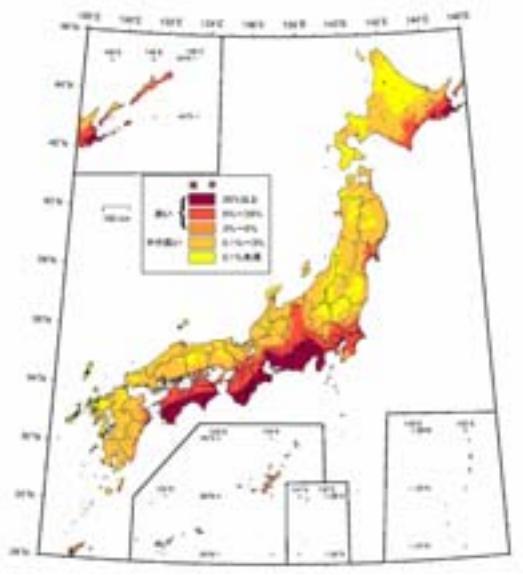
Natural disasters responsible for horrific damage occurred in Japan and abroad in 2009, including heavy rains in Chugoku and northern Kyushu in July 2009, the Haiti earthquake in January 2010, the Central Chile earthquake in February of the same year, and so on. These disasters make it extremely important to promote the earthquake-volcano forecasting research and disaster-prevention technologies aimed at reducing the damage caused by them.

Earthquake research in Japan is being promoted with the collaboration and cooperation of related administrative agencies under the Headquarters for Earthquake Research Promotion (Director: Minister of MEXT; hereinafter referred to as the "Earthquake Headquarters") established under the Act on Special Measures concerning the Earthquake Disaster Prevention (Act No. 111 of 1995). The Earthquake Headquarters compiled a new 10-year plan starting from FY 2009 with the "New Earthquake Research Promotion" [literal translation] in April 2009. This new plan suggests that research on ocean-trench earthquake and the active fault be promoted integrally and strategically within at least the first 10 years—with consideration to also be given to a 30-year timeframe—and their results be applied effectively to disaster-prevention and disaster-reduction countermeasures that aim to establish a society capable of minimizing seismic damage.

In regards to research on seismic/volcanic eruption forecasting, a new 10-year plan set forth by the Earthquake Headquarters also emphasized the importance of basic research based on the

recommendation, and the research is promoted at universities from FY 2009.

MEXT officially announced a new "National Seismic Hazard Map" in July 2009 that is more sophisticated and legible than the previous "National Seismic Hazard Maps for Japan," which had not been updated since 2005. In addition, "National Hazard Maps for Long-period Earthquake Ground Motion 2009: Trial Version" [literal translation] was published in September 2009 to illustrate the distribution of long-term earthquake ground motion, which is expected to occur locally or at a distance whenever major earthquakes of certain magnitudes occur. Furthermore, a "Special Project for Earthquake Disaster Mitigation in Metropolitan Tokyo Area," a "Intensive surveys and study on the concentrated strain zone," "Evaluation study of continuous movements associated with the Tokai, Tonankai and Nankai," and other investigations and research projects were conducted targeting areas vulnerable to serious social and economic losses. MEXT also expanded its investigation into faults in coastal areas previously uninvestigated, while conducting R&D of technology to create a high-density submarine network system equipped with seismographs and water pressure gauges that will enable real-time observation of the predicted seismogenic zones from the Tonankai Earthquake.



Distribution map of the probability of ground motions equal to or larger than a seismic intensity of 6, occurring within 30 years from the present
Source: Headquarters for Earthquake Research Promotion

MEXT is promoting the R&D of disaster prevention S&T based on the "Research and Development Policy on Disaster Prevention" [literal translation]. In FY 2009, MEXT implemented the "Program to promote education for disaster mitigation" in an effort to promote projects on disaster education based on the results of disaster prevention research and to disseminate them throughout the country. It is also conducting R&D on information systems for use in times of disaster under the Project on Science and Technology for a Safe and Secure Society.

The National Research Institute for Earth Science and Disaster Prevention (NIED) is implementing R&D using experiments and research on earthquake resistance with a 3-D Full-Scale Earthquake Testing Facility (E-Defense) that contributes to the reduction of seismic damage. It is also conducting research to reduce damage from natural disasters, including research on the highly accurate prediction of rainfall with next-generation high-performance radar (MP radar[1]), the prediction of landslides, windstorms, and flood disasters, and the prediction of volcanic eruptions and volcanic disasters. In addition, NIED initiated research related to the development of the Disaster Risk Information Platform, a system for the collection and distribution of information on various natural disasters. In 2009, it developed a volcano observation scheme, which included

1 MP (Multi-Parameter) Radar: A meteorological radar that uses two horizontal and vertical polarized waves. Compared with conventional radars, accurate estimation of rainfall and distinction of rain and snow are available.

assistance for university observational research activities.

JAXA operates the Advanced Land Observing Satellite "DAICHI" (ALOS), observes large-scale natural disaster areas and provides imaging to related disaster prevention facilities. In addition, JAXA is implementing R&D on highly accurate positioning measurement technology using a quasi-zenith satellite. These technologies are being developed and operated as technologies that make up the "Key Technologies of National Importance, Earth Observation and Ocean Exploration System," which aims to contribute both domestically and internationally by establishing a global observation and monitoring system using satellites that essential for Japan's overall security.

The National Institute of Information and Communications Technology (NICT) is conducting R&D of generic technologies related to Terahertz frequencies in order to develop high performance imaging sensory devices capable of recognizing local situations in hazy places—or in other locations where vision has deteriorated or harmful substances detected—that evade detection from conventional technologies such as X-rays, infrared rays, electric waves, etc.

FDMA is promoting R&D on fire prevention, led by the National Research Institute of Fire and Disaster, concerning the assurance of safe handling of hazardous materials by facilities in the event of earthquakes, technology to reduce damage from disasters, and research on technologies for disaster countermeasures.

The National Institute of Advanced Industrial Science and Technology (AIST) is promoting the seamless construction of a geological information system integrating information on sea and land obtained through geological and active fault investigation in coastal zones in addition to the installation and operation of integrated groundwater observation stations.

MLIT is promoting R&D on technologies aimed at realizing advanced social communities for disaster prevention that will serve as thorough precautions against disaster.

The Geographical Survey Institute (GSI) is conducting continuous GPS observation by using Electronic Reference Stations[1], observation of crustal deformation and plate motion by using state-of-the-art technologies, including a Very Long Baseline Interferometry (VLBI) and an interferometric SAR, and analysis of the data obtained from the above-stated observations.

The Japan Meteorological Agency (JMA) establishes and operates observation facilities and provides centrally integrated information, including observation data from relevant institutions. JMA also works together with NIED to conduct R&D toward further advancement of the emergency earthquake alert service.

To increase prediction accuracy for the Tokai earthquake, the Meteorological Research Institute (MRI) is developing an earthquake simulator which can reproduce the phenomenon of "slow slip" predicted to occur in the underground of the Tokai region. The institute is also conducting observations of crustal movement with the existing laser displacement meter.

The Japan Coast Guard (JCG) is promoting geodetic in the sea and investigation into submarine topography and active faults.

1 As of the end of March 2010, 1,240 stations were established.

Antiterrorism and public safety measures

In these troubled times with international terrorism and an evident deterioration of public order, the creation of a safe society with reduced crime is one of the most important and urgent needs of the general public. Therefore, it is extremely important to further enhance approaches to these problems utilizing the most advanced antiterrorism S&T and public safety measures.

In regards to antiterrorism and the prompt advanced detection of hazardous and dangerous materials, MEXT is conducting R&D under the Special Coordination Funds for Promoting Science and Technology and the Project on Science and Technology for a Safe and Secure Society, on systems for the detection of explosive materials, biological and chemical agents, and methods for the treatment of dangerous materials in a safe manner that are based on the excellence of our country's innovative technologies.

In addition, in regards to crime-fighting measures, intensive promotion of the development of technologies and systems that can be used at the site of crime prevention, investigation support, and identification is required in order to reduce crime while limiting the use of human resources. Therefore, the National Police Agency (NPA) is conducting various R&D of technologies utilizing S&T to assist in criminal investigations, antiterrorism, and crime prevention. The Japan Science and Technology Agency (JST) is promoting R&D to ensure child safety from criminal activity.

Transportation and transit systems

There is an urgent need to restore safety and reliability our means of transportation, which are necessary to the daily lives our citizens. It is therefore necessary to intensively promote the utilization of new technology to thoroughly prevent accidents and ensure safety by considering the expected increases in demand for air transportation in the future as well as human factors such as operators at transportation facilities, and the "discovery," "decision," and "operation" of car drivers.

NPA, MIC and MLIT are promoting R&D related to a system designed to support safe driving through coordination with infrastructure and an information processing capacity concerned with safe driving.

In addition, MLIT is implementing a project for the practical use of the Driving Safety Support System (DSSS) while developing infrastructure. It also conducts R&D in relation to drivers' information handling ability.

Furthermore, it is working on advanced R&D that will lead to safer and more comfortable transportation and transit systems in the future, as well as upgrades to information and telecommunications systems.

MLIT is also promoting R&D aiming to establish technologies for practical use of the superconducting magnetically elevated trains that will be the next-generation super speed mass transportation system.

In addition, in regards to air transportation, MLIT's research is expected not only to support the maintenance and improvement of safety and environmental compatibility, but to have a ripple effect on a wide range of areas, including information and telecommunications and nanotechnology and materials.

MEXT is promoting advanced and infrastructural R&D related to aeronautical science

technologies corresponding to the social needs of environmental compatibility and security. Specifically, MEXT is working on R&D for technologies to increase the performance of passenger airliners made in Japan, technologies to develop clean engines and silent supersonic aircraft, and technologies for all-weather and high-density operations, through JAXA. In addition, the ministry is cooperating in air accident investigation being carried out by MLIT's Japan Transport Safety Board, using the results of past R&D.

METI is promoting R&D to add value to the Japanese aircraft industry's bid to be the world leader next-generation ecological aircrafts, while breaking away from the "component and module division," and is also making efforts to strengthen Japan's competitiveness in the aircraft industry while conducting R&D of environmentally friendly engines for small aircrafts through the New Energy and Industrial Technology Development Organization (NEDO).

The Electronic Navigation Research Institute is selectively implementing R&D on the effective utilization of airspace and capacity expansion of flight routes, R&D on capacity expansion of congested airports, R&D of improved safety and efficiency achieved by preventive safety, and technologies for ensuring the security and smoothness of air traffic.

The major research topics in FY 2009 for infrastructure are shown on Table 2-2-8.

Table 2 2 8 Major Research Projects in Infrastructure (FY 2009)

Ministry	Research organization	Subject
National Police Agency	National Research Institute of Police Science	- Development of methods for identification from biological samples through the single nucleotide polymorphisms (SNPs) analysis - R&D on RN material detection technologies for R (Radiological) terrorism and equipment to support on-site activities [literal translation] - Research on on-site treatment technologies of explosive substances - Research on fast screening technology for multi-component drugs and poisons [literal translation] - Research on the sophistication of microphyte samples [literal translation] - Research on analysis of linked serial incidents and accelerated criminal profiling - Cognitive science study on the information processing abilities of drivers - Development of advanced traffic accident analysis technologies
Ministry of Internal Affairs and Communications	National Institute of Information and Communications Technology (NICT)	- R&D for terahertz radiation technology [literal translation] - R&D for global environmental change technology [literal translation] - R&D for subtropical environmental measurement technology [literal translation] - R&D for sensing network technology [literal translation]
	Fire and Disaster Management Agency	- Expenses required for R&D system of fire safety and disaster preparedness technologies
	National Research Institute of Fire and Disaster	- Information system for supporting dramatic improvement in on-site fire-fighting/rescue activities and disaster prevention activities - Reduction in damage of dangerous facilities during large-scale earthquakes - Understanding of fire behavior in buildings and facilities designed for various purposes
Ministry of Education, Culture, Sports, Science and Technology		- Comprehensive promotion of surveys on active faults [literal translation] - Development of Dense Ocean-floor Network System for Earthquakes and Tsunamis - Assessment of the synchronization of Tokai, Tonankai, and Nankai Earthquakes [literal translation] - Prioritized observation and research at the distortion-concentrated belt [literal translation] - Special Project for Earthquake Disaster Mitigation in Urban Areas - Promotion of seismic investigation and research (priority investigation and observation) - Safe and Secure Science and Technology Project
	Japan Science and Technology Agency	- Advanced integrated sensing technology
	National Research Institute for Earth Science and Disaster Prevention	- Earthquake engineering research utilizing the Three-Dimensional Full Scale Earthquake Testing Facility (E-Defense) - Research on the development of Disaster Risk Information Platform [literal translation] - Research on prediction of sediment, wind, and flood damage using MP radar

		[literal translation] - Research on developing volcano observation facilities, forecasting volcanic eruption, and preventing volcanic disaster [literal translation]
	Japan Agency for Marine-Earth Science and Technology	- Long-period monitoring system of excavation cavities - Sophistication of real-time seismic/tsunami monitoring system [literal translation]
	Japan Aerospace Exploration Agency	- Operation of the Advanced Land Observing Satellite "DAICHI" (ALOS) - High-precision positioning, navigation, and timing of experimental technology using a quasi-zenith satellite system - R&D on advanced land-observing satellites [literal translation] - Research and development of technologies for higher performance domestic passenger aircraft - R&D on clean engine technologies [literal translation] - Research and development of silent supersonic demonstrator air craft - R&D on all-weather and high-density service technologies [literal translation]
	Special Coordination Funds for Promoting Science and Technology	- Research and development of detection systems for nuclear substance concealed in hand-carried baggage
Ministry of Economy, Trade and Industry (METI)	New Energy and Industrial Technology Development Organization	- R&D on an engine for environmentally-compatible small aircraft
	National Institute of Advanced Industrial Science and Technology	- Maintenance technologies for land-sea integrated, seamless geological information [literal translation]
Ministry of Land, Infrastructure, Transport and Tourism (MLIT)		- Development of land monitoring technology aimed at disaster reduction by means of advanced image processing - Development of technology for housing land development and ultra-long-term durable house construction for multi generations - Technology for offering broad road traffic information and information related to safe drive assistance and for collecting information on vehicle travel routes - Technologies for air traffic control/operation support via utilization of IT technologies
	National Institute for Land and Infrastructure Management	- Examination of national land conservation measures compatible with climate change due to global warming [literal translation] - Research on the method for evaluating the level of social infrastructure development - Development of technologies for fire and safety measures in the aftermath of an earthquake for tall buildings [literal translation]
	Geographical Survey Institute	- Enhancement and improvement in prediction accuracy of crustal movement monitoring/modeling for reduction of damage caused by earthquake, volcanic eruption, etc.
	Japan Meteorological Agency	- Research on advanced technology for crustal movement monitoring along the Nankai Trough and technology for prediction of the Tokai earthquake [literal translation] - Research on development of technologies to grasp magmatic activities quantitatively and make advanced judgments on volcanic activity [literal translation]
	Public Works Research Institute	- Technologies for the perception of planar analysis information of precipitation by utilizing satellite information, etc. - Technologies for reducing damage, including quake-resistant design of structures for large-scale earthquakes - Development of technologies for predicting the danger of landslide disaster caused by heavy rain and earthquakes and the alleviation of damages thereof - Technology for the qualitative improvement of river levees for improved flood control safety - Enhancement of management of social capital, etc., and reduction of life cycle costs
	Building Research Institute	- Development of reorganization of cities and buildings to accommodate population reduction of an aging society with a falling birthrate - Development of technologies for the enhancement of daily safety and security functions in residences/buildings [literal translation] - Development of technologies related to production, maintenance, and distribution for the purpose of the long use of residences [literal translation] - Development of technologies related to advanced safety measures for structures such as skyscrapers and technologies for functional maintenance and early post-disaster recovery [literal translation]
	Port and Airport Research Institute	- Research on realization of the construction of more earthquake-resistant port areas, seaside facilities, and airport facilities [literal translation] - Research on protection of local society against enormous tsunamis [literal translation] - Research on prediction of seaside change in locations with several streams of overlapping currents and waves [literal translation] - Research on life cycle management of port areas, seaside, and airport facilities [literal translation] - Research on unmanned underwater works in port areas [literal translation]

8 Frontier Science

Frontier science is a science that exists for the exploration and probing of the unknown in space and oceans and the promotion of R&D for its development and utilization as new areas of activity. In the Science and Technology Basic Plan, frontier science is positioned as an area where R&D should be promoted and focused on as an R&D issue that must be addressed by the nation. This scientific field aims to contribute to improvements in the safety, security, and overall quality of people's lives, socio-economic development, the overall security of Japan, and sustainable development of humanity by using communication satellites and positioning, navigation and timing systems, earth observation and monitoring systems, and the oceans and their abundant resources.

(1) Space development and utilization

Space development and utilization have deeply infiltrated public life as seen in the work of weather and communication/broadcast satellites that have become indispensable to our existence. In June 2009, a national strategy for Japan was formulated based on the "Space Basic Law."

R&D on space contributes to the intellectual property of humankind with research results helping to improve security, add to people's lives, promote industry, develop society, and improve Japan's international standing. It is extremely important to advance policies that stress the utilization of space while improving technological development into the future.

The future major satellite launching plans of Japan are as shown on Table 2-2-9.

Table 2 2 9 Japan's Major Satellites Launch Schedule

Satellite	Weight (kg)	Orbital altitude (km)	Launch vehicle	Launch date	Major objectives
H-II Transfer Vehicle (HTV)	Weight: approx. 16,500 Supply weight: approx. 6,000	Elliptical orbit (200 x 300)	H-IIB	In FY 2010 (No.2)	To supply materials to the International Space Station via a Japanese transport system.
Space Environment Reliability Verification Integrated System-2 (SERVIS-2)	740	1200	Rockot (Russia)	In FY 2010	To demonstrate the durability of commercial off-the-shelf device/technologies in space.
Quasi-Zenith Satellite (QZS)	approx. 1,800	Quasi-zenith orbit (Long radius of the orbit: approx. 42,000)	H-IIA	In FY 2010	To demonstrate the fundamental technology of positioning, navigation and timing systems using satellites—which will reinforce the global positioning system.
Venus Climate Orbiter (PLANET-C)	approx. 480	Orbit around Venus (approx.300-80,000))	H-IIA	In FY 2010	To explore the Venusian atmosphere and solve riddles behind the basic principles of planetary weather and atmospheric evolution.
Global Change Observation Mission-Water (GCOM-W)	approx. 1,900	Sun synchronous sub-recurrent orbit (approx. 700)	H-IIA	In FY 2011	To observe global precipitation and water temperature on the surface of the sea in order to better understand global water recycle mechanisms.
Advanced Satellite with New system Architecture for Observation (ASNARO) *Tentative name	approx. 450	Sun synchronous orbit approx. 500	(Under review)	In FY 2012	To develop small, sophisticated satellites that feature functionality comparable to that of larger satellites, that are low cost, and that can be developed quickly.
Radio-Astronomical Satellite (ASTRO-G)	approx. 1,200	Highly elliptical orbit (approx.100-20,000)	H-IIA	In FY 2012	To draw the Milky Way and the core of a forming star with the highest resolution in history and to better understand their physical properties.

Advanced Land Observing Satellite-2 (ALOS-2)	approx. 2,000	Sun synchronous sub-recurrent orbit (approx. 630)	H-IIA	In FY2013	To observe global forests and geography for application of the data to meet needs under normal circumstances—including land and resource management—as well as to attempt to gain insight into disaster situations.
Global Precipitation Measurement /Dual-frequency Precipitation Radar (GPM/DPR)	approx. 3,500 (GPM Satellite)	Sun-asynchronous orbit (approx. 400)	H-IIA	In FY2013	To observe the three-dimensional distribution of precipitation and snow using the dual frequency precipitation radar (DPR) installed in the main satellite for international global precipitation measurement (GPM) project.
Mercury Exploration Project (BepiColombo)	approx. 220 (MMO)	Elliptical polar orbit around Mercury (approx. 400～12,000) (MMO)	Soyuz Fregat 2B	After FY2013	To observe the magnetic field, magnetosphere, the inside and the surface of Mercury from many angles through international cooperation with the European Space Agency. Japan is in charge of the Mercury Magnetospheric Orbiter (MMO).
Earth Clouds, Aerosols and Radiation Explorer/Cloud Profiling Radar (EarthCARE /CPR)	approx. 1,200 (EarthCARE Satellite)	Sun synchronous sub-recurrent orbit	Under review (Europe)	After FY2013	To observe the three-dimensional distribution of the cloud/aerosol in the atmosphere on a global scale with a cloud profiling radar mounted on the European Earth Clouds, Aerosols and Radiation Explorer (EarthCARE) Satellite.
Global Change Observation Mission - Climate (GCOM-C)	approx. 2,000	Sun synchronous sub-recurrent orbit (approx. 800)	H-IIA	After FY2014	To observe vegetation and cloud/aerosol on a global scale to contribute to the understanding of the mechanisms behind global climate change.
X-ray Astronomy Satellite "ASTRO-H"	approx. 2,400	Circular orbit (approx. 550)	H-IIA	After FY2013	To directly observe the growth of galactic clusters and huge black holes via X-rays to help clarify the large-scale structures of space and their development and to understand the extreme situations in space.
Geostationary earth environment observation satellite "Himawari-8"	approx. 3,500	Stationary orbit (approx. 35,800)	H-IIA	FY2014	To reinforce the monitoring capacity of global environment for the purpose of preventing natural disasters, including typhoons, in Japan and in Asian/ Western Pacific regions, through enhancement of the observational function of visible infrared radiometer.
Geostationary earth environment observation satellite "Himawari-9"	approx. 3,500	Stationary orbit (approx. 35,800)	H-IIA	FY2016	

Space transportation system technology

In order to maintain Japan's overall security and autonomy in space activity, it is important for Japan itself to have the ability to transport necessary satellites to a given place in space. Also, because space transportation system is an advanced system technology, the same activities that improve technical capability also help to sophisticate industry and develop social economy. That is the reason "Space Transportation System" has been selected as an essential R&D issue.

Particularly in relation to the H-IIA rocket developed as part of the "Space Transportation System," which is one of the Key Technologies of National Importance promoted under the national long-term strategy in the Basic Plan, No. 16 rockets launched the Information Gathering Satellite (IGS) Optical-3 in FY 2009. In addition, the unmanned cargo transfer spacecraft H-II Transfer Vehicle (HTV), which is used to transport supplies to the International Space Station (ISS), and the test vehicle of H-IIB rocket used to transport an eight-ton class satellite to the geostationary transfer orbit to secure means of launching HTV were successfully launched. As a result, it was the 11th consecutive success in launching large rockets, which included the H-II B rocket, leading to a launch success rate of 94%, which has earned Japan 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, Engineering Test Satellite-VIII "KIKU No.8" (ETS-VIII) was launched in December 2008 in cooperation with MEXT and MIC to develop and demonstrate large-scale satellite bus technologies, large deployable antenna technologies, and satellite mobile communication technologies. In February 2008, the Wideband InterNetworking engineering test and Demonstration Satellite "KIZUNA" (WINDS) was launched to develop and demonstrate gigabit-class satellite internet communication technologies, and experiments are being conducted in turn. As for the PNT satellite system, MIC, MEXT, METI and MLIT are jointly promoting the development of the quasi-zenith satellite (QZS), which makes high-precision positioning, navigation and timing possible without being affected by mountain valleys or tall buildings, under the Basic Plan for the Advancement of Utilizing Geospatial Information (Cabinet decision: April 15, 2008) and the Action Plan for the Advancement of Utilizing Geospatial Information (G-Spatial Action Plan) (Committee for the Advancement of Utilizing Geospatial Information, August 2008) based on the Basic Act on the Advancement of Utilizing Geospatial Information, and will launch it in FY 2010. 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.

New efforts in development and 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, a new scheme 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.

In addition, nano-satellites (100 kg-class or lighter), smaller than conventional artificial satellites (several metric tons), require shorter time and less cost for development, and are expected to incorporate the latest R&D achievements in miniaturization technology, in which Japan has

competitive advantage. Thus, corporations and universities are continuing their R&D activities. To accelerate these projects, a financial aid program for nano-satellite R&D was founded in FY 2009.

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(Japan, United States, Europe, Canada, and Russia) are participating to jointly construct the space station in low-earth orbit. Japan participates in the program, aiming to maintain and improve its international position as an advanced country in terms of space technology, and accumulate technologies for manned space activities through development and operation of the Japanese Experiment Module "Kibo" and the H-II Transfer Vehicle (HTV) . In July 2009, Kibo's Exposed Facility was attached to the ISS, which concluded the construction of "Kibo" and scientific experiment in Kibo was started in full scale. In September, HTV "Technical Demonstration Vehicle" was launched to transport supplies to the ISS and completed its missions successfully. In December, Astronaut Noguchi started long duration expedition to the ISS for about five and a half months, even longer than that of Astronaut Wakata.

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.

The final shot taken with the High-resolution photo-shot from the lunar explorer satellite "KAGUYA" (SELENE) (Altitude: about 14km)
Photo: Japan Aerospace Exploration Agency / Japan Broadcasting Corporation

Japan is promoting the scientific satellite project as one of the important R&D projects. The lunar orbiting satellite "KAGUYA" (SELENE) was deployed until June 2009 and is still analyzing the collected data to show us a variety of achievements. The Solar Observatory HINODE is also collecting solar observation data, and contributing to scientific research on the sun. In addition, Japan continuously promotes the development of projects, including the Venus Climate Orbiter (PLANET-C), the Mercury Exploration satellite (Bepi Colombo) under international cooperation with the European Space Agency, and others.

Promotion of international cooperation/collaboration

In accordance with worsening global problems, such as environmental changes and large-scale natural disasters, the necessity of earth observation satellite technology and the importance of multinational cooperation and collaboration in space technology are growing more than ever. Japan aims for further promotion of international cooperation in the area of space science through the Asia-Pacific Regional Space Agency Forum (APRSAF), which Japan serves as the 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 56 institutions in 22 countries and nine international organizations (as of January 2010) through APRSAF. In addition, based on Japan's initiative, the Satellite Application for Environment (SAFE) project to monitor global environmental changes and the Satellite Technology for the Asia-Pacific Region (STAR) project for the production of small-sized satellites, which will be developed jointly with other countries aiming at fostering competent persons, were established under APRSAF in December 2008, showing that the area of Japan's activities has expanded.

(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 advancement, including the solution to global environmental problems, countermeasures for ocean-trench earthquakes, and the development of ocean resources.

From such a perspective, the "Basic Act on Ocean Policy" was enacted in July 2007, and the "Basic Plan on Ocean Policy" was decided in a Cabinet meeting in March 2008 to determine the ocean policy for the next five years. Specific plans were set forth for exploration and R&D for the practical use of methane hydrate and sea-floor hydrothermal deposits, etc., in the "Ocean Energy and Mineral Resources Development Plan" [literal translation]. (March 2009)

MEXT organized important matters in relation to marine science and technology in preparation for implementation of the Fourth Science and Technology Basic Plan in the CST's Subdivision on Ocean Development in September 2009.

In the sectoral promotion strategy for the frontier (ocean) field in the Third Science and Technology 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 living marine resources

MEXT is promoting the development of the advanced fundamental technology necessary for the observation/exploration of oceans by JAMSTEC. For example, in June 2009, a telecommunications demonstration experiment was found to be successful for the first time in the world's open seas, for the horizontal distance of 300 km. Moreover, the deep-sea cruising vessel "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 technology for ocean riser drilling on the floor of the deepest sea in the world using the deep sea drilling vessel "CHIKYU," which was developed for drilling into earth's previously untouched mantles 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.

In June 2009, in preparation for promoting development of unused marine resources, such as sea-floor hydrothermal deposits, etc., MEXT organized a report titled, "About How R&D Should Be in Relation to Marine Mineral Resources Exploration [literal translation]." The CST's Subdivision on Ocean Development published this to promote development of marine resource exploitation technologies, including essential sensor and exploration technologies. In relation to the sensors and other exploration technologies, MEXT implemented the "Platform Tool Development Program for the Promotion of the Use of Marine Resources" [literal translation], aiming at promoting R&D for enabling broad and effective exploration of marine resources, including sea-floor hydrothermal deposits.

Conceptual diagram of the next generation deep-sea cruising vessel (left) and the deep-sea high-performance unmanned vessel (right) to be developed in the Next-generation Ocean Exploration Technology
Pictures: Japan Agency for Marine-Earth Science and Technology

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

MEXT is promoting observation and simulation research on the global environment (observation of ocean, land and atmosphere and prediction/simulation of climate changes conducted around the world using observation facilities such as research vessels, buoys and terrestrial observation tools, aiming to clarify global environmental changes including global warming) through JAMSTEC. Furthermore, MEXT 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.

Research on clarifying the inner structure of the earth, undersea earthquakes and tsunami prevention technologies

JAMSTEC is promoting research on the dynamics of the earth's interior, wherein surveys on crustal structure that contribute to the dynamics analysis of ocean floor plates and to the survey on the delimitation of the continental shelf are implemented using the remotely operated unmanned research vessel KAIKO 7000 and deep sea research vessels. For example, an earthquake and tsunami observation system is being developed to monitor the magnitude of earthquakes and tsunamis and the crustal movement in real-time at the source zone of the Tonankai and Nankai Earthquakes, which is predicted to cause extensive damage to Japan. In addition, MEXT promotes ocean drilling with the deep-sea drilling vessel “CHIKYU” off the Kumano-nada shore on the Kii Peninsula under the framework of the Integrated Ocean Drilling Program (IODP), aiming at clarifying the mechanism of massive ocean-trench earthquakes. In the FY 2009 Nankai Trough Seismogenic Zone Experiments, a riser was used for the first time in the world for scientific drilling to collect stratum samples and data through physical measurements for clarifying major seismetic mechanisms.

Major research areas in frontier science implemented in FY 2009 are as shown on Table 2-2-10.

Table 2 2 10 Major Research Projects in Frontier Science (FY 2009)

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)	**Technology for next generation ocean exploration systems** - Development of the world’s best deep sea riser drilling technology by CHIKYU - Development of technology for next-generation deep-sea cruising vessels - Development of technology for high performance unmanned research vehicles for deep ocean application
	Japan Aerospace Exploration Agency	**Highly reliable space transportation system technology** - Development, manufacturing and launch of H-IIA launch vehicles - H-IIB launch vehicles - H-II transfer vehicles (HTV) **Technology to improve the reliability and functions of satellites** - Program to Improve Reliability (in relation to satellites)

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
	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 restricted 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 Science and Technology Basic Plan and sectoral promotion strategy.

These Key Technologies of National Importance are intended for the improvement of overall national security and the achievement of world-class research capability, and will be promoted steadily as high priorities.

(1) Space transportation system technology

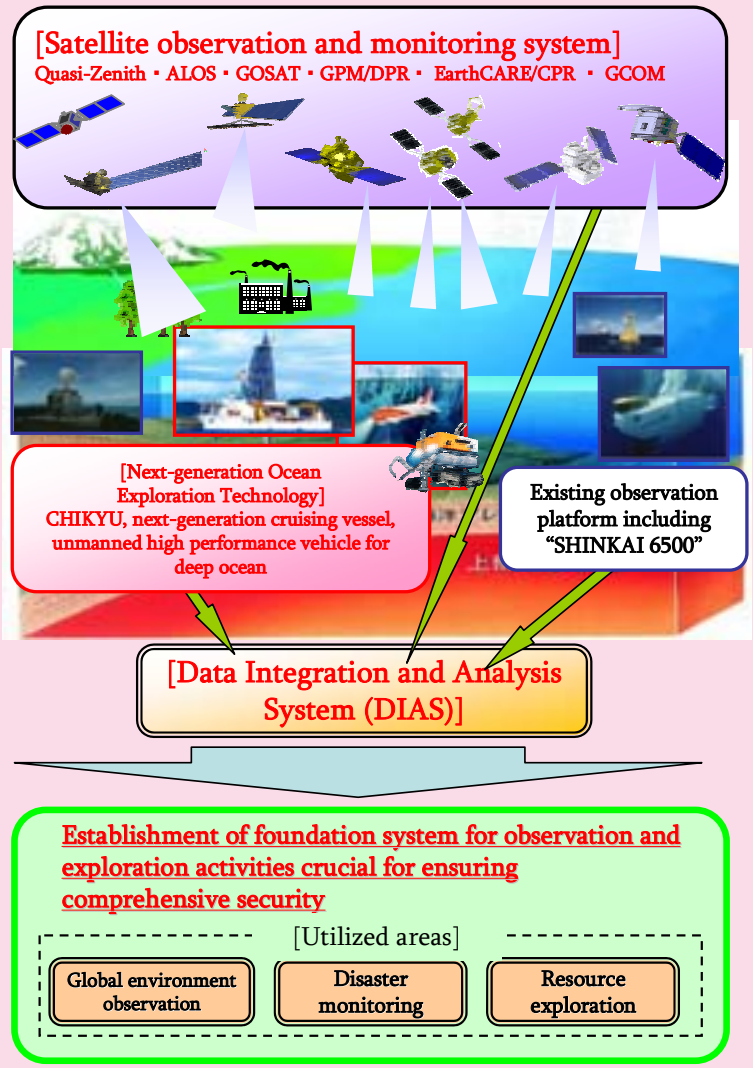
Refer to Part 2, Chapter 2, Section 2, 8 (1).

(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 that network. In addition, detailed surveys of topographic features and resources in Japan's oceanic surroundings are necessary from the viewpoint of overall national security. 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 the system for earth and marine 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. (Figure2-2-11)

Figure 2 2 11 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

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

Next-Generation Supercomputer (Conceptual image)
Source: RIKEN

order for Japan to maintain its world-leading positions in a wide range of areas, such as science and technology, academic research, industry, and medicine, MEXT is conducting the "Development and Use of a Next Generation Supercomputer" project. In FY 2009, the structure was changed to the scalar system based on the outcomes of the interim assessment. In addition, the plan was advanced and expanded to include the construction of the "Innovative Hyper Performance Computing Infrastructure" to meet various needs from the users' point of view. (Refer to Part 2, Chapter 2, Section 2, 2)

(5) X-ray free electron laser

The X-ray free electron laser (XFEL) is a light combining features of laser and radiation light, and is based on a technology facilitating analysis that was impossible with conventional measures. XFEL is expected to offer new wisdom in wide ranging S&T areas including life sciences and structure analysis at the nano-level as the bedrock of world-class research, enabling instantaneous measurement and analysis of ultra-microstructures at the atomic level and super-high-speed movement or changes in chemical reactions. RIKEN and the Japan Synchrotron Radiation Research Institute have jointly improved their facilities with the building of the synchrotron radiation facility SPring-8 at their current site. Shared use of XFEL is expected to start in FY 2011.

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 Basic Science and Technology 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 Tecnology 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 2009, and based on this promotion, will start the "R&D Program for Implementation

of Anti-Crime and Anti-Terrorism Technologies for a Safe and Secure Society" in 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 Community-based Actions against Global Warming and Environmental Degradation, Protection of Children from Crime, Science Technology and Humanity, Information Technology and Society, and Brain-Science and Society, 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.