Strategy for Innovative Technology

(Provisional Translation)

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Council for Science and Technology Policy, Cabinet Office

Contents

1．Strategic Promotion of Innovative Technology

Innovative technologies are the world's top-level, unrivaled technologies, that enable us to achieve sustainable economic growth and to build an affluent society. In order to overpace the competitors amidst the ongoing globalization, we should make ecomonic growth out of resource and environmental constraint by strongly promoting and taking advantage of innovative technologies that would have a considerable ripple effect in the economy.

In Japan about 80% of research and development investments (R&D) come from private sectors. They play a leading role in technological development, which is directly related to industrial competitiveness, and technological innovation amid the intense global competition. In addition, original technologies for the innovation have had an increasingly strong tendency to be backed by remarkable scientific discovery and knowledge since the advent of the 21st century. Therefore, basic and far-sighted research activities of colleges and universities, and national institutes for R&D (independent administrative institutions) will play an important role in the innovation. Also academia and government should smoothly share their research outcomes with industry, and we should make an engine of our nation's economic growth by increasing cooperation among industry, academia, and government in R&D, and technological innovation.

As a result, we should realize a sustained growth through science and technology, namely by breakthrough results, which are not from an improvement of existing technology and enable us to sustain the competitiveness, and by steady efforts in R&D. Therefore, it is very important for us to make some seeds of innovative technologies, to develop them rapidly, and to lead to society-wide innovation in the long term. This will necessitate a strategic program for research and development.

Actually we have created many excellent research results in basic and applied researches. Until now, however, we have not developed and utilized

most of the results to bring about great social and economic effects. Reflecting on this, we should choose excellent seeds of innovative technologies, and concentrate resources into the researches. Also we prepare a research-development system to develop the seeds steadily and rapidly, and to create a technological innovation.

（１）Our Goal: Growth through Technological Innovation

Our nation's goals and challenges to tackle with innovative technologies through which to resolve the issues are shown in three items below.

(i) Enhancement of the international competitiveness of industries

Japan has become one of the world's top economic powers because of our global competitive industries such as automobiles, electronics, and materials. In order to enhance the competitiveness of our industries, it is necessary to accelerate the progress of R&D with the seeds of technologies that would further enhance the performance of these competitive industries. In addition, Japan has an advantage in technology of environment and energy. Japan aims for the both of environmental conservation and economic growth by enhancing the advantage.

In addition to the policies described above, it is an important issue to accelerate the progress of R&D that would cause a generation of new industries in the near future.

In order to reach the goals: sustainable growth of our industries, enhancement of the performance of the competitive industries, and creation of new industries, it is necessary to develop and advance the following technologies: (i) green technology through which to solve the problems of global warming, natural resources, and energy, (ii) electronic device technology which is much higher than that of the emerging economic countries in aspects other than costs, and (iii) embedded software technology to cause a dramatic increase in reliability and productivity.

(ii) Building of a healthy society

Japan is facing an unprecedented situation with an aging society. Our nation aims at improving the quality of life because of new technologies which enable people to enjoy healthier and more comfortable lives, though our society is aging. International diffusion and expansion of

these technologies will contribute other countries which will have aging societies in 20 to 30 years later. We shall further enhance livelihood support robot technology using intelligent robot technology which our nation is taking advantage of, medical engineering technologies, regenerative medicine technologies using iPS cells and raise the health and healthcare industry to be leading industries.

(iii) Safety and Security of Japan and the world

Considering the population explosion and the economic growth in the emerging economic countries, we would face global issues: ensuring an adequate supply of natural resources and food, and stabilizing prices of them. These are serious problems in that Japan is a resource-supplied country. In addition, infection and environmental problems other than global warming would get more serious in the future. For Japan, a nation poor in resources, active use of advanced technologies must be the best way to resolve these issues. Japan would remain one of the economic powers because of growth through uninterrupted technological innovations.

Utilizing accumulated knowledge, the government needs to further develop the following technologies for the safety and security of the nation: (i) technology for relaxation of restrictions on the food supply, (ii) technology required for alternatives for rare mineral resources and recovery of them, (iii) fabrication process technology for decrease of burdens on the environment, and (iv) infection countermeasure technology. Also the government needs to remove obstacles inhibiting development of these technologies. These approaches would strengthen the global competitiveness of our industries. As a result, Japan would contribute the world through these technologies.

In addition, the government must advance Japan’s critical technologies, which are cutting-edge technologies to strongly affect basis of the nation’s existence.

In order to reach our goals in the three items (i) to (iii), it is essential to focus on developing and advancing innovative technologies listed in the appendix (hereinafter referred as ‘technological innovation’). In addition, it is necessary to strengthen the functions of the Council for Science and Technology Policy (CSTP) as a control tower. CSTP is responsible for the total management of all the measures of the Ministries. This will necessitate a new kind of mechanism to reform the R&D system. Although ‘technological innovation’ has been chosen as essential technologies for achieving our goals, CSTP needs to study the technology trend in the world and to revise the technologies uninterruptedly.

（２）A Significant Extension of The Structure to Promote "Innovative Technology"

In bringing about growth through innovative technology it is essential to accelerate R&D with an “All-in-One Japan system”, and create innovations through not only gathering excellent human resources irrespective of organization but also investing in research funds through cooperation, regardless of which government ministry is involved.

In order to do so a new “Innovative Technology Promotion Fund” will be established in 2009 for the specific promotion of “Innovative Technology” that will enable prompt, mobile investments to be made in R&D, irrespective of the government ministry responsible, and thus strengthen the connection to the private sector, and build a system using all our national resources.

○Establishment of "Innovative Technology Promotion Fund"

・To promote “Innovative Technology” using all of our national resources a newly “Innovative Technology Promotional Fund” will be established in 2009, and investment accelerated in specific technological R&D areas to encourage “Innovative Technologies” being developed.

・ The newly established “Innovative Technology Promotion Fund” will be allocated for “Special Coordination Funds for Promoting Science and Technology” and for the design a system for use in accelerating R&D being made in an encouraging and flexible manner (the exact scale of which will decided by the end of June 2008 but based on the proposal of being about 1% of the scientific technological promotional adjustment expenses that was offered by the council on economic and fiscal policy).

・ The “Innovative Technology Promotional Fund” will be used in seeking the acceleration of “Innovative Technology” in a flexible manner through selecting and issuing specific projects several times a year, applying for appropriate contract authorizations and in a multiple-year contract system, and enabling claims to be extended for more than one fiscal year.

・ The prerequisite with “Innovative Technology”, in which the budget of government ministries is used, will be particular resources being distributed with the promotion of “Innovative Technology” as the key issue through “Science and Technology related budget allocation policy”, which were designed by the council for science and technology policy.

・The plurality of R&D funds will be used in as much an integrated manner as possible, and through the design of a united promotion of "Innovative Technology", will be used in composing a nationwide efficient/effective development system.

○R&D Management Related to “Innovative Technology”

・As a managerial support system for the science and technology policy council a network of researchers/engineers (group of specialists) will be organized that can gather an extensive amount of information on

domestic/international technology trends and the position that Japanese technology has in the world (international benchmark information) and encouragingly select those which Japan should invest in as “Innovative Technologies”.

・ Regarding the promotion of "Innovative Technology", with the cooperation of related ministries, a technology roadmap will be prepared, which will outline how the results of R&D will be applied in society, and a PDCA cycle established. The systems that need revision in order to achieve integrated R&D management will be checked for in 2008, and the necessary system reformation then promptly carried out.

・ A system for planning the creation/protection/practice of strategic intellectual property will be arranged at the early stage of its R&D, and through the setting of exclusive licensing related to the intellectual property of corporations taking part in that R&D. The participation of industrial circles will be required from an early stage and top-class intellectuals, irrespective of the organization they belong to, amassed.

・Evaluations etc will be made from the point of view of the appropriate management of technological information.

○ **“Super Special Consortia” System etc for the Application of Innovative Technology Model Projects**

・Meetings (government ministry conferences) will be arranged where the controlling authorities and people participating in the R&D can continuously examine what is happening with the development in a simultaneous manner, and with regard to the aspect of the research fund system and controls on it exceptional measures adopted according to the features of individual subjects and the practical use of technologies promoted.

- Although not dependent on administrative districts like the old special zones for structural reform, according to the theme of the research support will be mainly provided at the initiative of a complex research body assembled from industry-academia-government R&D organizations and corporations etc. The main implementation will be decided competitively. And this scheme will be accelerated using “Innovative Technology Promotional Fund” as needed.

- In 2008 the establishment/promotion of “Super Special Consortia for supporting the development of cutting-edge medical care” will be the opener. After taking the results into consideration full-scale enforcement that will include legislation will aimed at. The expansion of technology into not only advanced medical fields but also other fields such as “Innovative Technology” and the technology needed in “Low Carbon Technology Plan” etc will be considered.

- Regarding the “Super Special Consortia for supporting the development of cutting-edge medical care” simultaneous meetings with their controlling authorities will be arranged where opinions on how safety/effectiveness and risk management inspections should take place can be exchanged.

Note: The “Super Special Consortia” system is an arrangement that will be established where exception(s) regarding research funds and controls in coordination with industry-academia-government can take place in encouraging the promotion of innovative technology R&D.

２．Organizing an Environment Where Continuous Innovative Technology can be Developed

As history reveals it is customary that innovative technology gets replaced by something totally new and different as time goes on. Consequently, to enable continuous growth in Japan, it is essential that an environment where innovative technology can persistently be pursued is organized, in particular by preparing a research fund that can be used to increase the potential of innovative technologies and to secure the human resources who can simultaneously challenge unknown fields.

（１）Realization of a Research Fund to Increase the Potential for Innovative Technology

Although the potential innovative technologies are derived from ideas that are often unusual, with former research funds the performance-based-idea tended to be prevail and it was difficult for challenging suggestions that were based on a totally different idea to be adopted. With this point taken into consideration it is important to invest in basic research that has the high ideal of challenging an unknown field, and to realize the supply of a constant research fund for use in connecting its results to its growth.

○Investment in Challenging High-Target-Setting Basic Research

・The number of competitive funds will be increased to promote a variety of basic research being carried out and a new "Big Challenge Research Scheme" set up at a specific percentage. Irrespective of former judging standards innovative ideas and challenging subjects will be selected. Researchers, who have failed to bring about the expected research outcome after completion of their research assignment, will be given another chance.

○Continuous Research Fund Supply

Several decades are needed to arrive at growth from the results after constantly creating innovative technology. Subsequently, to provide continuous support for excellent research to take place and bring about innovations, it will be necessary to establish a system that incorporates a supply of continuous research funds in coordination with Funding Agency.

・ Regarding items that are linked with the results of ongoing subsidy evaluations and been adopted as continuous subjects that will bring about excellent results and developments a system will be structured to support them intermittently towards the next step.

・ A tie-up system for all the national competitive funds will be established in 2008 at Program Director conferences (PD conferences) etc.

○Standardization of Competitive Fund Rules

To utilize research funds more effectively/efficiently, minimize complex administrative procedures and secure the time that researchers require it is essential to standardize rules for use with competitive funds.

・ In cooperation between the government, the science and technology policy council and all the related departments unification of the rules will be promoted, such as in standardizing the format of reports, filing multiple fund research reports together, standardizing the expense division and a limit on expenses applicable to other items, and by investing in integrated efficient multiple funds etc.

・Regarding the “Super Special Consortia for supporting the development of cutting-edge medical care”, in 2008, to help reduce the burden on research organizations etc related ministries will seek to improve research fund investment, as well as examine a united and efficient investment scheme for research funds from 2009 onwards.

（２）Securing the Human Resources to Explore a New Field

Innovative technologies are created by "humans", and thus hereafter the key to Japan continuing to experience economic growth, even with the decrease in population, will depend on securing the needed human resources. Consequently, it is necessary to educate/secure top-class human resources that can challenge unknown fields and create next-generation innovative technologies.

○ Securing the Mobility of and Educating/Acquiring Top-Class Human Resources

・The plan is to target university/Independent administrative institutions for research and development in promoting the mobility of human resources, and publish their degree of achievement (Eliminate the so called, "Thoroughbred-is-Best Principle" at universities, and maintain the percentage of teachers, who graduated from the university, at less than 50% etc.)

・Attractive research/living environments at the world's-highest-research institutions/bases will be arranged to attract excellent foreigners, and targets set for all research organizations (double the percentage of foreign professors and associate professors by 2011 etc) and thus attract excellent intellectuals from all over the world.

・To maintain/strengthen Japan’s international competitive power and also activate research activities that adopt various viewpoints/ideas support will be increased for the expansion of activities being carried

out by women and young researchers.

○Securing the Human Resources to Challenge in Next-Generation

・In close coordination between universities and educational committees the introduction of a "Core Science Teacher Training Program (tentative)" will be examined, and will be used to educate primary/high school teachers that have leadership qualities and abilities in science and mathematics, and that can in a key role in science and mathematics education guidance at all schools and local areas.

・Based on the experience of the Super Science High School (SSH) to date thematic research has been implemented in coordination with other local high schools through the formation etc of a network that teachers can use to exchange information and disseminate the science and mathematics education curriculum obtained through experience and guiding principles. The introduction of the "SSH Core Base Educational Program (tentative)", which supports core base schools, will be examined with the aim of improving the quality of science and mathematics education in all local areas.

Note: Regarding global warming measure technology the "Low Carbon Technology Plan" for technological strategy that aims at steadily reducing greenhouse gas emissions and plan for contributing to international cutback etc are included as part of its strategy.

Attached table

List of Innovative Technologies

Goal	Innovative Technology	
(i) Enhancement of international competitiveness of industry	High Speed Large Capacity Communication Network Technology	・All-Optical Networking Technology
	Electronic Device Technology	・Spintronics Technology
		・3-Dimensional Semiconductor Technology
		・Carbon Nanotube Technology (Capacitor Development)
		・Integrated MEMS Technology (Micro Electro-Mechanical System)
	Advanced Image Technology	・3-Dimensional Image Technology
	Embedded Software Technology	・Highly Reliable/Productive Software Development Technology
	Global Warming Countermeasure Technology	・Highly Efficiency Photovoltaic Power Generation Technology
		・Hydrogen Energy System Technology
(ii) Building of a healthy society	Intelligent Robot Technology	・Life Support Robot Technology
	Medical Engineering Technology	・Self-Support Technology for Elderly/Handicapped People (Brain Machine Interface)
		・Low Invasive Medical Device Technology (Build-in Touch Sensor Endoscopes)
		・Heart Function Prosthetic Device Technology
	Regenerative Medical Technology	・iPS Cell Regeneration Medical Technology
	Drug Discovery Technology	・Toxicological Evaluation Technology using iPS cells
(iii) Safety and Security of Japan and the world		・Vaccine Development Technology for Infectious Disease (Malaria)
	Detection Technology	・Noncontact Visualizing Analysis Technology (Terahertz)
	Food Production Technology	・Environmental Tolerance/High Yielding Technology for Chief Crop (wheat and soybeans)
		・Complete Cultured Technology for Wide-Area Migratory Fish (Eel and Tuna)
	Technology for Scarce Resources	・Rare Metals - Alternative Materials/Recovery Technologies
	Green Chemical Technology	・Production Technology by Using Genetic Recombination Microbial (Energy/Chemical Engineering Material)
		・New Catalyst Chemical Manufacturing Process Technology (Underwater Function Catalyst)
	New Material Technology	・New Superconducting Materials Technology (Superconductors incorporating Magnetic Element etc.)

List of National Critical Technologies

(Continual intensive investment led by the government will be made on the national critical technologies that concern consistence of Japan)

Next Generation Super Computer
The Earth Observation and Ocean Exploration System
Development and Sharing of X Ray Free Election Laser
Fast Breeder Reactor (FBR) Cycle Technology
Space Transportation System

Summary of Innovative Technologies

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(i) Enhancement of international competitiveness of industry	High Speed Large Capacity Communication Network Technology	All Optical Communication Process Technology	Along with the switch and pathway process all optical network technology will enable an explosive increase in information and the development of an ultra high speed backbone network that has several tens the power efficiency. It will also enhance the international competitive edge of the nation by establishing technology that can be used to acquire the international standard for the next generation Ethernet.	Japan has top level technology for use in expanding the transmission capacity of single wavelength multiplexing optical fiber and the toggling speed of optical switches (nanosecond level.)
	Electronic Device Technology	Spintronics Technology	Application of the spin rather than the movement of electrons will enable the development of revolutionary high speeds and high performance for nonvolatile memory compared to that existing (1000 times the write speed with almost unlimited rewrites when compared to flash memory.) This will lead to the expectation of the introduction of totally new devices that do not need an electrical power supply when in standby mode and low power devices.	The development of the world's largest scale nonvolatile memory through spin-injection magnetization reversal (2 MbRAM) was achieved. Currently an elemental device where the magnetic direction aiming at over 10 Gb becomes vertical to the surface is under development for global release.
		3-dimensional Semiconductor Technology	Enables for use by our future ubiquitous society the necessary development of an evolved mobile terminal with natural operation for users through audio/touch/motion rather than the simple key input. Introducing 3-dimensions, a totally new concept for semiconductor devices, will lead to the development of super high efficiency semiconductor devices with an intuitive human interface that supports sophisticated processes but still sufficiently compact to fit in portable terminals.	Japan has been developing DRAM layering technology since 1999 and is leading the way ahead of the United States as they started 2 to 3 years later. Semiconductor makers in particular have now started developing 3-dimensional semiconductor technology of heterogeneous chip mixed type.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(i) Enhancement of international competitiveness of industry	Electronic Device Technology	Carbon Nanotube Technology (Capacitor Development)	Appling excellent characteristics such as the high electron mobility and large surface area in capacitors enables the realization of high output and high energy density, twice that with current products, and much better charge-discharge behavior and a longer lifetime when compared to current products. Application in large equipment such as the hybrid construction machinery can also be expected.	Japan is dominant in the technology of CNT that was discovered and patented in Japan. Moreover, related patent applications are at a global top level too. "Super-growth" method, one of the methods of synthesizing long single-walled CNT, was discussed in 'Science' magazine and its number of quotes is the top in the chemical field.
		Integrated MEMS Technology (Micro Electro-Mechanical System)	Existing MEMS (Microscale devices with integration of mechanical components and electronic circuits) are integrated to develop multifunction/high efficiency/ultra-compact MEMS. Examples include a low cost, multifunctional MEMS with dimensions of 1 mm or less thickness and mm order width that combines environmental materials sensing and wireless communication capabilities for large-scale, on-site monitoring needs. The Technology stimulates the industries to create new businesses.	Japan is the global leader in developing a prototype device that integrates a 4 layer device (wafer) with different functions.
	Advanced Image Technology	3-Dimensional Image Technology	Using 3-dimensional imaging technology in holography will enable super real images, basically the same as the actual thing, to be displayed to audiences. The pursuit of a cross-interaction of human sensitivity and image technology and increasing the presence of phenomenon that is not limited to be depicted on the plane position will make it very natural looking and exciting for audiences. In addition, combining it with stereophony technology will lead to the creation of new information services in various fields such as in teleworking, medical, education, business, art and performance by enhancing the realism of them.	Japan is proceeding with 3-dimensional image technology R&D in cooperation with business and universities and is ahead of Europe, the United States and Korea. In those countries they are emphasizing multiple parallax visual display technology that utilizes special glasses. However, the electric holography technology Japan is working on has overwhelmingly superior reality when compared to multiple parallax technology as it can reproduce light exactly the same as the real light.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(i) Enhancement of international competitiveness of industry	Embedded Software Technology	Highly Reliable/ Productive Software Development Technology	For the rapidly expanding built-in software development field and in order to exponentially improve its reliability and productivity a base software architecture that can be used an international standard needs to be developed which can be used with various types of micro computer chips and applications. The developmental efficiency of built-in software needs to be boosted to twice that of existing products through software engineering and model base development, and the world's best reliability achieved. Our international competitive edge can then be enhanced not only in the software field but also in the automobile industry.	Japan is strong with built-in software technology and it can be a base that supports manufacturing. Japan currently has superior real-time, reliability and performance.
	Global Warming Countermeasure Technology	High Efficiency Photovoltaic Power Generation Technology	Has the potential to be nurtured into an industry worth over 2 trillion Yen using down-to-earth technology development that aims at making the cost of photovoltaic power generation, with its impressive potential as renewable energy, in 2020 14 JPY/kWh, a conversion efficiency to 10 to 19 percent, and in 2030 as low as 7 JPY/kWh, similar to fired power generation and a conversion efficiency of 15 to 22 percent.	Beginning with technology that was developed in the Sun Shine Project in 1974 improving the efficiency and the cost has been promoted through a diffusion policy. As a result Japan has the best production volume in the world, with the cumulatively introduced volume being the world's best.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(i) Enhancement of international competitiveness of industry	Global Warming Countermeasure Technology	Hydrogen Energy System Technology	Through establishing hydrogen production technology that does not emit any greenhouse gases through use of nuclear power, the growth of the nation can be supported by achieving a good balance between global warming countermeasures and a stable supply of energy. New environmental energy industries will be created such as iron manufacture by hydrogen reduction and fuel cell vehicles. Japan has developed a control method for the IS process (with patent 3 applications) and demonstrated a continuous hydrogen production of 30 liters per an hour in 2004. In addition, a prototype ceramic reactor was successfully test-fabricated in 2005. However, the United States and France are proceeding a collaborative investigation on the IS process and plan to test 200 liters per an hour hydrogen production using an apparatus made of engineering materials this year.	The steam reforming of natural gas used in the current industry of hydrogen production generates large amounts of CO2. Water electrolysis is a mature CO2 free technology when electric power sources such as hydro or nuclear is used; however, it has no competitive economic advantages at present in Japan. Thermochemical methods (such as IS process, WH process) and steam electrolysis are new methods that use high temperature heat of High Temperature Gas-cooled Reactors, and expected to be more efficient. The IS process, in particular as a pure thermochemical method, is excellent in that it does not require a large amount of electric power and can be expected to have merit of scale when compared to other methods featuring electrolysis. Japan is the leader in the R&D of the promising technology.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(ii) Building of a healthy society	Intelligent Robot Technology	Human Support Robot Technology	Robots will be realized that can be adapted to a wide range of areas in not only to the business field but also as national life supports such as in doing housework, and welfare and care of a super aged society. For this integrated technology needs to be developed that realizes the upgrading of the three basic robot technology elements (sensors, control and drive) and ensures the safeness, reliability and adjustability of the system. The plan is to enhance the efficiency of robot developments (for example, in the case of a cell production robot the aim is to shorten to under the half the developmental period.) In addition, through use of these technologies, the aim is to release those who have anybody handicapped in their family or caretakers from heavy daily labor by realizing a robot that can coexist with humans and support them in care activities whose burden is escalating.	・Japan has the world's biggest number of operating industrial robots (approximately 40 percent of the global total,) the biggest production (approximately 80 thousand a year) and base technologies (number of patent applications). ・Japan is leading the way to general usage (modularization.) ・'RT Middleware Technology' is the base for various robot developments and originated in Japan and was authorized as an international standard at the end of 2007. ・Japan is the global leader with system integration technology that includes an affinity with humans.
	Medical Engineering Technology	Elderly/Handicapped Self-Support Technology (Brain Machine Interface)	More than 4,300,000 of those who require nursing care and more than 100,000 of those who have lost their motor control through sickness or accidents such as spinal cord injuries will be able to freely operate function support devices through the development of brain machine interface technology by imparting their will and thoughts to a receiver (sensor) as a change in brain activity (brain wave) and convey them to a support device after being converted to a digital signal. And s a result the elderly and the handicapped will be able to move as they want without needing constant care.	Japan's infrared light, laser, and microchip sensor technology that are necessary in the interface to the brain are globally top level technologies.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(ii) Building of a healthy society	Medical Engineering Technology	Low Invasive Medical Device Technology (Touch sensor built-in Endoscope)	Operations using endoscopes have become popular in various fields. In the near future, the operational accuracy will have improved by utilizing advanced 3-dimensional image display technology and sensor technology, and these technology will extend into areas where they have been thought difficult to use, such as with cancer and cardiac diseases. In addition, the plan is to enable problems such as cancer to be revealed while minimizing the mental and physical burden on patients and preserving their functions. The expected effect on medical costs is estimated to reduce approximately 20 billion Japanese yen because of shorter hospital stays and treatment. For example, a medical cost of several tens of billion Japanese yen could be eliminated through endoscope operations on early stomach cancer patients and the diffusion of new technology and applications in the future.	41 percent of endoscope technology patents applied for in the United States during 1971 to 2003 were made by Japanese, and hence Japan has globally top class technology.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(ii) Building of a healthy society	Medical Engineering Technology	Heart Function Prosthetic Device Technology	Implantable Defibrillators (ICD) can prevent lethal arrhythmia and heighten the survival rate of chronic Heart Failure that is the end result of cardiovascular disease (number of the patients: 35 million in Japan and 1 billion globally); however, they still have the problems such as pain when defibrillating, resulting in unavoidable comas, unable to stop the advancement of the heart failure itself and so forth. Low voltage aponia implantable defibrillators (Super ICD) include technology that enables aponia using low voltage, the avoidance of comas through rapid diagnosis and the prevention of the progression of heart failure through an autonomic impulse. In addition, future generation respiration circulatory support systems will encompass technology that has excellent antithrombogenicity and permanence and will help avoid the acute death that 30 to 40 percent of the 180,000 cardiac death every year result in. In addition, patients will be able to stay at home and readjust to society without having to wait for a heart transplant, instead using an implantable compact mechanical heart system that has excellent antithrombogenicity and permanence.	・The low power defibrillation technology that realizes aponia defibrillation was developed by Japan ahead of the rest of the world and winning the agrius development race. ・Antithronbogenicity blood surface qualification technology is unprecedented and more globally effective over the long run when compared to existing technologies. ・The blood pump technology without rotating axis in the artificial heart system has the possibility of being the world's smallest and lightest because of its pioneering small amount of power consumption, permanence and stability. ・Life support technology can be provided to Japan.
	Regenerative Medical Technology	iPS Cell Regenerative Medical Technology	Regenerative medicine using the iPS cell is expected to improve the body functions of handicapped by accidents and diseases. They include approximately 100,000 spinal cord injuries, approximately 200,000 visually impaired, approximately 260,000 that need artificial dialysis (costing 1,300 billion in medical expenses) and approximately 22,800,000 diabetics (costing 1,150 billion in medical expenses.)	Japan succeeded in establishing human iPS cells of humans for the first time in the world.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(ii) Building of a healthy society	Drug Discovery Technology	Toxicological Evaluation Technology using iPS cells	The side effects and influence on the human body will be able to be evaluated through the cells of various internal organs being created from iPS cells of a person and then used for detection of the side effects of medication and the harmful effect of chemical substances. It will also be possible to evaluate drug efficacy and side effects efficiently for drug discoveries through developing information on the various cells and genes as an information bank. In addition, it would help clarify the mechanism of illnesses by creating model disease cells using iPS cells.	Japan succeeded in establishing human iPS cells for the first time in the world. The scale of the database on the drug toxicity to cells (toxicogenomics) and cell bank which will support drug discoveries, in Japan is of global top class.
(iii) Safety and Security of Japan and the world		Vaccine Development Technology for Infectious Disease (Malaria)	A vaccine to prevent the malaria that is said to infect 500 million people throughout the world every year has yet to be discovered because of issues that include not having the appropriate material (protein) for its creation. Use of technology that can acquire proteins by vegetative matter would enable the prompt acquirement of various proteins that could be used to produce a vaccine for malaria. It would enable the creation of a vaccine in the near future by being able to verify its efficacy.	Malaria vaccine development has reached a plateau, and technology using plants and acquiring a possible vaccine for malaria efficiently is unique to Japan. The related patent has already been acquired.
	Detection Technology	Noncontact Visualizing Analysis Technology (Terahertz)	Existing analysis systems are large and time-consuming because of high output pulse laser equipment; however, the development of small inexpensive real time analysis equipment for food contamination checks at food handling facilities, security checks at airports, verifying quality in the manufacturing process of medications and semiconductors, and the monitoring of environmental pollutants in the air can all be enabled through realizing terahertz sensor that incorporates semiconductor device technology.	1 THz oscillation, the world's highest frequency, was realized through use of semiconductor devices. Terahertz pulse generating technology with optical communication technology is original to Japan. Japan's material spectroscopy database is the largest in the world.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(iii) Safety and Security of Japan and the world	Food Production Technology	Environmental Tolerance/High Yielding Technology for Chief Crop (wheat and soybeans)	Rice genome information has been applied to the crop breeding (rice, wheat, soybeans etc). The developed crops grow in poor environments (rice, wheat, soybeans etc being more resistant to dryness, salt, high humidity etc.), get new quality and double the yield . It would enable more effective use of farmland and more stable global food supply.	More than 100 gene patents for the rice genome and gene function analysis have been acquired. Japan also has the edge in industrial application as European countries and the United States are not researching the field.
		Complete Cultured Technology for Wide-Area Migratory Fish (Eel and Tuna)	Establishment of complete culture technology for eel and tuna will contributes to conservation for natural resources and enrich Japanese food culture.	Japan has the best surrogate womb technology that can yield heterogeneous eggs. Only Japan in particular has perfect tuna, which is becoming endangered, aqua-farming and also artificial elver aqua-farming.
	Technology for Scarce Resources	Rare Metals - Alternative Material/ Recovery Technologies	Rare metals are crucial elements in emerging industries such as advanced automobiles, robotics, and electronics, which support Japanese economy. Development of alternative materials/recovery technologies of indium etc. would secure the competitiveness of Japan's emerging industries.	Japan leads the alternative material technology in transparent electrode without using indium. It also has the best technology to stabilize arsenic to recover rare metals.
	Green Chemical Technology	Production Technology by Utilizing Genetic Recombination Microbial (Energy/Chemical Engineering Material)	As renewable biomass materials which do not compete with food production, the developemnt of biological process technologies with GM microbes which produce bio-energy and chemicals will enable bio-ethanol production with efficiency several times higher than conventional microbial fermentation, and will achieve low-energy and evological recycling industries with fewer energy consumption and wastes. Moreover, it is expected that these technologies will link to new energy revolution to utilize bio-ethanol and bio-buthanol etc. in place of conventional petroleum in existing petrochemical plants.	Japan has advantage in fermentation technologies with microbes because of many researchers. Application researches of petroleum-free production of energy and chemicals is also active in Japan. From 1979 to 2000, there are about 36,000 patents and utility models which utilize microbes in fermentation including food production and basick technologies applied to the fermentation. Since then , about 1,500 patents and utility models have been applied every year.

Goal	Innovative Technology		Effect of the Innovative Technology	Superiority of the Technology (Reason the Top Global Level can be Achieved)
(iii) Safety and Security of Japan and the world	Green Chemical Technology	New Catalyst Chemical Manufacturing Process Technology (Underwater Function Catalyst)	Energy can be conserved, waste eliminated and productivity improved through the application of various types of catalyst technology when compared to existing chemical manufacturing processes. For example, 2700 million tons of MEK (Methyl Ethyl Ketone), which is used in coating compositions and adhesive, is produced every year and the process that used to need it to be heated to 350 to 400 degrees Celsius can be done at normal temperature. The by-product (ammonium sulfate) that is generated will be twice the MEK when the new catalyst functioning in water is used so significant waste elimination and energy saving can be realized.	A new catalyst that functions in water is original Japanese technology and articles on it have been published in top level academic journals such as 'Science' magazine and the 'Journal of the American Chemical Society.' The total number of times it has been quoted is 10th for the chemistry field in the world.
	New Material Technology	New Superconducting Materials Technology (Superconductors incorporating Magnetic Element etc.)	It is expected to achieve 'high superconducting transition temperature' and 'superconducting materials with high current / magnetic field tolerance' by means of the development of new superconducting materials. It would enable the development of compact and low cost superconductor applications to accelerate the commercialization. For instance, it is also expected to be applied to the magnetic levitation that is a super-high speed mass-transportation system and is currently under R&D phase.	A superconducting material has been recently discovered in Japan that has a high degree of freedom for changing materials composition and is highly expected for new superconducting mechanisms and excellent characteristics.

Summary of National Critical Technologies

National Critical Technology	Summary
Next Generation super Computer	In order to develop computational calculation technology, which can then be used to establish a strong position in modern scientific theory and experimental technology, a pioneering best global performance super computer needs to be developed. Software will then need to be developed and diffused that can utilize the future generation super computer to its utmost.
The Earth Observation and Ocean Exploration System	Global observation/supervision technology using satellites and ocean exploration technology are being planned for development that will enable examination of the bottom of the sea's seismogenic zone and submarine resources, which is original to the nation and they can be also used to analyze various observational global data in an integral manner, converting them into available and useful information.
Development and Sharing of X Ray Free Election Laser	A research facility with the world's highest capabilities is being developed that enables immediate measurement and analysis of hyperfine structures at the atomic level. An ultrahigh-speed dynamic state oscillating x-ray laser with as bright as 1 billion times those existing and the alternation of chemical reactions are being aimed at for common use in 2012.
Fast Breeder Reactor (FBR) Cycle Technology	R&D on FBR cycle technology that has the potential of contributing to long-term energy security by producing more fuel than is consumed while generating electricity and reduction of the effects of potential toxicity of radioactive waste is being implemented.
Space Transportation System	R&D related to the H-IIA rocket, H-IIB rocket (upgraded form of the H-IIA) and a spacecraft that will deliver supplies to the space station (HTV) is being implemented in order to secure and maintain the ability to launch the necessary artificial satellites into space independently when needed.