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Full Research in Society, for Society

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MESSAGE

President's Message
AIST as a Driving Force of a New Era
– The Third Term of AIST begins –

FEATURE

Global Trends in Green Information Technology, the Significance of Our Commitment, and Interdisciplinary and Domestic/International Collaboration

Research Hotline
UPDATE FROM THE CUTTING EDGE（January–March 2010）

In Brief

President's Message
AIST as a Driving Force of a New Era
— The Third Term of AIST begins —

Tamotsu Nomakuchi

President
National Institute of Advanced Industrial Science and Technology (AIST)

1. Introduction

The Third Medium Term of the National Institute of Advanced Industrial Science and Technology (AIST) began in April 2010. The First Term was initiated in 2001 when AIST was established as an independent administrative institution as a result of the merger of 15 research institutes and the Weights and Measures Training Institute. The basic structure of the present AIST was established during this period. In the Second Term, beginning in 2005, the research units in AIST were integrated and interregional cooperation was developed. Consequently, the activities of AIST as a multidisciplinary research institution addressing economic and industrial policies were fully set in motion.

In the Third Period, AIST will make necessary changes and take on the challenge of playing a more important role based on what has been achieved so far. Global economic and industrial competition is far fiercer than when AIST was established, and global issues threatening the existence of humanity itself are becoming more serious. There are a number of issues that AIST needs to address to realize a "sustainable society" with a bright future. In order to meet the expectations being placed on us, we need to conduct "*Full Research*", integrated research activities—from basic research to product realization and practical application—making use of all available resources in the six research fields: life science and biotechnology; information technology and electronics; nanotechnology, materials, and manufacturing; environment and energy; geological survey and applied geoscience; and metrology and measurement science.

2. Taking on the challenges of issues facing society in the 21st century

Examples of areas in which AIST should contribute are "green innovation" and "life innovation." Green innovation refers to further advancing Japan's environmental and energy technologies, which are already world-class in terms of comprehensive capabilities, thereby helping to solve climate change and other global issues. We would like to make significant contributions based on the accumulated results of research on solar power generation, power electronics, fuel cells, and secondary cells, as well as on the practical application of methane hydrate and biomass. Both developed and developing countries must make efforts to realize

a low-carbon society. Japan is expected to promote widespread dissemination and utilization of the results of technological development within Japan as well as abroad. We are determined to play a part in this endeavor.

While Japan ranks first in the world in healthy longevity, there is a strong ongoing need for high-quality medical services. In addition, issues such as the aging of the population, the declining birth rate, and nursing care are growing in importance. In order to address these issues, AIST is expected to promote research and development of safe, high-performance, and innovative medical, pharmaceutical, and nursing-care technologies, or "life innovation." To meet these expectations, we need to combine a variety of technologies in areas such as life science, telemedicine systems based on information and communication technology, and medical- and nursing-care robots based on manufacturing technology. In this sense, the role of AIST as a multidisciplinary research institute is of great significance.

Another important role of AIST is to provide foundations for ensuring the safety and security of industry and society through highly advanced national measurement standards, enhancement of performance and safety evaluation functions for new technologies, and strategic international standardization of the results of research and development. In today's society, where technological innovations are constantly evolving, new needs in measurements and evaluations arise daily. The researchers in measurements area and all other research areas must work together to promptly address these needs. A field of infrastructural technology that should not be overlooked is geological research. This field with a long history is gaining increasing importance in securing supplies of resources and energy, as well as in research contributing to disaster prevention. While serving as the national organization dealing with geological information, we are engaged in a growing number of projects such as of combining geological and satellite-image information, which match AIST's strong interdisciplinary research capabilities.

Since the time of the former Agency of Industrial Science and Technology, AIST has conducted research and development to provide the infrastructure for Japan's industrial competitiveness and to lead Japanese industries. Needless to say, this role remains unchanged. We must take on the challenges of developing unrivaled cutting-edge technologies in all areas, including materials and information technology, to support enhancement in the competitiveness of a wide range of Japanese industries.

3. Aiming to be a hub for open innovation

AIST has promoted collaborative research and development, or open innovation, with universities and the private sector. We will expand our efforts to facilitate the use of our advanced research environment and evaluation facilities by researchers outside AIST. It is no exaggeration to say that the world has now entered the days of innovation competition. Being a resource-poor country, Japan has to work harder than other countries to maintain its level of affluence. AIST must therefore further enhance its support for Japanese industries to help them survive the global competition.

The University of Tsukuba, the National Institute for Materials Science, industries, and AIST have jointly set up a framework called the "Tsukuba Innovation Arena" with the goal of building a worid-class research center for nanotechnology. We plan to develop innovations such as low-power devices by bringing together financial and human resources from industry, academia, and government. We also plan to use this framework to provide graduate students and corporate engineers with opportunities to learn and develop knowledge and practical skills, thereby making a significant contribution to human resource development. Although research activities in nanotechnology have begun to decline slightly, nanotechnology is an area in which Japan has been leading the world in terms of the creation of innovative technology and industrial application capabilities. We expect that the Tsukuba Innovation Arena will help to revitalize Japanese industries.

We have also established the "Robot Safety Research Center" jointly with organizations such as the Japan Automobile Research Institute and the Japan Robot Association. In October 2009, we set up the Consortium on the Fabrication and Characterization of Solar Cell Modules with Long Life and High Reliability with the participation

of 31 companies in the private sector. Similar activities are also being considered for various research and development including that of secondary cells. A feature of our recent cooperation projects is their objective of not only developing new competitive products, but also proposing as standards the technologies and evaluation techniques that were the bases for the development of products to the world. We are making efforts to possess the functions of certification and accreditation of standards in Japan. Japan has lagged behind Europe and the United States in establishing and certifying standards. With today's increasingly fierce competition in innovation, efforts to lead the world in international standardization are required. This is another new role for AIST.

We have nine research bases throughout the country from Hokkaido to Kyushu. Each regional center has the role of supporting the competitiveness of the local economy while conducting world-class research and development. We will strengthen their role as regional hubs of open innovation for public research laboratories, universities, and small to medium-sized enterprises by enhancing cooperation within AIST, with AIST Tsukuba Center serving as the core of the cooperation.

Not surprisingly, our open innovation is extending to other countries. To date, we have established mutually beneficial partnerships with 26 public research institutions in various countries including the United States and European and Asian nations. International research cooperation is also underway to solve global issues in such areas as the environment and energy. More than cooperation in general terms, however, it will be important to develop strategic relationships with clear objectives including standardization, particularly with Asian countries.

4. Conclusion

Since its establishment, AIST has continually transformed its organizational structure in a dynamic manner in order to make contributions "*Full Research* in Society for Society" as stated in its Charter. We will continue to consider the optimization of our systems for conducting and supporting research. Moreover, we will work to further enhance the level of communication among researchers, organizations, and regions so as to become a more organically coordinated research institution with high intellectual productivity.

I have no doubt that if we continue such efforts, AIST will be an even more outstanding research institution in the eyes of those both inside and outside the organization.

AIST's R&D Activities for Energy-Efficient and Green IT

What is Green IT?

Improvements in energy saving and efficiency in every aspect of society are required to reduce global warming gas emissions. Though IT equipment may be regarded as consuming less electricity than lighting, air conditioning, and electric trains, in fact it consumes 4 to 5 % of the total electric power generated in Japan, that is about 1 trillion kWh annually. Also, power consumption in this field is increasing in synch with the ascending curve of Internet traffic, which continues to grow at an annual pace of 40 %, through the widespread use of PCs (Fig. 1).

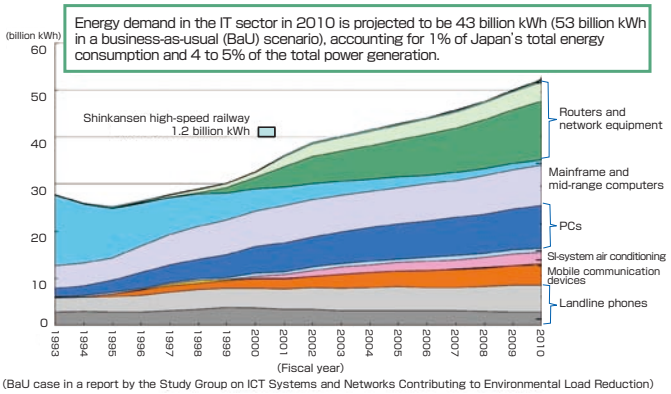
The energy supplied to vehicles and refrigerators produces physical effects such as the transportation of people and cooling of food. Although 100 % of the electric power input into computers is converted to heat, it allows information to be delivered to people and other devices. By using the delivered information, the work of transporting people and cooling food can be reduced, thereby lowering the energy consumption. As it can be seen in videoconferencing and weather forecasting, for example, the communication and information processing have two aspects: consumption of energy, and reduction of the energy consumed by other activities. The Ministry of Economy, Trade and Industry (METI) has proposed the energy savings in these two aspects named "Green-in-IT" and "Green-by-IT," which are together referred to as "Green IT". The Green IT Promotion Council estimates that CO_2 emissions can be reduced by as much as 130 million tons in 2020 by developing appropriate technologies, whereas Japan's total CO_2 emissions in 2007 were about 1.3 billion tons. Featured articles here describe Green IT-related research activities at AIST.

Targets of AIST's Green IT research

Most of the Green-IT research at AIST falls into the category of Green-in-IT, or improvement of the energy efficiency of IT equipment. Central processing units (CPUs, also referred to simply as processors) and memory devices play major roles in IT equipment. Power supplies and cooling devices are auxiliary devices to help the CPU perform tasks. If the power (= heat) consumed by the CPU and the memory is reduced, the power consumption of the power supply and the cooling device can be reduced accordingly. The CPU consists of more than 100 million transistors, while the memory (dynamic random access memory: DRAM) consists of capacitors, which need refreshing every tenth of a milli-second. The primary targets of Green IT research are transistors operable at lower power consumption and non-volatile memories that do not require refreshing. As an example of non-volatile memory, the spin-RAM to replace the DRAM is highlighted in one of the articles. Also described in another artilcle is our research on organic electroluminescence (EL) devices, which will lead to improvement in the energy efficiency of displays extensively used for IT and TV applications.

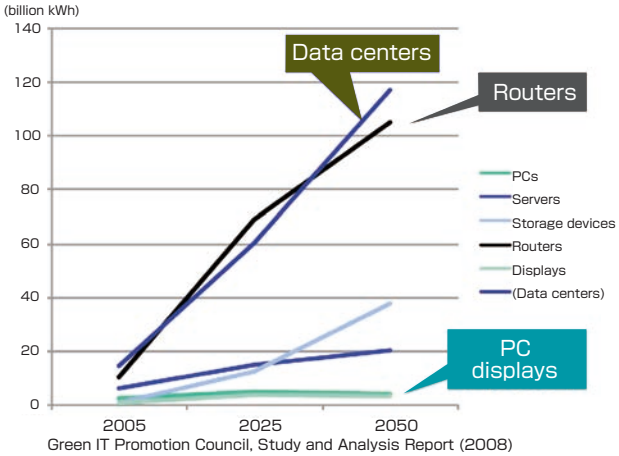
Fig. 2 shows the increasing trend of energy consumption by each type of IT equipment, as projected by the Green IT Promotion Council. Internet traffic of video images is rapidly increasing, replacing e-mails, texts and still images in html contents. In addition, the energy consumption of network and data centers is rising with the increasing speed and volume of traffic and the spread of ubiquitous services. We are proposing a fully optical communication system i.e. an optical path network, suitable for high-volume transmission of video that has consistent connections.

In the 1990s, it was predicted that information



(BaU case in a report by the Study Group on ICT Systems and Networks Contributing to Environmental Load Reduction)

Fig.1 Energy demand in the IT sector



Green IT Promotion Council, Study and Analysis Report (2008)

Fig.2 Projected energy consumption by IT equipment type

Scenario B: A projection for the case of no innovation in energy-efficiency technologies, with medium market penetration and medium growth rate of power consumption

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processing would be distributed throughout the world via networks. While PCs are a necessity for offices and homes, with a household penetration rate of 85 % in Japan, data storage and processing functions are being centralized in data centers. This is analogous to the situation in which the development of a transportation network for regional revitalization ends up reaccelerating the concentration of resources in metropolises. The concentration of functions in data centers allows quick updates and advanced management of equipment, and is therefore expected to save energy in a controlled manner. Some featured articles focus on improvement of the energy efficiency of power supplies and air conditioning in data centers, as well as technologies regarding cloud computing.

Toward green innovation

Green IT is a technology for energy saving of and by IT. The prices of goods and services include the cost of energy required to produce and deliver them. Saving this energy can help reduce prices and revitalize the economy. We expect the development of Green IT as described in these articles to bring about innovations by serving as a core for promoting the widespread use of new networks, creating computers with new usages, reorganizing systems, and fostering human resources.

Research Coordinator
Toshihiro Matsui

Power Consumption Visualization Technologies

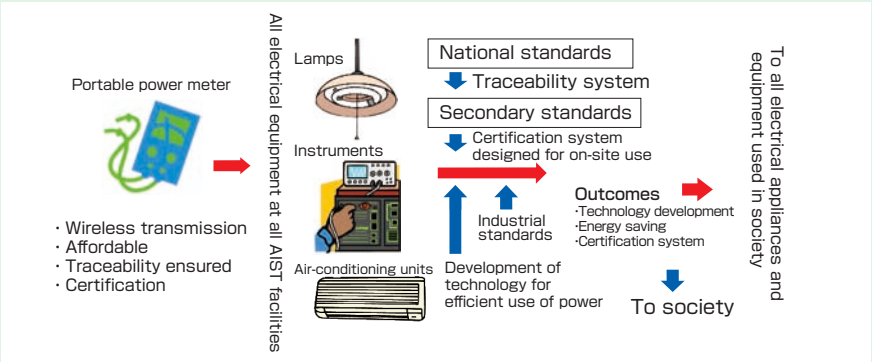
Metrology Institute of Japan
Toshiyuki Takatsuji

Plug-in power meters that indicate power consumption from hour to hour are available on the market. Some of them can also show power consumption in terms of electricity bills and CO_2 emissions. Last summer, new models of air conditioners with built-in power meters were released. The visualization of power consumption is expected to increase energy-saving awareness among consumers, leading to reductions in energy consumption.

The use of such visualization technologies in manufacturing plants makes it possible to individually measure and control the power being used by each plant and to systematically take energy-saving measures.

To implement visualization of power consumption on a large scale, reductions in the size and price of power measurement devices are needed. Technologies such as methods for transmitting measurement data, processing the large amounts of data received, and ensuring the reliability of the measurements must be developed. It is also necessary to build systems (measurement traceability, type approval, and inspection rules) to allow the widespread use of such visualization technologies by the public.

A series of these technology and system development activities are made possible through cooperation among multiple research units at AIST, where research and related tasks are conducted in a wide variety of areas. The development of visualization technologies has been under way since FY2009 as one of our interdisciplinary projects. A prototype system will be installed at AIST to achieve the visualization of power consumption and investigate its effectiveness.



Overview of project for power consumption visualization technology and measures to promote its widespread use

For inquiries about this article：Metrology Institute of Japan http://www.nmij.jp/english/

Optical Network-based Technology to Reduce Power Consumption

Network issues

Today, we rely on communication networks to such an extent that we cannot live and work without a network. The amount of information transmitted via networks continues to increase at an annual rate of 40 % (Fig. 1). This is due to the increase in video information transmitted through sites such as YouTube and Google Videos. Video images contain more information than e-mails and web pages. The amount of information contained in video images will continue to rise as their resolution becomes higher. The power consumption of network routers was 8 billion kWh in 2006 and is expected to increase in proportion to the expansion of network traffic. If it continues to rise at the current rate, the use of the network will be limited by restrictions on power consumption. Because of this, it is essential to develop technology to significantly reduce power consumption by changing the way networks are built.

Ultralow power consumption by the use of an optical path network

In the current Internet, small information packets called Internet Protocol (IP) packets are electronically processed by a router to determine their destination. This is the most power-consuming process of the router and is said to account for one-third of its power consumption. Our concept is to achieve ultralow power consumption by processing large amounts of information such as video information using an optical path network. In an optical path network, circuit (path) switching for information is performed by optical switches, instead of electronically determining the destination of packets. Users are connected to each other through the optical path. It would be possible to develop low power-consumption optical switches. Eventually, the consumption per unit of information is expected to decrease by 3 to 4 orders of magnitude compared with existing routers. We believe that in 10 years from now, a combination of two types of networks will be used: the existing IP packet network convenient for e-mailing and web browsing but with lower power consumption, and the optical path network for handling high-resolution images (Fig. 2).

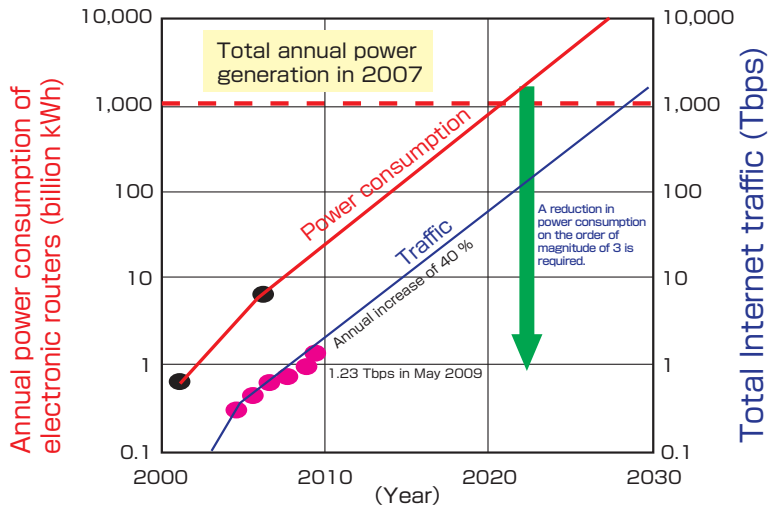


Fig.1 Amount of Internet traffic and power consumption of electronic routers in Japan

Research and development projects and the future

We are developing optical switches using a silicon micro-optical waveguide, as well as technologies to maintain the quality of transmission through the optical path, to control routing, and to manage network resources, in cooperation with companies in a project named "Vertically Integrated Center for Technologies of Optical Routing toward Ideal Energy Savings" funded by the Special Coordination Funds for Promoting Science and Technology. We are also evaluating the possibility of reducing the energy consumption of networks combining various routing protocols such as the packet and path protocols in the Green IT Project of the New Energy and Industrial Technology Development Organization (NEDO). In addition, we are engaged in the research and development of an ultra high-speed LAN that supports a super high-definition TV system being developed by the Japan Broadcasting Corporation (NHK) with 16 times the number of pixels of existing high-definition TV systems in NEDO's Next-Generation High-Efficiency Network Device Project.

In these research and development projects, our objective is to develop technologies that improve the utility of the network, make it possible to receive new services with ultra

For inquiries about this article：Network Photonics Research Center http://unit.aist.go.jp/nprc/ci/index.html

low power consumption such as highly realistic videoconferencing and distance medical services using high-definition video communication systems, and lead to a reduction in energy consumption from use of the network.

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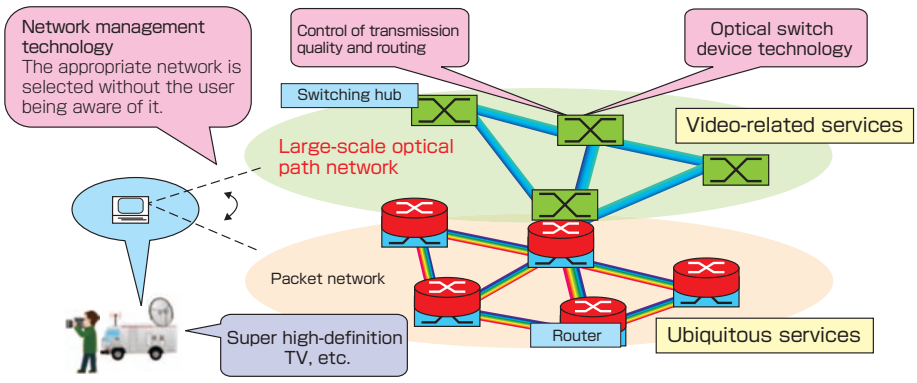


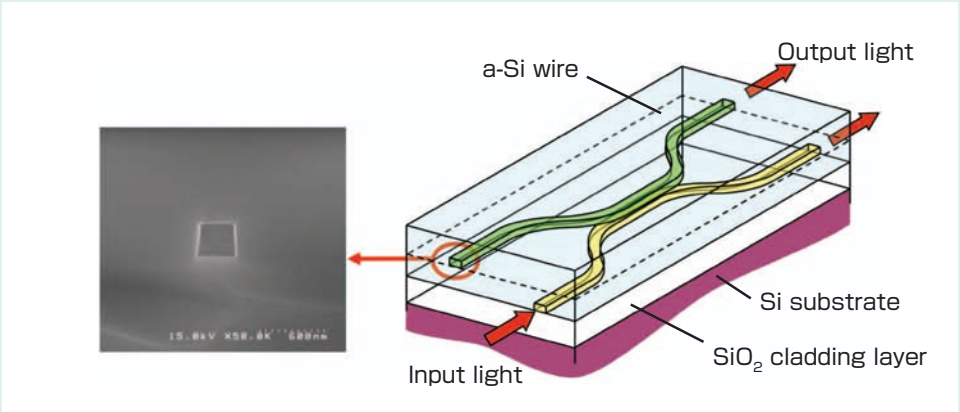
Fig.2 Image of the network of the future
The packet network is used for small volumes of information and the optical path network is used for large volumes.

Optical Interconnection

Photonics Research Institute
Masahiko Mori

With the never-ending growth in the volume of information to be processed today, the energy consumption of information processing equipment (e.g. high-performance computers and servers, which are the main equipment of data centers) is also increasing as well as that of networks, causing serious problems. Optical interconnection technology is a focus of expectations as a solution to these problems. Specifically, the bottleneck inside the equipment lies in the connections between the large-scale integrated circuit (LSI) chip packages and the printed circuit boards. Optical interconnection between the chips is therefore the first issue to be considered. It is also necessary to start the development of intra-chip connection technology, which requires long-term efforts.

In recent years, silicon photonics technology based on Si-CMOS process technology has been attracting attention as a means of photonics-electronics integration for optical interconnection. We have been developing a technology to integrate a laser source and a silicon optical waveguide, and an amorphous-silicon (a-Si) optical waveguide technology for three-dimensional optical interconnection. We will continue our research and development to achieve higher performance devices and modules and system demonstrations, for solving the above problems in collaboration with industrial circles and academic institutions.



Schematic illustration of a vertically coupled optical branch (a directional coupler) and cross-sectional view of an amorphous-silicon optical waveguide

For inquiries about this article：Photonics Research Institute http://unit.aist.go.jp/photonics/cie/index.html

Improvement in Energy Efficiency of Computers – Non-volatile Memories –

○Spintronics and normally-off computers

Two reasons of improving the energy efficiency of computers

Computers have become indispensable in our daily lives, and will be used in various forms from now on including large numbers of microelectronic devices embedded in home appliances, walls, and roads. Improvement of their energy efficiency has two aspects. One aspect is the total energy consumption. In addition to the massive power consumption of data centers, the power consumption of electronic devices smaller than PCs is not negligible due to their huge number. The other aspect is the convenience of electronic devices for prolonged use. Laptop PC batteries currently last only a few hours per charge. If they last a week, a few months, or a few years, new uses for PCs will emerge.

The advantage of spintronics: information storage in non-volatile memory

Spintronics is a new electronics technology using nanometer-scale magnets that is expected to play a significant role in improving the energy efficiency of computers. The greatest advantage of electronic devices employing magnets is their ability to store information without using energy (non-volatile memory). Up to now, however, it has been necessary to use conventional electromagnetic coils to make the connection between magnetism and electricity. This has been the principal cause of the difficulty in improving performance. Spintronics, a new technology that has rapidly advanced over the past 10 years, provides a fundamental solution to this problem. This technology allows magnetism and electricity to be connected at the quantum mechanics level. A typical example of its successful application is the CoFeB/MgO/CoFeB tunnel magnetic resistance (TMR) device jointly developed by AIST and Canon in 2004.[1][2] This has made it possible to develop small hard disk drives (HDDs) having considerably increased memory density and idle power reduced to about one-fifth. Currently, our technology is being used for HDDs worldwide and contributing to a reduction in their power consumption, which accounts for about one-third of the heat generated by information technology equipment in data centers.

Non-volatile memory and PCs with ultralow power consumption

The next target of spintronics technology is to develop a non-volatile computer memory. As current CPUs are very powerful, they are often not fully used. It is said that only a few percent of the CPU's power is utilized by netbooks, for example. For the most advanced CPUs, it is becoming common to use technology to power on and off the arithmetic-logic unit at short intervals of less than one-thousandth of a second when the CPU has no task to perform. However, the power of the computer itself cannot be turned off. This is mainly because power must be continuously supplied to retain the information in the dynamic RAM (DRAM) and static RAM (SRAM) used as the memory. As the density of the DRAM and the SRAM becomes higher, their standby power further increases. It is an important issue to reduce the power consumption of the memory.

If the memory is made non-volatile, the power of the computer can be completely turned off at short intervals without the user even being aware of it. Such a computer would not need

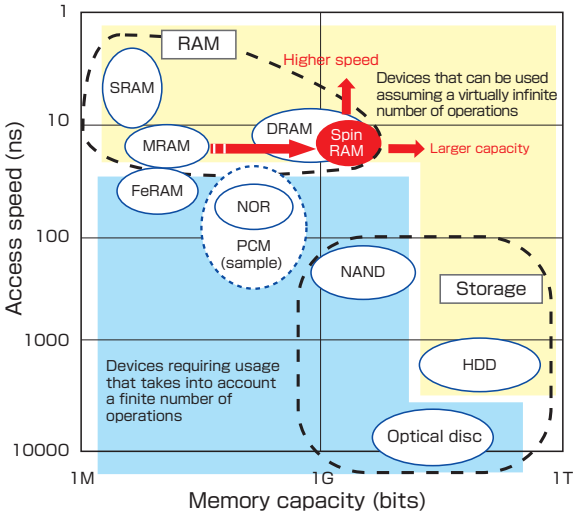


Fig.1 Status of various commercial memory storage devices (sample in the case of PCM)[3] and the goal of developing a spin-RAM

a power switch. We are working to realize such a computer, referred to as a normally-off computer.

However, computers need high-performance memories. The DRAM is required to have an operating speed of as fast as 30 ns and endure more than 10^{15} read and write operations. Also, a capacity exceeding 1 Gbit is needed. This is a very high hurdle to overcome, considering the performance of flash memories that are typical large-capacity non-volatile memories. They have the operating speed of the order of a microsecond and endure write operations of the order of 10^5. At the moment, no non-volatile memories are available to replace the DRAM and the SRAM.[3]

Spin-RAM

Magnet-based memories store information by changing the direction of the electron spin, and therefore do not involve the movement of atoms, making it possible in principle to perform an infinite number of write operations. The direction of the spin can be changed in less than 1 ns. The magnetic core memory used in early computers disappeared from the market because the magnetic coil used to read and write information prevented high integration of the memory. The situation has dramatically changed with the advent of spintronics technology. Magnetic RAMs(MRAMs) with comparable speed to the DRAM are already available on the market. However, their storage capacity is only 16 Mb and their theoretical maximum capacity is 256 Mb, making it impossible for them to replace the DRAM. This limitation is due to the fact that a TMR device is used to read information but a magnetic coil is used for write operations. However, when spintronics technology is used for writing, the capacity of the MRAM can be increased to more than 1 Gbit. The key to achieving this is the spin injection magnetization reversal process using quantum torque produced by the spin, which is a vector. The next-generation MRAM is called spin-RAM. We are jointly engaged in a NEDO project with Toshiba, Osaka University, Tohoku University, and the University of Electro-Communications to develop a large-capacity spin-RAM. It was initially taken for granted that the CoFeB/MgO/CoFeB TMR device developed by AIST would be used as the core of the spin-RAM. However, this TMR device was developed for HDD heads, and is not, in reality, suitable for the spin-RAM. This is because CoFeB loses magnetism if it is smaller than 65 nm, which corresponds to 1 Gbit. We recognized this problem early on and took on the challenge of developing a new TMR device using a material called a perpendicular magnetized film, which has strong magnetic properties. As a result, we succeeded in developing the world's first spin-RAM technology which enables more than 1 Gbit RAM.[4] This success has shown the possibility of realizing a high-speed spin-RAM to replace the SRAM and a very large-capacity spin-RAM for storage. We have, in fact, succeeded in demonstrating sub-nanosecond spin injection magnetization reversal.

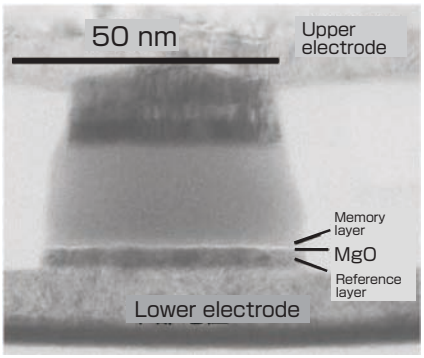


Fig.2 Electron microscope image of a 50 nm perpendicular magnetized TMR device (developed jointly with Toshiba, etc.)[4]

Toward the realization of normally-off computers

A high-performance non-volatile memory is required to realize normally-off computers. Also required is collaboration among a wide variety of technologies such as displays, power supplies, memory architecture, and operating systems. We are working to achieve a reduction in the power consumption of computers with the resulting improvement in convenience, using spintronics technology as the core.

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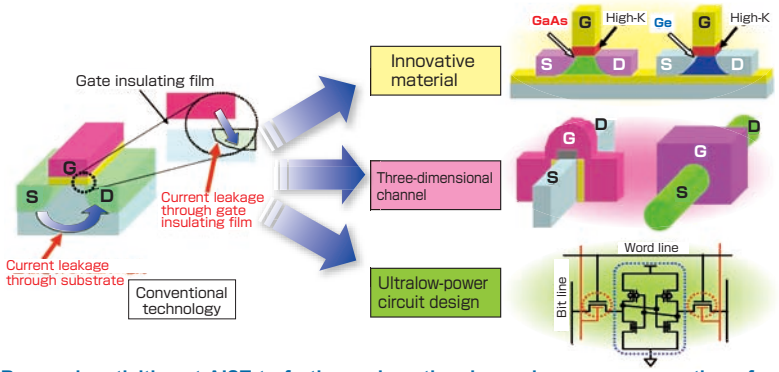
Improvement in Energy Efficiency of IT Equipment

○ Low-power transistors

Background

It is no exaggeration to say that the evolution of the IT society and the tremendous reduction in the power consumption of IT equipment is the outcome of reductions in the size of transistors. Further reductions in transistor size, however, are becoming increasingly difficult. As a result, power consumption is increasing instead of decreasing. We are working to develop innovative materials and new three-dimensional structures and to propose and verify new circuit configurations that make it possible to achieve ultralow power consumption, with the aim of obtaining solutions to the problems that prevent reductions in transistor size and achieving further significant reductions in power consumption.



Research activities at AIST to further reduce the size and power consumption of transistors and improve their performance

We are working to achieve high performance and ultralow power consumption using innovative technologies in the areas of materials, structures, and circuits.

Materials technology to achieve significant reductions in leakage current and significant performance improvements

With decreasing transistor size, power consumption increases due to the leakage of current through the gate insulating film. This is a major concern. We are developing a new gate insulating film with a high dielectric constant that can greatly reduce leakage current without increasing the film thickness. We are also developing channel materials that make it possible to improve performance without relying on reductions in transistor size. Specifically, we are developing transistors that outperform silicon-based transistors, using materials such as germanium and gallium arsenide.

A three-dimensional multi-gate transistor to achieve a further reduction in transistor size

In order to structurally reduce the large leakage current between the drain and the source due to reductions in transistor size, we have proposed a transistor (a three-dimensional multi-gate transistor) that has a three-dimensional channel structure instead of the conventional planar channel, and multiple gates over the channel. We confirmed that this structure provides ideal properties at gate lengths of even less than 20 nm without an increase in leakage current. We are also developing a transistor having a nanometer-order wire-shaped channel that makes it possible to further reduce the transistor size.

New circuit configurations and new-principle devices to achieve ultralow power consumption

The properties of a device after fabrication can be freely controlled if multiple gates can be controlled individually. We have proposed a new circuit to make effective use of the ability to control properties at will on the transistor level. For example, we have succeeded in reducing the static leakage current of the entire circuit to 1/100 by setting transistor properties not contributing to the functioning of the circuit to the standby state. We are conducting research and development to further reduce the voltage of the power supply by means of a device based on a new principle using the quantum tunnel effect.

Advances are being made in the reduction of transistor size using the innovative technologies described above in the areas of materials, structures, and circuits. This has opened up the possibility of reducing the power consumption of LSI circuits to less than 1/100. We are working on the development of basic technologies for high-performance, low-power, VLSI employing these technologies in order to contribute to the IT society and the semiconductor industry in Japan.

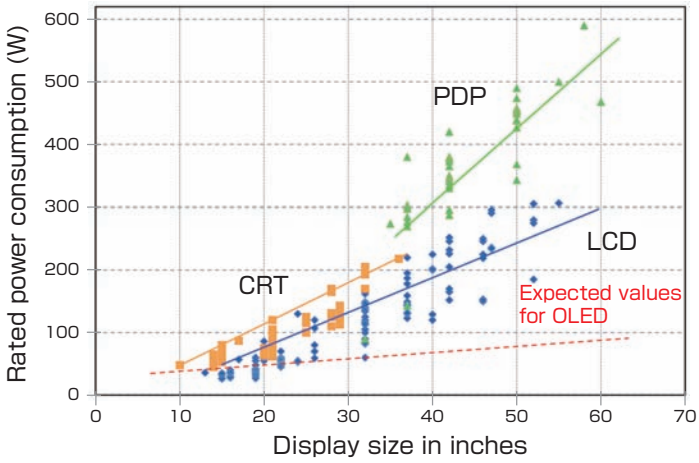
Nanoelectronics Research Institute
Meishoku Masahara

Nanodevice Innovation Research Center
Hiroyuki Ota

○ Organic LED displays

Trends in display development

Displays such as those used in TV sets are the most important devices by which people today receive electronic information in their daily lives. Against the backdrop of very strong demands for convenience and ease of use, improvements have been made such as increases in screen size, resolution, and operating speed. However, these functional improvements have been accompanied by increased power consumption. The total annual power consumption of TVs has increased at an annual rate of 5 to 7 % due to upgrading to higher performance sets. Today, TV sets account for about 2 % of Japan's total power consumption and are projected to consume three to four times as much power as at present 20 years from now unless their energy efficiency is improved.



Relationship between size and power consumption of different types of displays
CRT: cathode ray tube, PDP: plasma display panel, LCD: liquid crystal display, OLED: organic light-emitting diode display

Organic LED technology for ultralow-power displays

Today, extensive research is being conducted to develop low-power displays such as liquid crystal displays (LCD) and plasma displays. However, to achieve improvements in both function and power consumption, fundamental innovation of the display principle is required. Organic light-emitting diode (OLED) technology has been attracting attention in recent years, particularly as a means of achieving low power consumption. OLEDs for display as well as lighting applications are being extensively developed, and global competition in the development has become increasingly fierce. The OLED is a self-light-emitting device and, when used in a display, it reduces the number of parts, such as filters, that reduce the efficiency of utilization of the light. Almost 100 % efficiency of the light emission itself can be achieved in terms of internal quantum efficiency. For these reasons, OLEDs make it possible to develop ultralow-power displays capable of displaying high-quality images. They are all-solid-state, requiring no vacuum or liquid parts, allowing ultrathin, lightweight displays to be realized. There are rising expectations that large but space-saving and lightweight displays will be able to be developed thanks to this technology.

Development of technology for manufacturing large devices

The major technical issue in introducing OLED displays on the market is the development of technology to manufacture large devices with high productivity. Wide-ranging manufacturing technology is required to produce meter-order large-area thin-film devices with micrometer-order precision.

Unlike the case of LCDs, the manufacturing technology for small OLEDs cannot be applied readily to large-area OLED displays. Our aim is to realize displays with high performance and low power consumption by developing a technology for manufacturing large-area, solid-state thin-film devices that offers high speed, precision, homogeneity, and a low defect rate. The manufacturing technology for large thin-film devices is a basic technology applicable not only to displays but also to other large-area devices such as for lighting and solar cells. Its development requires the collaboration of industry, academic, and public sectors.

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Improvement of Energy Efficiency of Power Supplies and Air Conditioning in Data Centers

○SiC power devices

Present situation of power supplies in data centers

In usual data centers, AC power is supplied to the server racks via uninterruptible power supplies (UPSs). The supplied AC power is converted to DC (for example, 48 V) by the power supplies on the rack and further to lower voltages (such as 3.3 V) by the power supplies on the boards, and is then consumed by the memory, CPU, and other devices. The conversion efficiency of individual power supplies is high, at about 95 %, but the voltage conversion ratio cannot be increased. It is therefore necessary to perform the conversion in multiple stages. As a result, the total power supply efficiency between the receiving end and the load end is not necessarily high (Fig. (a)). This means that it is important to further increase the efficiency of each power supply and reduce the number of conversion stages.

Effect of introducing SiC power devices

Silicon carbide (SiC) power devices have the characteristics of lower loss, higher switching speed, and superior thermal durability compared with current mainstream silicon (Si) power devices, and represent a promising technology that can contribute to improved efficiency of power supplies and a reduction in the number of conversion stages. For example, the use of SiC converters makes it possible to improve the total efficiency by (1) reducing the conversion loss to about 65 % that of existing Si converters, (2) supplying high-voltage DC power (400 V class), and (3) reducing the number of conversion stages from 7 to 3. As a result, the total power supply efficiency between the receiving end and the load end can be dramatically increased from 72 to 91 % (Fig. (b)). With its experience in the development of low-loss/high-speed power devices and a high power-density power converter using these devices[1], the Advanced Power Electronics Research Center has been given responsibility for the research and development of power devices and power converters with higher operating temperatures [2].

Power supply management technology

The reliability of power supplies for information and communication equipment is ensured by redundancy*. Operation with redundancy always requires an excessive power supply capacity in comparison with the load capacity and is therefore disadvantageous in terms of power supply efficiency. We are investigating power supplies taking operational aspects into account, such as the application of adaptive management of the capacity of power supplies to prevent reduced efficiency during partial-load operation and to respond to load changes.

(*)An operation method in which auxiliary power units are always operating and the required capacity of the power supply is ensured by several power units. For example, a capacity of 100 is supplied by three power units each having a capacity of 50. The reliability of the power supply is enhanced because its required capacity is dependably supplied even when one of the units is out of service.

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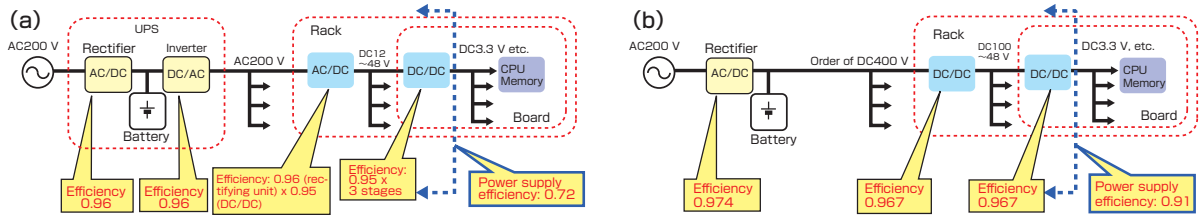


Efficiency of power supply in a data center

(a) Example of power supply system based on conventional method (b) Example of power supply system using SiC power devices
The conversion loss is reduced to 65 % by using SiC power devices. In addition, the use of SiC power devices makes it possible to supply high-voltage DC power (400 V class) and reduce the number of conversion stages.

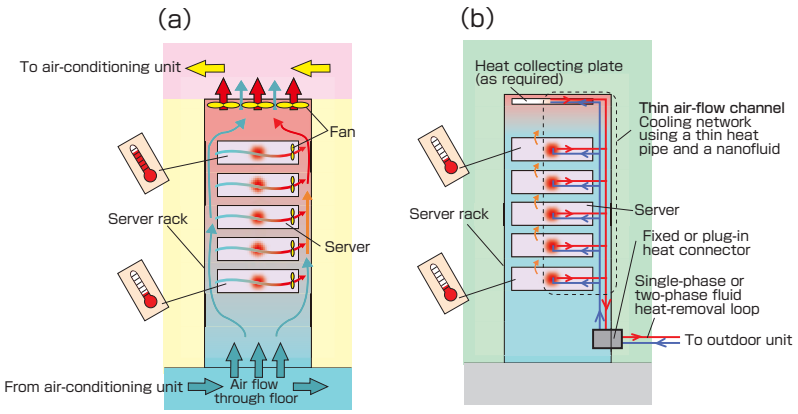
References

[1] AIST Advanced Power Electronics Research Center web page : http://unit.aist.go.jp/adperc/index.html
[2] NEDO web page : http://www.nedo.go.jp/activities/portal/p09004.html

○Advanced cooling-network system

Introduction

The shares of power consumption in a data center vary with its size and site conditions. Air conditioning accounts for 30 to 40 % of the power consumption and servers account for nearly the same percentage. CPUs account for about 70 % of the power consumption of the servers. Most of the power consumed by the CPUs is lost as heat. The heat generated by the CPUs in a server (each CPU consumes more than 100 W) is removed by the air conditioners and the fan for each CPU. It can therefore be said that the cooling of the CPUs in the servers accounts for most of the huge power consumption of the air-conditioning units in data centers.



Comparison of two server-cooling systems
(a) Conventional cooling system (b) Advanced cooling-network system

Methods of cooling servers

The figure shows a comparison of the concepts of a conventional air-cooling system for a server rack and the advanced cooling-network system[1] being developed by AIST. In an air-cooling system, cold air is supplied through the floor and circulated through the rack to cool the servers. Due to the significant amount of heat generated in the servers, however, the air temperature downstream of the air-conditioning unit increases significantly. As a result, the air-conditioning temperature is excessively lowered to cool the CPUs and other devices to the desired temperatures and the air-flow rate is increased, or the power to the fans is increased. The primary purpose of air conditioning is to cool the CPUs and other heat-generating devices only. In reality, however, air conditioning is wasted as a result of cooling the entire server room and the entire building more than necessary. In the advanced cooling-network system, first the CPUs are directly liquid cooled (by a single-phase fluid involving no phase change or a boiling two-phase fluid involving a gas-to-liquid phase change) or indirectly liquid cooled by a high-performance heat pipe to recover most of the heat generated by the CPUs as the sensible heat of the liquid or the latent heat of vaporization, thereby minimizing the heat released into the server room. Heat removal from one server rack is shown in the figure for illustration purposes. In this system, sets of server racks in the server room are interconnected by heat-transfer cables as if they were networked by LAN cables, and are systematically cooled for heat removal by the cooling network of cables.

Energy-saving effect

After cooling the servers, the warm coolant is cooled by an outdoor chiller. The power consumed by air conditioning of the server room can be reduced to 35 to 45 % of the current level even when the efficiency of heat removal is underestimated and the power consumption of the chiller is taken into consideration. We aim to achieve a reduction of more than 60 % by increasing the efficiency of heat removal.

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Reference
[1] Y. Abe *et al.* : *Advanced integrated cooling systems for thermal management in data centers*, Proc. IPACK2009, IPACK2009-89009 (2009).

For inquiries about this article : Energy Technology Research Institute http://unit.aist.go.jp/energy/index_e.htm

Improvement of Energy Efficiency in Cloud Computing

○ Storage system for cloud computing

'Cloud computing' is one of the promising approaches to reduce power consumption of IT equipment. In cloud computing, IT services and the equipment to provide the services are available on the network, instead of being owned by individual users or companies. For example, you could call web mail services, such as Gmail, cloud services. These services are centrally controlled and hosted by huge data centers. The overall power consumption of IT equipment is reduced through shared use by a large number of users as well as through improved efficiency by centralization.

In achieving cloud computing, data storage devices such as disks are of particular importance. Unprecedented volumes of data must be stored and provided to enormous number of users in cloud computing. Needless to say, reliability is absolutely essential. These requirements are met by placing multiple storage devices in parallel and automatically replicating data among them.

We believe that performance guarantees are also important for the advancement of cloud computing. Guaranteeing performance is not general practice in the Internet world. However, for applications such as video streaming, which is expected to become richer and richer in the coming years, it is necessary to guarantee the performance of data storage systems, as well as networks for data transfer to the end users.

Another important topic is the semiconductor storage devices, which are rapidly becoming commoditiesies. Semiconductor storage devices provide faster access speeds and consume less power than HDDs. However, if HDDs are replaced by semiconductor storage devices and the network speed remains the same, the network speed will become a bottleneck, preventing full use of the high speed of semiconductor storage devices. We are conducting research on technology to take full advantage of semiconductor storage devices by minimizing data transfer.

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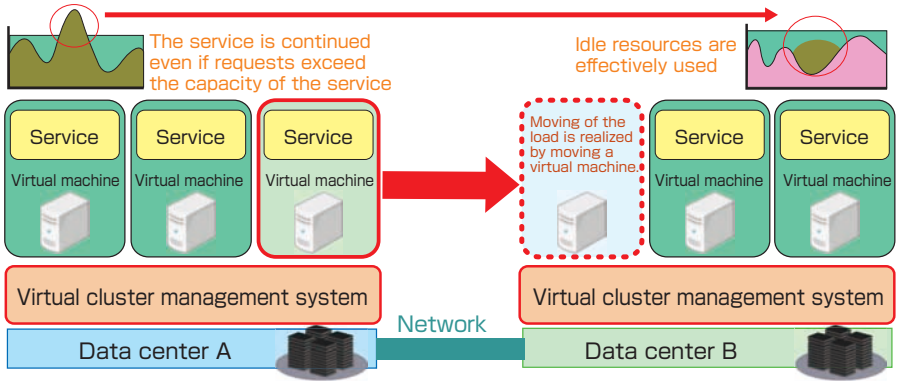
Hidemoto Nakada

○ Greening by virtualization

With the increasing number of information systems being operated in data centers in recent years, power consumption and heat generation at data centers have become a major concern. In particular, the server density per unit area is increasing, resulting in increased power consumption. There are, however, seasonal, weekly, and daily changes in the operation of most servers used for business applications. Their capacity is not fully utilized, with an average utilization rate of only about 30 %. From the perspective of energy saving, it is more efficient to turn off the power of servers not in use and increase the utilization of those that are turned on as much as possible.



Live migration of virtual machines makes it possible to balance the load on the data center through the network to maintain its utilization.

With the advent and dissemination of Software as a Service (SaaS) and cloud computing, users can enjoy a variety of services without being aware of the physical servers. In data centers providing these services, physical servers can be logically divided into several virtual servers to increase their utilization, employing virtualization technology. In this way, the number of physical servers used to provide the same service can be reduced, contributing to reductions in energy consumption. In reality, however, there is a limit to the improvement

of energy efficiency using the current level of virtualization technology. The utilization of data centers generally varies with time, making it difficult to constantly maintain high utilization.

We are developing a cross-data-center virtualization technology as an advanced solution to improve energy efficiency. This technology allows data centers remotely located from each other to be managed in a unified manner through an interconnecting network as if they were a single data center. It also allows a service being operated by a data center at one location to be moved to a data center at another location without interrupting the service.

Within a data center, a technology called live migration of virtual machines is used to change the operating location of services. However, it was believed to be difficult to use this technology between remotely located data centers due to performance degradation resulting from delays in the network. We have solved this problem by proposing a new data transfer technology to overcome such delays. Performance degradation due to a delay in the network is prevented by transparently moving storage data on a virtual computer to a remote location. A service can be moved in less than one second by optimizing the method of moving memory data on the virtual computer.

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Power Monitoring through kHz Band PLC

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The High-speed Power Line Communication Collaborative Research Team is conducting the research and development of kHz band power line communication (PLC) with The Tokyo Electric Power Company, Inc. (TEPCO). There are two types of PLC systems: one using a carrier wave in a MHz band to carry a signal and the other using a carrier wave in a kHz band. The MHz band PLC systems have high transfer rates and can only be used indoors in Japan. The kHz band PLC systems have low transfer rates, and yet they are allowed to be used both indoors and outdoors. Because of this regulation in Japan where power meters are placed outdoors, it is considered effective to incorporate a kHz band PLC device into the power meter, in order to read and monitor the power consumption of the home and to notify the users of their power consumption thus raising awareness of energy saving. The real-time power consumption of each home can be sent to the power company for optimal power distribution. The PLC main unit built into the power meter can also control the power consumption of household appliances by communicating with PLC sub-units built into the appliances. In this way, an in-home network can be created.

However, since the kHz band PLC systems use a carrier wave of less than 450 kHz, it is very important to withstand the intense noise from household appliances concentrated in this frequency range. Conventional kHz band PLC systems have only been able to offer slow transfer rates due to this noise. The PLC system developed by AIST and TEPCO solves the noise problem. It is very robust against the noise and has achieved the world's fastest transfer rate of 200 kbps (March 2009 press release).

A power meter with a built-in communication function such as PLC is called a smart meter. This is one of the fundamental technologies for the next-generation power grid (smart grid), which has recently been attracting attention. In the United States, there is a movement to use ZigBee, a short-distance wireless technology, as well as PLC. In the case of wireless technology, however, there are problems in communication with equipment located on different floors such as a basement. It is therefore unrealistic to use only ZigBee as the communication infrastructure for all power meters. In the United States, the new smart meter-based, in-home communication infrastructure is regarded to be the second Internet and is expected to provide new business opportunities. Therefore, the entry of business ventures as well as large companies into this field are accelerated.

For inquiries about this article :Information Technology Research Institute http://itri.aist-go.jp/en/index.html

UPDATE FROM THE CUTTING EDGE

Jan.-Mar. 2010

The abstracts of the recent research information appearing in Vol.10 No.1-3 of "AIST TODAY" are introduced here, classified by research areas.
For inquiry about the full article, please contact the author via e-mail.

Life Science and Biotechnology

Glycobiomarker test can evaluate progression of liver fibrosis by chronic hepatitis

A paradigm shift by development of glycobiomarkers on problem-oriented medical diagnosis

Hepatitis C-type virus (HCV) infection is known to be a main cause of chronic hepatitis (CH), resulting in liver cirrhosis and subsequent hepatocellular carcinoma. Regarding the current therapy on the diseases to eliminate HCV infection using interferon, instead of liver biopsy test, a new clinical test using blood samples has been required to establish the estimation of liver fibrosis. By intensive cooperation, we have developed glycobiomarkers that can evaluate the progression of liver fibrosis in patients with CH using blood samples. Our new biomarkers are expected to reduce overall burden of medical care by decreasing frequency of liver biopsy, and by cutting health care costs. Additionally, the biomarkers are expected to be useful in foreign countries where the prevalence of HCV infection is the same as, or more than Japan. Furthermore, it is expected to accelerate the development of antifibrotics for CH patients.

Thus, the development of glycobiomarkers proposes a paradigm shift on therapeutic approaches based on medical diagnosis of HCV infection.

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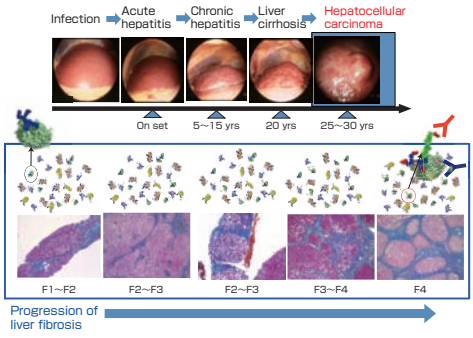

Evaluation of liver fibrosis stage of chronic hepatitis patients using glycobiomarker

Development of a far-red luminescence imaging technology

Imaging technology of a cancer cell based on chemical reactions in *Cypridina* bioluminescence

We have developed a far-red luminescence imaging technology for visualization of disease specific antigens on cell surfaces in a living body. First, we conjugated a far-red fluorescent dye to biotinylated *Cypridina* (sea-firefly *Umihotaru*) luciferase. This conjugate produced a bimodal spectrum that has long-wavelength bioluminescence emission in the far-red region as a result of bioluminescence resonance energy transfer. To generate a far-red luminescent probe with targeting and imaging capabilities of tumors, we then linked this conjugate to an anti-human Dlk-1 monoclonal antibody. This far-red luminescent probe enabled us to obtain high-resolution microscopic images of live, Dlk-1-expressing Huh-7 cells without an external light source, and to monitor the accumulation of this probe in tumor-bearing mice. Thus this far-red luminescent probe is a convenient analytical tool for the evaluations of monoclonal antibody localization in a living body.

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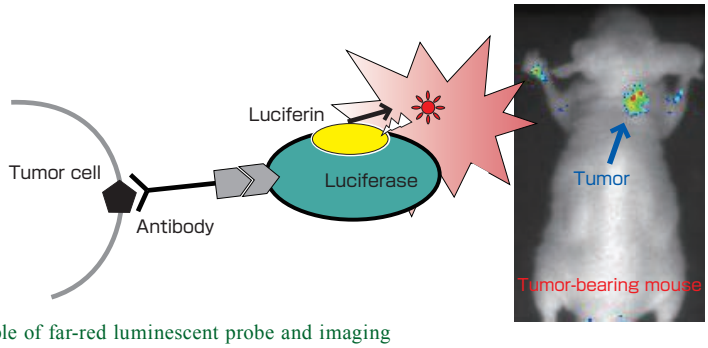
AIST TODAY Vol.10, No.1, p.20 (2010)



Principle of far-red luminescent probe and imaging of the location of tumor tissues in living mice

Development of an objective examination for olfactory malfunction

Possibility of early identification of Parkinson's disease and Alzheimer's disease

Currently, clinical examination of olfaction is not so familiar as vision, audition or tactile sensation, because of its difficulties in stimulus presentation. Objective diagnoses for diseases are also well developed in vision, audition and touch sensation. For olfaction, however, the situation is still poor. On the other hand, recent studies reveal that hyposmia is frequently observed in early stages of Alzheimer's disease or Parkinson's disease.

AIST has developed objective and subjective diagnostic methods for olfaction. We utilized olfactory event related magnetic fields of the brain for objective olfactory diagnosis. Five healthy participants and four anosmia patients were diagnosed using T & T olfactometry and intravenous olfactometry. We presented β-phenylethylalcohol in forty trials, with 400 milli seconds stimulus period, and inter-stimulus interval was thirty seconds. And we discovered clear change in the magnetic field of the healthy participants but not with the patients. This diagnosis method will be useful for the clarification of the mechanism for olfactory loss and degenerative neurologic disease.

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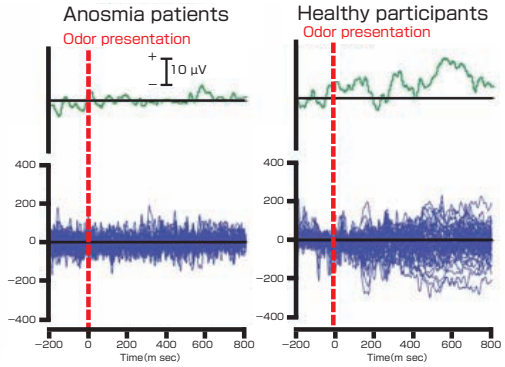

Measurement results
Electroencephalogram (EEG) (upper left) and magnetoencephalogram (MEG) (lower left) signals of anosmia, EEG (upper right) and MEG (lower right) signals of healthy participants

Standard evaluation circuit board for cryptographic modules

For enhancement of hardware security and establishment of international standards

We have developed an FPGA board, the SASEBO-GII, to serve as a standard platform for evaluating the security of a cryptographic module with respect to side channel attacks. Side channel attacks extract secret information from a cryptographic module by analyzing power consumption and electromagnetic radiation. The SASEBO-GII board provides a uniform environment for researching side-channel attacks, making possible the development of international standards and metrics for security testing of cryptographic modules. The SASEBO-GII board supports dynamic reconfiguration, so that the board's functionality can be updated and its malfunctions can be repaired without stopping or rebooting the system. On-demand hardware implementation made it compact and low-power consuming. By advancing research on dynamic reconfiguration of hardware using the SASEBO-GII board, more secure, more reliable, and higher performance systems can be developed.

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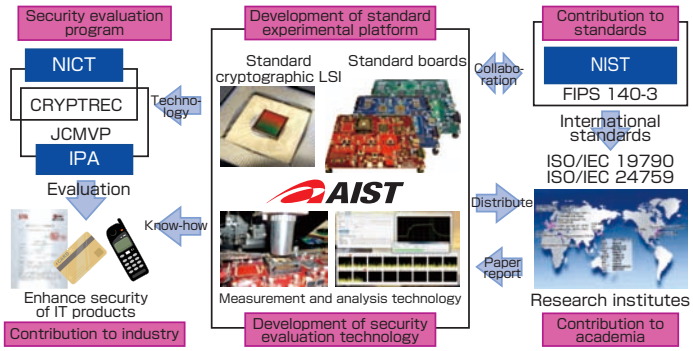
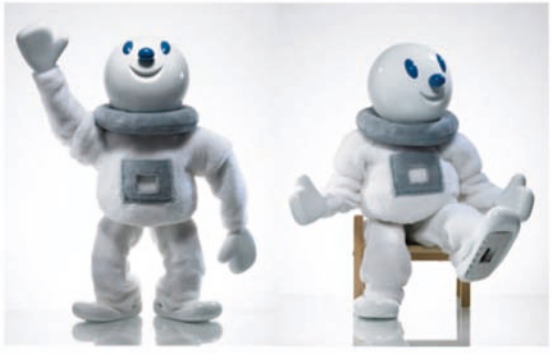


Development of security evaluation technology for cryptographic modules and activities on international standardization

An assistant robot "TAIZO" for rehabilitation exercises for seniors

To increase the motivation of the elderly for the exercises

We have developed an assistant robot "TAIZO" for rehabilitation exercises for seniors that is a set of exercises to help rehabilitation of the elderly with some disability. TAIZO is 70 cm tall and has 26 degrees of freedom with a familiar appearance, and can be operated easily by a senior instructor of the exercises through speech recognition and a remote controller. TAIZO can execute about thirty kinds of the exercises and talk with the instructor and the elderly. The robot has been applied to help the instructor of the exercises, and it has been observed that the robot can increase the motivation of seniors to learn the exercises.



Assistant Robot "TAIZO"

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AIST TODAY Vol.10, No.1, p.21 (2010)

Robotic Arm for Persons with Upper-limb DisAbilities (RAPUDA)

A safe and cost-effective measure for improving the quality of life

We have developed a small and light robotic arm, Robotic Arm for Persons with Upper-limb DisAbilities (RAPUDA), taking into consideration future safety certification standards.

RAPUDA is a robotic arm having seven degrees of freedom in arm and hand parts; it weighs approximately 6 kg and has a payload of 0.5 kg. In RAPUDA, a original mechanism of a linear expansion and contraction is adopted in order to enlarge the field of vision of the user during operation and to reduce the number of pinching parts (joints) of the arm. Since RAPUDA has been designed considering future safety certification standards, double sensors for measuring joint movements, a high-reliability communication system and so on are adopted. Further, cost reduction of the robotic arm is considered and the arm should be available at easily affordable prices.

It is expected that this small and light robotic arm can be operated independently by persons with upper-limb disabilities, who would otherwise require assistance. To realize this, evaluations are carried out by users suffering from muscular dystrophy or cervical spine damage.

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AIST TODAY Vol.10, No.2, p.17 (2010)

RAPUDA attached to an electric wheelchair

QuakeMap: a wide-ranging map showing the detailed strong ground motion

A wide range of information from several institutions is integrated and provided to users

We have developed the Quick Estimation System for Earthquake Maps Triggered by Observation Records (QuiQuake). QuakeMap, a part of QuiQuake, has been published on a website (http://qq.ghz.geogrid.org/) since October 13, 2009. In this system, an amplification capability map of ground motion (Vs30 map) based on a 250-m grid cell map of geomorphologic classification in Japan owned by AIST and seismic observation records from K-NET and KiK-net released by the National Research Institute for Earth Science and Disaster Prevention (NIED) are processed on a cluster computer of AIST. The system estimates and illustrates the wide-ranging and detailed ground motion of earthquakes immediately after the release of seismic observation records. Furthermore, ground motion maps for about 5,000 major earthquakes after June 1996 have been computed and archived such that they chronologically represent the seismic motions over the last 13 years. It is expected that these maps will be used as fundamental information for municipalities and private companies to develop business continuity plans (BCPs) and to take effective countermeasures against seismic disasters.

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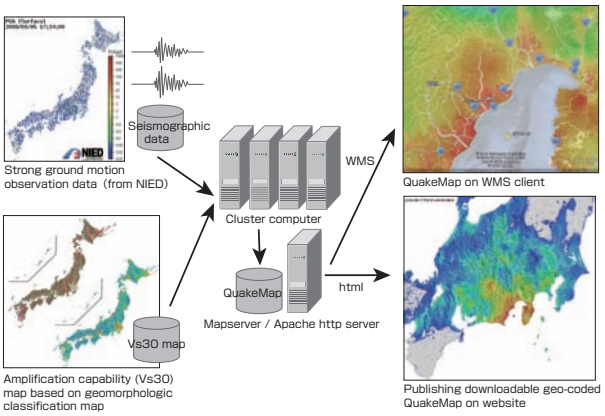
AIST TODAY Vol.10, No.2, p.18 (2010)



QuiQuake System Overview
Seismic observation records of NIED and Vs30 maps are integrated and processed on a cluster computer, and published on the web as QuakeMaps.

Development of a health monitoring system for chickens by using wireless sensors

Anticipated application for the early detection of avian influenza outbreaks in poultry farms

We have developed a health monitoring system for chickens, which could facilitate the early detection of avian influenza outbreaks in poultry farms, by using wireless sensors.

This system consists of shoulder-mark type wireless sensor nodes with temperature and acceleration sensors, having the shape of a one-yen coin with a weight of less than 3 g (including the battery), and a network system which monitors the health of a chicken herd using the temperature and physical exertion data received from the nodes. This system allows constant monitoring of a chicken herd, facilitating the early detection of suspected avian influenza infection in the herd through real-time access to a database. The database used in this system, which is the first of its kind, was constructed on the basis of experimental data on the changes in temperature and reduction in physical exertion as well as modes of transmission of highly pathogenic avian influenza viruses in chickens.

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AIST TODAY Vol.10, No.3, p.12 (2010)

A chicken wearing the shoulder-mark type wireless sensor node

A technique for evaluation of long-term stability of thermocouples at high temperatures above 1000 °C

Development of cobalt-carbon eutectic point for thermocouple calibration

Thermocouples are widely used in industry to measure high temperatures. However, their electromotive force changes (drifts) when exposed to high temperatures, and therefore the evaluation of the drift is very important to establish reliable measurements. To monitor the drifts accurately, a stable fixed point is usually used as a reference. As recently reported, the metal-carbon eutectic points are found to be practical reference points for the calibration of thermometers. In our project, cobalt-carbon (Co-C) eutectic (1324 °C) cells for thermocouple calibration were constructed and evaluated. Based upon this development, thermocouple calibration service is provided at the Co-C eutectic point by National Metrology Institute of Japan, AIST.

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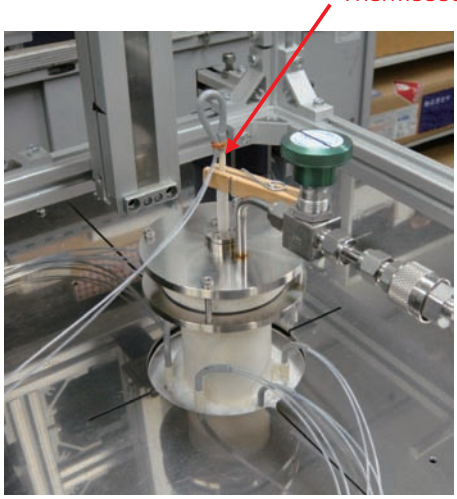

A thermocouple inserted into the Co-C eutectic point cell

Development of a hybrid preconcentration technique

For the highly-efficient preconcentration and highly-sensitive determination of ultra-trace heavy metals

It is important to determine regulated heavy metals such as cadmium, lead, and uranium, whose concentrations are extremely low in the environmental samples. Solid-phase-extraction is one of the effective techniques that could preconcentrate target heavy metals and separate them from the interfering elements. AIST developed a hybrid solid-phase-extraction method (Fig. (a)), in which the sample loading to the syringe-driven column was performed off-line while the elution and measurement of heavy metals were performed on-line. This method integrated the capabilities of multi-sample pretreatment and highly-sensitive measurement, which are the typical merits of off-line method and on-line method, respectively. Figure (b) shows that an off-line method (violet line) and the hybrid method (red line) respectively provided approximately 3-fold and 10-fold (commercial columns) enriched signal intensities compared to that of none-preconcentrated sample (green line). It is noted that the newly developed column could improve the enrichment factor up to approximately 65-fold.

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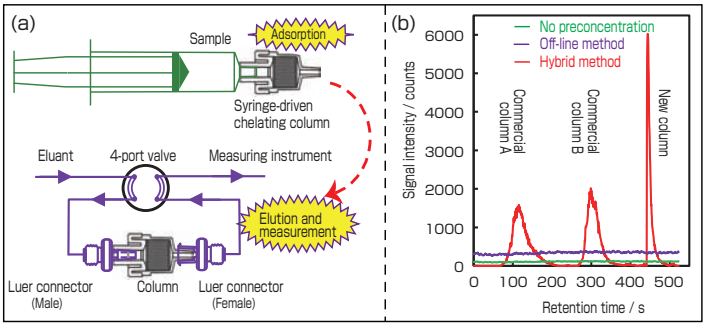

(a) A schematic diagram of the hybrid method
(b) A comparison of signal intensity*
*:Test solution, 1 ppb lanthanum solution; sample volume 5 mL

Disclosing the software system 'GERAS-3' for risk assessment of soil contamination

Free distribution of the developed system expecting wider utilization for environmental risk governance in companies and municipalities

We have developed our original software system 'GERAS-3', a geo-environmental risk assessment system with detailed modeling, for the practical risk assessment of soil and groundwater contamination. The development was completed by the integration of various researches in geology, risk analysis, environmental engineering, and computer science. GERAS-3 has some features and advantages, in order to ensure the assessment of multiple contaminants, the 3-dimensional analysis of soil and groundwater, and the risk mitigation after treatment of contaminated soil. We also developed the databases for GERAS-3, such as on soil parameters, transport parameters of porosity and permeability, and various data for contaminants of oils, metals and VOCs. CD-ROMs of GERAS-3 have been distributed for free upon requests from companies and municipalities. We expect the system will be utilized much by a wider range of users including, local governments, factories, consultants, and educators, for self-governance activities and risk communication related to environmental risks from soil and groundwater contamination.

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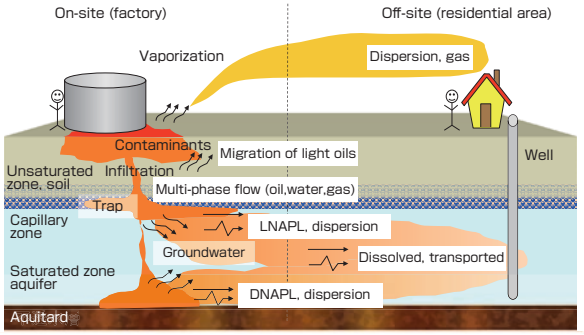

Advanced risk assessment system for multi-component contaminants of soil and groundwater contamination

Sixth Biomass-Asia Workshop

The 6th Biomass-Asia Workshop jointly organized by the Ministry of Agriculture, Forestry and Fisheries (MAFF), the Ministry of Economy, Trade and Industry (METI), and the Biomass-Asia Research Consortium was held from November 18 to 20, 2009 at Hiroshima City. This workshop was supported by Special Coordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and AIST functioned as the secretariat. The workshop welcomed 250 participants from 11 countries (202 from Japan including 75 from AIST). Four lectures were given by representatives from international organizations of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the Asian Development Bank (ADB), and the Economic Research Institute for ASEAN and East Asia (ERIA). Nine presentations were made by speakers from China, Indonesia, Korea, Laos, Malaysia, the Philippines, Thailand, Vietnam, and Japan.

The first opening remarks were made by Dr. Masuo Aizawa, Executive Member of the Council for Science and Technology Policy and Mr. Itaru Watanabe, Senior Deputy Director-General of the Science and Technology Policy Bureau, MEXT, and Dr. Kenji Iiyama, President of the Japan International Research Center for Agricultural Sciences, and Dr. Tamotsu Nomakuchi, President of AIST, representing the Biomass-Asia Research Consortium, gave remarks as the organizers. There were keynote speeches by speakers from MAFF, METI, and the Ministry of the Environment (MOE). Following the special lectures, five sessions were held for two days summarizing the feasibility studies and the workshops held during the past six years. On the second day, with a special lecture in between, the three models of biomass-utilization in Asia carried out for the past three years were summarized. The three models were: 1) the Palm Complex Model focused in Malaysia and Indonesia, 2) Rice and Sugar Complex Model focused in Thailand and Vietnam, 3) Hybrid Agricultural Waste Utilization Model envisioned to be used mainly in China. There were comprehensive discussions including also on surrounding issues such as manufacturing, standardization, and sustainability assessment of biomass production and biofuels. In the last session, the Biomass-Asia Strategy which had been the backbone of the six year activities was reviewed and there was a presentation on the future of Biomass-Town Concept in East Asia. After panel discussions, the Chair's Summary addressed for the further development of technology for sustainable biomass utilization. On the last day, the participants took a technical tour to visit the Biomass Technology Research Center of AIST Chugoku in Kure City and the new AIST facility in Higashihiroshima City where AIST Chugoku is planned to move.

AIST President Nomakuchi addressing the workshop

Regional Implementation Meeting for Asia and the Pacific ahead of the Eighteenth Session of the UN Commission on Sustainable Development

The Regional Implementation Meeting for Asia and the Pacific ahead of the eighteenth session of the UN Commission on Sustainable Development (CSD) was held in Bangkok for two days on November 30 and December 1, 2009. AIST cooperated in the arrangements upon the request of the UN, and sent a resource person to the meeting.

CSD was formed to review and monitor the implementation of Agenda 21. Initially meetings were held every year. From 2003, however, work became a two-year cycle, and since then, reviews of the same topic have been done in the first year, and the policy suggestions have been made in the second year of the cycle. Furthermore, in addition to Agenda 21, the international guideline has been extended to include "Plan of Further Implementation of Agenda 21" and "Johannesburg Plan of Implementation".

From 2010 to 2011, work will be done on the following topics: 1) transport, 2) waste management, 3) chemicals, 4) mining, 5) 10 year framework of programmes on sustainable consumption and production.

For the first year review, the report on the status quo by the Secretary-General of the UN is evaluated. In order to do so, a wide range of information needs to be collected from each government, regional organizations, specialists and NGOs. The UN therefore divides the world into several regions, and preliminary meetings, "regional implementation meetings", are held.

In Asia and the Pacific region, the United Nations Economic and Social Commission for Asia and the Pacific

(ESCAP) in Bangkok is in charge. In response to the request from ESCAP, AIST made arrangements for the topic of mining. The specific work was done by the Institute of Geo-Resources and Environment, and Dr. Satoshi Murao, Senior Research Scientist, coordinated the work, gathered information, wrote the paper, presented the paper, and answered questions from representatives of other countries at the meeting.

On the first day, Mr. Shigeru Mochida, Deputy Executive Secretary of ESCAP declared the meeting open, and stated that the meeting held an important position in the eighteenth session of CSD. He also thanked AIST publicly for our cooperation.

Discussions followed on the aforementioned topics, and each resource person of each specific topic presented review results of the status quo and the future issues of Asia and the Pacific region.

On the second day, the secretariat presented a report proposal, and the representatives of the various countries, and other groups considered the content. However, there were time limitations and a final agreement was not met. Thereupon it was decided that the secretariat would draw up the final report adopting the comments made at the meeting. The final consented report will be used at the CSD eighteenth session to be held in spring, 2010, as the Chair's summary of the Regional Implementation Meeting for Asia and the Pacific.

Senior Research Scientist Murao reporting on mining of Asia and the Pacific (right, directly under the screen)

Cover Photos
Above: Assistant Robot "TAIZO" (p. 19)
Below: RAPUDA attached to an electric wheelchair (p. 20)

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