

# Hitachi Review

Volume 63 Number 3 March 2014

**HITACHI**  
Inspire the Next

Special Issue "Hitachi Technology 2014"



## Hitachi Technology 2014

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# Innovation, an Answer to Society's Challenges. Through the Benefit of Technology.

The world is experiencing an accelerating process of economic globalization in which the cross-border movement of people and goods has become routine. Accompanying this, the need to put the development of society on to a sustainable basis is generating a steady stream of new demands. Rising to meet these challenges are a variety of innovations.

One such innovation is “Big Data.” By using the latest information technology (IT) to tie together vast torrents of data being generated by our society, Big Data offers new ways of creating value and achieving sustainable development. Such examples include the information created as people go about their daily activities, which takes many forms including operational data from social infrastructure systems, geophysical information such as weather data, and the structuring of healthcare information.

Underpinned by our 2015 Mid-term Management Plan, Hitachi's Social Innovation Business is helping to build a better future for the world by applying the latest technologies emerging from our global R&D network.

Also, this includes our work on delivering new systems and services through a sophisticated fusion of different technologies within our business portfolio. One such example is the global optimization of the value chain through the use of monitoring and leveraging simulation technologies. Another is the use of advanced control technology on offshore wind farms to cope with changing swell and wind conditions. In the railway sector, we have embarked on a project to build highly efficient networks that utilize data to manage continually growing traffic volumes. We are also focusing on promoting new industry development in countries that struggle with water shortage by establishing water treatment infrastructure that takes advantage of the low temperature and the purity of deep seawater. Closer to home, we are opening up new possibilities in the fight against cancer by participating in the development of groundbreaking proton beam therapy systems.

Building on these technical capabilities, Hitachi delivers innovations that answer society's challenges. In order to overcome the challenges of the future, we are engaging in dialogue with many external stakeholders from around the world and recognizing and addressing these growing concerns. As a result, we are seeking to create value by using advanced IT and the deep expertise that Hitachi has developed over our 100+ years in business. This is the

essence of our Social Innovation Business.

In this issue of *Hitachi Review*, you will read about the latest technological developments that hold the key to the success of our Social Innovation Business. In order to utilize these technologies and to expand the scope of social innovation globally, I welcome candid discussions with our readers of *Hitachi Review* so we can address respective areas of concern, and continue to address these challenges and help resolve them.

The notable milestones of 2014 include some major international events, such as the Winter Olympics in Sochi, Russia and the Football World Cup in Rio de Janeiro, Brazil. The emergence of new frameworks for the global economy, such as the Trans-Pacific Partnership (TPP), are also anticipated. With a widespread sense of a new era having arrived, we share in the desire to build a better future for generations to come by providing solutions that make the most out of our diverse range of technologies. This ambition is reflected in our Mission of “contributing to society through the development of superior, original technology and products.” It is through this philosophy that we seek to satisfy the expectations of the modern society. We truly believe and uphold that “Social Innovation—It's Our Future.”



**Hiroaki Nakanishi**  
Chairman & CEO, Hitachi, Ltd.

## Visionaries 2014

In striving to create new value by supplying a wide variety of solutions throughout the world, Hitachi is delivering innovations that will help society overcome the challenges ahead. To give a glimpse of this future, Visionaries 2014 presents five such examples in which the people involved describe their work and explain where it is taking us.

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# Information as a Resource

— Intelligent Operations Combining Big Data and the Cloud —

With big data and cloud computing having become new trends in IT platforms, there are moves to generate practical value through the incorporation into IT of know-how and other knowledge from a variety of industries.

Intelligent Operations are a suite of smart information services that use the latest IT to support innovation in business and other areas of society.

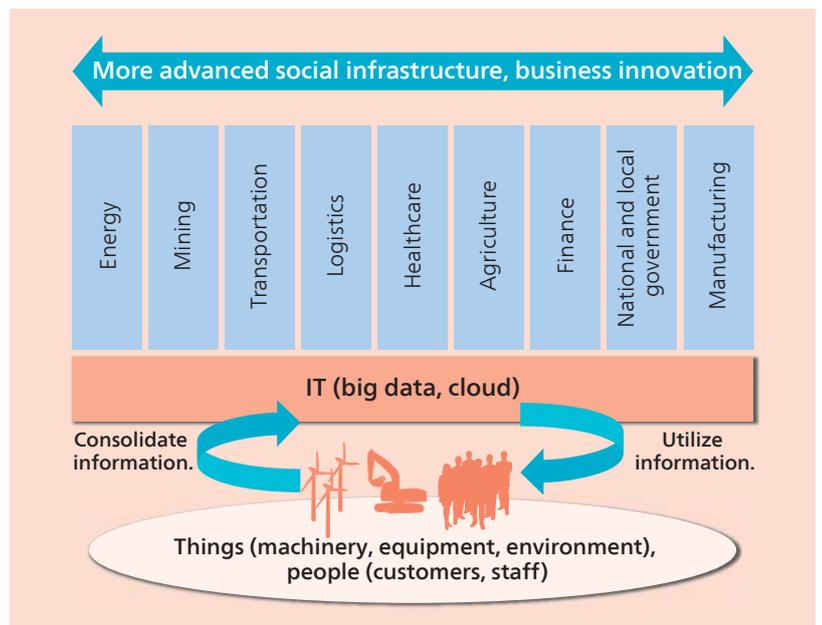
With applications that include enhancing the visibility of business processes, solving practical problems, maximizing service value, ensuring safety and security, and providing more advanced social infrastructure, a new era is emerging in which innovation is achieved through the utilization of the ongoing generation of large amounts of different types of information.

## Business Know-how x IT

The four trends in information technology (IT) represented by big data, the cloud, mobile devices, and social networks constitute a new direction in IT called the “third platform.” In addition to the standalone use of these technologies, it is anticipated that innovation in business and other areas of society will be achieved through the synergies that result from the combination of these different elements.

Based on advanced IT that incorporates features

such as the latest technologies for the utilization of big data and highly reliable and secure cloud services, Hitachi has launched the Intelligent Operations suite of services that combine different forms of know-how built up through its social infrastructure, IT, and other businesses to deliver a powerful boost for customers adopting smarter practices. The term “Intelligent Operations” is used to cover a suite of vertically integrated services for specific industries, the IT platforms (Intelligent Operations Suite) that underpin these



Hitachi has launched services that support innovation in social infrastructure and other business, particularly those industries where there is a potential for major benefits from the adoption of IT.

#### Vertically integrated services (industry-specific added-value services)

Intelligent Operations for Agriculture
Intelligent Operations for Community
Intelligent Operations for Energy
Intelligent Operations for Facilities
Intelligent Operations for Healthcare
Intelligent Operations for Manufacturing
Intelligent Operations for Mining
Intelligent Operations for Mobility
Intelligent Operations for Retail

These vertically integrated Intelligent Operations services are available for a variety of different industries.

services, and early-stage consulting in a variety of industries. By building IT systems from know-how and other practical knowledge that in the past was the preserve of people, these services help create real value, such as making business processes more visible and efficient, making social infrastructure more advanced, or enabling people to live in safety and security.

This concept dovetails with the ideas behind the Social Innovation Business in which Hitachi is engaged on a group-wide basis. The services are targeted at a variety of different industries. In addition to having prospects for growth in the global market and the potential for major benefits from IT-based innovation, another advantage is that Hitachi has collected data from its own operations in these fields.

Intelligent Operations website (in Japanese)  
<http://www.hitachi.co.jp/smart-it/hr403/>

In collaboration with its corporate customers in each industry, Hitachi is currently embarking on proof-of concept (PoC) studies of “practical operational know-how × IT” models to verify their effectiveness. The aim is to accelerate the expansion and reproduction of value creation by supplying these models to companies in the same industries based on the experience and knowledge built up through these PoC studies.

#### Improving Quality in Healthcare

Intelligent Operations work has already started in a number of areas. A leading example is the healthcare industry.

In September 2013, Hitachi and the **NHS GM<sup>(a)</sup>** in the UK announced that they would undertake a joint PoC project for using IT to improve healthcare services. The project has two broad objectives that are based on the two organizations’ shared vision for healthcare.

#### (a) NHS GM

The National Health Service (NHS) England (Greater Manchester). The NHS is the public health service for the UK. NHS GM is the NHS organization that serves the Manchester region.



Dr. Mike Burrows, Director of the NHS GM, and Masaya Watanabe, Vice President and Executive Officer, CSO and CIO of Information & Telecommunication Systems Company, Hitachi, Ltd. at a press conference. NHS GM and Hitachi announced the launch of a joint proof of concept project aimed at improving healthcare services.

and verify proprietary Hitachi technologies for presenting this data in a form suitable for analysis and optimizing its storage in a database.”

Both in the healthcare sector and elsewhere, protecting privacy and taking account of security are major prerequisites if data is to be put to use. To achieve this, Hitachi will supply a highly efficient and dependable technology called k-anonymization, data access control based on agreed levels of access, and other services in accordance with UK national standards and practices.

The second objective is to trial lifestyle disease programs that target people at risk of diabetes and to assess program effectiveness. In the Salford district of Manchester where the PoC project will be based, measures have already been implemented that use health counseling via telephone to help prevent lifestyle diseases. The aim now is to use IT to enhance these further.

Mr. Ugajin said, “The effectiveness of this assistance has depended to some extent on the skills of the counselor involved, with only a limited number of people able to perform this work. In response, we intend to use IT-based prevention support technologies developed over time by Hitachi to provide a means for the efficient delivery of effective advice based on data analysis. Another important point is the use of technology for estimating healthcare costs to make cost-benefit information available.”

In addition to improving quality of life (QoL) by preventing diabetes, the program is also expected to help control healthcare costs. Dealing with diabetes is currently a challenge for nations around the world. Setting up prevention solutions with

The first is the implementation and trialing of a secure integrated healthcare platform for the sharing of data between general practitioners (GPs)<sup>(b)</sup>, hospitals, and research institutions. Atsushi Ugajin (General Manager, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), one of the staff involved in the project, commented as follows.

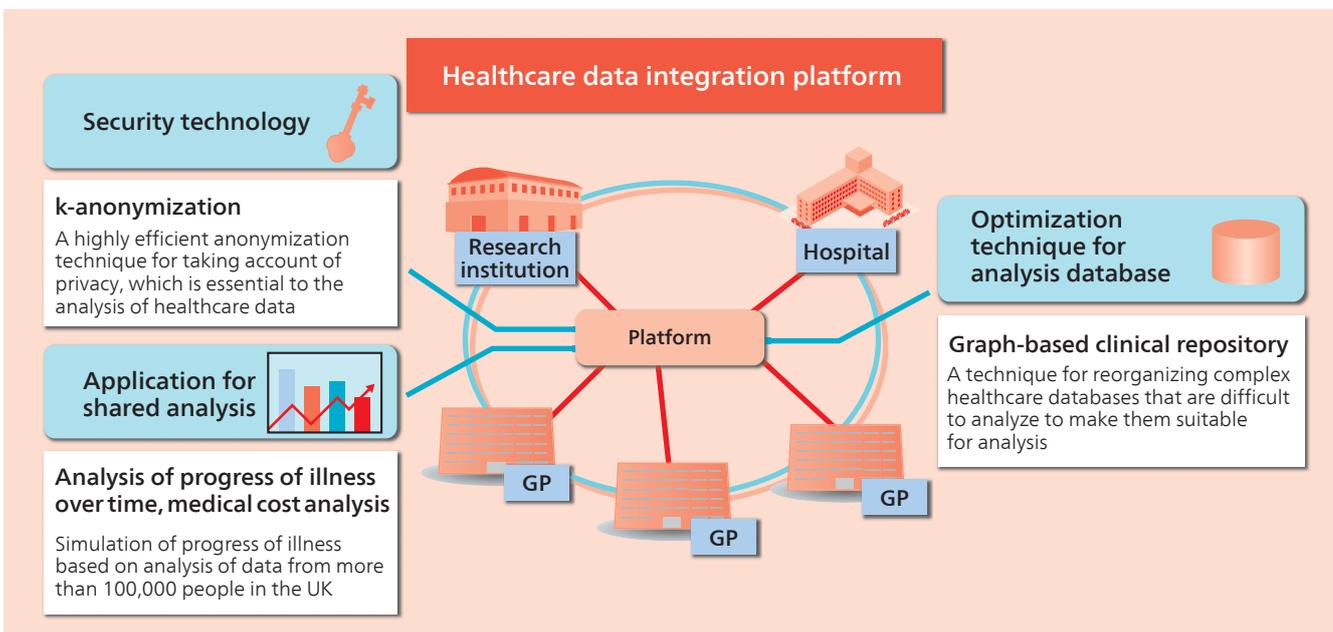
“The healthcare system in the UK has a hierarchical structure in which GPs who serve a particular community refer patients to specialists as required. We will build the system and network infrastructure for the centralized management of medical records and other data, which also provides for the analysis and utilization of a variety of healthcare big data. Because it is made up of a combination of different types of data in a variety of formats, such as test results, treatment details, or medication records, healthcare data is difficult to analyze in its raw form. The project will apply

**(b) GP**

A general practitioner (family doctor) who acts as the initial point of contact for consultations or treatment for any illness.



Atsushi Ugajin



Hitachi is working on the development of an integrated healthcare platform for Greater Manchester that takes account of privacy. The aim is to allow the shared use of data by GPs, hospitals, and research institutions.

## Acting as a Partner with a Shared Vision for Healthcare Services

Dr. Mike Burrows, a Director of NHS GM who is enthusiastic about improving the quality of healthcare services in the UK, has a leading role in the healthcare service improvement PoC being run jointly with Hitachi. He made the following comments.

“Like other parts of the world, England and Greater Manchester face a variety of healthcare challenges, including aging populations and the growing incidence of obesity and adult-onset diseases brought about by lifestyle or poverty. Meanwhile, rather than offering preventive measures, healthcare providers frequently only get to deal with problems after they have manifested. There is a need to overcome problems such as rising healthcare costs and the pressure on medical resources required to provide treatment.

This is why we want to build an IT system that can collate healthcare data from Greater Manchester in ways that do not compromise privacy, and use it to improve clinical decision-making, provide patients with the appropriate care, and cut healthcare costs. Based on our investigations, we concluded that the best way

forward was to collaborate with Hitachi, which has a track record of world-class technology and innovation. Hitachi’s approach is somewhat different to that of other IT suppliers. Rather than seeking to impose ready-made solutions, Hitachi took the time to understand the issues we are facing and then presented a clear vision of how these could be overcome. I felt confident that these were people who understood our problems.

Our success with implementing leading-edge practices at Greater Manchester should also have a positive impact on other regions. Being able to deliver the best possible healthcare in terms of both medical care and costs is a boon both to patients and the people of the city. To achieve these goals, we are working in partnership with Hitachi to accelerate the pace of healthcare innovation in the UK.”



Dr. Mike Burrows

a favorable cost-benefit ratio can make a global contribution and has the potential for application to other lifestyle diseases.

The PoC project commenced in October 2013 and covers approximately 250,000 people in Salford. The plan is to expand the scope of data sharing to cover the Greater Manchester population of about 2,870,000. Mr. Ugajin made the following comment.

“After that, we hope not only to extend the system to other parts of the UK or to the entire country, but also to expand the scope of data it handles to include the health promotion and nursing sectors, and to utilize collected big data to enhance treatments or in other areas of medical research.”

To help bring about a society in which everyone can enjoy a long and healthy life, there is interest in what can be achieved with higher quality healthcare services made possible by IT.

### Providing Access to Information on Mining Operations

Mining is another industry with the potential to use IT to adopt smarter operational practices.

Mining involves the extraction of resources such as coal or ore. It takes the form of a value chain that resembles a large factory, extending from

excavation and conveying through to crushing, separation, and transportation of the end product, and using mining machinery such as excavators and dump trucks. As this machinery requires a large amount of capital, there is a need to improve equipment utilization and get a quick return on investment.

Katsuya Koda (Senior Director, Smart Business Strategy Planning Department, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), who manages Intelligent Operations, describes the situation as follows.

“The inability to fully utilize their mining machinery assets due to operational problems or equipment failures is a major business issue for mining companies. As many aspects of mining are dependent on the skills and experience of individuals, major benefits can be expected from the incorporation of know-how into IT systems. Accordingly, we have taken on the challenge of using IT to raise the utilization of mining machinery as high as it will go.”

The goal is to contribute to efficient management by using IT to provide access to the operating details of machinery used across the mining process. As a first step, Hitachi is working on research and development aimed at enhancing the systems used



Katsuya Koda



Mining requires a large capital investment. Improving the utilization of machinery and increasing the efficiency of dump truck scheduling are important jobs at mine sites.

to support the remote monitoring and preventive maintenance of dump trucks and other equipment used for excavating and conveying ore at mine sites. For remote monitoring, Hitachi has implemented a system in which on-board units installed on dump trucks collect global positioning system (GPS) locations, engine operating conditions, and other parameters and transmit them to a control system. By viewing the information this makes available on dump truck operation, the dispatchers charged with dump truck scheduling can perform their job more efficiently.

Mr. Koda said, “Although systems like these are already operating in the mining industry, they require a major effort to set up and operate, such as providing electric power at mine sites and installing hardware, software, and other IT systems. Instead, we have sought to use cloud technology to allow monitoring to be performed via a data center from a remote site such as headquarters or a branch office. Also, by utilizing the collected big data on machinery operation for purposes such as maintenance management or the pre-emptive detection of faults, it becomes possible to prevent lower utilization due to faults and maximize the return on capital investment by choosing the ideal timing for performing maintenance.”

Once implemented, this provides mining companies with access to the latest remote monitoring and preventive maintenance systems via the cloud with a short lead time and small investment.

“We are also looking to integrate these systems with **Global e-Service on TWX-21<sup>(c)</sup>**,” said Mr. Koda. “We are aiming to provide visibility across the entire value chain and help improve business value at mining companies by using IT to tie together mine sites and administration. By analyzing large amounts of operational data, it may also be possible to do things like identifying

operating practices that prevent mine accidents before they happen.”

The sophisticated use of IT has the potential to bring about major changes in the mining business in the not-to-distant future.

### Extending Life of Social Infrastructure

The maintenance of social infrastructure is another field with potential for the use of IT. In Japan, social infrastructure built during the era of rapid economic growth is now aging and concerns are growing about how to extend its life and ensure its safety and security. A particular challenge for society is how to ensure the safety of road infrastructure such as tunnels and bridges. There are also growing moves aimed at maintaining the quality of social infrastructure at the level of government policy, including conferences being held by the Ministry of Land, Infrastructure, Transport and Tourism on how to deal with the aging of public assets, for example. To provide greater impetus for these moves, Hitachi has introduced a facility monitoring service.

Masaki Ogihara (Senior Engineer, Systems Department 2, Security Solution Operations, Services Creation Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), who is currently working on the development and delivery of this service, made the following comments.

“The first step is to attach small sensors to facilities and then to use machine-to-machine (**M2M**)<sup>(d)</sup> technology to perform measurements on these facilities and make this information available. The next step is to analyze the collected data to identify changes and to assist customers in deciding on the best time for remedial measures such as repairing or rebuilding. We will be providing all of these functions through a cloud service.”

#### (c) Global e-Service on TWX-21

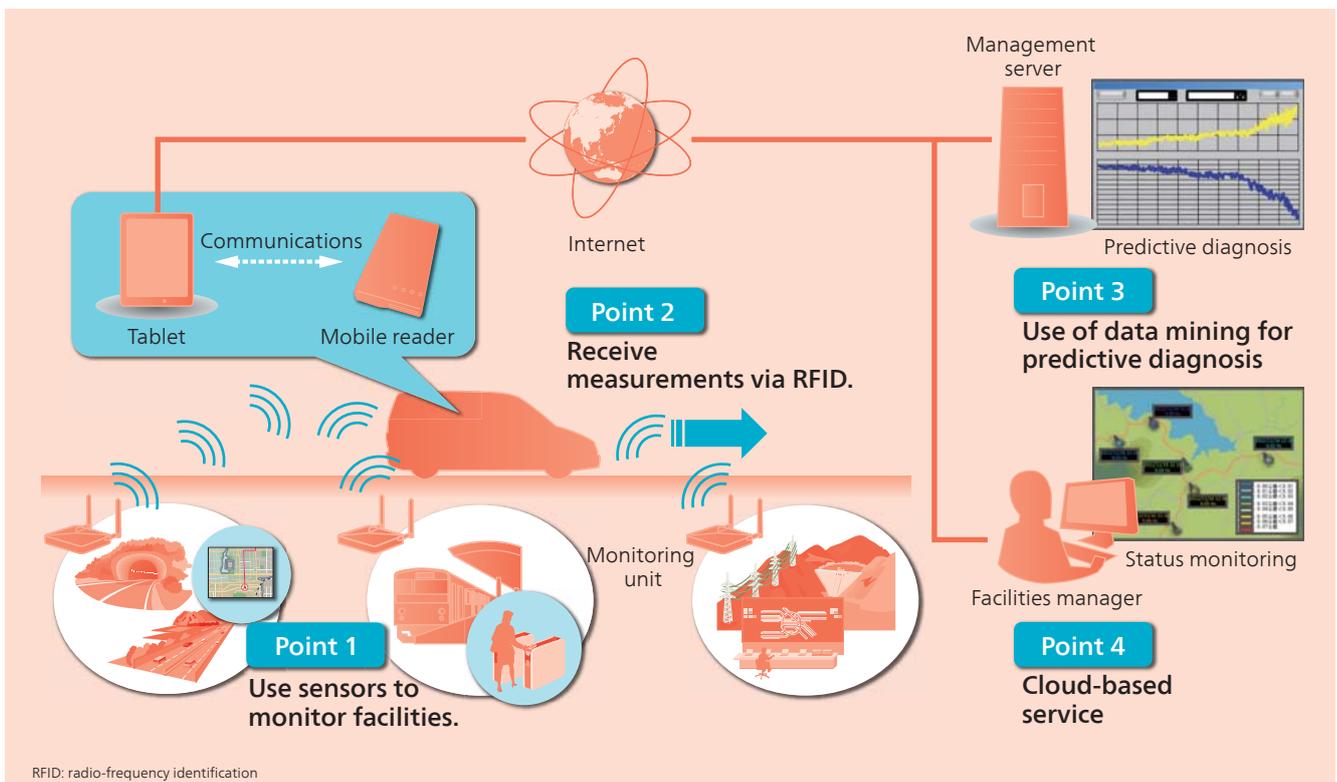
A cloud-based service that supports the lifecycle management of machinery by collecting information on the manufacture, sale, operation, maintenance, and other aspects of machinery, and making this information available for shared use. TWX-21 is a trademark of Hitachi, Ltd.

#### (d) M2M

Machine-to-machine. A system in which machines exchange information directly over a network.



Masaki Ogihara



The figure shows the outline of a facility monitoring service. The status monitoring service monitors for abnormal situations such as landslides and provides realtime notification. The predictive diagnosis service detects signs of problems such as deterioration or aging from data collected during daily inspection tour.

This status monitoring service incorporates active wireless functions into sensors that allow them to transmit radio signals capable of being received up to 200 m away so that sensor data can be collected automatically.

“When sensors are installed at a tunnel or other form of road infrastructure, for example, data can be collected easily from a vehicle as it drives by on a daily inspection tour. In addition to transmitting measurements to a management server in realtime, the data can also be displayed on a smartphone and used for on-site assessments of the state of the facility. We have already conducted field PoC studies on road infrastructure to demonstrate the reliability of the technology,” said Mr. Ogihara.

The sensors are chosen based on the infrastructure being measured and the data to be collected. Specialist of suppliers has a proven track record for devices such as characteristic frequency gauges, inclinometers, strain gauges, and anchor load cells. The range of available sensors is to be expanded in the future.

Another service of a type that only Hitachi could provide uses its proprietary data mining technology to perform predictive diagnosis. This system uses measurements taken over a period of time to learn what constitutes the normal situation, and then extracts correlations with abnormalities by comparing actual measurements with this normal-state data. For example, by attaching sensors to a jet fan installed in a tunnel for ventilation to measure the state of the fan blades

and suspension fittings, predictive diagnosis can be used to take appropriate steps to deal with deterioration or with the loosening of fittings that hold the fan in place.

While this facility monitoring service has been developed for the aging infrastructure of Japan, Hitachi is also considering its use overseas in the construction of new infrastructure, particularly in emerging nations.

Mr. Ogihara said, “If sensors are fitted when the infrastructure is being built, they can also help prevent construction accidents. In addition to road or railway infrastructure, they also have potential for widespread use in water treatment and other plants. Our aim is to deploy solutions that take advantage of the unique capabilities of Hitachi with its IT and infrastructure technology.”

### New Fields Opened up by IT

Progress in IT has made it possible to collect and utilize large amounts of real-world data, something that was difficult to achieve in the past, thereby opening up new fields and leading us into an era in which value is created from data. This steady accumulation of huge amounts of data can be seen as a resource for building a better society. As the diverse range of Intelligent Operations services expand into all the different areas of society, they will bring with them a variety of value and innovation.



Visionaries 2014

# The Wind from the Future

—Fukushima Floating Offshore Wind Farm Demonstration Project—

As use of renewable energy increases around the world, interest is growing in the harvesting of wind energy from off the coast of Japan. Unfortunately, numerous technical challenges stand in the way of achieving this goal of generating electric power from floating wind turbines. Hitachi is participating in a consortium that is taking on this challenge through a demonstration project, with roles that include the manufacture of a downwind turbine and the development of a world-first 66-kV offshore substation\*. The wind turbine and substation are moored approximately 20 km off the coast of Fukushima Prefecture and commenced floating offshore power generation in November 2013.

## Extensive Wind Energy Resources Waiting Offshore

The shortage of power generation capacity afflicted a wide area of Japan, including the Tokyo region, after many power plants were damaged in the Great East Japan Earthquake of March 2011. Subsequently, along with ongoing efforts by households and businesses to save power, there was also an acceleration of moves to encourage the wider use of renewable sources of energy such as photovoltaic or wind power.

As a mountainous country with limited flat land, Japan has a shortage of favorable sites for wind power and is seen as lagging behind Europe or China in its adoption of this form of power generation. Also, whereas offshore wind turbines in Europe tend to use fixed-bottom configurations

\* The floating offshore wind power generation system is part of the FY2011 Fukushima floating offshore wind farm demonstration project (Fukushima FORWARD) funded by the Ministry of Economy, Trade and Industry.



Photograph courtesy of Fukushima Offshore Wind Consortium

in which the turbine foundations are on the sea floor, Japan's lack of shallow offshore seabed means it has limited sites suitable for this approach. On the other hand, compared to onshore sites,

the sea around Japan is known to have more reliable and strong wind conditions. This means that, surrounded as it is by a broad expanse of ocean, Japan has extensive offshore wind energy resources waiting to be tapped. In other words, offshore floating wind turbines are an appropriate form of power generation for Japan's geographical conditions.

Professor Takeshi Ishihara of the Graduate School of Engineering at the University of Tokyo was among the first to recognize this situation and engage in research into floating offshore wind power generation.

### Grand Project Gets Underway off Fukushima

Wataru Saito (Chief Project Manager, Power & Industrial Systems Division, Power Systems Company, Hitachi, Ltd.), who has participated in the work of Professor Ishihara explained the situation as follows.

"Having recognized the potential of floating turbines, Professor Ishihara had undertaken some work on his own initiative in collaboration with construction companies and others, with practical investigatory work having only just begun when the Great East Japan Earthquake struck. This led to the Fukushima floating offshore **wind farm**<sup>(a)</sup> demonstration project."

The project was able to start in earnest when money was budgeted as part of the post-earthquake recovery and reconstruction work. Hitachi then formally joined the demonstration project in December 2011 after invitations to participate were announced by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry. It was through this process that the grand project to build a world-first offshore wind farm several tens of kilometers off the coast of Fukushima Prefecture got underway.

This project to aid recovery in Fukushima and



Wataru Saito

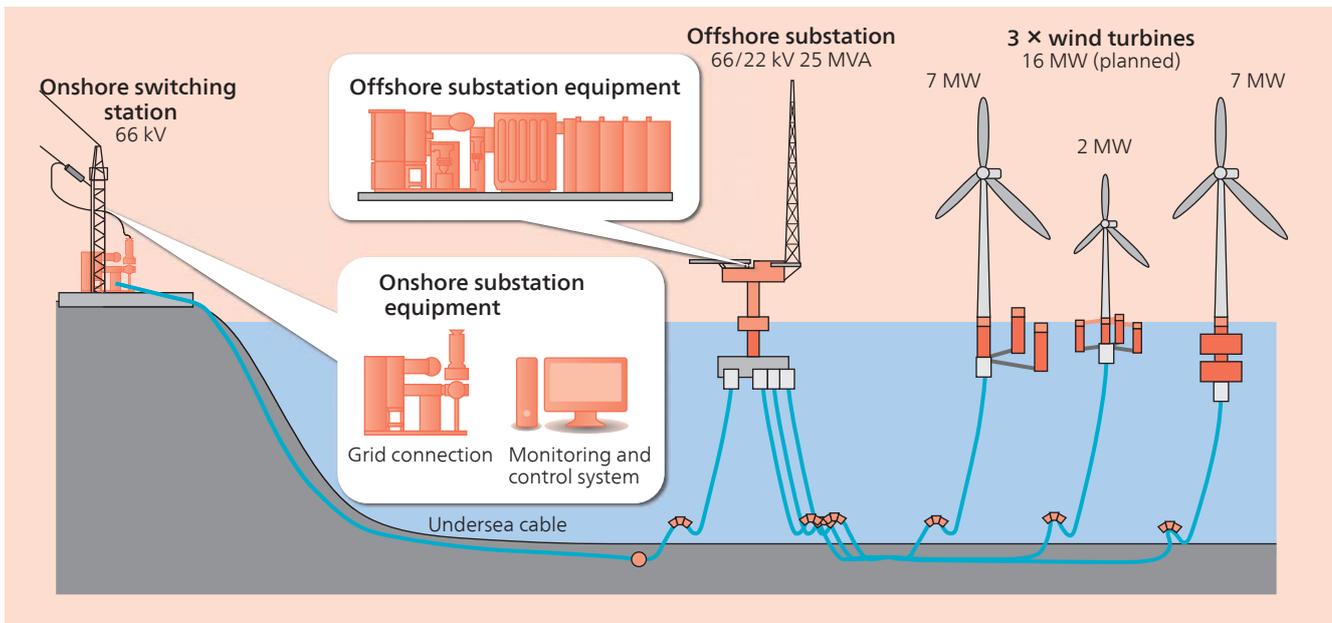
#### (a) Wind farm

A group of wind turbines used for power generation and also called as wind park. Installing a number of wind turbines (up to several dozen) in the same place can reduce the construction and operating costs per unit of output.

Consortium members	Main role
Marubeni Corporation (project integrator)	Feasibility study, approval and licensing, O&M, collaboration with fishery industry
The University of Tokyo (technical advisor)	Metocean measurement and prediction technology, marine navigation safety, public relation
Mitsubishi Corporation	Coordination for grid integration, environmental impact assessment
Mitsubishi Heavy Industries, Ltd.	V-shape semi-sub (7 MW)
Japan Marine United Corporation	Advanced spar, floating substation
Mitsui Engineering & Shipbuilding Co., Ltd.	Compact semi-sub (2 MW)
Nippon Steel & Sumitomo Metal	Advanced steel material
<b>Hitachi, Ltd.</b>	<b>Floating substation</b>
Furukawa Electric Co., Ltd.	Large capacity undersea cable
Shimizu Corporation	Pre-survey of ocean area, construction technology
Mizuho Information & Research Institute, Inc	Documentation, committee operation

O&M: operation and maintenance

Roles of consortium members. The project draws on the knowledge and technologies of each company.



Overview of demonstration project. The electric power generated by the wind turbines will be stepped up to 66 kV for transmission to the onshore switching station. The 66-kV floating offshore substation used for this purpose will be a world first.

**(b) Downwind turbine**

A wind turbine in which the rotor is oriented downwind of the tower. This configuration reduces the load on major components during sudden gusts due to a control mechanism that allows the rotor to freely orient itself downwind. Downwind turbines are suitable for difficult environments such as complex terrain.

trial a floating offshore wind farm was contracted by the Ministry of Economy, Trade and Industry to a consortium of 10 companies and one university. The first stage involves the installation of a single floating offshore wind power generation system with a 2-MW downwind turbine<sup>(b)</sup>, a world-first 25-MVA floating offshore substation, and an undersea cable. The second stage will see the installation of two 7-MW floating offshore wind power generation systems.

There is a certain significance in Fukushima being chosen for the site of this project. Mitsuru Saeki (Senior Project Manager, Power Systems Company, Hitachi, Ltd.), who was involved in reconstruction work at the time, recalls the decision as follows.

“Fukushima Prefecture had a strong desire to pursue renewable energy. Whether or not this project would provide direct assistance for the recovery, we felt that this was not something that could be ignored.”

**Installation at a Floating Site**

Hitachi’s responsibilities in the project included the 2-MW offshore downwind turbine, a world-first 66-kV floating offshore substation, and its monitoring system.

Most wind turbines used for power generation have an upwind configuration in which the rotor is oriented upwind of the tower. As Mr. Saeki explained, the reasons for choosing a downwind configuration for this project included factors specific to a turbine floating at sea.

“We believe that a downwind design will have particular advantages for a wind turbine mounted on a floating platform that is subject to tilting,

such as higher generation efficiency. The way a downwind turbine naturally tracks changes in wind angle when it blows from the side can be thought of as a match for the floating platform.”

The downwind turbine was developed for use in Japanese conditions where there is little flat land available. In addition to selecting the transformer, power conditioning system (PCS), and other electrical components with consideration for the swaying that occurs on a floating platform, the system also incorporates a stability mechanism that controls the pitch of the blades to minimize this swaying.

Another feature of this project is the construction of a world-first floating substation. Typically, the longer the distance electric power needs to be transmitted, the greater the losses. To minimize losses over the long distance from the offshore wind turbine to the shore (approximately 20 km), an offshore substation that raises the transmission voltage from 22 kV to 66 kV was part of the project plan from the earliest stages.



Mitsuru Saeki



Photograph courtesy of Fukushima Offshore Wind Consortium

The electrical conversion equipment is installed on the top of this floating substation.

Toshiyuki Takada (Department Manager, Wind Turbine Business Department, Power & Industrial Systems Division, Power Systems Company, Hitachi, Ltd.), who has responsibility for this work, commented as follows.

“While I had some concerns when we were only given two months to prepare our proposal to the Ministry of Economy, Trade and Industry, I spent considerable time at the factory discussing the work with the transformer designers and other staff as we settled on how we wanted to proceed.”

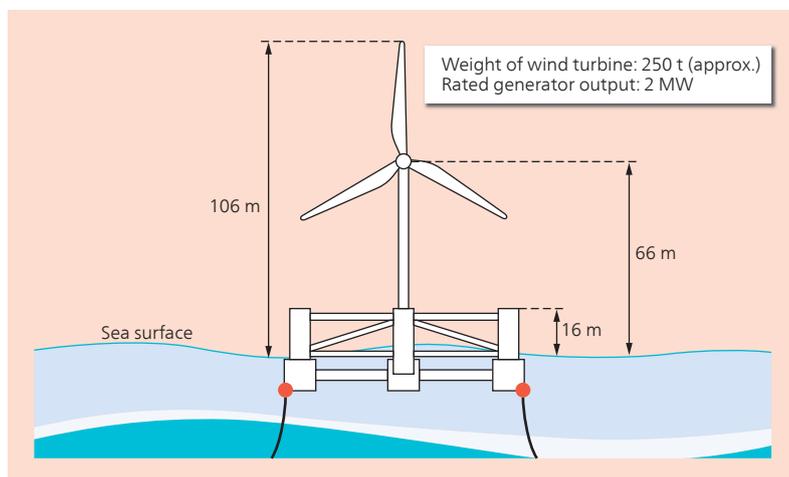
However, substation equipment is built on the assumption that it will be installed on stable ground. If inclined, the coils, core, or other internal parts of a transformer can be left bare of transformer oil, compromising the insulation that is vital to its operation and potentially causing a fault. This meant that the major challenge was how to deal with the swaying and inclining that would result from the large waves of the Pacific Ocean.

Futoshi Asaka (Engineer, Industrial Systems Engineering Section, Power Systems Company, Hitachi, Ltd.), whose work included transformer testing, describes the situation as follows.

“We had no experience of building high-voltage (66 kV) substation equipment for use in a swaying environment and this left us wondering how we could go about testing it. What we ended up doing was to test the 25-MVA transformer inclined at angle up to 35° to verify its ability to deal with the



The 66-kV gas-insulated switchgear (top) and 22-kV vacuum-insulated switchgear (bottom) installed in the substation. These can safely disconnect the current flow if necessary.



Main specifications of the 2-MW offshore downwind turbine. The wind turbine has been designed for floating use and manufactured to cope with the swaying that occurs.

swaying of the floating platform.”

Kazutaka Yokoyama (Manager, Electrical Systems Engineering Department, Electrical Solution Business Division, Power Systems Company, Hitachi, Ltd.), who had experience in technical developments that dealt with swaying, added the following comment.

“As Hitachi has had experience in building a wide variety of transformers, including manufacturing large transformers that need to be robust enough for transportation over long distances to overseas sites and new designs that consider seismic performance, we had the know-how to deal with this new challenge. I believe that our success in building the 66-kV floating offshore substation was due to this experience.”

A number of measures were adopted, including raising the height of the oil tank, increasing the quantity of transformer oil, and adding a number of bolts to ensure that the core and coils would not



Inclination test of transformer. Because the transformer will be installed on a floating platform, it needs adequate measures for dealing with swaying.



Toshiyuki Takada



Futoshi Asaka



Kazutaka Yokoyama

**(c) Dry dock**

A facility used for the construction or repair of ships. It consists of a trench dug deep into the ground that can be filled or emptied of water. The dry dock is emptied of water to allow work to proceed. When the ship is ready to depart, the water is then pumped back in to raise the water level in the dry dock up to sea level.

become dislodged by the swaying. A program of detailed testing was then performed to confirm that the equipment could cope with swaying and inclination.

**Collaboration between Consortium Partners**

The project still faced the difficult tasks of docking the wind turbine and substation to the floating platform, towing them to the installation site approximately 20 km off the coast of Fukushima, and then getting the system to operate as intended.

After they were fabricated, the tower, nacelle,

and other parts of the wind turbine were separated, the blades loaded onto trucks in one piece, and transported to a **dry dock**<sup>(c)</sup> at the Chiba Works of Mitsui Engineering & Shipbuilding Co., Ltd.

Hideyuki Mimura (Senior Engineer, FH Wind Turbine Business Department, Power & Industrial Systems Division, Power Systems Company, Hitachi, Ltd.), who was responsible for the wind turbine and acted as the technical liaison with Mitsui Engineering & Shipbuilding Co., Ltd., described the process as follows.

“The dock provided a stable location for placing the wind turbine. However, a certain amount of coordination was required to prepare a schedule

**Trial of Floating Offshore Wind Power Generation System off Goto Islands**

While the Fukushima floating offshore wind farm demonstration project is making steady progress, another trial of floating offshore wind power generation has commenced off the Goto Islands in Nagasaki Prefecture, Japan. A small (100 kW) prototype wind turbine was installed 1 km off Kabashima Island, part of Goto City, in June 2012. This was followed later by a larger demonstration model.

This demonstration project was led by the Ministry of the Environment, with participants including Toda Corporation, Hitachi, Fuyo Ocean Development & Engineering Co., Ltd., Kyoto University, and National Maritime Research Institute. The 100-kW prototype installed in 2012 was the same unit that had been used off Izena Island in Okinawa 10 years earlier. In 2013, a 2-MW downwind turbine (demonstration model) supplied by Hitachi was installed, increasing the rotor size from 22 m to 80 m. Operation of commercial-scale floating offshore wind power generation commenced in October 2013. The plan

from 2014 onwards is to collect data from the offshore site.

While the wind around Kabashima Island in the Goto Islands is strong, making it a good site for offshore wind power generation, the 100-kW prototype was vulnerable to the forces of nature. In FY2012, the region was struck by a one-in-50-year typhoon, one of the strongest on record. Although the wind turbine itself survived the typhoon, this led to changes in the construction of the 2-MW demonstration model, including a change to the maximum design wave height and revisions to parameters such as rotor vibration and angle of orientation.

The project provides an opportunity to gather valuable data on such questions as what form of wind power generation is suitable for regions of ocean like this that experience frequent typhoons. The data collected and analyzed from the Goto Islands will also provide valuable information for use in the wider adoption of offshore wind power generation.



Images courtesy of joint participants in Ministry of the Environment’s demonstration project for floating offshore wind power generation

A demonstration project aimed at achieving wider adoption of offshore wind power generation is also being undertaken in Nagasaki Prefecture.



Photograph courtesy of Fukushima Offshore Wind Consortium

Docking the wind turbine to the floating platform (photographed at the Chiba Works of Mitsui Engineering & Shipbuilding Co., Ltd.) Time constraints meant work proceeded rapidly.

for completing the assembly work within tight time constraints in an environment that was open to the weather.”

The substation was assembled at the Isogo Works in the Yokohama Shipyard of Japan Marine United Corporation.

Further arrangements were then needed for transporting the assembled wind turbine and the fitted-out substation to the sea off Fukushima. In particular, the 32-m draft of the substation during towing meant it was at risk of running aground in shallow waters.

“Together with Mitsui Engineering & Shipbuilding Co., Ltd., we held discussions with the relevant agencies on aerial identification during the period up until the power cables were connected out at sea,” commented Mr. Mimura.

The wind turbine and substation were successfully towed to their intended positions off the coast of Fukushima and positioned approximately 2 km from each other. The undersea cable was then connected, allowing the operational trials to commence. However, because of the numerous typhoons that passed through the region, they encountered difficulties that prevented equipment adjustment from being completed on schedule.

Speaking about the collaboration between the companies that made up the consortium and that had to deal with these difficulties, Jun Kamoshida (Engineer, Switchgear Equipment Development Section, Switchgear Design Department, Power Systems Company, Hitachi, Ltd.) made the following comment.

“It seemed like we were only able to get out to the floating platform to perform work about one day in 10. I worked on the design of the integrated monitoring system and network infrastructure for the entire facility. Because the facility included equipment from the various different suppliers, there were cases when systems did not function correctly. Furukawa Electric Co., Ltd. was



Photograph courtesy of Fukushima Offshore Wind Consortium

The substation fitted with electrical conversion equipment (front) and wind turbine (rear) are located about 2 km apart.

responsible for the undersea optic cable, and by calling on them, or others such as Hitachi Systems, Ltd., for help when problems like this happened, we succeeded in building a fast and highly secure network.”

By overcoming the various problems that arose in this way, they succeeded in supplying power from the mainland to the substation and wind power generation system.

### Symbol of Reconstruction and the Future

The Fukushima floating offshore wind farm demonstration project commenced operation in November 2013.

Yuhei Sato, the governor of Fukushima Prefecture who attended the opening ceremony, said, “I see floating offshore wind power as a symbol of the future.” The project’s aims extend beyond research trials to include helping with the recovery of Fukushima by attracting new industries based around renewable energy and creating employment. The requirements for achieving these goals include an increase in generation capacity and an expansion in the scale of activity.

“It is thanks to the consortium participants and other parties involved that we have been able to achieve the results that we have from this demonstration project. I would like to express my heartfelt thanks,” said Mr. Saeki.

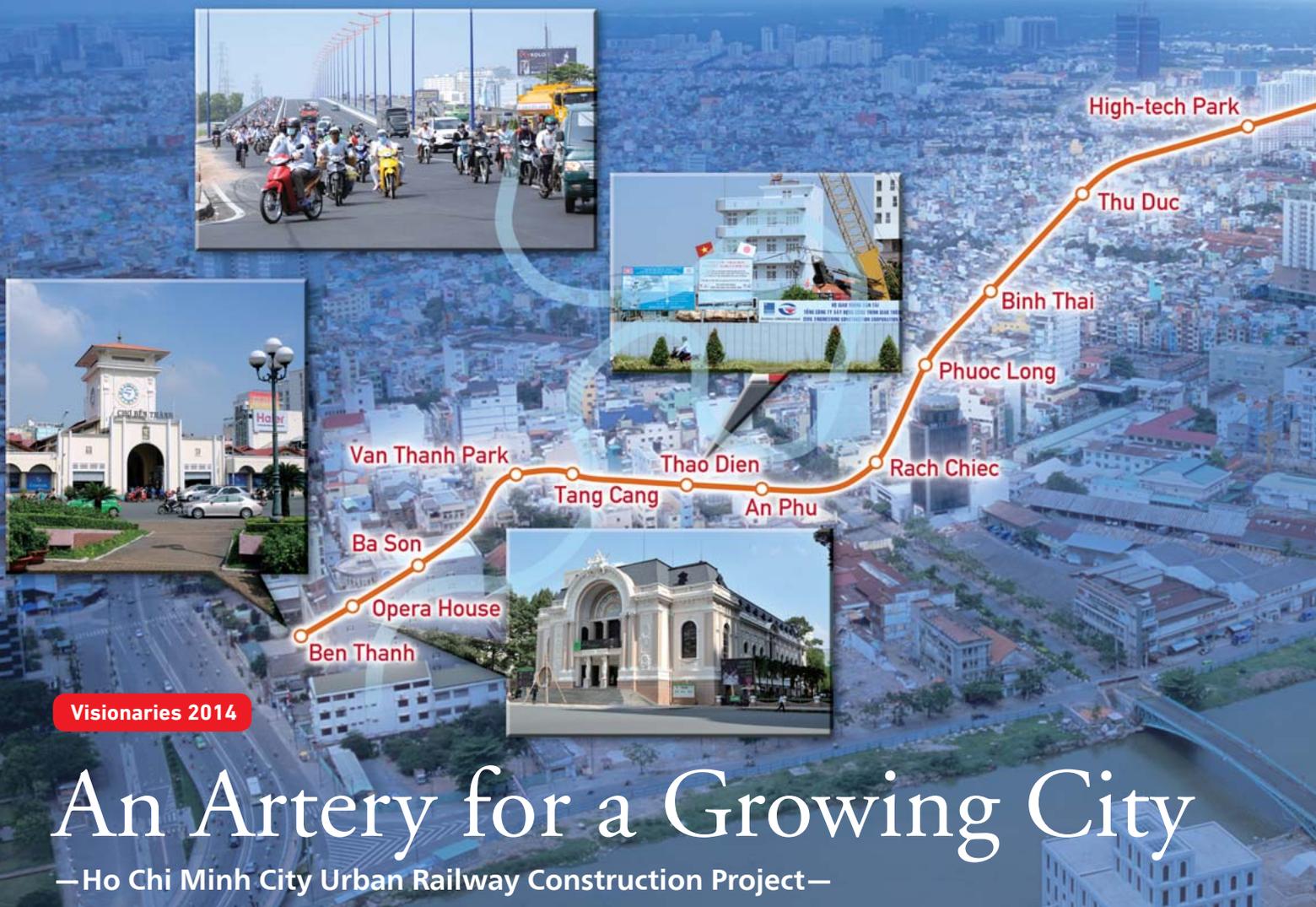
The substation is inscribed with the words “*Fukushima kizuna*” (Fukushima links), and the floating platform for the downwind turbine with “*Fukushima mirai*” (Fukushima’s future). It might be said that the wind that turns the giant blades off the coast of Fukushima is blowing from a future that people are creating for themselves.



Hideyuki Mimura



Jun Kamoshida



Visionaries 2014

# An Artery for a Growing City

— Ho Chi Minh City Urban Railway Construction Project —

Rapid economic growth in emerging economies can result in overcrowded cities that become an impediment to healthy development.

Ho Chi Minh City in Vietnam, where most residents get around by motorbike, is suffering from worsening traffic congestion and atmospheric pollution.

As part of a project to construct an urban railway system that is intended to resolve these problems, Hitachi has won a contract to supply 11 subsystems, including manufacture of the rolling stock, and provide maintenance services for five years after the system commences operation.

The project is now underway, taking a long-term perspective to the provision of transportation infrastructure, while considering local circumstances.



Kazuhiko Nagasawa

### Complex Road Conditions Due to Use of Motorbikes

The provision of public transportation is currently an issue for countries and regions with ongoing rapid growth. With the Socialist Republic of Viet Nam having enjoyed rapid economic development following the Doi Moi (“reforms” in Vietnamese) policy, Ho Chi Minh City, the nation’s largest city, is among those suffering from this problem. The city is experiencing chronic traffic congestion as a result of its rapid population growth, with other challenges including how to prevent traffic

accidents, reduce atmospheric pollution, and improve access to public and other facilities.

Through the global supply of transportation systems in which railways play a core role, Hitachi is seeking to create societies that provide the people of the world with a better way of life. Hitachi made a study trip to Ho Chi Minh City in April 2006. Local project leader, Kazuhiko Nagasawa (Deputy Project Manager, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), recalls the trip as follows.

“I was struck by the large number of motorbikes



Motorbikes are a vital means of transportation for the residents of Ho Chi Minh City.

The underground section of Ho Chi Minh City Urban Railway Line 1 runs from Ben Thanh to the Opera House and Ba Son stations. The overground section runs through major districts along a main highway, including suburban residential areas, industrial precincts, and a theme park at Suoi Tien, terminating after a total distance of 19.7 km at Suoi Tien.

being ridden around despite the general lack of traffic signals. I felt there was an immediate need to improve traffic safety. Because the number of cars in particular has increased from three or four years ago, the roads of Ho Chi Minh City have become even more crowded.”

For example, all of the people moving about or commuting by bike or car to work or school during the morning and evening rush hours make thoroughfares such as Dong Khoi Road, one of the city’s main streets, seem like a major river in flood. Tourist guides dressed in green uniforms have been stationed at street corners in Ho Chi Minh City since 2006 to provide help in crossing the road to overseas visitors unfamiliar with these traffic conditions. According to a survey by the Japan International Cooperation Agency (JICA), the number of motorbikes in the city had reached about 3.9 million in 2009. If you put this figure against the population of about 7 million, you

get an idea of how important motorbikes are to their way of life. Tran Anh Dung (Administration Manager, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), a local manager working on the Ho Chi Minh City Urban Railway Construction project, made the following point.

“When it rains, people ride around wearing poncho-style raincoats. It is not unusual to see mothers taking their children to or from kindergarten by motorbike, and there are cases when slips or other mishaps result in accidents.”

### Railway Project Seeks to Resolve Underlying Problem

The lack of public transportation other than buses and the fact that the people of the city use motorbikes and cars to get around make this severe congestion inevitable. In response, the Vietnamese government identified measures for dealing with traffic congestion as an urgent issue



Toru Komaki

### (a) Special Terms for Economic Partnership (STEP)

A program introduced in July 2002 aimed at raising the visibility of aid by utilizing Japanese technology and know-how for technology transfer to developing economies.

### (b) Standard Urban Railway System for Asia (STRASYA)

Standards for urban railway systems based on Japanese railway technology and know-how. The standards were initially developed in 2004 and will be applied for the first time on the Ho Chi Minh City Urban Railway Construction project.

in its Ninth Five-year Plan (2011 to 2015), and adopted a policy of building urban railway systems in the capital Hanoi and in Ho Chi Minh City as a way of dealing with the underlying problem. The plan for Ho Chi Minh City involves a total of seven railway lines, with Line 1 to be built first.

The Ho Chi Minh City Urban Railway Construction project will have a total length of 19.7 km, running between Ben Thanh in the city center and Suoi Tien in the city's north-east. It includes the construction of 11 stations for the 17.2-km overground section and a further three for the 2.5-km underground line. The rolling stock will be made up of 17 consists from 51 cars. The service is scheduled to commence operation in 2018.

The project is financed by a Japanese government loan ("yen loan") through the **Special Terms for Economic Partnership (STEP)<sup>(a)</sup>** program of Japan International Cooperation Agency (JICA).

A consequence of this is that the project's rolling stock and traffic management system will be the first to adopt the **Standard Urban Railway System for Asia (STRASYA)<sup>(b)</sup>** standards developed by Japanese railway industry suppliers and Japan's Ministry of Land, Infrastructure, Transport and Tourism. Toru Komaki (Project Manager, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), who is coordinating the project for Hitachi commented as follows.

"Having agreed on the use of the STRASYA standards for the rolling stock specifications on Line 1, our first priority is to build rolling stock that correctly follow these specifications, and that is what the customers expect."

### Utilizing Comprehensive Strength

The tender for the Ho Chi Minh City railway construction project (Ben Thanh to Suoi Tien), Vietnam's first urban railway system, was held in

## Thoughts of a Ho Chi Minh City Resident

Tran Anh Dung, Administration Manager of Ho Chi Minh City Urban Railway Line 1 Project Office, is involved with the Ho Chi Minh City Urban Railway Construction project, where he is responsible for administrative tasks such as translation, interpretation, local human resource management, and liaising with relevant agencies in Vietnam. As a long-time resident of Ho Chi Minh City, he is familiar with its traffic conditions. Here, he gives us his thoughts on the project.

"Despite a variety of recent and ongoing measures by the government, public transportation in Ho Chi Minh City remains inadequate, with the result that most residents use motorbikes to get around. Ho Chi Minh City is in urgent need of an urban railway system to provide efficient public transportation.

The Ho Chi Minh City Urban Railway Construction project is about more than just reducing the large number of bikes congesting the roads, and I have two expectations in particular. The first is that the provision of modern and highly convenient transportation, similar to the railway system in Japan, has the potential to enhance people's idea of public transportation. By allowing city residents, who have never seen an underground railway in Ho Chi Minh City before, to be confident about commuting to their places of work or study, Line 1 will introduce people to a new approach, which I call the "urban railway culture," and which is

totally different from our existing "bus culture." My second expectation is that it may provide the impetus, not only for a change in Ho Chi Minh City's public transportation, but also for the people and government to come to an appreciation

of its efficiency and wide effects, and that this will result in their doing their best to contribute to the establishment of the metro network in the city.

Line 1 is a pilot project, and the successes we have had to date are a testimony to the cooperation between many people from Vietnam and Japan. While no doubt there are many more challenges to come, we need to confront these and overcome them head on. As Vietnam has yet to establish its own urban railway standards, one challenge in particular will be how to reconcile these with Japanese standards. Looked at another way, however, Line 1 has the advantage of being built from scratch using the newest technologies.

This project has given the Vietnamese a new view of Hitachi. With the company already well regarded in Vietnam for its home appliances, the people are now looking forward to a Hitachi-built railway line."



Tran Anh Dung



Ho Chi Minh City Urban Railway Line 1 Project Office staff. An organization was put in place from an early stage.

December 2010. Four Japanese groups participated in the tender, with Hitachi forming a consortium that includes the Rail Systems Company of Hitachi, Ltd. and Hitachi Plant Technologies, Ltd. (now the Infrastructure Systems Company of Hitachi, Ltd.).

Mr. Komaki said, “We established a consortium with an organizational structure that allowed us to work together, including renting a dedicated office a year before the tender and staffing it with engineers. Because we were confident with the technical aspects of our bid, the key issue as we saw it was how best to manage costs.”

Thanks to careful preparations and successful negotiations with the relevant parties, the evaluation of the bids found that Hitachi not only had excellent technical capabilities and experience, but was also the favorite in terms of cost. Because the Vietnamese released the bid prices after the tender, everyone involved in the project was aware that Hitachi’s was the leading bid. Nevertheless, subsequent progress was slow.

Akihiro Taruya (Contract Control Manager, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), who has been involved on the commercial side of transportation projects in Southeast Asia and elsewhere since 2004, explained the reasons for this as follows.

“The approval process in Vietnam is complex and time-consuming. The extremely high degree of caution they applied to making decisions meant that progress was slow compared to projects in Japan.”

What followed was a long period of time spent making numerous visits to the offices of his Vietnamese counterparts to resolve the reasons for delay and finalize our preferred bidder status. It seemed that all customs and practices were

different, with one example of the problems they faced being the incremental changes in regulations that occurred at short notice. Nevertheless, Tran Anh Dung and the other local staff were able to keep pace with these changing circumstances and maintain a rapport with the customer.

Meanwhile, because the project was utilizing the JICA’s STEP program, officials from the Japanese government played a supporting role by using their influence on getting work started sooner. Hitachi was finally awarded official preferred bidder status by the Vietnamese government in January 2013. This was followed by approximately three months of contract negotiations before the contract was signed in June of this year.

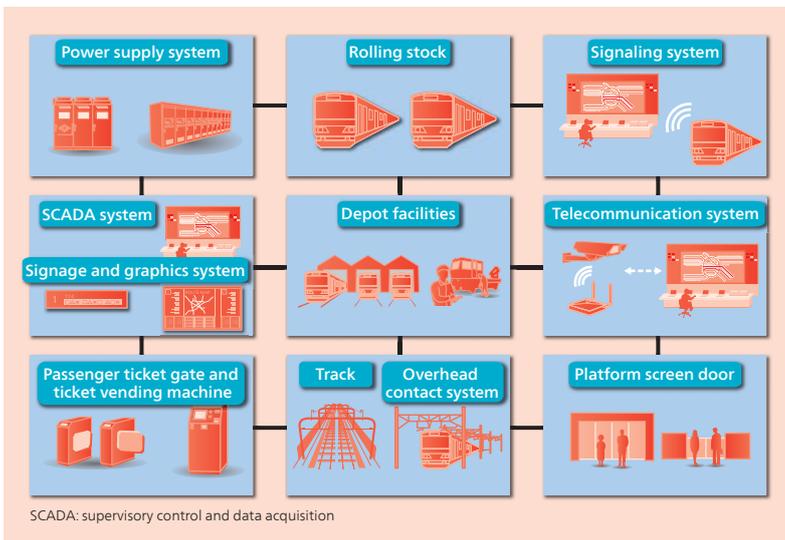
As Mr. Taruya commented, “While I was confident that Hitachi was the only Japanese supplier with the core technologies and the



Akihiro Taruya



After being awarded preferred bidder status in January 2013, Hitachi signed the formal contract in June of that year.



Hitachi has been contracted to supply 11 subsystems in total, including the rolling stock, signaling system, telecommunications system, and depot.



Hiroshi Nakaya

capability to coordinate the overall project, there were many difficulties to overcome during the two and a half years it took us to get to the point of signing the deal. We had organized a large number of engineers to ensure a smooth transition to the contract execution phase, so I was truly relieved when the formal contract was finally signed. Also, thanks to our careful preparations, we were able to get the project underway comparatively quickly.”

**Working Closely with Local Partners from Long-term Perspective**



Katsunori Kojima

Hitachi’s order for the Line 1 project included not only the rolling stock, but also the supply of 11 subsystem, including signaling system, telecommunication system, and power supply system, passenger ticket gate, ticket vending machine, platform screen door, and depot facilities. Hitachi will also be responsible for maintenance during the first five years of operation. While Hitachi seeks to operate under turnkey contracts in which it handles the overall project, this is the first time it has won such a contract for an overseas urban railway system.

Mr. Komaki said, “Hitachi has experience in

supplying overseas customers with not only rolling stock, but also signaling system, depot facilities, and other supporting products. Our success in reaching a formal contract was a consequence of our overall capabilities for supplying complete railway systems. The true worth of this will be put to the test in the future, I believe.”

Work is currently starting on site preparation for a depot located next to Suoi Tien Station. Hiroshi Nakaya (Chief System Integrator, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), who is responsible for the depot and is managing work on five of the subsystems, makes the point that they are now entering the crucial phase. As already noted, in addition to the equipment at the depot, Hitachi also has a five-year maintenance contract. This is because it would be impractical for the operation and maintenance (O&M) company to be established in Ho Chi Minh City to immediately get up and running on the maintenance of rolling stock, signaling systems, track, overhead contact system, and other subsystems for Vietnam’s first-ever urban railway system. Hitachi also has the important task of training the staff who will do this work.

Mr. Nakaya said, “We already have a year and a half of experience at maintaining the Sentosa Island monorail in Singapore, and I anticipate that we will draw on this know-how. However, because the Ho Chi Minh City Urban Railway Construction project involves not only rolling stock but also track, power supply system, and other subsystems, I am preparing myself for even more of a challenge.”

They will also need to deal with the electric power system in Vietnam. Ho Chi Minh City suffers from frequent power outages, including some that are scheduled. Katsunori Kojima (Chief Manager for Electrical Works, Ho Chi Minh City Urban Railway Line 1 Project Office, Hitachi, Ltd.), who is responsible for power supply system, has the problem of obtaining a reliable supply of electric power from this network. He made the



Planned site for rolling stock depot. In addition to the equipment at the depot, Hitachi also has a five-year maintenance contract.



Ben Thanh, home to the city's largest market, and adjacent bus terminal. The new metro station will be constructed at this site.

following comment.

“To enhance energy efficiency, the regenerative inverters installed at the Line 1 substations convert direct current at 1,500 V to alternating current at 22 kV and supply it to stations for lighting and other use. My first priority is to build a power supply system that will operate reliably.”

### Providing Foundation for Further Development

A sign noting the investment by the Japanese government currently stands at the planned site of the station building. Located at Ben Thanh, terminus of Line 1 and home to the city's largest market, the sign is accompanied by images depicting the completed underground station to inspire the expectations of Ho Chi Minh City

residents. Line 1 will be a major commercial route through the city and brings with it the potential for further business expansion. Also, if the project is a success, the know-how gained will be applicable to railway construction projects in other countries or regions.

As Mr. Komaki said, “Our experience here should provide a valuable model for projects in such places as Hanoi or Indonesia.”

Just as the flow of blood supplies animals' bodies with nutrients, the free movement of people brings dynamism to a city. Railways and other transportation systems act as a city's arteries. Clearly, Ho Chi Minh City Line 1 will not only provide residents with a safe and convenient means of transportation, it will also provide the foundations for the city's further development.



Planned site for station construction near Ben Thanh market. The image of the completed underground station is inspiring the expectations of city residents.



Visionaries 2014

# Treasure in the Depths of the Ocean

— Multi-stage Deep Seawater Utilization System —

The growth of the global population is bringing with it severe water shortages in different parts of the world. With a history of taking on the many challenges associated with water, Hitachi is now embarking on a new project that will bring relief to this situation.

This groundbreaking initiative will help provide drinking water and facilitate the creation of new industry by taking water from the deep ocean and utilizing it, firstly as a source of cold energy, and also to produce fresh water.

Research and other studies are currently underway aimed at commercializing the technology for coastal nations or offshore islands such as those in the Pacific and Indian Oceans.

## **Inexhaustible Supply of Water with Valuable Uses**

As the global population continues to grow, particularly in emerging and developing nations, providing the water infrastructure needed to support this population has become a matter of urgency. Annual worldwide demand for water is anticipated to grow by 30% or more over the 30-year period from 1995 to 2025\*.

Hitachi has been supplying products, systems, and services to various different parts of the water industry for many years, drawing on this

experience to help resolve water-related issues around the world. Akira Yokoyama (General Manager, Water Environment Solutions Business Management Division, Infrastructure Systems Company, Hitachi, Ltd.), who is involved in these global operations, described the situation as follows.

“The size of the global water business is expected to grow rapidly in the future. To contribute to water infrastructure in different parts of the world, Hitachi is seeking to keep in step with the Japanese government and its promotion of infrastructure



system exports, not only through conventional official development assistance (ODA), but also by utilizing new frameworks like public-private partnerships (PPPs).”

One notable example of a solution for the water sector is a multi-stage deep seawater utilization system on which Hitachi started work in FY2010. The initial objective of the project was to save energy.

Hitachi has for some time been developing numerous technologies for saving energy in air conditioning, including systems that utilize the cool outside air available at high-latitude locations to cool plant and equipment, or air conditioning systems that utilize the abundant solar heat available in low-latitude locations. There is also a demand for energy saving technologies that utilize geographic advantages in the low-latitude equatorial regions where many emerging nations are found.

As Mr. Yokoyama commented, “When struggling to decide how to proceed, we recalled our involvement in the construction of a food processing plant in Toyama Prefecture with a cooling system that utilized deep seawater. Of course the natural environment in Toyama, Japan is very different to that in equatorial regions. When we looked into it, however, we found that the temperature of deep seawater below 1,000 m is a steady 5 to 6°C, even at the equator.”

“Deep seawater” typically means water at depths of 200 m or more, where the lack of sunlight inhibits microorganism growth, making the water much purer than at the surface. At 1,000 m and below, the water quality becomes stable with a temperature of about 5°C or less. Because organic material that has decomposed at the surface tends to collect at these depths, they are rich in inorganic nutrients. Most of all, they are sustainable because of constant replenishment at polar regions.

Of course, the obstacle to actual use of deep seawater is finding a way to make it a profitable business. In turn, overcoming this requires a site with high demand for cold energy at which water can be raised from the deep ocean over as short a distance as possible. For these reasons, the Republic of Maldives and Republic of Mauritius were identified as sites for a model business, with plans already in progress at both these countries.

### Supporting a Tourism-based Economy

The seabed condition around the Maldives is favorable for deep seawater intake, and the Maldives’ tourism-based economy means strong demand for energy. With an average height above sea level of only 1.5 m, making it particularly vulnerable to the effects of global warming, the Maldives takes environmental measures seriously. Meanwhile, having taken a stake in the locally based Male’ Water & Sewerage Company Pvt. Ltd., Hitachi is already involved in operating water supply and sewage services in the Maldives, along with seawater desalination.

Given these circumstances, Hitachi has sketched out a blueprint for utilizing cold energy extracted



Akira Yokoyama



The Maldives are popular with tourists, having been described as a South Seas paradise. Hitachi took a stake in the company that operates the local water supply and sewage systems in 2010 and is involved in its business activities.



A plan is underway in the Maldives to use deep seawater first to produce chilled water for air conditioning, and then for a series of other uses.



A bathymetric survey is being conducted in the Maldives in preparation for the use of deep seawater.



Male' Water & Sewerage Company Pvt. Ltd. is currently engaged in seawater desalination and the production of bottled water. In addition to these businesses, deep seawater is also to be used in applications such as fisheries or agriculture.



Koji Suzuki

from deep seawater in the air conditioning of buildings and industrial sites, and also for supplying this water to seawater desalination, bottled water production, and industrial users. Koji Suzuki (Manager, Project Promotion Department, Water Environment Solutions Business Management Division, Infrastructure Systems Company, Hitachi, Ltd.), who has been involved in this work from the field survey stage, made the following comments about its feasibility.

“When used as the raw water for a desalination plant, deep seawater can reduce running costs significantly because its purity minimizes the amount of pre-treatment required. The amount of energy required to collect the water can also be minimized by building an underground pumping station below sea level, in which case water pressure alone is enough to bring deep seawater up to sea level of its own accord.”

These cost and energy efficiency benefits also reduce the load on the environment.

“We have estimated that, depending on the conditions, we can reduce the emission of greenhouse gases associated with air conditioning by around 80% compared to conventional systems. The concordance between Hitachi’s aim of having the system more widely adopted and the Japanese government’s desire to establish a **joint**

**crediting mechanism<sup>(a)</sup>** is another major driver behind the plan.”

Based on the assumption that the joint crediting mechanism would apply, Hitachi was able to obtain funding for preliminary work, including identifying and formulating potential projects, from sources such as the Ministry of Economy, Trade and Industry and New Energy and Industrial Technology Development Organization (NEDO). This made it possible to carry out detailed feasibility studies covering issues such as candidate sites, water quality and bathymetric survey, and local energy use.

### Production of Safe Drinking Water

A host to high-class resort development, the politics and economy of Mauritius are relatively stable compared to other African nations. Like the Maldives, the nearby seabed condition is favorable for deep seawater intake. However, the benign climate means that air conditioners do not need to operate all year round.

These circumstances meant that Hitachi’s proposal to utilize deep seawater cooling at a data center coincided well with plans by the government of Mauritius to promote the information technology (IT) industry. A very-high-capacity undersea cable linking USA and the BRICs (Brazil, Russia, India, China, and South Africa) is currently being planned, and is scheduled to go live in the latter half of 2014. Mauritius is to be one of the relay points for the cable, and there is also demand for the nation to act as a host for data backup by the BRICS nations.

Mr. Yokoyama said, “Because cooling is essential for data centers, their being such intense heat sources, it occurred to us that we could use deep seawater for this purpose. Used in combination with Hitachi’s energy-efficient spot air

#### (a) Joint Crediting Mechanism

The Joint Crediting Mechanism (JCM) is a program in which Japan’s contribution to the reduction and removal of greenhouse gas emissions in partner countries through transferring Japan’s low-carbon technology and products is calculated and evaluated as credits for contribution.

## Contributing to National Development through Good Relations

Ahmed Mujthaba (Engineering Manager, Male' Water & Sewerage Company Pvt. Ltd.) is dedicated to building a good relationship between Hitachi and the relevant agencies of the Maldives, including senior government officials and other people involved, by supporting the deep seawater project.

"Hitachi has maintained a close relationship with the government since taking a stake in the Male' Water & Sewerage Company in 2010. We are looking forward to exposure to the technology,

knowledge, and know-how of Hitachi.

The long time taken from feasibility study to approval could be seen as an issue for this project. While this was to some extent a consequence of the changes in the political situation in the Maldives, with factors such as the need to keep the investment cost to a minimum meaning that government approval was required, it is my hope that the project can proceed comparatively quickly once this approval is obtained.



Ahmed Mujthaba

I hope that Hitachi can continue to be involved in the development of the Maldives through its many solutions for water environment and saving energy."

## Building Stronger Relations between the Two Countries

Ahmed Khaleel (Ambassador Extraordinary and Plenipotentiary of the Republic of Maldives to Japan, Embassy of the Republic of Maldives) is working to build cordial relations between the Maldives and Japan through official inter-government communications.

"This project involving the utilization of deep seawater is the first of its nature in the Maldives and faces numerous difficult hurdles. However, since it is aimed at combining sustainable growth

with protection of the environment through improvements in energy efficiency, I believe there is a strong motivation to overcome these challenges. Hitachi is one of the world's leading companies in the field of water resource management, and we believe their technology will be essential to meeting our goals. The project also serves as a positive example for the Joint Crediting Mechanism (JCM) between our two countries, and I see it as further strengthening the



Ahmed Khaleel

cordial relations of friendship and understanding that exist between the Maldives and Japan."

conditioning systems, it can provide an extremely efficient cooling system."

The project was also aided by the fact that the government of Mauritius had itself been pursuing research into the use of deep seawater since about 2008.

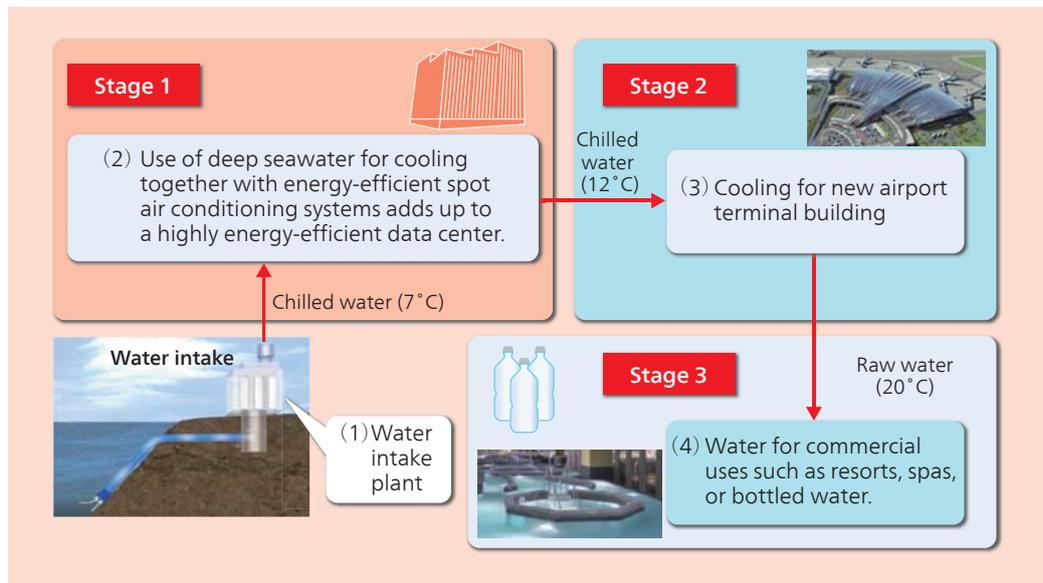
As Mr. Suzuki said, "Mauritius is actively seeking to establish a new industry based on the use of deep seawater, and has been investigating its use

in fields like aquaculture, cosmetics, and drinking water. A number of businesses have already shown a desire to utilize the deep seawater used for data center cooling."

Because deep seawater is cool, clean, and rich in mineral content, the scope of potential uses is broad. In the Toyama example referred to above, deep seawater discharged after its cold energy has been harvested is used for purposes such as the



Mauritius is an island in the Indian Ocean with roughly the same land area as Metropolitan Tokyo. Its main industries are textiles, sugar, and tourism.



Business model for Mauritius. The rich mineral content of the deep seawater has the potential for a variety of commercial uses.

**(b) Thalassotherapy**

Use of marine resources such as seawater, sediment, or seaweed in the restoration or enhancement of mental and bodily functions through techniques such as exercise, meditation, relaxation, massage, and food. The term was first coined in the late 19th century by the French doctor, Joseph de la Bonnardiere, from the Greek word "thalassa," meaning "sea."



Tomoyo Shiina

cultivation of abalone. There is genuine scope for the "multi-stage use" of this water in applications such as table salt or cosmetics production, agriculture, and **thalassotherapy**<sup>(b)</sup>.

Tomoyo Shiina (Project Promotion Department, Water Environment Solutions Business Management Division, Infrastructure Systems Company, Hitachi, Ltd.), who has worked with on the field survey and planning along with Mr. Yokoyama and Mr. Suzuki, expressed her expectations for the project as follows.

"Of particular interest is the bottled water business. Not only can we take advantage of the brand image of the place itself, scientific work is also being done to elucidate the health benefits of the minerals in deep seawater. Other investigations are looking at the potential for this deep seawater to be combined with other active ingredients to produce health supplement drinks that aid the prevention of obesity and other lifestyle diseases, or that are good for one's appearance."

Internationally, places where it is customary to drink the tap water are rare, being limited to a

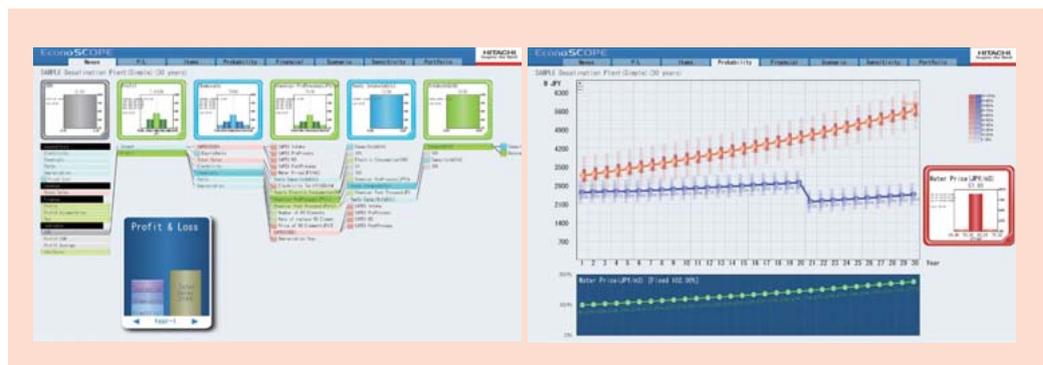
dozen or so countries like Japan and the nations of Europe. The production of bottled water from deep seawater is a way of meeting what must be one of the most basic of human needs, namely access to the safe drinking water that is essential to life.

**New Tools that Support Major Projects**

Before proceeding with a major project like those in the water and other social infrastructure sectors, it is first necessary to investigate the numerous uncertainties that surround it.

As Mr. Yokoyama said, "In the initial stages of a project, it can be very difficult to assess its long-term business viability, including such considerations as operation and maintenance. Estimates can be out by a factor of two in either direction depending on the initial assumptions."

Hitachi's proprietary economics simulator was developed to provide a tool for such business feasibility assessments. The work was done by Youichi Horii (Chief Engineer, Desalination Systems Department, Matsudo Research Center, Infrastructure Systems Company, Hitachi,



Example screen from the economics simulator. The simulator is used for business feasibility assessments, allowing the user to see things like the interdependencies between factors that influence income and expenditure, and how income and expenditure trend over time.

## Prospects for Reducing Burden on Environment and New Business Development

Ken Poonoosamy (Managing Director, Board of Investment, Mauritius) is responsible for attracting foreign direct investment to Mauritius. In addition to his involvement in the Deep Ocean Water Applications project, he has also assisted with market research for Hitachi's seawater air conditioning business and multi-stage deep seawater utilization.

"Air conditioning systems that use deep seawater will help reduce fuel consumption and CO<sub>2</sub> emissions and are well aligned with the government's vision of sustainable development. The multi-stage utilization of deep seawater will also

create new economic opportunities for high-end aquaculture and algal culture, premium water bottling, pharmaceuticals, and cosmetics.

While challenges remain in implementing the project, we have high expectations for the technical capabilities of Hitachi, a company involved in social infrastructure businesses around the world that brings newly developed expertise in the multi-stage utilization of deep seawater. Although we are still at the commercial feasibility stage, I have already been impressed by the professionalism of the team. It is fortunate that Mauritius has been



Ken Poonoosamy

chosen by Hitachi for its project in the Indian Ocean. I look forward to the success of the project and to Hitachi and Mauritius moving forward together."

Ltd.), who has also worked in the Research and Development Group on research into innovative interfaces for devices and displays. He described the functions of the economics simulator as follows.

"The simulator calculation considers all items that relate to income and expenditure, regardless of whether they are technical or commercial. Uncertainties such as the cost of electric power, chemicals, and components can be specified together with a margin of error. In other words, it is possible to make a rational assessment of business viability even when treating unknowns as unknown."

In this way, not only can the simulator indicate the ranges of income and expenditure at a glance, even during the initial planning stage, it can also instantaneously calculate things like internal rate of return (IRR) or long-term scenarios. Also, because it is based on standard spreadsheet software and designed for simple operation, it is easy enough for anyone to use after only about half an hour of training.

Mr. Horii said, "I wanted to make it so that business viability could be assessed without relying on the experience or intuition of the person doing the assessment, and in a way that made it easy to share the assessment among the people involved. To be a genuinely useful tool, it needed to be simple to understand and use. In this sense, I made the most of my knowledge of interface development."

Naturally, the economics simulator can also be used in fields other than water. As Hitachi is

involved in numerous major projects, it seems likely that, through its use as a tool for business process standardization, the economics simulator will play an essential part in meaningful discussion based on data.

### Toward a World with Abundant Water

While businesses that utilize deep seawater are already active in different parts of the world, few companies have the total capabilities to handle everything from the intake to cooling systems and multi-stage use of the water. In its deep seawater business and beyond, a feature of Hitachi is its ability to offer comprehensive and multi-faceted solutions based on intelligent water systems that fuse IT with engineering capabilities built up over time.

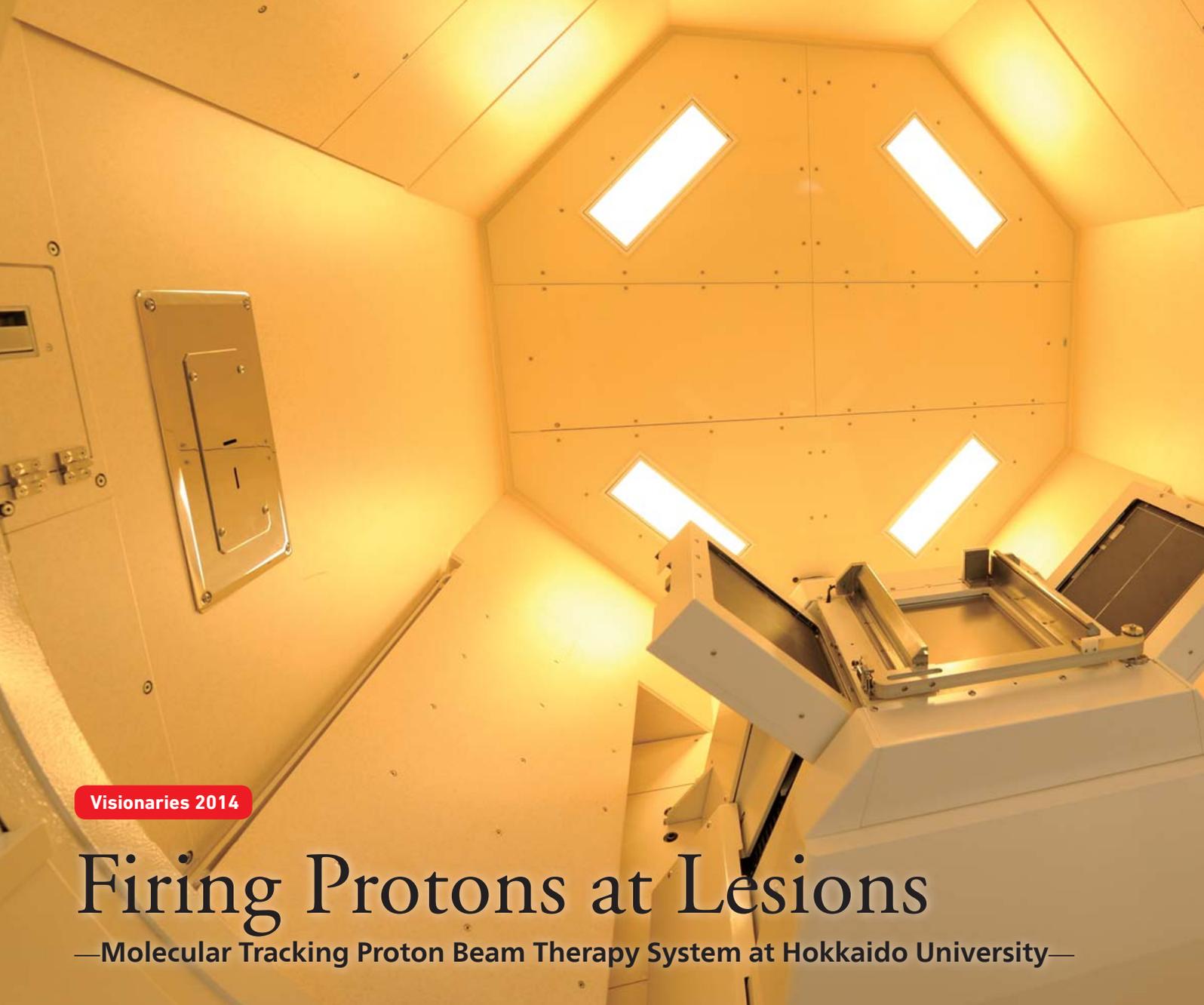
Mr. Yokoyama said, "Deep seawater is an abundant global resource, and we are seeking to draw on Hitachi's strengths to explore this potential in partnership with local communities so that it can be put to use in ways that suit their specific circumstances."

Fresh water suitable for people to use in their daily lives is estimated to make up only 0.01% of the world's total water resources\*. There are many communities that find it difficult to obtain enough water for domestic use despite being close to the ocean, or in some cases because they are close to the ocean. Multi-stage deep seawater utilization systems may well offer promising solutions to the problems faced by people who live in these communities.



Youichi Horii

\* Source: "Water Resources in Japan," Ministry of Land, Infrastructure, Transport and Tourism



Visionaries 2014

# Firing Protons at Lesions

—Molecular Tracking Proton Beam Therapy System at Hokkaido University—

Radiotherapy is widely used as a treatment for cancer (malignant tumors) that has minimal side effects and imposes only minimum stress on the body.

Despite this, the remaining challenges include the effects it has on healthy tissue and the problems of dealing with large tumors or ones that move about due to respiration or other bodily movement.

Hokkaido University and Hitachi, Ltd. have jointly developed a molecular tracking proton beam therapy system that can treat large tumors in internal organs that move.

The result of a decade of collaboration between the two partners, the new system is smaller and less expensive than previous proton beam therapy systems. It has attracted interest from around the world due to the improved cancer cure rates it offers and the potential to broaden the appeal of particle beam therapy.

## Keeping Track of Movement

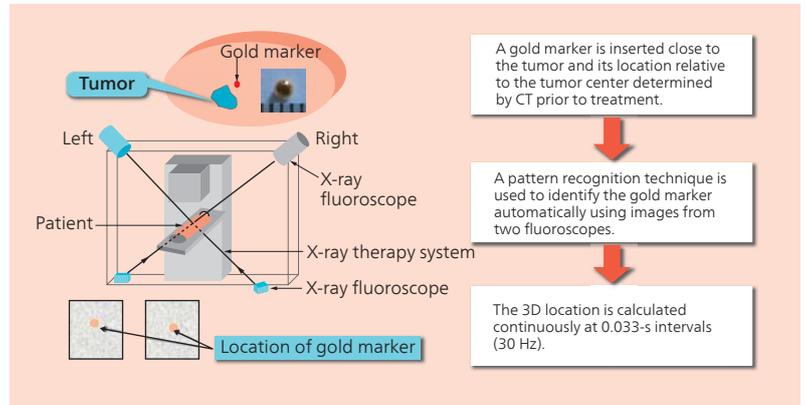
Passing through the entrance to the hospital that occupies a corner of Hokkaido University's sprawling campus and looking straight ahead past the main hospital building, a brand new building is visible with a prominent sign identifying it as the Hokkaido University Hospital Proton Beam Therapy Center\*. This leading-edge facility for molecular tracking proton beam therapy has been constructed jointly by Hokkaido University

and Hitachi, Ltd. since 2010. Work on finishing the light-brown interior decoration and on commissioning the various equipment and systems in preparation for the commencement of treatment in March 2014 is now proceeding at a rapid pace.

A major feature of the system is its combination of techniques for accurately tracking a moving lesion and techniques for targeting the proton beam with high precision. Professor Hiroki



Careful adjustments are being made at the Proton Beam Therapy Center in preparation for the commencement of patient treatment.



Realtime tumor-tracking radiotherapy developed by Professor Shirato's research group. The technique can significantly reduce effects on healthy tissue when irradiating a tumor at a moving site.

Shirato (Department of Radiation Medicine of the Hokkaido University Graduate School of Medicine), who is the project leader, described the development process as follows.

“**Radiotherapy<sup>(a)</sup>** is a form of non-surgical treatment that can preserve the form and function of the organ being treated, and has a low level of side effects on the patient's body. A major challenge, however, is how to deal with moving



Hokkaido University Hospital is located in a corner of the university's sprawling campus near Sapporo Station.

tissue. The pin-point irradiation of lung or liver tumors, for example, is made more difficult by the fact that they are in continuous motion due to respiration and digestive system movement.”

In response, Professor Shirato's research group developed a technique for **realtime tumor-tracking radiotherapy<sup>(b)</sup>** in 1998.

This succeeded in significantly reducing the effect of radiation on healthy tissue.

Because X-ray dosage gradually attenuates as the rays penetrate deeper into the body, being at its highest at the point of entry, it has a significant impact on healthy cells upstream of the tumor. Intensity-modulated radiation therapy was developed in response to this problem. It is a technique for improving cure rates and expanding the scope of application of the therapy by maximizing the dosage applied to the tumor while using a computer to manage and control the radiation dosage received by healthy tissue. When combined with realtime tumor-tracking radiotherapy, it allows radiotherapy to be used on moving tumors.

“Unfortunately, this still left the problems that X-rays are not particularly effective for some types of cancer cell, and that they are difficult to use to treat large tumors of more than 6 cm,” said Professor Shirato.

### Bringing into Focus

Particle beam therapy systems have been



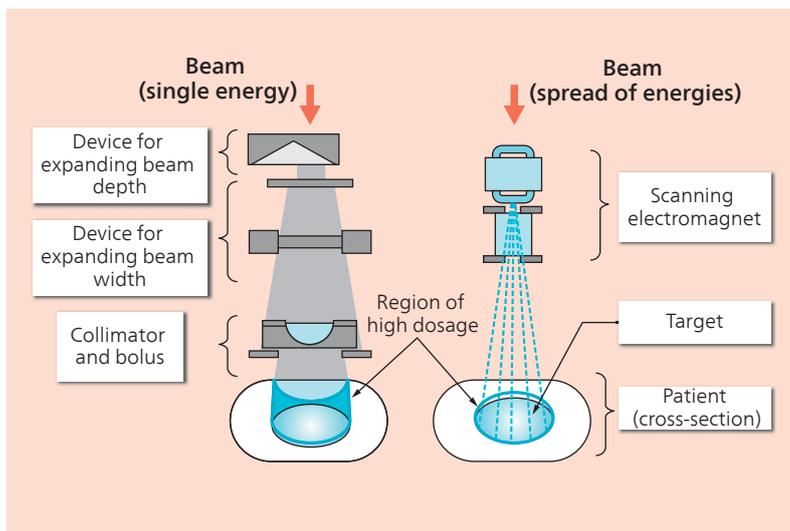
Professor Hiroki Shirato

#### (a) Radiotherapy

Along with surgery and chemotherapy, radiotherapy is a form of cancer treatment that uses either a photon beam (X-rays or gamma rays), electron beam, or particle beam (beams of protons or carbon ions).

#### (b) Realtime tumor-tracking radiotherapy

A technique for targeting radiotherapy beams. The location of a gold marker inserted close to the tumor is determined using two X-ray fluoroscopes and the beam only turned on when it is within a few millimeters of its intended position.



Spot scanning can accurately target the proton beam on tumors, even those with complex shapes.

**(c) Spot scanning**

A technique that interrupts the particle beam to irradiate sites point-by-point. It requires technology for generating a uniform proton beam and for controlling the beam with high accuracy.

**(d) Funding Program for World-Leading Innovative R&D on Science and Technology**

A research funding program for advanced research that seeks to lead the world, with the aims of enhancing Japan's international competitiveness over the medium to long term and delivering the fruits of research and development back to people and society. A request for submissions was issued by the Council for Science and Technology Policy of the Cabinet Office in 2009 and the top 30 of the 565 proposals received were selected.

attracting attention for offering a new generation of radiotherapy. Unlike X-rays, which are a form of electromagnetic radiation, matter particles have a low level of intensity after entering the body. Instead, the dosage is at its maximum (called the Bragg peak) at a depth determined by the energy of the accelerated protons. Because the dosage attenuates rapidly after this peak, it is easy to concentrate the dosage on the tumor and keep the effect on surrounding healthy cells to a very low level. Nevertheless, the radiation can kill cancer cells or destroy their ability to reproduce, even in large tumors.

Professor Shirato's research group started studying particle beam therapy systems around 2000. He commented as follows.

"Our fundamental idea was that particle beam therapy systems would become part of general medicine, just like X-ray therapy systems. Because the equipment back then was so large and expensive, it was not easy to install. Accordingly, our aim was to create a system that could be

installed in the limited space available in a hospital, and to minimize its up-front and operating costs."

To this end, they embarked on basic research in conjunction with Hitachi. As part of this work, they looked at a proton beam therapy system that Hitachi supplied to The University of Texas MD Anderson Cancer Center (MDA) in the USA. The MDA system uses a new technique called **spot scanning**<sup>(c)</sup> that focuses on the tumor and progressively targets it with repeated short bursts of a tight beam of protons. Compared to the double scattering method used in the past, it can target the proton beam on tumors with high accuracy, even those with complex shapes. In addition to minimizing the effect on nearby healthy cells and not requiring the production of patient-specific items (collimators and boluses), its features include making efficient use of the proton beam with minimal extraneous radiation. The objective now is to combine this with realtime tumor-tracking radiotherapy to develop a new generation of proton beam therapy systems that can deliver accurately targeted radiation treatment even for large lung or liver cancers with volumes of 1 L or more.

Meanwhile, the **Funding Program for World-Leading Innovative R&D on Science and Technology**<sup>(d)</sup>, a national project that seeks to deliver world-leading results, issued a call for submissions in 2009. With Professor Shirato as lead researcher, Hitachi participated in a proposal entitled "Sustainable Development of Molecular-Tracking Radiotherapy System" that was selected among the top 30.

Unfortunately, the government funding budget was subsequently cut by more than half, leaving Professor Shirato with the job of cancelling the project. However, Hitachi at that time was looking at the prospects for bringing the world-first spot scanning system that had been implemented at MDA to Japan. For the project to be cancelled would be a major setback. Presented with this situation, Fumito Nakamura (General Manager, Particle Therapy Division, Power Systems Company, Hitachi, Ltd.), who manages the proton beam therapy system business, made the decision to continue with the work despite the tight budget.



A synchrotron (shown here) uses electromagnetic force to accelerate protons obtained from hydrogen and deliver them to the treatment room.

**Change of Thinking**

With the primary objective of the joint research being to produce a compact and low-cost proton beam therapy system, it was felt that making further cost reductions within the short three-year development schedule would be difficult. What made it possible was the reduction in size of the synchrotron (accelerator) unit at the core of the



View from the rear of the treatment room as the gantry rotates. A comprehensive review of the design succeeded in downsizing the unit.

system and the rotating gantry.

Masumi Umezawa (Senior Researcher, Department of Applied Energy Systems Research, Energy and Environment Research Center, Hitachi Research Laboratory, Hitachi, Ltd.), the leader of the development unit that works on proton beam therapy systems, explained as follows.

“At the time, Hitachi Research Laboratory was working on research aimed at shrinking the size of synchrotrons. By building a unit specifically intended for spot scanning, we estimated that we could reduce the 23-m circumference of the previous model down to 18 m by changing from a hexagonal to a quadrilateral synchrotron.”

The rotating gantry, meanwhile, is a large device that allows the proton beam to be directed at the patient from any direction. The design and development department investigated how it could be made smaller and came up with ideas for achieving this. Although there were concerns that making the gantry smaller would restrict access to its interior, this problem was overcome by adopting a robot arm treatment platform. As a result, the unit’s approximate dimensions of 11-m maximum circumference and 3.5-m internal diameter were shrunk down to approximately 9 m and 2.5 m respectively.

Following on from this, a new design concept was put together with modifications being made to more than 100 parts of the overall system to eliminate the unnecessary wherever possible.

### Overcoming Differences

After Hitachi’s new design concept was put to Professor Shirato, he set about lobbying the university and relevant government agencies to make up the shortfall in funding. As a result, the project was able to proceed with the cooperation of engineering and other disciplines.

“As well as proceeding with the project, we also wanted to pursue radical innovations beyond just downsizing the system,” said Professor Shirato.

One of these was the incorporation of cone beam computed tomography (CT). Because this provides a three-dimensional (3D) image indicating the location and condition of the tumor, it can be combined with realtime tumor-tracking radiotherapy to improve targeting accuracy for a variety of different treatment sites. Toshie Sasaki (Senior Engineer, Particle Therapy Systems



Masumi Umezawa



Treatment room with molecular tracking proton beam therapy system (prior to completion of installation). The system is designed to be easy for hospital staff to use.



Toshie Sasaki



Professor Kikuo Umegaki

## Application of Engineering Technology from an All-encompassing Medical Perspective

Collaborative medical research by Hokkaido University and Hitachi first started around 2000, subsequently expanding in scope to include joint proposals and participation in important national projects from FY2006 onwards. The Development of the Real-time Tumor-tracking Proton Beam Therapy System with Molecular Imaging project in which Professor Hiroki Shirato of the Graduate School of Medicine was lead researcher was selected by the Japanese Cabinet Office's Funding Program for World-Leading Innovative R&D on Science and Technology and proceeded as a five-year plan starting in FY2009. Professor Kikuo Umegaki (Division of Quantum Science and Engineering,

Faculty of Engineering, Hokkaido University), who formerly belonged to a research and development division of Hitachi and who pioneered the establishment of joint research, works on quantum imaging through the Future Drug Discovery and Medical Care Innovation Program, a decade-long industry-academia collaboration that commenced in FY2006, and also acts as a project manager on the Development of the Real-time Tumor-tracking Proton Beam Therapy System with Molecular Imaging project, heading up the medical physics team that brings together the medical and engineering disciplines. He transferred to Hokkaido University in FY2010 where he is working on medical and engineering collaboration. He made the following comment.

"If engineering technology is to have a genuine role in medicine, then it is not enough simply to look at systems on their own. Rather, what is needed, I believe, is a broad-based understanding of radiation

medicine with an appreciation of how systems fit in with the overall medical process extending across prevention, diagnosis, treatment, and follow-up, and taking account of the patients, doctors, and others involved in providing treatment.

In this joint development with Hitachi, I have been involved in vigorous debate on what is needed if proton beam therapy systems are to play a central role in cancer treatment in the hospitals of the future, and in incorporating the conclusions into the system design. The combination of spot scanning and realtime tumor-tracking radiotherapy has attracted the attention of the international academic community for providing an advanced form of proton beam therapy for moving tumors. I look forward to Hitachi not only making further enhancements to its proton beam therapy systems, but also to their applying the strengths of the entire Hitachi group to the development of a full range of medical systems, including diagnostic equipment and medical information."

Design Department, Medical Systems and Nuclear Equipment Division, Hitachi Works, Power Systems Company, Hitachi, Ltd.), who worked on the development of the system, explained it as follows.

"Realtime tumor-tracking radiotherapy calculates the location of the moving target based on high-frame-rate X-ray images (30 per second) and controls the proton beam accordingly. Cone beam CT is a technique for generating 3D CT images from X-ray images captured as the gantry is rotated, and can be used to accurately identify the location of the treatment site. Both of these required an advanced level of technology development, and we devoted ourselves to the task because of its potential to provide a new generation of treatments."

In parallel with work on these radical innovations, it was also important that a more complete working system be produced that would be suitable for use in hospital treatment. Project manager Koji Matsuda (Senior Engineer, Particle Therapy Systems Design Department, Medical Systems and Nuclear Equipment Division, Hitachi Works, Power Systems Company, Hitachi, Ltd.) explained as follows.

"We consulted directly with hospital staff on questions such as whether the adoption of a smaller gantry, for example, would leave enough space for doctors and radiotherapists to move around, and whether treatment could still be performed efficiently."

Even after this, there were more than a few problems that arose because of the dual objectives



Koji Matsuda

of research and development and clinical treatment. Masato Osawa (Particle Beam Therapy Project Section, Particle Therapy Division, Power Systems Company, Hitachi, Ltd.), who was involved in the project, worked on collating the circumstances in meticulous detail to identify solutions.

Professor Shirato commented, “That we were able to overcome the crisis was thanks to the trust built up with Hitachi through 10 years of working together. While Hokkaido University has been involved in medical-engineering and industry-academia collaborations since the time of Professor Goro Irie, another major factor is that we have cultivated a research culture that seeks to overcome differences of perspective or professional demarcations to reach the forefront of our field.”

### Working toward an Ideal

In this way, the world’s first molecular tracking proton beam therapy system commenced treating patients in March 2014.

After MDA, another early adopter of the spot scanning system was Quality Life 21 Johoku in Nagoya. The newly developed compact system, meanwhile, is to be installed at the Mayo Clinic, a major general hospital, and St. Jude Children’s Research Hospital in the USA. In particular, the St. Jude system will also include cone beam CT.

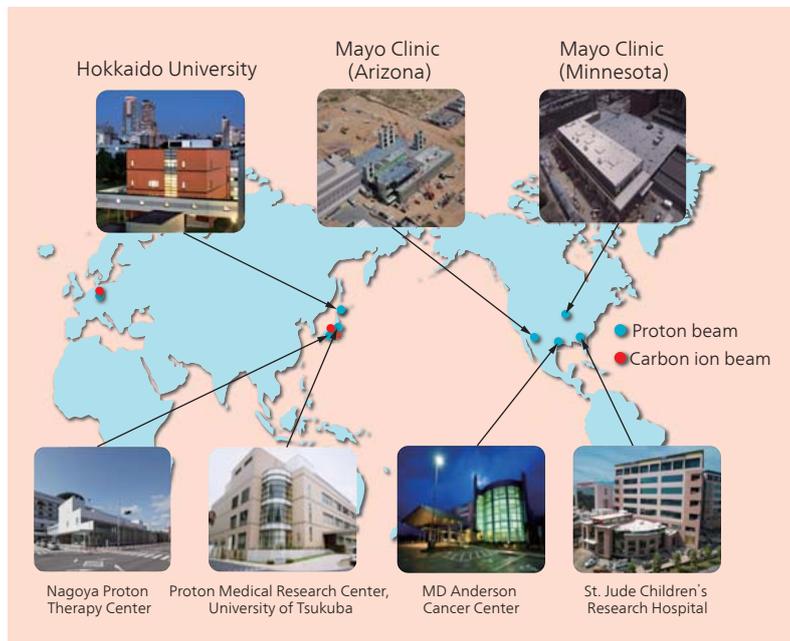
With demand for compact and reasonably priced proton beam therapy systems on the rise internationally since the global financial crisis, the Hitachi and Hokkaido University system has attracted significant interest from hospitals as far afield as Europe, Asia, and the Middle East.

Professor Shirato said, “For the people in the healthcare workplace, having a fully working system is only the beginning. Our role is to deliver high-quality research findings from treatment using world-first techniques for dealing with moving tumors, and to share the data we acquire with people in the healthcare field around the world. To say that our ultimate goal is to save all of the patients that we have been unable to treat in the past may sound grandiose, yet by being bold enough to express this aim out loud, I hope we can make at least some progress toward that ideal.”

In January 2014, a research team made up of doctors, radiotherapy specialists, medical physicists, biologists, and others at Stanford University in the USA embarked on joint research with Hokkaido University. This can be seen as a consequence of the opportunities opened up by the world-leading molecular tracking proton beam therapy system. Along with his determination to strive toward establishing a world-class clinical facility, Professor Shirato expressed his expectations for Hitachi as follows.



Numerous interested visitors from overseas have come to view the facility at Hokkaido University.



Sites that have ordered or taken delivery of proton or carbon ion beam systems from Hitachi. The systems have been adopted by some of the world’s most well-known medical institutions.

“Along with remaining a front-runner in the field of proton beam therapy systems, I hope that Hitachi will support international collaboration on clinical research with the world’s leading facilities such as MDA. Once the number of spot scanning therapy systems supplied to hospitals around the world reaches double figures or more, I believe it may well become a truly self-sustaining revolution in cancer treatment.”

There are many other illnesses besides cancer that cause people suffering and pain, and the battle against these adversaries will continue into the future. Nonetheless, people now have an effective new weapon in their arsenal in the form of the molecular tracking proton beam therapy system.



Masato Osawa

\* This facility was built as part of the Sustainable Development of Molecular-Tracking Radiotherapy System project of the Funding Program for World-Leading Innovative R&D on Science and Technology. The research was funded through the Japan Society for the Promotion of Science by the Funding Program for World-Leading Innovative R&D on Science and Technology, a funding program devised by the Council for Science and Technology Policy.

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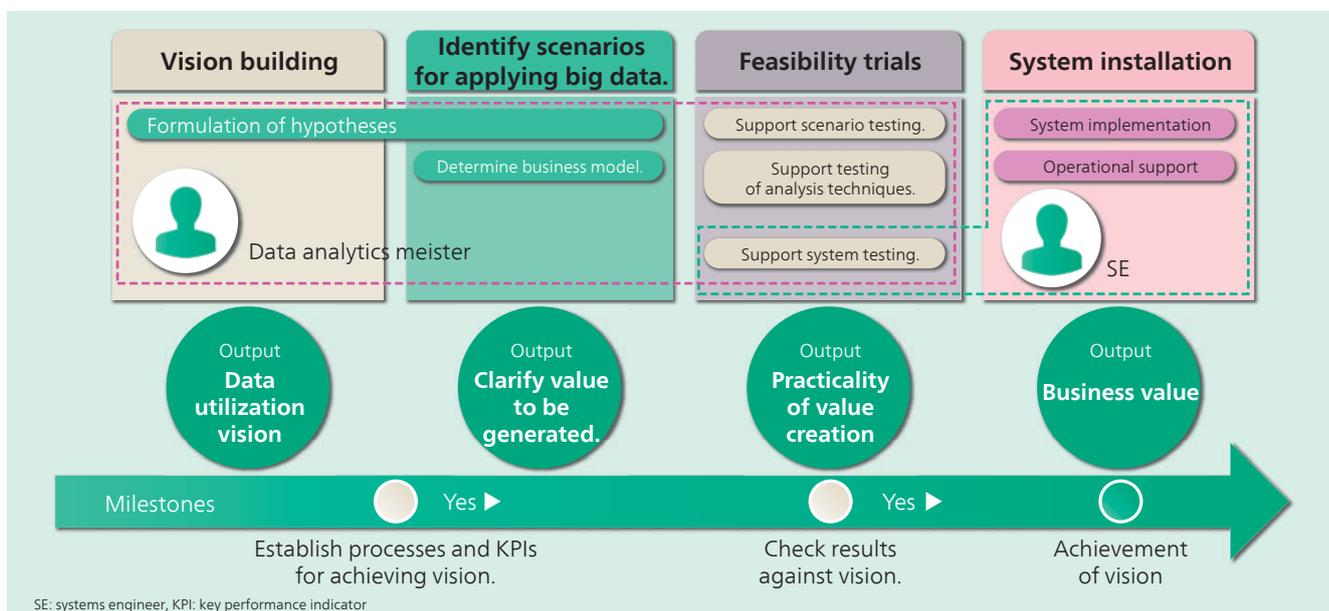
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# IT Solutions and Cloud Services



## 1 Process for utilization of big data

### 1 Data Analysis Service

Through its involvement with social infrastructure, Hitachi has collected large amounts of data from industrial machinery and other large plant and utilized it in applications such as the maintenance of this equipment. It has also proposed knowledge as a service systems that provide added value and knowledge extracted from large amounts of collected data and information technology (IT) resources. The data analysis service takes full advantage of these resources, working with customers to generate new value from big data.

To deliver this service, Hitachi has established an organization of more than 200 people, including consultants with expertise in system configuration and operation, engineers and researchers from the field of data analysis, and “meisters” who specialize in the use of big data, combining practical industry knowledge with expertise in fields like mathematical analysis and IT.

The analysis service process starts by agreeing on a clear vision with the customer. Next, hypotheses on how to achieve the targets are formulated based on an understanding of the customer’s business. The required data is then collected and the hypotheses tested using mathematical analysis to verify their validity before implementation on production systems.

### 2 Logistics Analysis Solution for Retailers

Hitachi has introduced a logistics analysis solution that speeds up

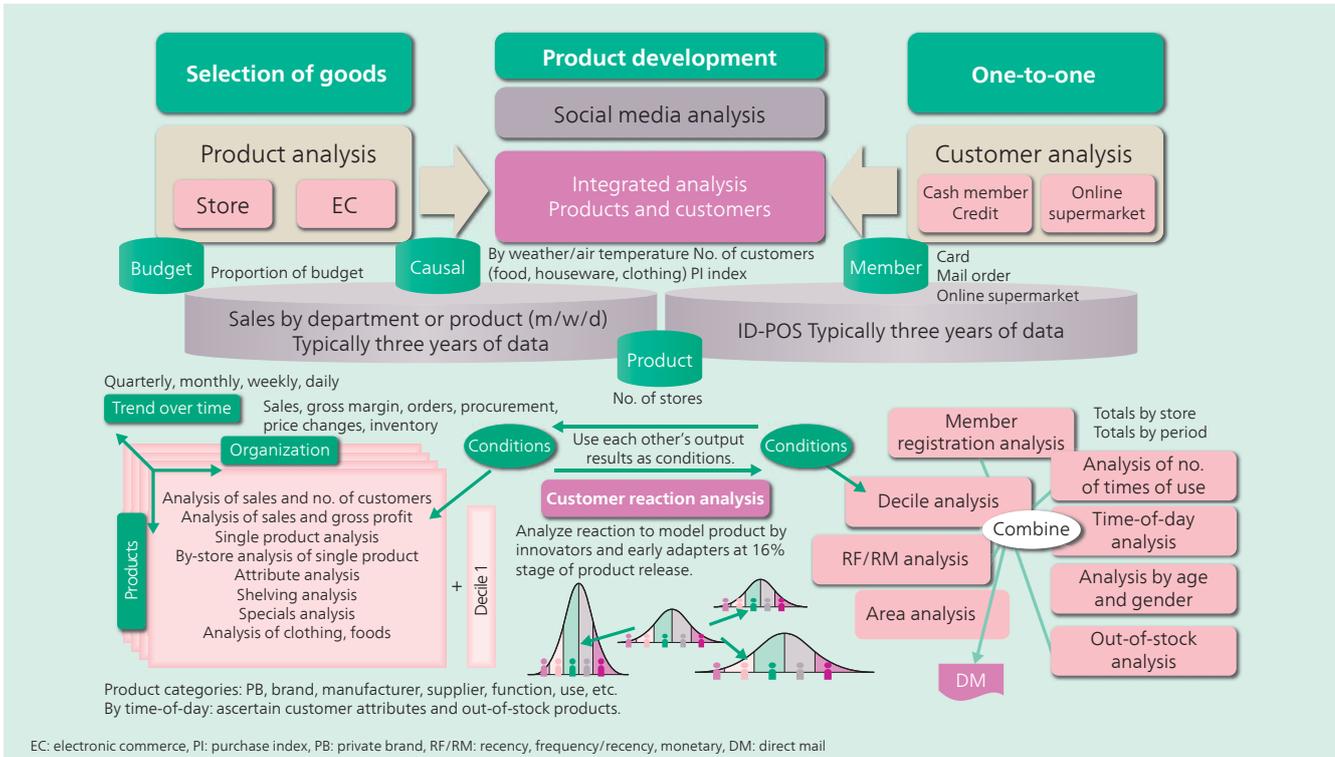
the utilization of big data such as point-of-sale (POS) data held by retailers or information from social networks.

The solution consists of three options: a product analysis system, a customer analysis system, and a social media integration system. The product analysis system facilitates the analysis of POS data from a variety of perspectives, including not only sales and inventory but also factors such as time or category. The customer analysis system uses a range of different analytical methods to analyze membership data and help decide on what approaches are needed for dealing with members, such as recency, frequency, and monetary (RFM) analysis and decile analysis. The social media integration system utilizes keywords and other information from tweets posted on social networks such as Twitter\*1 to help with tasks such as formulating sales plans for top-selling products. To increase the speed of analysis, a high-speed data access platform\*2 is used as the database engine.

These solutions are delivered in the form of an appliance that combines servers, storage, and other hardware with middleware such as the high-speed data access platform and the Job Management Partner 1 integrated systems management software.

\*1 See “Trademarks” on page 142.

\*2 Utilizes the results of “Development of the Fastest Database Engine for the Era of Very Large Database and Experiment and Evaluation of Strategic Social Services Enabled by the Database Engine” (Principal Investigator: Prof. Masaru Kitsuregawa, The University of Tokyo/Director General, National Institute of Informatics), which was supported by the Japanese Cabinet Office’s FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).



2 Concept behind logistics analysis solution

3 TWX-21 Global Huge Data Exchange Service

As the operations of manufacturers and other corporations have become increasingly global in recent years, overseas activities have extended beyond manufacturing to include such work as design, prototyping, selling, and maintenance. This has created a growing need for the fast and secure exchange of large amounts of data (in the gigabyte range) to facilitate the exchange of the design drawings, manuals, and various other types of information required for this work.

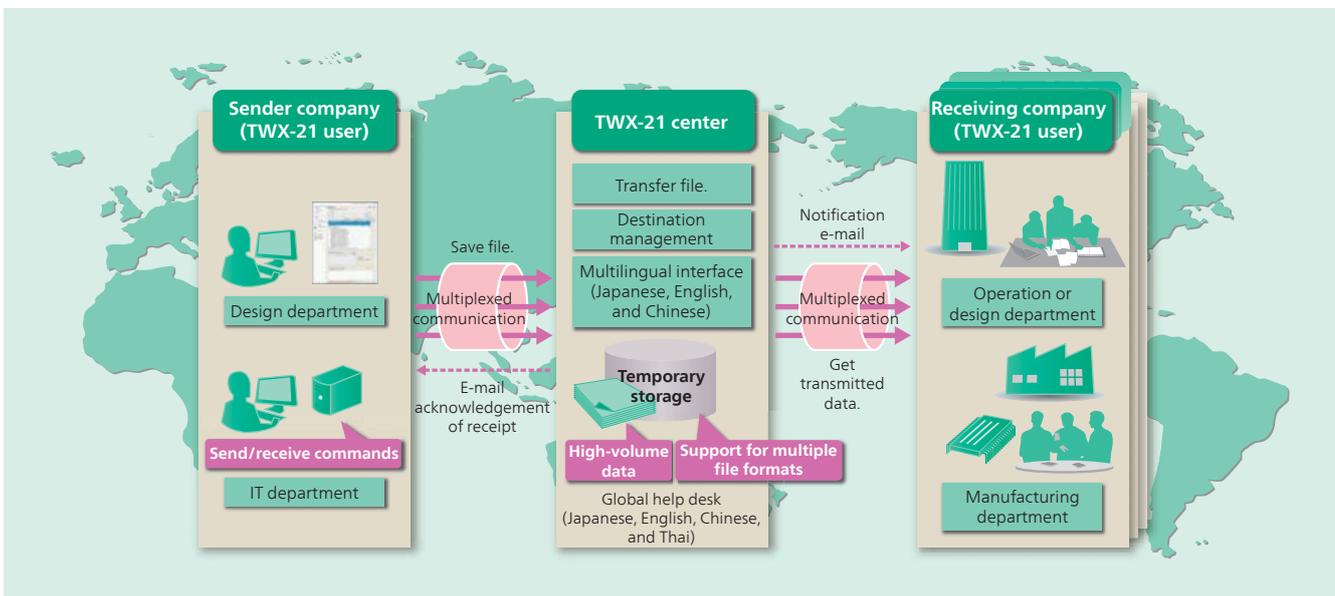
In response, Hitachi launched a new global huge data exchange service in June 2013. The service is provided as an option of the TWX-21\*1 business system cloud, which is used by 210,000 users at 50,000 companies across 24 countries or regions (approx-

mately).

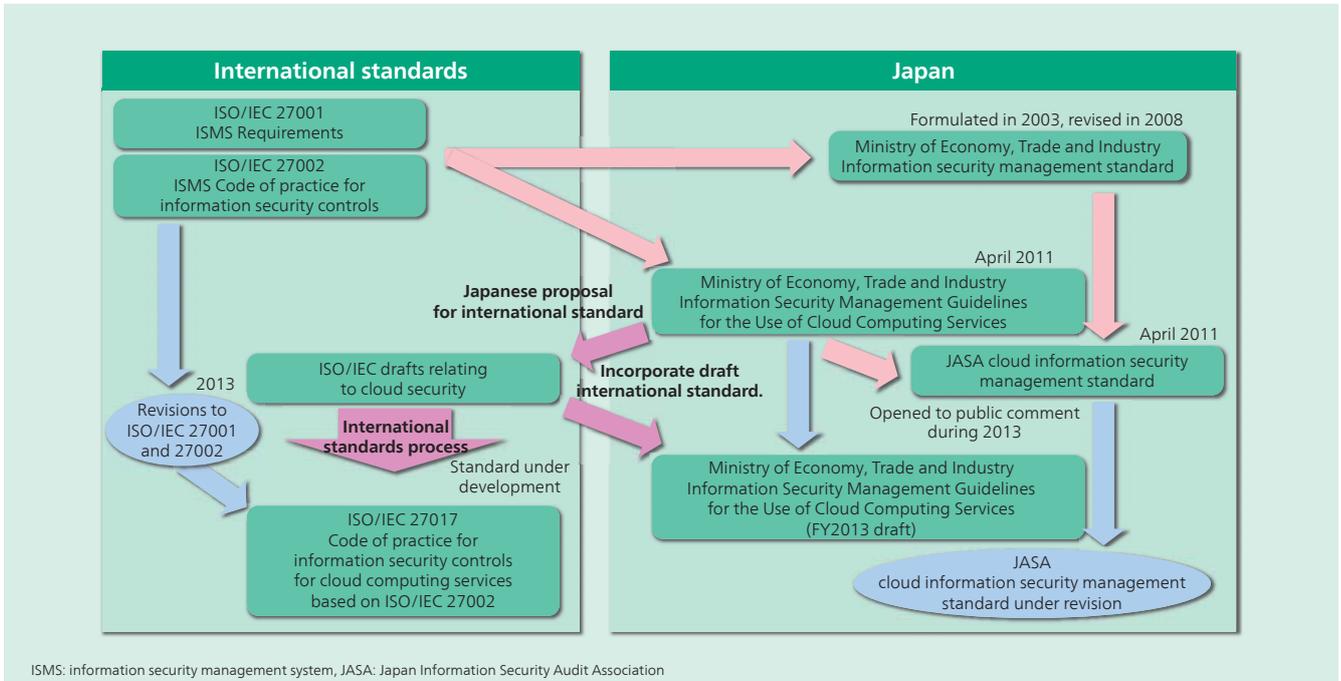
The service utilizes multiplexed communication techniques, security, and other technologies for the fast and high-quality transfer of large amounts of data across the internet. It also includes functions designed for business use, including a multi-lingual web interface (Japanese, English, and Chinese), global help desk (Japanese, English, Chinese, and Thai), administrator approval, and send and receive commands for linking different systems.

Hitachi intends to expand the range of global solutions offered on TWX-21 to support the anticipated increase in the number of companies from a variety of fields, such as manufacturing and logistics, that will establish overseas operations in the future.

\*1 TWX-21 is a trademark of Hitachi, Ltd.



3 TWX-21 global huge data exchange service



4 National and international developments in cloud security relating to ISO/IEC 27017

#### 4 International Standardization of Cloud Security

With security always an important issue in cloud computing, a number of guidelines have been published on the subject. Examples include those of the Cloud Security Alliance (CSA), a non-profit organization based in the USA; the European Union Agency for Network and Information Security (ENISA) and The Federal Risk and Authorization Management Program (FedRAMP), which deals with the certification of cloud procurement for US government agencies. In Japan, the Ministry of Economy, Trade and Industry, Ministry of Internal Affairs and Communications, National Information Security Center (NISC), and other agencies have each published guidelines from their own perspectives.

Along with these, the International Organization for Standardization (ISO), together with the International Electrotechnical Commission (IEC), is also working on a standard (ISO/IEC 27017) that deals with security considerations and management practices specific to the cloud. ISO/IEC 27017 is based on the existing ISO/IEC 27001 standard for information security management. The new standard is a Japanese proposal based on the Information Security Management Guidelines for the Use of Cloud Computing Services published by the Ministry of Economy, Trade and Industry. The ISO/IEC is closing the working draft phase for the proposal. With other agencies such as the CSA participating in the work, the proposal is likely to be adopted as an international standard.

In addition to participating in work on the ISO/IEC 27017 proposal, Hitachi is also taking part in the Cloud Information Security Promotion Alliance of the Japan Information Security Audit Association (JASA), which is seeking to establish security auditing practices in Japan based on the proposal. Hitachi contributes to the alliance by conducting pilot audits to promote improved cloud security based on the international standards.

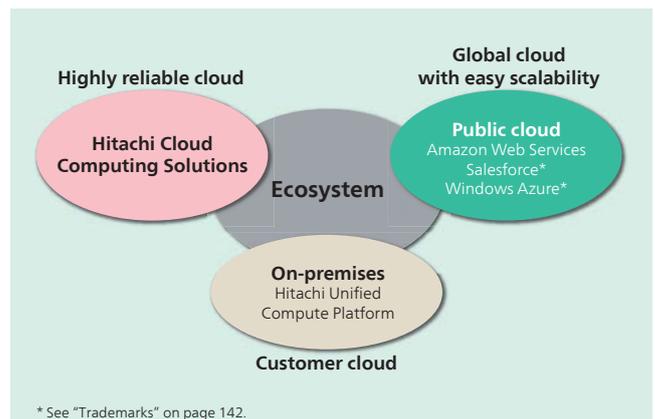
#### 5 Cloud Up-scaling by Ecosystem through Partnerships

IT systems require speed and the ability to respond to change. While Hitachi has traditionally turned to “technologies for building” to satisfy these requirements, dealing with these on its own has become more difficult in recent years.

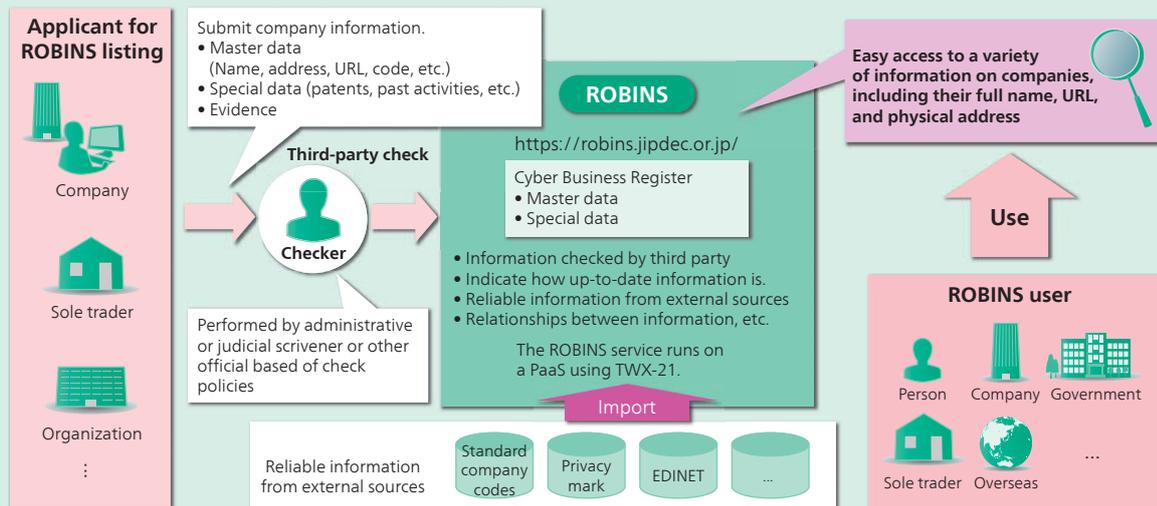
Given these developments, Hitachi has embarked on an up-scaling strategy for building IT systems through the application of “technologies for use,” and is establishing an ecosystem through partnerships with cloud vendors.

One example is the provision of a SAP\*-based accounting system through the integration of Hitachi Cloud Computing Solutions with Amazon Web Services\* (Amazon Web Services has a dominant share of the public cloud market). Other examples of services that deliver high added value include a monitoring and operation service that utilizes Job Management Partner 1 and combines Hitachi Cloud Computing Solutions with on-premises systems in an integrated package; a security platform enhanced by the use of data leakage prevention solution; and the mission-critical task solution for manufacturing and logistics service.

\* See “Trademarks” on page 142.



5 Ecosystem-based cloud platforms



URL: uniform resource locator, PaaS: platform as a service, EDINET: electronic disclosure for investors' network

## 6 ROBINS Cyber Business Register

### 6 ROBINS—Cyber Business Register

In Japan, the difficulty of obtaining reliable information about companies when trading on the internet is an impediment to the speed of business and a cause of missed opportunities. In response, JIPDEC launched ROBINS Cyber Business Register service in July 2013 to provide an online registry of businesses and facilitate internet-based business activities in Japan.

The service makes reliable information about companies available to everyone, regardless of time or place. While the information is submitted by the companies themselves, it is verified by third parties such as administrative or judicial scriveners before being published and therefore can be trusted in practice.

In addition to display on the web, the company information published by ROBINS can also be accessed via an application programming interface (API). One application for the service is the *Anshin* Mark certification that indicates that web mail is genuine, and which was adopted on some political party e-mail magazines produced for the July 2013 House of Councillors election.

It is anticipated that further new services will emerge that use ROBINS company information.

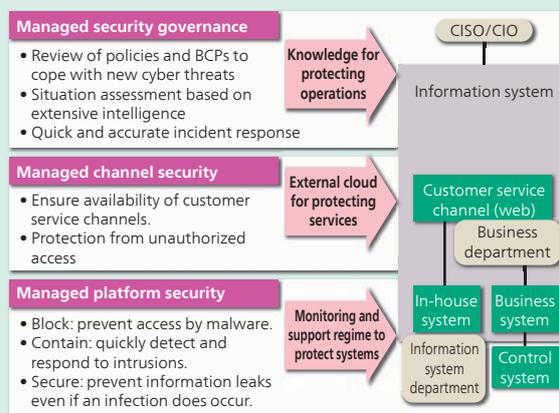
### 7 Managed Security Services

Hitachi launched cloud-based managed security services in October 2013 that supplies the latest security measures to protect organizations' information and systems from increasingly advanced cyber threats.

The increasing complexity and sophistication of cyber threats in recent years have imposed a growing workload on information system departments, including the securing of technical staff and the strengthening of monitoring regimes. In addition to existing improvement activities based on the plan, do, check and act (PDCA) cycle, there is also a need for operating practices based

on the observe, orient, decide, and act (OODA) concept that accept the inevitability of incidents occurring.

The managed security services provided by Hitachi are cloud-based and offer comprehensive support for cyber threat countermeasures. It reduces the burden on information system departments and implements dynamic security management based on



Category	Services	Functions
Managed security governance	Security consulting service	<ul style="list-style-type: none"> <li>Assistance with formulation of security policy</li> <li>Assistance with analysis of security risk</li> <li>Assistance with formulation of business continuity management</li> </ul>
	Security assessment service	<ul style="list-style-type: none"> <li>Assessment of IT infrastructure vulnerabilities</li> <li>Malware survey</li> </ul>
	Intelligence service	<ul style="list-style-type: none"> <li>Provision of system vulnerability information</li> <li>Assessment of reputational risk for specific sites</li> <li>Assistance with incident response</li> </ul>
	CSIRT technical support service	<ul style="list-style-type: none"> <li>Assistance with in-house CSIRT operation</li> <li>Targeted threat mail exercises</li> </ul>
Managed channel security	Web site protection service	<ul style="list-style-type: none"> <li>Web application firewall</li> <li>Countermeasures for DDoS attacks on web sites</li> </ul>
	Web site check service	<ul style="list-style-type: none"> <li>Assessment of web system vulnerabilities</li> <li>Falsification detection</li> </ul>
Managed platform security	Mail security service	<ul style="list-style-type: none"> <li>Anti-virus, anti-spam</li> <li>Content filtering</li> </ul>
	Web security service	<ul style="list-style-type: none"> <li>URL filtering for web browsing</li> <li>Anti-virus</li> </ul>
	Security event monitoring service	<ul style="list-style-type: none"> <li>Integrated log management</li> <li>Log correlation analysis</li> </ul>
	Virtual server protection service	<ul style="list-style-type: none"> <li>Virtual UTM operation monitoring</li> </ul>

BCP: business continuity plan, CISO: chief information security officer, CIO: chief information officer, CSIRT: computer security incident response team, DDoS: distributed denial of service, UTM: unified threat management

## 7 Services provided by managed security services

the OODA concept. In addition to the monitoring of both physical and virtual environments, the available services also include the correlation analysis of logs from different devices to support rapid incident detection and response.

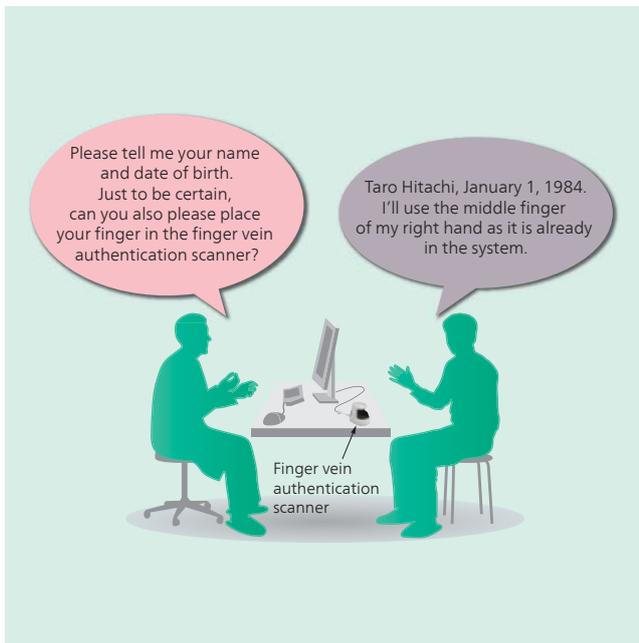
In the future, Hitachi intends to expand the range of services on offer to deal with increasingly sophisticated cyber threats and to support security measures that are suitable not only for corporate systems but also social infrastructure systems.

## 8 New Applications for Finger Vein Authentication Solutions

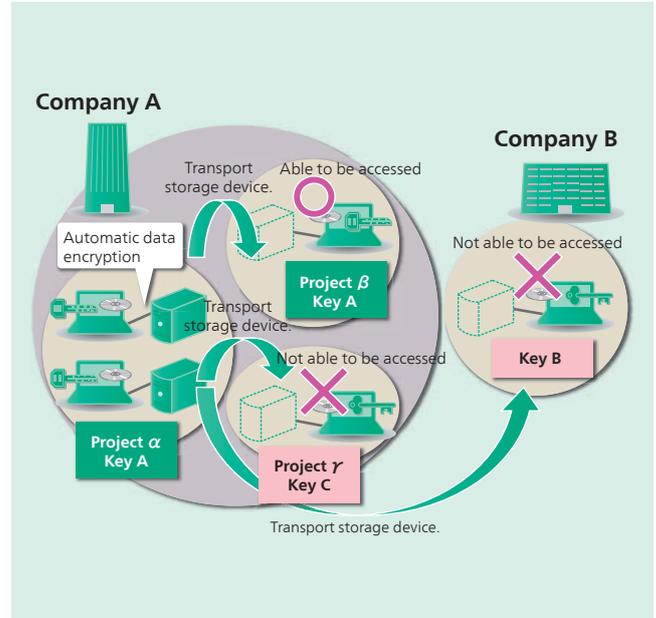
Hitachi's finger vein authentication systems achieve very accurate authentication by reading the pattern of veins in one's finger. They are already widely used in areas such as corporate IT security and physical security (premises access control). In recent years, their use has also expanded to include operator authentication on POS terminals and time and attendance applications in sectors such as the food and beverage industry or retail chains. The technology has been well regarded for its many advantages, which include preventing unauthorized operation or spoofing, reducing use of consumables such as identification cards, and eliminating the need for password entry.

2013 also saw growing use of the systems for patient identification in the healthcare and welfare sector. While the prevention of medical accidents due to patient misidentification has in the past relied on having the patient identify themselves by name and date of birth, use of finger vein authentication systems provides a reliable form of identification. Hospitals that offer radiological treatment have been the first in the healthcare sector to use finger vein authentication systems for patient identification.

It is anticipated that 2014 will see the technology being more widely adopted by other areas of healthcare (such as medical checkups and vaccinations).



8 Use of finger vein authentication systems for patient identification in the healthcare sector



9 Solutions for preventing mass data leaks through use of data protection middleware

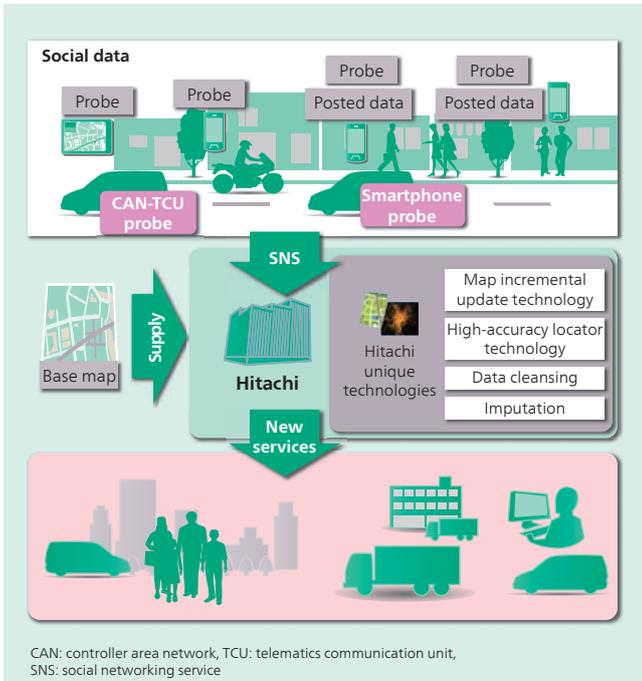
## 9 Solutions for Preventing Mass Data Leaks

To ensure security and convenience when taking mass storage data off site, Hitachi has developed data protection middleware for preventing data leaks.

Measures such as encryption are essential for preventing data leaks when transporting mass storage data on portable storage devices. Hitachi's data protection middleware enhances security by allowing each organization to set their own keys and only permitting data encryption and decryption in the specific areas assigned with that key. Also, because data encryption and decryption occurs automatically in a way that is transparent to users, the portable storage device can be used normally without any loss of convenience.

The volume of video content used in the broadcasting industry is progressively increasing as a consequence of developments such as the move to high definition and fully digital transmission for terrestrial broadcasting. There has also been a practice of transferring video data to external storage devices for editing, to improve the efficiency of this work. While this is convenient, the ease of copying video data and the potential for storage devices to be lost or used inappropriately raises the issue of what security measures should be adopted to deal with the risk of leaking private information or confidential corporate information that may be contained in this video. Hitachi's middleware can prevent information leaks resulting from the inappropriate use by third parties of video or other data.

In the future, Hitachi intends to supply the middleware to industries that need to maintain the security of mass storage data, including healthcare systems that handle diagnostic medical images, and surveillance and crime prevention systems in industries such as broadcasting, finance, logistics, and transportation.



10 Smart mobility services for vehicles

## 10 Smart Mobility Services for Vehicles

The trend in recent years has been away from vehicle-centric information sharing and toward user-centric information sharing. Meanwhile, advances in IT have made a wide variety of data available, leading to expectations for the creation of new value in ways that combine user information from different industries.

Through its existing car information system solutions (including traffic information services and map information services), Hitachi has built up a portfolio of technologies that include the conversion and processing of digital map data from map vendors, and also Hitachi's own probe data processing technologies\*<sup>1</sup>, data cleansing\*<sup>2</sup>, and imputation techniques\*<sup>3</sup>. By combining these technologies with data from vehicles and location-based information from social networks, Hitachi is providing

new smart mobility services for vehicles that allow people to travel in comfort while also taking account of safety and convenience.

\*1 Traffic information generated from location, speed, and other data collected from vehicles on the road.

\*2 A technique that uses probe data and map data to augment map-overlaid data based on factors such as distance and speed.

\*3 A technique for the precise imputation of missing traffic data through the analysis of nearby traffic conditions and past statistics.

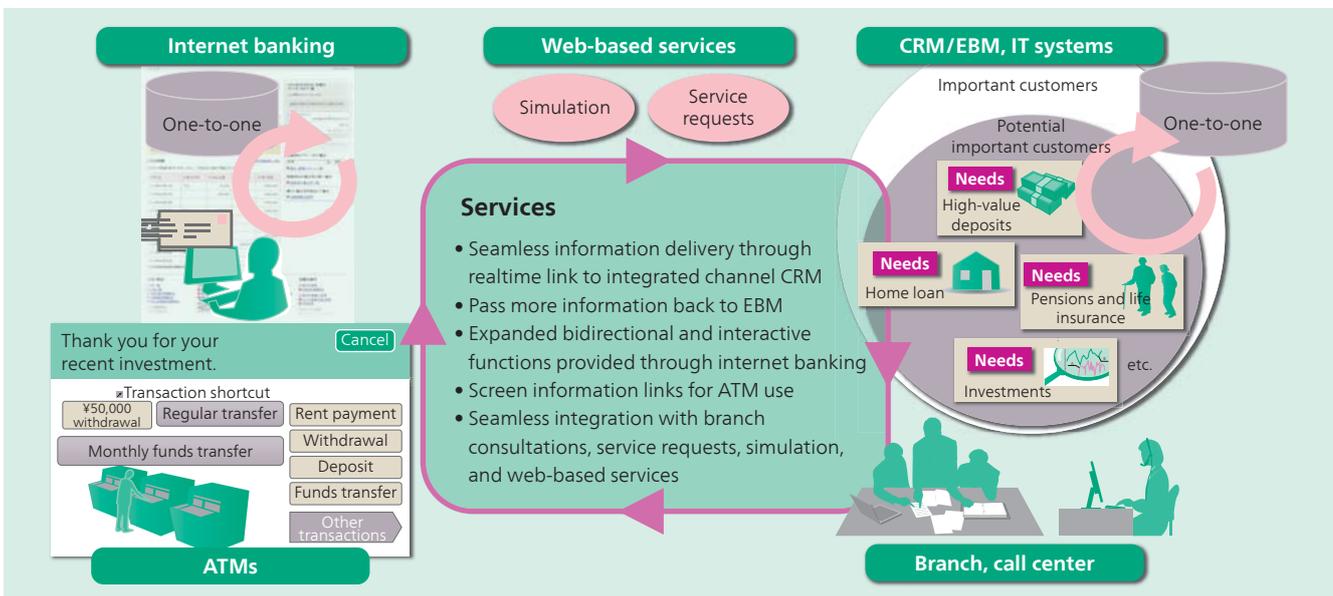
## 11 Omni-channel Environment for Regional Financial Institutions

It is more than a decade since internet banking first appeared. Nowadays, with services available via the internet having expanded beyond core transactions such as checking balances or transferring funds, there is a need to use internet banking as both a means of generating income and a channel for communication. This requires not only the sale of foreign exchange, investment funds, government bonds, and loans, but also the linking of internet banking to credit and securities; its use for data analysis, information delivery, and marketing; and its integration with stores and automated teller machines (ATMs). In response, Hitachi is utilizing a variety of solutions sourced in-house as well as working in conjunction with other service vendors.

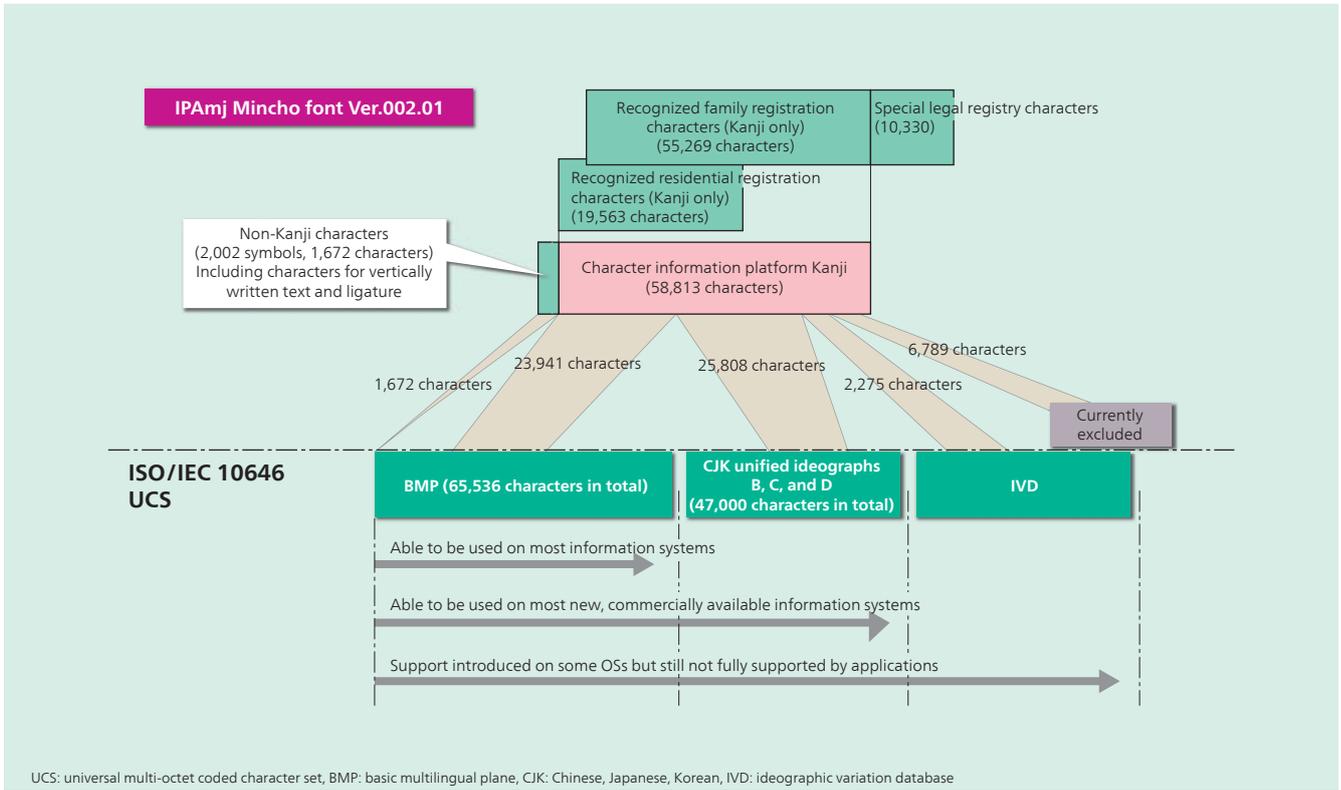
Regional financial institutions, meanwhile, in order to differentiate themselves from competitors such as major banks or dedicated internet banks, need to find distinctive competitive practices that take advantage of their dominant position in on-the-ground opportunities for contact with customers. Hitachi's joint internet banking center seeks to provide an omni-channel\*<sup>1</sup> environment that delivers the best possible experience value to customers by enhancing customer relationship management and event-based marketing\*<sup>2</sup> (CRM/EBM) in ways that link together the different channels (branches, call centers, ATMs, and internet banking).

\*1 A way of dealing with customers through a seamless combination of the various different channels

\*2 A customer information and marketing technique



11 Omni-channel environment



**12** Character information platform promoted by Ministry of Economy, Trade and Industry (encoding of IPAmj Mincho font)

## 12 Character Information Platform Promoted by Ministry of Economy, Trade and Industry

In collaboration with the National Strategy Office of Information and Communications Technology, Cabinet Secretariat, and the Ministry of Economy, Trade and Industry, the Information-technology Promotion Agency, Japan (IPA) is working on establishing the environment needed for the practical implementation of a character information platform. To provide a platform for the efficient handling of the currently unstandardized use of Kanji for names and other purposes in information systems operated by the national government or regional agencies and other public institutions, the IPA has published a table of character information and the IPAmj Mincho font, which includes approximately 60,000 characters.

As part of establishing the environment needed for the practical implementation of the character information platform, web trials were conducted during FY2012 to investigate the technical challenges associated with use of a web font that allows mainstream operating systems (OSs) and browsers to handle the approximately 60,000 characters without the need for clients to maintain their own copy of the font. The trial included use of character platform products from Hitachi.

Use of the character information platform is stipulated in documents such as the Technical Reference Model for the Government Procurement of Information Systems (FY2012 edition) published by the Ministry of Economy, Trade and Industry and the “Declaration to be the World’s Most Advanced IT Nation” (approved by cabinet in June 2013) of the Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters). It is anticipated that it will become a de facto standard

for future information system development.

Character platform products from Hitachi will be modified to suit the nationally decreed character information platform in a timely manner.

## 13 Geospatial Information Solutions

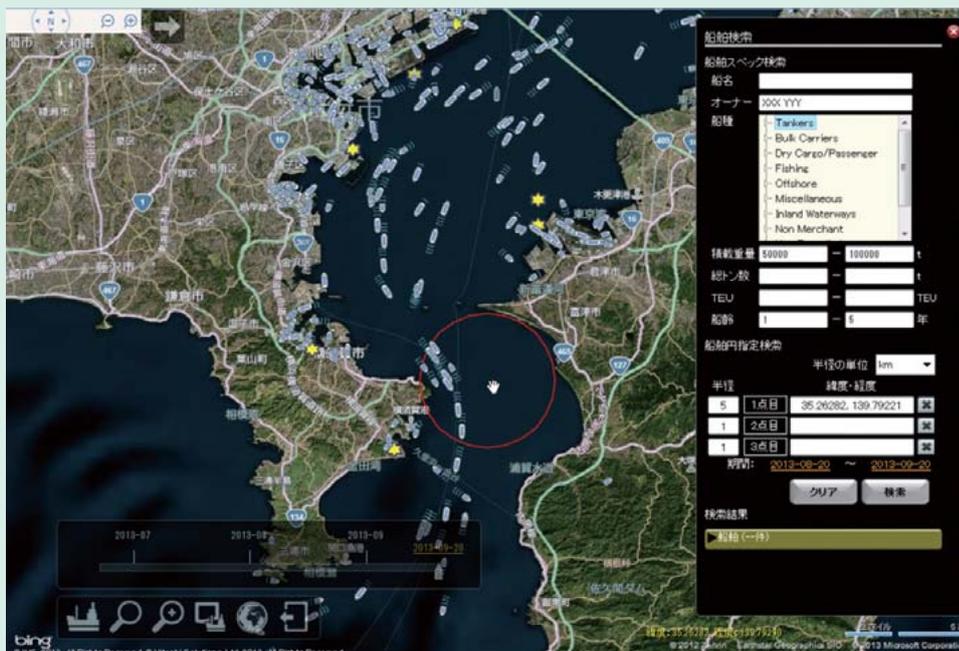
Hitachi’s geospatial information solution business is based around a geospatial information cloud and combines satellite images with geographic information systems (GIS). The business is operated on a geospatial information service platform that brings together different forms of geographic content including satellite images. Use of the platform allows applications and other services that use geospatial information to be implemented without the need for specialist GIS expertise.

A recently launched service that uses this cloud is a vessel location tracking service targeted at the shipping industry, ship-builders, and trading companies. The service presents information on vessel movements extracted using search keys such as vessel type or location, and it helps with objectives such as reducing vessel operating costs or risks.

The main uses envisaged for the system are as follows.

- (1) Use by shipping companies to optimize vessel routes, speeds, and other parameters based on information about the current location of other company’s vessels.
- (2) Design vessels that meet actual needs.
- (3) Plan less dangerous routes based on the movements of vessels along new routes or dangerous routes.

Hitachi plans to release a series of new services that utilize this geospatial information cloud.  
(Hitachi Solutions, Ltd.)



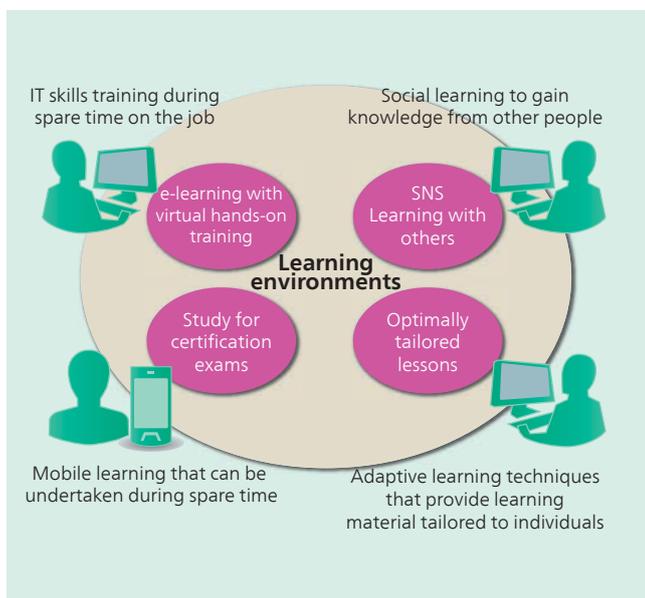
13 Example screen from vessel location tracking service

## 14 IT Human Capital Development Solution

Hitachi is extending the solutions it offers for developing IT staff who can identify problems on their own and collaborate to overcome them.

This form of human capital development requires not only the acquisition of knowledge and skills but also training exercises that cover judgment, action, and responsibility. The FY2013 intake of new recruits at the information and telecommunications division of Hitachi used an SNS that incorporated collaborative learning and gamification into their training. This enhanced educational effectiveness by encouraging more initiative and collaboration in the learning environment.

Representing a new approach to learning, Hitachi set up a



14 Variety of learning environments for IT staff training

teaching environment on a public cloud and launched a service in April 2013 that offers exercises to be taken anytime and anywhere. The service can be used to gain certification in Hitachi Open Middleware, for example, or to reinforce knowledge and skills gained through earlier training. Hitachi also added mobile learning in December 2013 by providing content such as preparation for certification exams that can be studied from a smart device.

In the future, Hitachi intends to establish learning programs that are user-friendly and tailored to individuals. The programs include adaptive learning techniques incorporating training methods that take into account the needs and level of understanding of individual students.

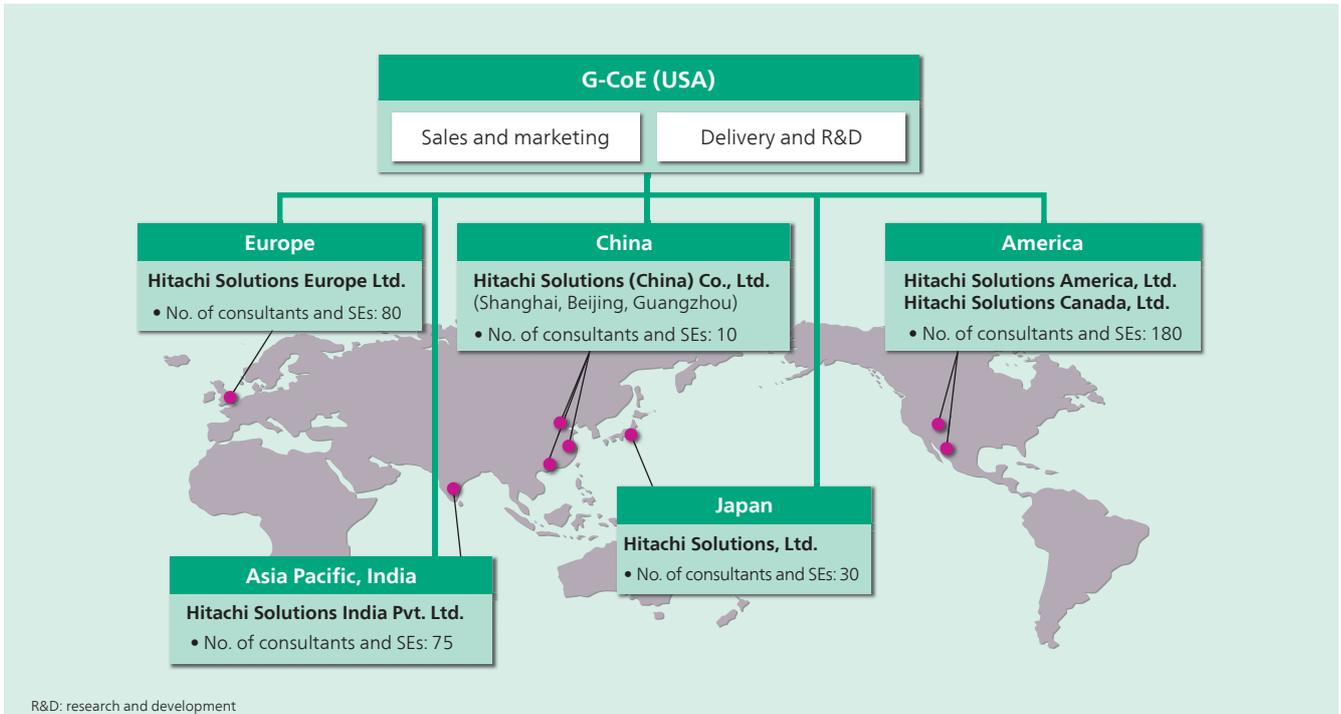
(Hitachi Information Academy Co., Ltd.)

## 15 Microsoft Dynamics Global Solution

Factors such as the acceleration in moves by Japanese corporations to establish overseas operations and an increase in mergers and acquisitions (M&A) are driving demand for the installation and integration of business systems at overseas sites.

Hitachi's Microsoft Dynamics\* businesses in North America and Europe were transferred from Hitachi Consulting Corporation to Hitachi Solutions, Ltd. in April 2012. Hitachi Solutions, Ltd. then went on to launch its Microsoft Dynamics global solution, a service providing consulting, installation, and maintenance of Microsoft enterprise resource planning (ERP) and CRM products. The service is available in five regional markets, namely Japan, China, America, Europe, and the Asia Pacific region.

A feature of this solution is its ability to meet customers' high level of global system needs. Hitachi has established a Global Center of Excellence (G-CoE) at its US subsidiary. The G-CoE



15 Organizational structure based on G-CoE and five regional hubs (September 2013)

acts as a center for commercial negotiations and service delivery for the five regional hubs, has an American Chief Operating Officer (COO) who is a leading consultant in Microsoft Dynamics, and coordinates customer projects and the activities of approximately 400 specialist engineers (as of September 2013) in the USA, Canada, the UK, India, Japan, and China. That is, engineers who are familiar with the local language and other needs provide a one-stop service on behalf of Hitachi for customer systems that operate across a number of countries or regions. This allows Hitachi both to meet the local needs of customers and to work directly with headquarters to assist with overall optimization, something that in the past could only be accomplished by global system integrators.

(Hitachi Solutions, Ltd.)

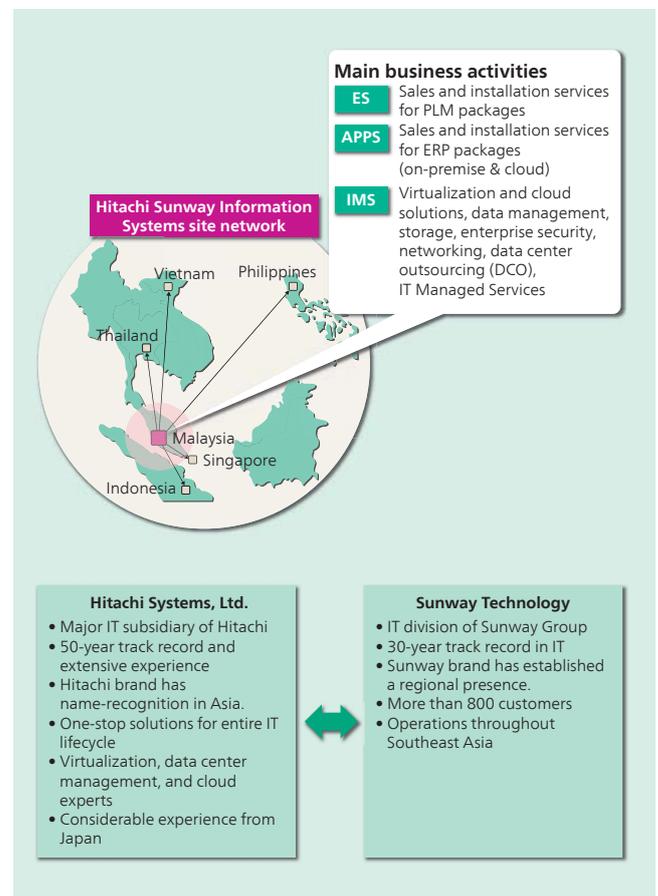
\* See "Trademarks" on page 142.

## 16 Establishment of Hitachi Sunway Information Systems

In April, 2013, Hitachi Systems, Ltd. established Hitachi Sunway Information Systems Sdn. Bhd. as a joint venture with Sunway Technology Sdn Bhd, a group of unlisted IT subsidiaries of Malaysian conglomerate Sunway Group. Set up with the aim of expanding its IT service business in Southeast Asia, Hitachi Sunway Information Systems has its headquarters on the outskirts of Kuala Lumpur in Malaysia and has launched IT service businesses in various countries around Southeast Asia (Malaysia, Republic of Singapore, Kingdom of Thailand, Republic of Indonesia, Republic of the Philippines, and the Socialist Republic of Viet Nam)

Hitachi Sunway Information Systems operates service businesses in each of these countries that help their customers adopt more advanced IT. The three businesses operated by Hitachi Sunway Information Systems are (1) engineering solutions (ES)

business that includes product lifecycle management (PLM) and product data management (PDM), (2) applications (APPS) business that handles ERP and other systems, and (3) infrastructure and managed services (IMS) business for building and operating IT infrastructure including virtualization, security, network and data center operations. Hitachi Sunway Information Systems is seeking to become a one-stop information and



16 Business expansion in Southeast Asia by partnering with Hitachi Sunway Information Systems

communication technology (ICT) solution and services provider by taking advantage of Sunway Technology's local engineers and the customers of about 800 companies, and by combining these resources with the extensive experience and know-how in IT services built up by Hitachi Systems, Ltd. in Japan. In doing so, it intends to supply excellent IT services technology to customers in Southeast Asia, and to provide Japanese companies that have established operations in Southeast Asia with the same level of support for their IT systems as they receive in Japan.

(Hitachi Systems, Ltd.)

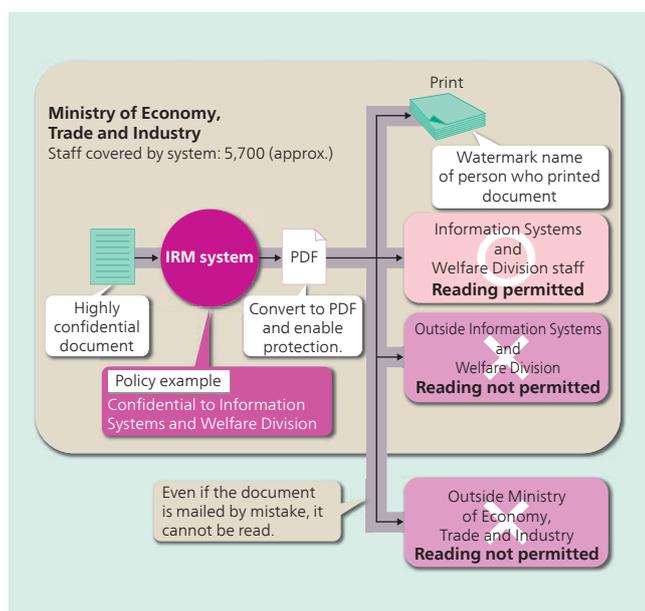
## 17 Restricted Readership System of Ministry of Economy, Trade and Industry

The Ministry of Economy, Trade and Industry upgraded its restricted readership system in February 2013. This system converts the highly confidential official documents handled by ministry staff to portable document format (PDF) and restricts read access to authorized personnel only. As protected documents are converted to a format in which only designated staff are able to view them, and only on the ministry's local area network (LAN), using the system prevents the documents from being viewed if they are taken outside the ministry.

This arrangement is underpinned by the information rights management (IRM) system. By incorporating security into the document itself, this solution allows documents to be protected appropriately even after they have left the hands of their creators.

Although the Ministry of Economy, Trade and Industry has used levels to classify and manage the confidentiality of official documents and taken steps to prevent leaks of confidential documents, information leaks are difficult to eliminate entirely. For this reason, the ministry runs education programs to raise staff awareness and teach them about the aims and practical aspects of information security. The Ministry of Economy, Trade and Industry will continue working on initiatives with the aim of achieving best practice in information management.

(Hitachi Solutions, Ltd.)



17 Management of electronic documents at the Ministry of Economy, Trade and Industry

## 18 Next-generation ATM

Hitachi has developed a next-generation ATM that has been designed for simplicity to provide reliability and ease of use and ensure that it can be used with confidence by a diverse range of people.

The ATM\* includes a variety of light and sound prompts to guide the user through its use, including a welcome light that illuminates when someone comes near, and a media spotlight that illuminates the user's card or bank book. It also has an enlarged area underneath to make it easy for people in wheelchairs to get close enough to the ATM to use it. The ATM has also been awarded color universal design certification by the Color Universal Design Organization [a non-profit organization (NPO) in Japan] for its case design and user screens that are designed for use by people with a variety of different forms of color perception. To ensure that the ATM can operate for long periods of time without halting or jamming, Hitachi has also combined the bill handling techniques it has built up from experience in different parts of the world to develop a new bill handling unit that significantly reduces the incidence of bill jams while simultaneously increasing the number of bills the ATM can hold. The design is conscious of the environment, with the power consumption of the ATM in standby mode having also been reduced.

The ATM has been adopted by a large number of financial institutions, including major banks, who have recognized it for its features, which include significant improvements in ease of use for both users and service staff, and a lower frequency of faults. In the future, Hitachi intends to continue supplying ATMs and associated services that meet the needs of society by improving on its core competencies of sensing and handling, and through measures such as taking account of the environment and the application of universal design as a response to an aging population.

(Hitachi-Omron Terminal Solutions, Corp.)

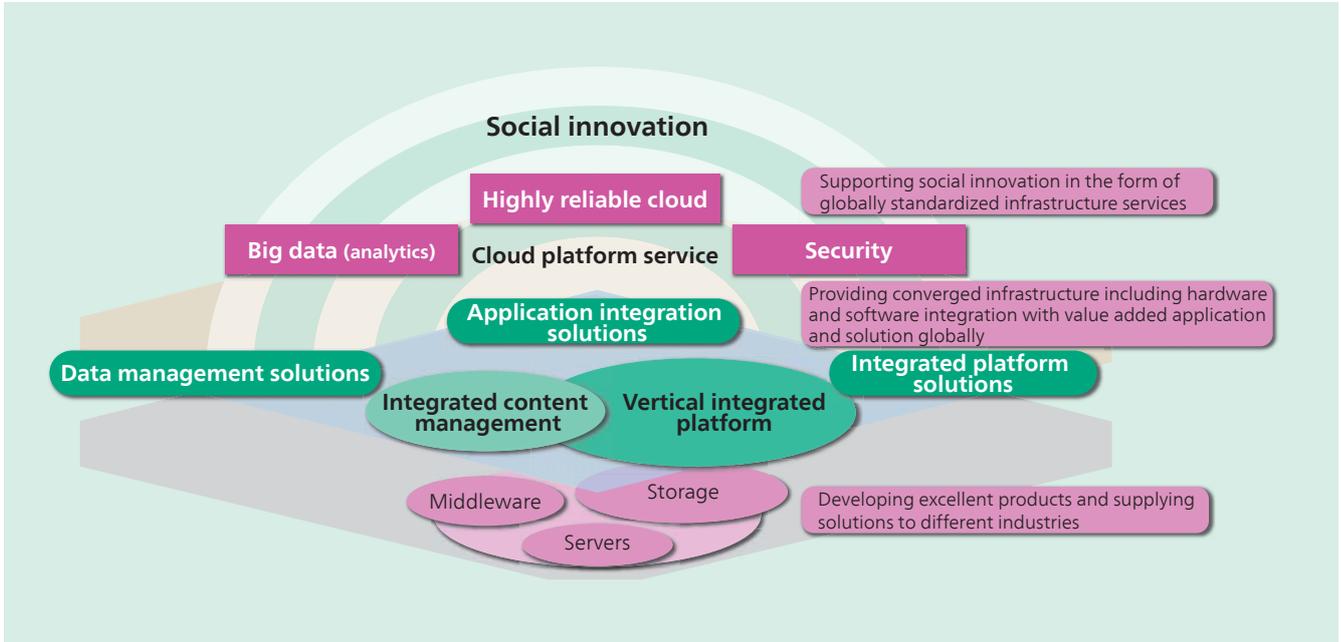
(Product released: June 2012)

\* The ATM is intended for the Japanese market.



18 Next-generation ATM

# IT Platform



1 Hitachi's IT platform business vision

## 1 Hitachi's IT Platform Business Vision

With the globalization of the economy in recent years and ongoing dramatic changes in the business environment, the requirements being placed on information technology (IT) are becoming more diverse. Also growing in importance are new developments such as cloud computing that can adapt quickly and flexibly to changing circumstances, and the utilization of big data with the potential to create new business value from the large amounts of different types of data being generated by companies and society.

In addition to the core systems that support the information society, Hitachi also supplies platforms and services that underpin social innovation through highly reliable cloud and security, and the utilization of big data.

Using its servers, storage, and middleware as a base, Hitachi is contributing to the growth of its customers' businesses by offering integrated platform solutions, application integration solutions, and data management solutions that generate added value through the collection, search, and analysis of data, and by using the latest functions such as virtualization and other advanced technologies and providing user-friendly systems.

## 2 Hitachi Unified Compute Platform

The use of different forms of cloud computing has gathered pace

in recent years, with aims that have included customers expanding existing businesses, the rapid startup of new ventures, or raising the efficiency of IT investment. The critical factors in these developments have been the speed and ease with which IT systems can be put in place.

The Hitachi Unified Compute Platform is an integrated platform solution including the required hardware, virtualization, and software in a single package. It helps customers get IT systems up and running quickly because it uses proven system configurations that are easy to install.



2 Hitachi Unified Compute Platform

The Hitachi Unified Compute Platform Pro for VMware vSphere\* is targeted at cloud service operators and the Hitachi Unified Compute Platform with OpenMiddleware is aimed at mid-range or larger private clouds. In addition to these two enterprise platforms, Hitachi also offers a model that has been optimized for small or medium-sized private clouds or server integration applications. This latter model is quick and easy to set up, and can be supplied to customers with a lead time as short as 10 working days. As it comes complete with dedicated management software that simplifies the operation of virtual servers as well as operation manuals and practical training, customers who are unfamiliar with virtual servers can be confident about installing the platform.

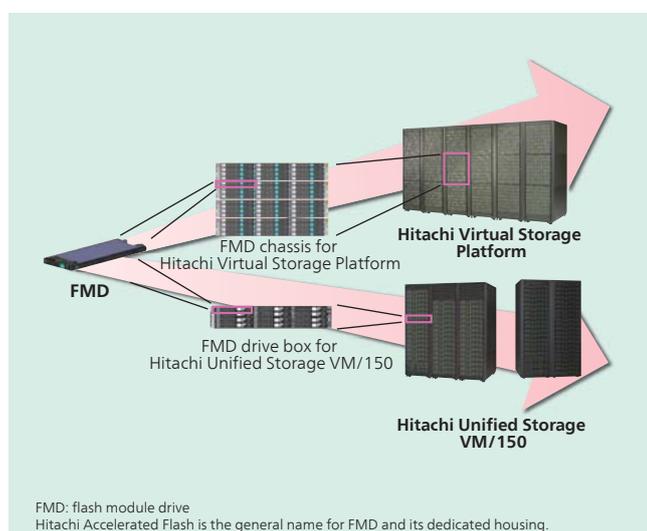
Hitachi also supplies a desktop virtualization platform model that can be used to configure suitable virtual desktop infrastructure (VDI) environments quickly and easily based on the system size and the type of installation (from the proof of concept level up to fully operational systems).

\* See "Trademarks" on page 142.

### 3 Flash Modules Hitachi Accelerated Flash

As companies take on new fields of business and grow globally, they are looking to their IT systems to make timely use of data generated from the different operations and products and to play a role in new value creation. Storage systems have an important role in the timely utilization of data, and these developments have been accompanied in recent years by growing interest in the use of flash memory and its ability to offer faster data access than hard disk drives (HDDs). However, because they are expensive to install, the solid state drives (SSDs) in which flash memory is typically supplied have limited usefulness as a mainstream form of data storage.

Hitachi Accelerated Flash provides large-capacity and high-performance flash modules that can be incorporated into Hitachi storage systems at lower cost than conventional SSDs thanks to features such as a flash memory controller developed by Hitachi. Hitachi Accelerated Flash incorporates techniques for improving the efficiency with which data is written to storage and can



3 Hitachi Accelerated Flash

maintain a high level of performance over long-term use. It also achieves high reliability thanks to a function that interoperates with the storage controller to detect faults before they occur.

Hitachi storage systems currently offer extensive support for Hitachi Accelerated Flash in products from the high-end Hitachi Virtual Storage Platform to the mid-range Hitachi Unified Storage VM and Hitachi Unified Storage 150. This makes it possible to offer storage solutions that satisfy customer needs for performance, cost-per-byte, and space-efficiency. For example, a Hitachi Virtual Storage Platform incorporating Hitachi Accelerated Flash achieved world-leading performance (as of July 11, 2013) on SPC Benchmark-1\*, the standard benchmark for data input and output performance. Hitachi also offers Hitachi Unified Storage VM in All Flash System to provide an easy and low-cost way to improve performance on small to medium-sized systems or in special applications.

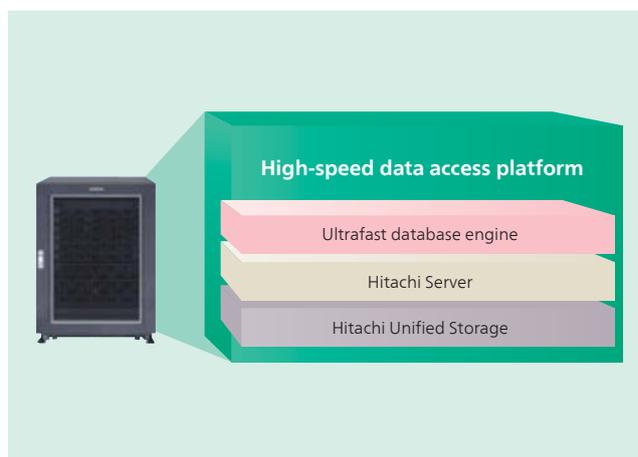
In the future, Hitachi intends to support the timely utilization of data by corporations and other organizations and contribute to the creation of new value by enhancing its storage solutions that incorporate flash memory.

\* See "Trademarks" on page 142.

### 4 High-speed Data Access Platform

Against a background that includes the growth of the cloud and the rapid spread of sophisticated mobile devices, there is a growing demand for the utilization of big data by companies and other parts of society. The rapid searching and analysis of big data requires that maximum advantage be taken of the ongoing dramatic improvements in hardware performance to significantly increase processing performance. With the aim of achieving the challenging task of performing rapid searches of big data, Hitachi has been collaborating with the University of Tokyo on the research and development of an ultrafast database engine\*<sup>1</sup>.

Hitachi's own ultrafast database engine draws on the results of this joint research and development and has become the first in the world to satisfy TPC-H\*<sup>2</sup>, the industry benchmark for decision support systems, for a 100-Tbyte-class database (the largest category). This achievement of world-leading performance on the largest class of database covered by the TPC-H benchmark demonstrates the major contribution that this product makes to



4 High-speed data access platform

the utilization of big data.

The high-speed data access platform also includes Hitachi hardware and storage products. Hitachi intends to continue developing this technology to meet customer needs.

\*1 Utilizes the results of “Development of the Fastest Database Engine for the Era of Very Large Database and Experiment and Evaluation of Strategic Social Services Enabled by the Database Engine” (Principal Investigator: Prof. Masaru Kitsuregawa, The University of Tokyo/Director General, National Institute of Informatics), which was supported by the Japanese Cabinet Office’s FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).

\*2 See “Trademarks” on page 142.

intelligence (BI) tool to visualize web access.

(2) Easy Hadoop solution for batch processing

Combines Hadoop with Asakusa Framework\*, a tool that facilitates the development of batch programs, to shorten the time taken to process batch jobs. By increasing the frequency with which batch processing can be performed, it supports timely and accurate understanding and utilization of data required for uses such as business decision making.

\* See “Trademarks” on page 142.

## 5 Easy Hadoop Solutions

The easy Hadoop solutions supply the highly integrated Hitachi Compute Blade 10 server with Hadoop\*, other required software, and sample programs preinstalled. The aim is to provide quick installation for systems that use the Hadoop technology for parallel and distributed processing of big data.

The two main solutions being offered are as follows.

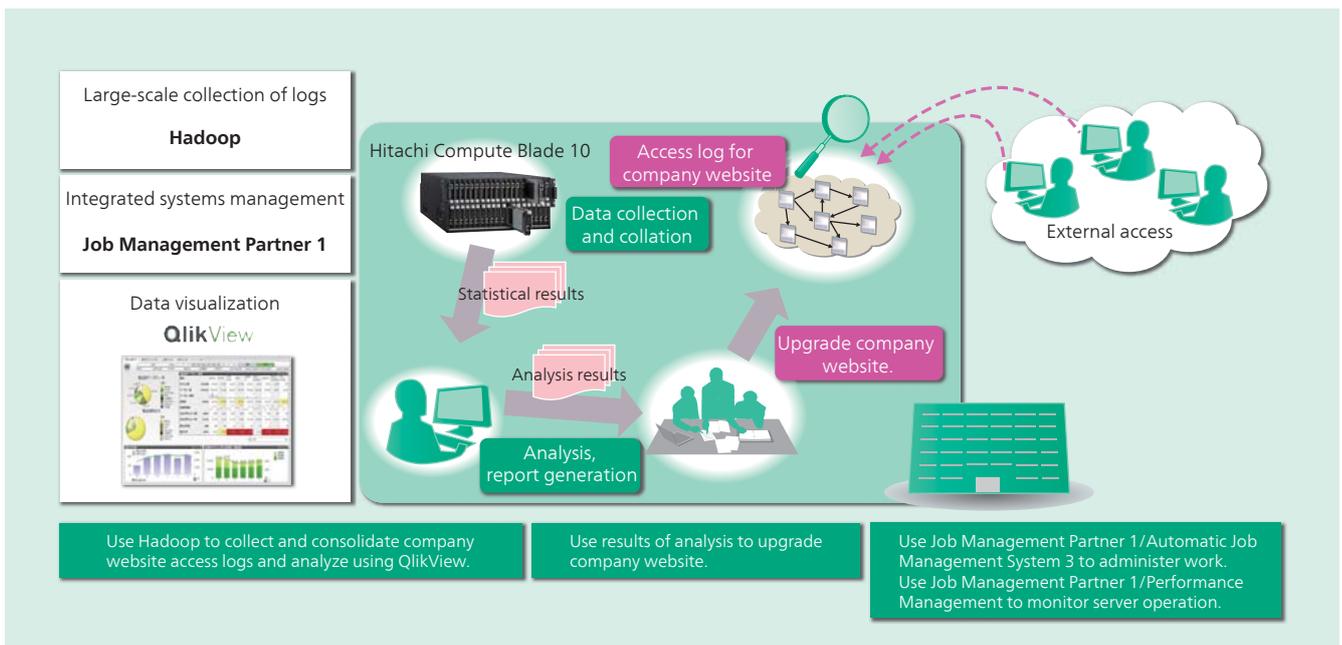
(1) Easy Hadoop solution for log analysis

Web access logs are a familiar form of big data. The solution uses Hadoop to collect this data and uses the QlikView\* business

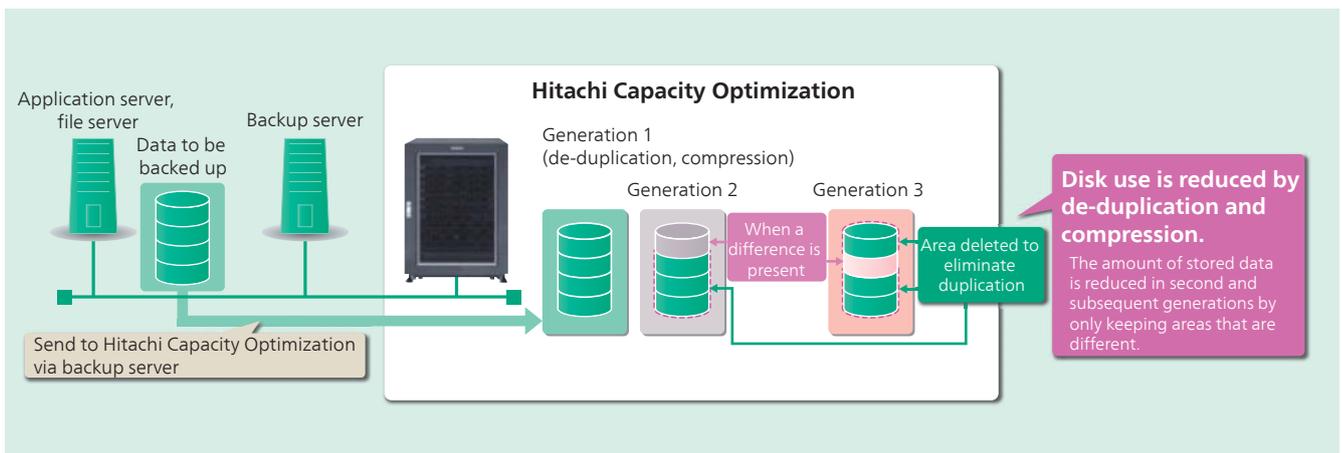
## 6 Hitachi Capacity Optimization File Storage System for Backups

As the volume of business data grows, backing up this data is becoming an increasingly important part of internal control and business continuity planning in case of disaster. In addition to storing data economically, the systems used for these backups also need sufficient performance to complete backups quickly.

Hitachi Capacity Optimization is a file storage system designed for backups to meet the demands. It includes a function for eliminating duplicate data that cuts storage costs by reducing the quantity of stored data. Also supported are functions for automatically selecting which of the available methods to use for elim-



5 Simple Hadoop solution for log analysis



6 Use of Hitachi Capacity Optimization to eliminate duplication in backup data

inating duplicate data based on the data format, and a hybrid function that can specify whether to eliminate duplications at the time of writing, at a later timing, or both, depending on whether disk capacity or performance is being prioritized. The system can reduce the quantity of backup data by a factor of around 20\* in cases when multiple generations of backup data are being held.

In the future, Hitachi intends to supply backup storage systems that are more economical and come equipped with high-performance functions that are easy to use.

\* Actual results depend on type of data, degree of duplication in data, and backup methods used.

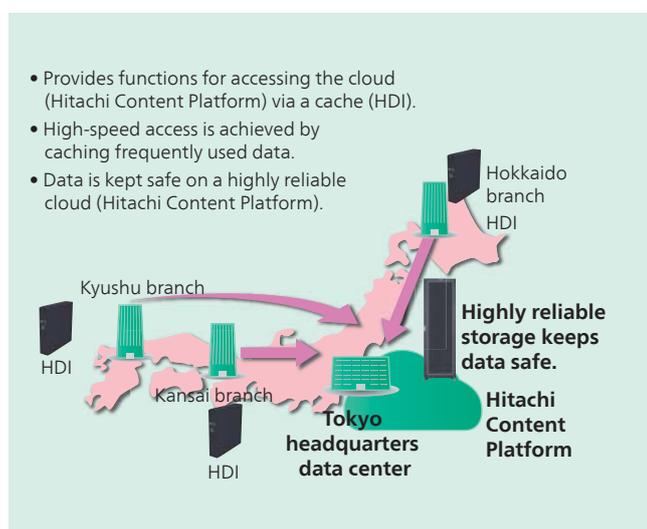
## 7 Hitachi Data Ingestor Small Storage Unit Specifically for Cloud on-Ramp Solution

Hitachi's cloud on-ramp solution resolves the issues associated with the efficient storage and management of the ever-increasing quantities of corporate data.

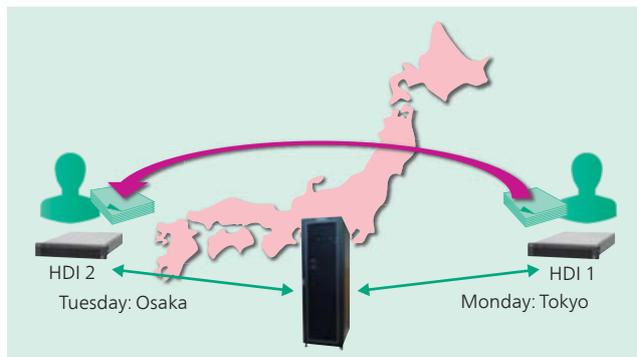
The solution uses storage systems located at different sites or departments as on-ramps to the cloud and provides automatic consolidation and centralized management at a data center of the file data spread across multiple sites and departments. The file virtualization function allows users at remote sites to use their data without needing to concern themselves with whether it is held locally or at the data center. Because this resolves the problems of having to administer each site and deal with complex storage system, capacity upgrade, and data management issues as the quantity of data increases, benefits include cutting the total cost of ownership (TCO) and improving return on investment (ROI).

The Hitachi Data Ingestor (HDI) released in October 2013 as part of Hitachi's partner strategy is a special-purpose cloud on-ramp appliance that is small and easy to install. With a compact case that is smaller even than an A4 sheet of paper (44.5 mm wide × 220 mm deep × 205 mm high), it is easy to install and takes only about 10 minutes to set up.

HDI is a component in cloud services supplied by partners. In the future, Hitachi intends to continue working with its partners to supply the benefits of cloud on-ramp solutions to more customers.



7 Typical cloud on-ramp solution incorporating HDI



8 Home directory roaming using HDI

## 8 Home Directory Roaming Using Hitachi Data Ingestor

Corporate file data, which consists primarily of unstructured data such as e-mail or documents, is typically spread across a number of sites or departments and is steadily growing in volume. How to reduce the total cost of storing, managing, and using this data has become an issue in recent years.

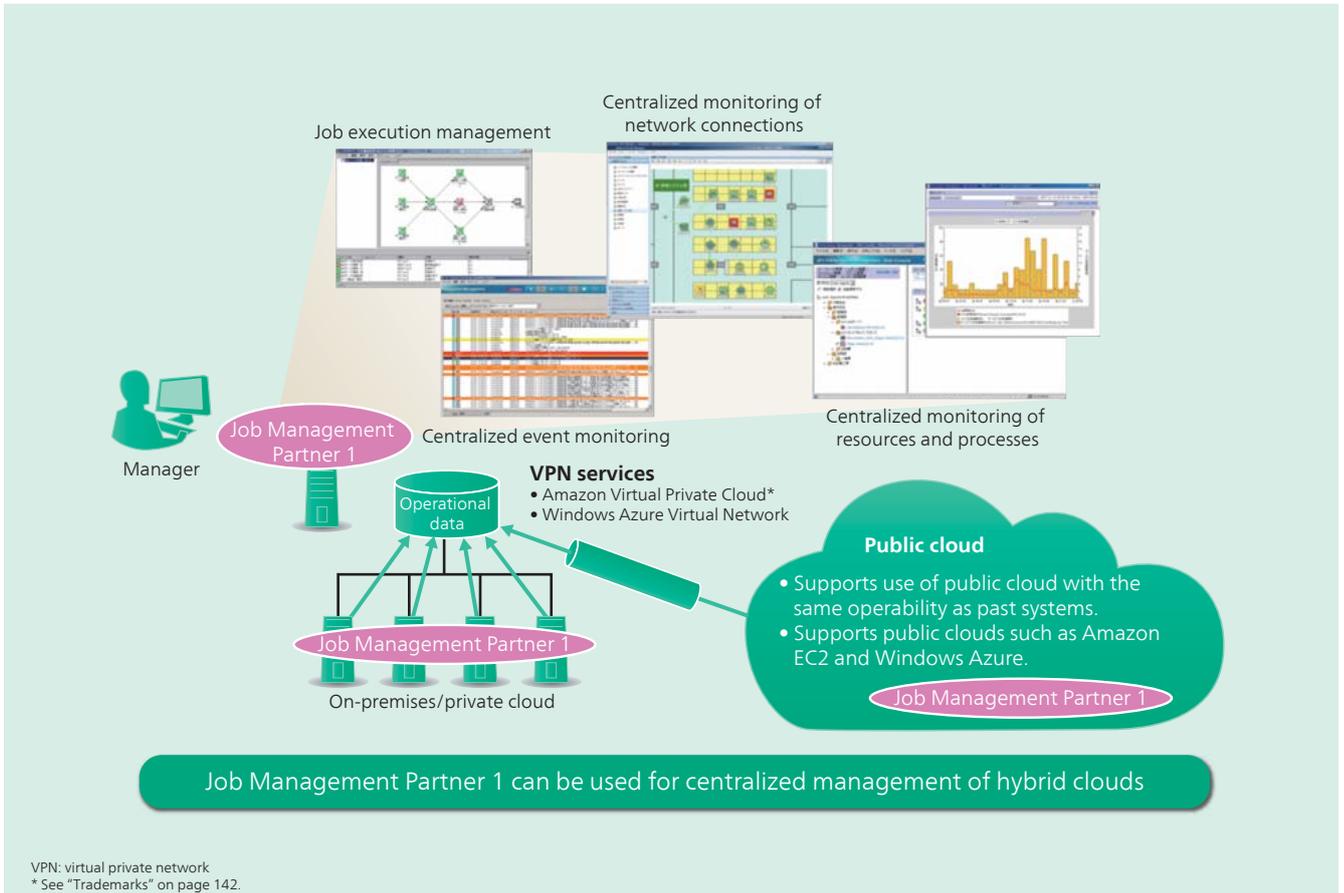
Hitachi Data Ingestor (HDI) offers a solution to this problem. As well as supporting use as conventional network-attached storage (NAS), HDI can also be integrated with Hitachi Content Platform, which provides backup or archive storage at data centers. By providing a means for the automatic consolidation and centralized management of unstructured data, it can also serve as a cloud on-ramp solution. This overcomes the problems of having to administer each site and to deal with the complex storage system, capacity upgrade, and data management issues associated with conventional NAS as the quantity of data increases.

In April 2013, the HDI content sharing model was enhanced by adding the ability to synchronize the content of home directories between HDI located at different sites. Through this mechanism, users can access the latest content stored in their home directories from any HDI system that is part of the content sharing network.

## 9 Job Management Partner 1 V10.1 Integrated Systems Management

The wholesale adoption by corporations of private and public clouds has raised the issue of how to boost the efficiency of IT operations in a hybrid cloud environment.

To provide more efficient operation of the cloud and data centers, Hitachi has enhanced Job Management Partner 1/Automatic Operation, a platform for automation of IT operations of the Job Management Partner 1 V10.1 integrated systems management suite. Job Management Partner 1/Automatic Operation Contents Set is a collection of automation templates based on Hitachi's operational paid know-how. It has been extended by the addition of new automation templates covering basic operating procedures, such as adding or deleting virtual servers, that are a necessary part of daily operations. In addition to VMware\*, Job Management Partner 1/Automatic Operation Contents Set can now also be used in Hyper-V\* environments. Hitachi also has plans to add automation templates for



VPN: virtual private network  
 \* See "Trademarks" on page 142.

9 Use of Job Management Partner 1 for centralized management, including public clouds

OpenStack\*, an open source cloud platform. Another enhancement is a new graphical user interface (GUI) editor for creating or customizing automation templates that simplifies the task of detailed operational automation.

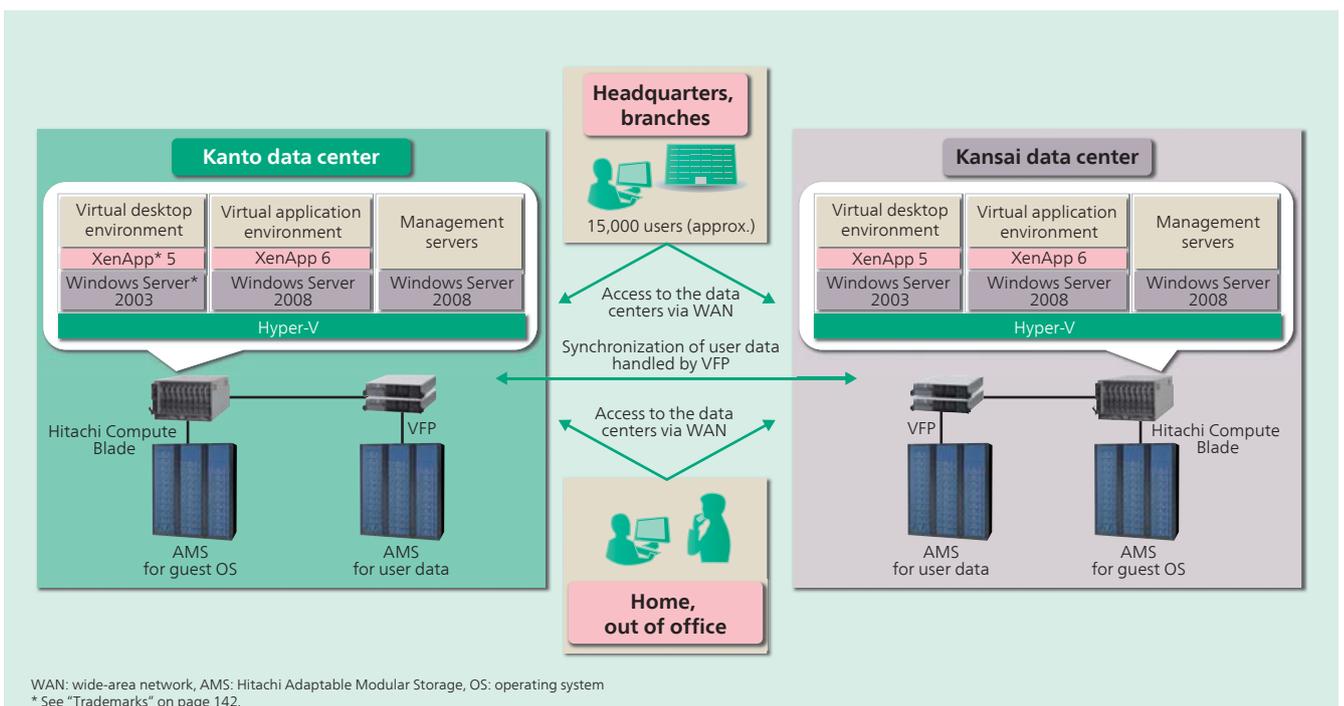
Job Management Partner 1 also supports public clouds such as Microsoft\* Windows Azure and Amazon Elastic Compute Cloud\* (Amazon EC2\*). Hitachi intends to continue delivering efficient operation through the centralized management of hybrid

clouds that combine private, public, and on-premises systems.

\* See "Trademarks" on page 142.

10 Virtual Desktop Environment for Sompō Japan Insurance Inc.

A large virtual desktop environment that incorporates Hitachi platform products and is used by approximately 15,000 staff at the



WAN: wide-area network, AMS: Hitachi Adaptable Modular Storage, OS: operating system  
 \* See "Trademarks" on page 142.

10 Virtual desktop environment for Sompō Japan Insurance Inc.

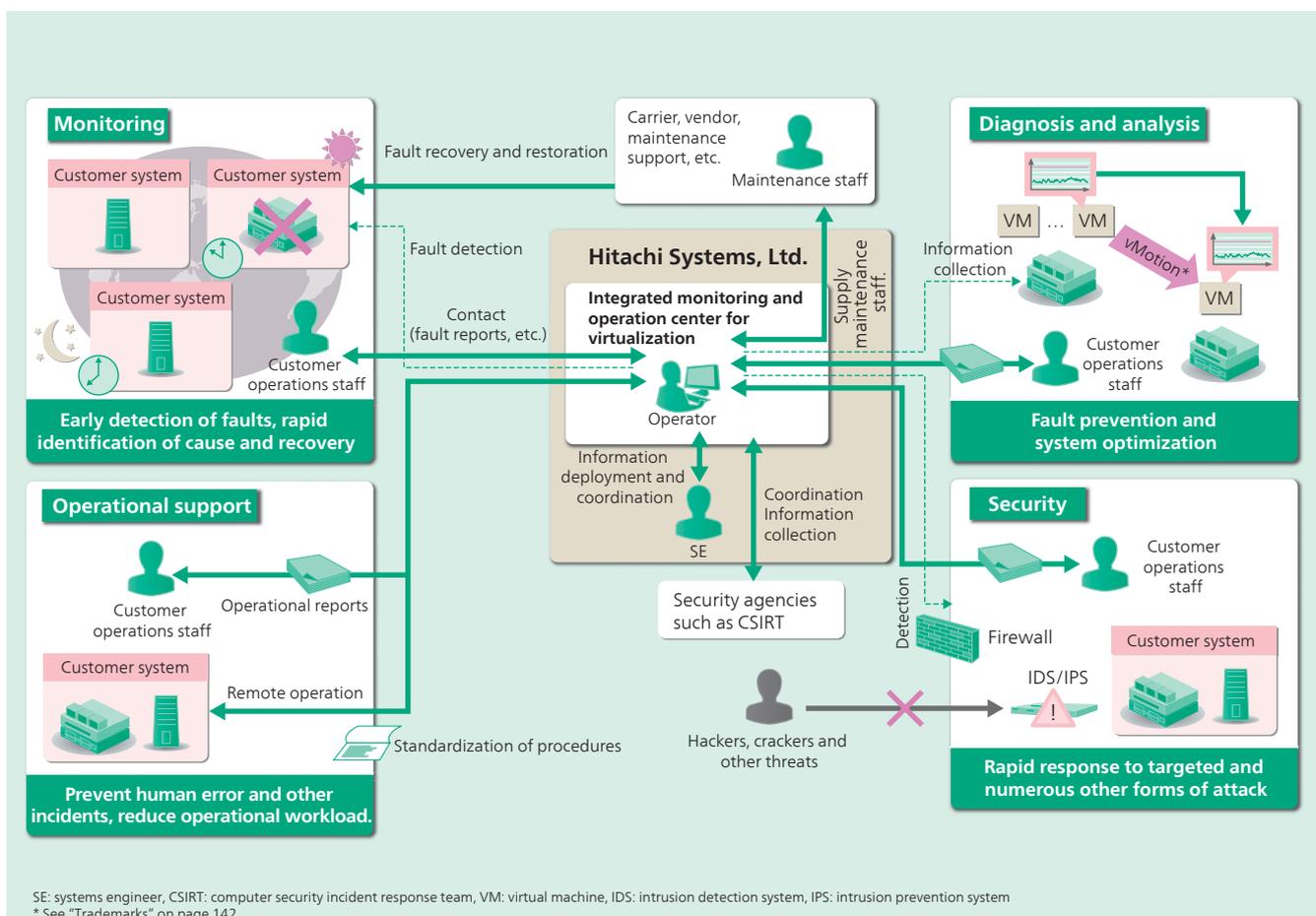
headquarters and branches of Sampo Japan Insurance Inc. entered full-scale operation in 2013. In addition to strengthening IT governance, the environment also delivers improved security and facilitates different ways of working to empower sales staff working out of the office and make them better able to deal with customers. The desktop environment also enhances business continuity because its operation has been consolidated at two data centers in the Kanto and Kansai regions respectively, so that in the event of one of the centers being disabled by a natural disaster, operation can continue using the other. With a merger between Sampo Japan Insurance Inc. and Nipponkoa Insurance Co., Ltd. planned for September 2014, an expansion of the system to cover approximately 38,000 users is scheduled to occur during FY2014. This will include approximately 10,000 personal computers (PCs) used by the headquarters and branch systems of Nipponkoa Insurance Co., Ltd., and a virtual application environment for approximately 13,000 PCs to be used by the new merged company for damage survey.

The current system includes 15,000 mobile thin client terminals that feature thin profiles and long battery life, 400 blade servers (Hitachi Compute Blade) for the data centers that host the desktop environment, and storage systems including Hitachi Virtual File Platform (VFP). It uses Job Management Partner 1 to manage system operation. VFP is used to synchronize user data between the two data centers and ensure business continuity in the event of a disaster.

## 11 Integrated Monitoring and Operation Service for Virtualization

With the growing globalization of business in recent years, virtualization has been widely adopted as a means of ensuring business continuity and the effective use of resources for core mission-critical systems and networks as well as for more peripheral systems. In contrast to the physical configurations used in the past, faults in virtualization platforms tend to have a wider impact extending across a number of systems. Along with greater use of multi-vendor and multi-platform configurations, this has made their management more sophisticated and complex. Other factors that are growing in importance include the ability to achieve a quick recovery when faults do occur, optimization of resources, security measures for dealing with targeted attacks, and the automation and standardization of operating procedures. Accordingly, there is a need for measures that help maintain reliable system operation, including operations monitoring to predict performance problems before they happen and identify the causes of faults quickly.

In response to these requirements, Hitachi Systems, Ltd. supplies a one-stop integrated monitoring and operation service for virtualization with 24-h/365-d operation that includes monitoring, diagnosis/analysis, security, and operational support services designed for use with platform virtualization technologies. (Hitachi Systems, Ltd.)



11 Overview of integrated monitoring and operation service for virtualization

# Network Systems

## 1 Hitachi's Network Products

The spread of smartphones, faster networks, and the growing use of cloud computing in recent years has seen the emergence of a variety of services delivered via networks. As these services transform people's lives and corporate activity, the networks that underpin them have become an important part of the social infrastructure. Now that networks, in their role as social infrastructure, support greater diversity in people's way of life and improvements in business efficiency and productivity, there is a need not only for high performance and reliability, but also for innovation in platforms that create new value.

In response to these changes, Hitachi is contributing to the construction of networks that provide safe and secure social infrastructure while also acting as platforms for the creation of new value by supplying solutions and other products both for telecommunications carriers and for the corporate sector.

For telecommunications carriers, Hitachi develops and supplies new solutions and other products that incorporate the latest technologies such as wireless access, wide-area network (WAN) virtualization, and big data processing. Its aim is to create the network systems that are forming a new highly reliable ecosystem encompassing not only telecommunications carriers, but also extending to service providers and end users. For the corporate sector, Hitachi is supporting the establishment of networks that help improve business efficiency and productivity and enhance corporate competitiveness by developing and supplying network solutions and appliance products that incorporate such technologies as data center network virtualization and cloud computing.

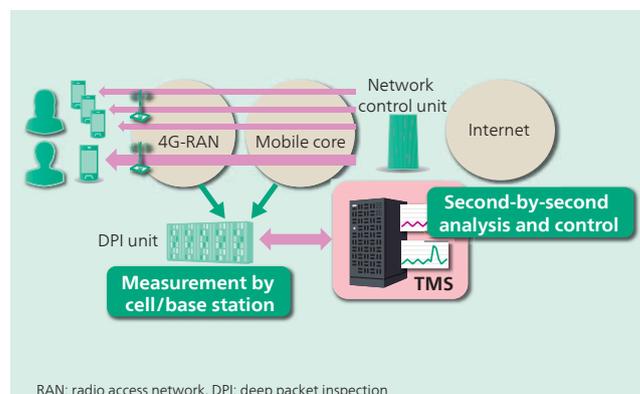
## 2 Traffic Management Solutions

The explosion in the volume of telecommunications traffic that has come with the widespread use of smartphones has complicated the task of equipment design for carriers. Traffic management solutions (TMSs) help build high-quality networks that maximize use of resources by monitoring the overall network and controlling traffic accordingly.

The main features are as follows.

### (1) Fusion of network technology and big data products

Hitachi possesses both diverse know-how that extends from the design to the operation of telecommunication networks, and software that incorporates new techniques such as stream data processing. By combining these resources, the TMS uses the large amounts of traffic data sent across the network to monitor the overall network status and perform traffic optimization.



2 System configuration of TMS

### (2) Network measurement, analysis, and control

This involves the collection of traffic data (measurement), the use of big data platform software for high-speed analysis of large amounts of traffic data (analysis), and the issuing of optimization commands to the network control equipment (control), all in realtime. This allows the TMS to assess and optimize the ever-changing network status instantaneously.

Hitachi has already received feedback from numerous customers about this TMS, which fuses Hitachi's network know-how with big data platform software. An order was received from a Japanese telecommunications carrier in July 2013 for a system for optimizing the traffic according to the congestion state of network equipment. This solution is currently being implemented and Hitachi has plans to build on this experience to deploy the solution at other telecommunications carriers in Japan and elsewhere. In addition to network optimization, Hitachi also has plans for additional functions such as revenue generation and the use of traffic predictions in equipment design.

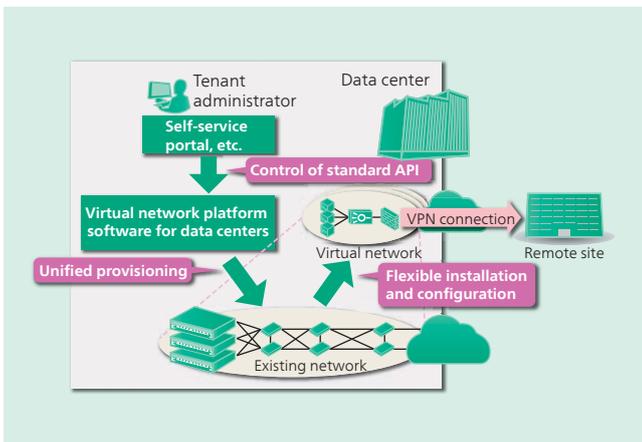
## 3 Virtual Network Platform Software for Data Centers

In terms of enhancing operational efficiency and speeding up service provision, providing those individual tenant administrators who handle their own provisioning with the means to build and configure virtual networks along with virtual servers has become an issue at large multi-tenancy data centers in recent years. In response, Hitachi has been developing virtual network platform software for data centers.

The main features are as follows.

(1) Application programming interface (API) for configuring physical and virtual network equipment is provided, allowing automatic configuration of self-service portals via software.

(2) Simplification of flexible network implementation procedures, including the transparent deployment of firewalls and



3 Overview of how virtual network platform software for data centers is used

virtual private network (VPN) connections to remote sites.

(3) Simplification of software development process for API calling programs through the standardization of the configuration APIs for network equipment such as firewalls, load balancers, and VPN hardware.

In addition to extending the range of network equipment that can be configured via the software, Hitachi also plans to incorporate additional functions such as traffic monitoring and analysis.

## 4 M2M Cloud Network Solution

This machine-to-machine (M2M) cloud network solution was developed by combining technology and know-how that Hitachi has acquired through the implementation of sensor networks and other large networked systems. It supports all aspects of M2M systems, through installation, operation, and maintenance.

The main features are as follows.

(1) Supports a wide range of customer needs, from starting small

to short development period before launch, by providing a single solution that combines communication nodes capable of housing a variety of different sensors, concentrators that take advantage of a high level of consolidation, and cloud services for things like node control and data collection and viewing.

(2) Flexible system operation achieved through features that include an automatic registration of sensors to reduce the workload associated with device configuration and portable data collection devices that can operate in locations not covered by public wireless networks.

(3) System maintenance environment that supports the centralized management and monitoring of large numbers of sensors and the data they collect through features that include the display of information on the operational status of sensors, alarms for notifying when problems occur, and remote control functions.

In the future, Hitachi intends to develop the solution into an M2M communication platform that can be shared by customers from a range of different industries.

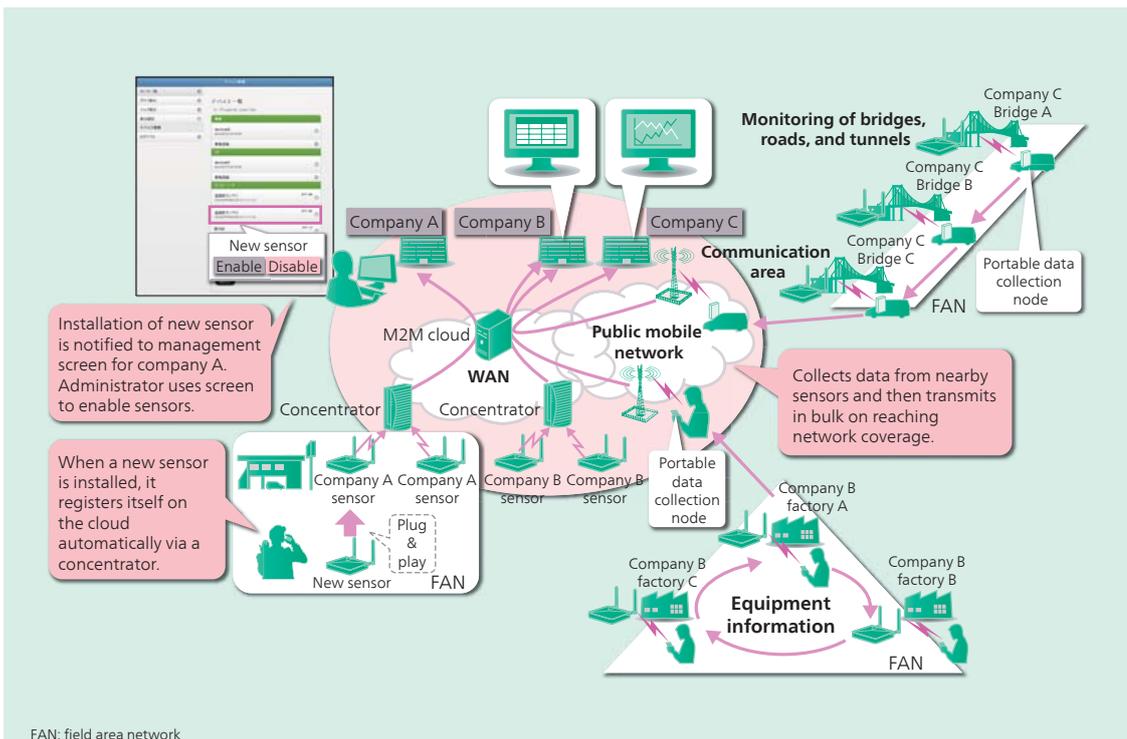
## 5 Hitachi Network Products Design Suite

Hitachi Network Products Design Suite is a comprehensive solution package of reference design, hardware, and software for building next-generation network products. Hitachi Network Products Design Suite helps simplify the product development process while enabling designers to concentrate their efforts on core competencies and differentiation of new products.

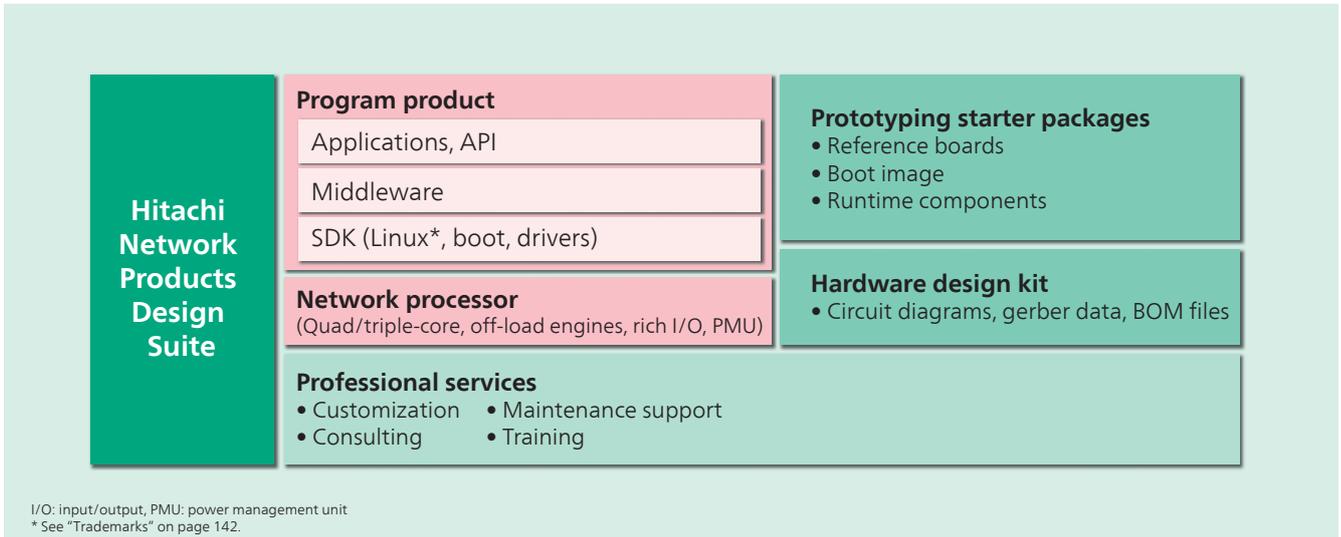
This package offers the following elements.

(1) Program Product: this consists of applications developed for various types of products, a software development kit (SDK), and middleware.

(2) Prototyping Starter Packages: these packages support prototyping and evaluation by providing reference boards, boot image,



4 Overview of how M2M cloud network solution is used



5 Main elements of Hitachi Network Products Design Suite

and runtime components as an integrated package needed in early-stage development.

(3) Hardware Design Kit: this consists of a network processor developed for communication and networking products, schematic diagrams, bills of materials (BOM), and other reference design manufacturing information for various types of products that use the network processor.

(4) Professional Services: these include hardware and software customization, porting, driver development and tuning, product design, technical support for testing, maintenance support, consulting, and training.

In the future, Hitachi intends to continuously help speed up development of network products along with enhancement of Hitachi Network Products Design Suite reference designs.

and LTE-Wi-Fi\* access points.

The main features are as follows.

(1) Evolved Packet Core (EPC)

This supports both LTE and TD-LTE. Its component parts include a Mobility Management Entity (MME) that handles mobility functions such as device handover, a Serving Gateway (S-GW) that handles the transfer of data packets to and from base stations, and a Packet Data Network (PDN) Gateway (P-GW) that handles connection to the external packet network (internet) and related functions such as Internet Protocol (IP) address allocation.

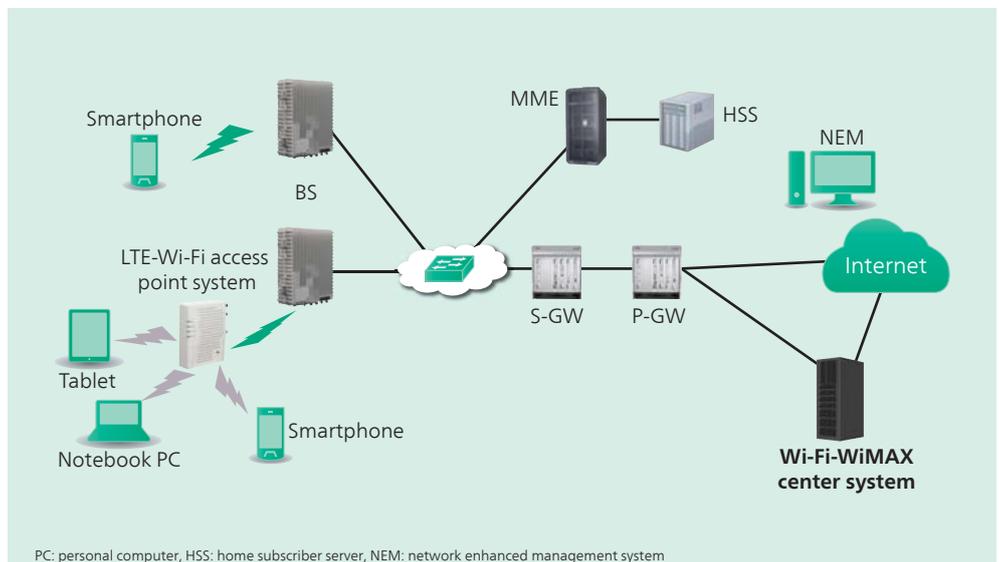
(2) Base station (BS)

This simplifies installation by providing a single housing of baseband and radio parts that is robust enough for outdoor installation and combines a high-output (80 W) radio unit with a highly integrated signal processing unit. The signal processing unit supports 2 × 20 MHz, 4 × 4 multiple-input and multiple-output (MIMO), and dual-mode (WiMAX\* and TD-LTE) operation. Features include smaller size and lighter weight thanks to significant reductions in power consumption achieved through improvements in amplifier efficiency.

(3) LTE-Wi-Fi access point system

## 6 TD-LTE System

In response to the rapid increase in the volume of mobile data traffic for devices such as smartphones and tablets, Hitachi has developed a range of Time Division-Long Term Evolution (TD-LTE) products that include center systems, base stations,



6 TD-LTE system

To facilitate data offloading, this provides a secure Wi-Fi service for buses and other forms of public transportation that uses a number of different wireless protocols (WiMAX, LTE, and TD-LTE) for the backbone link. A feature of Wi-Fi is that it operates in the 2.4 GHz and 5 GHz bands and can support a total of 200 users.

In the future, Hitachi intends to expand the functions of the system through the use of network virtualization techniques to ensure scalability, and cauterized self-organized network (C-SON) control to improve wireless network efficiency through autonomous control.

\* See "Trademarks" on page 142.

## 7 High-capacity Packet Transport System

Factors such as mobile communications for smartphones or the communications with data centers associated with cloud computing are behind ongoing increases in network traffic volumes. The cloud is also driving up the level of reliability expected from networks. To deal with this increase in communication volumes and satisfy demand for higher network quality, Hitachi has developed the packet transport system and its associated operating system. The packet transport system is targeted at telecommunications carriers and is capable of hosting a variety of services using multi-protocol label switching (MPLS).

Its main features are as follows.

- (1) High-capacity packet switch able to handle 1.6 Tbit/s
- (2) Enhanced network reliability and quality through monitoring of all communication paths using operation, administration, and maintenance (OAM) functions that interoperate with customer-premises equipment.
- (3) Comprehensive quality of service (QoS) function that provides reliable traffic quality on a service-by-service basis.
- (4) Faults on the network can be isolated easily using the various test functions provided.

In the future, Hitachi intends to add support for network virtualization as well as adding additional interfaces and new functions for hosting various services and access networks.

## 8 Model-driven BSS Development Solution

The increasingly competitive telecommunications business means that companies need to keep ahead of their competitors by offering attractive service plans that combine different services at competitive prices, such as the convergence of mobile and fixed-line services or interoperability with add-on services. For the business support systems (BSSs) that provide system-based support for service sign-up, contract administration, and billing, the challenge confronting telecommunications operators is how to speed up the provision of new services by shifting from stand-alone BSSs that implemented specific telecoms services to an integrated BSS that provides a one-stop shop for consolidating the introduction and withdrawal of a variety of different services so that they can accelerate the rollout of their service strategies. However, if the development of an integrated BSS were to continue along the same line as the development methods used on standalone BSSs, the result would be a lack of flexibility and difficulties in shortening development times and cutting costs.

The model-driven BSS development solution is intended to overcome these problems in the development of integrated BSSs. It provides new development methods that make BSS development and integration more efficient and allow telecommunications operators to implement their innovative services in a timely manner.

The elements that make up the service are as follows.

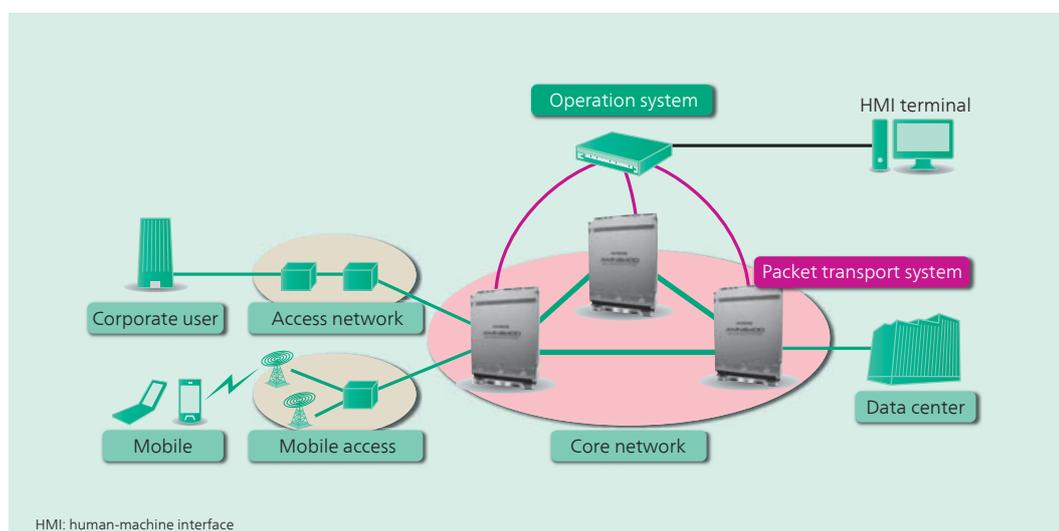
- (1) Model-driven BSS platform

This is a BSS application development platform that uses the BSS work flow and data model as a base. It allows rapid service development, expansion, and integration by utilizing advanced modeling techniques for the consistent design of a variety of different services.

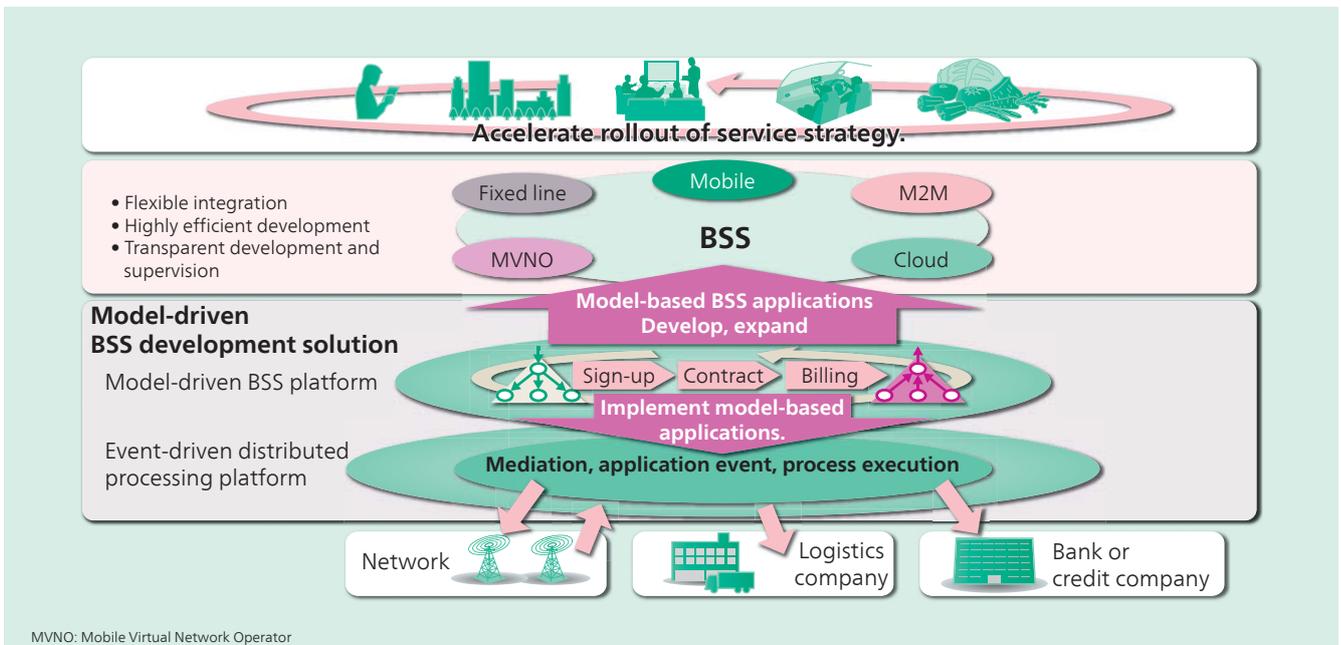
- (2) Event-driven distributed processing platform

This platform controls the distributed execution of model-based business processes. It supports flexible system up-scaling in response to service expansion or modifications.

By gaining experience through the development of BSS application sets that incorporate portal screens for LTE data communications services and provisioning functions for network



7 High-capacity packet transport system



8 Model-driven BSS development platform

equipment, Hitachi plans to make the implementation of BSSs for specific industries even faster by developing BSS application sets for various industries, including M2M and cloud applications.

## 9 Cloud Communication Service

Cloud communication service is a cloud-based voice service that enables telephony systems to be implemented quickly in a way that minimizes up-front investment and management costs by avoiding the need for companies to own the required equipment themselves.

The main features are as follows.

- (1) In addition to a standard telephony service that provides extension lines for a monthly fee, the options also include a high-reliability service that features redundancy in the call control functions and a high-security service based on VPN connections that uses a closed network to ensure security.
- (2) A unified communication (UC) portal service that integrates with a personal address book, which groups together frequently called people, and a presence function that indicates whether the

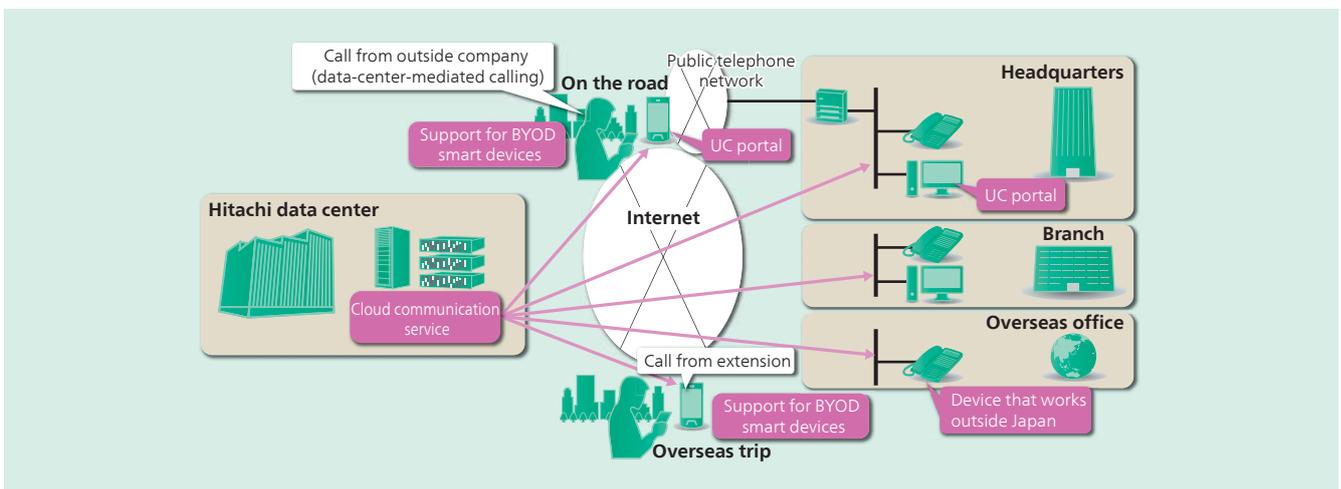
person you want to call is currently has another call in progress, for example.

(3) To allow for users who want to use their own phones [bring your own device (BYOD)], the service handles allocation of billing for personal and private calls, and supports data-center-mediated calling in which calls are first terminated at the data center so that the company telephone number can be passed to the call recipient. For Android\* smartphones, the service can also manage data such as the user's phone book or incoming and outgoing call records centrally at the data center to prevent the leaking of information should the phone be lost.

(4) Smartphones and similar devices can be used to make calls via the internet from overseas locations such as company offices to a company extension. This reduces the cost of using the phone overseas and helps with company globalization.

In the future, Hitachi intends to improve the service further by meeting increasingly diverse user and market needs, and by enhancing UC functions to expand compatibility with various other communication functions.

\* See "Trademarks" on page 142.



9 Overview of cloud communication service



10 Hitachi WAN Accelerator Office Model

## 10 Hitachi WAN Accelerator Office Model

The performance of transmission control protocol (TCP) communications can be reduced significantly due to round-trip delay time and packet loss<sup>\*1</sup>. The Hitachi WAN Accelerator Family uses a proprietary Hitachi algorithm to optimize the TCP data transfer performance and maximizes the use of physical WAN bandwidth. Hitachi WAN Accelerator Family dramatically improves business productivity by reducing the data transmission time for large data that is updated frequently, which is difficult to optimize with typical caching technology.

Hitachi has added a new Hitachi WAN Accelerator Office Model to its Hitachi WAN Accelerator Family lineup. Hitachi began selling this new Office Model on June, 2013. It is priced below current models and targeted at relatively small offices such as domestic and overseas branch offices and development sites. Optional licenses can also be added to incrementally upgrade the maximum TCP session<sup>\*2</sup> performance and optimized WAN capacity per device. This allows a flexible response to changes in network environments after the model has been introduced.

Hitachi provides a wide product lineup to respond flexibly to a variety of corporate applications and existing communications environments.

\*1 Packet loss: a packet is a small package of data used in computer communications that includes control information such as the destination address. Packet loss occurs when data is lost within a network and fails to arrive at the destination.

\*2 TCP session: a unit for communication via TCP.

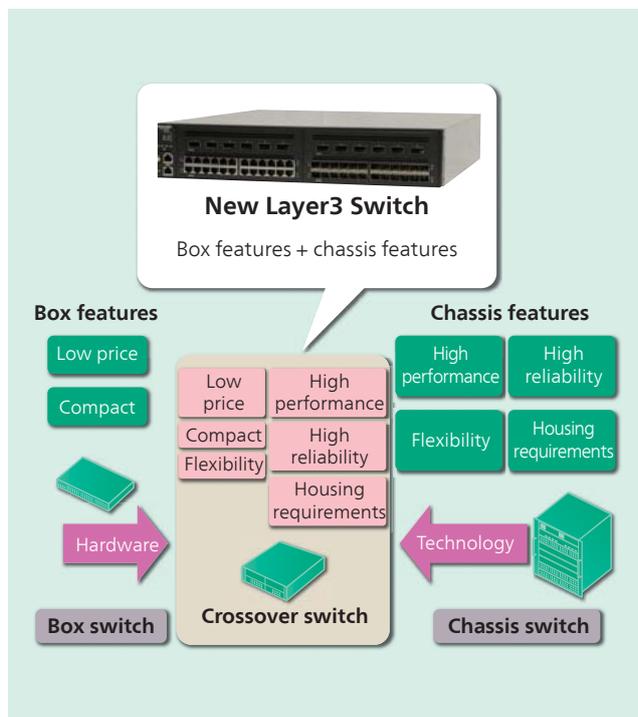
## 11 Crossover Switch

New Layer3 Switch is based on the new concept of a compact crossover switch with high cost-performance that also has the flexibility and expandability of a chassis switch.

The main features are as follows.

### (1) Performance

Superior specifications to chassis products



11 Crossover switch

- Maximum switching speed of 1.92 Tbit/s (to be upgraded to 2.24 Tbit/s from FY2014)

- Housing requirements suitable for use as core switch in large network

### (2) Flexibility

Can be configured as required from a choice of four interface modules.

- 24 × 1 G ports [unshielded twisted pair (UTP)]

- 24 × 1 G/10 G ports [small form-factor pluggable (SFP)/SFP+]

- 24 × 1 G ports (SFP)

- 6 × 40 G ports [quad SFP+ (QSFP+)] (to become available from FY2014)

### (3) High-density port housing

A large number of high-speed lines can be installed in a 2U<sup>\*1</sup> housing.

- 1 G/10 G: up to 96 ports

- 40 G: up to 28 ports (to become available from FY2014)

### (4) Reliability

- Full support for the layer 3 functions required for core switch in corporate network

- Virtual redundant system (VRS) function<sup>\*2</sup> provides device redundancy.

In the future, Hitachi plans to use the platform capabilities of the New Layer3 Switch to expand the scope of crossover switching.

\*1 1U is approximately 44.45 mm.

\*2 Function for connecting together two physical switches so that they operate as a single virtual switch

# Energy Solutions

## 1 Hitachi's Energy Solutions

The circumstances under which energy infrastructure operates are becoming more diverse at the national, regional, and environmental level.

The major centers of demand for energy infrastructure are shifting from developed to emerging economies. Although growth in demand is anticipated, few emerging economies have established a grand design for their energy policies, and financial frameworks in many cases are weak. This means that proposals need to include financing. Furthermore, energy policies need to be formulated on a comprehensive basis, encompassing not only economics but also safety assurance and the environment. It is also essential to consider consistency with these energy policies when offering to supply infrastructure in the form of a solution. There is often more than one way of implementing energy policy, with a number of different solutions possible depending on which factors are prioritized. As it is anticipated that emerging economies will experience ongoing urbanization and the concentration of population, there is a need for efficient (smarter) operation of the energy infrastructure. In developed economies, meanwhile, there is a shift away from coal and toward gas turbine combined cycle (GTCC) and renewable energy in response to the shale gas revolution and growing interest in environmental protection. Also ongoing is a reorganization of power systems to achieve separation between generators and transmission businesses.

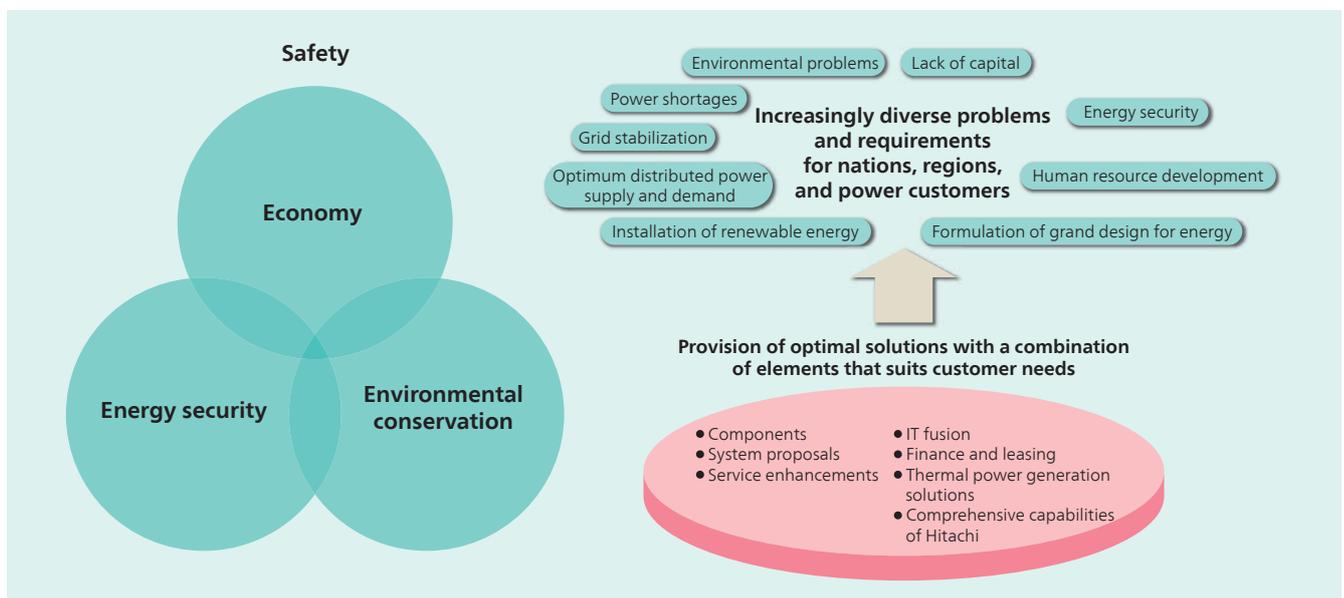
What is needed, then, is to look at power systems in terms of the "3Es + S," meaning not only economics but also energy

security and environmental conservation (3Es), and also safety (S), the prerequisite for achieving these. In particular, an important aspect of achieving energy security is the establishment of an appropriate energy mix that does not rely on a single source of energy. Key aspects of improving environmental conservation, meanwhile, include compliance with restrictions on the emission of the carbon dioxide (CO<sub>2</sub>) implicated in global warming, and the installation of renewable energy sources such as photovoltaic or wind power generation.

To resolve these complex issues that are closely tied up with increasingly diverse social needs, it is necessary to collaborate on identifying the issues faced by customers and other parts of society and to offer order-made solutions.

It is these needs that the energy solutions supplied by the Power Systems Company of Hitachi, Ltd. are intended to satisfy. In addition to enhancing components, systems, and services sourced from both inside and outside Hitachi, fusing these with information technology (IT), and offering leasing or other financing arrangements, Hitachi intends to propose comprehensive solutions that include the thermal power systems supplied by the new company formed through a business integration with Mitsubishi Heavy Industries, Ltd. that commenced operation in 2014.

Hitachi intends to accelerate its activities as a solution provider based around its comprehensive capabilities (which include IT, logistics, and finance) working flexibly in tandem with interested parties from outside the company, and by establishing dedicated teams to survey the problems faced by society and the wants and needs of customers, to plan and devise solutions, and to coordinate the providers of the different components.



1 Overview of "3E + S" (left) and energy solutions (right)

# Power Generation Equipment and Systems

## 1 New Technology for Taking Maximum Advantage of Hydro Energy

Hitachi supplied the turbines (used to drive generators supplied from the UK) at the Bhakra Power Station in India that commenced operation in 1959. In January 2008, a new order was received for the large-scale refurbishment of the five Francis turbines, which by then were nearly 50 years old.

The overhaul of the first turbine (Unit 2) commenced in April 2010. Due to cumulative delays at the site, the turbine did not resume operation until July 2013, followed by a second turbine (Unit 5) in October 2013. The refurbished turbines are currently in full commercial operation. Refurbishment is also planned for the remaining turbines, with work on a third (Unit 4) already underway on site.

By updating the runners, which were produced for the refurbishment using optimal design and have a forward-swept blade configuration (in which the shroud end of the inlet side of the blade is forward of the crown end relative to the direction of rotation), and the guide vanes, Hitachi succeeded in significantly increasing turbine efficiency. Similarly, increasing the output of individual turbines by 16.6 MW, and total output by 83 MW, is expected to make a major contribution to the tight electric power supply situation in India. Also, whereas the old runners had been periodically repaired to fix cavitation damage, the significant improvement in cavitation bubble formation characteristics in the relevant locations means that the upgraded runners will have

a longer operating life with less frequent repairs.

The specifications of the refurbished turbines are as follows.

Effective head: 134 m (normal)

Turbine output: 128 MW (max.)

Speed: 166.7 min<sup>-1</sup> (rated)

(Hitachi Mitsubishi Hydro Corporation)

## 2 Latest Switchboard Upgrade Technology for Hydro Power Plants

Hitachi has developed the G-HIACS\* and deployed it in plant upgrades such as the unit 1 automatic control system of the Numappara Power Plant of Electric Power Development Co., Ltd. and the supervisory control system of the Shin-Nariwagawa Power Station of The Chugoku Electric Power Co., Inc. After commencing on-site installation in October 2013, these projects have now completed commissioning and are in operation.

Compared to the previous HIACS\* series, G-HIACS features enhancements to maintenance tools in particular. Its main features are as follows.

(1) Enhanced ability to analyze what is happening when faults occur in sequence operation due to an upgrade to the trend monitor to support recording of approximately 100 data points at the computational cycle time (100 ms), compared to 48 points at 1-s intervals previously.

(2) Enhanced quality through logic debugging and easier simulation of key equipment and control devices thanks to the addition



1 128-MW Francis turbine for Bhakra Power Station in India



2 Unit 1 automatic control system of the Numappara Power Plant of Electric Power Development Co., Ltd.

to logic simulator mode of a function for specifying the changes in analog signals and a one-shot function for digital signals.

The ND series of unit-type protection relays were used to upgrade the protection systems for the Unit 4 motor-generator at the Shin-Nariwagawa Power Station of The Chugoku Electric Power Co., Inc. These comply with the B-402 electric power standard and IEC 60255 international standard, with features that include the ability to enable or disable the relay elements, select wide-band frequency characteristics, and customize the protection interlock circuit.

(Hitachi Mitsubishi Hydro Corporation)

\* HIACS and G-HIACS are trademarks of Hitachi, Ltd.

### 3 Characteristics Improvement through Use of CFD in Runner Upgrade

Hitachi Mitsubishi Hydro Corporation used computational fluid dynamics (CFD) analysis to develop a turbine runner that features improved efficiency and reduced wear due to sediment abrasion for the 23,300-kW Francis turbine at Unit 1 of the Himekawa No. 7 Power Station of The Tokyo Electric Generation Co., Inc. The plant commenced operation with the upgraded runner in March 2012. The upgrade used a runner that was developed using a shape design technique involving the use of a solid-liquid two-phase flow analysis that modeled the flow of sediment to assess those intricate parts of a runner that are difficult to protect from sediment abrasion using surface treatments such as thermal spraying. An inspection conducted after nine months of use in December 2012 found no sediment abrasion. The upgraded runner is scheduled to be installed on Unit 2 in February 2014.

The 35,000-kW Francis turbine at the Shin-Inotani Power Station of the Hokuriku Electric Power Company commenced in May 2013 after a runner upgrade to improve cavitation characteristics was undertaken using CFD analysis. The turbine uses a

runner with forward-swept blades in which the blade shape twists three-dimensionally and has a shape that prevents the formation of the localized pressure drops associated with cavitation. Use of this runner shape has resulted in stable operation.

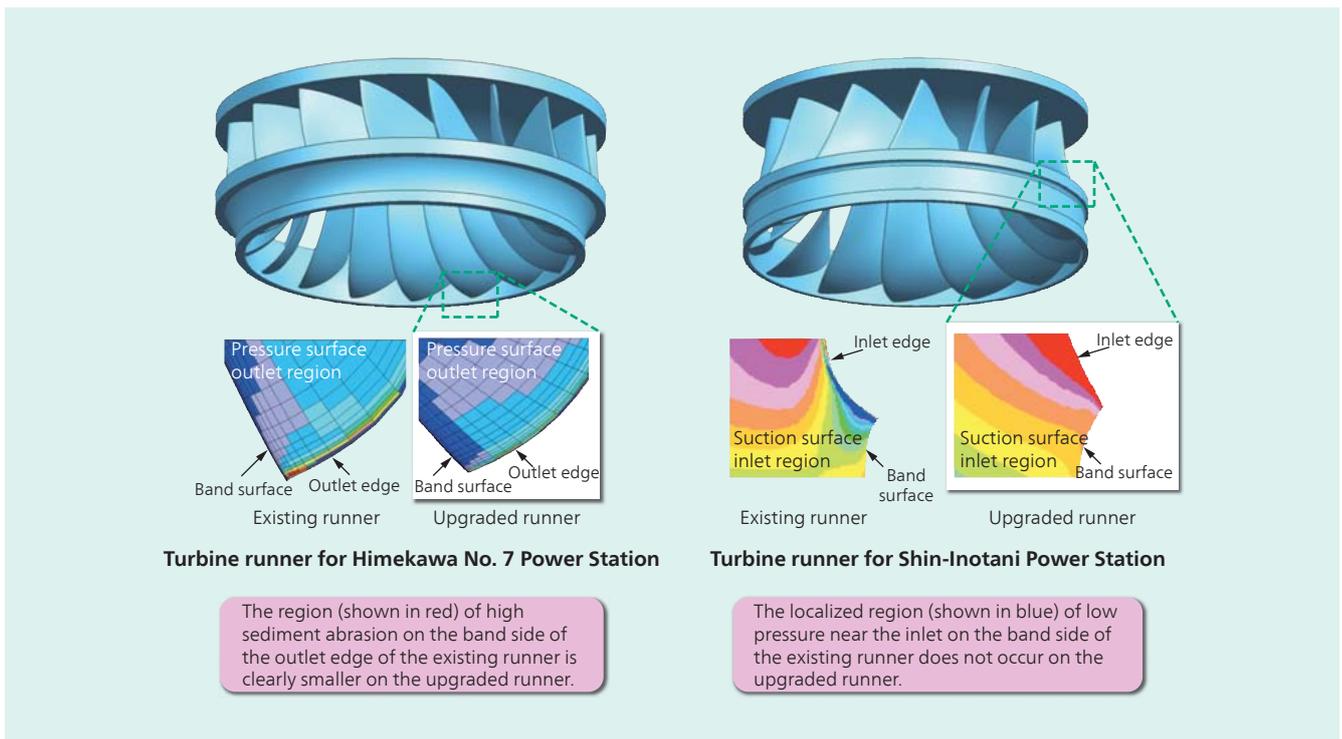
(Hitachi Mitsubishi Hydro Corporation)

### 4 Orders for Emergency Repair of Jebba Hydro Power Plant in Nigeria and Rehabilitation of Baluchaung No. 2 Hydro Power Plant in Myanmar

Although the Jebba Hydro Power Plant in the Federal Republic of Nigeria plays an important role, accounting for approximately 15% of the nation's generation capacity, it is currently operating at about half-capacity due to damage to the No. 4 generator incurred after an accident on the power grid in 2009. In December 2012, Hitachi Mitsubishi Hydro Corporation tendered for the emergency repair of the plant and was awarded a contract for the project based on its proposal to refurbish the plant's existing Hitachi, Ltd. equipment. The on-site refurbishment work is planned to take a minimum of eight months, from March to October 2014.

The Baluchaung No. 2 Hydro Power Plant in Republic of the Union of Myanmar accounts for approximately 10% of the nation's generation capacity, and thanks to its abundant water resources, operates as a reliable year-round, base-load generator. However, progressive aging and deterioration of the plant's equipment due to continuous operation since it entered service in 1960 means there is a need to repair and replace the equipment in the near future. Tendering for the rehabilitation project took place in June 2013, with Hitachi Mitsubishi Hydro Corporation being awarded the contract based on its proposal to refurbish the plant's existing Hitachi equipment. The plan is to perform on-site repairs and replaces to a total of six units from July 2014 to March 2016.

(Hitachi Mitsubishi Hydro Corporation)



3 Upgraded runner shape and improvements made through use of CFD



4 Interiors of the Jebba Hydro Power Plant in Nigeria (top) and the Baluchang No. 2 Hydro Power Plant in Myanmar (bottom)

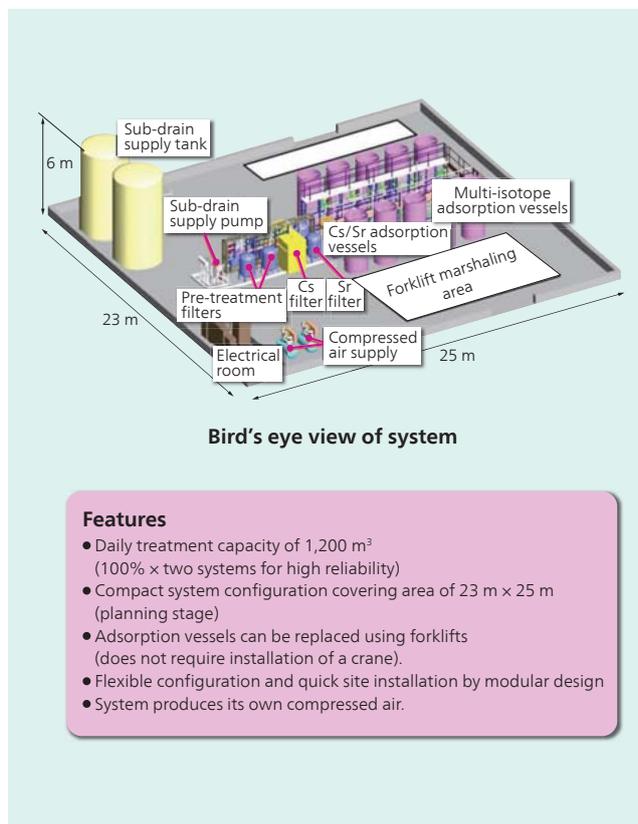
## 5 Sub-drain Water Purification System

There are three levels of contaminated water at the Fukushima Daiichi Nuclear Power Station; highly contaminated water in reactor buildings and turbine buildings, concentrated brine discharged from reverse osmosis (RO) desalination systems, and relatively low contaminated water that has been collected from sub-drains located around buildings. This water has various levels of contamination, and contains a variety of radioactive nuclides that include cesium (Cs-134 and Cs-137), strontium (Sr-89 and Sr-90), and antimony (Sb-125). To respond to this difficult situation, Hitachi-GE Nuclear Energy has developed a contaminated water treatment system specifically for treating sub-drain water.

The main features of the system are as follows.

- (1) Pre-treatment filters including not only conventional filters but also filters that can remove colloids
- (2) Hitachi-GE Nuclear Energy's newly developed superior adsorbent to simultaneously remove Cs and Sr
- (3) A flexible system with a sophisticated modular design to allow a combination of optimum adsorbents from all over the world when multi-nuclide removal is required

The new system will reduce the concentration of radioactive nuclides in sub-drain water to below discharge limits. By installing the system at the Fukushima Daiichi Nuclear Power Station, Hitachi is making a continuing contribution to the treatment of



5 Sub-drain water purification system

contaminated water.

(Hitachi-GE Nuclear Energy, Ltd.)

## 6 Project for Construction of New Nuclear Power Plants in UK

Even after the accident at Fukushima Daiichi Nuclear Power Station, the UK government has stuck to its policy of encouraging nuclear power and is proceeding with the introduction of a feed-in tariff scheme to guarantee the purchase price of nuclear power because of its status as low-carbon energy source. The laws relating to this electricity market reform were introduced into parliament in November 2012 and are scheduled to become law during 2014.

In November 2012, Hitachi purchased all issued stock in the UK nuclear power development company, Horizon Nuclear Power Limited.

Horizon Nuclear Power plans to construct two or three 1,300-MW-class advanced boiling water reactors (ABWRs) at each of its two sites (at Wylfa and Oldbury), with the first reactor scheduled to commence generation in the first half of the 2020s. To this end, the UK's Office for Nuclear Regulation and the Environment Agency embarked on a Generic Design Assessment process in April 2013. Hitachi is also expediting its activities aimed at advancing construction plans at the Wylfa site, including a plant design prepared to UK specifications and the establishment of supply chain management.

By adding a nuclear power business to its existing railway business in the UK, Hitachi believes it can contribute to advances in social infrastructure in the country, including employment.



6 Artist's impression of completed Wylfa Newydd Power Station

## 7 Power Conditioner for Megasolar Power Plants

With sunlight recognized as a form of renewable energy, the number of large photovoltaic power generation systems with capacities greater than 1 MW is growing rapidly. To improve the efficiency and reduce the installation costs for photovoltaic power generation systems, an increasing number of these systems are adopting a direct current (DC) voltage of 1,000 V, the standard outside Japan, in place of the 600 V used in the past.

In response, Hitachi has added the 660-kW power conditioning system (PCS), which can work with DC voltages in the 1,000-V range, to its line-up of PCSs for megasolar power plants. The inverter in the 660-kW PCS uses a three-level conversion circuit with high reverse conversion efficiency. It has a maximum efficiency of 98.8% (at 520 V DC), and is able to maintain high efficiency (98% or more) over alternating current (AC) outputs of between 5% and 90% (at 620 V DC). It also incorporates grid stabilization functions as standard features, including functions for suppressing voltage fluctuations and for adjusting reactive power, including a function for maintaining constant power factor. An outdoor package that includes three 660-kW PCSs has also been added to the product range. The ability to configure a 2-MW-class power generation system using a single outdoor package helps reduce the space requirements and cost of installation.

As it is forecast that photovoltaic power generation systems will

switch to 1,000-V DC operation in the future, growth in demand is anticipated.

(Product release date: November 2013)

## 8 3.0-MW DF Converter for Wind Power Generation

Hitachi has participated in the Chinese market for wind power converters since 2008. Its products for this market have consisted to date of 1.5-MW and 2.0-MW converters for doubly fed (DF) generators and a 2.0-MW converter for permanent magnet generators (PMGs). (The 1.5-MW DF converter commenced operation in October 2010, the 2.0-MW DF converter in July 2013, and the 2.0-MW PMG converter in December 2012).

The newly developed 3.0-MW water-cooled DF converter provides greater capacity than the 2.0-MW air-cooled model, and is a response to demand from the Chinese market for higher capacity wind power generators.

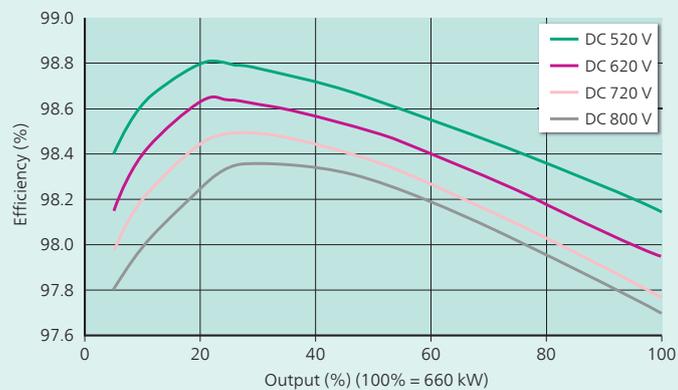
Its main features are as follows.

- (1) Suitable for sites with sudden changes in wind and at which turbines are frequently taken in and out of service
- (2) Able to continue operating through short-duration spikes in the grid voltage (130% of rated voltage for 0.1 s)
- (3) Able to continue operating through short-duration fluctuations in the grid frequency [rated frequency (50 Hz)±10 Hz for 0.5 s (+10 Hz) or 0.2 s (−10 Hz)]
- (4) An independently operating converter connected to the grid can output reactive power.
- (5) 2,415 mm (W) × 600 mm (D) × 2,190 mm (H) (excluding protrusions), weight: 2,600 kg
- (6) Capacity:volume ratio: 1.01 MW/m<sup>3</sup>
- (7) Water cooled: fully enclosed recirculated cooling

In the future, Hitachi intends to build its experience in the renewable energy sector by conducting verification tests of low-voltage ride through (LVRT), also available on the 1.5-MW and 2.0-MW DF models. Additional models are also planned along with deployment in Japan.



**660-kW PCS**  
1,400 mm (W) × 1,000 mm (D) × 1,900 mm (H)



**Example efficiency characteristics (typ.)**

7 Power conditioner for megasolar



8 3.0-MW DF converter for wind power generation

## 9 Large 5-MW Offshore Wind Power Generation System

Demand for renewable energy has been on the rise in recent years, with growing interest in wind power as a source of domestic energy production in Japan. While most of the wind power generation systems currently operating in Japan are land-based, offshore sites typically have higher wind speeds and it is anticipated that they will become more common due to this and other advantages, including being less likely to cause difficulties due to noise or impact on scenery.

Compared to onshore sites, construction of offshore wind farms requires greater investment due to higher costs that include building foundations, installation, and laying undersea cables. Accordingly, using a smaller number of turbines with higher output is seen as a way of improving the profitability of wind farms, and this has led to demand for even larger wind power generation systems than systems in the 2-MW to 3-MW class that are large by the standards of onshore sites.

The 5-MW downwind turbine currently being developed for offshore use not only has a higher output than the previous 2-MW model, it also incorporates a medium-speed gear drive mechanism that combines permanent magnet synchronous generator with a speed-increasing gear with a ratio of approximately 1:40. The system will also help reduce wind farm construction costs thanks to a lighter and more compact nacelle that reduces the over-



9 Large 5-MW offshore wind turbine

turning moment of the downwind turbine and allows a more practical foundation design.

## 10 Megasolar System

Progress has been made in recent years on utilizing renewable forms of energy such as sunlight and wind. In Japan, a feed-in tariff scheme was introduced in 2012 following the passing of the “Act on Special Measures Concerning Procurement of Renewable Energy Sourced Electricity by Electric Utilities” in August 2011. This has led to a rapid expansion in plans for the installation of photovoltaic power generation systems and work is underway throughout Japan on the construction of large systems.

Hitachi has been involved in the development of high-capacity PCSs for large photovoltaic power plants and is anticipating the installation of several hundred megawatts of generation capacity, including a megasolar power plant at Ashikita that commenced operation at the end of 2013 and the 82-MW Oita Mega-solar Power Plant, Japan’s largest class, which is scheduled to start generating power in the spring of 2014.

The Oita Mega-solar Power Plant being built in Oita City, Oita Prefecture to be operated by Oita Mega-solar Power Co., Ltd. will be the largest class such plant in Japan, with a 105-hectare site (1,050,000 m<sup>2</sup>) and generation capacity of 82 MW. It is forecast to generate 87,000 MWh of electric power annually, enough for about 30,000 typical homes. If all of the solar panels in this very large system were laid in a line, they would stretch for approximately 500 km, roughly the distance from Tokyo to Osaka.

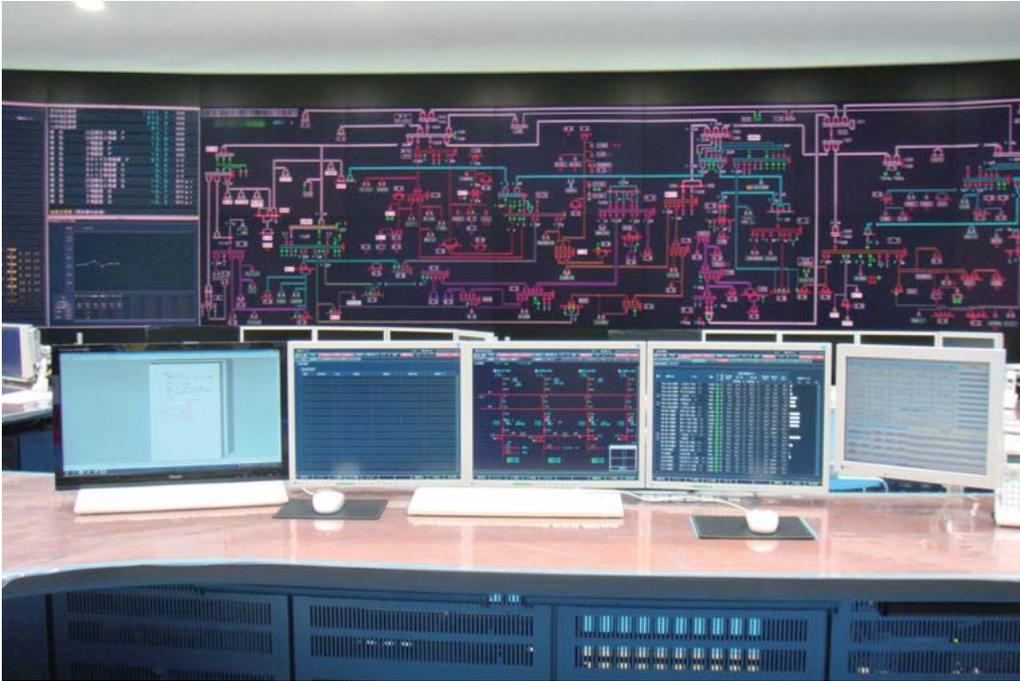
Meanwhile, vigorous efforts are being made to achieve further improvements in the efficiency of the PCS, a core component of photovoltaic power generation. In addition to the existing 500-kW model with a DC voltage of 600 V, Hitachi has also commenced sale of a 660-kW model that can operate at 1,000 V DC. This PCS uses a three-level inverter for a chopper-less design that delivers a world-leading level of conversion efficiency, with a maximum efficiency of 98.8%. Drawing on its past experience in engineering, procurement and construction (EPC), Hitachi is also enjoying strong sales for its package that bundles the main equipment needed for a medium-sized photovoltaic power generation system.

In the future, Hitachi intends to continue operating a broad-based photovoltaic power generation business that extends from medium to large systems, primarily in Japan, while also working aggressively to expand its business in overseas markets.



10 Power plant of SGET Ashikita Mega Solar LLC

# Electric Power Transmission Equipment and Systems



1 Kumamoto Integrated Control Center of Kyushu Electric Power Co., Inc. (control room)

## 1 Kumamoto Integrated Control Center Kyushu Electric Power Co., Inc.

Kyushu Electric Power Co., Inc. is undertaking a full upgrade of its integrated control center systems, and is building the Kumamoto Integrated Control Center System under the supervision of Seiko Electric Co., Ltd. The upgrade will merge two existing integrated control centers, resulting in the new system being responsible for the monitoring and control of generation and substation facilities at approximately 200 sites. The system is currently undergoing final commissioning in preparation for commencing operation in April 2014.

The main features are as follows.

- (1) Very high system reliability. The computer that underpins the online monitoring and control functions has a triply redundant configuration to allow for maintenance or faults, and the computer that handles operational support functions, such as issuing operating command sheets, has a doubly redundant configuration.
- (2) A grid status panel that uses a projector-based display system and is designed to facilitate the effective sharing of information between the staff on duty. This includes grid information such as the constantly changing flow of electric power, and weather information such as thunderstorm warnings.
- (3) Reduced workload for staff on duty. Functions include partial automation of grid reliability monitoring and the preparation of fault recovery procedures and operating orders.

## 2 Enhancements to Generator Protection Relay

In order to protect equipment by, for example, quickly disconnecting a generator from the grid and performing an emergency stop in the event of an internal electrical fault, the generator protection relays used in thermal, hydro, and other forms of power generation require high reliability and the selectivity to accurately detect the faults they are intended to catch. A new multi-function unit-type protection relay developed by Hitachi provides this selectivity and reliability as well as complying with the IEC 60255 international standard. It includes an English-language human interface and has the flexibility for use in a variety of different protection system applications.

The main features are as follows.



2 Unit-type protection relay

(1) Can be customized using engineering tools to perform protection, measurement, and control in ways that are specific to the application. This includes the ability to select the protection relay element and wide-band frequency characteristics, and to build protection sequence circuits.

(2) Designed for use with analysis tools that can perform measurement, oscillography, and event logging for the collection and analysis of grid data.

(3) Compact, swappable design in which the modules required for the protection relay are housed in a single unit case. It also features improved toughness, with temperature characteristics, electromagnetic compatibility (EMC), and seismic ratings that comply with the IEC 60255 international standard.

In the future, Hitachi intends to make the tools more efficient to use and extend the product range to expand the scope of applications.

### 3 Demonstration Smart Grid (Satsumasendai Area) Kyushu Electric Power Co., Inc.

Hitachi is conducting joint demonstrations with Kyushu Electric Power Co., Inc. on a demonstration smart grid built by the power company in Satsumasendai City, Kagoshima Prefecture, Japan that was completed in October 2013.

The demonstration smart grid includes photovoltaic power generation, lithium-ion batteries, a simulated power distribution system (simulated power lines, simulated loads, and voltage regulation equipment), and an energy management system that measures, monitors, and controls the output, voltages, currents, and other parameters of these systems. The total outputs of the photovoltaic power generation system and lithium-ion batteries are 278 kW and 118 kW respectively, and they provide both high-voltage and low-voltage grid connections.

The demonstration project involves using these systems to trial various ways of overcoming the supply and demand and voltage problems that are associated with the connection of large amounts of photovoltaic generation capacity. In the case of supply and demand, this consists of collecting data on parameters such as sunlight intensity and photovoltaic power generation, and battery charging, discharging, and state of charge, and using it to test methods for predicting the output of photovoltaic power genera-



3 Demonstration smart grid (Satsumasendai area) of Kyushu Electric Power Co., Inc.

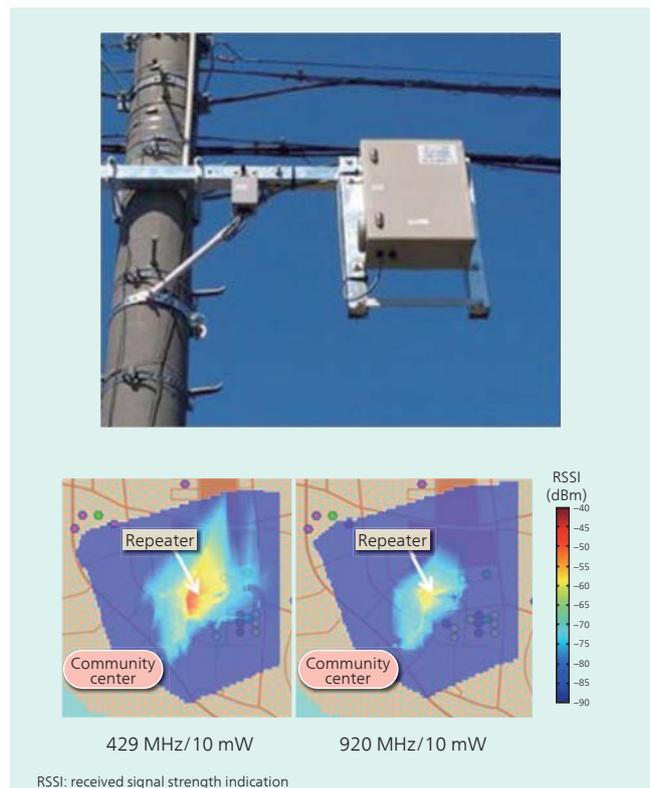
tion and for optimizing control of the batteries. In the case of voltage, the project will test optimized voltage control methods by conducting experiments on the sort of voltage management problems that are likely to occur on future distribution systems, using the simulated load to generate fluctuations in the grid load, and then collecting and analyzing data on resulting power line voltages, currents, and other parameters.

The demonstrations are scheduled to continue until March 2015.

### 4 Demonstration Project for Next-generation Output Control Using Two-way Communication

Since FY2011 Hitachi has been participating in the “Demonstration Projects for Next Generation Power Control Systems by Two-way Communications” funded by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, Japan. The objective of these demonstration projects is to investigate the stabilization of power grids that include extensive photovoltaic power generation. As part of this work, Hitachi is demonstrating the monitoring and control of a power conditioning system (PCS) at Rokkasho-mura in Aomori Prefecture and two other sites, which use a communications system to regulate power output.

Hitachi is trialing a two-way communication system that controls PCS output via specified low-power radio or Japan’s various cellular phone networks. The tests conducted over four periods, starting in December 2012 and covering each of the four seasons, have achieved favorable communications in a variety of weather conditions. By measuring the radio transmission characteristics of the different communication methods, the tests succeeded in combining different forms of radio communication



4 Repeater (top) and radio transmission characteristics (bottom) for specified low power radio

to suit the local conditions.

Through these year-round, long-run trials, the demonstration project indicated that it is possible to implement a communication system that can perform detailed control of PCS output.

## 5 Japan-U.S. Island Grid Project

The island of Maui in Hawaii is by far the most oil-dependent part of the USA, with electricity tariffs three times higher than those on the mainland due to the rising price of oil. It is also a site of rapid progress on the introduction of renewable energy, with plans to replace 40% of total power generation on the island with renewable energy by 2030.

It is against this background that a project has been launched on Maui aimed at supporting the large-scale use of electric vehicles (EVs), maximizing use of renewable energy, and ensuring the security of electric power supply.

Together with the State of Hawaii, County of Maui, Hawaiian Electric Company, Inc., Maui Electric Company, Ltd., The University of Hawaii, and US national research laboratories, Hitachi has been contracted by the New Energy and Industrial Technology Development Organization (NEDO) to participate in its Japan-U.S. Island Grid Project in Maui (project name: JUMPSmartMaui).

Quick charging stations have been installed at five sites around the island, chosen based on an analysis that considered traffic flow and the distances to homes, office districts, and tourist sites. A further 15 stations are planned. In addition to encouraging the wider adoption of EVs by making them easier to use, the project will also establish an energy infrastructure for the island that is not dependent solely on fossil fuels by using the energy storage capacity of EVs for surplus power absorption and to stabilize renewable energy. There are also plans to expand it to include a virtual power plant (VPP) function that contributes to the energy supply and demand balance for the entire island through the inte-

grated management of the decentralized energy resources. (Commencement of operation: December 2013)

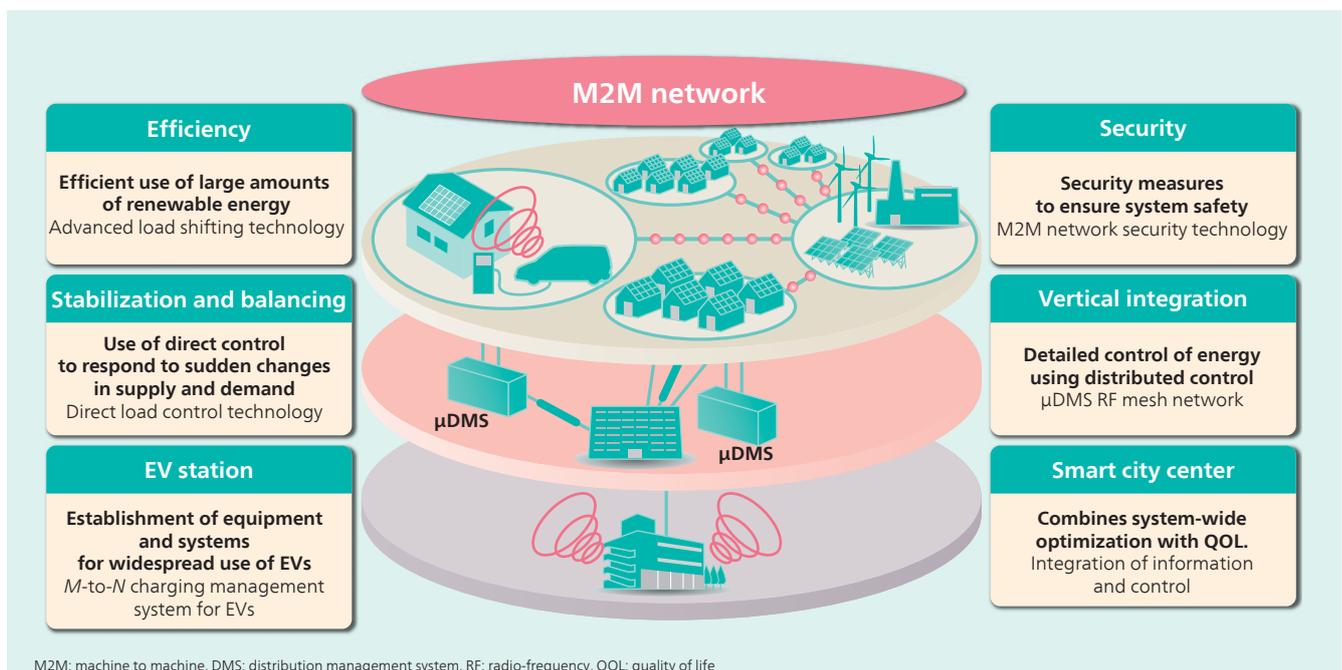
## 6 Kashiwa-no-ha Smart City Smart Grid Model Based on Grid Power Coordination

The Kashiwa-no-ha Smart City Project aims to achieve safe, secure, and sustainable urban development in the form of a city that provides a model for the future through a collaboration between the public, private, and academic sectors. Based around the central Gate Square district, it provides support for making significant reductions in carbon dioxide (CO<sub>2</sub>) emissions and for the local community's business continuity plan (BCP), including the provision of backup lines of energy supply for the entire region and the effective use of renewable and unused sources of energy.

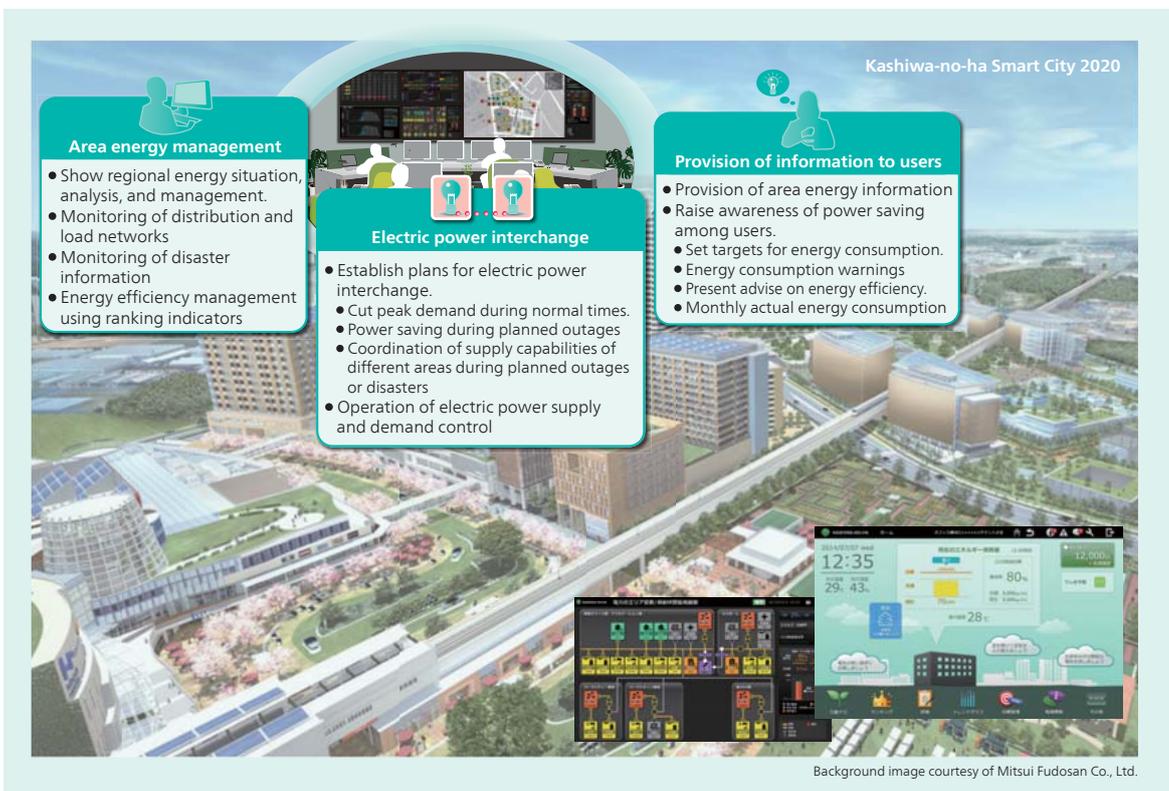
The project involves installing independent power lines within the district so that locally produced electric power from storage batteries installed at major facilities can be distributed to buildings that normally have secure and reliable supplies of grid power but experience peak demand at different times. This also provides a bare-minimum supply of domestic electric power to the surrounding neighborhood in the event of a grid power outage.

The equipment supplied to the project by Hitachi included one of Japan's largest stationery lithium-ion batteries (3,800 kWh), a system for the electric power interchange device between different parts of the city, distribution equipment, and also an area energy management system that not only monitors, controls, and operates these other systems, but also provides residents with information such as the mechanisms of energy use and guidance on their behavior.

In the future, Kashiwa-no-ha plans to construct a network that covers the entire city while also expanding the coverage area of its "Smart Grid Model Based on Grid Power Coordination" and adding additional functions. (Scheduled commencement date: April 2014)



5 Solutions supplied to demonstration project by Hitachi



6 Kashiwa-no-ha Smart City

## 7 Ongoing Supply of 380-kV Transformers to Saudi Arabia

Since the 1970s, Hitachi has supplied a total of more than 40 large transformers to the Kingdom of Saudi Arabia. This has included a series of major orders since 2005 for large transformers of 500 MVA or more for use in power plants, with on-site installation currently in progress at the same time as work proceeds on design and fabrication for new orders.

Products for the Kingdom of Saudi Arabia require special specifications to deal with the harsh environmental conditions, including limits on temperature rise. In addition to giving full

consideration to these requirements prior to design and fabrication, Hitachi also takes advantage of the ongoing orders to hold periodic technical consultations with customers to deepen the relationship of trust through the exchange of information about the reasons behind the specifications and other technical issues. In recent times, Hitachi has utilized these relationships to enter into discussions about future projects.

With numerous plans for power plant construction in Saudi Arabia in response to rising demand, Hitachi intends to draw on its past experience to meet the demand for large power plant transformers while also strengthening cooperation with the customers.



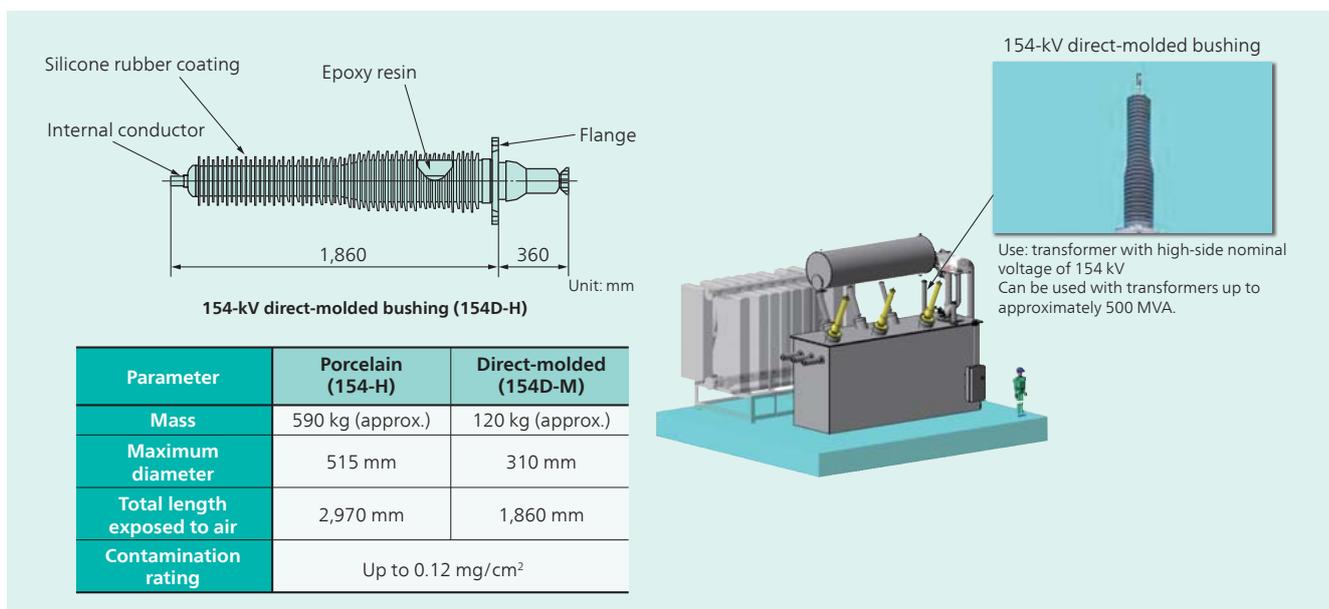
7 Factory testing of first 900-MVA-class power plant transformer (four transformers are to be supplied in total)

## 8 154-kV-class Earthquake-proof Transformer

The newly developed 154-kV-class earthquake-proof transformer uses 154-kV-class direct-molded bushings made by SWCC Showa Cable Systems Co., Ltd., which use new materials and feature light weight and small size, and also provides improved earthquake resistance due to a lower center of gravity for the completed transformer and greater rigidity in the bushing attachments.

The transformer also has a function for instantaneous and automatic recovery if the pressure of sloshing transformer oil during an earthquake causes a relief valve to open.

Instead of using oil for insulation, the direct-molded bushings have an insulation design in which a coating of silicone rubber is laid directly over epoxy resin. In addition to eliminating the risk of oil leaks, this is also approximately 80% lighter and 40% smaller than the porcelain-insulated bushings used previously. This lighter weight and smaller size increases the natural frequency, thereby reducing the risk that resonance with the seismic

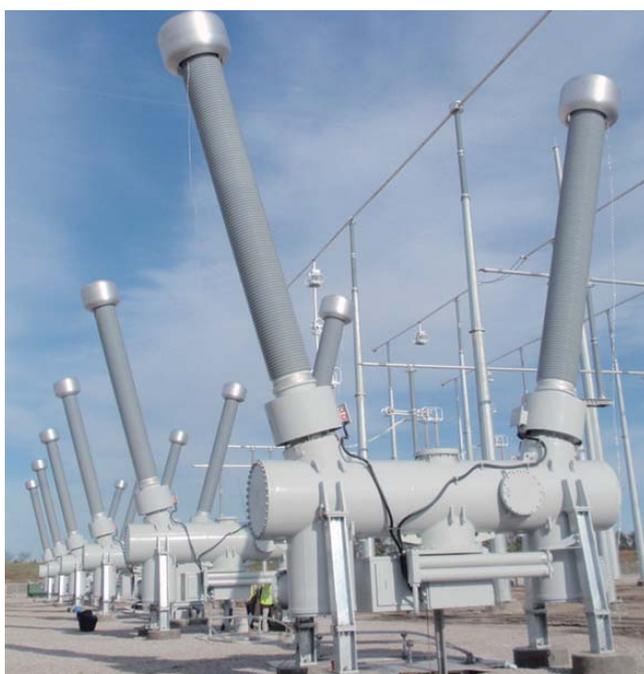


8 Design of 154-kV direct-molded bushings made of new materials (top) and overview of earthquake-proof transformer (bottom)

vibration will cause large stresses in the bushings. As restrictions on the angle of attachment of the bushings have also been eliminated, the new transformer provides more flexibility in layout design, making it suitable for a wider range of applications.

## 9 800-kV GCB for North American Market

A gas circuit breaker (GCB) is a grid protection device that can perform rapid switching of high voltages and heavy currents. Although Hitachi has already supplied about 40 800-kV GCBs (for the highest voltage level in North America) with double mechanisms per phase, there is demand for single-mechanism models for greater reliability and easier maintenance. Accordingly, Hitachi has developed a single-mechanism GCB with the high performance to comply with both the latest IEEE standards and customer specifications.



9 800-kV GCB developed and supplied by Hitachi (single-mechanism model)

The GCB is rated for 800 kV, 4,000 A, breaking current of 50 kA, and 60 Hz. Its main features are as follows.

- (1) Easier maintenance and greater reliability from using a single mechanism to drive two contacts, reducing the operational variability inherent in the design compared with the dual-mechanism GCBs used in the past.
- (2) Achieving duties complies with latest standards and customer specifications, thanks to mechanical systems that have been made lighter and faster through the fluid and strength analyses.
- (3) Easier operation and lower failure rate achieved through lower component count and simplified design.

Hitachi's aim is to continue expanding its share of the North American GCB market.

## 10 Assembly Guidance System for Switchgear

Gas-insulated switchgear (GIS) and GCBs have an important role in the electrical conversion equipment used in the distribution of electric power. In operating its business globally, Hitachi demands high-quality products, not only from its Japanese facilities but also from production at overseas affiliates.

The newly developed Global (GIS, GCB) Kokubu (Kumitate) Instruction Training System (G-KITS) is a system for guiding workers through assembly work to ensure consistent quality. It incorporates operating procedures and automatic monitoring of work quality.

The main features are as follows.

- (1) Clear and easy-to-understand work instructions using three-dimensional animations.
- (2) Realtime data collection made possible by the use of digital approvals implemented through the adoption of information technology (IT) in the workplace to replace the paper- and rubber-stamp-based practices used for work records in the past.
- (3) Uses digital torque wrenches to prevent problems such as bolts being missed or tightened with insufficient torque, and uses the associated work records to perform automatic monitoring.



10 Example G-KITS screen in Chinese

Kokubu Engineering & Product Division at Hitachi Works, Hitachi, Ltd. is designated by Hitachi as a “mother factory.” The division has set up a model production line using G-KITS to conduct verification testing, including actual assembly. After its initial use in the assembly of 145-kV GCBs, the system was subsequently adopted at Hitachi (Suzhou) EHV Switchgear Corporation, an overseas affiliate.

In the future, Hitachi intends to extend use of G-KITS to other standardized models and will consider adopting it at other overseas affiliates.

## 11 Substation for Floating Offshore Wind Power Facilities

This substation equipment for floating offshore wind power facilities was built by Hitachi as part of an FY2011 demonstration project run by the Agency for Natural Resources and Energy of the Ministry of Economy, Trade and Industry, Japan with the aim of developing technologies that will be required in future large wind farms.

The main challenges posed by the development, and the measures adopted to deal with them, are listed below.

### (1) Development of techniques for dealing with swaying

To verify the robustness of the systems, vibration testing and tilt testing were conducted based on data on swaying provided by the manufacturer of the floating platform.

### (2) Reliability and maintainability testing of equipment to be installed offshore

Compared with equipment intended for land-based installation, parts with tougher galvanizing or other surface coatings were selected.

### (3) Testing of grid connection via long undersea cable

Analyses of both systems were conducted based on grid data supplied by Tohoku Electric Power Co., Inc. to confirm that the effect on the existing grid would be within permitted limits.

The substation systems were rated at 66 kV and 25 MVA, with the electric power from the turbines being stepped up from 22 kV to 66 kV for connection to the Tohoku Electric Power Co., Inc.

grid. The floating platform on which the substation is installed is stationed approximately 20 km off the coast of Fukushima Prefecture.

In the future, Hitachi intends to perform comparison tests on the data acquired from the demonstration project and to use this in the development of key technologies.



Built by Japan Marine United Corporation

11 Floating offshore substation  
[The electrical conversion equipment is installed on the superstructure (painted white).]

# Transportation Systems



1 Class 97 locomotives fitted with Hitachi's on-board ETCS signalling system

## 1 SIL 4 Certification for On-board ETCS Signalling System for Main Lines

In November 2013, Hitachi released an on-board signalling system for main line railways that complies with the European Train Control System (ETCS) requirements, satisfies Safety Integrity Level 4 (SIL 4), and delivers the highest levels of safety.

To achieve this certification and demonstrate that the system provides maximum safety levels, Hitachi prepared extensive evidence to demonstrate that the product specifications and all of the processes involved with product development, including design, manufacturing, and testing, complied with European safety requirements. Certification was only gained after a rigorous audit by a third-party European certification agency. In parallel with this, certification of ETCS compliance was also achieved by preparing evidence to demonstrate compliance with all ETCS standards, passing independent functional testing by a European Reference Laboratory, and then passing a final audit carried out by a European Notified Body (NoBo).

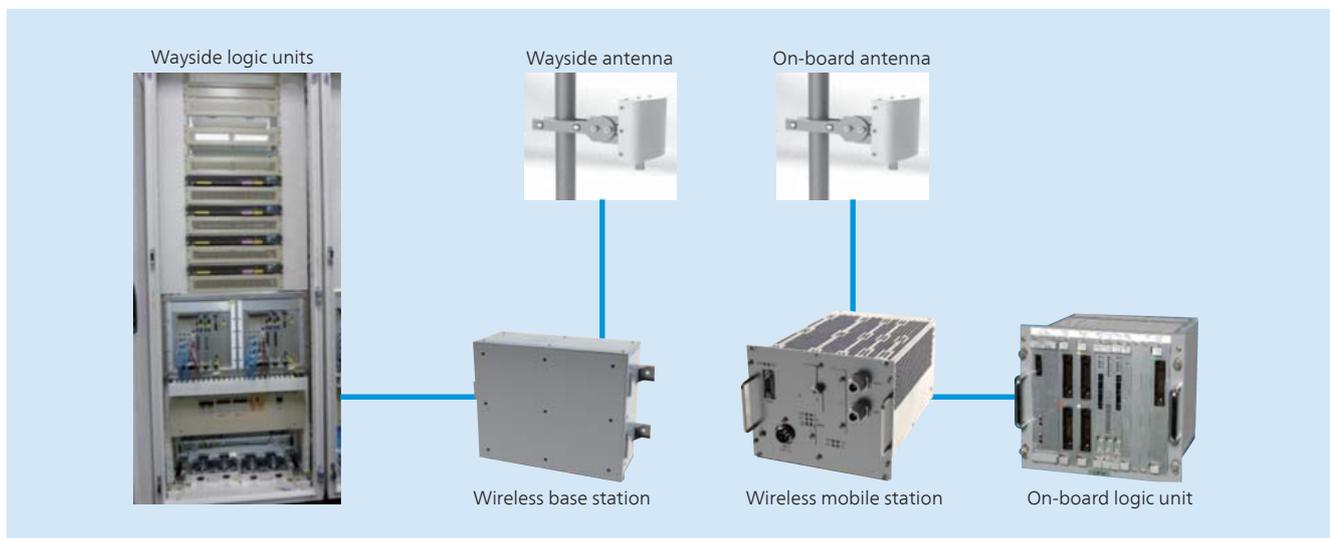
As part of joint development with Network Rail of the UK, Hitachi has also run on-rail trials of Class 97 locomotives fitted with the new system to verify compatibility with wayside ETCS signalling systems from other vendors. While the ETCS standard was formulated to ensure interoperability on European railways, its status as the only standardized signalling system means it is also being adopted in the Middle East and Asia. Hitachi intends to expand sales of the system throughout the world.

## 2 SIL 4 Certification for Urban Rail CBTC System

The urban railway market is seeing growing use of communication-based train control (CBTC) systems in the construction of new lines and in upgrades to existing signalling systems. Hitachi has gained the highest-level international safety certification (SIL 4) for its CBTC system. SIL 4 certification is an essential prerequisite for entering overseas markets for signalling systems.

The system is based on one that is already in operation and was developed using a "V-model" process that emphasizes traceability and was put in place by Hitachi to satisfy the requirements of the international safety standards. To obtain certification, Hitachi prepared the safety case and other documentation required by the standard for each phase of development; underwent a document audit and a review of its design, testing, and other processes by a European certification agency; and successfully resolved all of the issues that the certification agency identified. This means that Hitachi is now able to place on market its products to overseas urban rail projects that require compliance with international safety standards, including IEEE 1474.

The knowledge gained from this system certification will be useful for other projects that require certification, and will have widespread applications in future overseas signalling system work.



2 Block diagram of CBTC system

### 3 Tetsuhoku Substation on Namboku Line of Sapporo Municipal Subway Upgrade Using Portable Substation

The Tetsuhoku Substation on the Sapporo Municipal Subway Namboku Line of Sapporo City Transportation Bureau has a key role, not only supplying trains with electric power from the Hokkaido Electric Power Co., Inc., but also supplying power to other substations and electrical rooms. A recent upgrade replaced not only substation equipment that first entered service 41 years ago (excluding extra-high voltage substation facilities), but also the aging substation building itself.

To maintain the supply of electric power during the substation upgrade while the building dismantling and extension work took place, a portable substation housed in an aluminum package and with equivalent functions to the Tetsuhoku Substation itself was installed in free space inside the substation compound. By allowing the Tetsuhoku Substation to be fully shut down, use of the portable substation helped simplify and speed up the upgrade work. After upgrading the substation building was complete, Hitachi went on to install a full set of new substation equipment. The upgraded Tetsuhoku Substation entered service in July 2013 when operation switched over from the portable to the new equipment.

Hitachi intends to use the portable substation in future substation upgrades.



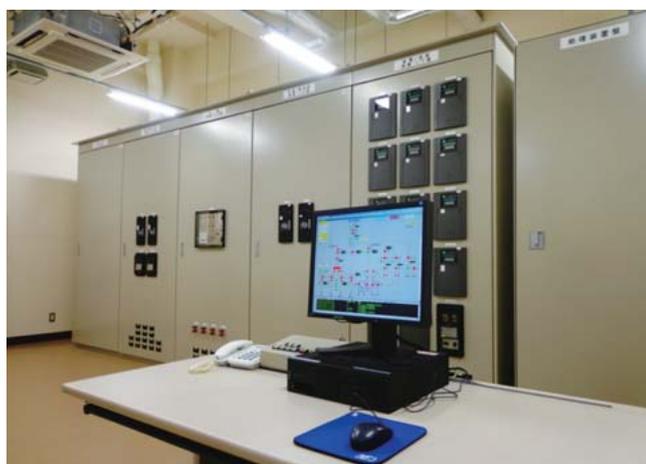
### 4 Nishi-Nippon Railroad Co., Ltd. Passenger Information System for Tenjin-Omuta Line

As part of an upgrade to the passenger information system for the Tenjin-Omuta Line of Nishi-Nippon Railroad Co., Ltd., its display panel was switched from light-emitting diode (LED) to liquid crystal display (LCD).

Hitachi was responsible for the passenger information equipment including the center and eight station-based systems [Fukuoka (Tenjin), Yakuin, Ohashi, Nishitetsu Futsukaichi, Chikushi, Nishitetsu Kurume, Nishitetsu Yanagawa, and Omuta stations], announcement equipment, and destination displays.

The upgrade added new functions to provide passengers with an intuitive display of any disruption to services, with pictograms being used to indicate the cause of schedule disruption and a track map display indicating which services are affected. Also, the system reduces the control center workload by continued supervision aiming to provide correct information from the train number tracking function about the number of doors and cars in each train and about train movements, even when schedule corrections are not ready in time. To ensure reliability, all critical systems have a redundant configuration.

The location and screen size of destination displays were determined by Design Division of Hitachi, Ltd. based on on-site



3 Portable substation (top), and power management system and protection interface panels (bottom)



4 20-screen multi-display for Fukuoka (Tenjin) station (scheduled to enter service in 2014) and example screens

analysis of passenger movement. The screen designs took account of visibility to users and the screen panel provides upcoming departures and map displays to indicate current train location and the stations at which the train will stop.

The system commenced operation at Nishitetsu Futsukaichi, Chikushi, and Nishitetsu Yanagawa stations in March 2013. The service will be extended to include Fukuoka (Tenjin) and Yakuin stations in 2014, and Ohashi, Nishitetsu Kurume, and Omuta stations in 2015.

**5 Bureau of Transportation of the Tokyo Metropolitan Government Upgrade to Traffic Control Systems for Four Toei Subway Lines**

Traffic control systems supplied to the Toei Mita and Asakusa Lines of the Bureau of Transportation, Tokyo Metropolitan Government entered service in February 2013, followed by a system for the Toei Shinjuku Line in November 2013. An upgrade to the Toei Oedo Line is also planned.

In response to the aging of existing equipment, the new system includes upgrades to the central control systems built for indi-

vidual lines, the traffic control equipment and passenger information displays installed at each station, and the traffic control network. The individual line supervisory staff and center systems will be consolidated at a new central operation control center in the near future. To improve customer service, the upgrades included replacing the passenger displays on the Asakusa Line with full-color screens. A new method of providing supervisory information to train crew and station staff is also to be adopted, involving the installation of new traffic notification units at all stations. In addition to automating train traffic control, the introduction of these systems has helped make traffic supervision more efficient and allowed for a faster response to abnormal situations by consolidating and sharing information about each railway line, while also providing more detailed services to passengers through the use of visual information display.

Hitachi intends to continue working on development of the new operation control center in collaboration with customers to make these subway systems and other important transport arteries in the Tokyo metropolitan area more robust with respect to disasters.



5 Traffic display panels and controller desks that form part of the traffic control systems for four Toei Subway Lines of the Bureau of Transportation, Tokyo Metropolitan Government



6 Control room for Yurakucho Line and Fukutoshin Line traffic management system

## 6 Traffic Management System for Tokyo Metro Co., Ltd.

Because the Fukutoshin Line of Tokyo Metro Co., Ltd. shares track with the Yurakucho Line, meaning that any schedule disruption to one can cause delays on the other, the traffic management system for the two lines is configured as a single system. With the commencement of mutual through-train operation with the Toyoko Line of Tokyu Corporation in March 2013, the line now carries traffic from five different railway companies. Because this means that any localized schedule disruption will spread to affect a wide area, the traffic management system was upgraded with a particular priority being placed on more efficient command entry and functional enhancements.

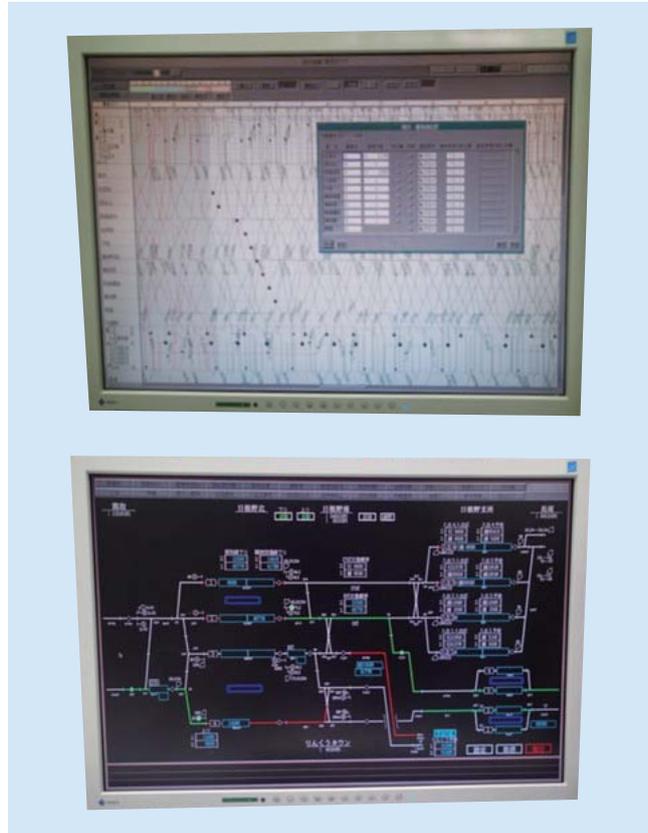
The control servers chosen for use as the core computers for the system feature a high level of reliability and responsiveness. Also, although the controller desks have multiple monitors, the series of tasks from situation assessment to the issuing of commands can be performed more efficiently with a single control unit that can be used for both situation monitoring and the entry of traffic management commands. Furthermore, to facilitate rapid recovery from schedule delays, the system includes manual group control terminals that can send commands such as stop times and operation resumption for multiple selected stations all at once, rather than issuing these commands to trains one at a time via the radio system as in the past, and also a dedicated manual terminal for Kotake-mukaihara Station where the Yurakucho Line, Fukutoshin Line, and Seibu-yurakucho Line of the Seibu Railway Co., Ltd. intersect.

In the future, Hitachi intends to utilize these rescheduling functions on other lines to improve traffic management functions and achieve safe and punctual operation.

## 7 Upgrade to Traffic Management System for Hanwa Line of West Japan Railway Company

The traffic management system for the Hanwa Line of West Japan Railway Company has been in service for 20 years since it commenced operation in 1993. Recently, to make further improvements in operational quality and the efficiency of traffic management, all equipment at both the center and stations has been upgraded to the latest systems.

Running for 61.3 km from Tennoji Station to Wakayama Station, and including the Kansai Airport Line as a branch line,



7 Operational graphics screens from Hanwa Line traffic management system

the Hanwa Line is an important railway line for the Kansai region. The system controls 26 stations, with station control equipment installed at Wakayama Station where shunting frequently occurs to manage shunted rolling stock at the station. To improve the efficiency of rescheduling when traffic disruptions occur, the system also includes functions for sharing information about the status of related lines. This uses interface equipment for connecting to the traffic management systems for the JR Kyoto and Kobe Lines, the Takarazuka, Tozai, and Gakkentoshi Lines, and the Osaka Loop and Yamatoji Lines, which have already entered service. For line and other maintenance work carried out overnight, the system provides online storage of the procedures for maintenance work planning and for starting and completing work. To cope with trains leaving from different platforms, the system also has enhanced functions for passenger information.

## 8 Osaka Municipal Transportation Bureau Electric Power Management System

The Osaka Municipal Transportation Bureau's power management system performs centralized monitoring and remote control of substations and other equipment for its eight subway lines and the medium-capacity Nanko Port Town Line.

Hitachi recently undertook an equipment manufacturing and upgrading project that covered the substations and other electrical facilities for Lines 1 to 7 and the Nanko Port Town Line, and also the power management systems at the electrical power control center and Nanko transportation control center. The project provides centralized management and control, with connections to existing systems that include the Line 8 remote



8 Electrical power control center after switchover to the new system

monitoring and control equipment and other equipment management systems. The system consists of a monitoring and control computer, remote monitoring and control equipment, and various support functions. These latter include a simulator, support functions for electric power management work, power use data display, and receiving and distribution of disaster and weather information.

Operation of the new system commenced in March 2013 with switchover to a temporary installation to allow for construction work. Work on the full system, including relocation and demolition, was completed in December. The electrical power control center handles centralized monitoring and control, and this was its first upgrade in the 22 years since it first entered service in April 1991.

## 9 Osaka Municipal Transportation Bureau Integrated Supervisory System for Sennichimae Line

The supervisory system (traffic management system) for the Sennichimae Line of the Osaka Municipal Transportation Bureau was the final line to be included in an operation control center consolidation project in which the separate operation control centers for each of the bureau's subway lines (Lines 1 to 8) were combined into a single operation control center as part of an upgrade of their traffic management systems. The Sennichimae Line (Line 5) serves 14 stations and runs for 12.6 km between Nodahanshin and Minami-Tatsumi stations.

As is the case for the other lines, the configuration of the newly commissioned system is designed for continuous operation, including backup for traffic management functions to ensure that passenger information services continue even if traffic management shuts down. The operation control center equipment includes two 70-inch LCD projection screens that are used as traffic display panels and have the same specifications as the units



9 Traffic display panel and controller desk for Sennichimae Line

used for the other lines. The top halves of the display panels show six surveillance camera images for operational supervision, while the bottom halves show a representation of the entire Sennichimae Line. The controller desk on the new system uses mouse-based operation. This method is common to all lines and is designed to be easier for staff to use, replacing the lever and push-button controls used in the past. Inputs for functions such as traffic management, manual train movement instructions, and passenger information can be entered from the same terminal for all six units. For consistency, the training equipment uses the same traffic display panel and desk configuration as the actual lines.

Relocation of the operation control center for the Sennichimae Line was completed in March 2013, marking the completion of the traffic management facility.

## 10 Enhancements to Power Management Supervision in ATOS Maintenance Work Management System

The Autonomous Decentralized Transport Operation Control System (ATOS) for the Tokyo region was installed in 1996. The objectives of the system included making the supervision of the railway system more efficient and improving the safety of maintenance work. Similarly, a power supervision system was installed in 1995 to automate the supply and control of the electric power required by the region's railway services and improve the efficiency of power management supervision. ATOS handles transportation supervision and the power supervision system handles power management. The two systems are linked through communication between the supervisory staff who operate them.

As part of the replacement of the aging power supervision system, systems have been introduced to electronically handle tasks (checks performed prior to scheduled electrical outages or reconnections) performed through cooperation between the transportation and electrical supervisory staff. Specifically, these were a function in which the system automatically coordinates train schedules with the very large numbers of scheduled electrical outages and reconnections, and a function for sharing the latest information on, for example, the location of the final train of the day and the sections of track on which maintenance work is prohibited. These functions were added to the maintenance work management system in ATOS.

The system entered service in November 2013. It is delivering further enhancements in the automation and efficiency of tasks handled by cooperation between supervisory staff.



10 Control room and desk for new power supervision system

# Public Sector Systems



1 Central control room of integrated water management system of Osaka City Waterworks Bureau

## 1 Osaka City Waterworks Bureau Integrated Water Management System

The integrated water management system of the Osaka City Waterworks Bureau has commenced operation, providing a central system for managing the water treatment facilities that serve the entire city. The system connects to the various central monitoring and control systems that perform distributed management of water treatment facilities (at three sites) and water distribution infrastructure (divided into 12 blocks) located around the city, managing information on flow rates, pressures, water quality, pumping station operation, and power consumption in realtime. To improve overall work efficiency, demand forecasting and reporting functions that were previously handled by the central monitoring and control systems have also been transferred to the integrated water management system.

The main features of the system are as follows.

- (1) Scheduling of the water pumps, which are heavy power users, takes account of pump energy efficiency when allocating the water volumes to be carried by the different routes in the water network.
- (2) Automation of parameter learning and forecasting error correction for the demand forecasting function allows operators to work more efficiently.
- (3) Control settings for maintaining an appropriate concentration of residual chlorine at the point of supply are provided to the water treatment facilities in realtime using an in-pipe consumption model of residual chlorine concentration.

(Commencement of operation: April 2013)

## 2 Ideura Water Purification Plant Monitoring and Control System

The Ideura Water Purification Plant of the Kitakyushu City Water



2 Monitoring and control system at Ideura Water Purification Plant

and Sewer Bureau has the capacity to supply 255,200 m<sup>3</sup>/d of treated water, representing 33% of the city's total water supply. It sources water from the Aburagi Reservoir, Masubuchi Water Reservoir, Heisei Ozeki Dam, and Murasaki River, treats it using a rapid settling and rapid-rate filtration method, and then supplies the treated water via the Horikoshi pumping station approximately 4 km away from the plant to the distribution reservoirs that serve the eastern districts of Kitakyushu City.

Hitachi has recently upgraded the central monitoring system to provide a system that performs centralized monitoring and control of the entire system from three operations desks.

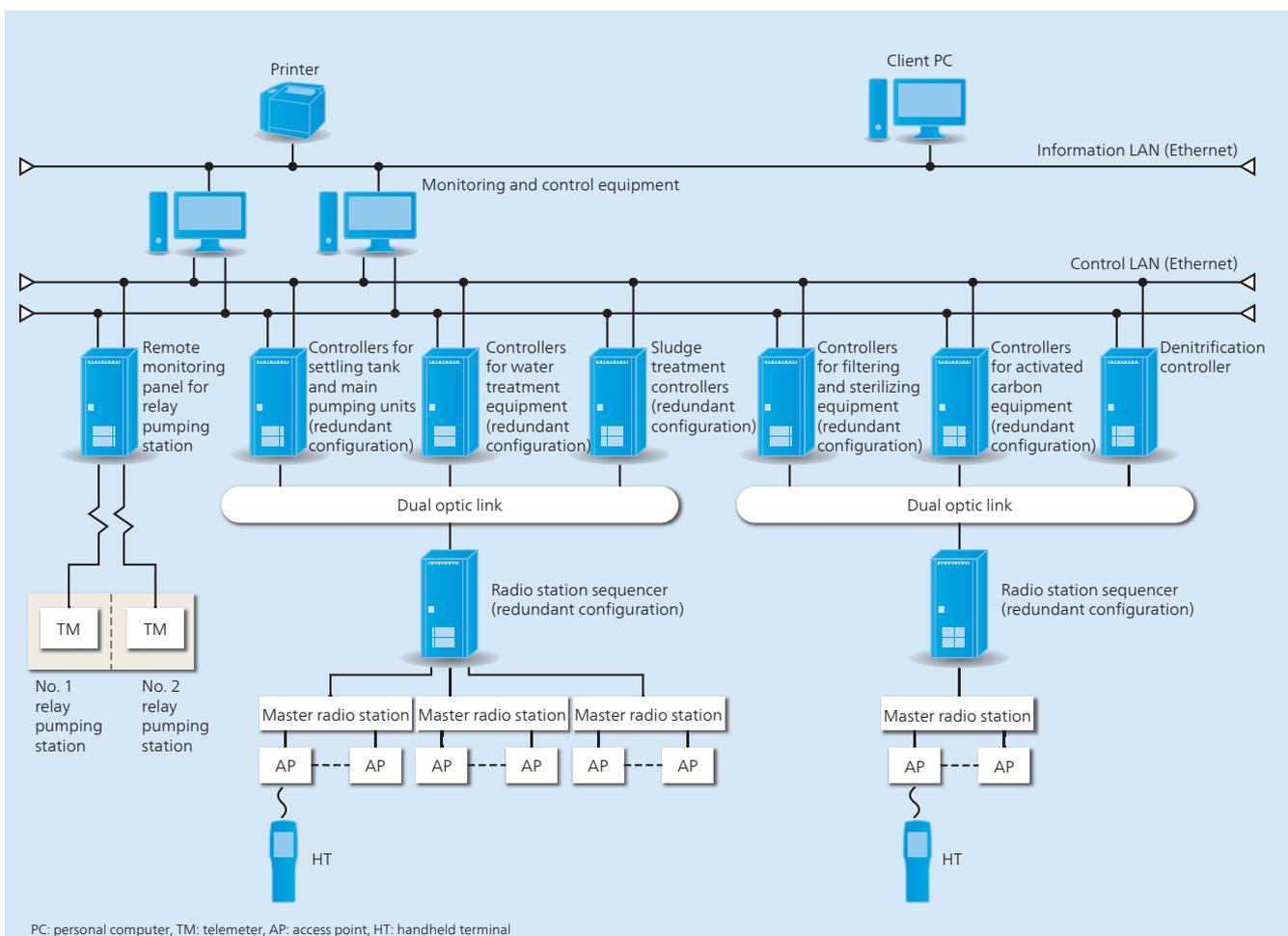
The main features are as follows.

- (1) Enhanced reliability and scalability achieved by using a client-server system configuration that distributes the functionality and processing load to its servers. In addition to backup servers, the system includes a data server that collects all of the plant data sent from the field control units, remote monitoring and control devices, and other equipment, and an application server that handles functions such as report generation, audible warning output, printing, and data archiving.
- (2) Enhanced reliability achieved by using a redundant configuration with automatic switchover for the telemetry units that provide communications between the water intakes, pumping stations, and treatment plant.
- (3) Consolidated monitoring of both equipment located at the facility and remote equipment, with distribution reservoir remote control equipment being connected directly to the control local-area network (LAN).

(Commencement of operation: April 2013)

## 3 Technoport Fukui Wastewater Purification Center Monitoring and Control System

The Technoport Fukui Wastewater Purification Center in Fukui Prefecture, Japan commenced operation in December 1993, treating industrial wastewater from Technoport Fukui (an indus-



**3** Monitoring and control system at Technoport Fukui Wastewater Purification Center

trial complex on the Fukui waterfront). In addition to a conventional wastewater treatment facility, the plant was the first public wastewater plant in Japan to utilize advanced treatment equipment (coagulation sedimentation system, rapid-rate filtration, and activated carbon adsorption system).

The new monitoring and control system supplied by Hitachi was intended to upgrade the central monitoring and control equipment and to enhance its reliability and ease-of-operation.

The main features are as follows.

- (1) Enhanced reliability achieved by using a client-server architecture with backup monitoring and control equipment (servers).
- (2) Enhanced reliability achieved by using a redundant configuration for the control LAN and for the controllers for key equipment.
- (3) Use of wireless handheld terminals for monitoring and operating field equipment to eliminate need for on-site control panels. To improve reliability, the radio station sequencer also has a redundant configuration.
- (4) Improved operation achieved by a function in the handheld terminals that displays the relevant operation screen simply by scanning the bar code attached to each device.

(Commencement of operation: April 2013)

#### 4 Eniwa Sewage Treatment Plant Monitoring and Control System

The Eniwa Sewage Treatment Plant in Eniwa City, Hokkaido, Japan commenced operation in 1980 and has a capacity of

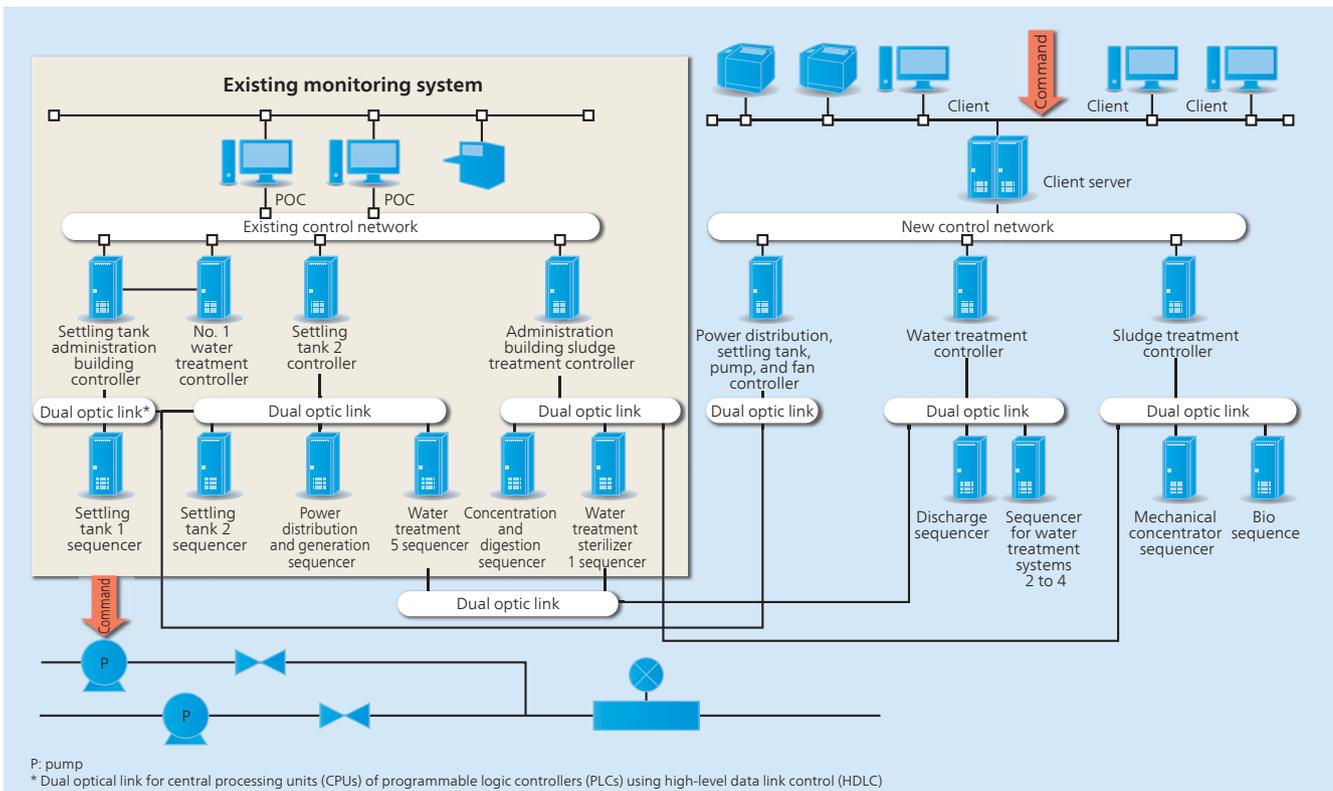
47,500 m<sup>3</sup>/d. The plant handles all sewage from Eniwa City and operates five streams that use the conventional activated sludge treatment method. In addition to conventional sewage treatment, the plant has installed a facility that accepts raw trash, human waste, and septic tank sludge, and since FY2012 has been mixing it in with sewage sludge.

For the recent center upgrade, Hitachi proposed a system configuration that could operate alongside the existing monitoring system to satisfy the customer's requirement to spread equipment upgrade costs over time.

The main features are as follows.

- (1) Enhanced maintenance and reliability achieved by using a client-server architecture with a redundant configuration for the network and key equipment such as the monitoring and control equipment (servers).
- (2) Ability to use both the new and old monitoring systems, with the new and existing controllers and sequencers both being connected to a dual optic link network. This improves reliability by allowing the old and new systems to operate alongside each other on the same network.
- (3) Enhanced reliability achieved by storing the monitoring and control software at four different locations, consisting of two locations for the process operator consoles (POCs) of the existing system and two locations for the (redundant) client servers of the new system.

(Commencement of operation: March 2013)



**4** Monitoring and control system for Eniwa Sewage Treatment Plant

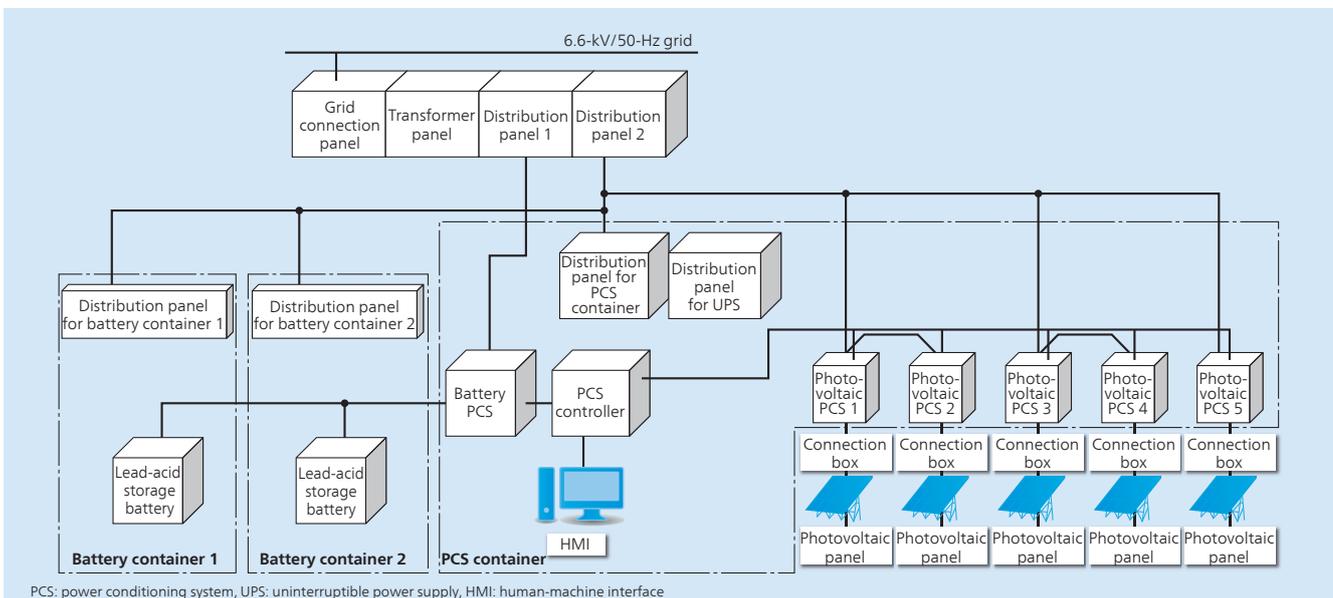
## 5 Participation in Joint Project of Ministry of the Environment and Ministry of Land, Infrastructure, Transport and Tourism

Hitachi has installed photovoltaic panels (50 kVA), power conditioners, power distribution equipment, and storage batteries (500 kVA) at the north public wharf at the port of Kashima in Ibaraki Prefecture, Japan as part of “FY2012 Project for Effective Low-carbon Measures for Ports that are Also Applicable During Disasters or Other Emergencies,” a joint demonstration project run by the Ministry of the Environment and Ministry of Land, Infrastructure, Transport and Tourism aimed at reducing greenhouse gas emissions and providing emergency power supplies at ports that play a central role in maritime and land transportation. The equipment will be used for the following trials, the objectives

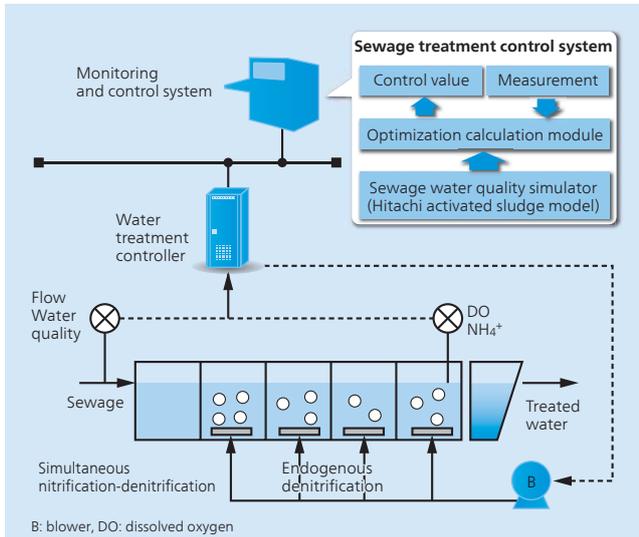
of which are to assess the viability and profitability of the system by calculating its costs and benefits during routine operation and quantifying the benefits it provides in times of emergency. The suitability of the system for use at other ports of a similar size will also be assessed.

- (1) Supply of electric power for lighting and administration facilities
- (2) Supply of electric power to gantry cranes
- (3) Operation of a system that uses equipment for generating electric power from renewable energy to augment power supplies
- (4) Assessment of reduction in carbon dioxide emissions

This project is being run over a three-year period from FY 2012 to FY2014 as a joint project of the Ministry of the Environment and Ministry of Land, Infrastructure, Transport and Tourism.



**5** Configuration of system installed at the north public wharf at the port of Kashima



6 Main components of sewage treatment control system

## 6 Sewage Treatment Control System Incorporating Water Quality Simulation Technology

The requirements for sewage treatment include reducing the environmental load on public watercourses and operating in an energy-efficient manner. These demands are providing the impetus for the adoption of techniques such as the use of ammonia sensors to control the extent of nitrification (conversion of nitrogen from ammonia to nitrate form), or advanced treatment (or quasi-advanced treatment) techniques that involve improving blower operation at existing sewage treatment facilities that use conventional activated sludge treatment.

Currently, Hitachi is working toward the use of sewage treatment control systems that use water quality simulation technologies that have already been developed. In the case of the nitrification quantitative control technique, feedback from an ammonia sensor is combined with simulation-based feed-forward to optimize blower power consumption and the quality of the treated water. In the case of quasi-advanced treatment, meanwhile, Hitachi is developing technology for improving denitrification performance without using circulation pumps through tech-

niques such as endogenous denitrification and simultaneous nitrification-denitrification involving the use of simulation for control of the air flow from the blowers. Hitachi has expanded the range of blowers that can be used for control, providing higher efficiency and smaller size while simultaneously enhancing control performance. By working on the development of these software and hardware technologies together, Hitachi is improving the energy efficiency performance of the overall system.

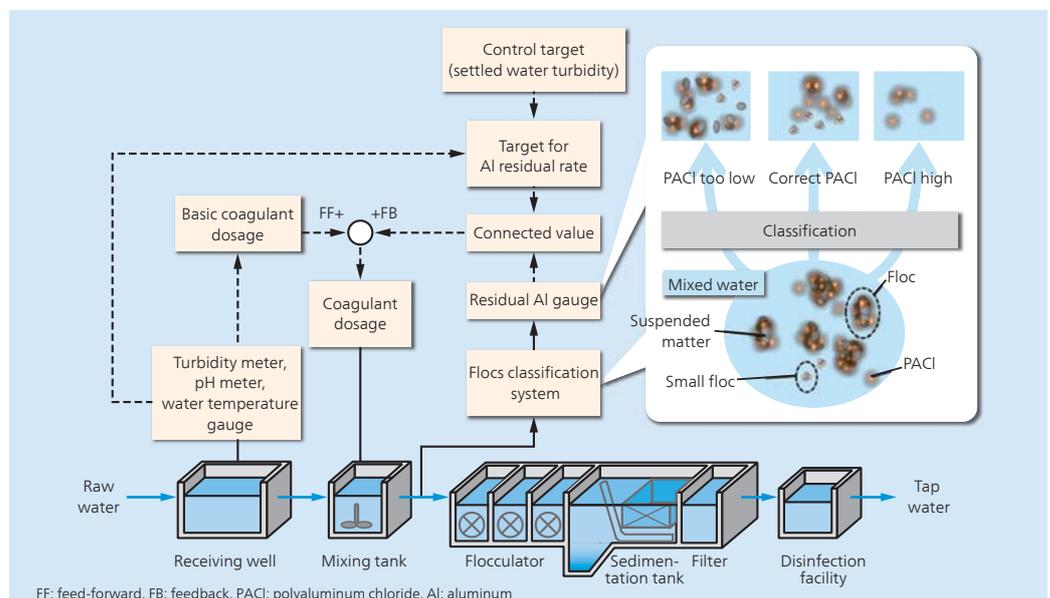
## 7 Automatic Control Technique for Coagulant Dosage Using Aluminum as Indicator

Adverse natural events such as droughts or heavy rain have been on the increase in recent years. The New Waterworks Vision published by the Ministry of Health, Labour and Welfare, Japan in March 2013 identified risk management that takes account of these events as being important to ensuring a safe water supply.

The quality of raw water is a major risk factor in water quality management, and it is common for experienced staff to intervene manually when adverse natural events occur. As water treatment plants are gradually losing their experienced staff, Hitachi has developed a new control system for automatic coagulant dosage control in response to sudden changes in the quality of raw water.

Flocs (aggregation of coagulant and suspended matter) occur in the water at the outlet of the mixing tank. A feature of the system is that it controls coagulant dosage based on the concentration of aluminum in those small flocs in which the flocculation process has insufficiently advanced. In a demonstration using actual raw water, the system showed that it could shorten the feedback time and prevent deterioration in the quality of the tap water when sudden changes occur in the quality of the raw water. To improve reliability further, work is continuing on collecting data under different conditions, including varying the coagulant and raw water quality.

The new system reduces risks from both natural and human sources and will contribute to realizing the New Waterworks Vision.



7 Flocculant addition control based on aluminum concentration



8 Command center of Shirakawa Fire Department

## 8 Shirakawa Regional Civil Defense Organization Digital Radio System for Firefighting and Emergencies, and Advanced System for Firefighting Command Center

Hitachi supplied a digital radio system for firefighting and emergencies and advanced system for the firefighting command center of the Shirakawa Regional Civil Defense Organization, which serves Shirakawa City, four nearby towns, and four nearby villages in Fukushima Prefecture, Japan. The systems will help ensure that command and control of the response to fires or other emergencies will be accurate and prompt. The Fire and Disaster Management Agency of the Ministry of Internal Affairs and Communications, Japan has directed that the radio systems used for firefighting and emergencies, which are currently analog-based, be switched to digital systems by May 2016. In addition to satisfying this requirement, the new system included the installation of advanced system at the firefighting command center. This was the first time Hitachi had received an order for both types of new systems.

The main features are as follows.

(1) Operational support functions, including the management and sharing of support information, improved command effi-

ciency through the processes from receiving a 119 call (the emergency phone number in Japan) through to assigning and dispatching the emergency response vehicles or fire engines.

(2) Time-shifting of the transmission of commands from radio base stations is used for radio call-out orders issued during a disaster to eliminate radio dead zones caused by interference.

(3) Automatic selection of the best radio base station for transmitting commands to a vehicle based on the vehicle's position and the base station coverage areas.

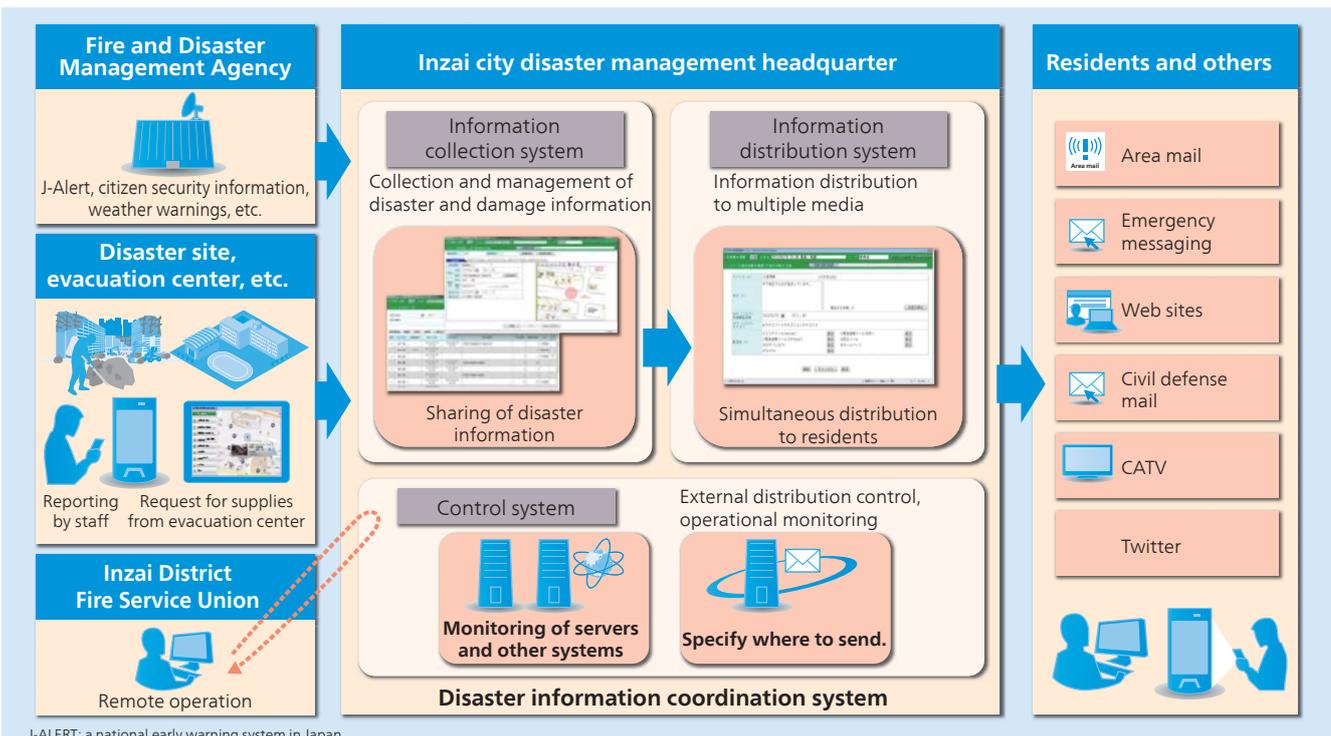
(Date supplied: March 2013)

## 9 Inzai City Disaster Information Coordination System

Learning from its experience in the Great East Japan Earthquake, Inzai City has introduced a disaster information coordination system that is designed to ensure quick and accurate communication of disaster information by providing multiple, diversified means for its transmission.

The system helps the city respond to disasters by providing functions such as the prompt collection and sharing of disaster information based on reports from the site of the disaster sent in from mobile terminals and the use of maps for centralized management of the situation. It can also provide residents with timely and accurate disaster information by sending it out across a diverse range of media, including area mail, emergency messaging, web sites, civil defense mail, community access television (CATV), and Twitter.

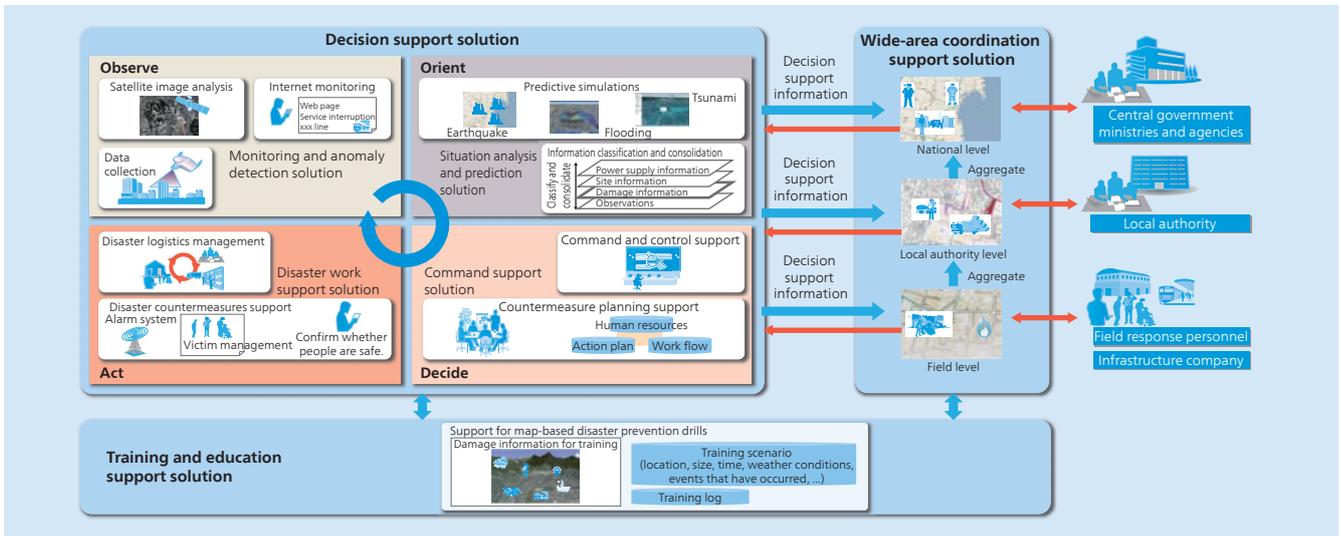
Amid a shift in requirements away from previous systems that have focused on information collation and sharing and toward systems that emphasize information distribution and delivery, Hitachi is deploying new solutions that support regional safety and security by providing a platform for coordinating information and information delivering.



J-ALERT: a national early warning system in Japan

9 Inzai City disaster information coordination system

# Security Technologies for Social Infrastructure



1 Disaster prevention management solution

## 1 Disaster Prevention Management Solution for National Security

Based on lessons from the Great East Japan Earthquake, there is an urgent need to establish organizations and schemes and provide facilities and systems aimed at mitigating disasters. In particular, in the case of large disasters that affect a wide area and in which the situation changes rapidly with time, it is vital that national and regional agencies, as well as the general public, work together efficiently in order to reduce the amount of damage and speed up the subsequent recovery and reconstruction.

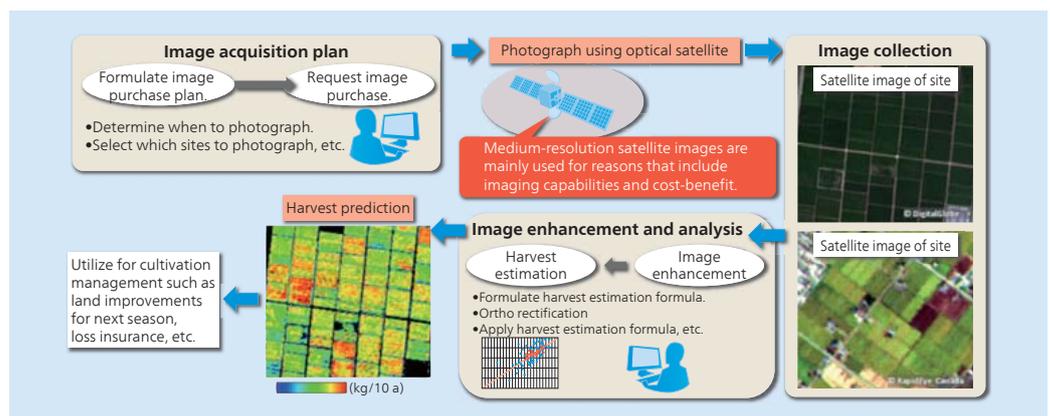
Hitachi already supplies disaster response support systems to central government ministries and agencies as well as local authorities. Currently, Hitachi believes that the best way to ensure national security is by raising awareness through education and training and through wide-area coordination and decision making that takes account of operational concepts in times of emergency. Hitachi is working to expand disaster prevention

management solutions intended to achieve this. In the case of large, widespread disasters in particular, a lack of information from the field is an impediment to rapid decision-making. In response to this problem, Hitachi supplies solutions that support ongoing decision-making, including the use of information from sources such as social networking services (SNSs) for rapid situation assessment.

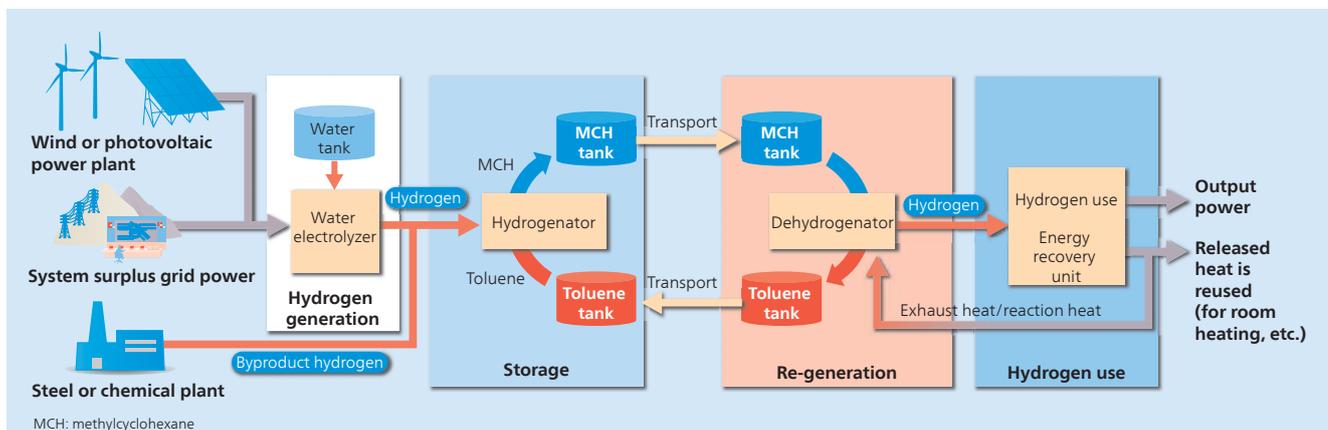
In the future, Hitachi intends to support safety and security in the context of disaster prevention and to contribute to the maintenance of social security through collaborations between national/local authorities, private corporations, and citizens, while also considering the potential for international disaster prevention cooperation.

## 2 Satellite Imaging Solution for Agriculture

The global population is forecast to peak at more than nine billion



2 Use of satellite images to assess rice harvest volumes



3 Block diagram of carbon-hydride energy storage system

in 2050. Meanwhile, consumption of animal products is also expected to grow, including in emerging economies, and its production requires large amounts of grain feed. For these reasons, the Ministry of Agriculture, Forestry and Fisheries is forecasting a significant increase in global demand for grain.

Images taken by Earth-imaging satellites can be used to monitor large territories, while assessments of harvest volumes for paddy-grown rice made with the benefit of satellite image enhancement and analysis techniques can determine current harvest size. Hitachi is currently looking at introducing such an information service. Hitachi believes that the use of such a service to assist with finding ways to increase rice production will help reduce the imbalance between supply and demand.

In the future, Hitachi intends to use its satellite imaging solutions to help resolve food problems on a global scale.

### 3 Energy Storage System Using Carbon Hydride

Hydrogen is a difficult fuel to handle. The carbon-hydride energy storage system (CHES) stores hydrogen in the form of the stable liquid methylcyclohexane, thereby making it easy to transport and keep in long-term storage.

To store energy, CHES produces methylcyclohexane by catalytic reaction of hydrogen and toluene, which acts as an energy carrier that is able to be stored and transported. To use the energy, a catalytic reaction splits the methylcyclohexane into hydrogen and toluene, supplying the hydrogen for use as an energy source and allowing the toluene to be reused in future production of methylcyclohexane. As a result, the large-scale long-term storage, transportation, and safe distribution of energy from unstable renewable sources can be achieved by using the electrolysis of water to convert the energy into hydrogen, and then using the hydrogen to make methylcyclohexane.

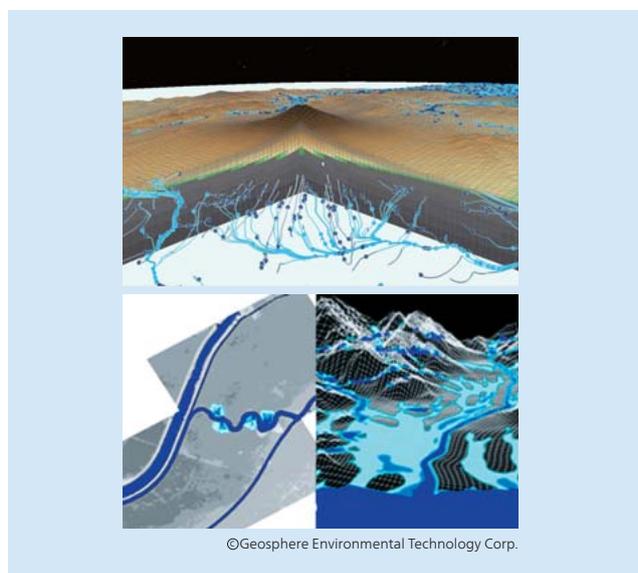
This technology can contribute to wider use of renewable energy, energy self-sufficiency for islands or other remote locations that suffer from high energy supply and transportation costs, improvements in the percentage of Japan's energy supplied domestically, and the realization of a low-carbon society and hydrogen society.

### 4 Water Cycle Simulation Service

Hitachi is developing a service that assists with water resource management and flood prevention by combining a simulation technique for analysis that fully incorporates both surface water and groundwater with visual representation technology that presents the simulation results quickly and in an easily understood form.

The features of the simulation technique include that it takes account of the interaction between surface water and groundwater, analyzes the movement of contaminants or other material, and supports high-speed computation on a personal computer (PC) cluster. The features of the visual representation technology include highly precise display of large amounts of time-series data on surface and underground conditions, calculation of spatial statistics from the simulation results, and high-speed rendering of data to suit the display scale. By utilizing these features, the service can present situation assessments and highly accurate predictions for water resources or flooding in a form that is easy to understand.

In the future, Hitachi intends to supply the service to help resolve the many global-scale problems associated with obtaining water resources and with flooding.



4 Groundwater flow analysis (top) and flood prediction (bottom) made by water cycle simulation service

# Elevators



Rated load	600 kg	1,000 kg
Rated speed	60 m/min	105 m/min
Rated output	3.7 kW	11 kW
Control system	VVVF inverter control	
Roping	1 : 1	
Traction machine	Gearless traction machine	
Motor	PM motor	
Brakes	Disk brakes	

1,642 kWh/year



**Before modernization**

- Six passengers
- Rated speed: 60 m/min
- AC motor
- Geared (worm gear) traction machine
- Dynamic brake control

Up to  
67%  
lower

547 kWh/year



**After modernization**

- Six passengers
- Rated speed: 60 m/min
- PM motor
- Gearless traction machine
- VVVF inverter control

VVVF: variable voltage variable frequency, AC: alternating current

1 Photograph and specifications of gearless traction machine intended for elevator modernization projects (top), and comparison of power consumption before and after modernization (bottom)

## 1 Gearless Machine for Elevator Modernization

In response to demand for modernizing the functions and performance of existing elevators that have been in use for many years, and for improving their safety and energy efficiency, Hitachi has adopted a proprietary gearless traction machine which is the key component in Hitachi's Elevator Modernization package.

The main features are as follows.

- (1) Enhanced energy saving through the efficiency improvements delivered by use of a permanent magnet (PM) motor and gearless design. Ride comfort has also been improved by using the latest operational control techniques to reduce machine room noise and elevator car vibration.
- (2) Unintended car movement protection (UCMP) has become a standard function for improving product safety that works by fitting double brakes on the gearless traction machine.
- (3) The UCMP system is independent of the main elevator control. The system can quickly detect elevator travel with the door open, even in cases when the drive mechanism or control equipment has failed, and bring the elevator to a halt automati-

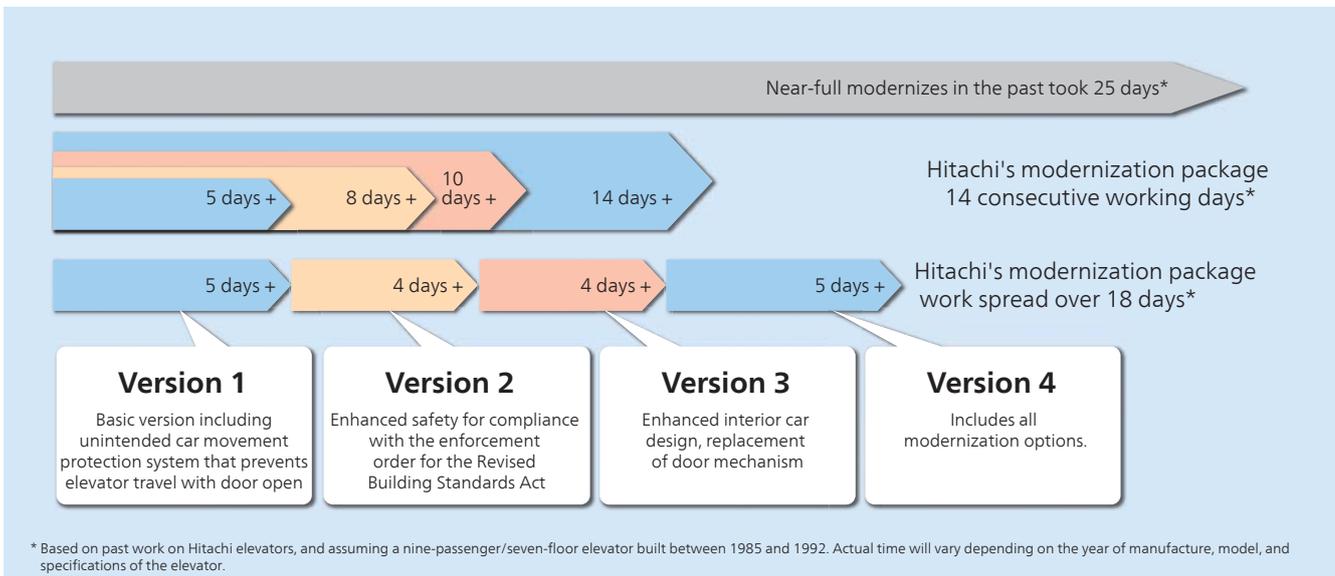
cally.

Hitachi intends to continue developing and supplying elevators that keep up with changing requirements.

## 2 Modernization Package for Compliance with New Elevator Regulations

Hitachi sells a package for modernizing elevators to comply with the new regulations in Japan\*. To meet the growing demand for improving the safety of existing elevators, this package uses a highly efficient gearless traction machine and its standard features include an unintended car movement protection system that utilizes the dual-brake design to prevent elevator travel with the door open.

This package is available in four different versions to suit different auxiliary specifications and work schedules. Features supplied by the basic version, version 1, include a function for emergency operation during an earthquake that can detect preliminary tremors, light-emitting diode (LED) lighting, and floor indicators. To comply with the new regulations, version 2 adds earthquake strengthening and a function for automatically



\* Based on past work on Hitachi elevators, and assuming a nine-passenger/seven-floor elevator built between 1985 and 1992. Actual time will vary depending on the year of manufacture, model, and specifications of the elevator.

**2 Work schedule for a Hitachi's modernization package**

landing at the nearest floor in the event of a power outage. Version 3 features enhanced interior design, with ceiling lighting and sheet coverings. Version 4 replaces the entire elevator car with the latest model and is equivalent to a near-full refit.

In terms of work scheduling, version 4 takes 14 consecutive working days to perform a near-full refit, which in the past could take around 25 days. Work can also be split between the different parts of the package to minimize the out-of-service time.

Hitachi also offers the networked building care service for post-modernization maintenance. The service allows the customer to use the internet to change elevator settings or display messages on the liquid crystal displays (LCDs) in the elevator cars.

As demand for elevator modernizes grows, Hitachi intends to continue satisfying diverse customer needs.

(Hitachi Building Systems Co., Ltd.)  
(Product release date in Japan: December 2012)

\* Compliance with the enforcement order for the Revised Building Standards Act issued in September 2009.

**3 Gearless Traction Machine Installation Method**

With the brake removed, the gearless traction machine used in a Hitachi's modernization package weighs approximately 450 kg

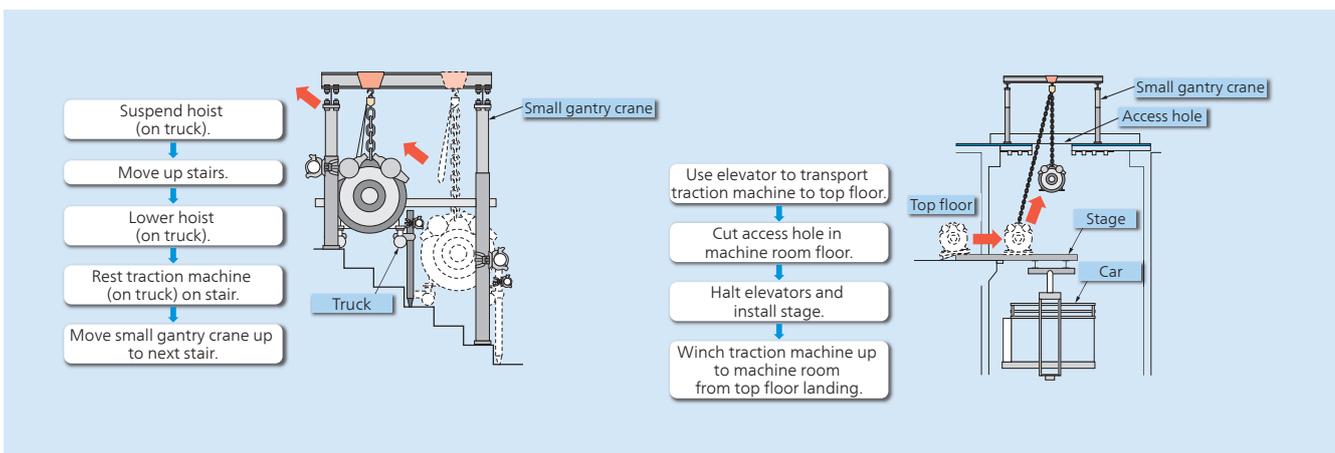
(for the 3.7-kW model). Accordingly, to reduce lifting costs and improve handling, Hitachi has developed two different installation methods to suit different housing conditions.

“Installation via stairway” involves transporting the traction machine up the stairs from the top floor to the elevator machine room. The traction machine is transported up the stairs suspended under a specially designed small gantry crane. At each step, the traction machine is temporarily rested on the stair while the small gantry crane is moved up to the next stair. This is repeated until the top of the stairs is reached. The traction machine is shipped from the factory on this truck so that it can easily be pulled along on the way to the installation site.

“Installation via the elevator shaft” lifts the traction machine up through an opening in the shaft. A stage is placed in the elevator shaft at the top floor and the traction machine is lifted up through an access hole in the machine room floor. This method is suitable in cases when carrying the traction machine in by crane or “via stairway” is not practical.

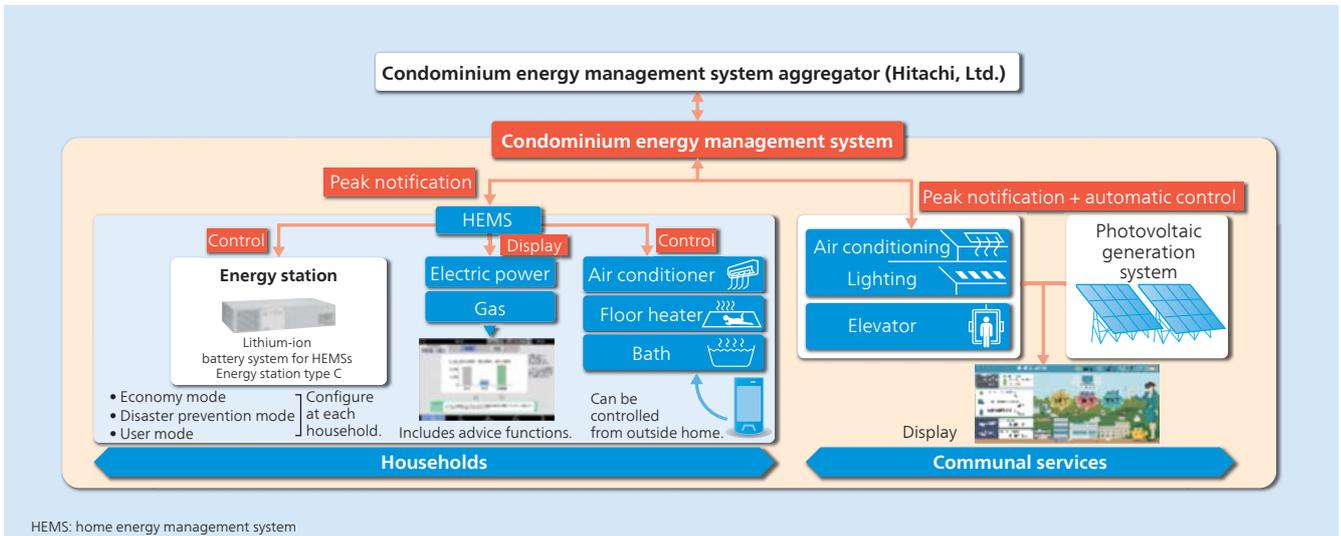
By allowing the work to be performed by elevator installers who do not have specialists such as steeplejacks on hand, these installation methods reduce the cost of lifting the traction machine into place by approximately 30%.

(Hitachi Building Systems Co., Ltd.)



**3 Installation via stairway (left) and elevator shaft (right)**

# Industrial Equipment and Systems



## 1 Overview of energy management system for condominiums

### 1 Energy Management System for Condominiums

In addition to providing stress-free ways of saving power at condominiums and other housing complexes, there is also a need to ensure energy supplies during disasters or when electric power is in short supply.

Hitachi has developed a new energy management system for condominiums that uses information and communication technology (ICT) for security and energy saving. In addition to its security functions, the energy management system also presents information on power use and billing. Its control functions cover both communal air conditioning and lighting, and private air conditioners or storage batteries. Hitachi is playing a major role in promoting the adoption of smart condominiums, including

being selected, in March 2013, as an aggregator that introduces an energy management system for apartments and provide energy management support services run by the Sustainable Open Innovation Initiative.

In the future, Hitachi plans to expand its condominium energy management system business by drawing on its extensive experience with solutions and systems for condominiums and its cloud-based service platforms.

### 2 Surveillance Camera Module with New DSP DI-SC221

The DI-SC221 is a full high-definition (FHD) surveillance camera module with a new digital signal processor (DSP). With functions that include  $\times 20$  optical zoom and auto-focus, the camera uses



2 Input image (left) and output image enhanced using enhanced intensity (right)

the combination of a new DSP and sensor to deliver crisp images and significantly improve image quality under low lighting condition, a feature for which there is strong market demand.

The camera module also has a new “enhanced intensity” feature. This enhances the brightness of darker parts of the image to produce a bright image even under low lighting condition. Whereas a tendency for bright regions to become over-bright has been a problem with past intensity enhancement techniques, the new function minimizes changes in the intensity of bright regions. Potential applications include urban surveillance and traffic monitoring.

Along with promoting enhanced intensity and the defog function developed and introduced during FY2012 as examples of the image enhancement functions that are a feature of Hitachi surveillance camera modules, Hitachi also intends to continue to develop new functions.

### 3 Smart Next-generation Factories

As progress is made on improving the energy efficiency of manufacturing plants to help create a low-carbon society, interest is being directed at the use of renewable energy or otherwise unused energy sources. Hitachi is currently working on a variety of developments based on the concept of smart next-generation factories with the aim of making manufacturing plants more advanced, including through energy management practices that use renewable energy.

The aim is to make manufacturing systems, such as production equipment and workplaces, highly efficient by seeking to use production information made available through a manufacturing execution system (MES) or other method to eliminate waste. Delivering a high level of energy management in these production processes requires a factory energy management system (FEMS) that can integrate manufacturing systems with utilities such as electric power and heat. Based on the production plans or

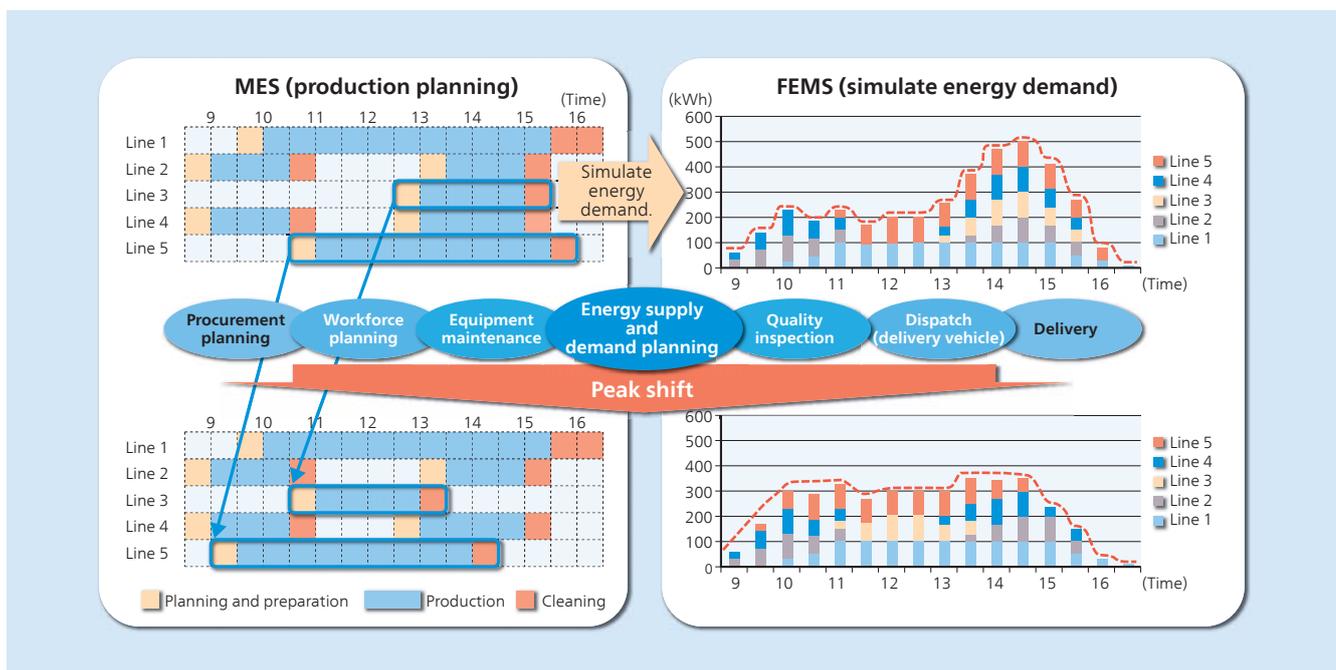
demand forecast for the manufacturing system, the FEMS controls supply and demand of each type of energy in order to minimize the plant’s energy consumption per unit of production. This achieves low-cost operation by saving energy and shifting peak demand.

By integrating and coordinating these production and energy supply plans, Hitachi is seeking to achieve overall optimization of production and energy.

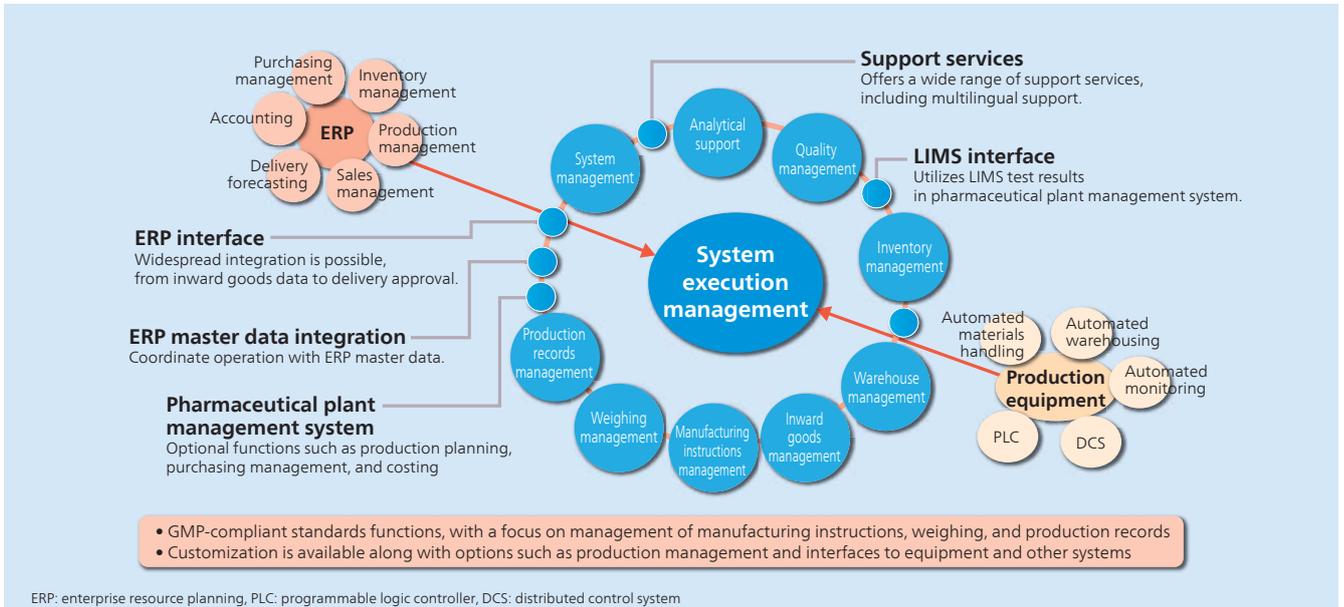
### 4 Globalization of Pharmaceutical Plant Management System

The pharmaceutical plant management system is an MES package that supports the manufacture of high-quality pharmaceuticals and complies with the good manufacturing practice (GMP) rules demanded by the global market. Since it was first installed in 1994, the system has been recognized as a top class product in Japan, with more than 130 systems having been supplied to approximately 70 companies, and with applications that cover a diverse range of manufacturing processes, including bulk drugs, solid and injectable preparations, and medical equipment.

With recent years having seen numerous instances of adverse drug reactions or sales of counterfeit medicines, particularly in certain emerging economies, there has been an acceleration in measures that treat the safety and security of the pharmaceutical market as a high-priority matter of national policy and seek to restore trust. Furthermore, with overseas companies exerting an increasing presence in the market, business opportunities will increase in the future. Given these circumstances, Hitachi is drawing on its in-house strengths, which include validation consulting, together with the extensive functions of its application packages developed in Japan, and is working in collaboration with local partners to adapt its systems for overseas markets. In the future, Hitachi aims to supply integrated solutions to the pharmaceutical manufacturing industry that are based around this pharmaceutical plant management system but also integrate



3 Peak-shift optimization of electric power through coordination with production planning (MES)



4 Functional overview of pharmaceutical plant management system

with plant equipment and with the other systems that operate in tandem with an MES, such as laboratory information management systems (LIMSs) and supervisory control and data acquisition (SCADA) systems.

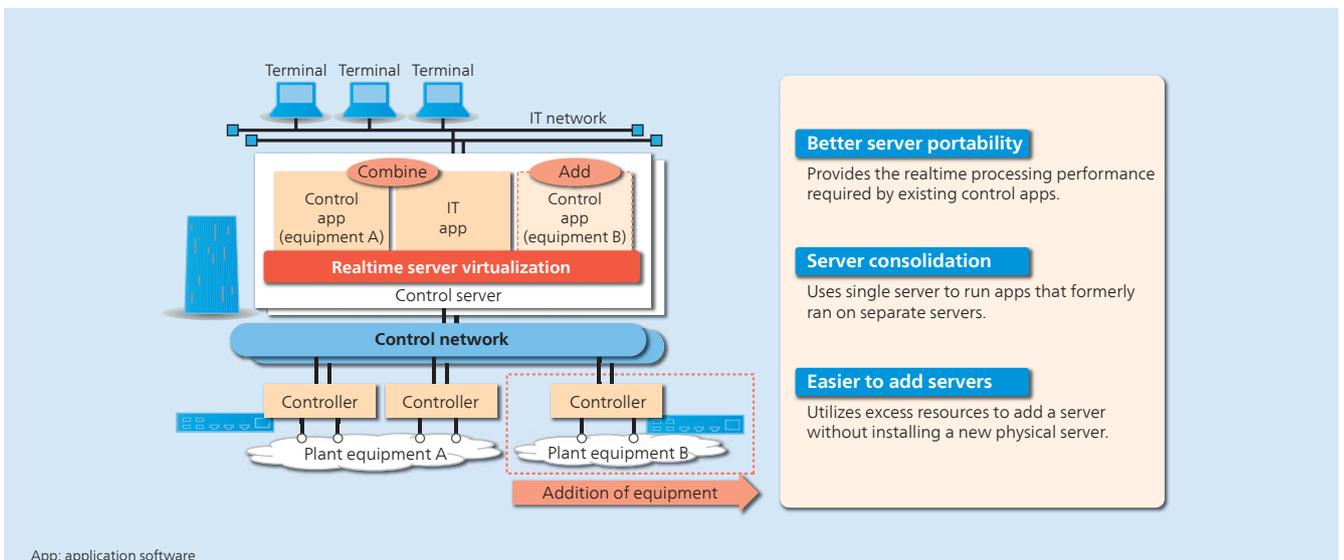
## 5 Realtime Server Virtualization

Featuring long-term product availability and high reliability, RS90 series control servers are used in information and control systems in a wide range of industries, including power generation and steel manufacturing. With systems in Japan having become increasingly larger in recent years, the challenge has been to extend the life of software to control maintenance costs and keep up with rapid advances in hardware and operating systems (OSs). In emerging nations and other overseas markets, meanwhile, there is demand for systems that can be installed on a small scale and then progressively expanded. Server virtualization (running a number of virtual servers on one physical server) has been adopted as a response to these needs. This makes software more

portable when servers are upgraded and facilitates the adding of additional servers or their consolidation.

Delivering realtime processing performance is a problem for the server virtualization used for conventional information technology (IT) systems, which is prone to delays in software execution due to competition for resources between the multiple virtual servers running concurrently. A new technique for realtime server virtualization developed by Hitachi minimizes execution delays and ensures realtime performance by providing mechanisms for the virtual servers to reserve exclusive access, at the logical level, to the resources they use. In response to the problem whereby the hosting of multiple virtual servers makes fault analysis more complex, Hitachi has added functions such as operational trace and operation monitoring mechanisms that provide a comprehensive assessment of the operation of each virtual server and shorten the time taken from detecting to resolving a fault.

In the future, Hitachi intends to continue expanding the range of applications for this technology by improving its reliability and making it easier to operate and maintain.



5 Example application of realtime server virtualization for control servers



6 Battery charging and discharging unit with autonomous output function

## 6 50-kVA/100-kVA Battery Charging and Discharging Unit with Autonomous Output Function

Energy storage is recognized as an important aspect of smart energy systems. Hitachi's new series of 50-kVA and 100-kVA battery charging and discharging units can be connected to a variety of different storage batteries. Applications include cutting or shifting peak demand for electric power and business continuity planning (BCP).

The main features are as follows.

- (1) Charging and discharging is performed in response to commands from a supervisory controller. Flexible systems can be configured for applications such as peak cutting or shifting.
- (2) Can be used with a variety of different battery types, including lead-acid and lithium-ion batteries\*.
- (3) Autonomous operation function suitable for BCP applications (including three-phase three-wire output option)
- (4) Complies with grid connection rules [JEAC (The Japan Electric Association) 9701-2010].

This series can play a central role in smart energy systems. (Hitachi Industrial Equipment Systems Co., Ltd.)

\* Requires consultation on battery specifications prior to purchase.

## 7 Amorphous Transformer

As of April 2014, Hitachi's 6-kV distribution transformers will become "Top Runner 2014 Transformers" that comply with the stage II criteria for "specified equipment" transformers, as defined under Japan's Energy Saving Act (the Act on the Rational Use of Energy). Along with this, Hitachi also plans to use amorphous transformers for some of its standard oil-filled models.

Despite an increase in transformer weight resulting from



7 Amorphous oil-filled distribution transformer

enlarging the wire cross-section and changing the materials used in order to reduce losses to comply with changes to the criteria, Hitachi has succeeded in reducing the winding size by using heat-resistant paper that allows the permitted windings temperature to rise by 10°C under revisions to the Japanese Industrial Standards. Furthermore, by using an amorphous alloy for the core, Hitachi has reduced no-load losses by approximately 70% and taken advantage of the lower losses to minimize material use. Also, optimization of manufacturing practices to suit the new amorphous alloy\*<sup>1</sup>, which features a high saturation magnetic flux density, has increased the design magnetic flux density by approximately 5% and reduced the size of the core. Together with a compact winding technique with a high resistance to short circuits, changes to the core structure have also made the transformer 15% lighter, making its weight roughly equivalent to current Top Runner transformers\*<sup>2</sup>.

Hitachi has already expanded its product range to include Scott-type mold transformers, step-up transformers for photovoltaic power generation, and extra-high-voltage transformers. To these, Hitachi has now also added standard 6-kV oil-filled transformers, one of its major product lines, to expand further the applications for amorphous transformers.

(Hitachi Industrial Equipment Systems Co., Ltd.)

(Date of initial production: January 2014)

\*<sup>1</sup> 2605HB1M supplied by Hitachi Metals, Ltd.

\*<sup>2</sup> For a 1,000-kVA three-phase oil-filled transformer

## 8 Three-phase Induction Motor that Complies with Top Runner Program

Amid growing demand for energy savings, various nations are adopting efficiency standards to improve the efficiency of electric motors, which are responsible for about 40% of total power consumption. In Japan, electric motors will come under the Top Runner standards from FY2015. This will oblige manufacturer to supply motors that meet the IE3 standard\*.

In response, Hitachi has pre-empted the regulations and has been supplying 55-kW and smaller models in its series, which comply with the premium efficiency standard, since January 2013. Through measures that included the use of electromagnetic



**8** Three-phase induction motor that complies with Top Runner criteria (3.7 kW, 4P)

field analysis to optimize the design and cooling and structural optimization, Hitachi has produced motors with IE3-equivalent efficiency while maintaining the same mounting dimensions.

By combining these energy efficiency improvements with greater reliability achieved by upgrading the thermal class of the motors, and by offering frame variations to make the motors easier to install, Hitachi is responding to increasingly diverse requirements.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* The premium efficiency class, as defined in the International Electrotechnical Commission (IEC) 60034-30 standard



**9** Inline (left) and end-suction (right) models of pump

with a built-in controller. The controller is attached to the PM motor housing and includes control panel functions (such as dealing with harmonics and electrical noise). Also, the pump is made as monoblock outdoor installation type to realize more environmentally resilient control and motor parts. To facilitate upgrade projects, the pump unit has dimensions that are compatible with those of previous motors. Incorporating a built-in controller board with input and output terminals and proportional-integral-derivative (PID) control software that is included as a standard feature, pressure signal inputs can be used by the pump to perform constant-pressure control of its own outlet pressure.

(Hitachi Industrial Equipment Systems Co., Ltd.)

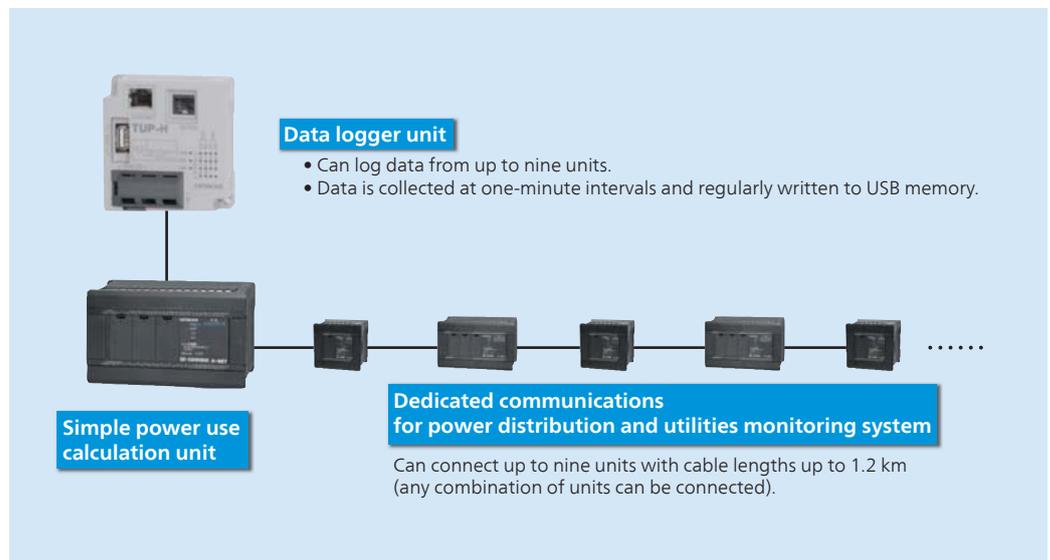
## 9 Pump Incorporating PM Motor with Built-in Controller

Use of an inverter to control motor speed is an effective technique for improving the energy efficiency of pumps. There is also a trend toward using more efficient permanent magnet (PM) motors in place of induction motors. However, because PM motors are a form of synchronous motor and therefore require a control system, they need both a controller and a control panel to house it.

Designed to satisfy requirements for energy efficiency and small size, the newly developed pump incorporates a PM motor

## 10 Simple Energy Monitoring System

Against a background that includes the enactment of the April 2010 revisions to the Energy Saving Act and the power shortages that followed the Great East Japan Earthquake, there is an urgent need for reductions in energy consumption. In particular, small and medium-size enterprises are experiencing growing demand to make devices smaller and to use connections between diverse devices for automatic control of air conditioning, lighting, and



**10** Simple energy monitoring system

other appliances.

To support energy efficiency, Hitachi has already developed and released the Hitachi power distribution and utility monitoring system. Along with the addition of the Modbus\*/remote terminal unit (RTU) protocol in July 2011 to add support for a common communication standard, Hitachi has now also made the system smaller (37% of previous system) in response to customer needs over recent years. In October 2013, Hitachi went on to release a simple energy monitoring system using a data logger and universal serial bus (USB) memory to allow the configuration of systems that are simpler than Hitachi power distribution and utility monitoring system. The data logger can collect data from up to nine measurement units and periodically store the collected measurements on the USB memory at one-minute intervals. A 4-Gbyte USB memory is capable of storing an year's worth of data.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* See "Trademarks" on page 142.

## 11 Inverter Designed for Use with PM Motors

Developments such as the revisions to the Energy Saving Act in April 2010 and motor efficiency standards (IEC 60034-30) have resulted in inverters being used as a way of saving energy in a variety of sectors. With the prevention of global warming and the creation of a low-carbon society being a challenge for emerging economies as much as developed ones, demand for energy efficiency measures in emerging economies looks likely to lead to even wider use of inverters. The growth of these needs is behind demand for inverters capable of driving both induction motors (IMs) (the typical type of asynchronous motor) and PM motors (the typical type of synchronous motor).

The high-performance, small-capacity WJ200 series was developed for this purpose and has built a strong reputation since being released in 2010. Hitachi also plans to support PM motor

drive in its high-performance SJ700 series and small-capacity/low-cost NE-S1 series models. These inverters will be able to drive the small, lightweight EHM1 series and the EHM2 series PM motors from Hitachi as well as PM motors from other suppliers. The EHM2 series of PM motors are intended as IM motor replacements and have the same housing design.

(Hitachi Industrial Equipment Systems Co., Ltd.)

## 12 New Oil-free Screw Compressors

With a high priority being placed on environmental and energy efficiency measures throughout the world, Hitachi has an extensive range of new oil-free screw compressors (22 to 240 kW) to meet these needs.

The main features are as follows.

(1) Improved efficiency and reliability through use of a specialty stainless steel with excellent corrosion resistance and durability in the first and second stage rotors of the newly developed air end. A special coating is also used along with precision grinding of the teeth surfaces. The variable speed drive also improves energy efficiency, with features that include a proprietary capacity control mechanism.

(2) The compressed air cleanliness satisfies class zero, the highest class in the ISO8573-1:2010 standard. This means that, in addition to conventional industrial applications in the food, pharmaceutical, or electronics industry, the compressors can be used in applications that require a reduced risk of contamination or environmental load.

(3) Quieter operation achieved through development of a new air end with low noise and high efficiency together with enhanced anti-vibration performance in the air end drive and cooling systems.

(Hitachi Industrial Equipment Systems Co., Ltd.)



11 Inverters for PM motors



12 Hitachi's range of new oil-free screw compressors (22 to 240 kW)

### 13 New Series of PM Motors

With growing demand for energy savings to prevent global warming, there is a particular need for higher efficiency in the motors that account for approximately 40% of all power consumption. This has led to greater standardization, with the JIS C4034-30 efficiency standard for induction motors defining the IE3 premium efficiency standard. There are also plans to add a definition of IE4 super-premium efficiency that will assume the use of PM or other high-efficiency motors.

Hitachi has now developed a series of new PM motors that comply with the IE4 standard (3.7 to 55 kW, 1,500 min<sup>-1</sup>). Like the existing 1,800-min<sup>-1</sup> series, the new models are compatible with the induction motor frame numbers and feature smaller external fans and use of electrical steel with low iron loss for higher efficiency.

The main features are as follows.

- (1) Complies with IE4 motor efficiency standard.
- (2) Compatible with induction motors (same motor frame numbers)

Hitachi is currently working on the development of larger motors and high-efficiency motors with new structural designs that use amorphous alloy.

(Hitachi Industrial Equipment Systems Co., Ltd.)

### 14 IEC 61131-3 Compliant Compact PLC

The newly developed series are an addition to the existing range of PLCs that include Ethernet ports in their standard features and have earned a strong reputation for their ability to use USB memory for program updates. They also comply with the IEC 61131-3 international standard for PLC programming languages.

The new PLCs use the CODESYS\* integrated development environment as their IEC 61131-3 platform, as do the series of module PLCs currently under development that will also comply with the IEC standard. CODESYS includes extensive editing functions that provide graphical assistance for program coding, and a wide range of debugging functions including sampling trace and offline simulation.

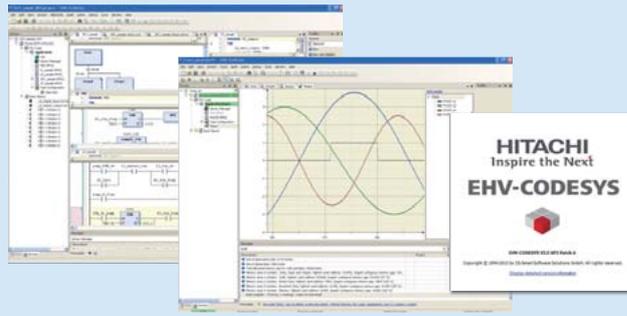
With systems and mechanical equipment becoming larger and more complex due to growing use of PLCs, this is creating a need for higher software productivity to reduce costs and improve quality. Meanwhile, because manufacturers are moving production to overseas sites, PLCs are being used in many different countries and regions and by engineers with varying skill levels from a variety of different industries. This is why the new series offers an internationally standardized programming language that suits different applications and skill levels.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* See "Trademarks" on page 142.



13 New series of PM motors (3.7 to 55 kW, 1,500 min<sup>-1</sup>)



Integrated development environment (programming software)

I/O: input/output

14 Series of IEC 61131-3 compliant compact PLCs

15 Wireless Monitor Wireless Temperature Monitoring System

The wireless monitor wireless temperature monitoring system uses platinum (Pt) sensors to record temperatures with high accuracy ( $\pm 1^{\circ}\text{C}$ ) over a wide range ( $-200$  to  $500^{\circ}\text{C}$ ).

Applications such as the processing or storage of pharmaceuticals or food require not only precise temperature management but also management of dust and other interior environmental factors, and this can raise problems when new equipment is installed as part of plant upgrades. With this new system, however, the use of wireless communication simplifies the installation of temperature monitoring systems at sites where this would have been difficult in the past due to the need to run cables. Also, the combined use of the 2.4-GHz low-power band and 429-MHz specified low-power band allows the sensor units to use battery power and extends the transmission range to access points. Wireless monitor is designed with system configuration in mind. In addition to the logging of temperature data, it also has a function to generate an alarm in the event of an abnormal temperature reading.

Along with the development of other products such as 920-MHz wireless devices and analog input interfaces, Hitachi is making it possible to configure wireless network systems suitable for an even wider range of uses.

(Hitachi Industrial Equipment Systems Co., Ltd.)



15 Remote unit with temperature sensor (left) and access point (right) for wireless monitor wireless temperature monitoring system

16 New Multi-function Coding Verification Machine

The inspection of date of production, use by date, and lot number labeling is becoming increasingly important in food, pharmaceutical, and other manufacturing industries for reasons of legal compliance and traceability. Hitachi supplies coding verification machines to meet future market requirements.

The newly developed MC-20S is a multi-function coding verification machine that extends Hitachi's existing lineup. It includes the adjustable matching function provided for inspection of inkjet printing.

The main features are as follows.

- (1) Includes support for color cameras and has a built-in standard white light-emitting diode (LED) strobe, with standard functions that are suitable for inspecting text printed on surfaces such as the paper or plastic packaging widely used in the food and pharmaceutical industries.
- (2) Supports user configuration of settings for the products to be inspected, with simple adjustment, recommended setting, and focusing and aperture adjustment functions.
- (3) Suitable for user-specific environments, with standard position, rotating inspection, and identification of tilted text.
- (4) Multi-lingual support (further languages to be added) and designed for export.

(Hitachi Industrial Equipment Systems Co., Ltd.)



16 MC-20S coding verification machine



17 New ADV series servo amp (with EtherCAT support)

## 17 New ADV Series of Servo Amps

The ADV series are a new range of servo amps that meet market demand for even higher performance in machine tools, industrial robots, semiconductor production equipment, and other machinery. They achieve a speed control response frequency of 2.2 kHz through use of a high-speed microcontroller and new dedicated current controller integrated circuit (IC) that allow cycle times for speed control and current control that are approximately 50% shorter than previous models from Hitachi. The newly released products are a 200-V-class model for applications up to 750 W and a 100-V-class model for up to 400 W.

The main features are as follows.

- (1) More compact dimensions for mounting in control panels due to a thin-profile design that can be installed side-by-side without a gap between amps.
- (2) Shortening high-speed positioning times is made easier by improvements to the auto-tuning function for determining control parameters and the moment of inertia of the load.
- (3) Incorporates a safe torque-off (STO) function that complies with European Norm (EN)/ISO 13849-1 Cat. 3 PL d and EN

61800-5-2 safety integrity level (SIL) 2 functional safety requirements to facilitate the certification of machines that use the servo amp under European machinery ordinances.

(4) Multi-axis motion systems can be configured using models that support the EtherCAT\* open network standard that allows high-speed synchronized control.

(Hitachi Industrial Equipment Systems Co., Ltd.)

\* See "Trademarks" on page 142.

## 18 Hitachi Positioning System for Mobile Robots

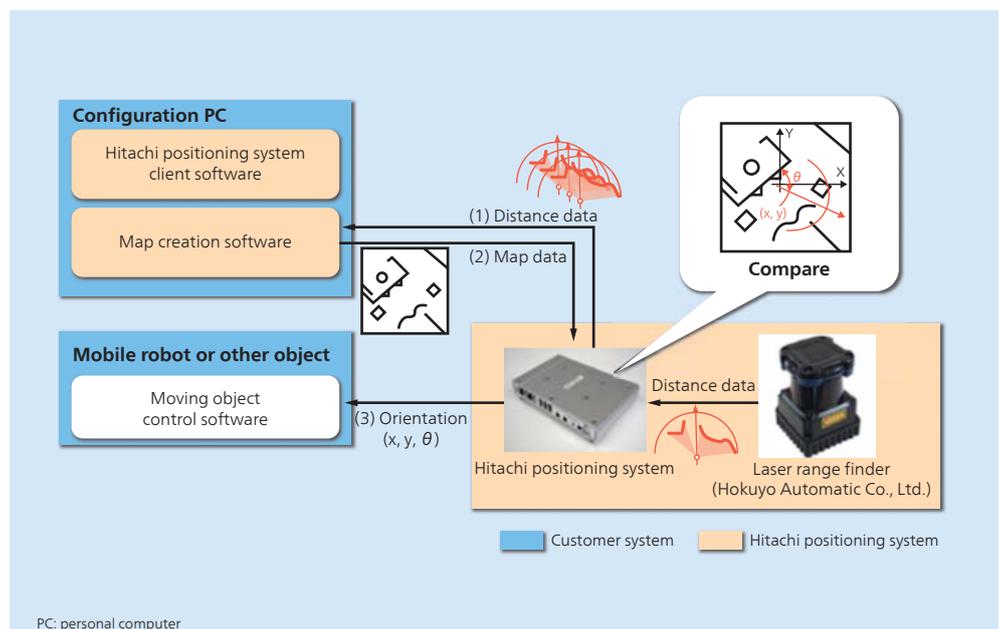
The image collecting Hitachi data acquisition system uses laser range finder to detect the position of a moving object. It can generate maps both indoors and outdoors, and then perform positioning (detect the position and orientation of the sensor on the map).

The first step is to generate the map. This uses a log of the distance data collected by the laser range finder. Because these distances are the only data that the system requires, the user can survey a route simply by moving along it using a hand trolley or similar. The map creation software in the positioning system then transforms this collected data into a map. As a result, the time taken to map a region of 50 m × 50 m, for example, to an accuracy of about 2 cm is a mere 30 minutes from surveying to map creation.

Next, map and distance data are compared to determine the position and orientation of the moving object. While considerable computation is required for accurate positioning, Hitachi has developed an algorithm that can perform precise map matching with a reduced computational complexity. It achieves an accuracy of ±50 mm and ±3° with an output cycle time of 25 ms.

In addition to positioning for moving objects such as autonomous mobile robot, the system is also suitable for map-based applications.

(Hitachi Industrial Equipment Systems Co., Ltd.)



18 Block diagram of Hitachi positioning system



OLED production system



Film assembly equipment



Micro-ball printing system for semiconductor packaging

**19** Production equipment for advanced electronic components

**19** Production Equipment for Advanced Electronic Components

Recently, smartphones and tablets have grown so rapidly to almost replace PCs. This growth is mainly due to the progress of the production equipment technology, which has realized the high-resolution thinner display, and high-density component mounting for higher performance of the device.

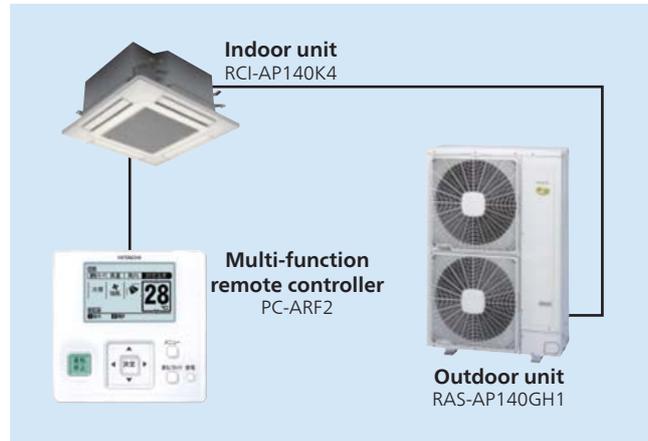
As the production equipment for the mobile devices is required to have the advanced performance and the solutions for the further progress, Hitachi has recently developed precision printing technology, and film assembly technology for flexible devices, such as organic light emitting diodes (OLED) display and lighting, and semiconductor packaging.

From now on, Hitachi will continue to develop high productivity production equipment to contribute to the progress of the advanced electronic devices.

**20** Energy-efficient Premium Series of Highly Efficient Packaged Air Conditioners for Shops and Offices

For the updated model range of its energy-efficient premium series of highly efficient packaged air conditioners for shops and offices, Hitachi has simultaneously developed a new outdoor unit, 4-way cassetted type indoor unit, and multi-function remote controller.

In addition to optimizing the over-compression regulator, Hitachi also developed a new compressor with enhanced



**20** 14.0-kW model of energy-efficient premium series of highly efficient packaged air conditioners for shops and offices

mid-range performance, and a new propeller fan with improved efficiency achieved by using computational fluid dynamics (CFD) to optimize the blade shape. As a result, when used in conjunction with 4-way cassetted type indoor units, the models ranging from 4.0 kW to 28.0 kW satisfy the 2015 standards specified in Japan's Energy Conservation Law, which are defined in terms of the annual performance factor (APF) energy efficiency rating. The new system reduces annual energy consumption by approximately 50% compared to Hitachi's previous fixed capacity model released about a decade ago (comparison based on 14.0-kW model). A variety of new functions have been added to help save power, including controlling the capacity of the outdoor unit, and the power saving modes can be selected and configured easily from the multi-function remote controller. The multi-function remote controller also presents information on energy savings by displaying graphs and tables on its screen that show indicative values of parameters such as power consumption and carbon dioxide (CO<sub>2</sub>) emissions, and that provide comparisons with past data such as the previous day.

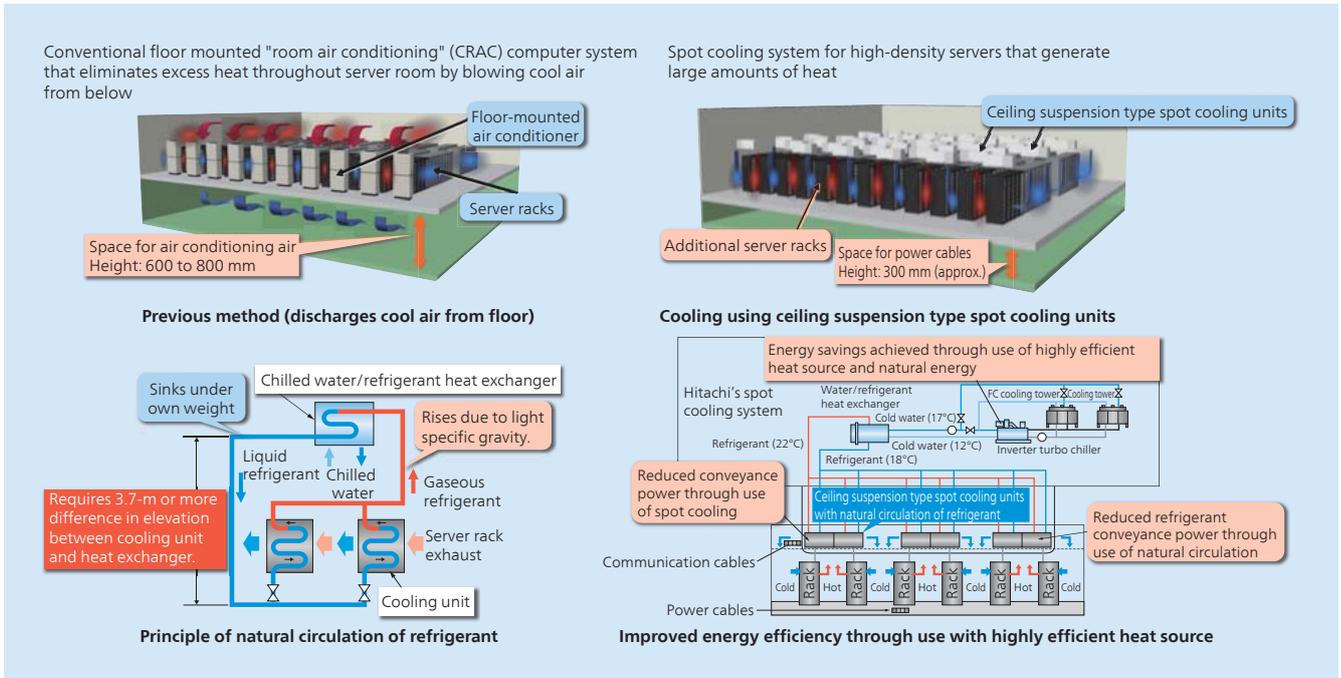
(Hitachi Appliances, Inc.)

**21** Spot Cooling System for Data Centers

Compared to past computer room air conditioners\* (CRACs), Hitachi's spot cooling system for data centers delivers significant energy savings, provides more room for server racks, and minimizes under-floor space requirements.

Conventional systems have installed air conditioners on both sides of server racks, cooling them by discharging the cool air supplied by the air conditioners from under the floor. In contrast, Hitachi's system uses spot cooling units that are suspended from the ceiling above the servers. This provides the following benefits.

- (1) The shorter path for cool air circulation reduces pressure loss and allows a fan with a significantly lower power to be used.
- (2) Provides room for more server racks to be installed using the space that was previously taken up by underfloor air conditioning units.
- (3) Height of underfloor space can be made smaller because, unlike previous systems, Hitachi's spot cooling system does not pass cool air under the floor.



21 Hitachi's spot cooling system

It also uses a cooling system with naturally circulated refrigerant. This works by the liquefied refrigerant being heated and then vaporized in the cooling units by the heat from the servers, causing it to flow up the riser pipe due to its lower specific gravity until it reaches the chilled water/refrigerant heat exchanger. The refrigerant is then cooled and condensed by the chilled water in the heat exchanger, after which its higher specific gravity causes it to return to the cooling unit by gravity. This results in the natural circulation of refrigerant without the need for a pump or other external driving force.

When combined with highly efficient heat sources such as inverter turbo chillers or free cooling (FC), the spot cooling system can save up to 60% of total system energy consumption.

\* An air conditioning method that cools the entire server room by discharging cool air from the floor.

## 22 Hyper Hydrogen Compressor for Hydrogen Refueling Station

Hitachi has delivered hyper hydrogen compressors to JX Nippon Oil & Energy Corporation for use in hydrogen refueling stations.

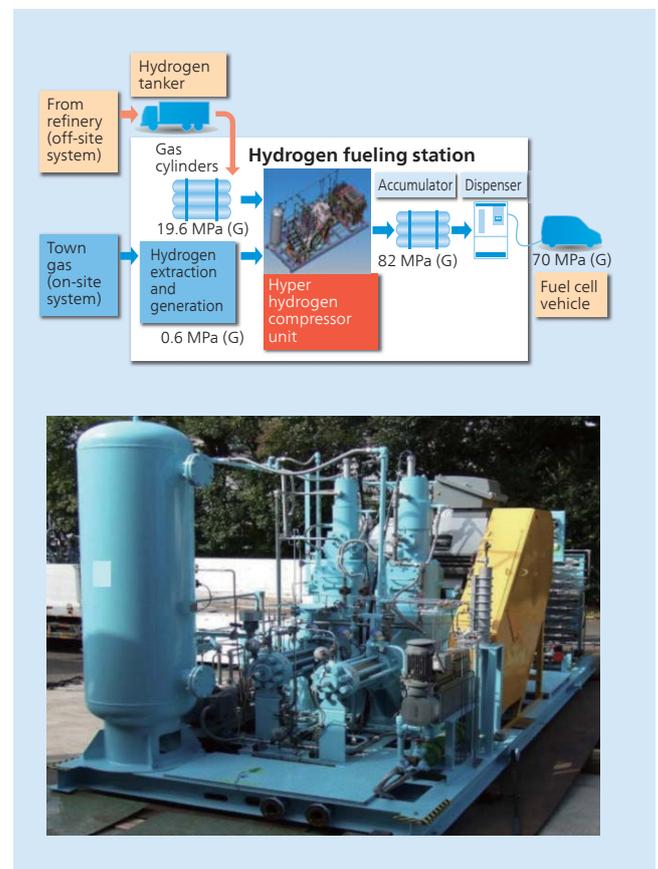
To help prevent global warming, fuel cell vehicles, which do not emit carbon dioxide gas (CO<sub>2</sub>), are anticipated to enter widespread use worldwide. Fuel cell vehicles run on hydrogen gas, making them an alternative to fossil fuel. In Japan, automotive manufacturers have targeted 2015 as the date for commencing sales of fuel cell vehicles to the public. In order to promote use of fuel cell vehicles, the Japanese government plans to construct 100 hydrogen fuel gas stations in Japan by 2015. At these stations, compressors that handle flammable pure hydrogen and discharge hydrogen at hyper pressure (82 MPa) will be installed to supply the fuel gas to vehicles.

The most reliable and safe machines are essential for this application. Hitachi has been supplying medium-large hyper compressors with a delivery pressure of 343 MPa of ethylene for over 40

years. Based on this hyper compressor technology, Hitachi has also been developing state-of-the-art hyper hydrogen compressors for several years with the assistance of government funding.

The special features of the hyper hydrogen compressors are as follows.

(1) Sliding parts that achieve high reliability and long life through the injection of lubricant into the compressor. The quality of discharged hydrogen gas is guaranteed to satisfy the ISO-14687



22 Process flowchart for hydrogen fueling station (top) and hyper hydrogen compressor (bottom)

standard.

(2) Compact frame construction achieved by the development of a special crank mechanism. The same technology is utilized in the hyper ethylene compressor.

(3) High level of safety and reliability achieved by the adoption of materials to comply with Japan's latest High Pressure Gas Safety Law. This law specifies which materials are to be used to avoid hydrogen embrittlement based on joint research by government authorities and relevant universities.

(4) High reliability was demonstrated by a full load test that involved repeated loading and unloading of gas under actual conditions.

Hitachi intends to work actively on developing hydrogen compressors in anticipation of growing requirements for infrastructure to encourage wider use of fuel cell vehicles.

through the provision of business improvement consulting and by building manufacturing equipment and systems. In particular, Hitachi has released its MES package software and supplied more than 130 installations to about 70 companies, mainly in Japan.

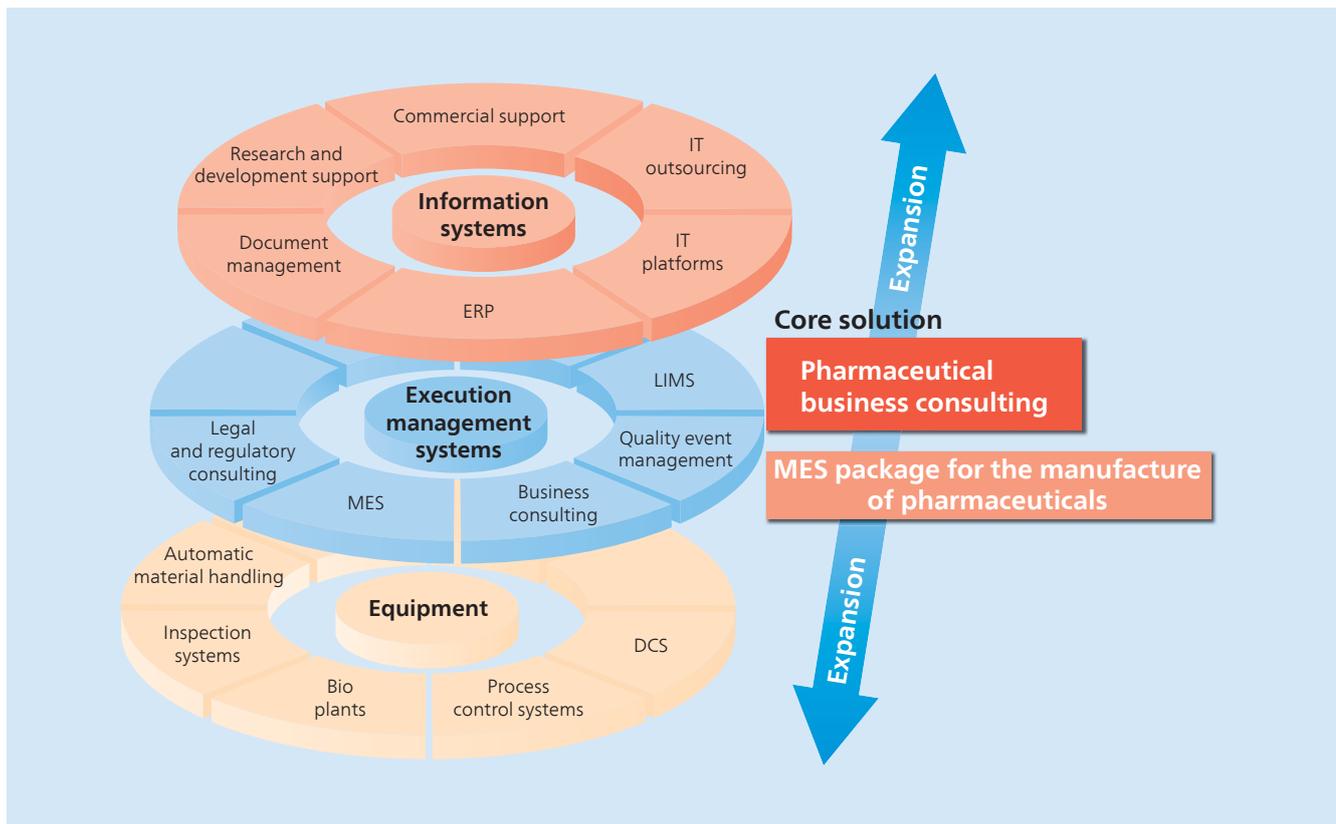
Asia currently has a high profile in the pharmaceutical manufacturing market, with China and India in particular experiencing rapid annual growth of 10% or more. It is anticipated that the size of these two markets will be the second and seventh largest respectively in the global market by 2015\*. Hitachi is proceeding with the establishment of its own business by utilizing its extensive industry experience with MESs and its business improvement consulting to gain a foothold in these growth markets. It has had dedicated teams stationed in China (Beijing) and India (New Delhi) since 2012, and has commenced engineering work in partnership with local companies.

In the future, Hitachi intends to extend its solutions beyond control systems and manufacturing equipment for pharmaceutical product manufacturing processes to also include information systems, and to expand the services it offers progressively from consulting to system configuration and after-sales support.

\* Source: IMS Market Prognosis (May 2012)

## 23 Pharmaceutical Manufacturing Solution for China and India

Since the 1990s, Hitachi has been helping pharmaceutical manufacturers ensure high quality and improve business efficiency



23 Solutions for pharmaceutical industry

# Plant and Factory Equipment



1 Pickling line and tandem cold mill at Ternium Mexico S.A de C.V



## 1 Ternium Mexico S.A de C.V Pickling Line and Tandem Cold Mill

The pickling line and tandem cold mill (PL-TCM) supplied to Ternium Mexico S.A de C.V of the United Mexican States has commenced commercial operation and is operating. In addition to its main purpose of producing automotive sheet steel, the plant is also capable of producing a wide range of other steel grades, including electrical and high strength steels.

The plant control system includes Hitachi's plant controller capable of high-speed computing, insulated-gate bipolar transistor (IGBT) drives with high performance and capacity, and process input/output (I/O) equipment and small and medium-capacity drives supplied by a North American vendor. During site commissioning, Hitachi's system integration capabilities and past experience and know-how ensured that product quality requirements were met along the entire strip length, and helped commence commercial operation ahead of schedule. Hitachi also utilized local electrical suppliers in the commissioning work so that they could act as a local point of contact after the plant entered operation and to ensure comprehensive after-sales service.

In the future, Hitachi intends to undertake further work in the Central and South American markets.

(Commencement of commercial operation: August 2013)

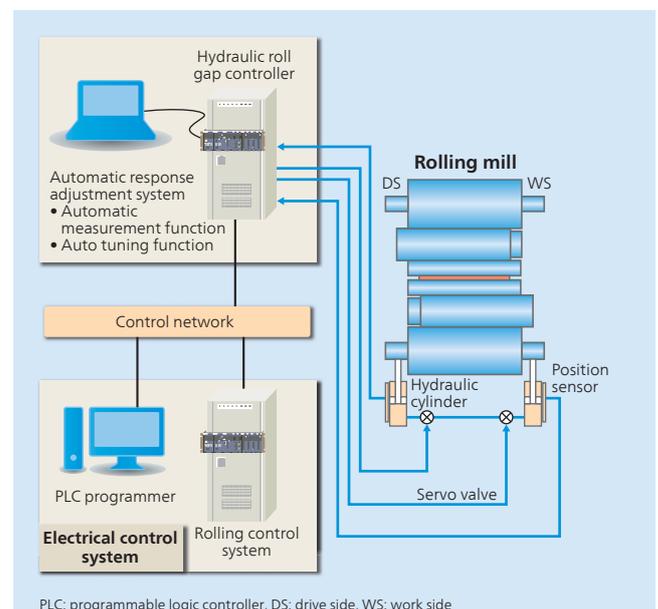
## 2 Automatic Response Adjustment System for Hydraulic Roll Gap Controller

Improving strip thickness accuracy and maintaining stable operation are key challenges for rolling mills, and adjusting the response of their hydraulic roll gap controller is a critical aspect of their maintenance. In the past, maintenance staff have made ongoing adjustments to the control gain based on response

measurements to achieve the desired performance. As a result, this response adjustment work has taken up considerable time and effort during rolling mill maintenance shutdowns.

Hitachi's newly developed automatic response adjustment system consists of an automatic preset measurement function that performs measurements for a number of preset control gains, and an auto tuning function that searches the control gain that achieves the desired response performance. The new system also significantly improves the efficiency of maintenance work by introducing a new single frequency waveform measurement method in place of the sweep frequency waveform measurement used previously, reducing the measurement time from 30 s to only 5 s.

Operating in conjunction with the electrical control system, the new system can also perform rapid adjustment of the response prior to rolling to ensure that the mill is set up appropriately for



2 Standard configuration of automatic response adjustment system for hydraulic roll gap controller

actual rolling conditions when the mill response changes, such as the roll position change and the roll exchange.

In the future, Hitachi intends to expand applications for the new system as part of its electrical control systems.

### 3 3.3-kV IGBT Inverter (Second Generation)

Hitachi has contributed to the new construction or upgrading of numerous steel manufacturing plants in Japan, China, South Korea, and other Asian countries by supplying 3.3-kV IGBT inverter drives. It has now developed a second generation of 3.3-kV IGBT inverter drives for rolling mills that have been designed to meet user needs throughout the world. To this end, they include comprehensive changes to device dimensions and available drive capacities, while still maintaining the features of previous models.

Three key features of these drives are listed below.

- (1) Use of globally standard 3.3-kV/1.5-kA (3.0-kAp) IGBTs to increase output capacity and ensure long-term product availability.
- (2) Smaller drive size due to simplified circuit design. The new drive is 55% smaller (panel width dimension) than the equivalent earlier model (for a 10.4-MVA drive).
- (3) A range of different capacities are available, meaning that the best drive system can be selected to suit user requirements. This is achieved by using a configuration in which main circuits are connected in parallel. Maximum capacity is 13.0 MVA (or 26.0 MVA in a two-bank configuration).

(Commencement of production: September 2013)

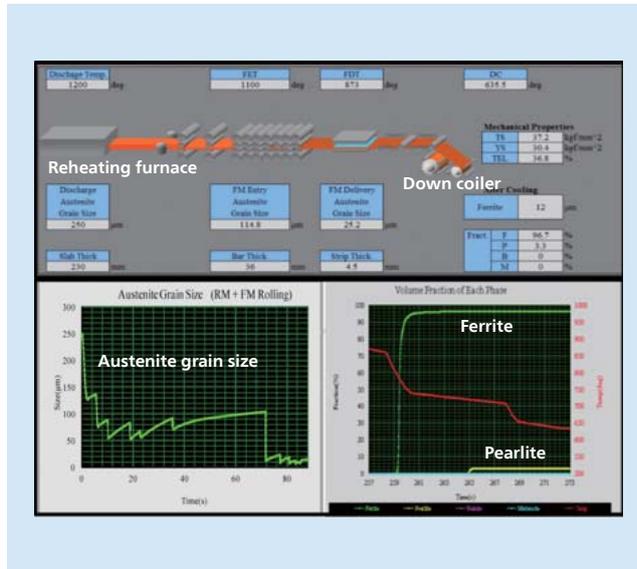


13.0-MVA converter/inverter

Parameter	Specification					
Circuit type	Three-level NPC inverter					
Motor type	Three-terminal			Six-terminal		
No. of converter panels	1 × 2 banks					
No. of cell unit rows	1	2	3	4	2 × 3 rows	2 × 4 rows
Rated output (MVA)	3.8	7.0	10.1	13.0	20.2	26.0
Rated output voltage (Vrms)	2,250					
Cooling	Water cooled (purified water)					
Overload	150% for 1 min					
Conversion efficiency	98% or higher (converter + inverter)					

NPC: neutral point clamped

3 Second-generation 3.3-kV IGBT inverter and its specifications



4 Example results screen for material properties simulation system for hot rolling [Summary screen (top) and graphs of changes in grain size and microstructure fractions (bottom)]

### 4 Material Properties Simulation System for Hot Rolling

In addition to dimensional control of strip thickness and width, hot rolling also needs to meet targets for material properties such as steel strength and formability. To meet this requirement, Hitachi has developed a simulation system for predicting the material properties of hot rolled steel strip.

Using actual data on strip temperature and rolling conditions collected from the hot rolling process, this system can estimate the metallurgical properties of the steel (including grain size, volume fraction of different microstructures, and dislocation density) from the time the slab is inserted into the reheating furnace until it is coiled by the down coiler and predict the mechanical properties (including strength, hardness, and elongation) of the coiled strip. In addition, the system can simulate how the mechanical properties will change for a designated strip [specified using a human-machine interface (HMI)] in response to changes in its temperature history, reduction at each stand, and chemical composition. It also has a learning function that adjusts the prediction parameters to correct for any error between the actual and predicted mechanical properties.

Having delivered the first implementation in May 2013, Hitachi anticipates that the new system will be used for purposes such as the management of hot rolled strip quality and to help design optimal rolling schedules.

### 5 PBS Production Plant at PTT MCC Biochem Co., Ltd.

Hitachi has extensive experience in supplying equipment and constructing plants for production of polycondensation polymer as engineering plastics in the world. In particular, it is notable that Hitachi has own high-performance special polymerization processors that are designed and produced by being based on simulation of the polymerization reaction. In February 2013,



5 High-performance special polymerization processor

Hitachi made a full turnkey agreement for production plant of polybutylene succinate (PBS), a biodegradable plastic with its capacity of 20,000 t per year with PTT MCC Biochem Co., Ltd., a joint venture between PTT Public Co., Ltd. of the Kingdom of Thailand and Mitsubishi Chemical Corporation.

Among chemically synthesized biodegradable plastics, PBS is classified as a plastic with particularly good degradability. It is seen as a viable alternative to polyethylene, polyvinyl chloride, and polypropylene whose applications are such as degradable plastic bags or multi-wall agricultural plastic sheet. Moreover, PTT MCC Biochem plans to build the Succinic Acid and 1,4-Butanediol plants as feed stocks of PBS plant. By achieving the above plans, PTT MCC Biochem will realize production of environmentally sustainable plastics that do not depend on fossil fuel resources.

(Commencement of operation: April 2015)

systems. Those systems include equipment, electrical instrumentation, and monitoring and control systems. In addition, on-site construction work, commissioning, and validation services were supplied by Hitachi. Features of the new plant include optimal design for large-scale cell culture using sophisticated culture process simulations, and automation of almost all processes including cleaning, sterilizing and process operations. Following trial production by the customer and auditing of the equipment by the supervisory authority, the plant is scheduled to receive drug manufacturing approval during FY2013.

Technologies such as process automation and the scale-up of bioreactors acquired through this plant construction will be able to be deployed in other plants for antibody drugs or vaccines productions using mammalian cell culture.

## 6 Pandemic Influenza Vaccine Production Facility for Kitasato Daiichi Sankyo Vaccine Co., Ltd.

A pandemic influenza vaccine production facility that uses a mammalian cell culture system supplied by Hitachi to Kitasato Daiichi Sankyo Vaccine Co., Ltd. was constructed as the second stage of Ministry of Health, Labor and Welfare project for establishing production capabilities for pandemic influenza preparedness. Were a pandemic to occur, the facility would produce and supply sufficient vaccine for 40 million of Japan's roughly 130 million people within half a year.

The scope of the contract includes the cell culture, virus propagation, virus recovery and concentration, and purification processes, as well as culture medium and buffer preparation



6 Virus production room in pandemic influenza vaccine production facility

# Medical Equipment and Systems



1 Nagoya Proton Therapy Center (left) and proton therapy treatment room (right)

## 1 Japan's First Spot Scanning Proton Therapy System at Nagoya Proton Therapy Center

In January 2014, the Nagoya Proton Therapy Center became the first clinic in Japan to treat patients using proton spot scanning. The new system operates alongside two existing treatment rooms that started treating patients in February 2013 and use a passive scattering system. This means that the Nagoya Proton Therapy Center now has three treatment rooms, two with rotating gantries and one with a fixed-nozzle system. The center is part of Nagoya City's "Quality Life 21 Johoku" program that fosters the health-care and welfare of its people. The newly installed spot scanning system is Hitachi's latest proton therapy system.

Compared to conventional passive scattering, spot scanning can target the proton beam more accurately on complex tumor shapes, reducing adverse effects on surrounding healthy tissue while still delivering a high dose to the tumor. Two other features of spot scanning are that it eliminates the need for patient-specific beam shaping collimators and compensators (which eventually become radioactive waste), and that its high proton usage factor minimizes the generation of harmful secondary radiation.

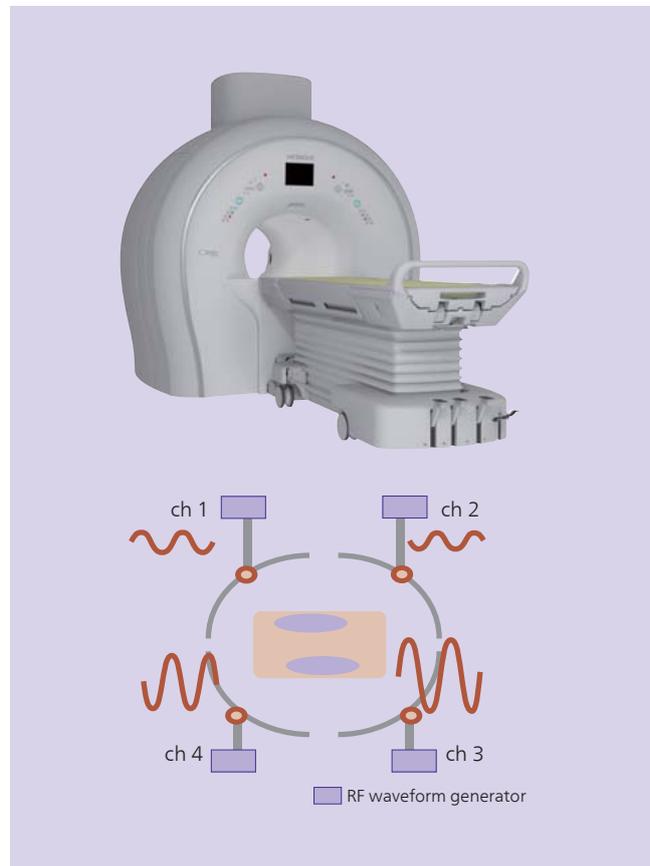
## 2 3T MRI System Superconducting MRI System

The 3T (tesla) MRI System superconducting magnet magnetic resonance imaging (MRI) system uses the same oval gantry bore shape that was highly rated in the 1.5T MRI System.

Since the body of the subject lying on the bed spreads out to the sides, 3T MRI System has been given a 74-cm-wide oval bore so that large-bodied or claustrophobic subjects do not feel oppressed by the equipment. Extending the exam space out to the sides also enables the subject on the bed to be moved sideways. This

movement enables imaging at the center of the magnetic field (the location providing the highest image quality) even when imaging off-center locations such as shoulder joints.

3T MRI System achieves high image quality by using a radio frequency (RF) irradiation coil enabling 4-channel, 4-port independent control. Since 3T MRI Systems are generally prone to



2 3T MRI System superconducting MRI system (top) and schematic diagram of RF irradiation coil with 4-channel, 4-port independent control (bottom)

non-uniform RF irradiation of the torso region, 3T MRI System acquires an RF map used to check the RF irradiation status during the exam. This map is used to control the irradiated RF waves by independently controlling the 4 channels to reduce RF irradiation non-uniformity, providing a highly uniform image.

Hitachi will continue to develop distinctive superconducting MRI systems driven by its original technologies.  
(Hitachi Medical Corporation)

### 3 Supria Full-body X-ray CT Diagnostic System

With seniors (those aged 65 and over) accounting for over 24% of Japan's total population in 2012, Japan's medical industry requires medical exam and treatment methods that meet their needs. Since the nuclear power plant disaster in 2011, the public has been increasingly worried about exposure to X-ray radiation, with the medical industry called on to reduce exposure to subjects and medical workers.

Supria\* is a recently developed 16-channel computed tomography (CT) system with an open and compact design concept enabled by a top-class aperture diameter (75 cm) and reduced gantry size. Consisting of just three units (one less than conventional models), it can be installed in exam rooms of limited space.

Supria features several advanced technologies used in higher-end 64-channel/128-slice CT systems, such as the image noise reduction technology that uses an iterative approximation-based reconstruction algorithm that is a promising approach to reducing exposure. Supria can provide high-definition images in little imaging time, with better operation than conventional models.

(Hitachi Medical Corporation)

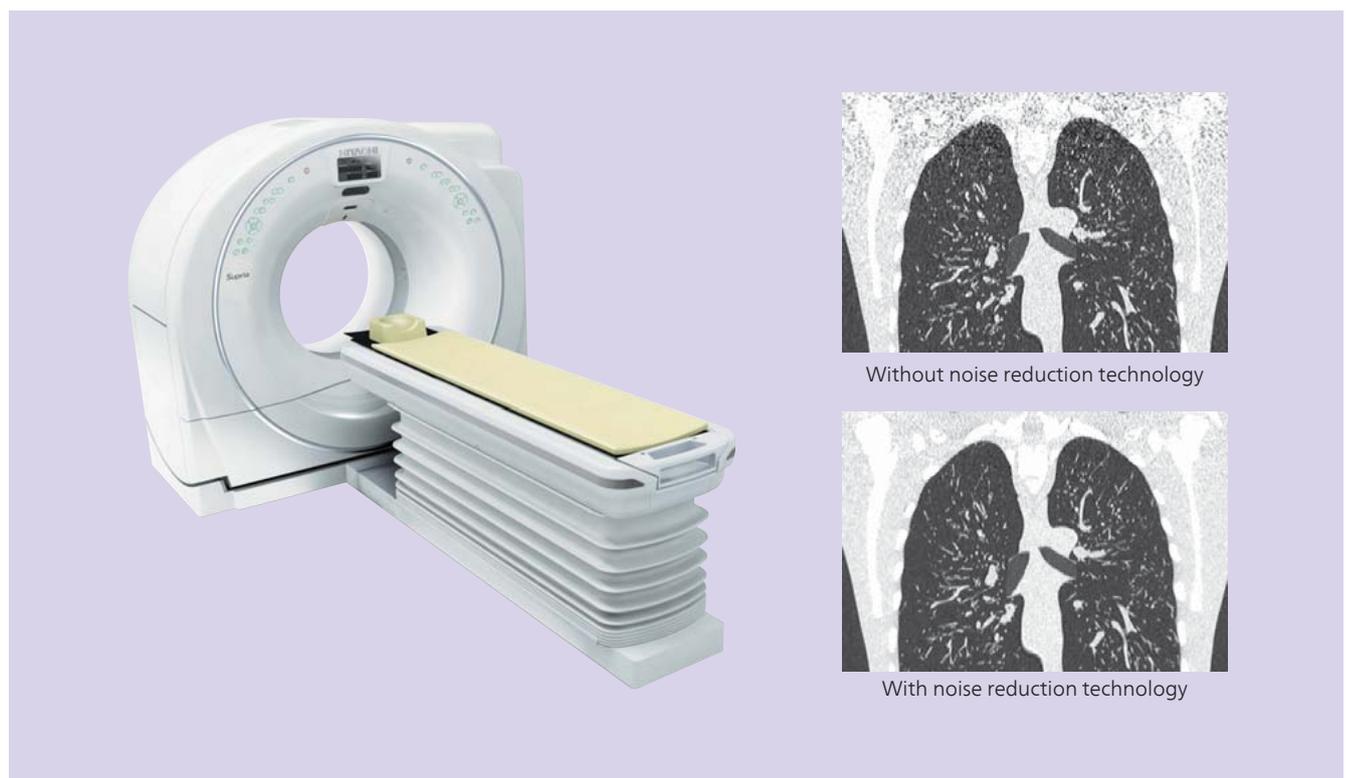
\* Supria is a trademark of Hitachi Medical Corporation.

### 4 ARIETTA 70 and ARIETTA 60 Diagnostic Ultrasound Systems —Visualize and Sense Ultrasound—

The ARIETTA 70 and ARIETTA 60\*<sup>1</sup> are Hitachi's latest diagnostic ultrasound systems. They were developed with the assistance of Central Research Laboratory, Hitachi, Ltd. and combine technologies from Hitachi Medical Corporation's HI VISION\*<sup>2</sup> series and the ProSound\*<sup>1</sup> series manufactured by the former Aloka Co., Ltd. These compact diagnostic ultrasound systems feature outstanding image quality achieved through a range of technical enhancements that extend from ultrasound signal generation to image processing.

Sensitivity and resolution are essential features for diagnostic ultrasound imaging and the new models achieve these through the use of multi-layered crystal technology in the probes and an optimized compound pulse wave generator<sup>+</sup> (CPWG<sup>+</sup>) as the front-end. To deliver the clearest possible images, the systems utilize the powerful signal processing technologies of the backend unit and incorporate a wide-field, high-contrast IPS-Pro\*<sup>3</sup> monitor. Each and every component of the imaging platform harmonizes to guarantee the high image quality and performance of the ARIETTA 70 and ARIETTA 60.

Real-time Virtual Sonography and Real-time Tissue Elastography\*<sup>2</sup> are now seen as essential requirements for diagnostic ultrasound examinations. As well as being a pioneer of this technology, Hitachi Aloka Medical, Ltd. has also upgraded these functions in the new systems. Another feature is a two-dimensional (2D) tissue tracking function for evaluating cardiac muscle movement and changes in phase. An extensive range of probes are available for the ARIETTA 70 and ARIETTA 60 to suit different clinical applications. Together, these features make the new diagnostic ultrasound systems suitable for a wide range of clinical purposes.



3 Supria 16-channel CT scanner (left) and comparison of image without/with noise reduction technology (right)



4 ARIETTA 70 (left) and ARIETTA 60 (right) diagnostic ultrasound systems

(Hitachi Aloka Medical, Ltd.)

\*1 ARIETTA and ProSound are registered trademarks or trademarks of Hitachi Aloka Medical in Japan and other countries.

\*2 HI VISION, Real-time Virtual Sonography and Real-time Tissue Elastography are registered trademarks or trademarks of Hitachi Medical Corporation in Japan and other countries.

\*3 See "Trademarks" on page 142.

## 5 Argus Safety-based Solutions for Safety Information Management Systems

Pharmaceutical companies are required to collect and evaluate drug safety control information, and report it to regulatory authorities. As drug development and sales have become increasingly globalized in recent years, pharmaceutical companies are

being called on for fast and accurate reporting to regulatory authorities in areas such as Japan, the USA and Europe.

The pharmaceutical industry has responded with increasingly widespread moves to implement new safety information management systems designed to enable unified management of safety control information for more efficient business operations and strategic analysis and evaluation of aggregated data.

Drawing on its experience with the start of Japan's domestic safety information management system, Hitachi has developed a solution based on Oracle\* Argus Safety. Argus Safety is a single-instance global package in use by many global pharmaceutical companies. Hitachi has implemented the first full operation of Argus Safety by a Japanese domestic pharmaceutical company. Hitachi offers the following advantages.

- (1) Thorough knowledge of Japan specific regulatory requirements and knowledge of product issues and solutions.
- (2) Certified as one of Oracle Diamond Partners, and able to solve problems rapidly while exchanging information directly with product developers.
- (3) Accumulated knowledge of past potential issues and solutions for key processes such as defining requirements, design, and data migration.

These solutions will be used to provide continued support for safety information management work done by pharmaceutical companies in future.

\* See "Trademarks" on page 142.

### Ability to deal with problems unique to Japan

- Thorough knowledge of Green Book information
- Knowledge of implementation states of other companies
- Experience in developing safety information management system for Japan from scratch

### Understanding of Argus specifications for Japan

- Understanding best-adapted version for Japanese specifications
- Understanding product issues
- Understanding unsatisfied regulatory requirements for Japan

### Key points of data migration

- Expertise in Argus data structure investigation
- Stockpile of control data investigation results
- Expertise in configuration and data migration correlations

### Expertise in working with Oracle Corporation

- Strengthening partnerships
- Periodic discussion of issues
- Experientially derived expertise in maintaining coordination within project as it progresses

### Understanding of potential issues

- Actual project experience leading to thorough knowledge of past issues with requirement definitions and basic design (CRP)
- Actual project experience leading to thorough understanding of past issues with data mapping and data conversion

### Stockpiles of solutions

- Possession of Argus target version solutions
- Stockpile of solutions driven by implementing resolutions to issues
- Stockpile of solutions driven by systems for resolving issues
- Understanding of issues requiring requested product improvements

CRP: conference room pilot

## 5 Hitachi advantages for Argus Safety implementation

# Measurement/Analysis Equipment



1 ChromasterUltra Rs UHPLC

## 1 ChromasterUltra Rs Ultra High Performance Liquid Chromatograph

Ultra high performance liquid chromatograph (UHPLC) is analysis instrument enabling high-precision measurement of the compositions and constituent quantities of liquid-soluble substances. UHPLC is able to greatly reduce analysis time relative to general-purpose liquid chromatographs. It can measure a wide range of specimens and components, and is important equipment for many analysis applications such as research and development and quality control in the pharmaceutical, chemical, food, and other industries.

The ChromasterUltra Rs UHPLC enables high resolution and high sensitivity during ultra-high-speed analysis, enabling high-speed analysis of trace impurities, an issue and demand in pharmaceutical research and development. The system's pressure resistance of 140 MPa is the highest in the world\*. This high values enables both ultra-high-speed analysis and use of mobile phases of substances prone to rising analysis pressure such as methanol, providing various analysis variations. The concurrently developed LaChromUltra II Series is a lineup of C18 columns with high resolution performance (50,000 theoretical plates). When combined with high system pressure resistance and a low dispersion system, it enables high resolution analysis and is an asset to analysis labs.

(Hitachi High-Tech Science Corporation)

\* As determined by Hitachi High-Technologies Corporation as at July, 2013, among models sold in Japan.

## 2 SU8200 Series Ultra-high-resolution Field-emission SEMs

Scanning electron microscopes (SEMs) are research and development tools for nanometer-size structure observations and material analysis and used by various organizations such as universities research institutes, and development and quality assurance departments in corporations.

SU8200 series have a new cold field emission (FE) electron gun ideal for ultra-high-resolution observation at low acceleration voltage. They can capture images that are brighter and have much better signal-to-noise (S/N) ratios than conventional electron guns. Signal detection enables discrimination between secondary electron (SE) detection (very good for surface potential contrast) and back-scattered electron (BSE) detection (very good for material compositional contrast), enabling high-contrast image capture of shape or composition information to meet the objectives. The series has greater specimen current than previous models, enabling electron back scattering diffraction (EBSD) analysis. The series also supports high spatial resolution analysis when performing energy dispersive X-ray spectrometry (EDX) using a low acceleration voltage.

The lineup's three models (SU8220, SU8230, and SU8240) are designed for different specimens and applications, assisting material development and research as tools that enable both cutting-edge material structure observations and analysis. (Hitachi High-Technologies Corporation)



2 SU8200 series ultra-high-resolution field-emission SEMs



3 Automatic analyzer system

### 3 Advanced Dispensing Technology of Automatic Analyzer System

As medical treatments become more advanced and diverse, it is important for healthcare facilities to improve both patient service and administrative efficiency. In laboratories that need to obtain accurate measurement results faster and more efficiently, automatic analysis equipment needs to assure data quality, shorten measurement time, microscale reagent and sample volumes, and increase the number of measurement items.

The newly innovated medium-class automatic analyzer system that can be used as a mainstay model for medium-sized hospitals where huge demands and expectation in this category are observed. The system has maintained highly reliable performances being accumulated in previous models.

It uses a new mechanism control method and achieves a minimum specimen dispensing quantity of 1.0  $\mu\text{L}$ . The new control method achieves reproducibility far better than previous methods. Its key features are its specimen dispensing volume and the stability of the specimen quantity adhering to the probe outer walls. Microscaling of gathered sample quantities reduces the impact on pediatric or elderly patients. It also helps reduce quantities of reagents used, enabling a lower running cost and aiding future clinical tests.

(Hitachi High-Technologies Corporation)

### 4 EA1000VX X-ray Fluorescence Analyzer

An X-ray fluorescence analyzer enables non-destructive, rapid measurement of quantities of elements in solid, powder or liquid samples. Since it can be operated easily without special knowledge, it has been widely used by electronic device manufacturers and other companies around the world to screen for environmentally regulated substances since the 2003, announcement of European

regulations on hazardous substances [the Waste Electrical and Electronic Equipment (WEEE) directive and Restriction of the Use of Certain Hazardous Substances (RoHS) directive].

EA1000VX is an X-ray fluorescence analyzer dedicated to measure environmentally regulated substance in samples. It is developed to reduce cost of test for a sample by shortening total measurement time and by improved operation.

Its main features are as follows.

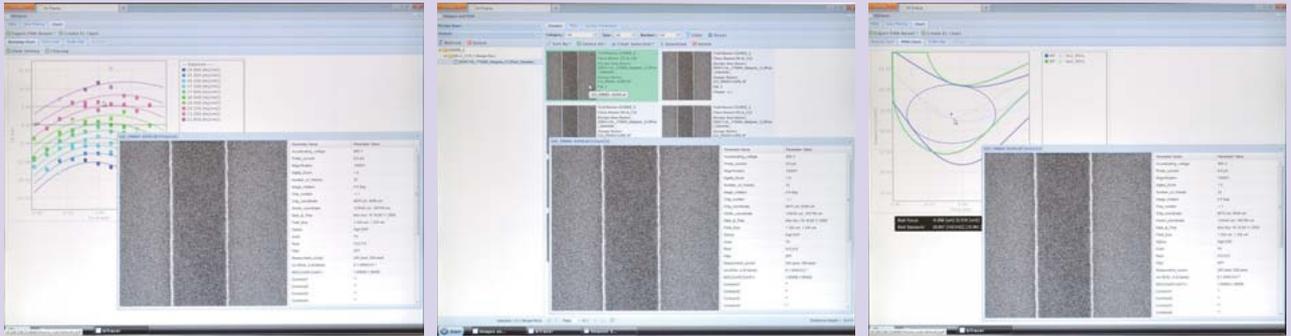
- (1) The use of the high-count-rate silicon drift detector combined with reduced overhead time by simultaneous setup of electrical and mechanical conditions greatly reduced total measurement time to about one-tenth compared to previous Hitachi model.
- (2) A function that automatically identifies measurement sample materials and an easy door operation mechanism reduce the operator's workload.
- (3) Improved analysis/management software facilitates multiple-equipment data base management, trend management, and result list output.

(Hitachi High-Tech Science Corporation)



4 EA1000VX X-ray fluorescence analyzer

# Semiconductor Manufacturing and Inspection Equipment



1 HI5000 metrology and analysis smart solution system

## 1 HI5000 Metrology and Analysis Smart Solution System

The increasing miniaturization of the semiconductor devices that support the global growth of smartphones and tablets has been achieved by continuing progress in device and process technologies, such as advanced lithography technology and topographic device structures. Hitachi has been developing various innovative solutions for fulfilling these demands.

Advances in lithography (technology for patterning extremely fine structure as narrow as 10-20 nm) requires more highly sensitive measurement/monitoring technology that not only manages dimensions but also detects two dimensional (2D) shape changes.

The HI5000 metrology and analysis smart solution system for advanced semiconductors is an application server-type system created from a platform consisting of a critical dimension (CD) measurement algorithm for a Hitachi critical dimension scanning electron microscope (CD-SEM), and a high-precision contour extraction technology that uses this algorithm. Using measurement results automatically acquired from the CD-SEM and using SEM image data, a re-measuring function, process window analysis function and 2D shape comparison function provide yield-improving solutions such as optical proximity correction (OPC), process condition setting, and process variation monitoring.

This system is promising for use as a solution platform that helps improve yields in more miniaturized and complex device generations with a minimum processing dimension of 20 nm

or less.

(Hitachi High-Technologies Corporation)

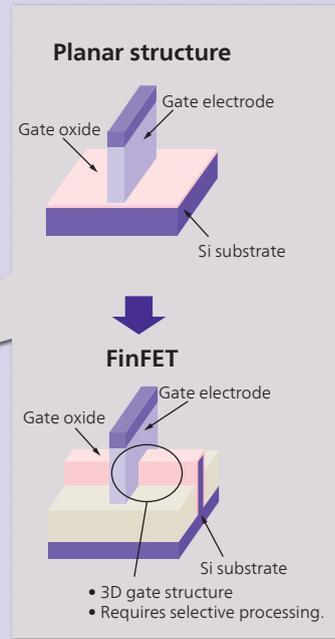
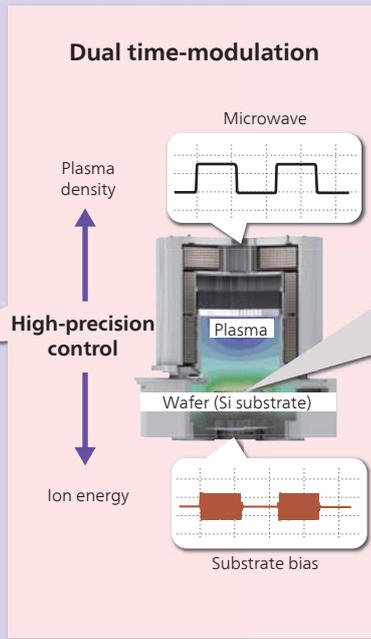
## 2 Dual Time-modulation High-precision Plasma Etching Control Technology

Transistor architectures have characteristically adopted a planar structure. While the conventional planar structure runs up against device scaling limits in 22-nm node devices, new 3D transistor architectures, such as fin-shaped transistors (FinFETs), offer ways of overcoming this scaling limitation. Hitachi has led the industry in the use of microwave electron cyclotron resonance (ECR) plasma etchers enabling miniaturized processing for semiconductor manufacturing. But processing for the new 3D structures requires profile control that can handle large steps (high aspects) and complex film structures, and selectivity that enables selective etching of only the film to be processed.

Dual time-modulation is a high-precision plasma etching control technology that can meet these needs. This technology creates wafer bias pulses for precise control of the conventional ion energy [wide range time-modulation (WR-TM)], creates pulses in the microwaves that generate the plasma, and can precisely control the plasma density. By optimizing each of these features, the technology enables high-precision processing adapted to 3D structures.

This technology is used in Hitachi's mainstay M-8000 series and M-9000 series, and can be retrofitted in equipment already delivered, enabling support for user needs.

(Hitachi High-Technologies Corporation)



2 Dual time-modulation system

### 3 RQ9000 Optical Media Tester

Used for final inspection in media manufacturing processes, this optical media tester tests for minute defects on media surfaces using optical technology. The continual increase of hard disk capacity and recording density is creating a need for faster, more precise media inspection processes.

RQ9000 contains two optical test units (for upper and lower media surfaces) mounted in a compact unit, and uses a laser beam to simultaneously scan the media top and bottom surfaces to detect defects. It enables a better media-surface inspection area

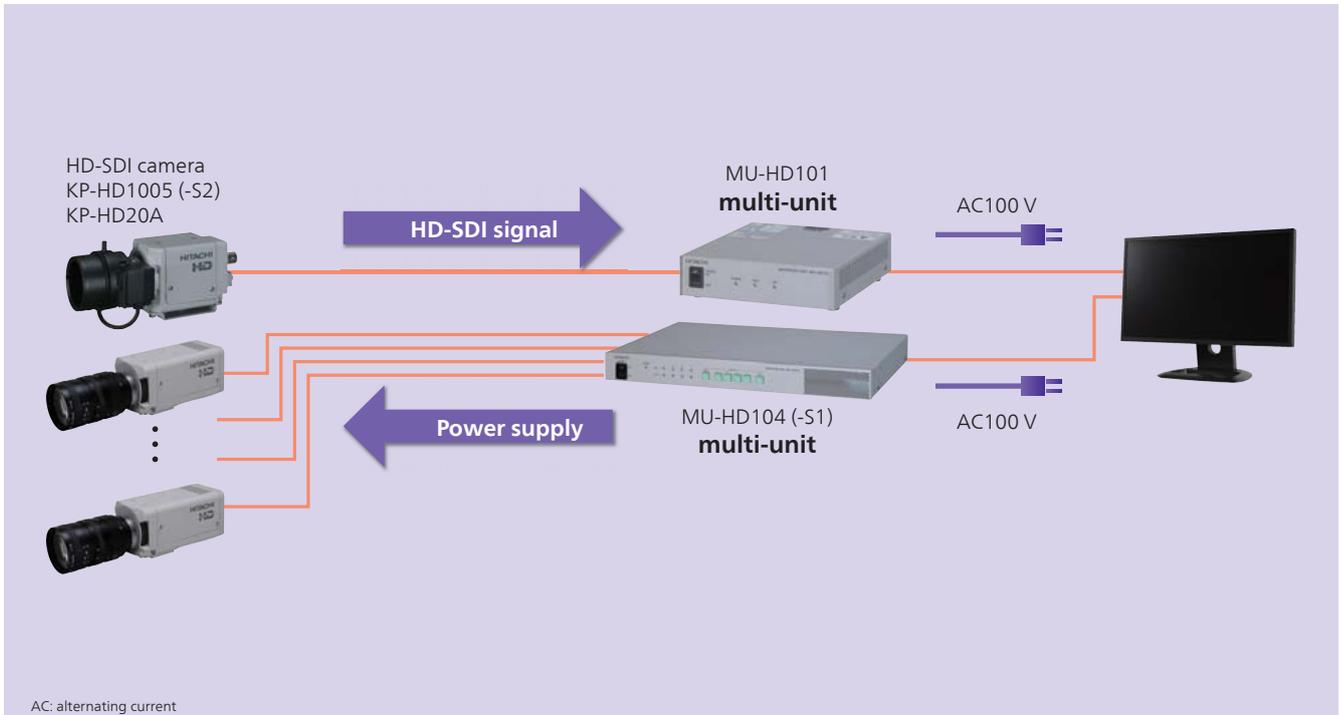
coverage rate than test devices with conventional magnetic heads, and shorter test times. Since the tester does not use a magnetic test head, it supports the thermally assisted recording method, a next-generation technology designed for greater recording density. The system has about the same dimensions as conventional devices, so can be used with handling equipment (used to supply and discharge media completely automatically) and glide test equipment (guaranteeing head floating) to construct the same types of test cells used by conventional equipment. RQ9000 is a media tester that supports media including next-generation thermally assisted recording media.

(Hitachi High-Tech Fine Systems Corporation)



3 RQ9000 optical media tester

# Electronic Equipment and Power Tools



1 Power superimposition function mounted in the multi-unit

## 1 Surveillance Camera System Supporting HD-SDI Broadcast Standard

Hitachi's new-interface surveillance camera system is supporting the high-definition serial digital interface (HD-SDI) broadcast standard. This system supports two camera outputs: a standard-type HD-SDI output, and a High-Definition Visually Lossless CODEC (HD-VLC)\*, which is a compressed output mode for long-distance transmission. HD-VLC uses a line-memory compression process to compress a 1.5-Gbit/s full HD signal to 270 Mbit/s, and achieves 300-m long-distance transmission (100 m for HD-SDI) on coaxial cable (5C-2V) with a delay of 16 ms or less. Integrated with the full HD video signal processing circuit on a single chip, the HD-VLC compression processing circuit is designed to reduce power consumption.

HD-VLC compression output mode is implemented in combination with an HD-SDI multi-unit (peripheral device). A power superimposition function mounted in the multi-unit supplies power by superimposing it on the coaxial cable transmitting the camera image.

Terrestrial digital broadcasting is rapidly switching to Hi-Vision\*. The HD-SDI surveillance camera system will facilitate the easy switch to Hi-Vision for analog cameras currently running in various environments.  
(Hitachi Kokusai Electric Inc.)

\* See "Trademarks" on page 142.

## 2 DH28PCY/DH28PBY Rotary Hammer Drills

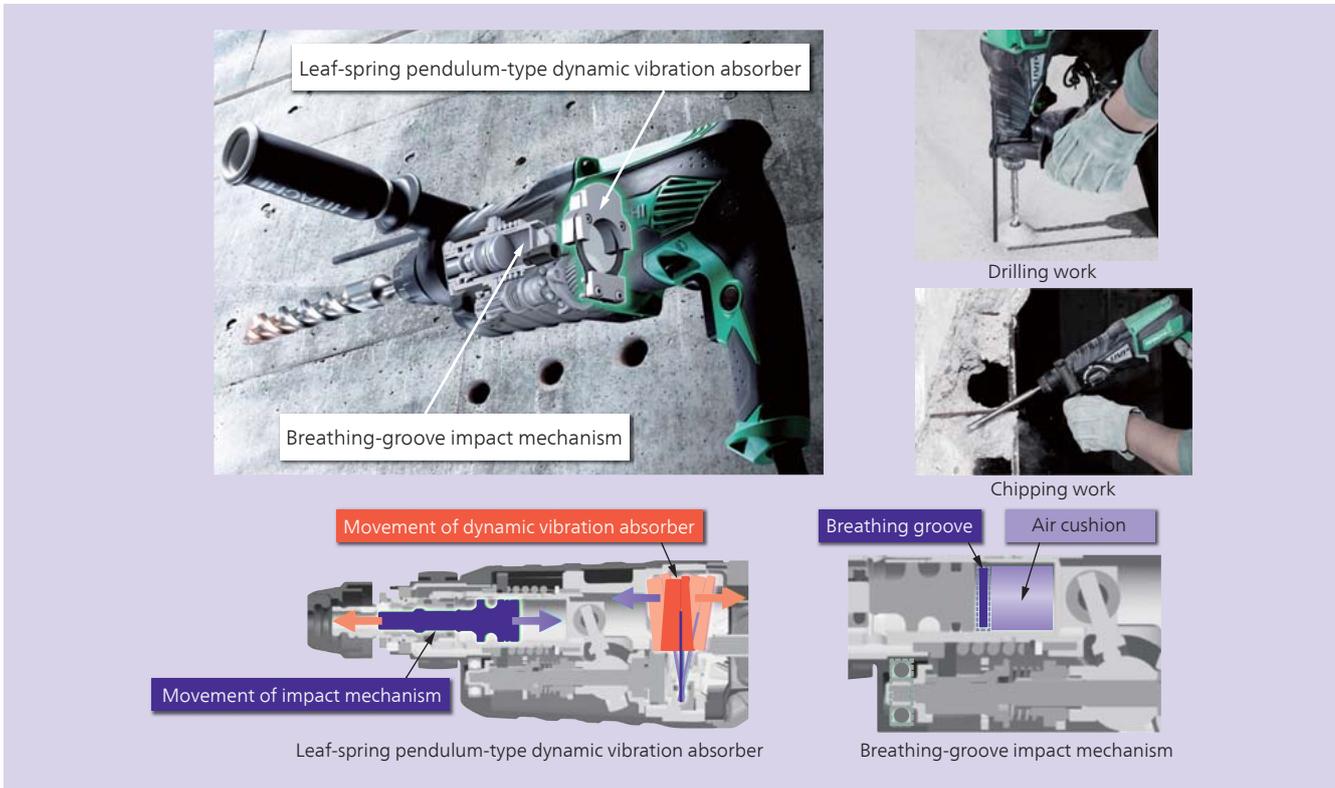
Rotary hammer drills are generally used around the world for concrete drilling and light chipping work. The performance and functionality of rotary hammer drills have improved significantly in recent years, as drilling speeds have increased and low-vibration mechanisms have been added.

A change in the structure of the impact mechanism has given these models the fastest drilling speed in their class\*<sup>1</sup> and improved durability. The use of an original Hitachi leaf-spring pendulum-type dynamic vibration absorber enables a major reduction in vibrations. The main features are as follows.

- (1) Optimizing the breathing-groove impact mechanism and impact specifications enables the fastest drilling speed in this class (30% faster than previous models).
- (2) Improving the air cushioning effect greatly improves durability (twice as durable as previous models).
- (3) An original Hitachi leaf-spring pendulum-type dynamic vibration absorber (world-first\*<sup>2</sup>) enables the lowest level of vibrations in this class\*<sup>1</sup> (33% lower than previous models).  
(Hitachi Koki Co., Ltd.)

\*<sup>1</sup> As of June 2013, for 2-kg-class rotary hammer drills made by domestic Japanese power tool manufacturers (researched by Hitachi Koki Co., Ltd.).

\*<sup>2</sup> As determined by Hitachi Koki Co., Ltd.



2 DH28PCY/DH28PBY rotary hammer drills

### 3 WH14DDL/WH18DDL Cordless Impact Drivers

Users demand cordless impact drivers that provide better work efficiency through higher performance, such as faster screw fastening speed, higher work volume on a single charge, and a more compact/lightweight design.

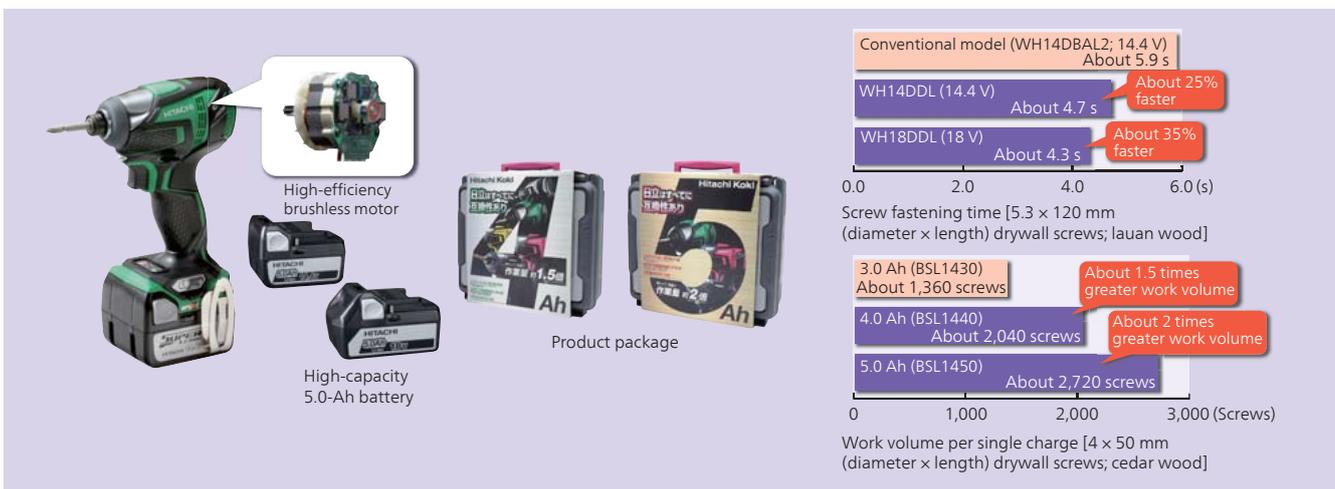
These cordless impact drivers are compact/lightweight models that dramatically improve fastening speed by means of an original high-efficiency Hitachi brushless motor and a feature called an active control system (ACS) that automatically controls the rotation speed and impact timing according to the work load. They can be run on high-capacity 4.0/5.0-Ah lithium ion batteries (developed to be the same size and mass as conventional 3.0-Ah batteries), providing much higher work volume on a single charge. The batteries feature an original multiple protection system developed by Hitachi (protecting against overloading,

over-discharging, and over-charging), giving them long life and compatibility with other tools. The main features are as follows.

- (1) Hitachi's original brushless motor and ACS feature result in the fastest screw-fastening speed in the class\* (25% faster than conventional models).
- (2) Higher work volume on a single charge when run on a high-capacity lithium ion battery (about 1.5 times longer with 4.0-Ah battery; about twice as long with 5.0-Ah battery).
- (3) Compact (128-mm overall length) and lightweight (1.3 kg) design, for excellent adaptability.
- (4) Batteries feature an original multiple protection system developed by Hitachi, giving them long life and compatibility with other tools.

(Hitachi Koki Co., Ltd.)

\* As of August 2013, for 14.4-V/18-V cordless impact drivers made by domestic Japanese power tool manufacturers (researched by Hitachi Koki Co., Ltd.).



3 WH14DDL cordless impact driver (left) and comparison of screw fastening speed and work volume (right)



1 EX8000-6 backhoe mining-use ultra-large hydraulic excavator

## 1 EX8000-6 Backhoe Hydraulic Excavator

As demand for resources continues to increase, mining-use dump trucks are expected to increase in size in efforts to reduce operating costs. To meet this need for larger dump trucks, there is a growing need for the EX8000-6 hydraulic excavator (operating weight: 837 t) with large-capacity bucket. Until now, the EX8000 line of hydraulic excavators featured only front-loading attachment, but an 800-t class backhoe front attachment has been added due to anticipated use in Australia and Republic of Indonesia.

The main features are as follows.

- (1) Uses a 43-m<sup>3</sup> large-capacity bucket for efficient loading into large-scale dump trucks with a loading mass of 300 t or more.
- (2) Features a system that senses the front attachment position and automatically softens the impact at the hydraulic cylinder stroke end while providing a reliable welded construction to enhance the reliability of structures.
- (3) Uses a hydraulic system that makes use of the own weight of the front attachment and recycles the energy to reduce fuel consumption.
- (4) Incorporates a monitoring system that detects the status of the body to reduce downtime and increase the operation rate.  
(Hitachi Construction Machinery Co., Ltd.)

## 2 EX1900-6 Electric-hydraulic Excavator

As fuel prices continue to change, mines are increasingly creating electrical infrastructures that operate rope shovels equipped with electric motors. To meet this market demand, Hitachi has continued to introduce various electric-hydraulic excavators. These hydraulic excavators retrofitted with electric motors have an operating mass ranging from 260 to 800 t. Hitachi has completed a new series, starting with the 190-t class EX1900-6 electric-hydraulic excavator.

The power system electrical machinery of this product is comprised of a three-core cable that receives external power supply, a slip ring that enables the cable connected to the under carriage rotate with the upper swing body, a cubicle that is positioned on the upper swing body and controls starting and stopping of the electric motor, and a high-voltage, three-phase induction motor. This electric motor drives the hydraulic pump in place of the engine and supplies hydraulic pressure to the hydraulic cylinder and the swing and traction motors via the control valve.

The main features are as follows.

- (1) Equipped with a monitor display that indicates the status of the electric motor, power source, and machinery and a realtime fault diagnostic function to reduce downtime.
- (2) Eliminates the use of engine lubricating oil and filters, thereby lowering maintenance costs and the load on the environment.  
(Hitachi Construction Machinery Co., Ltd.)



2 EX1900-6 electric-hydraulic excavator



3 ZX65USB-5A mini hydraulic excavator

### 3 ZX65USB-5A Mini Hydraulic Excavator European Model

The ZX65USB-5A is the next evolution of excavator whose operating mass is 6 t and is built for the European market. It follows the series of compact hydraulic excavators released in Japan in August 2012, ZX30U-5A, ZX35U-5A, ZX40U-5A, and ZX50U-5A, whose operating mass ranging from 3 to 5 t.

The main features are as follows.

- (1) Enables switching between economical mode (conserves fuel) and power mode (increases power) for more economical operations.
- (2) Uses a 3.6-inch multi-liquid-crystal-display (LCD) monitor and floor steps for easy entry and exiting, and offers a wide operator station for greater comfort.
- (3) Easy to maintain due to improved covers for the radiator, tank, engine, and other parts, and divided floor mats for easy cleaning
- (4) Improved safety due to the use of a roll-over protective structure (ROPS)

In addition to these features, Hitachi focused on a variety of attachments that are both durable and reliable to handle diverse usage requirements in various regions in Europe. This model even meets European Union (EU) Stage III A emission regulations.

The ZX65USB-5A has high expectations in the European market as construction machinery that fuses comfort and operability with environmental considerations.  
(Hitachi Construction Machinery Co., Ltd.)

### 4 ZW180-5B Wheel Loader Complies with Standards of Non-road Special Motor Vehicle Act of 2011

The ZW180-5B wheel loader, which meets the latest emission regulations in Europe, North America, and Japan and fuses environmental considerations with operating performance, is now available in Japan.

This product is equipped with an engine control system that determines the work status using various sensors installed in the vehicle and reduces fuel consumption. In terms of actual operations, there is an approximate 10% reduction in fuel consumption over conventional models. This wheel loader features the same basic cab design as the comfortable European model with quality interior panels and greater noise reduction for higher product marketability.

The other features are as follows.

- (1) Choose from normal mode for modest and efficient acceleration or P mode for quicker acceleration and greater excavation power.
  - (2) A ride control system and lift arm smooth stop to reduce operator fatigue.
  - (3) Cooling fan with automatic reverse operation function.
  - (4) Exhaust gas post processing equipment without a particulate matter filter to reduce maintenance costs.
  - (5) Comes with an eco-mark indicator to promote fuel-efficient operation.
- (Hitachi Construction Machinery Co., Ltd.)



4 ZW180-5B wheel loader



5 ZX200-5B hydraulic excavator

## 5 ZX200-5B Hydraulic Excavator Complies with Standards of Non-road Special Motor Vehicle Act of 2011

With growing concerns to reduce carbon dioxide (CO<sub>2</sub>) emissions to ease global warming and new environmental restrictions, such as the Non-road Special Motor Vehicle Act of 2011, which regulates vehicle emissions, the construction machinery sector is looking for technology that conserves energy and provides clean emissions.

The ZX200-5B uses the new energy-saving three-pump/three-valve hydraulic system to realize an approximate 17% reduction in fuel consumption over conventional models (ZX200-3) but with the same workload. In addition, it reduces emissions by trapping particulate matter from the engine in the muffler filter and by burning efficiently with a proprietary exhaust gas temperature control. The variable turbocharger and high-volume cooled exhaust gas recirculation (EGR) system also help to reduce nitrogen oxide (NO<sub>x</sub>) emissions.

In terms of operator safety equipment, the model comes with a head cab that conforms to the Industrial Safety and Health Act for objects dropped from above and an International Organization for Standardization (ISO) standard ROPS cab to protect the operator in the event the hydraulic excavator rolls over. It is also equipped with a rear view monitor to confirm the safety behind the vehicle.

(Hitachi Construction Machinery Co., Ltd.)

## 6 Vibratory Roller Series

Hitachi's new line of vibratory rollers (ZC35C-3, ZC35T-3, ZC50C-3, ZC50T-3) are designed for mid-scale paving work and have the same safety features of existing models but with enhanced

reliability and durability.

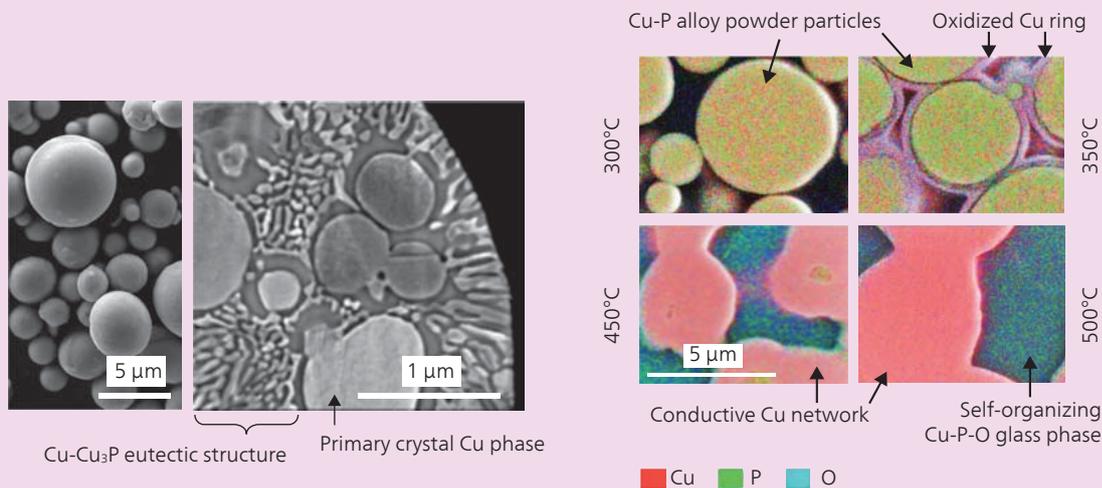
These models conform to the Non-road Special Motor Vehicle Act of 2006 for emissions regulations as well as the standards for ultra-low noise construction machinery set forth by the Ministry of Land, Infrastructure, Transport and Tourism, Japan. These rollers are designed to lessen the load on the environment by using a recyclable aluminum radiator and lead-free wiring. The main harness uses wiring with excellent bending resilience for enhanced durability. The combined roller, featuring a steel wheel in front and tires in the rear, uses a wheel-motor drive system that directly drives the left and right tires with two hydraulic motors. In addition, an optional hydraulic differential lock can be added to eliminate problems caused by one wheel slipping when depressing the pedal and easier extrication from soft ground. A key pad lock system and electronic key lock system are two options available for the anti-theft device.

(Hitachi Construction Machinery Co., Ltd.)



6 ZC50C-3 vibratory roller

# High Functional Materials & Components



Note: The illustration of the atmospheric sintering process was created by compositing a chemical composition map obtained from energy dispersive X-ray analysis on an SEM photograph of an application film cross-section.

1 SEM overview photograph of developed Cu-P alloy powder particles (Cu-7 mass%P), and SEM photograph of cross-sectional structure (left) and atmospheric sintering process (right)

## 1 Copper Electrode Application Film for Silicon Solar Cells Formed by High-temperature Atmospheric Sintering

To create sustainable society, there is a demand for greater use of renewable energy from non-depletable resources such as sunlight. Hitachi has developed a copper (Cu)-based paste for cell electrode formation. It is a high-function paste material that can help lower the cost of silicon solar cells.

To lower cell cost, researchers throughout the world have been working on developing electrode materials made of copper, which is significantly cheaper than the silver (Ag) paste normally used in silicon solar cells. But so far no low-cost material has been discovered that can function as an electrode and can be manufactured using the same high-temperature atmospheric sintering process (at 200 to 900°C) as Ag. Hitachi has responded to this need by developing a material technology that enables electrodes to be manufactured from a low-cost copper-based material with high-temperature atmospheric sintering at a temperature above 200°C. The material is a copper-phosphorus (Cu-P) alloy designed mainly for use in back electrodes of silicon solar cells. It is applied in paste form as an application film.

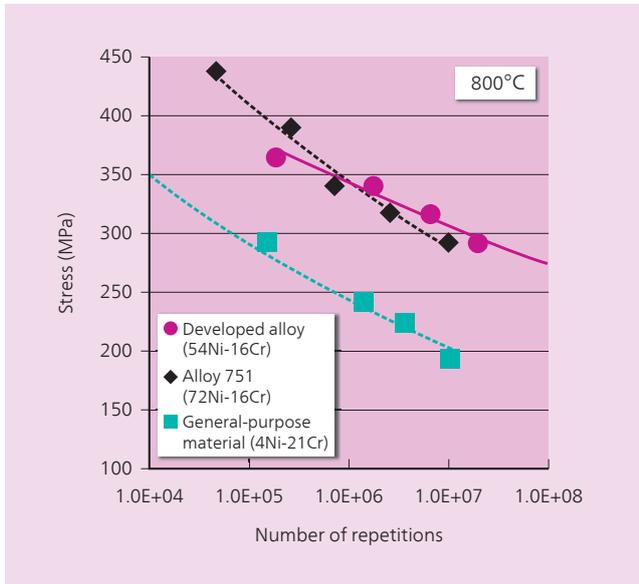
The developed alloy powder appears as spherical particles when viewed under a scanning electron microscope (SEM). The cross-sectional structure of the powder comprises a Cu phase (primary crystals) that starts crystallizing in the cooling process during manufacture, and a Cu phase and copper phosphide (Cu<sub>3</sub>P) compound phase that exhibit final crystallization between the primary crystals. This layered structure is a special structure

known as a eutectic structure. Atmospheric sintering causes the Cu phase to oxidize and disappear at temperatures up to 400°C. At temperatures over 450°C, the Cu<sub>3</sub>P compound is oxidized and disappears, while the previously oxidized Cu phase [copper oxide (Cu<sub>2</sub>O) phase] is deoxidized. As a result, a completely new conductive Cu phase is networked in the sintered application film, creating a material that can satisfy the electrical resistance specification that back electrodes require. Hitachi has also concurrently developed basic technologies supporting a paste able to guarantee barrier performance between the developed Cu-based application film and silicon substrate, and connectivity with tab lines.

## 2 Nickel-saving High-strength Heat-resistant Alloy for Engine Exhaust Valves

A key component of vehicle engines, exhaust valves reach temperatures of over 800°C due to exposure to the high-temperature combustion-gas exhaust from the combustion chambers. Exhaust valve materials therefore need to be strong at high temperatures, wear-resistant and oxidation-resistant. Wanting to increase the fuel efficiency and power of vehicle engines to help protect the environment and save resources, manufacturers are moving toward smaller engines and direct-fuel-injection turbo types. As a result, exhaust temperatures are increasing, and there is increasing demand for engine exhaust valves with high strength at high temperatures.

The developed alloy is a low-cost, nickel-saving heat-resistant



2 Rotary bending fatigue characteristic of engine valve material at 800°C

alloy composed of 54% nickel (Ni) and 16% chromium (Cr). It has the high strength and long-term structural stability demanded for use in exhaust valves in high-performance vehicle engines. It was developed using an alloy design method, with a strengthening mechanism devised from precipitation strengthening enabled by increasing the amount of gamma-prime-phase precipitates, and solute strengthening enabled by adding molybdenum (Mo). It contains more than 15% less Ni than alloy 751 (a conventional heat-resistant alloy composed of 72% Ni and 16% Cr), while exhibiting high strength at high temperatures and maintaining outstanding characteristics after extended high-temperature heating.

Exhaust valves made of this alloy have already been used in mass-produced vehicles.  
(Hitachi Metals, Ltd.)

### 3 Development and Mass-production of Low Dy NEOMAX Magnets

The NEOMAX<sup>\*</sup> neodymium (Nd), iron (Fe) and boron (B) rare

earth sintered magnet shows better coercive force by replacing the main component (Nd) with dysprosium (Dy) since Dy has a higher anisotropic field than Nd. Increased coercive force improves demagnetization durability, and created huge demand of these magnets in applications requiring heat resistance such as factory automation, electric power steering (EPS), and hybrid electric vehicles (HEVs). But since the scale of the commercial production of Dy is very limited, there was supply and price risk. Actually, in 2011, the price of Dy jumped up to about 20 times of its 2008 price, and the reduction of Dy consumption became the top priority issue.

This technology is focusing on magnetic interaction to improve coercive force for Dy reduction. Coercive force can be obtained by separating the main phase (ferromagnetic phase) with a non-magnetic grain boundary phase. Hitachi succeeded in reducing the weight of Dy used in magnets by at least 2%, utilizing the new knowledge on the effect of the additive element to the phases other than the main phase, and the improvement of the magnetization process.

Hitachi will start mass-production of low Dy series magnets in April 2014, and is planning to add a higher-performance series in October.

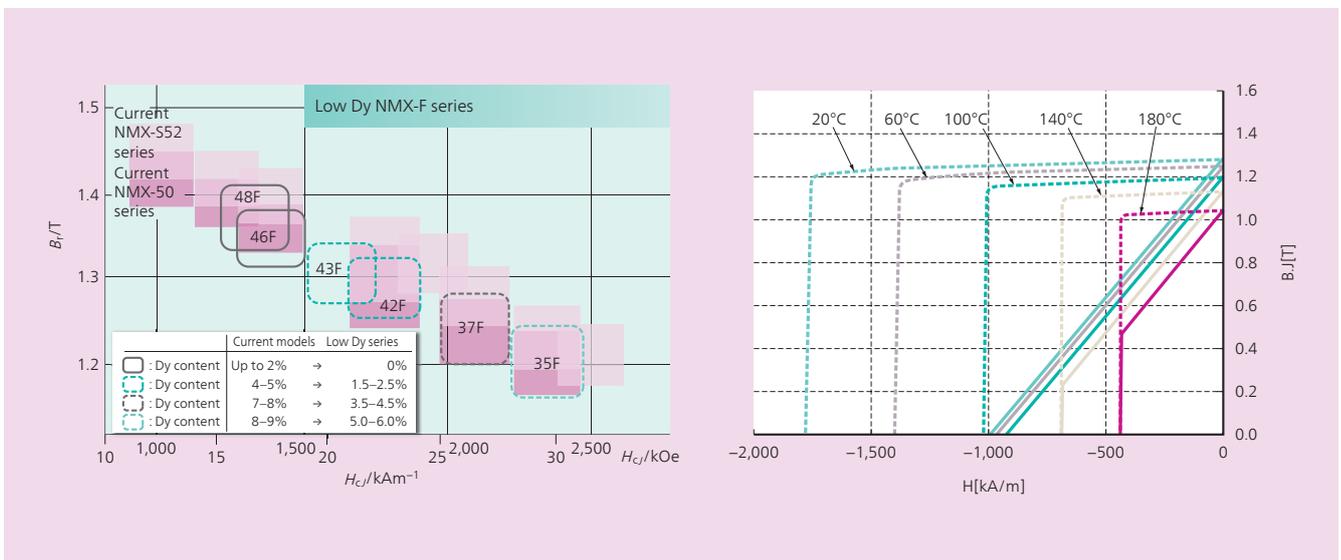
(Hitachi Metals, Ltd.)

\* NEOMAX is a trademark of Hitachi Metals, Ltd.

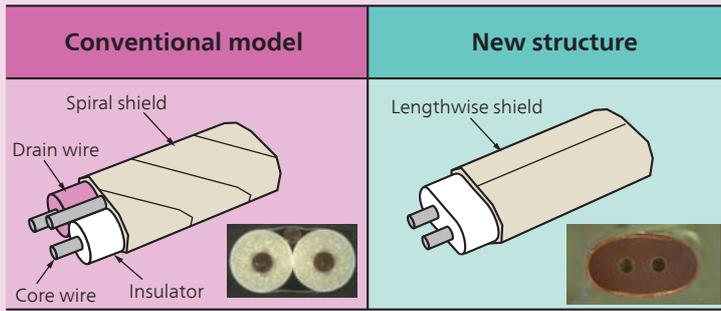
### 4 New Structure Metal Cable for High-speed (25 Gbit/s) Transmission

Servers, switches, storage devices, and other information network devices are increasing in speed and capacity. New structure cable is a metal cable for device interconnection, enabling high-speed transmission of up to 25 Gbit/s to meet near future network device needs.

Due to cost and performance considerations, the cables generally used for interconnection are two-core differential coaxial metal cables. But the faster the signal transmission speed becomes, the greater the effect of signal waveform deterioration caused by the propagation time lag (intra-pair skew) of the signal generated between the two conductors comprising the transmis-



3 Low Dy magnet lineup (left) and temperature characteristic curve of NMX-42F (right)



4 New structure for high-speed (25 Gbit/s) metal transmission cable (left) and harness using new structure cable (right)

sion path. Hitachi has solved this problem by optimizing the interval between the two conductors and strengthening the electrical bond between them by bundling them with an insulator, making the dielectric constant around the two conductors equal. These changes reduce intra-pair skew by over 50% (compared to previous Hitachi Metals models), enabling a cable with no signal waveform distortion even during 25 Gbit/s signal transmission.

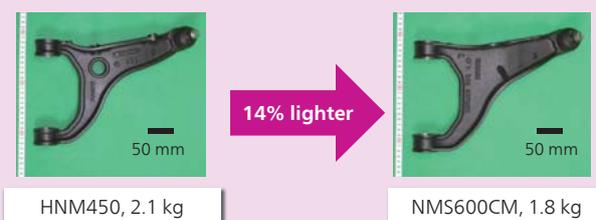
Hitachi is planning to focus on developing faster and slimmer cables, and to augment the lineup of new structure models and harness products using them.  
(Hitachi Metals, Ltd.)

## 5 High-strength, High-toughness Ductile Cast-iron Lightweight Suspension Components

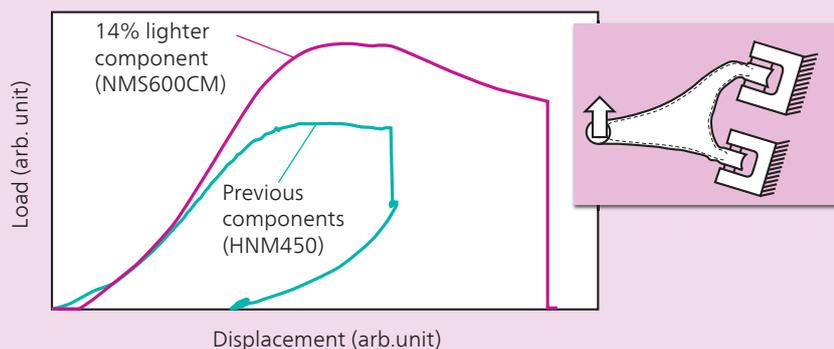
Automotive suspension components should combine enough strength to support the vehicle body with enough toughness to withstand the shock of a collision, while being lightweight. In 2005, Hitachi Metals, Ltd. released NMS380CM, a material with greater toughness than the general cast-iron material FCD370 [stipulated in a superseded Japanese Industrial Standards (JIS) standard]. To meet increased demand for more lightweight suspension parts, Hitachi Metals developed NMS600CM in 2008,



Lower arm for light duty truck



Upper arm for passenger car



5 Example applications for NMS600CM in lightweight suspension arms (top) and the load-displacement graph obtained by bench testing an upper arm for passenger cars (comparison of previous Hitachi model and lightweight NMS600CM) (bottom)

which offers improved material strength. Starting with NMS380CM as a base material, NMS600CM is created by heat treatment and control of components such as silicon, manganese, and copper. It is a material with improved strength, good bending deformation performance and good shock resistance.

NMS600CM has been trialed for the front suspension lower arm of a light duty truck since 2009, and mass production of the arm was commenced in 2010 aiming to reduce weight by 25% relative to the NMS380CM version. In 2011, use was expanded into passenger car rear suspension upper arms. Lightweight components made with NMS600CM have been made 14% lighter than previous components made of Hitachi Metals's HNM450 material (equivalent to JIS FCD450), and have improved the maximum load and deformability of the finished products they are used in. The suspension arms are thin-walled cast components with a minimum wall thickness of 4 mm. Hitachi Metals is working on further development of high-strength, high-toughness materials, helping reduce the weight of suspension components.

(Hitachi Metals, Ltd.)

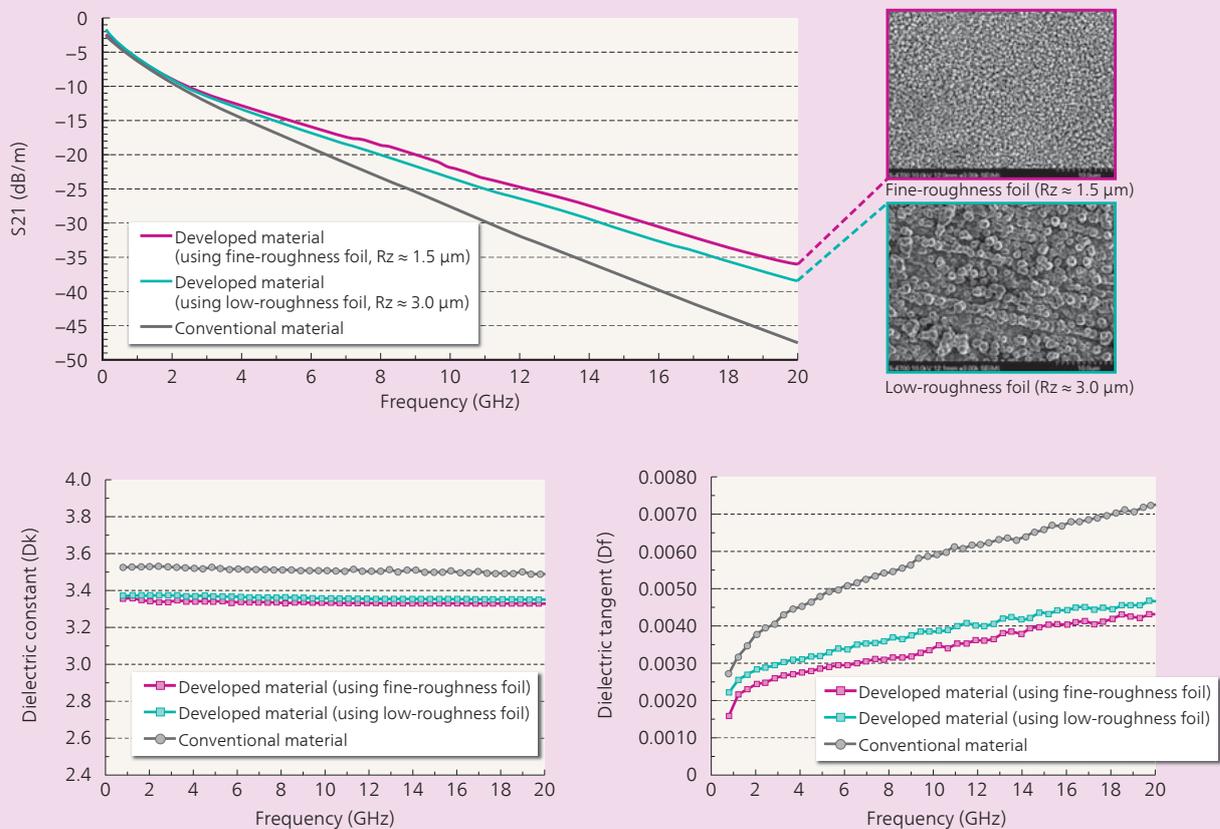
## 6 Low-transmission-loss Multilayer Material for High-speed/high-frequency Signals

In recent years, the ability to handle high speeds and high frequen-

cies has become indispensable for the printed circuit boards (PCBs) used in the high-speed digital devices (such as servers and routers) and wireless devices (such as mobile devices) that require high-speed/large-capacity transmission. For high-speed digital devices, efforts to release a technology for electrical transmission at a next-generation transmission speed (25 Gbit/s per link) are gaining momentum, and there is increasing demand for PCB materials with better high-frequency characteristics than current low-loss materials.

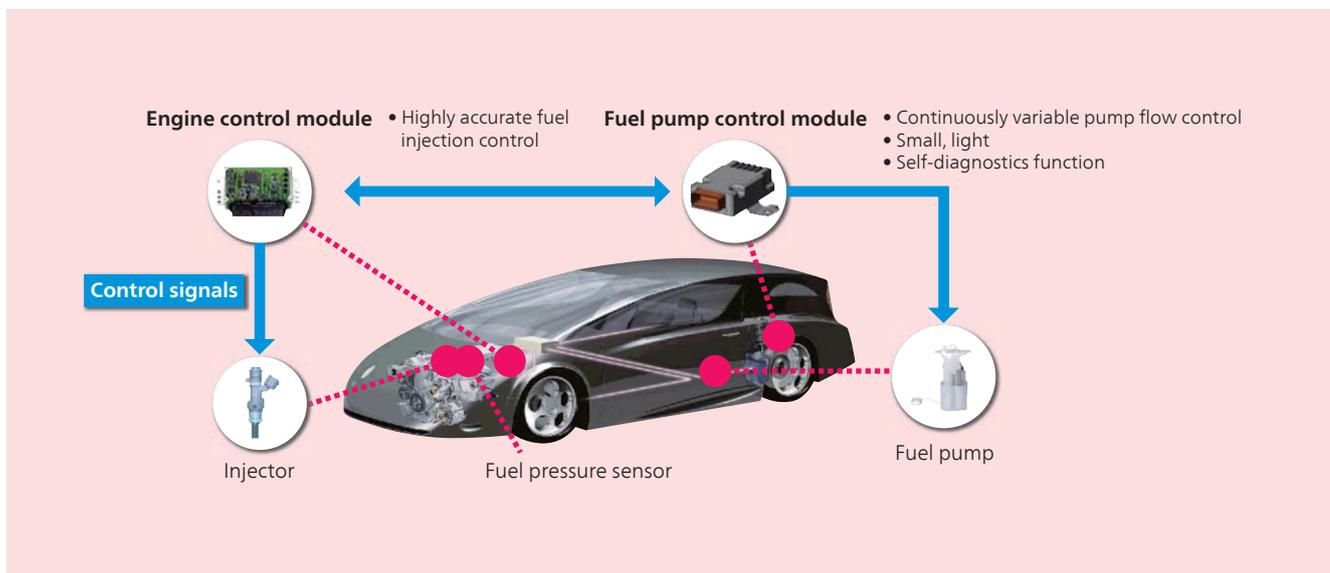
Hitachi has developed a low-transmission-loss multilayer material that supports these types of next-generation high-speed/high-frequency applications. This material has a better high-frequency characteristic than conventional materials, and when combined with a fine-roughness copper foil, enables signal transmission supporting next-generation transmission speed. In addition to its outstanding high-frequency characteristic, it has high heat resistance, high insulation reliability and good workability, while its halogen-free composition for reducing environmental load makes it highly flame retardant. Its use can therefore be extended to high-frequency semiconductor packages for which non-halogen materials are becoming a requirement.

Hitachi is planning widespread release of the material.  
(Hitachi Chemical Co., Ltd.)



6 Transmission loss measurement result for developed material (top) and electrical characteristics (frequency dependence of dielectric constant/dielectric tangent) measurement result (bottom)

# Automotive Systems



1 Fuel pressure control system

## 1 Fuel Pressure Control System

The fuel pressure control system (FPCS) was developed to comply with increasingly strict fuel-efficiency and emissions regulations by improving fuel economy and reducing emissions. It controls the discharge flow rate of the fuel pump and fuel injection pressure in accordance with engine operating conditions.

Past fuel supply systems have operated the fuel pump at maximum flow rate and maintained a constant fuel injection pressure, regardless of engine operating conditions. In contrast, the new system improves fuel economy in situations such as idling (when the required amount of fuel injection is low) by lowering the discharge flow rate so that the fuel pump power consumption is reduced. It also boosts the fuel injection pressure when cold-starting the engine to atomize the injected fuel and reduce hydrocarbon (HC) emissions.

The system components have the following features.

- (1) Fuel pump control module: designed for smaller size and lighter weight, it provides a continuously variable fuel pump output and supports large capacity fuel pumps.
- (2) Engine control module: high level of accuracy for control of fuel injection pressure.
- (3) Fuel pump: controls costs by minimizing changes from previous fuel pumps.

(Hitachi Automotive Systems, Ltd.)

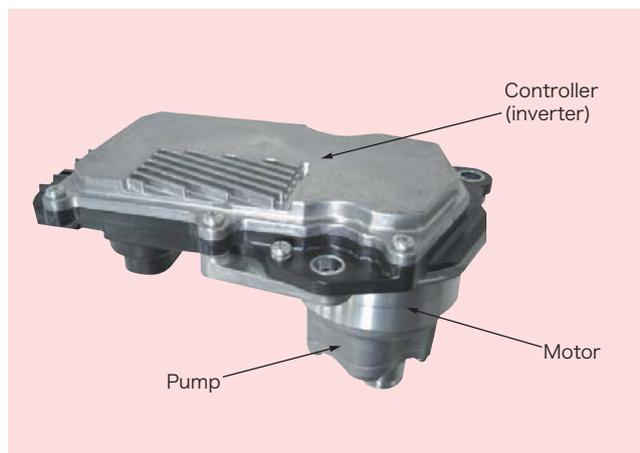
(Date of initial production: September 2013)

## 2 Electric Oil Pump with Built-in Electronics

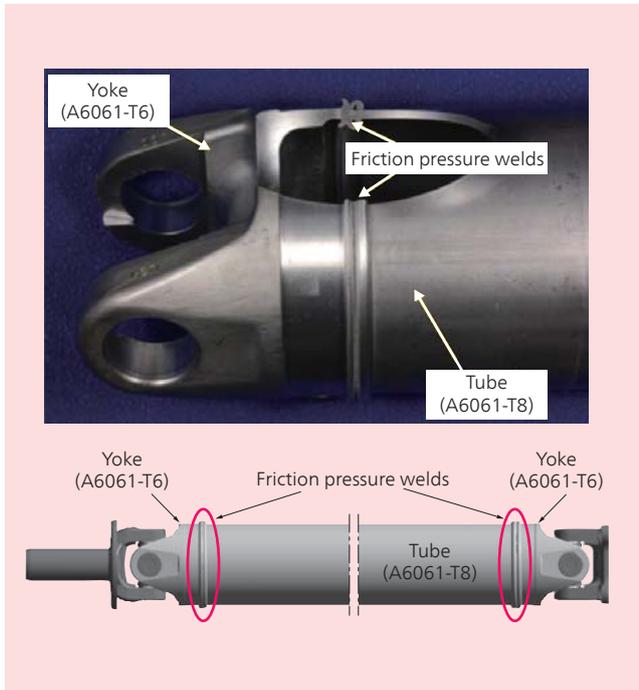
This electric oil pump was developed for cooling the transmission in a hybrid car. The new pump features low cost and is easy to install on the transmission thanks to a design that integrates the pump motor and controller (inverter) into the pump housing. The unit also features a proprietary Hitachi motor drive technique that does not require a position sensor for the motor rotor. Instead, the technique estimates the rotor position by taking advantage of the tiny changes in winding inductance that occur in response to changing rotor position. The technique also overcomes the problem of low torque at slow speeds to ensure good performance even at very low oil temperatures.

(Hitachi Automotive Systems, Ltd.)

(Date of initial production: February 2013)



2 Electric oil pump with built-in electronics



3 Cut sample of friction pressure weld on aluminum propeller shaft (top) and aluminum propeller shaft for NV350 Caravan (bottom)

### 3 Welding Technique for Lightweight Aluminum Propeller Shaft

Amid demand for improving vehicle fuel efficiency, a newly developed propeller shaft has been made considerably lighter than its predecessors by using aluminum in place of steel.

A propeller shaft transmits engine torque to the rear wheels and therefore needs to be strong and reliable. The new shaft uses A6061 heat-treated aluminum for the yoke and tube, two parts that have an important role in weight reduction. The major technical challenge, however, is how to ensure weld strength as a high level of heat input when the parts are welded together diminishes the strength of the base material.

In response, Hitachi has adopted a friction pressure welding technique that utilizes the friction heat generated when the yoke and tube are pressed together and rotated. While optimizing welding conditions for aluminum is a difficult technical challenge,

Hitachi succeeded in achieving the target strength by performing a sensitivity analysis of the welding parameters (pressure, speed of rotation, and time) and observing the weld cross section. Also, while problems were experienced with welding variability affecting shaft length accuracy, the new propeller shaft was successfully put into full production by switching equipment control from hydraulics to a numerical controlled (NC) servo.

The first vehicle to adopt the new aluminum propeller shaft in Japan has been the NV350 Caravan made by Nissan Motor Co., Ltd.

In the future, Hitachi intends to respond to demand from customers for wider use of aluminum engineering as a key technology for reducing weight.

(Hitachi Automotive Systems, Ltd.)

(Date of initial production: July 2012)

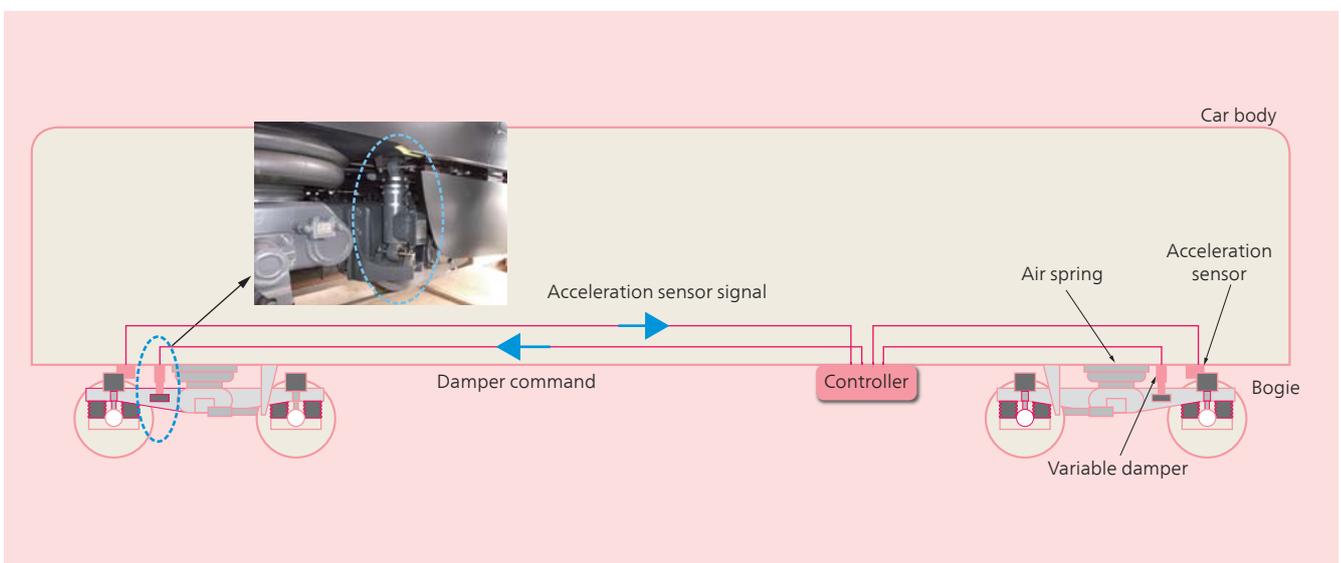
### 4 Variable Damper System for Rolling Stock

This variable damper system for rolling stock uses air springs between the bogie and car body and was developed in collaboration with the Railway Technical Research Institute. The damper improves ride comfort by using an array of air springs to damp vertical vibration of the car body (vertical movement, pitching, and rolling). The new dampers have been fitted on the luxury sleepers of the Seven Stars in Kyushu, a “cruise train” in Kyushu, Japan, operated by the Kyushu Railway Company, and entered commercial operation in October 2013.

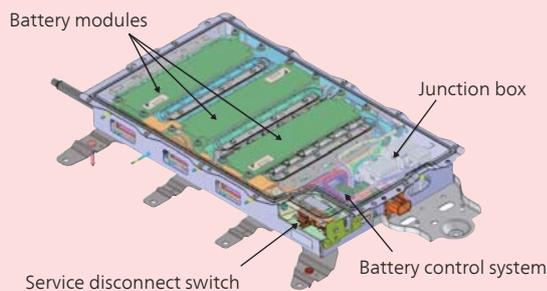
The new system was developed by modifying the damper design and control technique used by the dampers on the Ibusuki no Tamatebako tourist train, which is already in commercial operation, resulting in improved damping force characteristics and responsiveness. In particular, the new system provides a way to improve ride comfort on a particular train set or car without doing anything to the track.

Hitachi hopes to have the dampers adopted on new trains, particularly sleeper cars that are planned for the future.

(Hitachi Automotive Systems, Ltd.)



4 Variable damper system for rolling stock



Main battery pack specifications	
Energy capacity	634 Wh
Capacity	4.4 Ah
Voltage	144 V
Input power	19 kW
Output power	17 kW
Operating temperature	-30 to +60°C
Weight	29 kg or less
Dimensions	744 mm (W) × 427 mm (D) × 93 mm (H)



5 Battery pack structure and main specifications (top) and finished battery pack (bottom)

## 5 Lithium-ion Battery for Electric Vehicles

In response to growing awareness of the environment, nations around the world are adopting stricter vehicle emission standards. In addition to improvements in the fuel economy of gasoline vehicles, complying with these standards will also require the widespread introduction of hybrid and other electric vehicles. In response, Hitachi has developed its generation 3.5 battery pack for use in hybrid cars for the North American market.

The battery pack includes functions for power assist during acceleration, assistance with engine starting, and absorbing regenerated energy during deceleration or braking. The packs combine a number of components in a box-shaped case, including the battery modules (which use cylindrical battery cells), battery control system, junction box, and service disconnect switch. Production has already commenced at the Kentucky plant of Hitachi Automotive Systems Americas, Inc.

In the future, Hitachi intends to continue satisfying customer needs through its market-proven reliability technology and other advanced technologies such as high energy materials.

(Hitachi Vehicle Energy, Ltd.)

(Date of initial production: July 2013)

## 6 Cloud-based Voice Recognition for Vehicle IT Devices

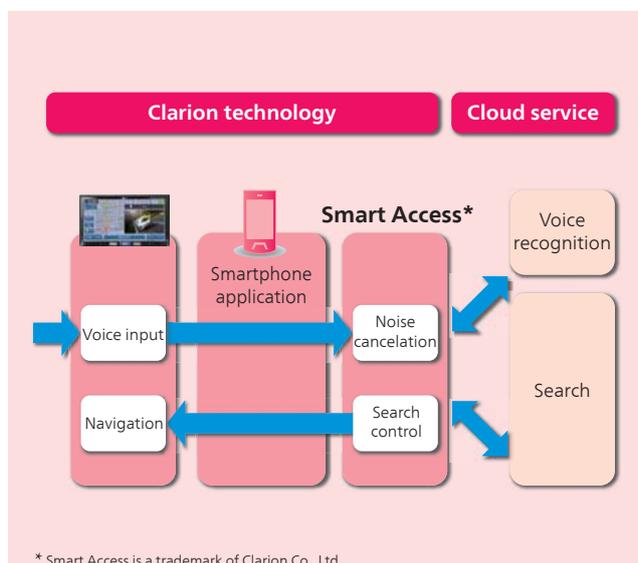
While voice recognition requires advanced data processing and algorithms, the processor capacity and memory available in car navigation and other embedded systems tends to be limited. Accordingly, although car navigation systems started using voice recognition in the early 1990s, the recognition accuracy remained low and little progress was made on functionality. Meanwhile, cloud-based voice recognition started to be adopted in consumer

electronics during the 2000s, including in smartphones, and this has led to the technique coming to be seen once again as an important form of human-machine interface (HMI).

Along with the introduction of cloud-based voice recognition, the use of cloud-based processing and algorithms has also achieved a step up in the performance of other forms of audio processing (such as noise cancellation) that were already used in vehicle-mounted devices. The adoption of features such as cloud-based agent functions and large data clouds has also brought a dramatic improvement in the performance of the search functions that form an important part of navigation.

In the future, Hitachi hopes to bring even greater convenience to vehicles by making further enhancements to cloud-based voice recognition and working towards its use in interactive voice control.

(Clarion Co., Ltd.)



\* Smart Access is a trademark of Clarion Co., Ltd.

6 Block diagram of cloud-based voice recognition system

# Consumer Appliances



1 Big Drum washer-dryer (left), and Big Drum Slim washer-dryer (right) featuring heat recycling and Wind Iron

## 1 Big Drum Washer-dryer and Big Drum Slim Washer-dryer Featuring Heat Recycling and Wind Iron

Hitachi has released the Big Drum washer-dryer featuring heat recycling and Wind Iron, a large-volume drum washer-dryer fitted with a new-concept washing system that suppresses coarsening and darkening in laundry, removing most stains. The Big Drum Slim washer-dryer featuring heat recycling and Wind Iron, a large-volume washer-dryer with a liquid crystal display (LCD) touch panel and a 60-cm width body, has been also released.

The main features are as follows:

- (1) The washing system incorporates a high-flow-rate pumping system with a maximum flow rate of approximately 60 L/min—three times that of conventional systems<sup>\*1</sup>—supplying sufficient water to suppress coarsening and darkening, removing most stains.
  - (2) An Auto Self Clean function that spins the drum at high speed, spraying water from 16 different points to flush out dirt from even out-of-sight locations, eliminating bacteria<sup>\*2</sup> and suppressing black mold<sup>\*3</sup>. A hose with a flat internal surface has been utilized to prevent drain water and dirt from adhering to the inside of the hose.
  - (3) A Wind Iron function that utilizes a high-speed air jet at approximately 300 km/h<sup>\*4</sup> to smooth out wrinkles in clothing. Additionally, these products feature a steam iron function that blows steam onto dried clothing, removing wrinkles and eliminating odor using a high-speed air jet.
- (Hitachi Appliances, Inc.)

\*1 Maximum flow rate of the 2012 model: approximately 20 L/min

\*2 Test agency: Kitasato Research Center for Environmental Science, test method: measurement based on reduction in bacteria count on bacteria-infected plate attached to outer tub and drum, tested operation: the Auto Self Clean function, tested parts: outer tub and drum, result: 99% reduction in bacteria count

\*3 Test agency: Kitasato Research Center for Environmental Science, test method: confirm suppression of mold growth on culture plates attached to outer tub and drum, tested operation: the Auto Self Clean function, tested parts: outer tub and drum, result: 99% reduction in mold

\*4 Determined from flow rate divided by the area of the exhaust outlet.

## 2 Two-Stage Boost Cyclonic Cleaner

Hitachi has released two models of Two-Stage Boost cyclonic cleaners that are easier to use thanks to a new slim, lightweight suction head design, which can even suck up dust at the rear of the head when being pulled.

The main features are as follows:

- (1) Use a double suction mechanism to efficiently suck up dust when pushing or pulling the suction head. At approximately 30 cm wide, the head enables quick and easy cleaning. The newly designed suction head is slim and lighter<sup>\*1</sup>. These models have the lightweight and easy-to-maneuver hose and carbon-fiber-reinforced plastic suction head and pipe used in previous models.
- (2) The higher-end model boasts a powerful 470 W of suction power while the operation noise has been reduced to an industry-leading level<sup>\*2</sup> of 52 dB. In addition, both models feature clean output, with a high filtering rate of 99.999%<sup>\*3</sup>, confirmed by the method specified in the International Electrotechnical Commission (IEC) standard IEC 60312-1:2010(ed. 1).
- (3) The suction power is sustained at 99%<sup>\*4</sup> or higher due to the



2 Two-Stage Boost cyclonic cleaner

unique Two-Stage Boost Cyclone technology, which improves the dust separation performance and the sustainability of a strong air flow rate.

(Hitachi Appliances, Inc.)

\*1 Comparison between new model (head weight of approx. 495 g) and old model (2012, head weight of approx. 525 g).

\*2 As of July 2013 among cyclonic cleaners.

\*3 Result of third-party testing by German test agency SLG Prüf- und Zertifizierungs GmbH in accordance with IEC standard 60312-1:2010(ed. 1). The dust capture ratio (mean) for particle diameters between 0.3 and 10 µm was 99.999%.

\*4 Confirmed using the “method for measuring the rate of sustained suction power of electric vacuum cleaners” standard of The Japan Electrical Manufacturers’ Association. The air flow rate from when the filter and dust box were empty to when the full line was reached was kept at 99% or higher.

### 3 Stainless/Clean Room Air Conditioner

Hitachi has released a series of stainless/clean room air conditioners that provide comfortable air conditioning while quickly conserving energy by using two cameras with different functions to perform detailed monitoring of the room and the people in it.

The main features are as follows:

(1) Uses a system of two cameras with different functions that includes an image sensor to detect the number of people in the room, their active mass, location, taking account of the layout of the room, and a temperature sensor to detect the ambient temperature of the floor, walls, and around people in the room. This model provides comfortable air conditioning while quickly saving energy by carefully sensing the occupancy of the room and the room conditions to prevent wasted energy, such as overheating or overcooling of the occupied spaces.

(2) Uses stainless steel in the air ducts and filter that is effective in reducing bacteria and dust, and new large double louver is also applied with stainless steel. This provides a cleaner air conditioner interior.

(3) Features a new heated floor setting to warm the space at your feet in a way that can be felt similar to underfloor heating. It also comes with a warm air plus setting to constantly supply very warm air at 55°C for approximately 30 minutes and a quick heating setting, which starts blowing warm air in about 30 seconds.

(Hitachi Appliances, Inc.)



3 Stainless/clean room air conditioner



4 Home lighting fixture LED ceiling light and the supplied remote control

### 4 Home Lighting Fixtures LED Ceiling Light

Hitachi has released LED ceiling home lighting fixtures, which balance high energy efficiency (intrinsic energy consumption efficiency of 102.4–104.8 lm/W<sup>\*1</sup>) with the ability to provide maximum brightness within the brightness standard for applicable room size<sup>\*2</sup>.

The main features are as follows:

(1) Newly-devised arrangement of domed light-emitting diode (LED) units equipped with a unique lens function, as used in previous products<sup>\*3</sup>, together with a large heat dissipation structure controls the heat generated from the LEDs, balancing maximum brightness for each applicable room size with high energy efficiency. This provides an approximately 16–18% reduction in energy consumption in comparison to previous products<sup>\*4</sup>. The lens function diffuses light efficiently, allowing the entire room, including the ceilings and walls, to be lit brightly.

(2) Equipped with a light selection function that combines four different combinations of lighting colors and brightness to allow people to select suitable lighting for a scene of life.

(3) The high-end models automatically dim or switch off lighting when the room is lit sufficiently by natural light, lowering energy consumption by approximately 70%<sup>\*5</sup> in comparison to using full-strength lighting. Additionally, these products now feature a new brightness up button that will increase total brightness by a factor of 1.2 for 30 minutes at times when additional brightness is required, such as when doing detailed work.

(Hitachi Appliances, Inc.)

\*1 The intrinsic energy consumption efficiency is equal to the rated luminous flux divided by rated power consumption.

\*2 “Residential catalog applicable room size standards” (guide 121:2011) established by Japan Lighting Manufacturers Association.

\*3 The models released in October 2012.

\*4 Compared new models with previous models (released in October 2012) of the same type and applicable room size.

\*5 According to Hitachi measurement conditions. Energy consumption results depend on changes in daylight hours due to region, location, weather, and season.

### 5 Large Capacity Refrigerators Featuring Vacuum Compartment

Hitachi has released large capacity refrigerators featuring “Vacuum\* Compartment,” which offer improved food preserva-



5 Large capacity refrigerators featuring Vacuum Compartment

tion together with an evolved version of the “Photocatalyst Preservation” function that has been offered on models from 2012 onwards. These new models use a new “Fresh Cassette” in the Vacuum Compartment (a unique Hitachi feature that uses vacuum to suppress oxidation in food and keep it fresh), which uses the effect of piquant flavor components to preserve the *umami* (pleasant savory taste) and texture of fish.

The main features are as follows:

(1) The fresh cassette releases piquant flavor components such as *wasabi* (Japanese horseradish) in the Vacuum Compartment to suppress the functions of enzymes of food and preserve the *umami* and texture of fish. Photocatalysts and the operation of an LED light source are used in “Photocatalyst Preservation,” which preserves food as if it “sleeps.” These models feature an increased number of LED light sources and other innovations that offer better food preservation and deodorization than previous models. (2) Continued use of “Frost Recycle Cooling,” which utilizes cold air from frost that builds up on the evaporator. These models are also equipped with a new dedicated fan in the upper area of the refrigerator compartment, acting in tandem with the existing fan to chill the refrigerator compartment quickly with lower energy loss.

(Hitachi Appliances, Inc.)

\* Indicate a state when atmospheric pressure is low with the Vacuum Compartment deemed to be in a “vacuum” when it is at approximately 0.8 atmospheric pressure.

complete the entire process from kneading and proofing the dough to baking it. Operation is easy, performed via an LCD touch panel.

The main features are as follows:

(1) Enhances kneading and adds processes of steaming and others during proofing to reduce the time required for cooking a loaf of bread to approximately 100 minutes, down from approximately 2 hours for previous products.

(2) Fitted with a grill and steam function that allows frying without oil as well as cooking of foods such as fried dumplings, for which it is difficult to control the heating temperature appropriately. Low-oxygen cooking is also possible, allowing the preparation of steamed vegetables with a lower reduction in vitamin C\* than oven cooking.

(3) LCD touch panel and voice guidance functionality allows easy operation of 483 automatic menus.

(Hitachi Appliances, Inc.)

\* Vitamin C remaining per 100 g serving of broccoli after “grilled and steamed broccoli” (69.1 mg) compared to when just grilled (48.3 mg) (ascertained by Hitachi Appliances).

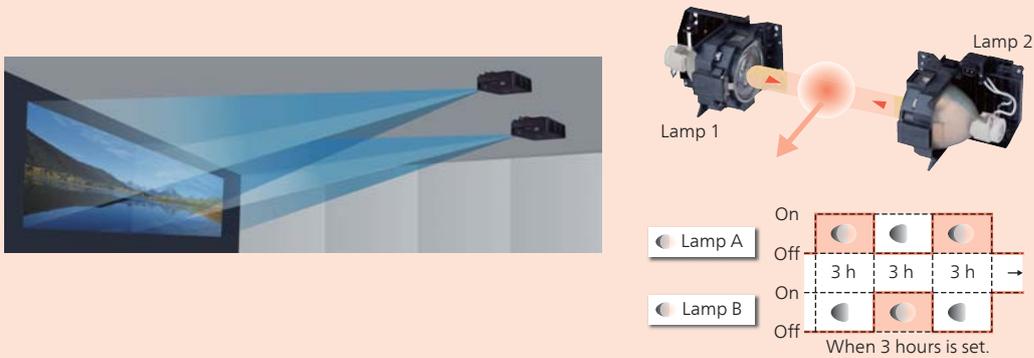
## 6 Superheated Steam Microwave Oven

Hitachi has released a superheated steam microwave oven. It is equipped with a unique Hitachi grill and steam function and a quick-baking function that allows bakers to bake a delicious loaf of bread, taking approximately 100 minutes to automatically



6 Superheated steam microwave oven

# Projector



1 Edge blending image, dual lamp system, and alternative mode for 24-hour use (above) and CP-X9110 10,000-lm high-brightness projector (bottom)

## 1 CP-X9110 10,000-lm High-brightness Projector

CP-X9110 10,000-lm high-brightness projector is ideal for 24-hour use and capable of multi-projection using multiple projectors. Equipped with a dual lamp system that achieves a high brightness of 10,000 lm, the projector provides 24-hour continuous operation in alternative mode which alternates the use of the two lamps.

This projector is equipped with an edge blending function that achieves seamless projection using multiple projectors. (Hitachi Maxell, Ltd.)

The projector offers several groundbreaking features, including two High-Definition Multimedia Interface (HDMI)\* inputs to address the increasing demand for digital connectivity. It features motorized focus, zoom, and lens shift for easy image adjustment, and a 360-degree vertical adjustment capability that makes it ideal for creative applications. (Hitachi Maxell, Ltd.)

\* See "Trademarks" on page 142.

## 2 CP-WU8460 WUXGA Projector

Hitachi has released a projector with high-brightness (6,000-lm) and high-resolution [wide ultra extended graphics array (WUXGA): 1,920 × 1,200 dots] that is about 10% taller than full high definition. Part of the new Hitachi installation series, the projector provides ease of installation and ideal functionality for large venue applications.



2 CP-WU8460 WUXGA projector

# Batteries



1 Lithium-ion energy storage system (1.4-kWh storage capacity)

## 1 Compact, Lightweight Energy Storage Systems for Apartment Complexes

Hitachi has developed an 800-W rated-output lithium-ion energy storage system with a 1.4-kWh storage capacity, intended for installation in individual apartments in apartment complexes. It was developed in cooperation with Mitsui Fudosan Residential Co., Ltd.

Equipped with small, high-capacity battery packs utilizing laminated lithium-ion rechargeable batteries and industry-leading compact inverters, these systems offer a high energy density of 43.6 Wh/L<sup>\*1</sup>. As a result, they can now be fitted in the area above a refrigerator. Additionally, power supply can be switched over to battery output within 10 ms after the unit detects a power outage, allowing it to function as an uninterruptible power supply (UPS) in order to protect connected appliances for extended periods after power is cut off. Furthermore, since this energy storage system conforms to the ECHONET<sup>\*2</sup> Lite communications standard, it can also be linked to home energy management systems (HEMS), allowing energy management for electric power peak shifts and others. This product will be installed in Mitsui Fudosan Residential's "Park Tower Shin-kawasaki" (planned for completion in March 2015), and commercial sale is to start in spring 2014.

Hitachi will continue to expand the energy storage system lineup.

(Hitachi Maxell, Ltd.)

\*1 As an ECHONET Lite compatible energy storage system. As of August 2013.

\*2 See "Trademarks" on page 142.

## 2 Standby Energy Storage System Utilizing Flame Retardant Large-capacity Lithium-ion Batteries

The expanding and diversifying market for communications equipment has brought about a rapid increase in demand for both high-performance in emergency power systems, and for high reliability in energy storage systems. Since installation space for energy storage systems is particularly limited in urban centers, such equipment must be able to function in existing spaces.

This situation prompted Hitachi to develop a lithium-ion battery (LIB) system in cooperation with NTT Facilities, Inc. The resulting LIBs have a rated capacity of 100 Ah, and can produce a large current discharge up to 500 A. Additionally, they have a long life in standby state, which was problematic for previous LIBs. They can therefore be used efficiently for short-term backup, and allow highly reliable systems to be configured using small numbers of batteries. On the safety front, these batteries utilize electrolyte that has been rendered flame retardant, in order to suppress fire in the unlikely event of an accident. Furthermore, the systems developed monitor voltage and temperature constantly, and keep the voltage in each battery within certain range. They also have the ability to separate batteries from power sources and load devices when abnormal circumstances occur.

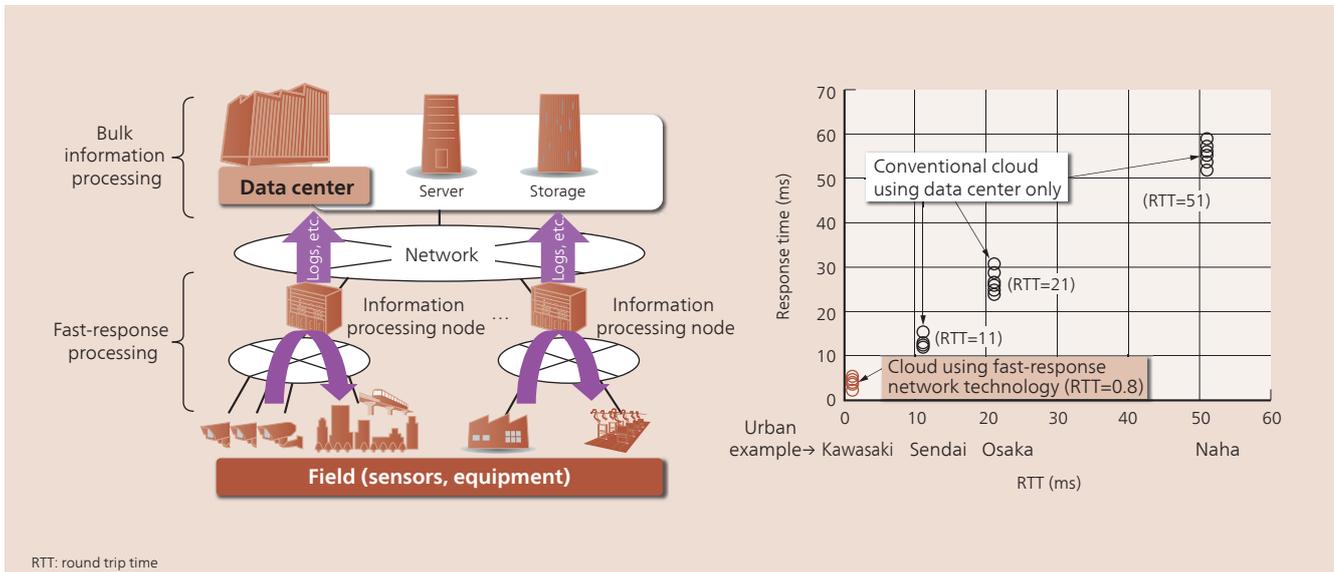
This system reduces installation area to approximately half that of a lead-acid storage battery, allowing existing spaces to be used effectively.

(Hitachi Chemical Co., Ltd., Shin-Kobe Electric Machinery Co., Ltd.)



2 Lithium-ion storage battery system (maximum continuous electrical discharge 500 A)

# Research & Development



## 1 Fast-response network technology

### 1 Fast-response Network Technology for Cloud-based M2M Services for Social Infrastructure

A newly developed fast-response network technology is used with cloud computing to implement machine-to-machine (M2M) services for power, transportation, urban services, and other social infrastructure.

The technology combines networked information processing nodes located near the field with a conventional remotely located data center, with the information processing nodes being used to process sensor data that requires a rapid response, and the data center being used for data mining and other bulk data processing applications. When a new sensor or control application (item of equipment) is registered with the cloud, it automatically searches for information processing nodes with sufficient spare capacity and with a communication delay that is within the service's requirements, and then allocates the processing nodes for the new sensor or equipment accordingly. Because this results in a shorter communication delay than conventional cloud configurations that use a data center only, it provides fast response times.

Hitachi conducted a demonstration in which information processing nodes were installed at Kawasaki (Kanagawa Prefecture) and Sendai (Miyagi Prefecture), with mock sensors and control applications located at Kawasaki and the data center at Sendai. The information processing node at the Kawasaki site was automatically selected to handle the processing for the mock sensors and control applications and achieved response times of 10 ms or better. Hitachi is currently working on enhancements to the technology to ready it for use in actual services.

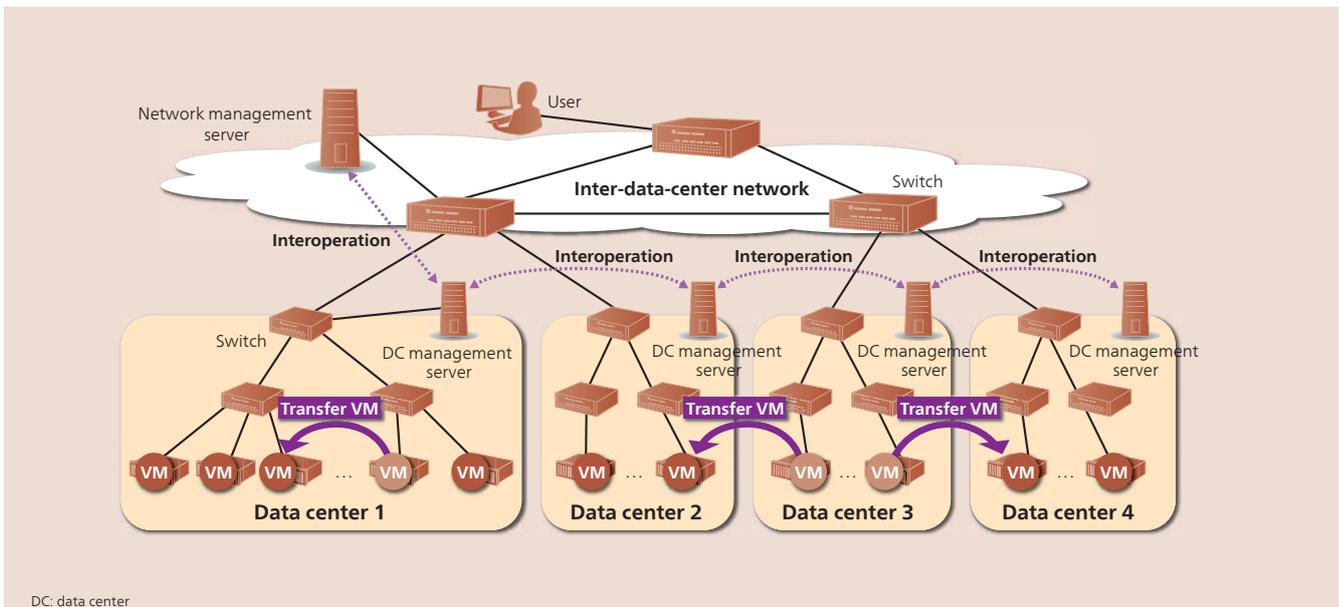
Part of this research was conducted under the "Research and

Development on Secure Cloud Networking Technologies (Intelligent Distributed Processing Technologies)" and "Research and Development on Cloud Service Infrastructure for Recovering Wide-area Disaster (High Reliable Cloud Services Platform Technology)" programs funded by the Ministry of Internal Affairs and Communications.

## 2 Technology for Reducing Cloud Power Consumption

One method for reducing power consumption by the data centers that form the cloud is to consolidate virtual machines (VMs) on a smaller number of servers during the night or at other times of low demand for services so that unused servers can be turned off. While achieving even larger power savings requires that this consolidation of VMs takes place across multiple data centers, if performed without consideration for network traffic, this risks degrading service quality due to the volume of data on the network exceeding its capacity.

In response, Hitachi has developed a technique for determining whether to consolidate VMs at times of low service demand while still maintaining communication quality. The technique combines a server that manages operating conditions at each data center with another that manages network traffic, and selects where to transfer VMs so as to ensure that adequate network capacity is still available at the new hosting site. In a trial in which a large cloud test system was configured with 1,000 virtual servers spread across four regions, power savings of approximately 30% were achieved by the VM consolidation technique making decisions within six minutes.



**2 Technology for reducing cloud power consumption**

In the future, Hitachi intends to expand uses for the new management technique beyond power saving to include such objectives as improving communication quality for cloud services and enhancing the reliability of communications used to support social infrastructure.

Part of this research was conducted under the “R&D on Cloud Service Infrastructure for Recovering Wide-area Disaster (Signaling Technology of Network Configuration for Sustainable Environment)” program funded by the Ministry of Internal Affairs and Communications.

wireless LAN devices such as smartphones or personal computers (PCs), resulting in frame loss and other degradation of the surveillance video.

In response, Central Research Laboratory of Hitachi, Ltd. and Hitachi Kokusai Electric Inc. have collaborated on applying the hybrid coordination function controlled channel access (HCCA) communication method specified in the IEEE 802.11e standard for wireless LANs to video surveillance systems, including the development of a proprietary communication protocol that minimizes degradation of video quality. When the new technology was trialed in a wireless video surveillance system, it succeeded in increasing the interval between frame loss events from the several minutes of previous systems to more than nine hours, reducing the frame loss frequency by a factor of 100 or more. This results in a highly reliable wireless video surveillance system with excellent economics.

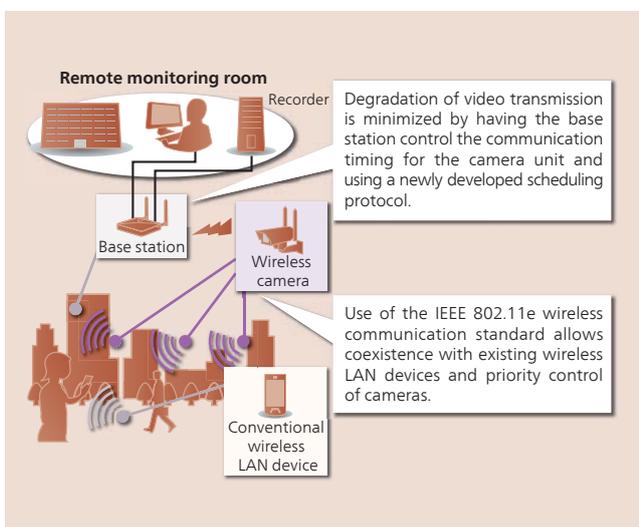
**3 High-quality Wireless LAN Transmission Technology for Video Surveillance Systems**

Video surveillance systems have become more widely used in recent years to help create a safe and secure society. While most of these systems currently operate on fixed-wire networks, there is interest in the use of wireless networks to provide greater flexibility in where to locate cameras and to expand surveillance over a wider area. However, existing systems that operate on wireless local-area networks (LANs) are subject to interference from other

**4 Explosives Detector with Automatic Sampling**

Hitachi has developed explosives detection technology that automatically and promptly detects minute quantities of explosive material on cards, luggage or other objects. It is intended to strengthen safety at airports, railways, and other public facilities. It uses a cyclone-type centrifugal separation and concentration technique to quickly and efficiently concentrate tiny particles released from the surface of the target materials by blowing air. It uses a mass spectrometry sensor incorporating highly sensitive proprietary technology for rapid detection of minute quantities of explosive materials. Hitachi has developed prototype boarding gates and luggage inspection machines fitted with this technology that are designed with use at airports or railway stations in mind, and plans further work aimed at commercialization.

This research was conducted under the “R&D Program for Implementation of Anti-Crime and Anti-Terrorism Technologies for a Safe and Secure Society” in the “Integrated Promotion of Social System Reform and Research and Development” funded



**3 Wireless LAN video surveillance camera system**



Partner: The Nippon Signal Co., Ltd.



Partner: Hitachi Power Solutions Co., Ltd.

4 Prototype boarding gate (top) and luggage inspection machine (bottom) fitted with explosives detection technology

by the Ministry of Education, Culture, Sports, Science and Technology.

## 5 Predictive Diagnostic Method for Preventing Unscheduled Shutdowns of Social Infrastructure

The social infrastructure equipment is expected to operate reliably. Hitachi has developed a predictive diagnostic method for these by utilizing machine learning and a form of data mining.

Whereas past methods based on thresholds for sensor data have failed to provide adequate detection of abnormalities, the new method prevents unscheduled shutdowns due to faults by providing early detection of problems. The method learns element

which constitutes normal conditions of an item of equipment and then outputs an estimate the degree of abnormality based on the difference between normal and current conditions. A feature of this method is that, by learning in advance, it can achieve a high level of detection performance regardless of the operation environment.

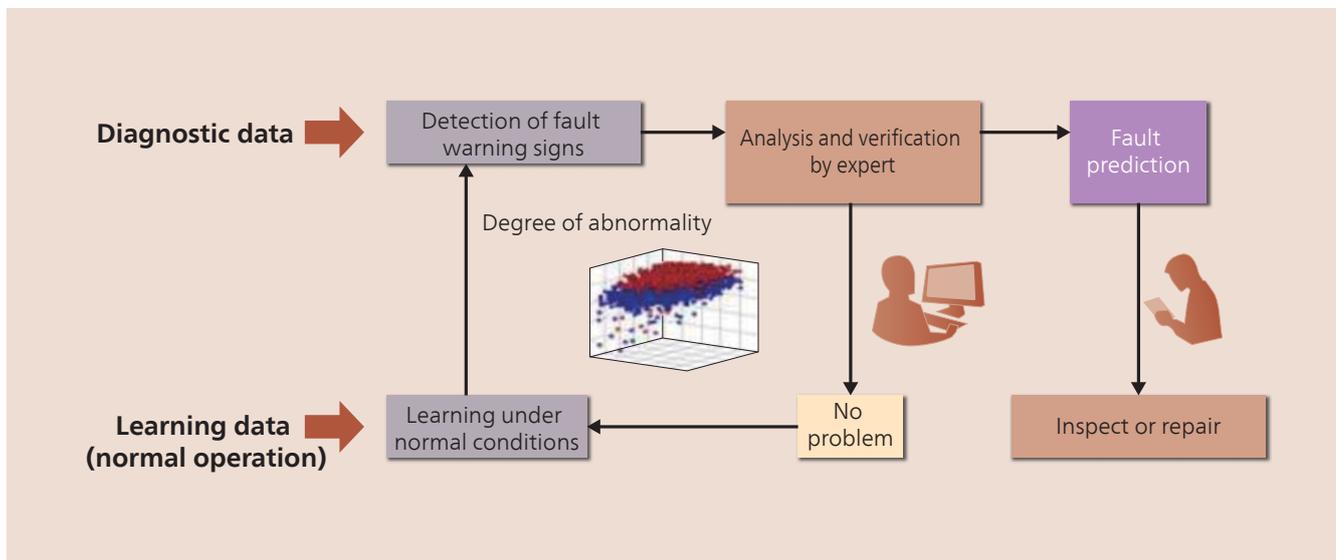
The technology has been adopted in the predictive diagnostics system product of Hitachi Power Solutions Co., Ltd.

## 6 Highly Efficient Amorphous Reactor for PCSs and UPSs

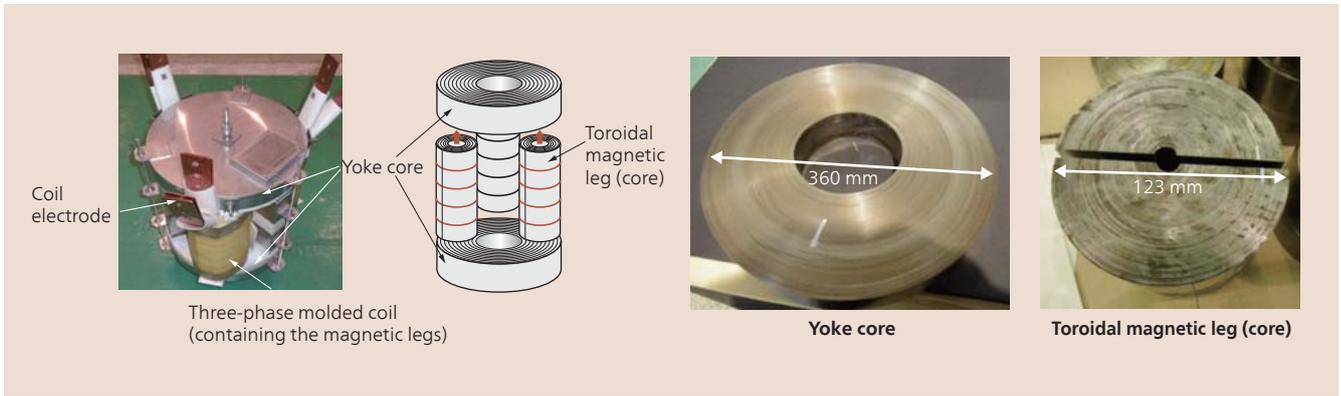
Hitachi Research Laboratory of Hitachi, Ltd. and Hitachi Industrial Equipment Systems Co., Ltd. have jointly developed an amorphous core with a new design for use in the filter reactors used in 400-kVA-class uninterruptible power systems (UPSs).

As the magnetic losses (iron loss) of the soft magnetic amorphous alloy are one-third to one-half those of previous materials, it provides a useful way to improve the efficiency of systems that include inverters. Unfortunately, the expected reduction in losses is difficult to achieve in practice because the high toughness of the amorphous alloy makes it impossible to obtain adequate forming accuracy when using the same core design as current reactors made from silicon steel sheet. In developing the new design, Hitachi solved this problem by devising a new method for forming a three-leg (three-phase) configuration made of toroidal cores in which the amorphous ribbon is wound in a circular (toroidal) pattern. Hitachi also developed a loss model that takes account of the layering of the ribbon and succeeded in reducing the prediction error of losses in three-dimensional magnetic field analysis from 30% to 10% or less. By using this model to optimize the design, Hitachi reduced losses by half and volume by 20% compared to the current model, achieving a 0.55% improvement in UPS efficiency.

The new amorphous core is also suitable for use in power conditioning subsystems (PCSs) for wind or photovoltaic power generation. The first model to use the new core will be a 100-kW photovoltaic PCS that is scheduled to commence production at Hitachi Industrial Equipment Systems in April 2014.



5 Predictive diagnostic method based on machine learning



6 UPS filter reactor and design of core

## 7 Technology for Evaluating Crashworthy Structures in Rolling Stock

The standards for rolling stock for overseas markets specify that their designs consider collisions between vehicles or with obstacles, and require them to use crashworthy structures that undergo plastic deformation to absorb the energy of impact in a collision. One way to increase energy absorption by crashworthy structures is to ensure that, rather than fracturing when a collision occurs, materials and welds undergo plastic deformation instead. Accordingly, it is important to be able to accurately predict fracturing at the design stage and thereby prevent it from occurring.

Hitachi has developed technology for evaluating crashworthy structures that features use of a collision analysis model that considers the accumulation of tiny cracks in the material, and use of a new method for determining by experiment the material properties that affect this accumulation of cracks. This allows accurate predictions to be made of where fractures will occur during a collision and the absorption of energy by the crashworthy structure. In the future, it will be possible to take steps at the design stage to reduce locations where fracturing will occur, and to design crashworthy structures with high impact perfor-

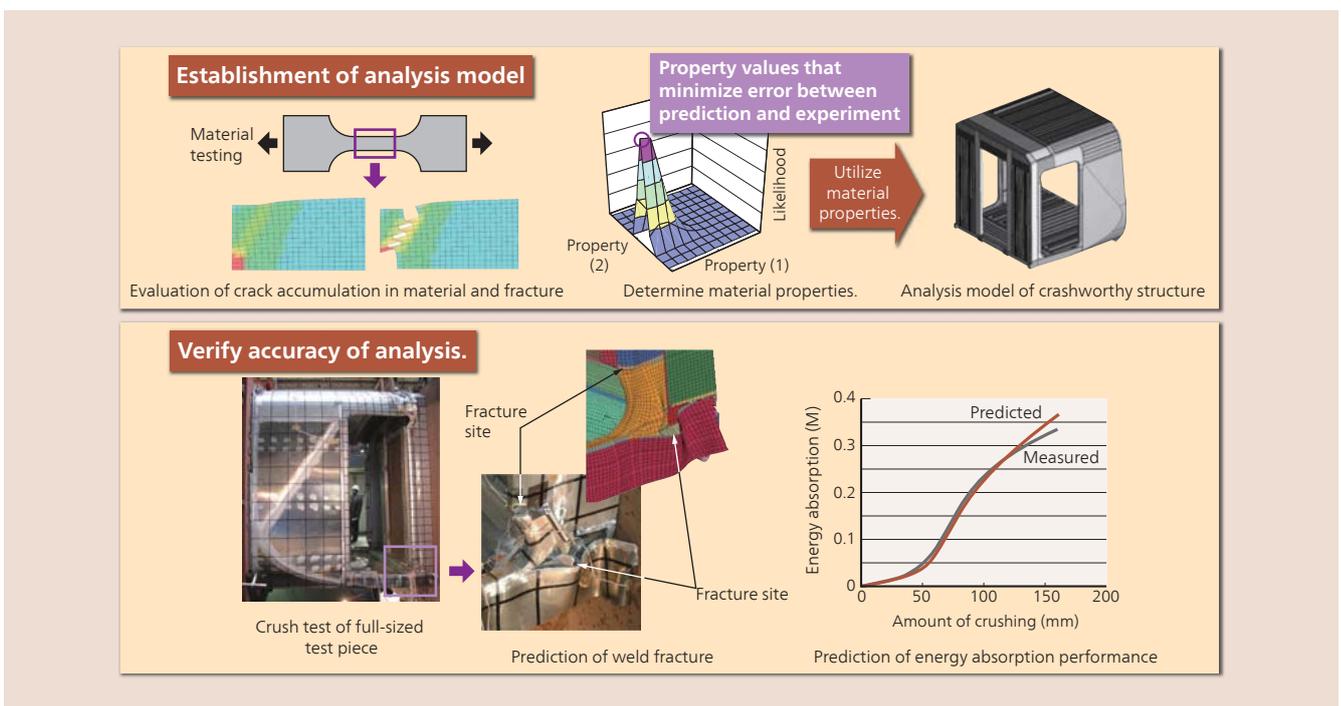
mance.

Hitachi is using this evaluation technology in the development of crashworthy structures for rolling stock intended for European markets.

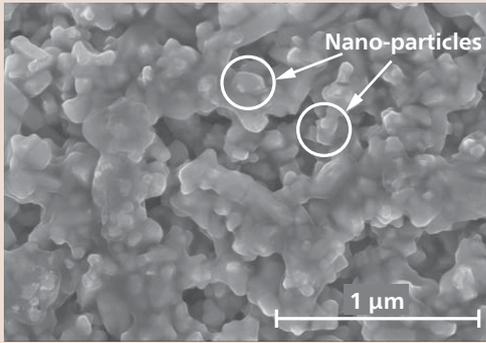
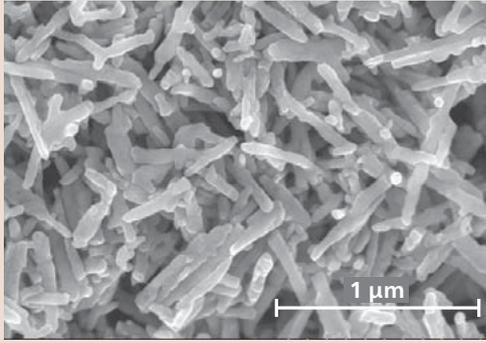
## 8 High-capacity Anode for Lithium-ion Battery

Increasing the energy density of lithium-ion batteries is important for improving the convenience of smartphones and other mobile devices or electric vehicles. In response to this requirement, there is a need to develop high-capacity anode materials that can improve on the 372-Ah/kg theoretical capacity of the graphite currently used in lithium-ion batteries. Hitachi has developed an anode made of iron oxide, a widely available, low-cost material that places a low load on the environment, and which has a high capacity of 1,000 Ah/kg or more.

Although iron oxide anodes have high capacity, they have suffered from the problems of a rapid fall off in capacity with charging and discharging, and poor charging and discharging efficiency. To improve charging and discharging efficiency, Hitachi has developed a technique for pre-doping the iron oxide



7 Example evaluation of energy absorption performance of crashworthy structure



8 Particle shapes for conventional iron oxide (top) and Li-doped iron oxide (bottom)

with lithium (Li). In the new Li-doped iron oxide, pre-doping with Li stabilizes changes in the crystal structure during charging and discharging. Also, the use of nano-sized particles reduces resistance to the charging and discharging reaction compared to conventional iron oxides. As a result, the charging and discharging efficiency of iron oxide has been improved by 70 to 80% over previous materials.

In the future, Hitachi intends to contribute to further improvements in the energy density of lithium-ion batteries by analyzing the relationship between crystal structure and charging and discharging mechanisms in more detail.

## 9 Sour Shift Catalyst

The coal gasification market consists of the market for power

plants and the market for synthetic fuel plants that gasify coal and use it to produce light oil or methane gas. Shift catalysts are used to form carbon dioxide (CO<sub>2</sub>) and hydrogen (H<sub>2</sub>) from the carbon monoxide (CO) and steam in the gas produced by a coal gasification furnace, so that the CO<sub>2</sub> can be captured and stored in the case of a power plant, or to adjust the H<sub>2</sub>/CO concentration to suit the synthesis reaction in the case of a synthetic fuel plant.

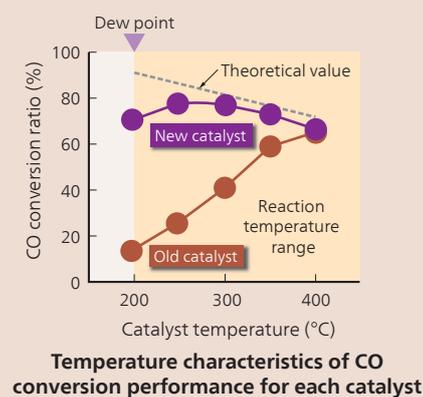
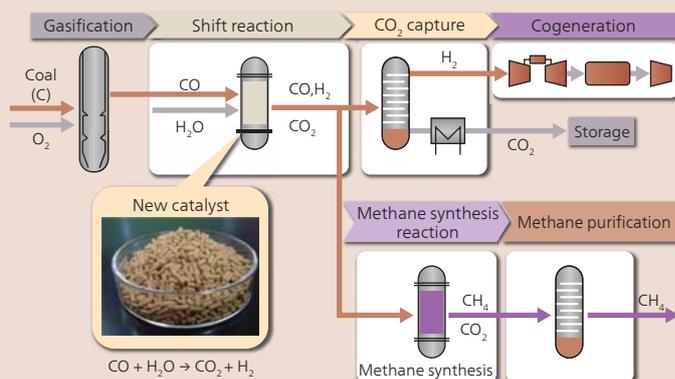
This newly developed sour shift catalyst has achieved higher reaction rate by spreading the reaction activity point across the carrier and by efficiently achieving the reaction activity point. This dramatically improves performance at the lower limit of the operating temperature range (200°C) compared to the catalyst used in the past. As a result, the amount of excess steam added to promote the reaction can be reduced. The shift catalyst boosts the efficiency of coal-fired power generation and reduces CO<sub>2</sub> emissions, and also reduces the cost of producing clean synthetic methane gas or light oil from coal.

In the future, Hitachi plans to work toward commercializing the catalyst by testing its reliability in actual systems.

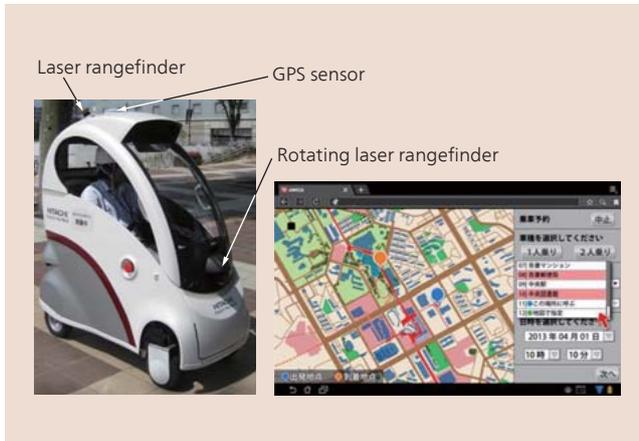
## 10 Mobility Support Robot

In anticipation of the extreme aging of society, Hitachi has developed a mobility support robot intended as a “last mile” short-distance mode of transportation providing mobility assistance for the elderly or others who have difficulty moving about. It has a function for autonomous travel to a designated point whereby it makes its own way to a location specified on a map displayed on a mobile device.

The robot incorporates a detailed three-dimensional (3D) geometric environment map of terrain and other features (including sidewalk altitudes) that it can use for highly accurate self-positioning by measuring its surroundings with a laser range-finder and comparing the results with the map. It uses this to travel through a city’s pedestrian spaces, including along sidewalks, across over or underpasses, and indoors, to make its way directly to its destination. The 3D geometric environment map is produced using a technique that performs the precise merging of data on the surrounding topography collected by the robot as it moves along, sidewalk elevation data collected from



9 Processes that use shift catalysts and the temperature characteristics of the new catalyst



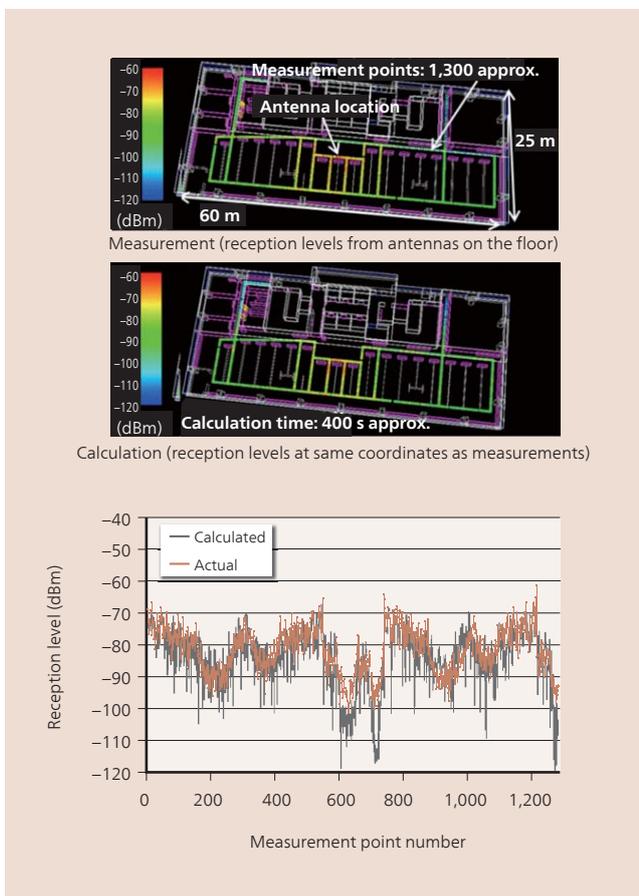
10 Mobility support robot and example reservation screen on mobile device

electronic maps provided by the Geospatial Information Authority of Japan and by a highly accurate global positioning system (GPS).

In the future, Hitachi intends to make further improvements in the mobility support service functions with the aim of making it suitable for practical use.

## 11 Support Software for Wireless Network Design

The rapid spread of smartphones, tablets, and other devices has created a need for wireless area designs that can handle the throughputs experienced in this era of high-volume data communications. A problem with past manual methods has been the



11 Comparison between floor model produced by radio propagation simulator and actual data

large workload involved in tuning the designs, including on-site trial and error.

This newly developed support software for wireless network design provides guidance on where best to locate antennas when configuring wireless networks at corporate offices or other sites. This makes it possible to create high-quality antenna location designs that provide reliable wireless communications with a smaller number of antennas.

The software consists of a radio propagation simulator that performs fast and accurate calculations of radio signal reflection and transmission, and an antenna location search program that uses the results from the simulator. The simulator combines ray tracing, which treats the propagation of radio waves as being similar to that of light, with the finite-difference time-domain (FDTD) method for directly solving the electromagnetic wave equation. For the location search program, meanwhile, Hitachi was able to reduce the search time by 83% by using the simulation results to narrow down the search scope. The result is that the overall design and implementation schedule for a wireless network can be shortened by up to a half\*, while also contributing to cost savings.

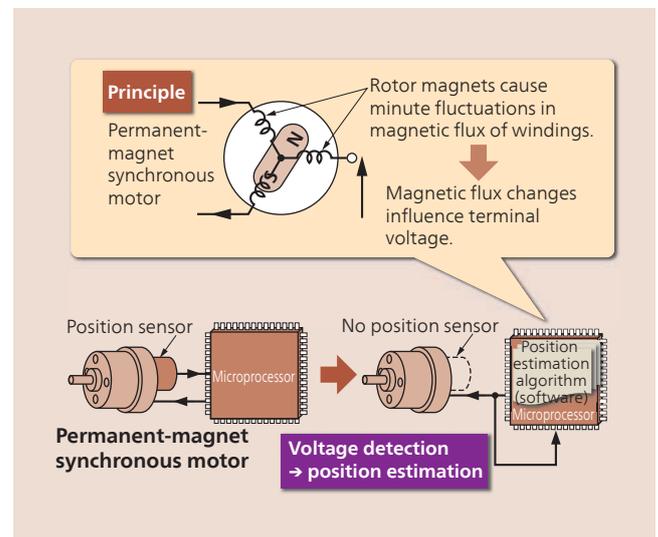
\* Based on research by Hitachi, Ltd.

## 12 A Position-sensorless Drive Technique for Low-speed Operation of Permanent-magnet Synchronous Motors

Hitachi has developed a control technique for permanent-magnet synchronous motors that does not require a rotor position sensor. This technique achieves smooth start-up with high torque from a stop or from a low speed.

Eliminating the need for a rotor position sensor reduces the motor size and simplifies installation and maintenance. Furthermore, since this technique provides high torque at low speed, it helps expand the range of applications for permanent-magnet synchronous motors, being suitable for use in systems such as conveyors, elevators, and escalators.

In recent years, greater environmental awareness and efforts to reduce energy consumption have increased demand for highly efficient permanent-magnet synchronous motors. Convention-



12 Principle of new control method that does not require a position sensor

ally, permanent-magnet synchronous motors have required use of a rotor position sensor to achieve a smooth start-up. The problem with this is that a position sensor makes installation more difficult and adds cost and technical difficulties. Hence, a motor-drive system that does not require a position sensor is most desirable.

Against this background, Hitachi has developed a new technique that uses the motor terminal voltage to estimate the rotor position. Because the rotor magnet changes the magnet flux of each winding as it rotates, the terminal voltage contains information about its position. Accordingly, this technique can be applied to many kinds of motors with different designs. Hitachi has tested its operation at the rated torque on its axial-gap amorphous motors, which do not use rare-earth metals. Future plans include applying the technique to motors used in industry.

This newly developed coupled fluid and biological analysis determines the appropriate bioreactor design, stirrer shape, and composition of nutrient additives, taking account of the formation of metabolites that impede cell growth and the influence that the spatial distribution of hydrodynamic force has on cell metabolism. Culture processes designed using this technique have demonstrated a 50%\* improvement in productivity over past design methods when tested in 3-L and 200-L bioreactors.

Hitachi is a member of the Next-generation Biopharmaceutical Production Technology Research Association (approved by the Ministry of Economy, Trade and Industry), the aims of which are to integrate processes and establish platforms for biopharmaceutical production. In the future, Hitachi intends to expand its technical capabilities and play a leading role in activities.

\* Based on research by Hitachi, Ltd.

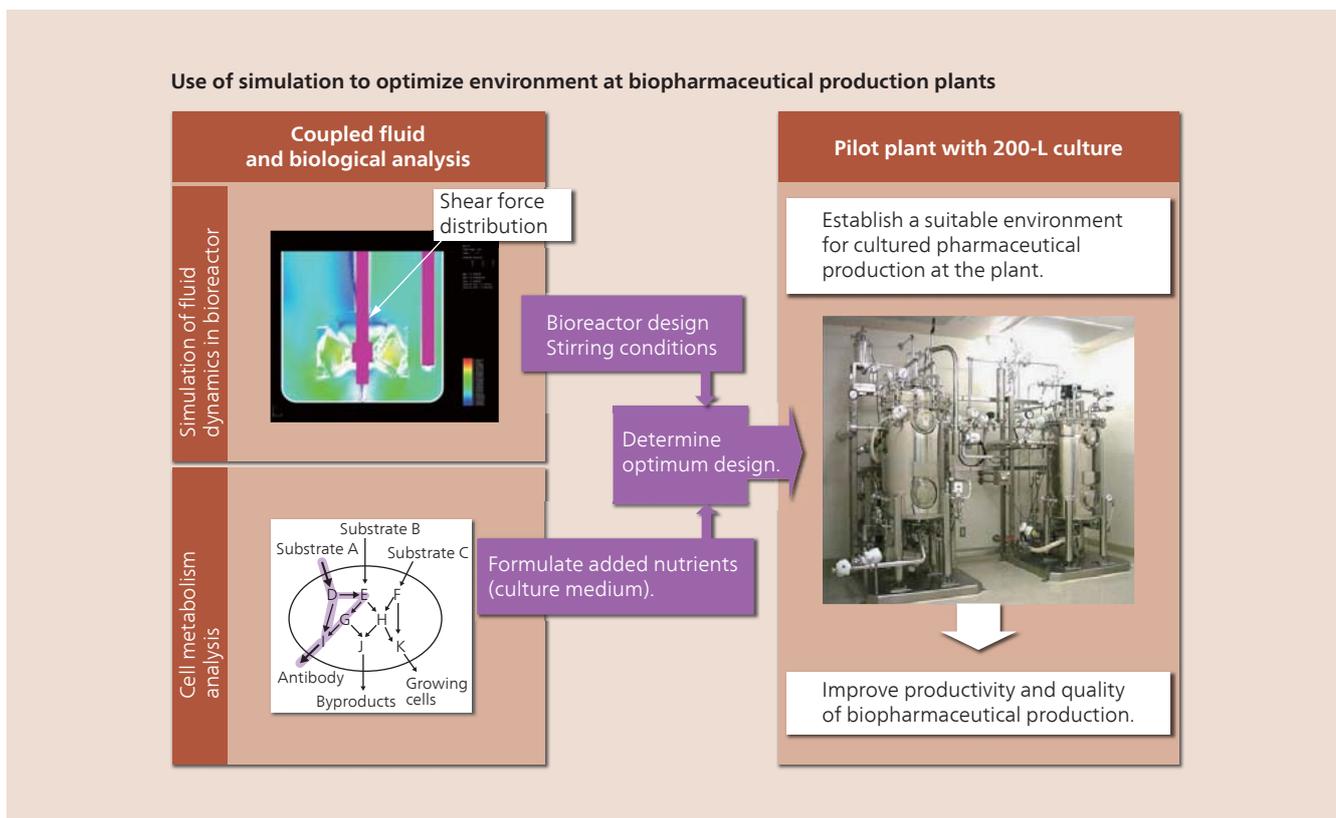
### 13 Coupled Fluid and Biological Analysis

Demand for biopharmaceuticals such as monoclonal antibody drugs has grown in recent years because of their ability to provide effective treatments with few side effects. These biopharmaceuticals are produced by culturing genetically engineered animal cells. When designing the process for plants based around bioreactors, providing an appropriate cell culture environment (hydrodynamic force generated by stirring, dissolved oxygen, dissolved carbon dioxide, uniformity of mixing, and foaming) is important to achieving high productivity and quality. Past culture process design used experimental cultures and computational fluid dynamics (CFD) analysis of the bioreactor to select the bioreactor design and stirrer shape that minimize the damage that the culture environment inflicts on cells.

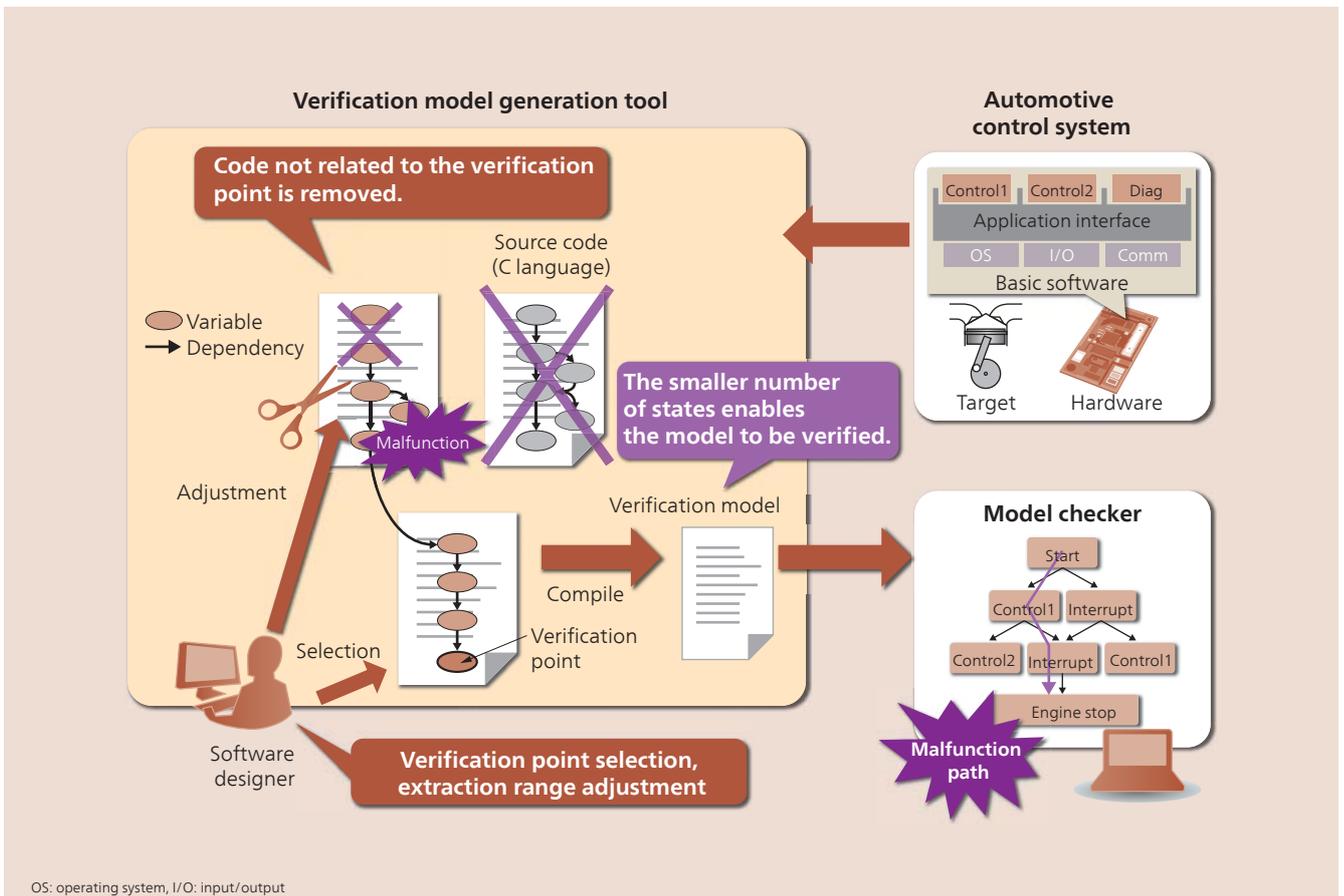
### 14 Formal Verification of Automotive Control Software

A formal method is a technique for describing requirements and designs using a language in which meanings are strictly defined. Model checking is one example of a formal method. It can be used to perform an exhaustive search of all software behavior states to detect malfunctions that could not be identified in the design phase. The advantage of model checking is that it can identify defects that would be difficult to find using conventional testing. Unfortunately, the problem with model checking when applied to large software is that the huge number of states means that verification requires too much computer resource to be practical.

A model generation technique has been developed to solve this problem. It analyzes the dependencies between variables in the source code to identify which parts of the code are related to the



13 Coupled fluid and biological analysis

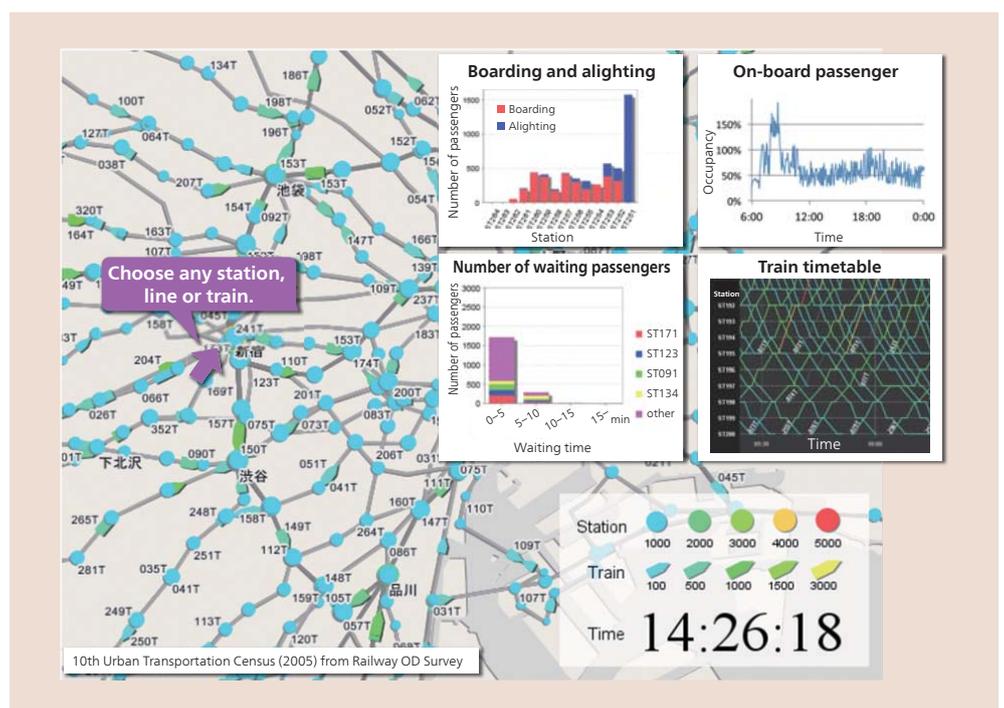


14 Automated generation of verification model derived from source code

item to be verified. The verification model is then generated from this small subset of the code. Because it significantly reduces the number of states in the verification model, the technique is suitable for use with production code that may contain hundreds of thousands of lines. Hitachi has started using the technique for model checking in the development of products with an automotive safety integrity level (ASIL) rating of C/D, the highest safety level defined in ISO 26262.

## 15 Passenger Flow Simulator

With railway infrastructure development plans in progress around the world with the aim of providing environmentally conscious transportation, recent years have seen growing demand for railway systems that deliver services that suit passenger needs. Unfortunately, in major cities where large numbers of passengers



15 Overview of passenger flow simulator

travel on complex railway networks, it can be difficult to determine what these passenger needs actually are.

To meet this challenge, Hitachi has developed a passenger flow simulator that models the interactions between train operations and passenger movements to predict the movements of 10,000,000 passengers and 10,000 trains on multiple lines, with a time-resolution of one second. In the simulation, the train operations are defined by their timetables and passenger movements are based on rational decisions about travel time, transfers, and other considerations. The simulator can perform a comprehensive evaluation of train occupancy rates and the number of passengers boarding or alighting from each train at each station. This can then be used to investigate the implications of changes in passenger travel demands. The simulator also has a function for balancing train occupancy rates to ease congestion by optimizing train departure times. This can help avoid long boarding and alighting times, which sometimes causes trains to be delayed.

## 16 Railway Traffic Management and Scheduling Techniques

Because recovering from train timetable disruptions in complex railway networks that operate over a wide area can take a long time, there is a concern that this will result in poorer passenger services.

Hitachi has developed a new technique for predicting future divergences from scheduled train operations from the current point in time. The technique calculates predictions at high speed using constraint programming, a method from a branch of mathematical programming. It mathematically models the constraints that ensure that trains do not get in each other's way at or between stations, while still keeping to timetables as far as possible even if a schedule disruption occurs. To make changes to train schedules, such as overtaking, to avoid major delays, Hitachi has also developed another technique using constraint programming that makes these changes in such a way that the number of trains

running behind schedule is minimized. In simulation testing conducted on the world's largest railway network (1,100 km total length, 8,000 trains), the new method achieved a calculation time approximately one-tenth that of the previous method. The technique has also been incorporated into a prototype railway traffic management system ordered from the UK.

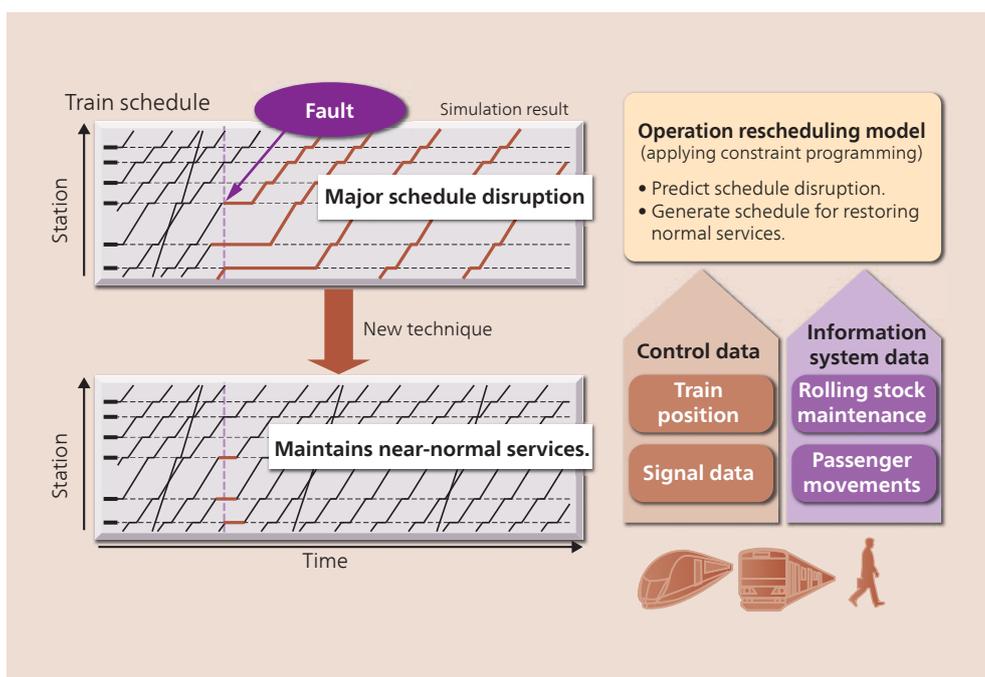
In the future, Hitachi plans to support high-density railway services by taking the traffic management and scheduling techniques it has developed through its experience with high-density railway operations in Japan and adapting them to better suit conditions in overseas railways.

## 17 Fault Recovery Navigation System Based on Autonomous IT Operation Technology

The "3R" autonomous IT operation technique automates the steps from information technology (IT) system monitoring and analysis to utilizing the analysis to decide on how to respond, and then executing that decision.

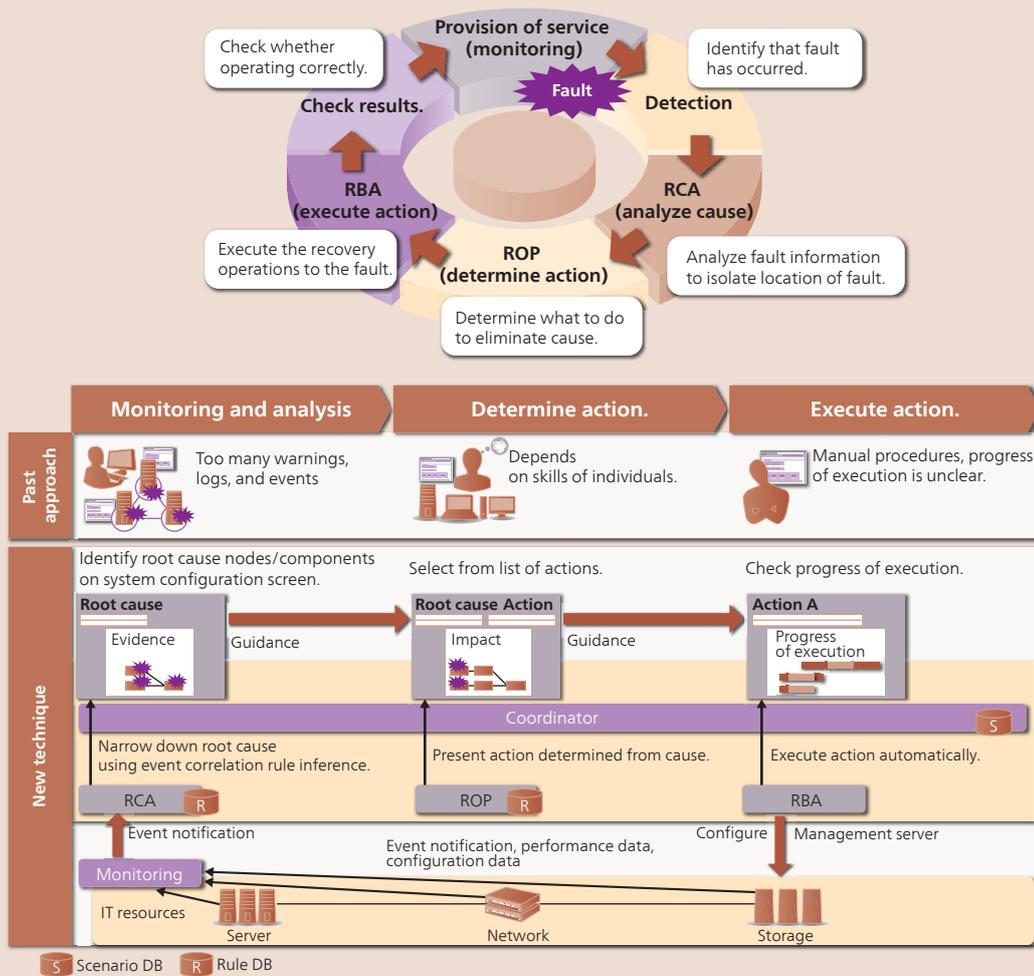
The three Rs that make up the 3R technique are root cause analysis (RCA), resource optimization planning (ROP), and run book automation (RBA). RCA determines the cause of an event from event messages sent by IT resources, ROP determines the actions to optimize system configuration and resource allocations needed to eliminate the cause, and RBA automatically executes the selected actions. By using 3R, the response to a fault in an IT system, which in the past may have taken several hours, can get underway in a matter of minutes based on pre-defined fault pattern scenarios. Even in situations that require high-level judgments and complex actions, administrators can be guided toward good decisions based on information provided by RCA and ROP.

In the future, Hitachi intends to extend the rules defined in RCA and ROP to cover both equipment and systems and fault patterns, and to incorporate the technology into its main hardware and middleware products.



16 Railway traffic management and scheduling techniques

### IT system fault recovery cycle

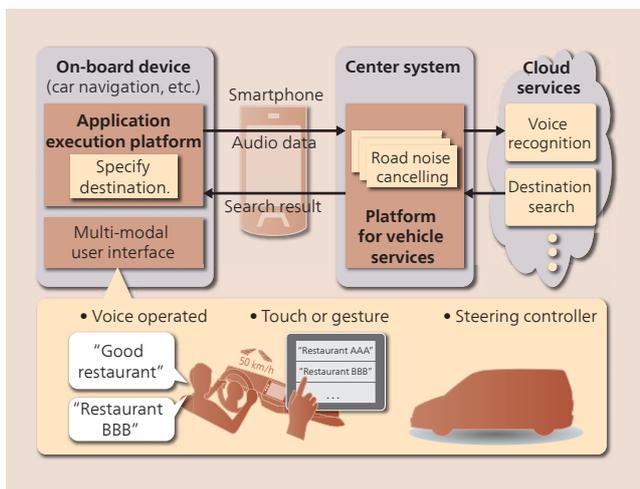


DB: database

17 Fault recovery navigation system based on autonomous IT operation technology

## 18 Multi-modal Technology for Next Generation of Car Navigation

Strict laws are being introduced, particularly in the USA, to ban the hand operation of car navigation systems, smartphones, and other digital devices while driving. On the other hand, the rapid spread of cloud services in recent years has led to growing demand for their use when driving.



18 Destination search system that uses cloud-based voice recognition

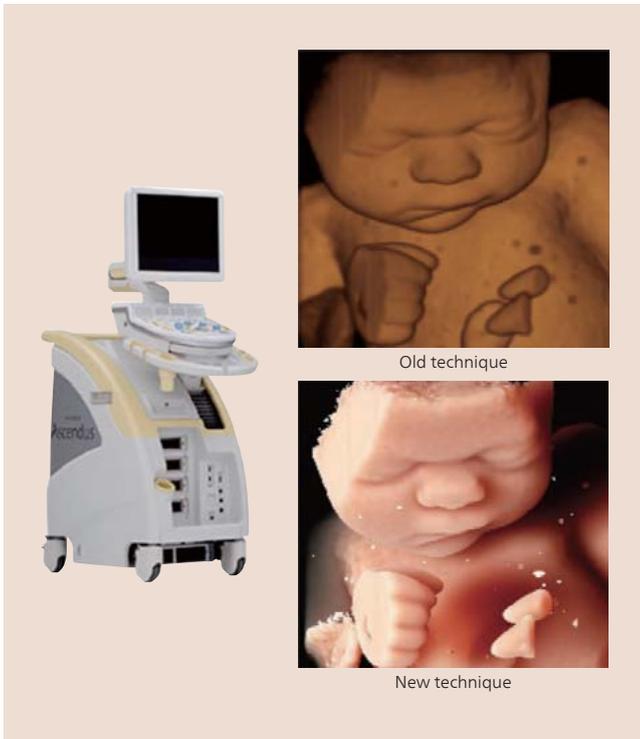
In response, Hitachi has developed a multi-modal user interface for vehicles based around the use of cloud-based voice recognition. To facilitate access to cloud services while driving, the interface incorporates features that act as a cloud service front end specifically designed for use in vehicles, including performing road noise cancellation prior to voice recognition. It also allows operation to be integrated with cloud services through an application execution platform for on-board devices. These features allow the use natural language commands such as “a good noodle bar” to specify a destination, for example, and some of them have been adopted in car navigation systems made by Clarion Co., Ltd.

To help make vehicles safer, Hitachi intends to focus on the user interfaces of on-board devices, and to combine a number of different modes of operation, such as gesture recognition or the use of an interactive interface to clarify the driver’s intentions.

## 19 3D Fetal Imaging Technique for Diagnostic Ultrasound Systems

Volume rendering is used in obstetric ultrasound systems to generate 3D images of the fetus for the mother and family members to view.

The role of obstetrics equipment is not just to provide diag-



19 HI VISION series diagnostic ultrasound system (left) and three-dimensional fetal image produced using old and new techniques (right)

nostic functions for use by doctors and ultrasound operators. Rather, their functions intended for mothers are also important and represent added product value. There has also been the potential with existing technology for functions that are intended to invoke an emotional response or reassure the mother by providing more realistic images of the fetus to instead cause anxiety, because they lack an adequate ability to present features such as shape or skin color. In response, Hitachi has been able to

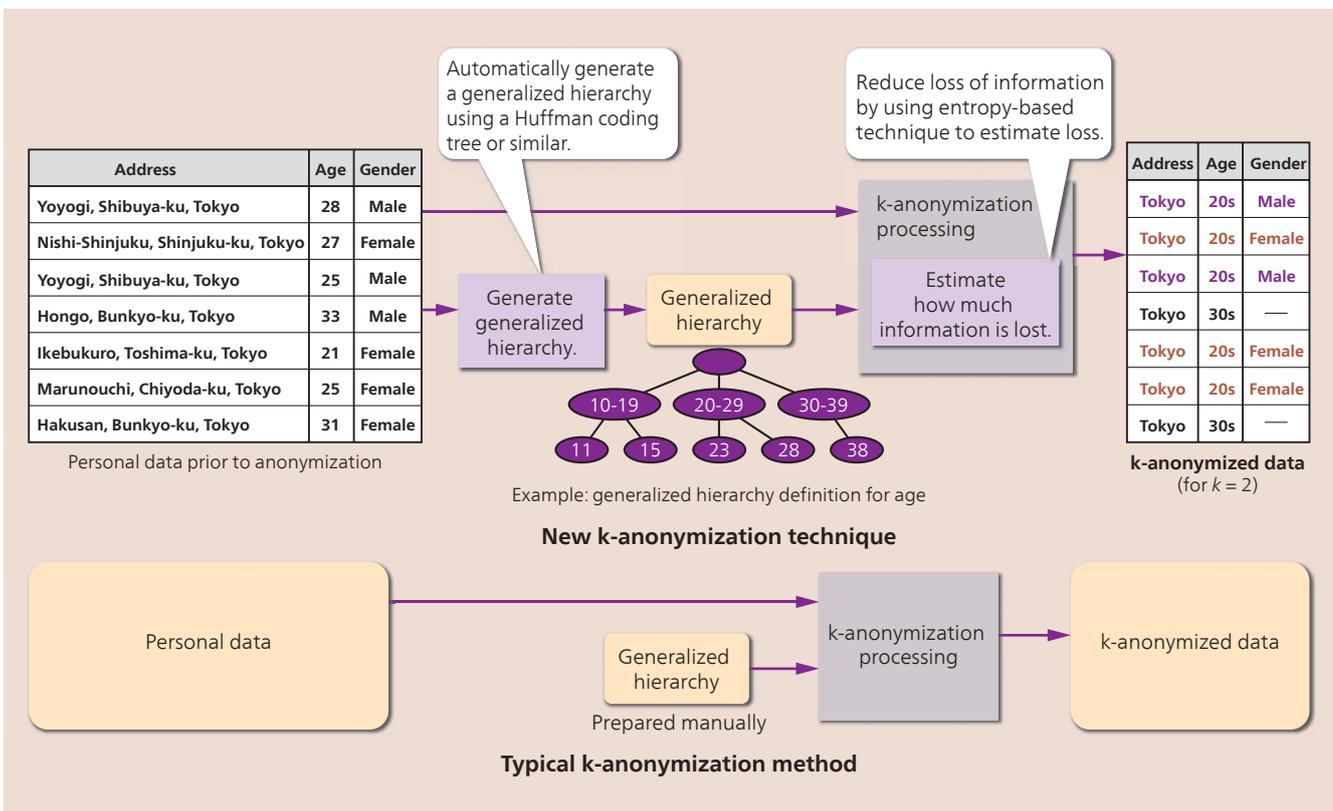
generate three-dimensional fetal images that pregnant women find highly acceptable by utilizing a color map that invokes an emotional response and was produced using a subjective quantification technique based on machine learning, and a new rendering technique that reproduces shading and the dispersion and absorption of light. The technology has been incorporated into the HI VISION\* series of diagnostic ultrasound systems made by Hitachi Aloka Medical, Ltd. (released in April 2013).

In the future, Hitachi intends to proceed with research aimed at making further improvements in image quality to facilitate diagnostic use, and at upgrading functions, including making the system easier to use.

\* HI VISION is a registered trademark or trademark of Hitachi Medical Corporation in Japan and other countries.

## 20 Anonymization and Authentication Technology to Facilitate Use of Personal Data

k-anonymization is a technique for preventing people from being identified from their personal data when it is used for research or other purposes. The technique processes data to ensure that, for each data item that could be used for identification, at least  $k$  records will contain the same value. The problem with k-anonymization has been that it involves a loss of information. In response, Hitachi has developed a k-anonymization scheme that reduces information loss by approximately 25% compared to previous k-anonymization methods by automatically generating a generalized hierarchy for data processing, and by adding a technique that uses entropy to estimate how much information is lost when data is anonymized. The new scheme is to be evaluated as part of a proof of concept project regarding the use of healthcare information in the Manchester region of the UK.



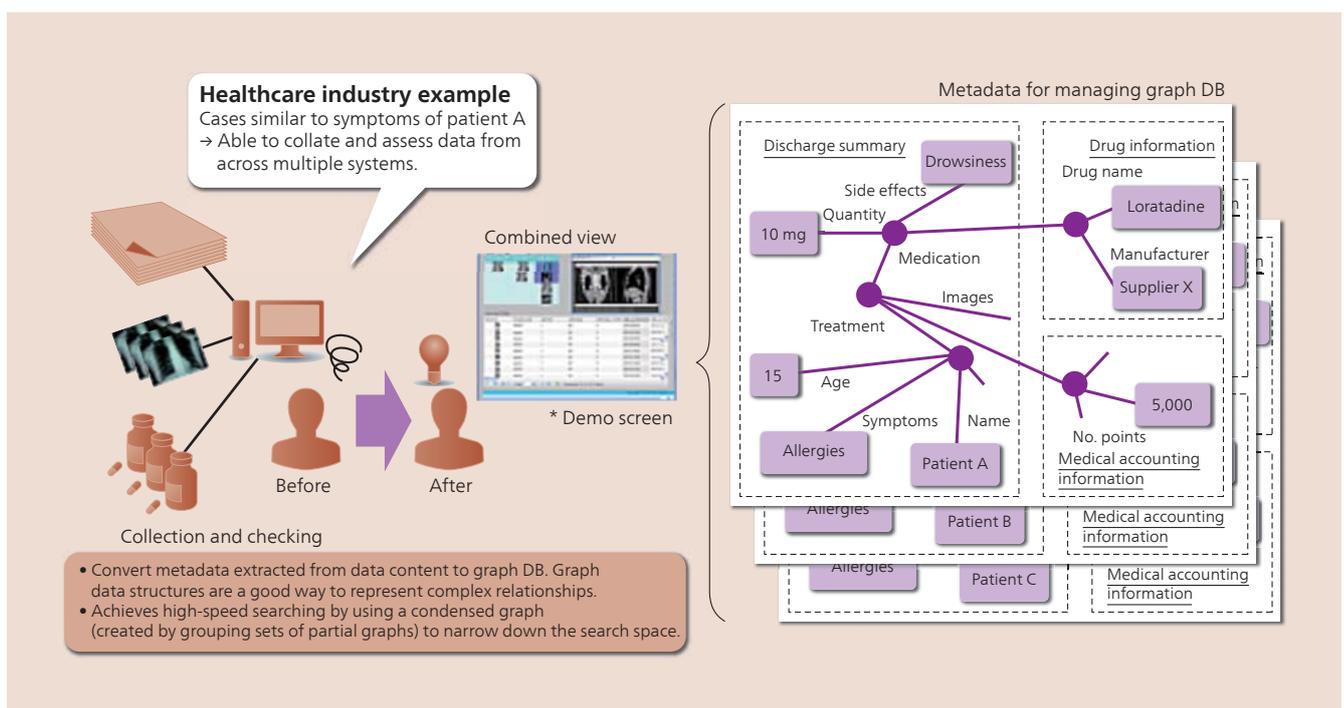
20 Newly developed k-anonymization technique

Hitachi is also working on a technique for handling sensitive personal biometric information that makes this information available for personal authentication but still maintains a high level of protection. Currently, public key infrastructure (PKI) based on digital signature technology is widely used as a reliable means of personal authentication for e-government or e-commerce transactions. However, this relies on methods such as smartcards or passwords to safeguard the private key that certifies a user's identity, leaving open the risk of theft, loss, or forgetfulness. To eliminate these risks while also improving convenience, Hitachi has developed a new digital signature technique that uses biometric information such as a finger vein pattern as the private key. This establishes a safe, secure, and convenient infrastructure for personal authentication, which we call a public biometrics infrastructure (PBI).

## 21 Technology for Utilizing Unstructured Data

There is growing interest in business applications that use the unstructured data collected by companies, such as text, images, or audio. Hitachi is currently working on the research and development of platforms for utilizing unstructured data that can make this easier to achieve.

These platforms use media analysis technology to extract metadata from the content of unstructured data, and use it to create a database with a special type of structure called a "graph." This makes it possible to use the metadata to search or analyze the unstructured data. In the case of electronic healthcare records or medical images at a hospital, for example, this might involve extracting patients' names, diagnoses, and examination and treatment records and using a graph data structure to manage this information. This could then be used to extract similar cases by performing a search of the graph data structure to identify other patients with similar symptoms.



21 Metadata management in a graph database

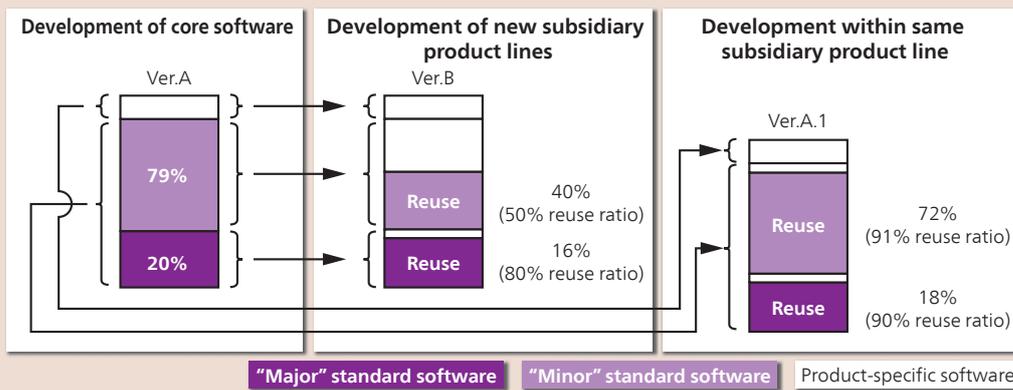
A problem with this, however, is that performing a search of information contained in a graph data structure typically requires a lot of computing time. To overcome this, Hitachi has developed a technique for speeding up searching by narrowing down the search space. To achieve this, it condenses the overall data structure by grouping sets of partial graphs made up of adjacent structures. When tested on medical data, the technique increased speed by a factor of 100 or more compared to previous methods.

In the future, Hitachi plans to develop applied technologies such as the use of graph data structures in knowledge processing for diagnostic support or other advanced analytical applications.

## 22 Cost Reduction in Network Switch Software Development by Software Product Line Engineering

In developing software for a network switch product series, Hitachi Metals, Ltd. is facing a proliferation in its product line as customer needs become more diverse, and a consequent increase in the volume of development work. In response, it has introduced software product line engineering that has allowed it to rationalize its software product line, with an emphasis on software modularization and reuse. This has resulted in greater development efficiency across its entire product line.

Hitachi has improved software reusability and development efficiency by integrating and rebuilding its source code, which in the past was developed and managed separately for each product, and by modularizing its core software into two classes, consisting of the "major" standard software that can be reused across all products (20%), and the "minor" standard software that can be reused within subsidiary product lines (79%). By improving the reusability of all different types of software assets, including establishing an environment for automating unit testing and consolidating similar documents, this has reduced software development costs by 68%. The first products developed under this regime were released in 2013.



22 Software modularization and reuse achieved using product line engineering

In the future, Hitachi plans to release more series products, and expects to make ongoing cost savings.

### 23 Formal Methods for Highly Reliable System Development

Social infrastructure systems require efficient software development techniques that can cope with the increasing size and complexity of systems and still maintain a high level of reliability. One such technique that has attracted attention in recent years is the use of formal methods. While formal methods can ensure the high reliability of software, because verification is performed each time a formal model is created (to match the software design specification), they result in a longer development time due to the labor-intensive nature of verification.

In response, a new technique developed by Hitachi generates a template from the formal model created to verify a particular system that keeps the states that have already been verified, and then makes this template available for reuse in the development of other similar systems. This shortens development times by reducing the amount of time taken to create and verify a model. When trialed on an in-house project, the amount of work required to create and verify formal models was reduced by about 80%

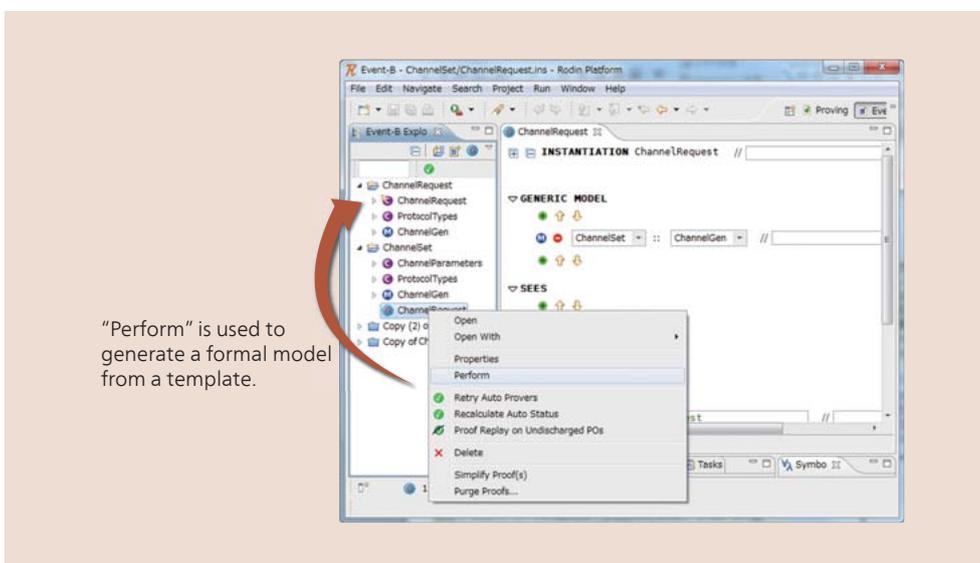
compared to creating a new model each time.

Formal verification support software that incorporates this technique is currently being released as open source software. Hitachi plans to make further enhancements with the aim of introducing it in practice.

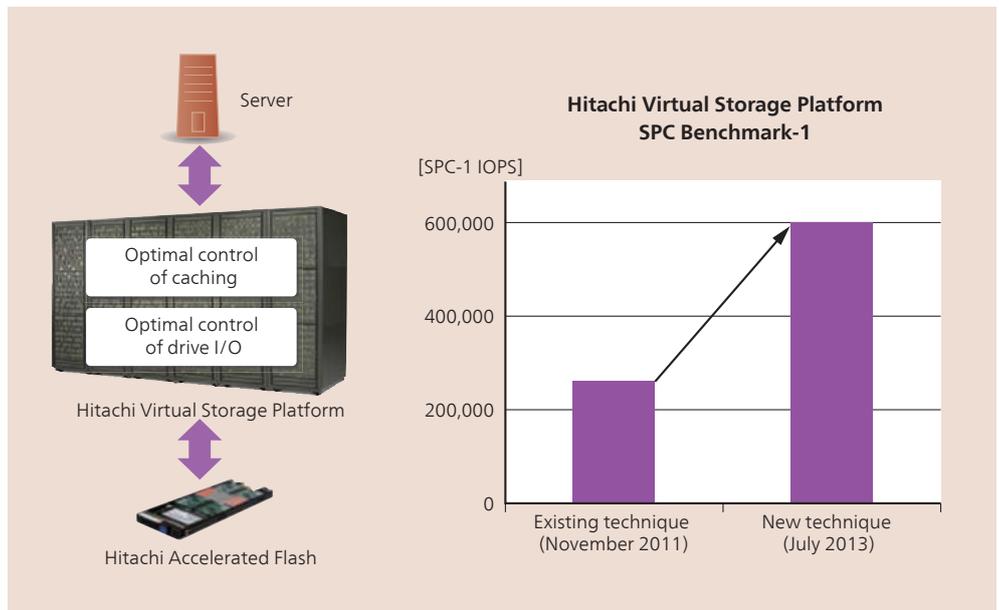
### 24 Flash Acceleration for High-end Storage

The explosive growth in corporate and other data and growing diversity of business applications are driving demand for storage systems that support high-speed processing of large amounts of different types of data. As a manufacturer of both storage controllers and flash drives, Hitachi develops and supplies storage systems that utilize flash drives for high-speed data processing.

This newly developed data processing acceleration technique uses interoperation with flash drives to achieve optimal control of caching and drive I/O by the storage controller. When incorporated into Hitachi Virtual Storage Platform, a high-end storage system that includes proprietary Hitachi Accelerated Flash drives, and benchmarked using SPC Benchmark-1, the new acceleration technique delivered world-leading\*1 data processing performance (for a high-end storage system) of 602,019.47 SPC-1 IOPS\*2.



23 Newly developed formal verification support software



24 Technique for accelerating data processing in high-end storage systems

In the future, Hitachi intends to take advantage of being a manufacturer of both types of devices to continue developing technology that uses flash drives to improve the performance of storage systems.

\*1 As of July 11, 2013

\*2 See "Trademarks" on page 142.

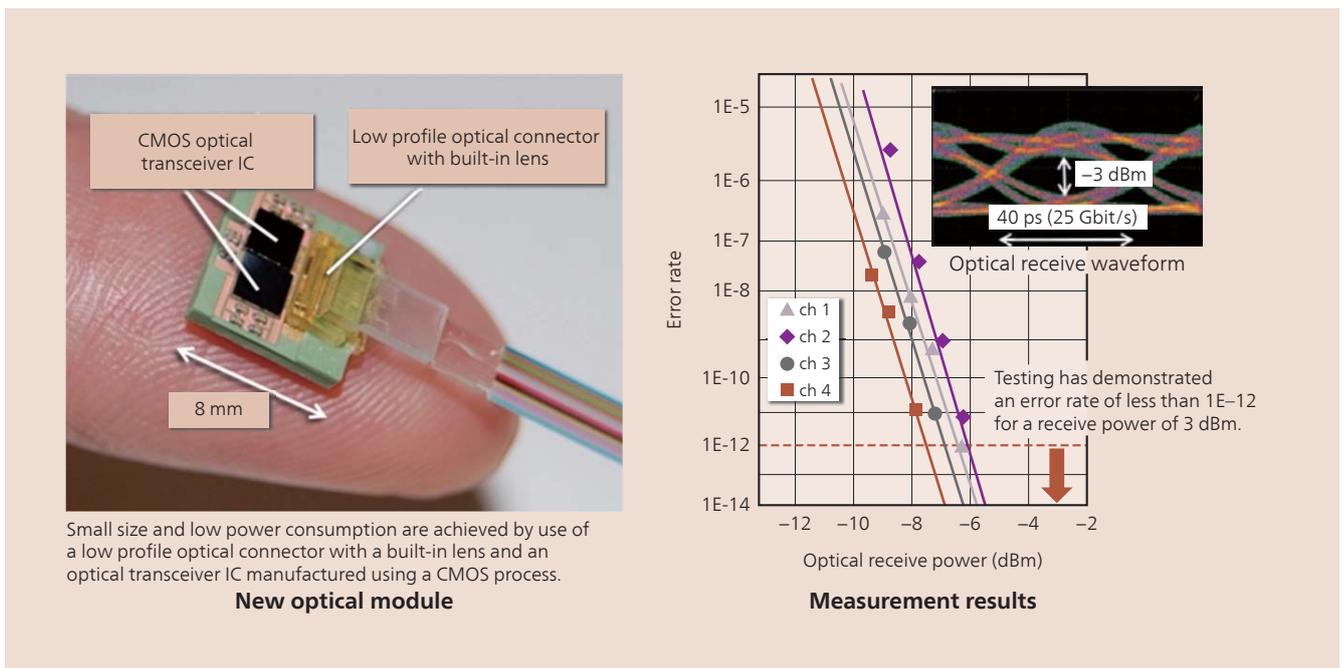
## 25 Optical Module with High Transmission Density and Low Power Consumption for Internal Communications in IT Devices

Hitachi Metals, Ltd. and Central Research Laboratory and Yokohama Research Laboratory of Hitachi, Ltd. have jointly developed an optical module with high transmission density and low power consumption with the aim of improving the performance of IT devices that use these modules.

In the past, servers, routers, storage, and other IT systems have used electrical signals for internal communications. However, the

higher level of signal distortion that accompanies the rising transmission speeds and wiring densities needed to provide greater capacity makes this communication more difficult. Optical transmission, on the other hand, although it has been used for longer transmission distances of tens of meters or more, faces problems such as module size and power consumption when used for internal communications in IT devices.

The new optical module developed by Hitachi makes it possible to incorporate optical transmission into IT devices. It achieves world-class transmission density and low power consumption using an optical transceiver integrated circuit (IC) that incorporates a low profile optical connector with a built-in lens and is manufactured using a complementary metal oxide semiconductor (CMOS) process. The 8 mm × 8 mm module has four input and output channels. Each channel is capable of 25 Gbit/s of error-free transmission (error rate < 1E-12), providing a total capacity of 100 Gbit/s. The 1.2-W power consumption is approxi-



25 Optical module with high transmission density and low power consumption

mately half that of previous modules, and suitable for commercial use.

In the future, Hitachi intends to contribute to increases in capacity through the use of optical transmission for internal communications in IT devices.

## 26 Pb-free Zn/Al Clad Metal with Cu Coating for Heat-tolerant Soldering

Hitachi Metals, Ltd. and Yokohama Research Laboratory of Hitachi, Ltd. have jointly developed a copper- (Cu) coated zinc/aluminum (Zn/Al) clad metal for use as a heat-tolerant solder for power semiconductors.

Most materials used for soldering power semiconductors are made primarily of lead (Pb) and tin (Sn). In recent years, however, there has been demand for more reliable solders that, for reasons of environmental protection, do not use Pb. While this has directed attention toward Zn-Al solders, these materials are easily oxidized and there are problems with their wetting and soldering characteristics.

This new Cu-coated Zn/Al clad solder uses a roll cladding technique in which the solder is built up in layers of different materials in the sequence: Cu, Al, Zn, Al, and Cu. When heated to 382°C, the five layers melt together and function as a Zn-Al-Cu solder. The Cu surface layer prevents oxidization of the interior Zn and Al. Meanwhile, a problem when Cu and Zn are in contact is that they react over time resulting in the loss of the Cu surface layer. In this material, the Al layer ensures the long-term stability of the Cu layer by preventing the Cu and Zn from coming into contact and reacting. These effects provide the solder with good storage characteristics and good wetting and soldering

characteristics in standard soldering machines.

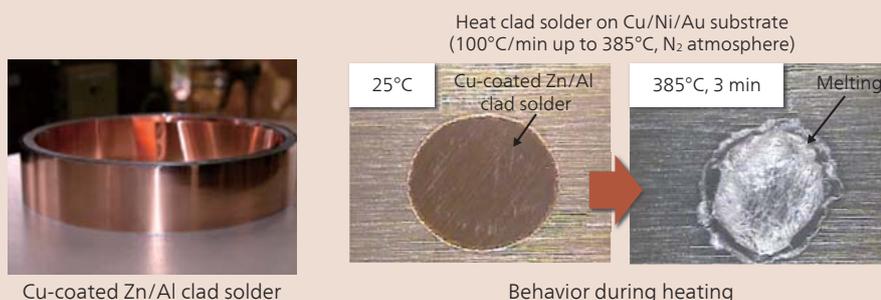
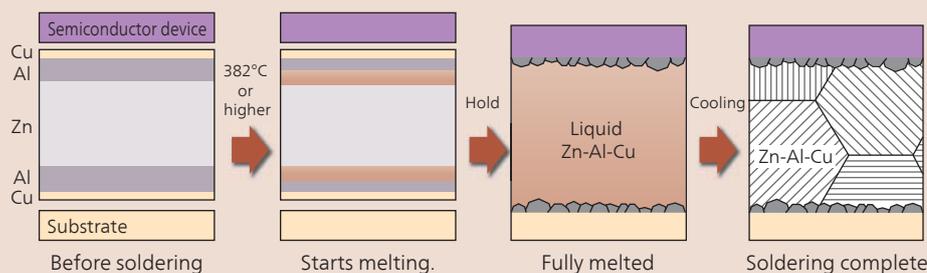
When a semiconductor device was soldered using the new solder, it demonstrated a longer temperature cycle life than Pb solder and maintained the integrity of the joint interface when kept in a 250°C environment. The new material has the potential to provide an alternative to Pb solder and to find uses as a solder for silicon carbide (SiC) devices that operate at high temperatures.

## 27 Flow Control Technique for Messaging Systems

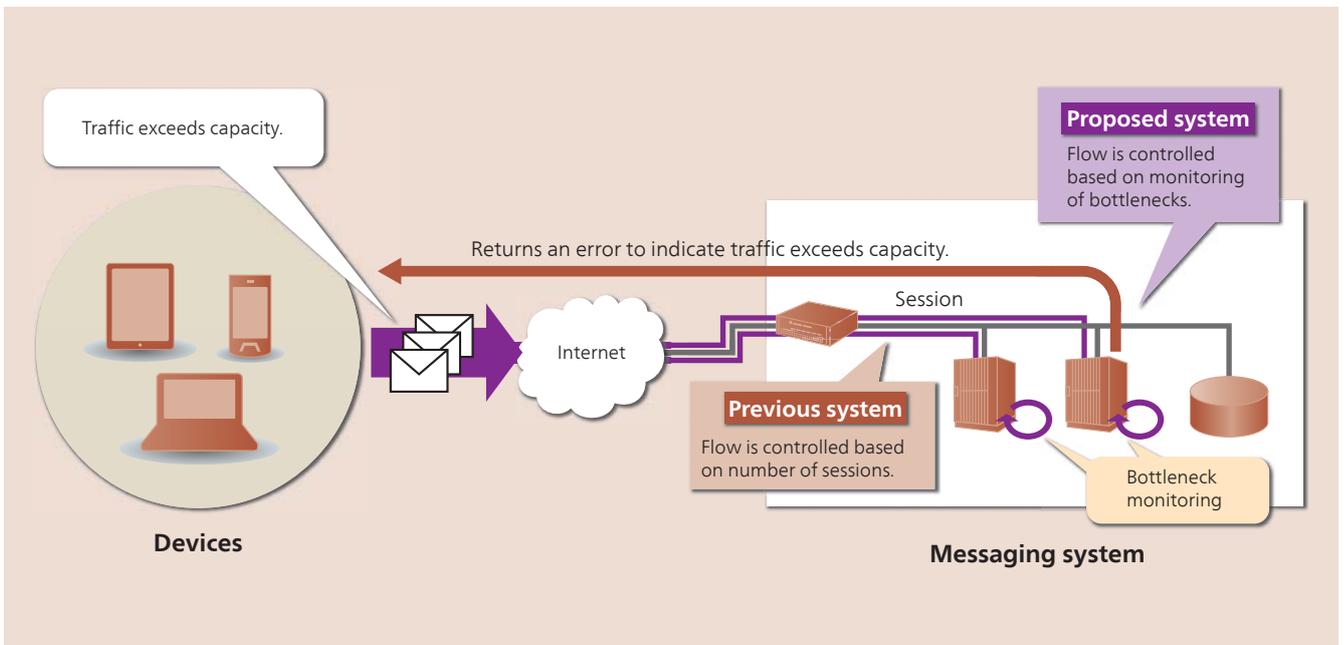
This era of big data is likely to involve large numbers of devices sending large volumes of message traffic. This makes it essential that the messaging systems that relay these messages be able to continue to operate reliably even under conditions of overloading due to heavy traffic. Past systems have used a predefined limit on the number of sessions to regulate message flow when traffic exceeds their capacity. A problem with these systems, however, is that they have not been able to make effective use of resources because messaging systems that place a priority on reliable operation have needed to control flows by building enough of a margin into their limits to prevent congestion from occurring.

Hitachi's newly developed technique includes a function that monitors bottlenecks in the messaging system and regulates message flow accordingly. Because flow control is based on realtime monitoring results, the technique ensures reliable operation while also making effective use of system resources.

In the future, Hitachi intends to use this technique as a base for further improving the availability of messaging systems.



26 Diagram of joint cross-section and soldering mechanism of Cu-coated Zn/Al clad solder



27 Flow control technique for messaging systems

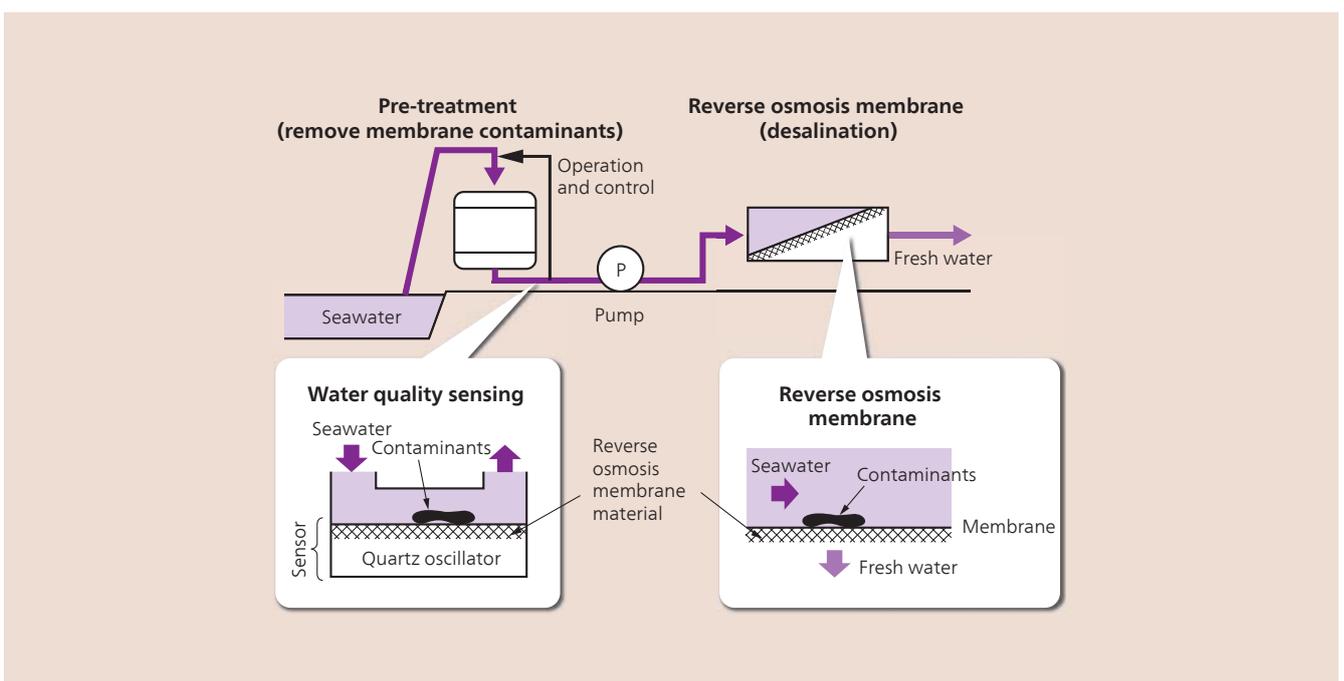
## 28 Water Quality Sensing Technique for Seawater Desalination Plants

Seawater desalination plants use reverse osmosis membranes to remove the salt from seawater. Preventing the clogging of the membrane by organic contaminants in the seawater is an important requirement for ensuring efficient operation. In the past, the lack of a direct means of detecting organic contaminants in the seawater has meant that clogging has instead been identified from increases in pressure at the pumps that supply the seawater to the reverse osmosis membranes.

A new technique developed by Hitachi can sense the presence of organic contaminants quickly and with high sensitivity. Given that clogging is caused by these organic contaminants being sucked into the surface of the membrane, organic contaminants

can be selectively captured by a reverse osmosis membrane material coated on a highly sensitive quartz oscillating sensor. The new sensing technique has a strong correlation with pressure increase (0.95) but takes less than one-twentieth of the time required to detect clogging from an increase in pressure (less than two hours compared to several days). It is anticipated that the technique will facilitate highly efficient operation by detecting the presence of organic contaminants in advance so that they can be removed by chemical or other means before they reach the membranes.

In the future, Hitachi intends to improve detection accuracy and establish automatic measurement methods, and to apply this technology to the operation and control of seawater desalination plants.



28 Diagram of seawater desalination plant and sensor features

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