Hitachi Review

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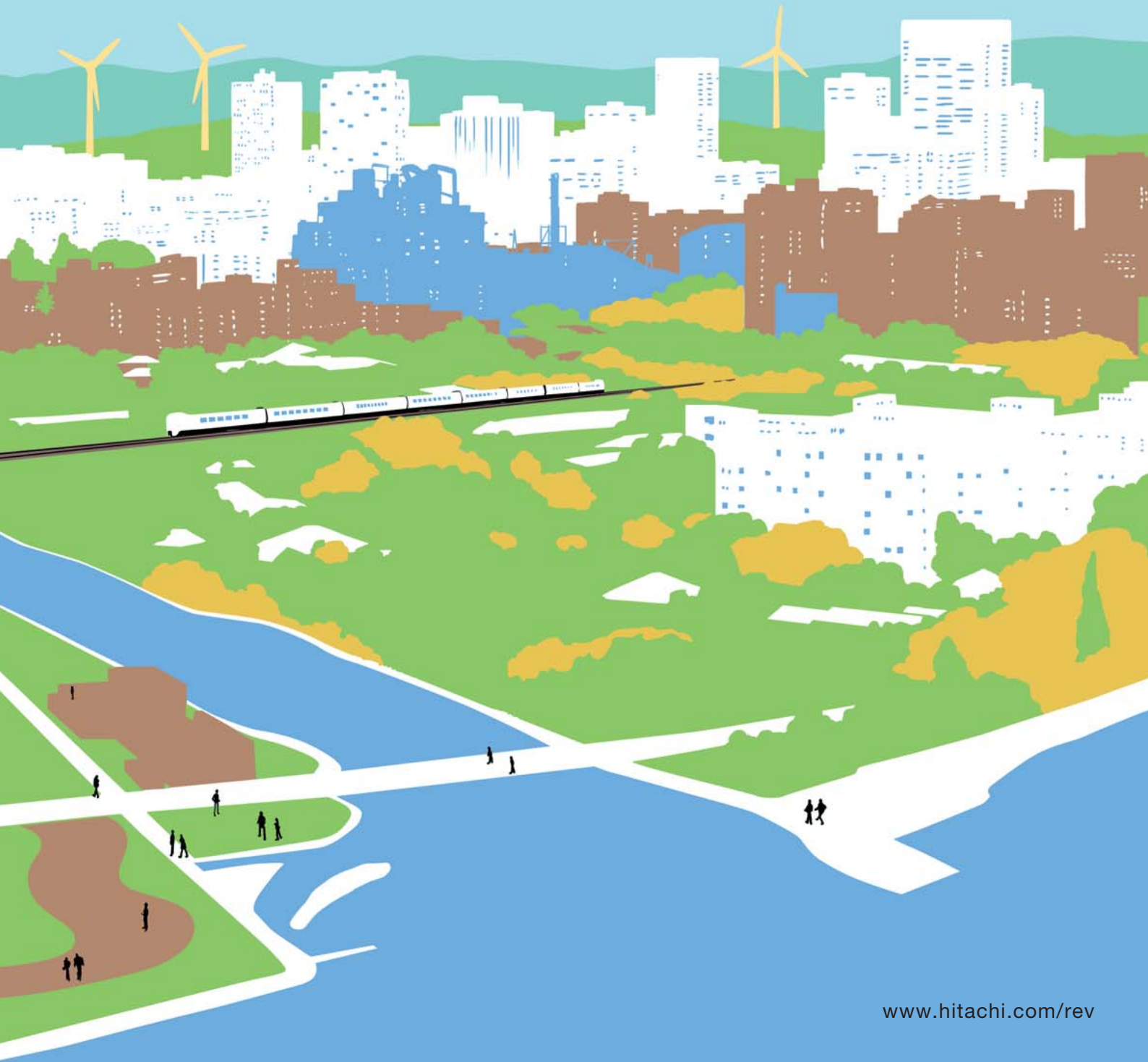

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Moving Forward with our Social Innovation Business

Hitachi's Social Innovation Business provides safe and reliable social infrastructure that has been enhanced by the application of information technology (IT). The Hitachi Group has embraced the Social Innovation Business as a unifying focus globally. In that time, we have achieved numerous successes while, at the same time, earning the support of customers and other partners from around the world.

In the UK, where we have been awarded a contract to supply railway systems for the Intercity Express Programme (a high-speed railway project), Hitachi unveiled leading production rolling stock last year and started transporting it to local areas. Moving the railway systems business head office functions to London has accelerated business development because it has enabled us to maintain closer contact with the people in the local area. And, in the Manchester Region of the country, Hitachi is engaging in a proof-of-concept project to improve healthcare services utilizing IT. While these are only some examples of our work, what they have in common is our practice of working in close proximity to customers so we can identify and understand their underlying challenges and not only overcome these challenges, but do so in ways that contribute to improving people's quality of life.

Modern society continues to face a combination of serious problems and a range of threats that need to be confronted on a global scale; these include securing a stable food supply, reducing resource and energy depletion, and achieving environmental sustainability. All of these complex challenges — such as energy, transportation and water — involve numerous interrelated problems. This means that the progress that can be made when working on a specific social infrastructure system in isolation is limited. To achieve progress in social infrastructure, I believe we need to move away from a micro approach and, instead, seek to improve all aspects of the infrastructure by integrating and harmonizing systems operations. This will require a major paradigm shift to a concept we call "symbiotic autonomous decentralized systems." The seamless interconnection between different systems that define this concept will allow these systems to operate together and deliver functions at the macro level. This will facilitate business innovation by providing more sophisticated services while making better use of limited resources, and it will help create a society that can adapt flexibly to environmental changes.

While sharing in each and everyone's tireless ambitions and the joys of growth with our customers, and through our Social Innovation Business, we at Hitachi are working to create such a society by taking on challenges around the world. For example, some of the technology developments described in this issue of *Hitachi Review* include the use of large electric power storage systems to ensure a reliable supply of energy, a new generation of traffic infrastructure that links vehicles with IT, and new achievements in the care cycle made possible by improvements in medical equipment functionality. Through solutions like these, based on the symbiotic autonomous decentralized systems concept, we are supplying IT platforms that foster innovation by linking these technologies together, and we are working to ensure the security that will protect both corporate activity and people's lives.

In pursuing these many innovations in response to the ongoing changes in society, we have continued our Mission of "contributing to society through the development of superior, original technology and products." To quote our global campaign — "SOCIAL INNOVATION — IT'S OUR FUTURE." I hope that everyone will support us as we continue to create a Hitachi that answers the world's needs through our Social Innovation Business.

T. Higashihara

Toshiaki Higashihara
President & COO, Hitachi, Ltd.

Visionaries 2015

These articles describe five aspects of Hitachi's Social Innovation Business through the voices of the people involved.

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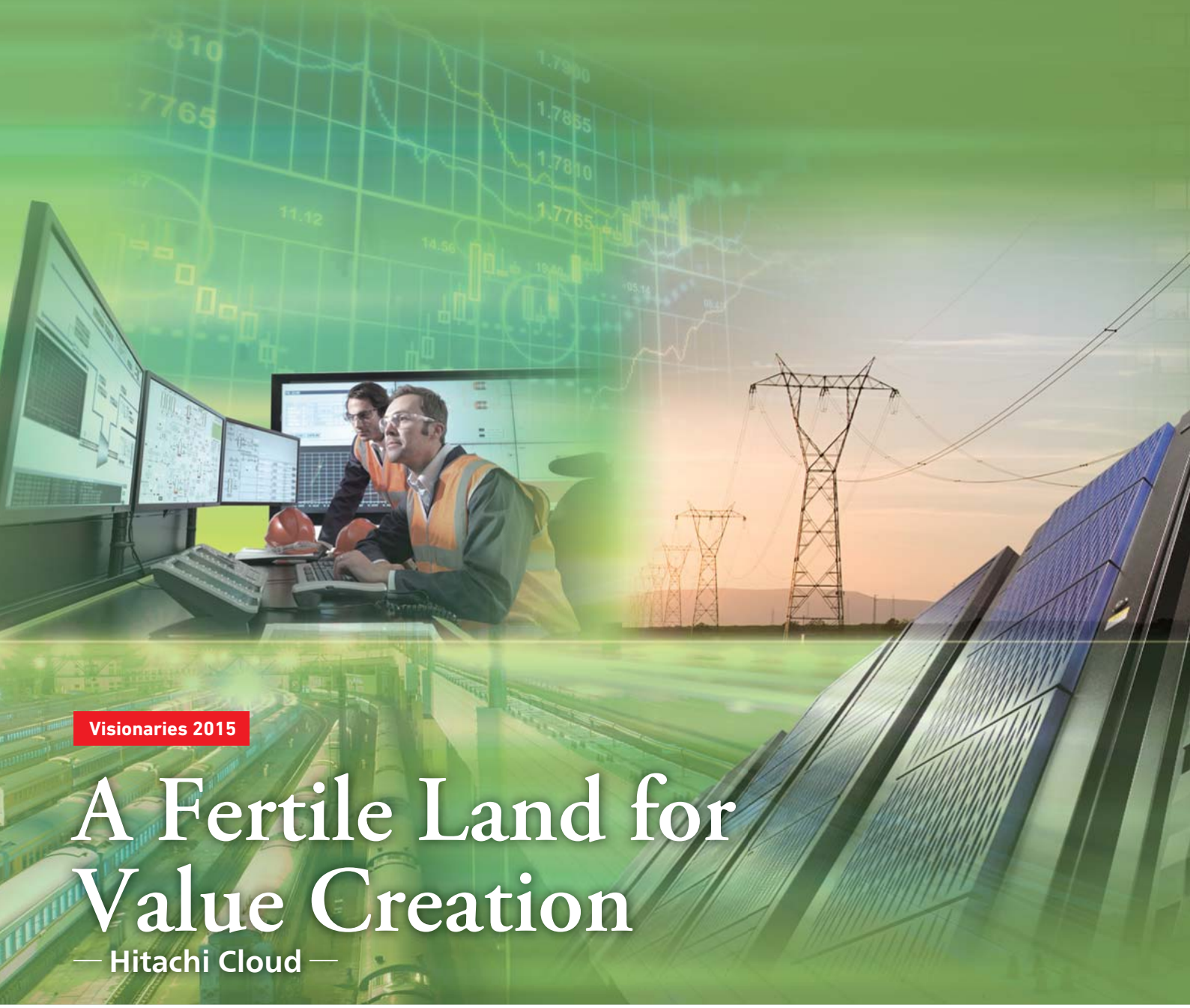


Visionaries 2015

A Fertile Land for Value Creation

— Hitachi Cloud —

By providing computing resources as services, the cloud is emerging as a platform for creating value in ways that facilitate business growth and innovation in social infrastructure.
Amid this trend, Hitachi has restructured its cloud platform and the products and services that support it as the "Hitachi Cloud."
Based on the technologies it possesses by virtue of being an IT platform vendor, with products that feature high reliability, experience and know-how from the support of social infrastructure, and knowledge built up through the activities of its group companies, Hitachi is picking up the pace of its Social Innovation Business by supplying a cloud with high added value.

Working Toward Co-creation by Aggregating Information

The "cloud" is said to have become a trending term in the information technology (IT) field around 2006. The new concept of on-demand access to computing resources (such as computer processing and data storage) provided as a service via a network triggered a shift in the nature of IT assets toward being something that can be rented rather than owned, and attracted attention for such benefits as lower costs and reliable operation. Now, nine years later, the cloud is starting to be recognized as something more than just a way of providing computing resources as a service.

For this next generation of the cloud, Hitachi has developed a new cloud platform and supporting products and services that it has formalized as the "Hitachi Cloud." Naoki Ono (President of Cloud Services Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), who manages the cloud service business, explains the background to this as follows.

"The cloud has rapidly risen in prominence as a business platform in recent times, increasingly

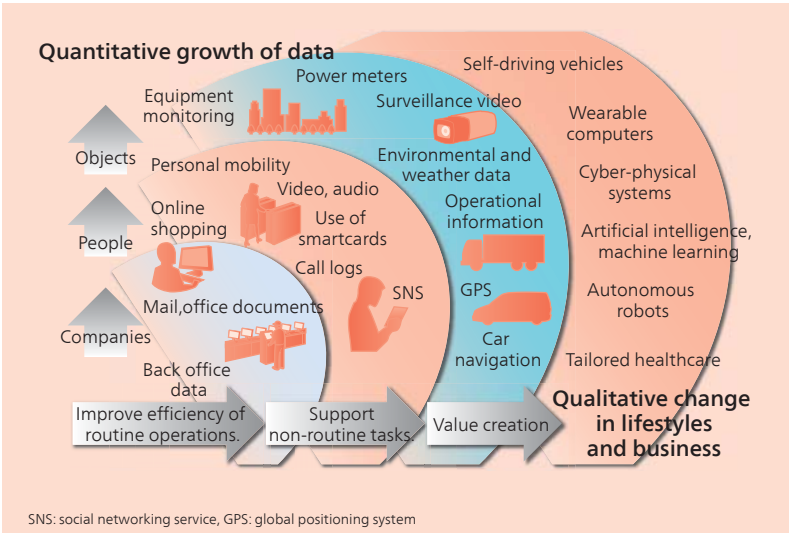
that helps quickly set up SaaS environments. Itself provided in the form of a service, the SaaS business platform provides the resources needed to offer an application program as a SaaS-style cloud service. The SaaS business platform utilizes know-how from another of Hitachi's cloud services, the TWX-21*2 business media service, which provides a forum for business-to-business transactions over the Internet that has around 55,000 member companies spread across 24 countries and regions.

Mr. Ono also notes that, "In addition to business-to-business transactions, the service has also brought about advances in the role of the cloud as a place for member companies to do business by, for example, allowing them to hold discussions. In other words, it has become a recognized platform for co-creation. The true value of the cloud lies in facilitating things like co-creation and value creation through resource sharing and the aggregation of information within companies, groups, or communities. Furthermore, our aim is to make progress on turning the cloud into a platform for innovation in social infrastructures and other businesses by supplying Hitachi's practical business know-how in the form of a service."

Naoki Ono

being adopted for core applications. At Hitachi, we have drawn on our experience in social infrastructure and our other capabilities to supply highly reliable cloud services that support such mission critical areas. Meanwhile, there has also been growing use made of the public cloud, which can respond flexibly to changing user workloads. To satisfy customers' diverse needs, we have strengthened our collaboration with leading cloud vendors and offer a cloud environment that makes available the best combination of Hitachi's managed cloud*1, the customer's private cloud, and our partners' public clouds."

Based around a federated cloud made up of these multiple clouds, which can be managed as a single unit, this newly formalized cloud platform also includes service integration to support tasks such as the development of business applications, and a software-as-a-service (SaaS) business platform



Hitachi' s view of future trends in the use of information. The Hitachi Cloud acts as a platform supporting value creation amid these changes in business and society.

Maintenance depot for Class 395 high-speed trains in the UK. Work is proceeding on the use for predictive diagnosis of data collected from sensors fitted to the trains.

*1 A cloud service that provides public cloud resources and also added value such as design and implementation or operation and maintenance. The service can be adapted to suit the user's system, operational, and other requirements.
*2 TWX-21 is a trademark of Hitachi, Ltd.

Providing a Platform that Delivers Advances throughout Society

Living as we now do in the "information society," information has become an essential service for the functioning of society and the source of a variety of new value creation. As a platform that aggregates information, the cloud is recognized as having the potential to transform not only business but also the infrastructure of society.

For example, with the emergence of machine-to-machine (M2M) communications and the Internet of things (IoT), which link together a wide range of different objects via networks and enable optimal control through the sharing of sensor and other data, the cloud has already started to be used as a platform for aggregating the information generated by real-world objects so that it can be analyzed and put to use in the form of big data.

Toshiaki Tokunaga (President of Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), who is in charge of the smart information business that uses IT to empower Hitachi's Social Innovation Business, expressed this as follows.

"One of the demonstration projects being undertaken by my division involves the predictive diagnosis of faults on rolling stock. When one of Hitachi's high-speed Class 395 trains used in the UK returns to the depot, the information from the server and several dozen sensors installed on each train is automatically collected using M2M communications and then analyzed on the cloud. This analysis can identify advance indications of a fault on a particular component based on knowledge built up over time. We believe that this will help improve service quality by replacing such parts before they fail to avoid problems such as timetable disruption or loss of utilization due to faults."

Sensor data cannot generate value on its own. Instead, the value for customers and for Hitachi itself lies in the knowledge acquired by analyzing large amounts of data. The practical business know-how of Hitachi and its partners contributes to this knowledge acquisition process.

Accordingly, the collection and analysis of big data for use as a resource for creating value is performed on a global cloud. Customers are given access to an environment that allows them to concentrate on value creation rather than spending time and effort building IT infrastructure.

As Mr. Tokunaga commented, "It is fair to say that the Hitachi Cloud is a true combination of IT and infrastructure, providing the platform on which we can realize our Social Innovation Business. The trend toward enhancing social infrastructures and other businesses as well as people's lifestyles by transforming various real-world activities and situations into data for analysis is only likely to become more pronounced in the future."

Given this situation, the aim of the Hitachi Cloud is to achieve innovation in social infrastructure and become a platform that delivers advances throughout society by acting as a reliable, high-quality, and secure IT platform for supporting essential information services, and by incorporating knowledge from data analysis into the provision of services.

Financial Services as Part of Social Infrastructure

Social innovation on a cloud platform is already taking place in a variety of fields. Payment services are one example.

In 2014, Hitachi acquired PRIZM PAYMENT SERVICES PRIVATE LIMITED, a major provider of payment services using automatic teller machines (ATMs) and point-of-sale (POS) systems in India. PRIZM PAYMENT SERVICES' business involves supplying financial institutions with a total ATM operation service that provides 24-hour/365-day ATM services and encompasses:

Toshiaki Tokunaga

Value Underpinned by Technologies Honed Prior to the Cloud


Hiroyuki Kumazaki

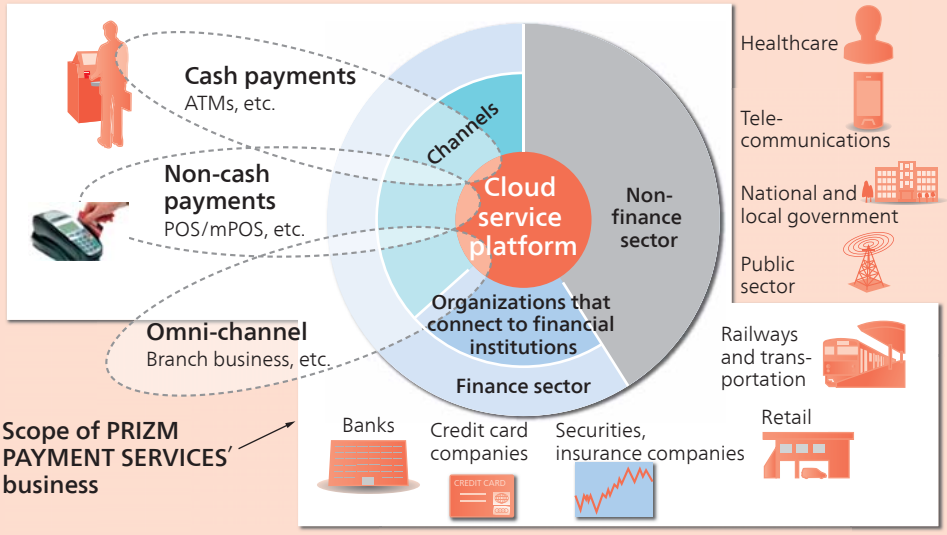
Underpinning the value of the Hitachi Cloud in its role as a platform for value creation are IT platform technologies. Hiroyuki Kumazaki (President of IT Platform R & D Management Division, Information & Telecommunication Systems Company, Hitachi, Ltd.) leads the department responsible for developing these technologies.

"The cloud is built on IT resources such as servers, storage, and networks together with virtualization and administration technologies that overcome physical constraints to allow whoever wants to use the cloud to do so, whenever they want, and as much as they want. Having honed such technologies since before the emergence of the cloud, Hitachi is able to provide the cloud as a platform that is flexible and can be used with confidence. One could say that it is these capabilities of Hitachi that make possible the "ready-made cloud" in which individual cloud technologies are bundled together and delivered to customers in such a way that they can set up a private cloud simply by clicking the power switch.

Our current focus is on technology that simplifies the analysis on the cloud of a wide variety of M2M and other data. We intend to support innovation by supplying this technology in the form of tools for extracting knowledge from data."

ATMs; networking, air conditioning and other ancillary equipment; installation sites; and cash pick-up, delivery, removal, and replenishment. PRIZM PAYMENT SERVICES also operates the White Label ATM (WLA) service under its own brand and is playing a part in extending the financial systems to places that are not covered by financial services. Although unfamiliar to Japan, it is estimated that about half of all ATMs in India are operated by payment services like these. The acquisition will enable a fusion between PRIZM PAYMENT SERVICES' strong customer base, which includes major financial institutions, its payment and cash handling systems, and Hitachi's financial sector IT services, which have the leading share of the Japanese ATM market.

Atsushi Hasegawa (President of Payment Services Division, Information & Telecommunication Systems Company, Hitachi, Ltd.) who manages the payment services business explains the significance of the merger of the two companies to the development of the financial sector in India as



PRIZM PAYMENT SERVICES supplies payment services in India using ATMs, POS systems, and other methods. Its chain of services is supported by Hitachi' s cloud.

Atsushi Hasegawa

Shop-front ATM in India. The provision of services takes account of special factors such as the local climate and the state of the electric power and telecommunications infrastructure.

follows.

"While India currently has about 200,000 ATMs, only about one-tenth as many as Japan per capita, this is expected to increase to 300,000 by 2016. Although only a low 35% (approximately) of people have a bank account, this proportion is expected to grow rapidly under the vigorous economic policies of Prime Minister Narendra Modi. PRIZM PAYMENT SERVICES plans to increase the number of its ATMs from about 32,000 now to 60,000 in 2016. As its payment services extend beyond ATMs to include credit cards and public transportation cards, we believe that PRIZM PAYMENT SERVICES can contribute to the spread and development of financial services by utilizing Hitachi technology and other know-how to provide customers with very convenient services for both cash and non-cash payments."

Underpinning these services is the Hitachi Cloud. By utilizing technologies built up from past work on social infrastructure, the Hitachi Cloud is maintaining the level of quality that is expected of the financial infrastructure, even in India with its difficulties in areas such as telecommunications and electric power. By linking to this cloud, financial institutions can improve convenience for users by utilizing PRIZM PAYMENT SERVICES' ATMs, POSs and other capabilities, and by making available all of their different payment channels.

Mr. Hasegawa notes, "Finance is an important part of the infrastructure that allows the public to live in safety and security. Its development is likely to bring major changes to the lifestyles and societies of the people of India. We intend to use India as a starting point for speeding up the global expansion of our payment service business, and to press forward with social innovation through the development of financial services."

Yoshihiro Hayashi

The Cloud as a "Cradle of Innovation"

Smart mobility services are another example of social innovation on a cloud platform. While transportation is an important part of the social infrastructure, it also faces a variety of challenges, including congestion, environmental problems, concern for people who find transportation difficult, and disaster countermeasures. To overcome these challenges, IT can speed up the building of transportation infrastructure that is conscious of the environment and that enables people to move around in safety and comfort.

Moves to make transportation infrastructure smarter have been focused around the automobile, which has been the main mode of transportation in the past. Typical examples include the Vehicle Information and Communication System (VICS), which utilizes sensor data to provide traffic congestion and other information, and electronic toll collection (ETC) systems.

Yoshihiro Hayashi (Vice President of Enterprise Solutions Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), who works on the front lines of Hitachi's smart mobility services business, expresses the potential of this field as follows.

"If we make transportation even smarter and connect vehicles directly to the Internet or via smartphones, we can collect more information and put it to use. For example, by analyzing the prevalence of traffic regulation, event, and other keywords in social network services (SNSs) along with smartphone position information, it becomes possible to do things like predicting congestion with high accuracy or determine the most efficient route for a trip. In addition to services that keep map data updated in greater detail, this information can also be used to create services that assess driving characteristics that can be utilized for vehicle insurance and other purposes."

In the automotive field, automated driving is becoming a reality, with progress being made on the commercialization of driving safety support systems such as collision avoidance, automatic following of the vehicle ahead, and lane-keeping. Making automated driving safer will also require

Enhancements to the Cloud Based on the Symbiotic Autonomous Decentralized Systems Concept

Yuichi Yagawa

Research and development is another important element underpinning the value of the Hitachi Cloud. Yuichi Yagawa (General Manager, Information Service Research Center, Yokohama Research Laboratory, Hitachi, Ltd.) manages research and development on information and control systems and information services.

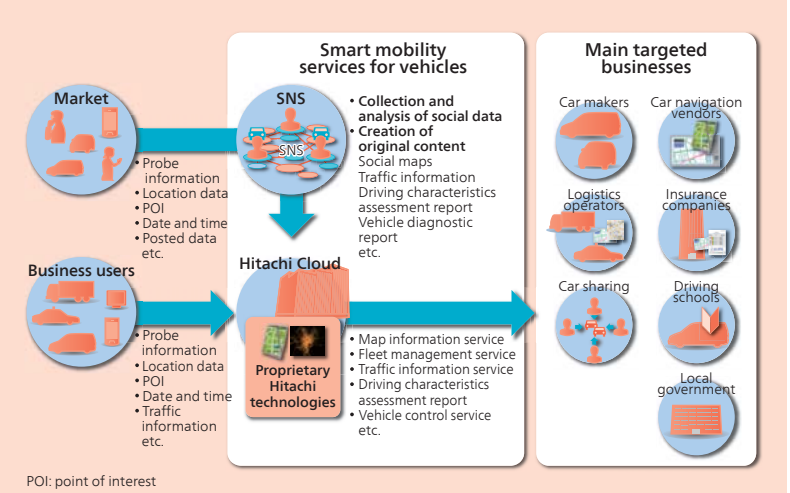
"Clouds that handle a large amount of data with privacy implications need to maintain security. While virtualization, which logically partitions physical IT resources, can in itself be thought of as providing a secure environment, at the Yokohama Research Laboratory we are developing privacy-preserving information processing techniques that can rapidly search data in encrypted form, and supplying them as a technology that can maintain the safety and security of the cloud.

The Hitachi information and control system technologies used in social infrastructure are based on the "symbiotic autonomous decentralized systems" concept. This is a system technology for achieving higher levels of sophistication by having different types of systems work together in a coordinated manner to achieve their objectives. It represents a further enhancement of the autonomous decentralized system technologies that Hitachi has built up over many years in the information and control systems field. The federated cloud provided by Hitachi Cloud is an expression of this concept of optimizing overall performance through the loose integration of systems that have been optimized independently of each other. Interconnection is recognized as a difficult yet critical aspect of IT. We aim to continue supporting advances in this field by undertaking research and development that can realize the Hitachi Cloud concept of interconnecting different entities to create value."

the exchange of information with external entities, leading to the implementation of functions such as the use of M2M communications between the vehicle and pedestrians' smartphones for risk avoidance.

Mr. Hayashi states, "Once sensor data from a diverse range of sources and SNS data generated by people is collected in the cloud, it can be analyzed and processed to provide useful content or trouble-free services that have not existed in the past. It is possible to achieve innovation in transportation infrastructure by integrating different elements that Hitachi possesses, including IT, car parts, navigation systems, and maps. Considering this in terms of the cloud, linking these to other social infrastructure information and knowledge aggregated in the cloud will lead not only to transportation becoming smarter, but also society as a whole. In this sense, the cloud can be described not only as a platform for social infrastructure, but also as a "cradle of innovation" that encourages interoperation and fusion and produces new value."

While the term "cloud" evokes the idea of something as elusive as a cloud in the sky, clouds are also the source of the rain that nourishes all living things. Now that the cloud has moved on from the installation phase to actual utilization, one wonders what benefits it may bring to society. On the other side of the large Hitachi Cloud lies a new horizon of value creation.



Overview of smart mobility services. These services combine social networks with proprietary Hitachi technologies that use location data.

Visionaries 2015

Taming Energy

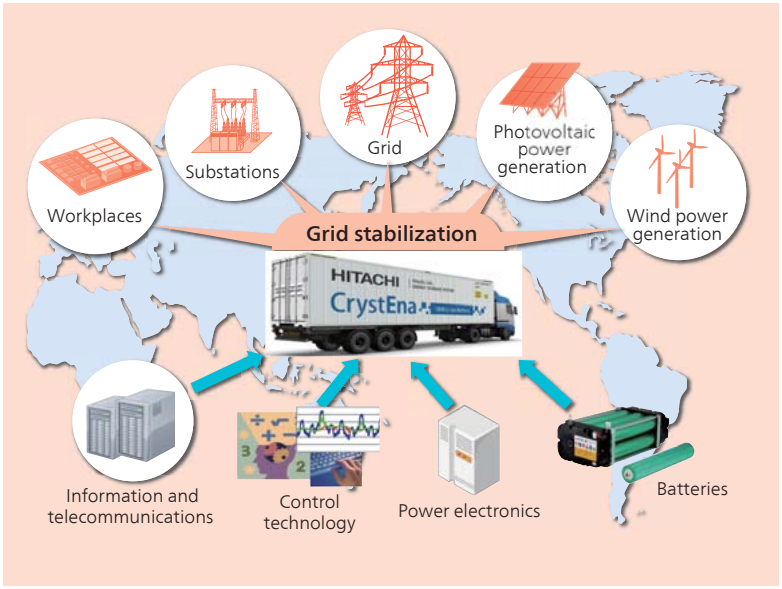
— Energy Storage System Solutions —

The growing deployment of renewable energy, in the form of hillside and offshore wind farms, extensive megawatt-class solar power plants, and household photovoltaic panels has created an urgent need for commercializing solutions to stabilize the power grid, which enable the large-scale installation of fluctuating renewable energy sources.
Hitachi is combining the technologies across its group to develop an energy storage system that can stabilize power grids.
A demonstration project using a container-type energy storage system commenced in the USA in the summer of 2014, and another using a large hybrid energy storage system based on lead-acid batteries will commence on Izu Oshima island in early 2015.

Demonstration Projects Underway for Commercialization

Renewable energy is being developed and installed throughout the world with aims that include satisfying the growing demand for electric power and reducing emissions of carbon dioxide (CO_2). National governments are making an effort to support this process, with the Japanese government having introduced a feed-in tariff scheme for renewable energy in July 2012 following the Great East Japan Earthquake.

Along with the growth in the proportion of these energies such as wind, photovoltaic, and other power sources with outputs that vary depending on the weather, the problem about grid instability will get more serious because the regulatory capacity is not so high. Supply-demand imbalance for electric power will cause fluctuations in its frequency, one of the important power quality, which leads to major outages. On the other hand, there is also a need to reduce power generation when demand is low. This is currently dealt with through regulation by adjustable-speed pumped hydro and thermal power generation based on fre-



Concept behind Hitachi' s energy storage systems. Hitachi contributes to grid stabilization by combining different technologies, including information and telecommunications, control technology, and power electronics as well as batteries.

quency control commands issued by a central load dispatching center. However, it will be difficult to provide sufficient capacity if the amount of renewable energy generation grows rapidly over a short period of time. Because it is difficult to obtain sites for new building or upgrading plants for adjustable-speed pumped hydro and thermal power generation, and requires long construction times.

This has led to raised expectations for energy storage systems that can store large amounts of electric power. Hitachi has developed energy storage systems that can rapidly adjust supply and demand over a time frame of a few seconds by combining technologies of battery materials, battery development and manufacturing, power conversion, control, information systems and so on.

With a view toward commercialization, Hitachi has been putting the finishing touches on its systems by participating in the demonstration projects that combine renewable energy with large energy storage systems undertaken by the New Energy and Industrial Technology Development Organization (NEDO) in places like New Mexico and Hawaii in the USA, and in a residential smart grid demonstration project involving a wind farm with a large battery capacity in Rokkasho-mura in Aomori Prefecture.

Now, finally, the commercialization of an energy storage system for grid stabilization is about to get underway in the USA.

Providing Container-type Energy Storage System for Ancillary Market in USA

A 12-m (approx.) container was delivered on a large trailer to a site in New Jersey, USA. This is the Hitachi container-type energy storage system that is being used in a demonstration project with Demansys Energy LLC, a company that supplies demand control services for electric power.

The liberalization of the electricity market in the USA has included not only the opening up of markets for transmission networks but deregulation of electricity retailers as well as generation. The USA is also the world's largest generator of wind and photovoltaic power. There are concerns that frequency fluctuations, and in some cases consequent power outages, will be brought about by supply-demand imbalances of electric power with the growing adoption of renewable energy. This has created an ancillary market, in which the adjusting capacity for stabilizing electric power itself can be traded in the market, moving to turn it into a business. In particular, pioneering initiatives in the ancillary market are taking place in New Jersey, home to the current demonstration project, and other parts of the northeast USA.

Atsushi Honzawa (Senior Engineer, Power System Information & Control Department, Energy

Atsushi Honzawa

On-site installation at project in New Jersey, USA

Solutions Business Management Division, Hitachi, Ltd.) who is engaged as the project manager for this project, comments:

"We promptly focused attention on this ancillary market targeting it to establish an energy storage system business in the USA and developed the container-type energy storage system to serve as a solution that enables the power grid to be stabilized."

Hitachi developed the container-type energy storage system in 2013. In a demonstration project launched in conjunction with Demansys Energy in the summer of 2014, it was able to demonstrate the benefits to grid stabilization of rapidly adjusting input and output over a time frame in the order of a few seconds in response to the ancillary market signals, which vary over short time periods.

To put the results of the demonstration project into practice, Hitachi intends to proceed with the project connected to the actual power grid.


Taichi Nomura


Hiroshi Arita

Achieving a 10-year Life

The container-type energy storage system supplied to the New Jersey demonstration project was an all-in-one package that includes approximately 1,600 lithium-ion batteries, a control unit, and a power conditioner fitted inside a container. This containerization reduces the time and cost of installation. It also means that a large system can be configured easily by installing a number of systems in tandem.

The first hurdle that the system had to overcome on the way to commercialization was the development of a battery system with a life of 10 years or more. Looking back on this challenge, development team member Taichi Nomura (Senior Engineer, Energy Business Development & Management Center, Energy Solutions Business Management Division, Hitachi, Ltd.) comments:

"Achieving a 10-year operating life was one of the objectives for ensuring the economics of the system. We were also able to combine system reliability and safety with a compact design that could be housed in a container."

Hitachi has three types of battery for industrial applications: long-life, low-cost lead-acid batteries; high-output lithium-ion batteries; and lithium-ion capacitors with even higher output. Of these, the new energy storage system selected lithium-ion batteries. Hiroshi Arita (Senior Engineer, System R&D Department, Energy Devices & System Development Center, Hitachi Chemical Co., Ltd.), who worked on battery development, explained the reason as follows.

"With their ability to handle charging and discharging of large amounts of electric power and to provide sufficient capacity for ancillary applications where the objective is to stabilize short-term fluctuations in electric power, lithium-ion batteries are a suitable choice. However, giving lithium-ion batteries a 10-year operating life was a major hurdle. Nevertheless, thanks to battery cell enhancements, we were able to develop a lithium-ion battery that satisfied our operating life target, being able to withstand a high discharge rate (225 A, 3C) and more than 8,000 charge/discharge cycles."

In terms of safety, the batteries have an electrode structure that is resistant to internal short circuits and a system that performs continuous monitoring and management of the voltage, current, and temperature of each cell through interoperation between the cell controllers and battery management system. Reliability has also been improved by cell voltage equalization and the balancing of charging and discharging as well as by an efficient heat flow design that takes account of outdoor in-

stallation and the fact that battery cells are influenced by temperature variations, spreading the air flow from the cooling fan equally across the battery panels.

Kazuyuki Tsunoda (Engineer, Energy Systems Engineering Department, Power System Protection Automation & Solution Center, Infrastructure Systems Company, Hitachi, Ltd.), adds the following comment:

"To ready the control side for commercialization, we sought to improve the power conditioner efficiency, reduce the power losses in charging and discharging, shorten maintenance inspection times, and reduce failure rates. We also fitted multi-layered safety measures that included disconnection in the event of an emergency and an automatic fire fighting system."

The research and development division plays an important role in developments like this. The Hitachi Research Laboratory (part of Hitachi, Ltd.) has been engaged in basic research into energy storage systems for electricity grids for many years. In addition to utilizing research into battery materials, control techniques, power conversion, and safety, the project also included an evaluation of performance over 10 years, which was done by developing a simulator for predicting battery life. Kenji Takeda (Senior Researcher, Battery Research Department, Materials Research Center, Hitachi Research Laboratory, Hitachi, Ltd.) describes this as follows.

"Battery life is influenced by both the degradation that occurs over time and the degradation that results from repeated charging and discharging. We developed the lifetime prediction simulator by conducting basic experiments aimed at predicting this compound performance degradation. How the energy storage system is operated also significantly influences its life, so we suggested to the customer that they operate the batteries in the way that this work identified as being the best."

In this way, Hitachi combined the comprehensive capabilities of the entire Group to complete the 1-MW container-type energy storage system as a single package.

Mr. Honzawa describes the work planned in the lead up to commercialization as follows.

"Through the demonstration project we are currently operating in the ancillary market, we are optimizing the input and output characteristics and capacity of the batteries and verifying the actual performance in terms of durability and other factors. Based on the results of this work, we are undertaking developments that we will utilize in the commercial system, including making the system more compact, with lower cost and longer life, and enhancing the control algorithms for maximizing user revenue from power sales."

Izu Oshima Island Demonstration Project Commences

In Japan, meanwhile, a demonstration project involving a new large energy storage system is being readied to commence in the spring of 2015 on Izu Oshima island, southeast of the Izu Peninsula. Since the island relies primarily on diesel generators, the active adoption of renewable forms of energy such as wind and photovoltaic power generation in particular is expected to cut fuel costs.

In parallel with the demonstration projects in New Mexico and Hawaii, Hitachi has also since 2011 participated in the "Development of Safety and Cost Competitive Energy Storage System for Renewable Energy" project run by NEDO. This project developed a hybrid energy storage control system that combines low-cost lead-acid batteries that have a long operating life and high capacity with high-output lithium-ion capacitors, with the batteries being manufactured by Shin-Kobe Electric Machinery Co., Ltd. among others.

Yoshikazu Hirose (Engineer, Battery Design Department, Shin-Kobe Electric Machinery Co., Ltd.) expresses his enthusiasm as follows.

"Long life, reliability, and cost are important for use as electric power infrastructure. As with the batteries for the container-type energy storage system, we focused on the construction of the battery cell to produce a battery with high levels of dura-


Kazuyuki Tsunoda


Kenji Takeda

Parameter	Specification	Remarks
System capacity	±1 MW	System-side
PCS configuration	2 × 500 kW (parallel)	
PCS efficiency	97% or higher (30% or higher load)	
Batteries	Lithium-ion batteries 450 kWh	Modules: CH75-6 (75 Ah-22.2 V)
Applicable standard	PCS: UL 1741	
Expected life	10 years or more (system)	When installed in the specified environment and subject to specified maintenance
Cooling	Air cooled	
Container size	12 m (approx.)	

PCS: power conditioning system

Internal components of the container-type energy storage system (1-MW container package) and its main specifications. The container houses batteries, a power conditioner, controllers, a data logger, air conditioning, and other components.

The container-type energy storage system was developed by bringing together knowledge from across Hitachi, including technology for batteries, safety design, and control.


Yoshikazu Hirose

bility and reliability and competitive costs, and we worked to achieve internationally competitive battery manufacturing."

Talking about the system, Mr. Tsunoda comments:

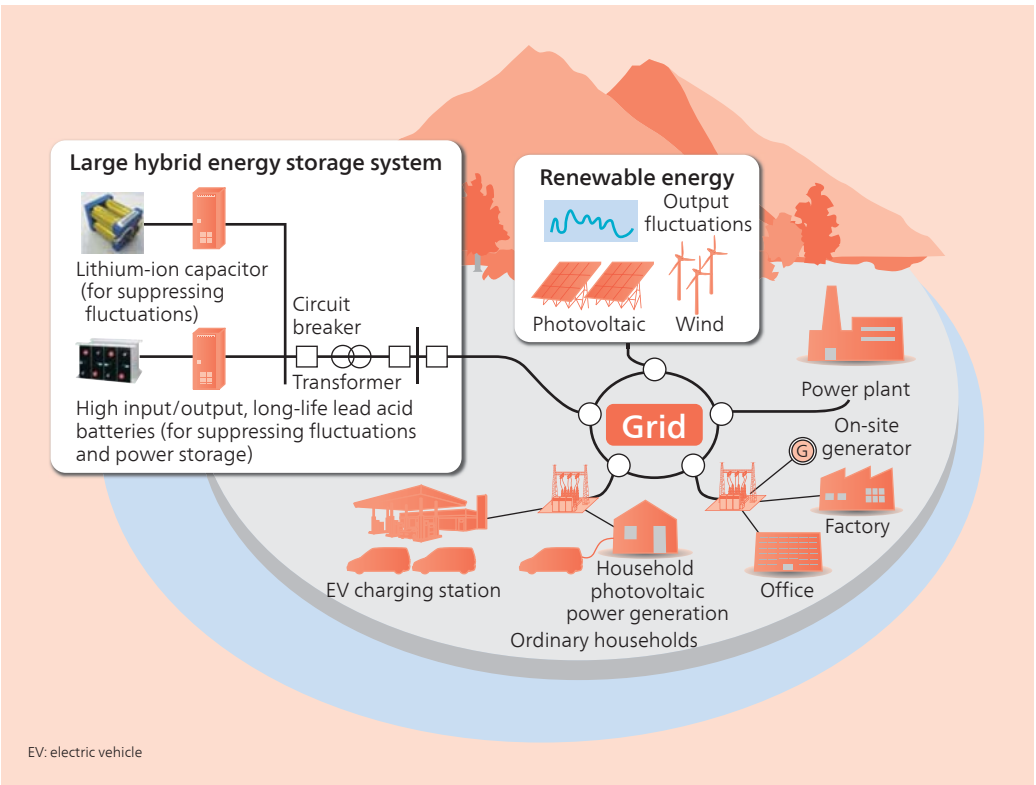
"As peak shifting is an important application for large energy storage systems, which are not only intended for use with renewable energy, we developed and designed an energy storage system that could substitute for adjustable-speed pumped storage hydro power generation. Anticipating that islands will be among the first places to face problems with the grid as greater use is made of renewable energy, we are including measures to make the system suitable for islands by using remote monitoring to improve operation and maintenance."

Shin-Kobe Electric Machinery achieved major successes in terms of specific technologies, including improved battery characteristics (approximate 1.7-fold* improvement in input and output currents) and an anticipated extension of the battery life to 20 years. Hitachi has developed a grid interconnection simulator that can model the effects of installing renewable energy on an actual grid, and another simulator that can model the optimal energy storage system configuration required for grid stabilization. It has also developed optimal operation control for hybrid energy storage systems that combine a number of different types of batteries. Hitachi plans to utilize these technologies to build a 1.5-MW energy storage system on Izu Oshima island and embark on a demonstration project for the use of large energy storage systems on the grid in collaboration with the Tokyo Electric Power Co., Inc.

* Compared to previous Shin-Kobe Electric Machinery model (LL1500-WS)

Targeting Global Markets

Electric power distribution, including energy storage systems, is at the core of Hitachi's power systems business, and it is seeking to expand its solutions business that combines information



Overview of large hybrid energy storage system installed on an island. The system helps maintain grid stability when a large amount of renewable energy generation is installed.

Creating a Growing Business from Energy Storage Technology


Kei Hosoi

Kei Hosoi (Director, Smart Community Department, Electricity Storage Technology Development Division, NEDO) is involved in work that includes the development of energy storage technology, fostering growth industries in Japan, and enhancing their international competitiveness.

"We are undertaking a strategic energy storage technology development project at NEDO with a mission of resolving energy and global environmental problems and enhancing industrial competitiveness. In the grid demonstration projects utilizing energy storage systems that we have undertaken to date, not just in Japan, but also in such places as New Mexico and Hawaii in the USA, there has been considerable interest in Japan's advanced energy storage systems from many partner nations and institutions.

Energy storage systems are a key technology with a central role to play in facilitating the introduction of renewable energy and encouraging the spread of smart communities and the next generation of vehicles. The government's Basic Energy Plan (4th Strategic Energy Plan) issued in 2014 includes encouragement for their introduction, with aims of international standardization, cost reduction, and performance enhancement. Batteries are recognized as being a high-added-value product for Japanese industry with the potential for considerable growth in global markets. The Storage Battery Strategy issued by the Ministry of Economy, Trade and Industry in 2012 estimated a global market worth 20 trillion yen in 2020 and set a market share target for Japanese companies of 50%. While international competition is naturally becoming more intense, we can look forward to improvements in battery technology with the expectation of growing demand from next generation vehicles and other uses. The key subjects of NEDO's work on energy storage technology are automotive lithium-ion batteries, large batteries for electricity grids, and innovative batteries (which can exceed the lithium-ion battery) looking ahead to 2030. Hitachi is participating in all of these projects. In the case of large batteries for electricity grids, a demonstration project is underway on the electricity grid of Izu Oshima island and I look forward to the results of this work leading to new business activities and to making a contribution to the growth of Japanese industry."

technology (IT), control technology, and power electronics. Some of the participants in this article describe their enthusiasm for the expansion into global markets as follows.

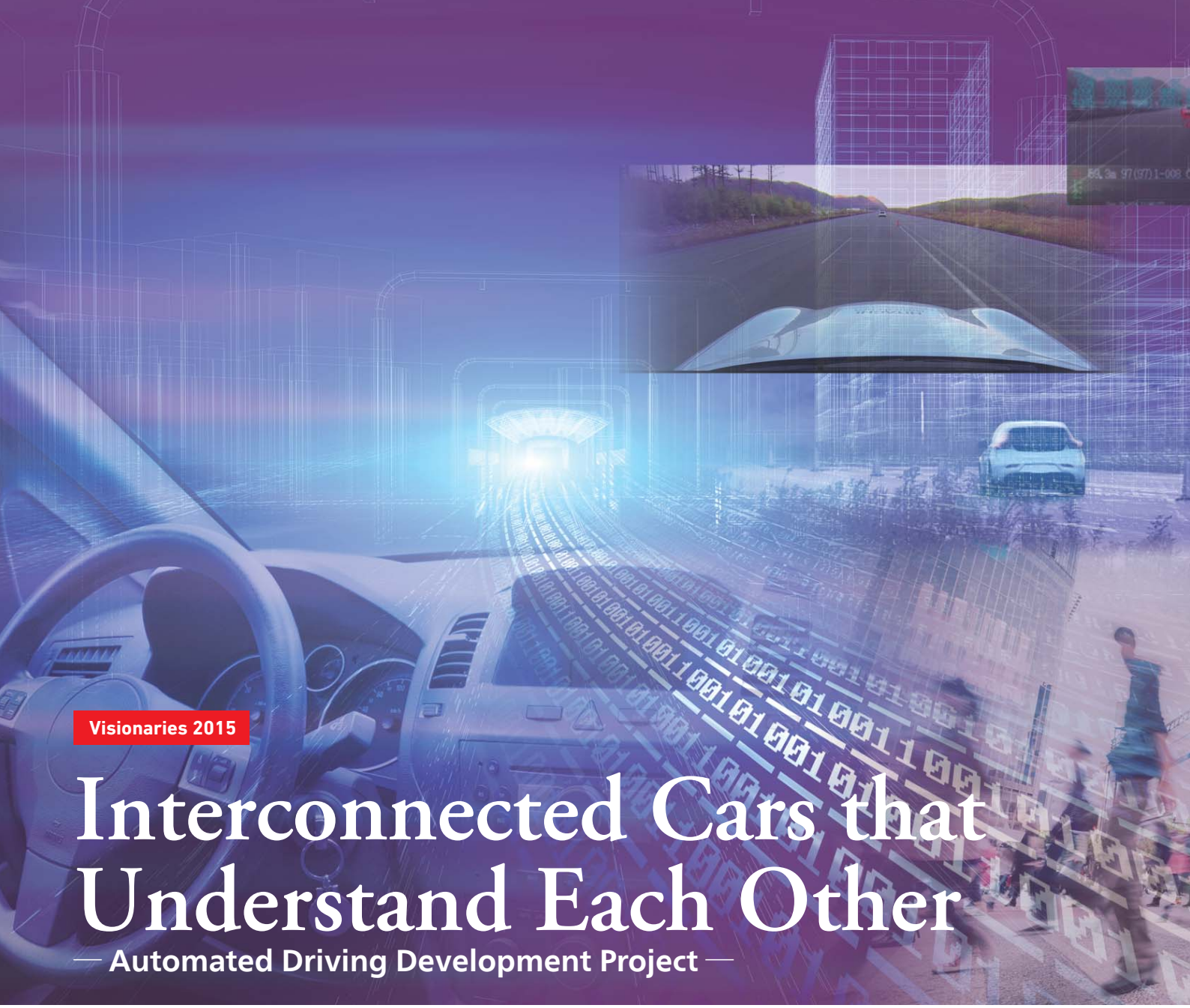
"I am looking forward to completing the systems for the ancillary market and establishing highly competitive systems that help reduce the load on the environment." (Nomura)

"We are seeking to develop low-cost battery systems that are compact, have high output, and can serve as the next generation of energy storage systems." (Arita)

"In addition to improving temperature tolerance to lengthen operating life of battery systems, and conducting fundamental research on how to ensure the safety of electricity grids that operate as essential services, we intend to engage actively in field work to utilize this in the building of systems with excellent operating characteristics." (Takeda)

"The brand name represents overall energy storage system solutions made by Hitachi group. The brand name was created by combining "Crystal" from state-of-the-art technologies in the Hitachi group and "Energy." We want to help create a clean society by installing these systems, not only in power grids, but also in a wide variety of other areas including demand-side applications in factories or other buildings." (Honzawa)

The process of delivering generated electric power to consumers is supported by numerous technologies that can be thought of as providing ongoing energy links. Hitachi intends to contribute to the spread of renewable energy and the reliable supply of electric power by deploying its energy storage systems globally.



Visionaries 2015

Interconnected Cars that Understand Each Other

— Automated Driving Development Project —

Moves by car makers, suppliers, and others to implement automatic driving are accelerating.
With many years of involvement in automotive technology, Hitachi is working on developments that aim to implement automated driving systems from a variety of angles, including "seeing" and "sensing" as well as driving, cornering, and stopping.
Anticipating integration with the cloud, big data, and other forms of IT, Hitachi is also combining a variety of different technologies.
Automated driving systems are set to forge a new relationship between vehicles and people, and also with the wider world.

From Driving Support to Automated Driving

In 2014, the Japanese cabinet announced that a plan for research and development of automated driving systems would be one of its strategic innovation promotion programs (SIPs). The plan includes a target of achieving fully automated driving by the late 2020s, anticipating benefits in the form of fewer traffic accidents, less congestion, less load on the environment, and mobility assistance for the elderly and others.

The US National Highway Traffic Safety Administration (NHTSA) defines the level of vehicle automation on a scale of zero to four. Already car makers, suppliers, and others in Japan and elsewhere are accelerating research and development into automated driving with the aim of achieving "semi-automated driving" (level 2) by around 2017.

Given this situation, Hitachi launched a project

for the development of automated driving systems in October 2013. Atsushi Kawabata (Board Director and CTO, Hitachi Automotive Systems, Ltd.), who is managing the project, describes it as follows.

"Intermediate technologies that take us some of the way toward automated driving are already part of our daily lives. Driving assistance systems that apply the brakes automatically in an emergency are one example. The project involves the further development of components like these, utilizing the comprehensive capabilities that are Hitachi's strength to drive the work forward."

Hitachi and Fuji Heavy Industries Ltd. have jointly developed the EyeSight driving safety system, which incorporates such functions as automatic emergency braking. EyeSight uses stereo cameras and was first fitted to a Subaru Legacy model released in 2008. The considerable interest this "uncrashable car" attracted is still a fresh memory.

Smart ADAS + IT

Building on this success, Hitachi's aim is to produce an automated driving system that balances the four objectives of fuel economy, time, comfort, and safety. Automated driving using a smart advanced driver assistance system (ADAS), currently under development as a further enhancement of conventional ADASs, provides drivers with benefits such as better fuel economy and earlier arrival times achieved through optimal route selection. Taisetsu Tanimichi (Senior Engineer, Smart ADAS Technology Development Department, Advanced Development Center, Technology Development Division, Hitachi Automotive Systems, Ltd.), project coordinator with responsibility for its execution and direction, explains:

"Hitachi has know-how from supplying a wide range of products, including driving actuators and engine and gearbox control as well as electric power trains, which have a major influence on fuel economy, and the project is taking advantage of this. Furthermore, achieving high-level automated driving will likely require integration between the smart ADAS onboard the vehicle and the trans-

Atsushi Kawabata

Taisetsu Tanimichi

	Control	Practical examples	Traffic monitoring	Responsibility for driving safety
Level 0	Acceleration, steering, and deceleration are always under driver control.	Warning systems only	Driver (continuous)	Driver
Level 1	Vehicle performs either acceleration, steering, or braking (without relieving the driver from driving).	ACC, LKS, and similar functions operate independently.	Driver (continuous)	Driver
Level 2	Under specific conditions, the vehicle performs two or more of following operations: acceleration, steering, and deceleration. [In automated driving mode, the driver is physically relieved from driving (can remove hands from the steering wheel and feet from the pedals).] * The driver is responsible for responding to emergencies.	ACC and LKS operate in tandem, etc.	Driver (continuous)	Driver
Level 3	Under specific conditions, the vehicle performs all three operations: acceleration, steering, and deceleration. * The driver is responsible for responding to emergencies.	Automated driving on designated sections of highway or vehicle-only roads	System (under specific conditions)	System (control can be handed back to the driver with appropriate leeway when the system judges it is unable to continue driving automatically.)
Level 4	The vehicle performs all three operations: acceleration, steering, and braking.		System	System

LKS: lane keeping system

Levels 0 to 4 of driving automation defined by the NHTSA. Similarly, documents from the Autopilot System Study meeting of Japan's Ministry of Land, Infrastructure, Transport and Tourism define automated driving as the vehicle performing two or more of the following operations: acceleration, steering, and braking.

Hiroki Uchiyama

Yoshitaka Uchida

portation infrastructure and other social infrastructure."

Coordination between vehicle and road, vehicle and vehicle, and pedestrians are important aspects of high-level automated driving. Essential to this is communication based on integration and other links with transportation infrastructure to assist with the acquisition of vehicle, road, and pedestrian information. This synergy with information technology (IT) provides another opportunity for taking advantage of the strengths of Hitachi. Hiroki Uchiyama (Department Manager, Smart ADAS Technology Development Department, Advanced Development Center, Technology Development Division, Hitachi Automotive Systems, Ltd.), who coordinates work on onboard architectures and control maps and communications, makes the following comment:

"Roughly nine million vehicles are produced in Japan each year. This means that the technologies they use must have very high levels of reliability. We are also looking to take technologies that have been proven in automobiles and deploy them in other fields."

Automatic Parking Systems as a Precursor of Things to Come

In October 2014, Hitachi hosted a safety technology presentation in front of about 120 people from 13 Japanese and overseas car makers at the Tokachi test track in Hokkaido where they staged demonstrations that included the unveiling of a smart ADAS that is currently under development.

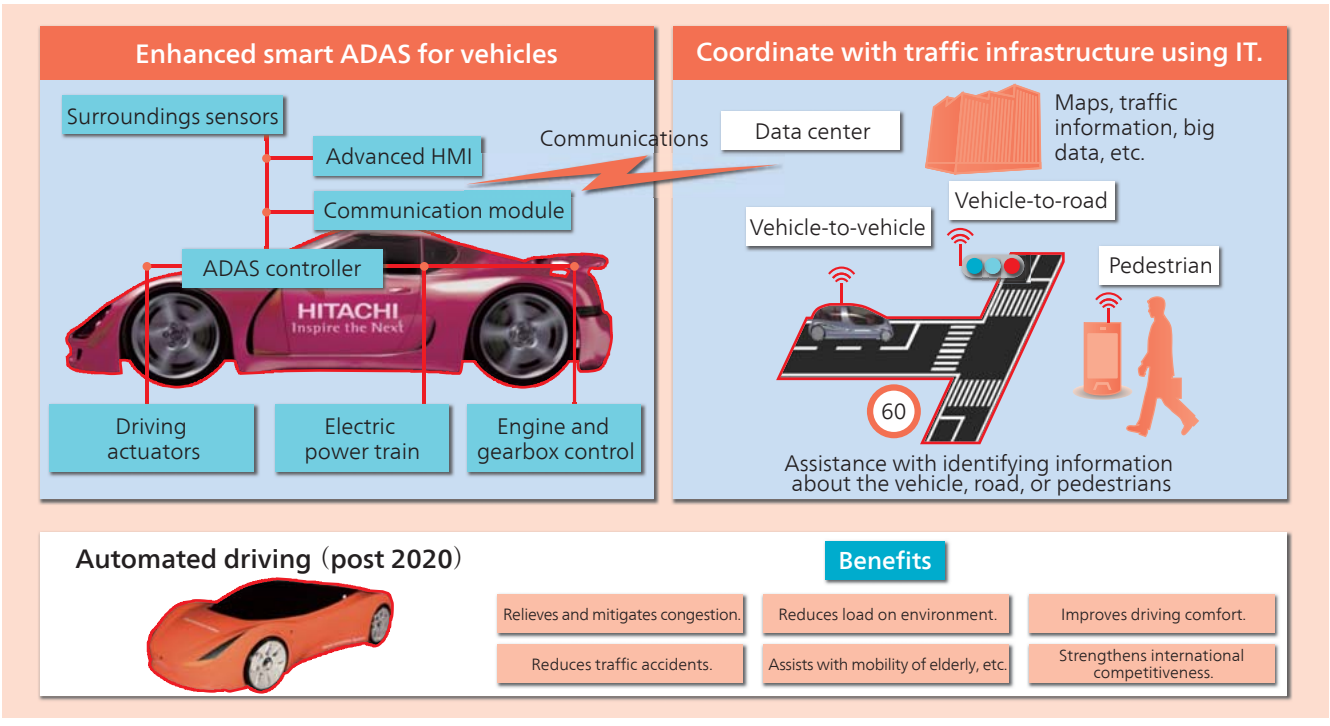
At the demonstration, there was particular interest in the presentation of an automatic parking system intended for commercial release in 2018. This system integrates driving actuators and vehicle control devices with SurroundEye*, a 360° bird's eye camera system developed by Clarion Co., Ltd. The demonstration was based on the scenario of a person suddenly appearing in the path of a reversing vehicle. The audience was fascinated by the movements of the test vehicle, which halted immediately when it detected the manikin used in place of a person, and then resumed its parking maneuver once the manikin was moved out of the way.

Yoshitaka Uchida (Manager, Application Development Group, Camera System Development Dept., Camera System Management Department, Clarion Co., Ltd.) explains the significance of this work as follows.

"Automatic parking systems are an important technology for automated driving because parking represents the start point and end point of each vehicle journey. While current systems can sense a region of 3 to 4 m around the vehicle, the new system extends this to between 10 and 20 m."

The image recognition techniques utilized in automatic parking systems hold the key to automated driving. Furthermore, the sensors used to detect the surroundings include infra-red, ultrasound, and radar as well as monocular and stereo cameras, each of which has different characteristics.

* SurroundEye is a registered trademark of Clarion Co., Ltd. in the United States, EU, Australia, and Japan; and is pending trademark registration in China.



Coordination between vehicles and the infrastructure will be essential to achieving automated driving. In this respect, synergies can be expected with IT, which is one of Hitachi' s strengths.

Takeshi Shima (Senior Researcher, SS1 Unit, Department of Smart Systems Research, Hitachi Research Laboratory, Hitachi, Ltd.), who deals with all aspects of image recognition, describes their development plans as follows.

"While sensing capability is important, we also need to be aware of cost when considering commercialization. Accordingly, our first challenge is to determine how much can be achieved using cameras. Of course, cameras have their weaknesses, and therefore we are looking into using a 'sensor fusion' that utilizes the respective advantages of different sensors."

With cameras, there is the risk that they may not be able to reliably sense their surroundings at night or during wet or snowy weather. Accordingly, to ensure safety, Hitachi is working on developments that can cope even with environments that exacerbate uncertainty by utilizing methods such as multiple sensors.

Automated Driving that Feels Natural

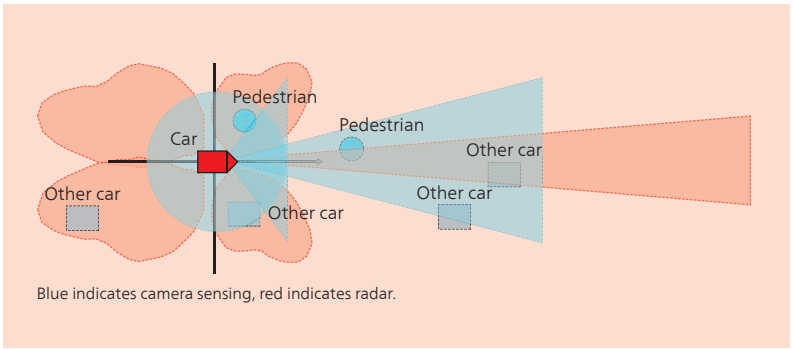
In addition to the ability for vehicles to "see" and "sense," automated driving also requires technologies for driving control that can coordinate these abilities with the vehicle's driving, cornering, and stopping capabilities. Takuya Murakami (Chief Engineer, Vehicle Integrated Control Technology Development Department, Advanced Development Center, Technology Development Division, Hitachi Automotive Systems, Ltd.), who works on automatic parking and vehicle driving control, explains this as follows.

"Along with automatic emergency braking and other collision prevention systems, lane-keeping assist is a vehicle control technique associated with automated driving that is largely complete. We are working on further developments that will 'read' the shape of the road ahead and control the steering accordingly."

A test vehicle has been fitted with a control system that combines adaptive cruise control (ACC) with G-Vectoring Control (GVC), a proprietary Hitachi technology that automatically controls acceleration and deceleration during cornering based on steering wheel position. In a demonstration, which consisted of using ACC (with a stereo camera) to follow the car ahead, and then using GVC to control the vehicle as it entered a corner at a speed of 70 to 80 km/h, the vehicle exhibited the same smooth cornering you would expect from an experienced driver.

Mr. Murakami notes that, "It is not uncommon to feel disconcerted when traveling as a passenger in a car driven by someone else. For automated driving at level 2 or 3, vehicle control needs to be good enough to avoid this."

The next step is to combine these individual technologies for the purpose of changing, merging, or diverging lanes on a highway. Beyond that lies the realm of level 3, which is close to fully automated driving.

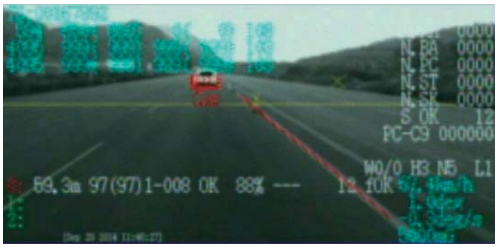


Concept of sensor fusion. There is a need to study how to combine the benefits of different techniques.

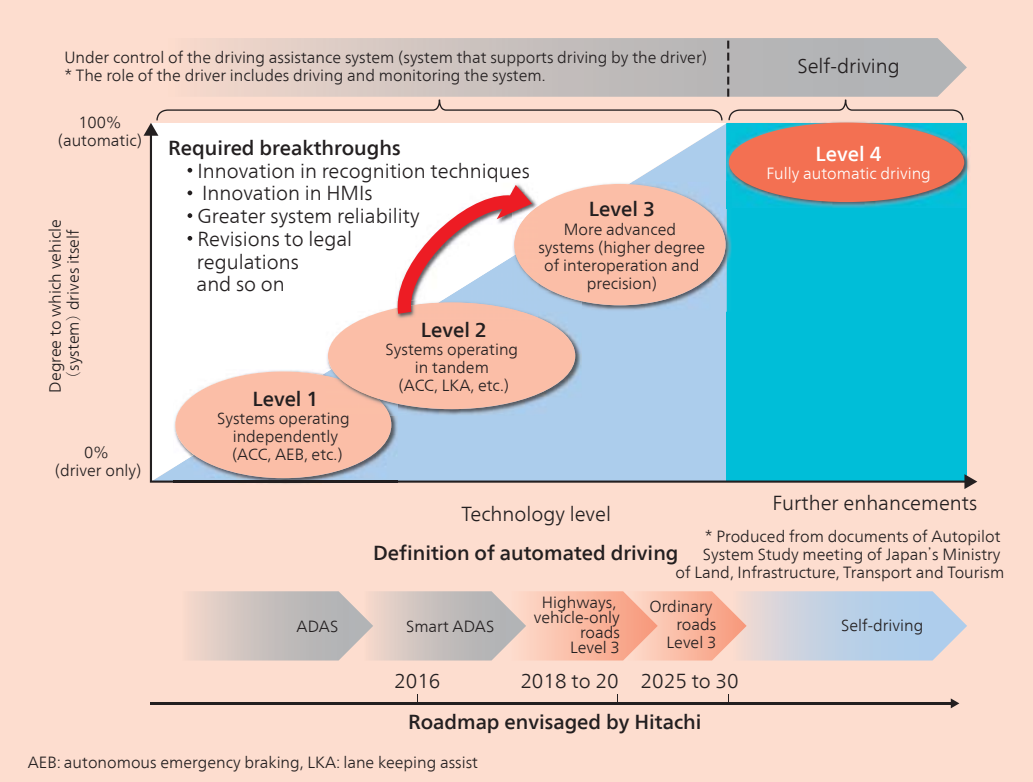

Takeshi Shima


Takuya Murakami


Demonstration of automatic parking system at Tokachi test track. The system incorporates technologies essential to automated driving.


A demonstration of ACC using only small stereo cameras. Delicate control of the vehicle is needed to prevent the operation from feeling unnatural to people in the car.



Hitachi is working on a project targeting automated driving at levels 1 to 3. A number of technically challenging hurdles separate levels 2 and 3.

Challenges on the Way to Fully Automated Driving

Between automated driving on a highway and unrestricted automated driving lie a number of difficult technical hurdles. Hitachi is working on research aimed at fully automated driving in the future. Atsushi Yokoyama (Senior Researcher, Green Mobility Research Department, Information and Control Systems Research Center, Hitachi Research Laboratory, Hitachi, Ltd.), who is engaged in leading-edge research and development in this field, describes the difficulties as follows.

"When we look at operating under all the different road environments, we see that the self-driving vehicle will need to interpret not only unexpected obstacles but also complex traffic rules in the same way as a human driver. Accordingly, various technologies for recognition, decision-making, and driving need to work at a level that is an order of magnitude higher than on a highway. In the case of recognition, along with the obvious need to be able to identify pedestrians, there is also a requirement to predict their behavior and use this as a basis for on-the-spot control of the engine, brakes, and steering."

The project has improved recognition performance through advances in sensing technologies that primarily involve cameras. For decision-making, meanwhile, the basis is provided by using a local dynamic map (LDM), a technology on which the laboratory has already started working.

Atsushi Yokoyama

An LDM is a database consisting of precise map data overlaid with information about surrounding vehicles, road conditions, traffic conditions, the weather, and so on. When using an LDM, automated driving is performed by utilizing communication information (communications between vehicles and between vehicles and the road) as well as sensing information.

As the range of times and situations in which automated driving is possible increases, interaction between the driver and the system also becomes more important. This is because it is necessary to switch from automated to manual driving to hand control back to the driver when the system judges that it cannot continue to drive automatically. By extending cockpit technologies, Hitachi is making it possible for the driver to smoothly take over the driving actions that the vehicle is about to perform.

As Mr. Yokoyama said, "Since assistance is needed for both driving and awareness, interaction with humans will come to have an important role as a step toward fully automated driving. In particular, because control at the level of milliseconds becomes necessary as vehicle speed increases, advanced technology is essential."

Hitachi is developing human-machine interfaces (HMIs) that will be essential to automated driving, and Mr. Yokoyama believes that utilizing advanced artificial intelligence for a deeper understanding of people will be needed in the future.

Forging New Relationships between Vehicles, People, and Society

Hope for Wider Scope of Driving Assistance Systems


Hiroshi Mouri

Hiroshi Mouri (Professor, Division of Advanced Mechanical Systems Engineering, Institute of Engineering, Tokyo University of Agriculture and Technology) works on important vehicle control algorithms for automated driving, driving assistance, and other systems. His relationship with Hitachi Automotive Systems, Ltd. includes joint research.

"Automated driving can be seen as a revolutionary development for overcoming the societal problems associated with automobiles such as traffic accidents and environmental degradation. However, because there are problems associated with automated driving, such as security and who is responsible in the event of an incident, there will likely be a need for things like determining standards and establishing the legal framework before it can become a reality. On the other hand, as things currently stand, it remains a serious technical challenge even for vehicles to identify their own position with a high level of accuracy, or to read the traffic conditions as they go and drive accordingly, the way an experienced driver would.

Nevertheless, the prospect of a 'super aging society' means there is a growing demand for safe and convenient means of transportation, with automated driving clearly being one of the key technologies. However, before fully automated driving becomes a reality, I believe that the wider adoption of driving assistance systems that reduce the psychological and physiological burden on drivers is important.

A strength of Hitachi is that it can configure complete systems by combining stereo camera sensors with actuators, electric power trains, and other components, and I believe it has the capabilities to compete with major overseas suppliers. I am looking at safe and secure driving assistance systems that draw on these capabilities, as well as the research and development of automated driving systems for use in the future.

While Japan's automotive industry is behind Europe and the USA when it comes to collaboration between industry and academia, speaking as an academic, it is my hope that there will be more activity in the future in the area of personnel exchanges, such as internships and guest engineers, and in joint research and development. As a leading Japanese corporation, I look forward to Hitachi taking the initiative in this field also."

Mitsuhide Sasaki (Department Manager, Vehicle Integrated Control Technology Development Department, Advanced Development Center, Technology Development Division, Hitachi Automotive Systems, Ltd.), who manages these developments and projects, expresses his resolve as follows.

"If we are to ensure that the elderly and other vulnerable users of transportation are able to drive vehicles with confidence, then I believe we will need to work on the research and development of automated driving. Although we are only just getting started, we intend to overcome the difficult obstacles one step at a time."

It is believed that the successful realization of automated driving will dramatically reduce traffic accidents by eliminating driving mistakes and other forms of human error. Another aspect worth considering is that of linking cars to information from the outside world. It is clear that vehicles will be connected to extensive cloud networks, with a steady stream of new services emerging that analyze the resulting big data.

As Mr. Kawabata says, "Along with being an innovative technology for preventive safety, automated driving also adds value to vehicles. That is, it creates new value for vehicles, people, and society, and the realization of a richer world."

This will be a world in which vehicles and drivers, vehicles and other vehicles, and vehicles and their surrounding environments will be interconnected and able to co-exist harmoniously. Once such an outcome has been achieved, it may result in a major change in how people think about cars.


Mitsuhide Sasaki

Visionaries 2015

Beyond Imaging

— Quantitative Techniques for Medical Modalities —

**Creating a society in which everyone can live a healthy and worry-free life calls for the establishment of comprehensive healthcare as part of the infrastructure of society.
Meanwhile, the steadily rising cost of healthcare is becoming more severe, particularly in developed economies that are characterized by aging populations and the growing prevalence of lifestyle diseases.
The early diagnosis and treatment of illnesses are essential to simultaneously improving the quality and controlling the cost of healthcare.
In the field of medical modalities, Hitachi is developing techniques for obtaining biophysical information on the pathology of diseases in quantitative form.
Advances in diagnostic imaging that provide more accurate clinical information are set to open up new possibilities for healthcare in the future.**

Color Imaging Made Possible by Technical Advances

Dealing with the societal healthcare problems of an aging society and the growing prevalence of lifestyle diseases have become urgent issues. The associated rise in healthcare costs has also become a serious concern for many developed economies.

The early diagnosis and treatment of illness based on accurate clinical information has an important role in controlling the cost of healthcare while improving its quality at the same time. This clearly requires improvements in the performance of the healthcare modalities* used in diagnosis, along with advances in the associated technologies.

Based around the Healthcare Company established in 2014, Hitachi supplies solutions that encompass every stage of the care cycle, covering everything from health promotion/disease prevention and examination to testing/diagnosis, treatment, and monitoring. The Central Research Laboratory of Hitachi, Ltd. undertakes leading-edge research and development in the healthcare field. Keiji Kobashi (Department Manager, Medical Systems Research Department, Central Research Laboratory, Hitachi, Ltd.), who researches the healthcare modality technologies that drive care cycle innovation, comments:

"The world of diagnostic imaging has been making dramatic progress. One analogy might be to photographs, which once could only be taken in black and white, but now can be taken in color."

In other words, in the same way that a color photograph provides much more information about the subject than a black and white one, functional progress in each modality provides medical practitioners with large amounts of information that was unobtainable in the past.

The advances made in diagnostic imaging over recent years in tandem with progress in technologies like computers and electronics has made it possible to use medical modalities to measure and quantify a variety of biophysical parameters. Within these new technologies lie important possibilities for things like the very early diagnosis of illness or the searching out of optimal treatments for individual patients. The Central Research Laboratory is working on the research and development of quantitative techniques for some important diseases, having already produced a variety of results.

Keiji Kobashi

* Classifications for the diagnostic equipment that is used in healthcare, such as magnetic resonance imaging (MRI) systems, X-ray computed tomography (CT) systems, and diagnostic ultrasound systems.

Imaging Iron in the Brain

In clinical settings, MRI systems basically provide diagnostic imaging through morphology, but they also have the ability to provide information on biological function without any associated exposure to radiation, unlike X-ray CTs.

The development of MRIs with high static magnetic field strengths in the 3-T range has seen the performance of these systems improve rapidly in recent years, including the ability to provide images with high contrast and high resolution. Also, the development of imaging techniques such as susceptibility weighted imaging, which utilizes phase differences due to spatial variations in magnetic susceptibility, has made possible the clear identification of things like microbleeds or veins.

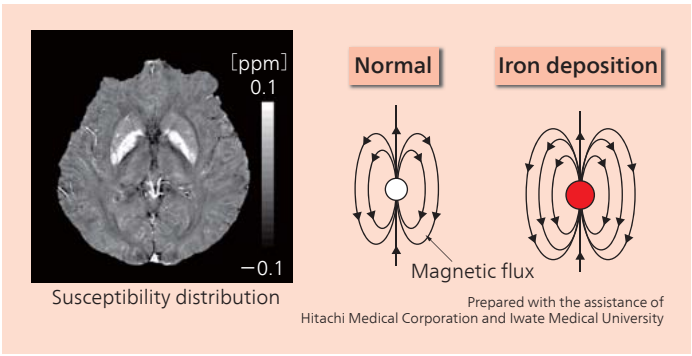
Taking advantage of these developments, Hitachi is working with university hospitals on research into MRI techniques for the early diagnosis of neurodegenerative diseases such as Parkinson's and Alzheimer's. Hisaaki Ochi (Chief Researcher, Life Science Research Laboratory, Central Research Laboratory, Hitachi, Ltd.), who leads this research and development, explains as follows.

"Very small-scale degeneration appears during the early stages of neurodegenerative diseases. Specifically, deposits of iron occur in brain tissue and these cause an increase in magnetic susceptibility. Our aim is to achieve very early diagnosis of neurodegenerative disease by imaging the distribution of susceptibility to detect abnormalities in the iron turnover rate."

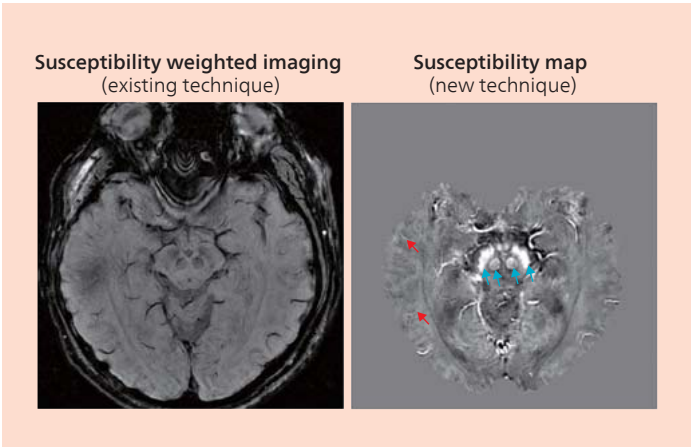
This susceptibility imaging technique can estimate a body's susceptibility distribution with high

Hisaaki Ochi

3-T superconducting MRI system (Hitachi Medical Corporation)



Example of susceptibility distribution imaging. With the aim of enabling early detection, Hitachi is developing a technique for the identification of very small-scale degeneration in the early stages of neurodegenerative disease.



Comparison of images for magnetic susceptibility in the brain obtained using the existing and new (susceptibility imaging) techniques. The new technique clearly identifies iron deposition. Also, the iron concentration can be estimated from the pixel values for tissues in which iron deposits are present (indicated by the blue arrows), and oxygen extraction fraction can be estimated from the pixel values for veins (red arrows).

accuracy from phase information contained in the MRI signal. Its advantage over the previous susceptibility weighted imaging technique is that it can reveal iron deposition with greater clarity. It is also possible to estimate the iron concentration from pixel values for tissue in which iron deposition is occurring, and the oxygen extraction fraction from vein pixel values.

"It is no longer the case that MRI scans only provide morphology. It is our hope that the iron concentration, oxygen extraction fraction, and other physical quantities obtained by this technique will prove to have clinical significance in the future," says Mr. Ochi.

The clinical value of the quantification of iron concentration extends beyond the very early diagnosis of neurodegenerative disease. There are also a number of other conditions similar to Parkinson's that are difficult to distinguish from each other at an early stage. However, if iron deposition in brain tissue can be quantified, the early diagnosis and differentiation of these conditions should be possible based on links between these quantities and changes in pathology.

Meanwhile, stroke may turn out to be one of the applications for oxygen extraction fraction imaging. Strokes are the result of blockages in the blood vessels that supply the brain. When abnormalities in these blood vessels cause inadequate blood flow, it is known that the oxygen extraction fraction of brain cells increases in order to obtain as much oxygen as possible from a small amount of blood, making the ability to look at things like blood flow, oxygen extraction fraction, and metabolism important for diagnosis. While patients are typically scanned using positron emission tomography (PET), MRI imposes less of a burden because it is non-invasive. Although susceptibility imaging using MRI is very new, it is likely to enter practical use in the future following clinical testing based on further data collection.

Determining Heart Blood Flow Dynamics

Because of their excellent realtime characteristics, ultrasound systems are frequently used for examination and diagnosis of circulatory organs such as the rapidly beating heart. This movement of the heart can be imaged by detecting the ultrasound waves that are reflected off of heart muscles or valves. It is also possible to measure the speed of blood flow from the information contained in ultrasound waves reflected off of blood cells. The speed and direction of blood flow can be displayed in a color-coded format using a color Doppler method developed in the 1980s.

While the cardiac ultrasound system is indis-

pensable as an essential piece of equipment for examination and diagnosis of cardiovascular disease, Hitachi has also developed vector flow mapping (VFM), an advanced technique for obtaining detailed information about blood flow in the heart. Hiroki Tanaka (Senior Researcher, Medical Systems Research Department, Central Research Laboratory, Hitachi, Ltd.), who took part in the development, explains it as follows.

"VFM is a blood flow imaging technique that combines ultrasound measurement with a fluid dynamics model. Our aim is to help assess heart and other cardiovascular conditions by enabling information to be acquired on detailed blood flow phenomena that posed a problem in the past, such as vortices inside the ventricle."

The principle behind VFM is to display the velocity vector distribution, using the speed in the vertical direction obtained by the color Doppler method and the heart wall speed obtained by speckle tracking as boundary conditions, and using the conservation of mass to calculate the speed in the horizontal direction.

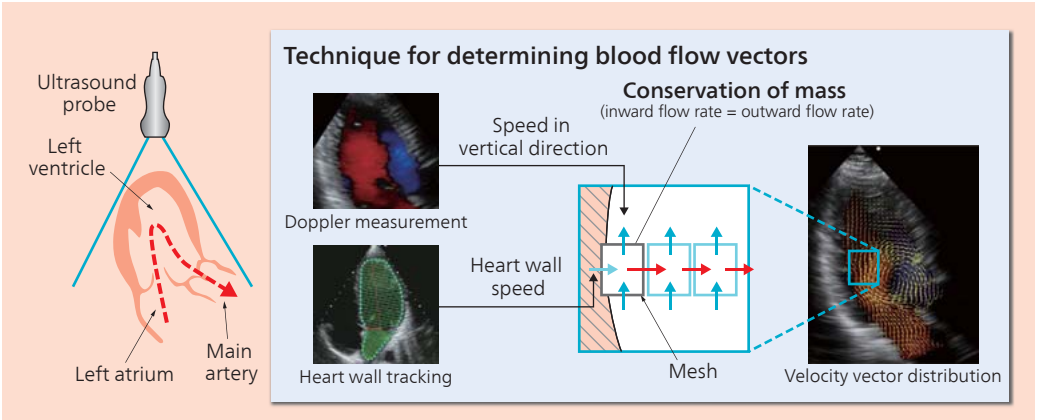
Advances in clinical cardiovascular testing have found that vortex flow patterns are changed by specific conditions such as heart failure. That is, a detailed picture of blood flow in the heart can be used to determine the seriousness of a condition and its pathology. Because VFM can image in detail the flow of blood from the left atrium through the left ventricle to the aorta, it provides more reliable assessments.

As to what benefits to cardiovascular diagnosis will result from the detailed understanding of blood flow in the heart and other blood vessels provided by VFM, this will depend to a large extent on the outcome of future clinical research.

Mr. Tanaka says, "First of all, I believe the ability to quantify is important. VFM has provided us with a way of determining the energy loss in blood flow as a physical quantity. The use of physical quantities that relate directly to heart disease, rather than the heart functions shown by previous diagnostic imaging, has the potential in the future to provide things like predictions of deterioration in heart function or a metric for assessing the benefits of improved treatments."

In research and development work, it has been demonstrated that, in contrast to blood flow information obtained by methods that use a laser, VFM is accurate to within a few percent. In the future, metrics obtained using VFM should bring a new perspective to cardiovascular medicine.

Diagnostic ultrasound system and DAS-RS1 + VFM software for personal computers (PCs) (Hitachi Aloka Medical, Ltd.)



Ultrasound VFM can obtain a detailed picture of blood flow in the heart. Its use in cardiovascular medicine has found that vortex flow patterns are changed by specific diseases.

Hiroki Tanaka

Atsushi Maki

An Objective View of Mental Health

Optical topography is a brain activity imaging technique that uses near-infrared light to identify localized changes in blood flow in the brain. The first in the world to develop the technology, Hitachi is working on healthcare applications such as clinical uses for psychiatric disorders as well as its use in brain function research. Looking back at the progress to date, Atsushi Maki (Chief Researcher, Life Science Research Laboratory, Central Research Laboratory, Hitachi, Ltd.), who has been engaged in the research and development of optical topography for many years, makes the following comment.

"For healthcare, our research has included work that leads toward the differential diagnosis of depression by imaging blood flow distribution to assess brain activities specific to particular disorders. Depression is characterized by weaker activity than other disorders, and we have succeeded in differentiating conditions such as schizophrenia and bipolar disorder (manic depression), which has proven difficult in the past. A healthy person, on the other hand, demonstrates strong activity across their frontal lobes."

A psychiatric disorder with a diverse range of symptoms, depression is difficult to diagnose, as is differentiating it from other conditions such as bipolar disorder and schizophrenia. However, because each condition requires different medication, a mistaken differential diagnosis can delay treatment. Optical topography, on the other hand, provides an objective basis for differential diagnosis.

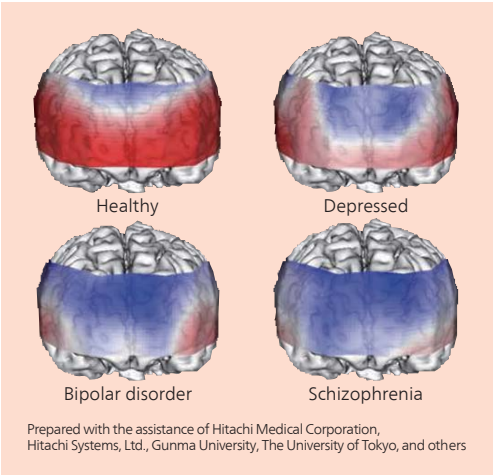
With this accumulation of findings, the insurance-funded clinical use of optical topography has commenced following the acceptance of the "use of optical topography examinations to aid differential diagnosis of depressive symptoms" for insurance coverage in Japan in FY2014. Whereas psychiatric care has primarily involved patient consultations in the past, it is anticipated that optical topography will be able to lead to accurate and early diagnosis, treatment, and medication at an early stage by providing an objective means of assessment.

The scope of potential healthcare applications for optical topography is growing, with work also progressing on basic research and clinical applications for other mental disorders such as attention deficit hyperactivity disorder (ADHD) and post-traumatic stress disorder (PTSD). This includes the development by Hitachi of a technique for quantifying depressed moods with a view to preventing the onset of depression.

As Mr. Maki says, "We have demonstrated a correlation between brain activity metrics obtained using optical topography and scores for depressed mood obtained from questionnaires. That is, it is possible to visualize what is happening before the disorder manifests and use this to help prevent the onset of depression."

A topic of interest during the development of this technology was prefrontal area 46, which is the seat of working memory function and associated with mood. In an experiment, optical topography was used to obtain a value for brain activity by measuring changes in blood flow in the prefrontal areas of subjects when they were given a problem to solve, and to obtain a score for depressed mood by using a questionnaire to provide a benchmark mood assessment. This experiment found a strong correlation between the two values. The experiment also demonstrated the ability to track changes in depressed mood over time. That is, it found that metrics obtained using optical topography

ETG-4000P optical topography system (Hitachi Medical Corporation)



Blood flow distribution in brain obtained using optical topography. Since this technique can assess brain activity distinctive of particular mental conditions or other illnesses, it has the potential for use in the prevention and treatment of depression.

Quantitative Diagnostic Imaging Techniques with Clinical Benefits

Professor Eiju Watanabe

Eiju Watanabe (Professor and Chairman, Department Neurosurgery, Jichi Medical University Hospital) has been providing medical advice and direction to Hitachi's research and development since the joint development of optical topography with the Central Research Laboratory of Hitachi, Ltd. in 1994.

"Neurosurgery can be thought of as the discipline with the greatest need for imaging in the diagnosis of illness. While there have been some remarkable developments in technology over recent years, to use the current situation with focal cortical dysplasia (a cortical malformation linked to epilepsy) as an example, the two lowest of the four grades used to classify these malformations are often not visible in an MRI scan. In this sense, I believe imaging technology will continue to grow in importance in the future.

While functional MRI (fMRI) is useful for obtaining fundamental and detailed data, optical topography is able to capture information about brain activity while the subject goes through the motions of his or her normal daily life. In medical practice, I believe that combining these different modalities in accordance with their respective advantages will be important.

In putting medical modalities to use, attention is currently focused on the ability to obtain quantitative clinical information. One example is an initiative being launched to use optical topography to quantify the efficacy of medication for children with ADHD. In addition to determining the efficacies of different medications, this elucidates the mechanism of how each medication works, and therefore should help reduce the number of patients trying out medications with a low level of efficacy. Fundamental findings have also been obtained that can be used as a basis for personalized treatments tailored to each patient's individual symptoms. Furthermore, since recovery from aphasia or other cognitive impairment involves the brain healing itself, work is proceeding on the use of optical topography to obtain information on this plasticity. The data obtained from this study may well provide metrics that can be used in the future for rehabilitation.

These metrics and other quantitative data will become important factors when considering treatments. I look forward to Hitachi's support for medical practice through the establishment of quantitative techniques with clinical benefits."

provided an effective self-checking mechanism for day-to-day changes in mood.

Mr. Maki says, "Given the increasing number of people developing depression in recent times, there is a need to prevent its onset and to provide early detection, treatment, and rehabilitation. While the early identification of downturns in mood is important for prevention, the quantification of depressed mood has the potential to go beyond this to become a solution that can help empower the mental health of the general public."

Achieving Care Cycle Innovation

Mr. Kobashi says, "It seems likely that applications that quantify biophysical information will grow in importance in the future along with advances in diagnostic imaging systems. My hope is that, in time, the utilization of this technology in areas such as the very early detection of disease or more accurate diagnosis will lead to innovation throughout the care cycle."

As the amount of quantitative data with medical significance grows, its deployment can be anticipated in healthcare information technology (IT) applications that collect this information and put it to use. Advances in diagnostic imaging systems have a significance that transcends merely providing information about diseases. Hitachi intends to continue working on research and development that aims to enable very early detection, control healthcare costs, and to create a society in which people can live long and healthy lives.

Visionaries 2015

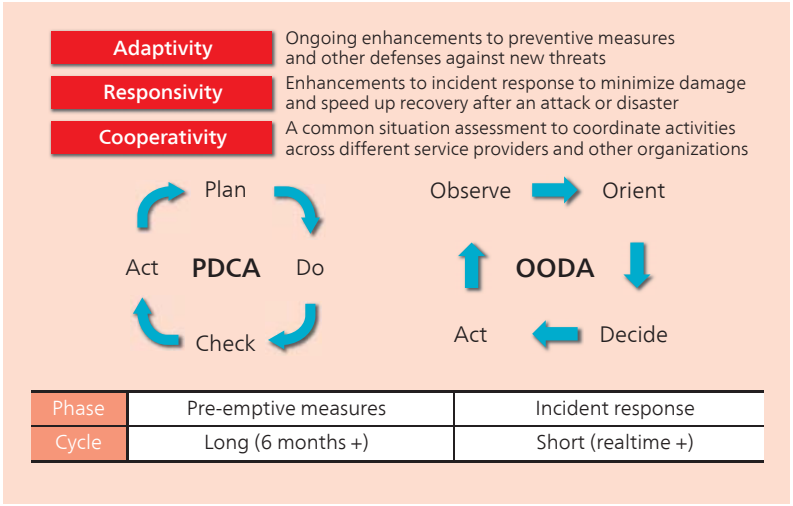
Achieving Agile Strength

— Social Infrastructure Security —

The sophistication and convenience of social infrastructure such as energy and transportation are enhanced through interoperation.
This also means that the social infrastructure is a vast multi-faceted system comprising many different organizations and systems.
Currently, social infrastructure faces rapidly growing threats, such as natural disasters or cyber terrorism, while the consequences of incidents are also expanding in scope.
In its involvement in social infrastructure security, Hitachi brings together safety and security technologies it has built up in many different fields.
Moves are underway to optimize all aspects of security based on the concept of making it adaptive, responsive, and cooperative.

Accepting that Damage will Occur

For all its convenience and comfort, modern society is vulnerable to a variety of risks. The social infrastructure that underpins our daily lives and business activity includes electric power, gas, water, railways, roads, public facilities, and telecommunication networks, and the scope of these services has grown through greater interoperation. The corollary of this, however, is that when a problem arises, its consequences spread more widely. Such problems are not necessarily the result of equipment faults or human error. Abnormal weather or other natural disasters are predicted to progressively increase in severity in the future due to global climate change. Along with the growing worries about armed terrorist attacks that come with globalization, the rise in cyber terrorism associated with the spread of information technol-



Phase	Pre-emptive measures	Incident response
Cycle	Long (6 months +)	Short (realtime +)

Hitachi bases its requirements for social infrastructure security measures around the three concepts of adaptivity, responsivity, and cooperativity. Adaptivity relates to the PDCA cycle, and responsivity to the OODA decision-making process used in military activities.

ogy (IT) can no longer be dismissed as a problem that only concerns other people.

The infrastructure that underpins society, 24 hours a day, 365 days a year, needs to be able to continue to provide essential services even in the event of a problem. Unfortunately, it is no longer realistic to take steps to deal with all of the growing and increasingly diverse range of potential threats. What is needed is a flexible approach that accepts that some damage will be inflicted when an unanticipated disaster or attack occurs, but that seeks to react appropriately to prevent the damage from being exacerbated or spreading more widely, and to quickly restore services.

Hitachi has identified three particular requirements for security measures that take account of these special circumstances surrounding social infrastructure: "adaptivity," "responsivity," and "cooperativity." Toshiaki Arai (CTO, Defense Systems Company, Hitachi, Ltd.), who coordinates work on security technology across the Hitachi Group, explains the concepts as follows.

"Adaptivity means working through an ongoing process of identifying new threats; devising countermeasures; and planning, implementing, and evaluating those countermeasures in order to make them more effective. In other words, it relates to measures that can be taken prior to an incident. Responsivity, on the other hand, is about enhancing the ability to react to an incident. It is about focusing on the best measures to take given the available resources, and seeking to minimize damage and speed up recovery after a disaster, attack, or other incident has occurred. Cooperativity, meanwhile, is about increasing interoperation. This means sharing information between different organizations and service providers so that they can be aware of each other's circumstances and take account of these in their subsequent actions."

With system-level robustness as a base, Hitachi employs the concepts embodied by these three terms in its work on wide-ranging security measures that encompass both the physical and cyber realms.

Combining Convenience and Safety

To put these concepts into practice in the realm of physical security, Hitachi products include city-wide safety and security solutions that conduct border security checks on the aircraft, ships, vehicles, and people that enter a city through the interoperation between the associated systems, and also disaster response support solutions that utilize sensor data and simulation techniques.

In the past, physical security has been provided by standalone systems that serve different facili-


Toshiaki Arai

Tatsuhiko Kagehiro

ties and areas. In cities with sophisticated interoperation and coordination of social infrastructure systems, however, even greater benefits can be obtained by tracking the movement of people and goods through the interoperation and coordination of different security systems.

One example is a traceable physical security system developed to provide security at large public facilities and areas. Tatsuhiko Kagehiro (Senior Researcher, Intelligent Media Systems Research Department, Central Research Laboratory, Hitachi, Ltd.), who coordinated the development, describes the features of the system as follows.

"Our aim was to combine convenience with a high level of safety. While the problem with improving security in the past has been the extra effort and work associated with things like authentication and inspection, this system is able to authenticate people that are entering a site, for example, without compromising convenience, by using touch panel operation together with finger vein authentication and the capturing of facial images."

It can also be used, for example, in the provision of information or services to individuals by checking against personal information that has been obtained with their consent. Also, safety checks on individual items of baggage can be performed by combining a baggage tracking system with devices that can quickly identify the location of explosives by using mass spectrometry to detect the presence of explosive ingredients within the area being monitored. The baggage tracking system works by recording images of items people have with them as part of the baggage inspection procedure and then uses these images to track the movement of the items on surveillance cameras located across the facility.

In the event of malicious activity like planting explosives, it is necessary to find the suspicious individuals quickly by searching large amounts of surveillance camera data based on information from witnesses or other sources. Multi-perspective searching is a valuable tool in such cases.

Mr. Kagehiro says, "Utilizing similar image retrieval, a technique on which we have already been working, we are able to quickly find images with a high degree of similarity in stored image data, even when using fragmentary search conditions comprising not only the face but also upper body, lower body, baggage color, or route traveled."

It is anticipated that this system will dramatically improve the efficiency with which people can be tracked from surveillance camera images.

Defending against Attacks through Early Detection and Response

The field of cybersecurity can be broadly divided into information systems and control systems.

Shuji Senoo (Senior Director, Advanced Security Technology Operations, Services Creation Division, Information & Telecommunication Systems Company, Hitachi, Ltd.), an expert in the latest technology for information security, makes the following comments about measures for dealing with cyber-attacks, which are becoming more sophisticated and organized year by year.

"The steady stream of new malware, such as targeted attacks on individuals, means that it is now

Prototype touch panel finger vein authentication system. The system provides enhanced convenience by performing authentication without the user's awareness (but with their prior consent) by identifying their finger vein pattern as they use the touch panel, while at the same time taking a facial photograph.

Multi-perspective search utilizing a similar image retrieval technique. Yuki Watanabe (Intelligent Media Systems Research Department, Central Research Laboratory, Hitachi, Ltd.), who was part of the development team, emphasizes the system's effectiveness in applications such as suspect tracking.

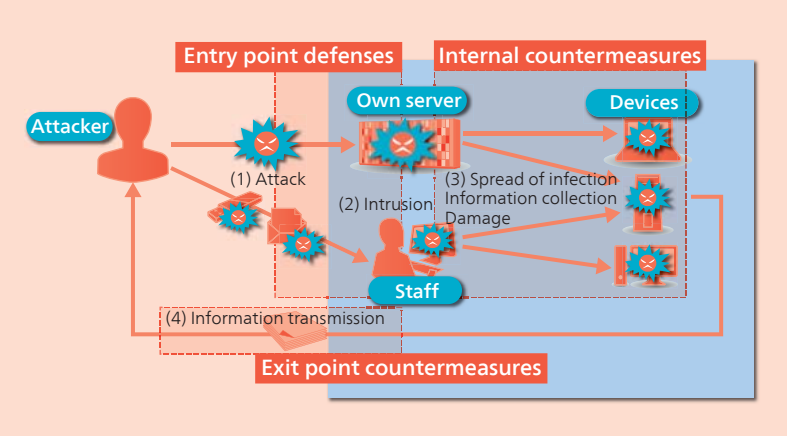
practically impossible to prevent all intrusions into a system. Accepting this, I believe that the basis for information security at present is to consider how to achieve early detection and response based on the concept of the observe, orient, decide, and act (OODA) loop. For example, in addition to conventional entry point defenses, the prompt execution of internal detection and response is crucial, as is the interception of unauthorized transmission of information at exit points to prevent practical losses."

Based on this approach, Hitachi's information security solutions provide multi-layered (defense in depth) monitoring and protection that combines techniques such as a monitoring service for detecting and preventing unauthorized access or malware, and the automatic monitoring and blocking of unauthorized connections to personal computers (PCs). The characteristics of detected malware are determined by a proprietary technique that automatically executes it in a variety of environments to analyze its structure so that this knowledge can be utilized in the subsequent response.

The control systems that support social infrastructure such as power plants and other key industries also face a growing risk of cyber-attacks, having become increasingly integrated with information systems in recent years. Toshihiko Nakano (General Manager, Control System Security Center, Infrastructure Systems Company, Hitachi, Ltd.), describes the characteristics of the control security for which he is responsible as follows.

"Hitachi has participated in the Control System Security Center (CSSC), which was established as a collaboration between industry, academia, and government, since its inception, working on enhancements to control security. The potential for security threats is growing in the control sector, making it important to consider how defenses can be strengthened at a system-wide level."

Hitachi was among the first companies to start developing controller products with ISASecure*1 EDSA Certification*1 in order to reduce the risk of cyber-attacks via a network. On particularly important systems, high security is achieved by providing one-way bridges that block access from external networks. To prevent security threats due to the connection of unauthorized devices to the network, Hitachi also supplies systems for detecting and forcibly disconnecting unauthorized PCs. Another solution installs decoy servers in a system for the early detection of malware intrusions, and to capture and analyze the malware. Operating these in tandem with unauthorized access detection systems makes it possible to respond quickly to both known and unknown threats.



It has recently come to be accepted in information security that preventing all malware intrusions is impossible. Given this situation, organizations need to implement internal and exit point countermeasures in addition to their conventional entry point defenses.

Devices for protecting against cyber-attacks on the control systems of vital industrial infrastructure. Hitachi supplies these as part of its solutions for countering attacks.

Information and control are the foundations of social infrastructure systems. Based on the technologies described here, Hitachi supplies comprehensive security services that cover everything from risk analysis and consulting to system configuration and operational support.

System-wide Optimization of Security

In addition to important business data, social infrastructure security also involves handling a variety of personal information, such as finger vein and other biometric information. Masahiro Mimura (General Manager, Enterprise Systems Research Department, Yokohama Research Laboratory, Hitachi, Ltd.), who is engaged in research into finance and public sector security technologies, describes some of the advanced techniques for protecting such information as follows.

Shuji Senoo

*1 EDSA is an abbreviation of Embedded Device Security Assurance. EDSA is a security certification program for embedded systems in control equipment. It is run by an international certification agency made up primarily of members of the International Society of Automation.
See "Trademarks" on page 146.

Developing Technology and People to Improve Social Infrastructure Security


Professor Seiichi Shin

The Control System Security Center (CSSC) based in Tagajo City in Miyagi Prefecture was established in March 2012 as an industry-academia-government partnership that undertakes security certification, research and development, training, and awareness raising activities with the aim of strengthening security for the control systems that underpin social infrastructure. CSSC President, Seiichi Shin (Professor, Control Systems Program, Department of Mechanical Engineering and Intelligent Systems, Graduate School of Informatics and Engineering, The University of Electro-Communications) specializes in control engineering and is recognized as a leader in the field of microcomputer control.

"In the past we have strived to make the world a more convenient place by linking various different things together. As a result we have achieved a level of social infrastructure that is unsurpassed anywhere in the world, with trains that run on time, safe drinking water, and a power system that is not prone to blackouts. While it goes without saying that it is the diverse technologies of companies like Hitachi that help maintain this world in which all of these things continue to function correctly as a matter of course, security in particular has become an important factor in recent years.

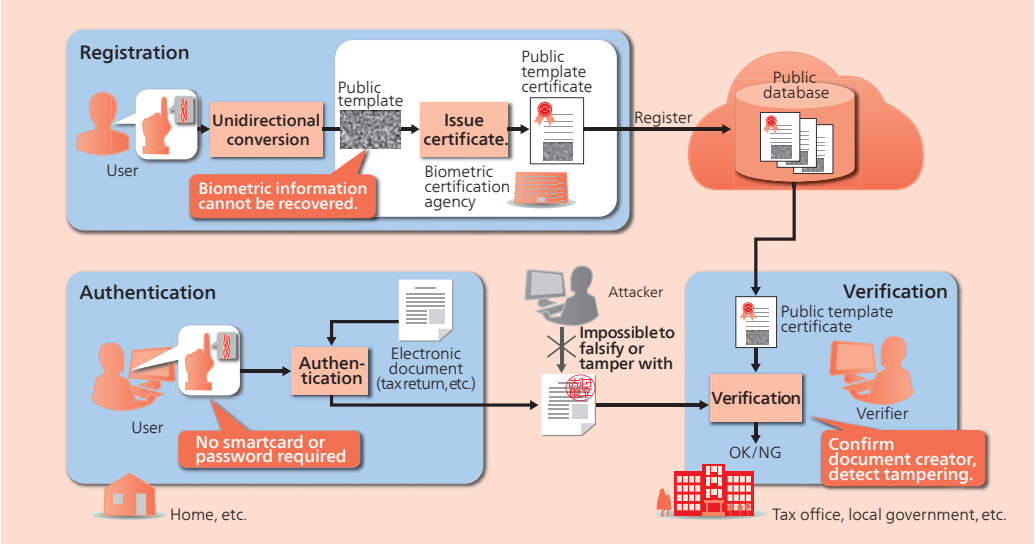
Once the preserve of mischief makers, cyber terrorist activity has become a form of organized crime undertaken for commercial motives, with the control systems in social infrastructure increasingly being targeted. Defending against this requires not only security technology but also policies and management capabilities for deploying the technology to good effect.

In this, international standards and their certification systems have important roles to play. Security certification was one of the founding objectives of CSSC and we are the certification agency for EDSA in Japan. We also seek to support the export of Japan' s excellent social infrastructure systems by keeping up with technical trends in international standards and encouraging their adoption by Japanese companies.

To improve social infrastructure security in terms of both awareness and actions, the CSSC also conducts cyber-attack drills for the operators of thermal power plants, electricity network control, sewage treatment plants, building control systems, assembly plants, gas plants, and petrochemical plants. We collaborate on global information sharing and on research and development with other agencies, including cybersecurity promotion agencies in Europe, America, and Asia.

People are another important consideration. At both CSSC and The University of Electro-Communications, we are striving to train people with an understanding of both information security and control systems, a combination that will be increasingly needed in the future. The safety and security of social infrastructure is underpinned by ethical considerations as well as by technical capabilities. To attract the best people with high levels of both qualities, I hope that those who work in this field will receive their due respect. I ask this because it will in itself result in higher levels of safety and security for society as a whole.

Cybersecurity is already widely recognized as a military technology, and Japan is the only country in the world where critical infrastructure is protected by the private sector. I look forward to Hitachi playing a central role in helping improve social infrastructure security."



The PBI public template biometric authentication platform facilitates the shifting to the cloud of systems that require rigorous user authentication, and provides a low-cost way to use the same identification across a number of related systems.

Toshihiko Nakano

"The public biometric infrastructure (PBI) is a technique for authentication and identification that works in conjunction with an encryption key and stores biometric information in a form that can safely be made public by converting it to a template from which the original information cannot be recovered. We also have privacy-preserving information processing techniques that can rapidly search, compare, and analyze data in encrypted form."

PBI combines the convenience of being able to use your own biometric information (such as finger vein patterns) for authentication with a reduced risk of information disclosure. The privacy-preserving information processing techniques are able to process large quantities of data while maintaining a high level of security. Future advanced security technology will reduce the risk of handling important social infrastructure information on the cloud. In other words, Hitachi's concept of social infrastructure security is of a platform for society that maintains security without compromising public convenience and without users needing to concern themselves with particular details.

As described above, attempting to increase security on its own not only results in more complex equipment operation and other procedures, it also tends to demand ongoing vigilance. Atsutoshi Sato (Information Design Department, Design Division, Hitachi, Ltd.), a specialist in information design, reinforces Mr. Mimura's comments by describing the approach needed for future security measures as follows.

"A society in which people are always feeling stressed about security is unlikely to be a comfortable place to live. I believe that, by utilizing our design capabilities, we can identify the ideal security measures that will maintain the required level of security without compromising comfort."

Equipment, for example, can be made easier to use, and human error can be avoided, by providing better user interfaces. Providing effective presentation of alarm and warning levels helps the transition between emergency and non-emergency situations. Hitachi is seeking to utilize methods such as ethnography*2 and the experience-oriented approach*3 to achieve this.

The infrastructure that underpins society needs to keep not only individual systems but also the overall infrastructure secure. Along with adopting approaches to design like these, Hitachi is seeking to achieve this by supplying safety and security technologies built up over a wide range of fields together with services that consolidate the operation of these technologies, and also by participating in standardization work to raise standards and facilitate the further development of security. Underlying these activities is the concept of the total optimization of security.

With its social infrastructure security, Hitachi intends to support the creation of a society that enjoys behind-the-scenes protection from diverse threats and that is capable of agile but strong resistance to unanticipated dangers.

Masahiro Mimura

Atsutoshi Sato

*2 A method for observing user workplaces to identify latent needs at the earliest stages of human-centric design. Through close observation of people's actual behavior and fact-based analyses of the collected data, it can obtain an overview of what people are actually doing together with things like their tacit assumed values and their unfulfilled needs or wants.

*3 A methodology for consensus-building in the very earliest stages of system development (concept development and planning stages), with an emphasis on user experiences. The experience-oriented approach has been formalized by Hitachi based on the experience design method.

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47 IT Platform
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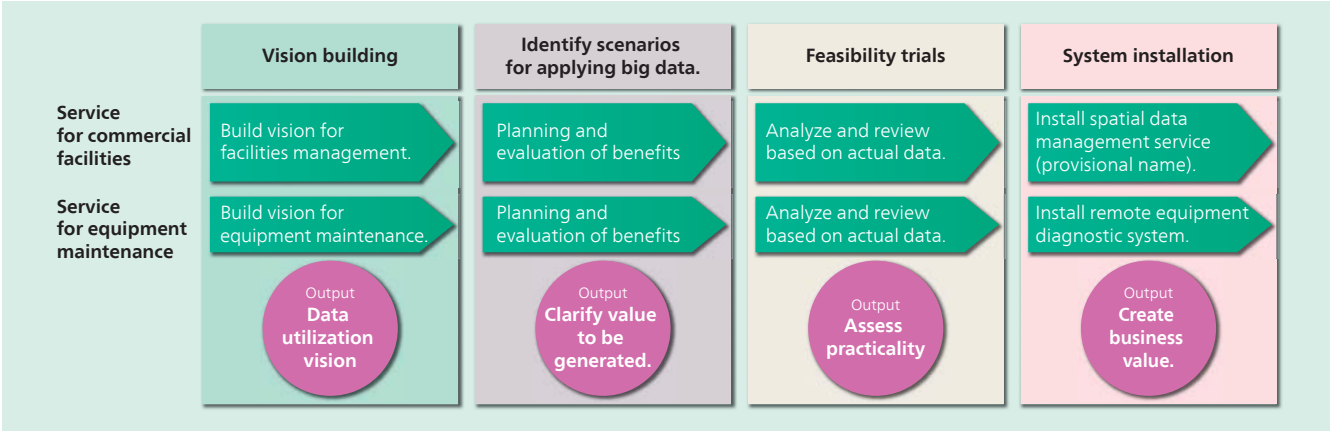
IT Solutions and Cloud Services



1 Process of data analysis service

1 Data Analysis Service

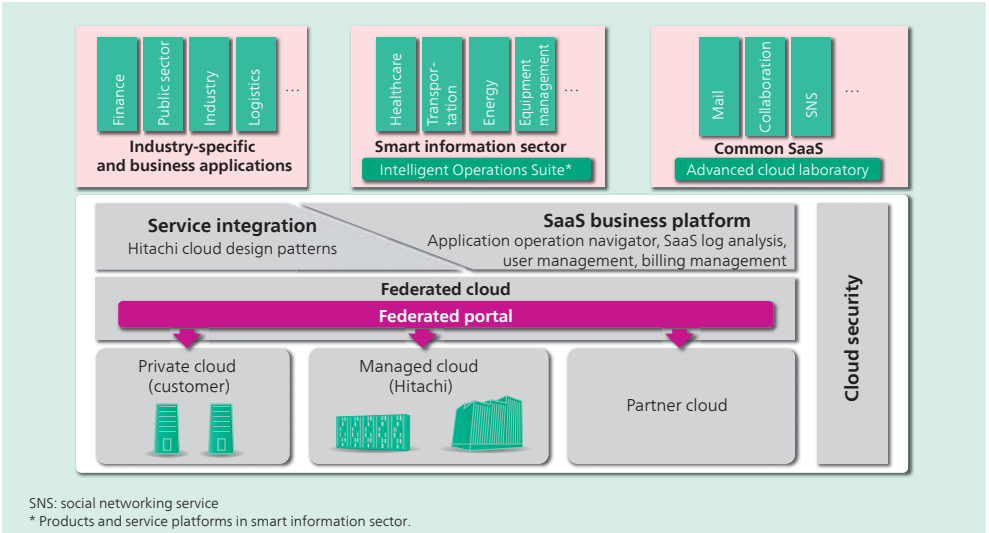
The spread of the Internet and use of digital sensors in recent years have reduced the cost of collecting sensor data. Hitachi is developing services for generating customer value from the analysis of collected sensor data in the form of data analysis services that draw on expertise in mathematical analysis and practical business know-how.

For commercial facilities, Hitachi intends to provide a spatial data management service that can assess the effectiveness of sales promotions and the health of tenant businesses, for example, by analyzing data collected on how people move through and gather at the facility, and provide this information to the organizations engaged in facility planning, tenant management, and facility management. Similarly, an equipment maintenance service performs mathematical analyses on information such as routine equipment operation data or inspection and part replacement records to determine equipment condition and detect fault in early phase. This can help improve utilization and reduce maintenance costs by providing the basis of a system for the remote diagnosis of equipment.

In the future, Hitachi intends to work together as a group to provide total services that extend from data collection to analysis and system implementation, while also strengthening its work with customers on creating value in the early stages of projects.

2 Hitachi Cloud

Hitachi Cloud is a suite of services based around a federated cloud that provides unified management for the customer's own private



SNS: social networking service
* Products and service platforms in smart information sector.

2 New cloud platform and services

cloud, a managed cloud operated by Hitachi, or partner clouds operated by providers such as Amazon Web Services*.

For these services, Hitachi has developed a federated portal for the centralized monitoring and operation of different types of clouds and is encouraging their interactions. Hitachi has also established an integrated cloud network that connects between Hitachi's data centers in Japan and also connects to Amazon Web Services in broadband. For security, a security gateway enables single-sign-on to partner clouds together with 24-hour monitoring and security measures. The software-as-a-service (SaaS) business platform provides basic functions usually required to start a new SaaS, including user management, log analysis, and billing. Service integration, meanwhile, delivers system design and implementation knowledge in the form of Hitachi cloud design patterns.

Hitachi strengthens its global capabilities under the unified "Hitachi Cloud" brand with worldwide group companies.

* See "Trademarks" on page 146.

3 TWX-21 Web-EDI Global Service

As companies seek to enhance their design, procurement, and production activities, there is growing demand in China and other parts of Asia for cloud services that can provide fast and low-cost data exchange and sharing between businesses.

TWX-21 provides a customizable Web-Electronic Data Interchange (EDI) Global Service from data centers in Japan and China. The EDI function provides applications that use links to the internal systems at the buyer company to entry quotations, purchase orders and other data to TWX-21, and allow the supplier to handle quotations, ordering, shipment, and invoicing from a web browser. The purchasing and logistics function is used to enter data on quotations, purchases, and freight that is required for complex delivery scheduling and logistics management tasks, and to handle user access permissions and workflows such as assessing and approving quotations. This allows users to concentrate on core activities because it significantly reduces the workload associated with such tasks as coordination, parts ordering, and progress management, which were previously done manually.

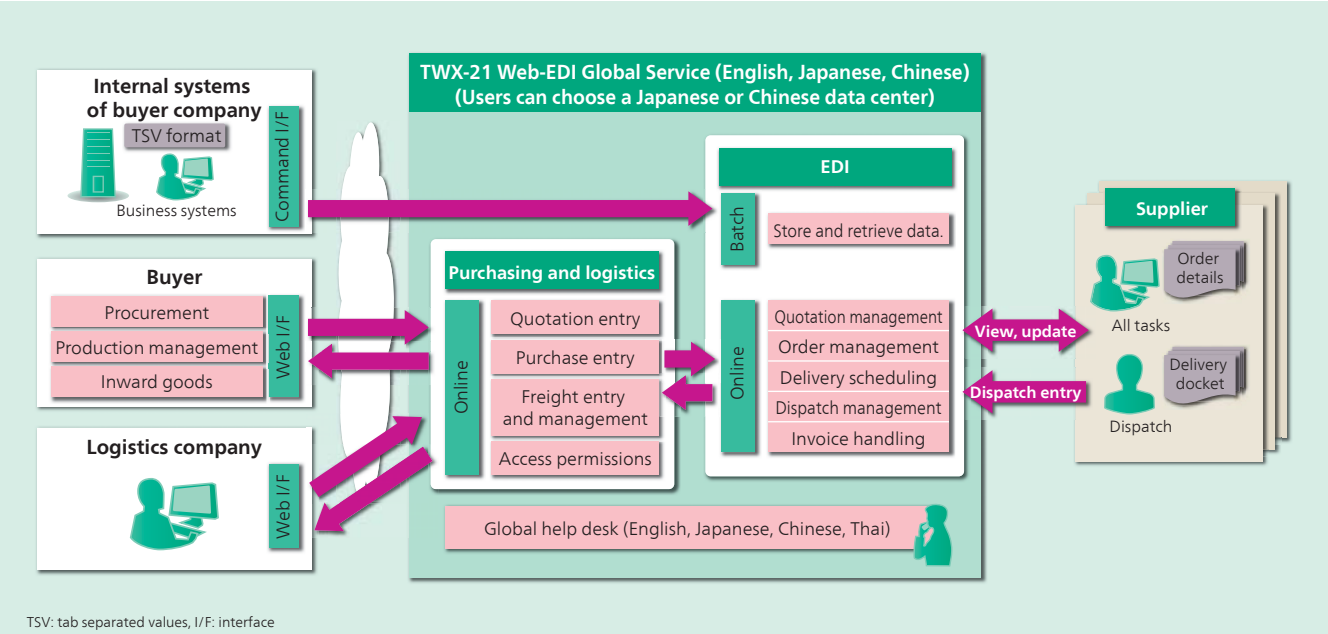
TWX-21 runs on the Hitachi Cloud SaaS business platform. Hitachi intends to continue supporting greater global competitiveness along with making ongoing enhancements based on user needs.

4 Global e-Service on TWX-21 Predictive Diagnosis

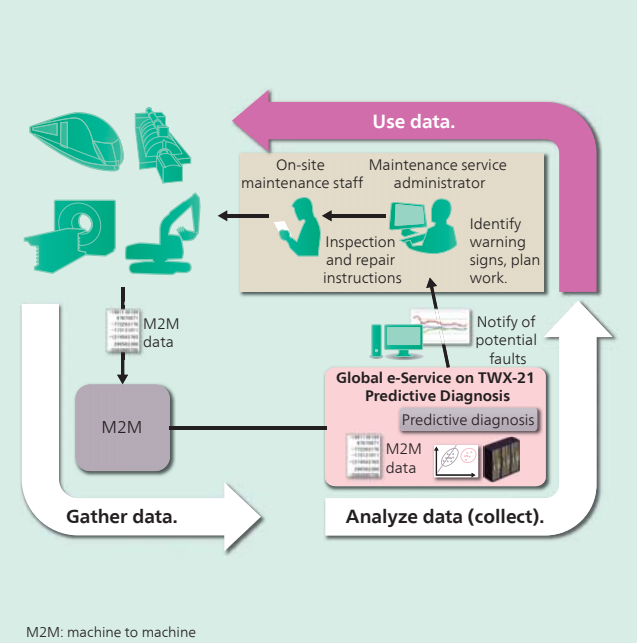
Against a background of intensifying global competition, many machinery suppliers have been building up their after-sales service businesses in recent years, including maintenance and the sale of spare parts. The requirements of machinery users, meanwhile, include a high level of utilization and lower maintenance costs. Accordingly, machinery suppliers are increasingly setting up preventive maintenance services that use remote monitoring of equipment conditions to prevent faults from occurring.

After many years of research and development, Hitachi has now implemented predictive fault diagnosis techniques for use in preventive maintenance services. It plans to launch a predictive diagnosis service in March 2015 that will use proprietary diagnostic algorithms established through this work to detect potential faults by performing automatic remote diagnosis of equipment conditions. The service will help improve utilization and reduce maintenance costs by performing remote monitoring of operating conditions and fault warning signs on machinery deployed throughout the world.

In developing diagnostic techniques that take account of machinery characteristics, Hitachi will also provide consulting services to help develop diagnostic models for the machinery being monitored, including having its specialists in big data analytics study specific diagnostic methods and conduct perfor-



3 TWX-21 Web-EDI Global Service



4 Predictive diagnosis service cycle

mance assessments. These services will shorten the time taken to develop diagnostic models and to move from model development to deployment in practical diagnostics.

5 Total SCM Cloud Service

The increasing globalization of manufacturing in recent years has exposed manufacturers to problems such as the inability to grasp sales, inventory, and production throughout the world causing mismatches between supply and demand, variability in the quality of designs from different sites, and the risk of design data being leaked. To overcome these problems, Hitachi supplies a total supply chain management (SCM) cloud service that encourages global standardization of business practices and achieves appropriate decision-making through the centralized management of data and systems for all business processes, from sales to design, production, and procurement.

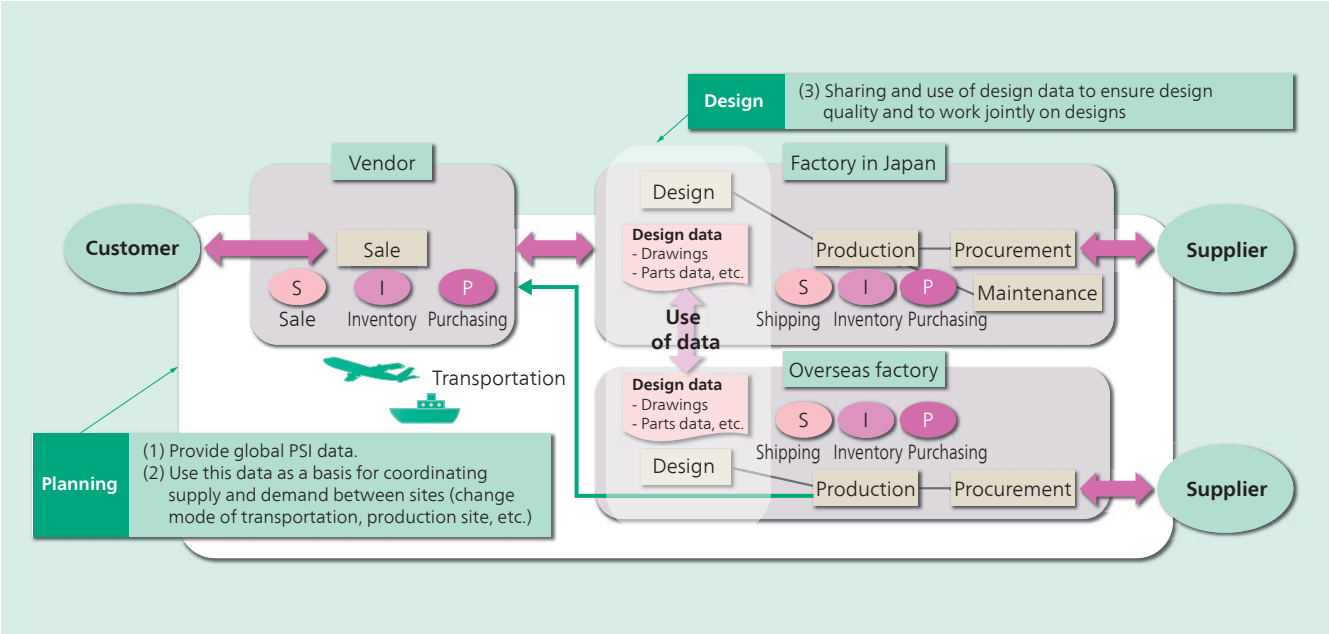
This service provides access to production, sales, and inventory (PSI) data throughout the world. It makes possible to take measures to prevent problems such as late delivery or overstocking by performing rapid simulations of how supply and demand vary across multiple sites in response to changes such as the mode of transportation or site of production. It also makes it possible to maintain design quality and work together on designs in a timely manner by using the same computer-aided design (CAD) virtual desktop infrastructure (VDI), product data management (PDM), and other systems across all sites, enabling the secure sharing and use of highly confidential design data.

Hitachi plans to add additional service options in the future, including execution systems such as quality management and production line monitoring, and business strategy systems such as the use of cost data for revenue simulation.

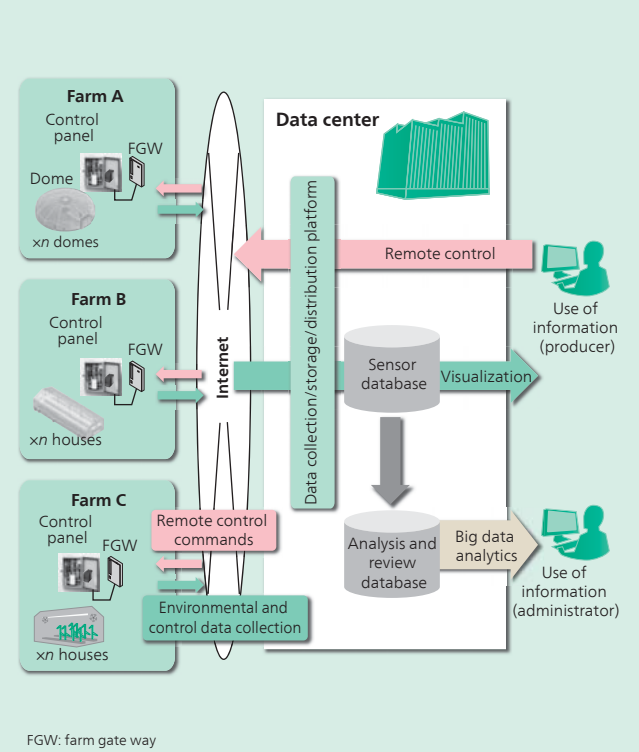
6 Cloud Services Supporting Plant Factory Production

"Plant factories" (closed growing systems) are increasingly being used to ensure reliable production and a steady supply of agricultural products by controlling the growing conditions to suit the crop being grown. This in turn has created a demand for services that monitor production conditions and equipment operation remotely to improve productivity through the use of various data analyses and by optimizing control of energy and other aspects of the environment.

The Cloud Services Supporting Plant Factory Production use the cloud to collect and manage data on plant factory growing conditions and control data from production equipment. It can supply management information to producers and equipment administrators in realtime and also control growing conditions and production equipment. All of the collected data is stored in a



5 Total SCM cloud service



6 Cloud Services Supporting Plant Factory Production

database where it can be analyzed and reviewed using business intelligence (BI)* tools to optimize growing conditions and provide support for decision-making from a management perspective.

* Tools and techniques for collecting, analyzing, and processing large quantities of corporate or other organizational data, and for utilizing it in management and other decision-making.

7 Hitachi's Lifestyle Change Program: A Cloud-based Service for Promoting Health

If a medical examination ("special health check-up") finds that a patient is suffering from metabolic syndrome, the patient needs to receive specialist health maintenance advice. The problem with this, however, is that in many cases patients find it difficult to obtain this specialist health maintenance advice because they cannot get to daytime appointments for the necessary initial consultation with an advisor, or because health associations cannot provide such advisors at remotely located clinics. In response, Japan's Ministry of Health, Labour and Welfare relaxed the rules in August 2013 to allow videoconferencing or other information technology (IT) to be used for the initial consultation.

Accordingly, Hitachi has added a remote advice service to Hitachi's cloud-based lifestyle change program for promoting health. This involves Hitachi taking total responsibility for providing advice, including the initial consultation, via Internet-based videoconferencing. To access the service, participants use a tablet or camera- and microphone-equipped personal computer (PC) to visit a special website.

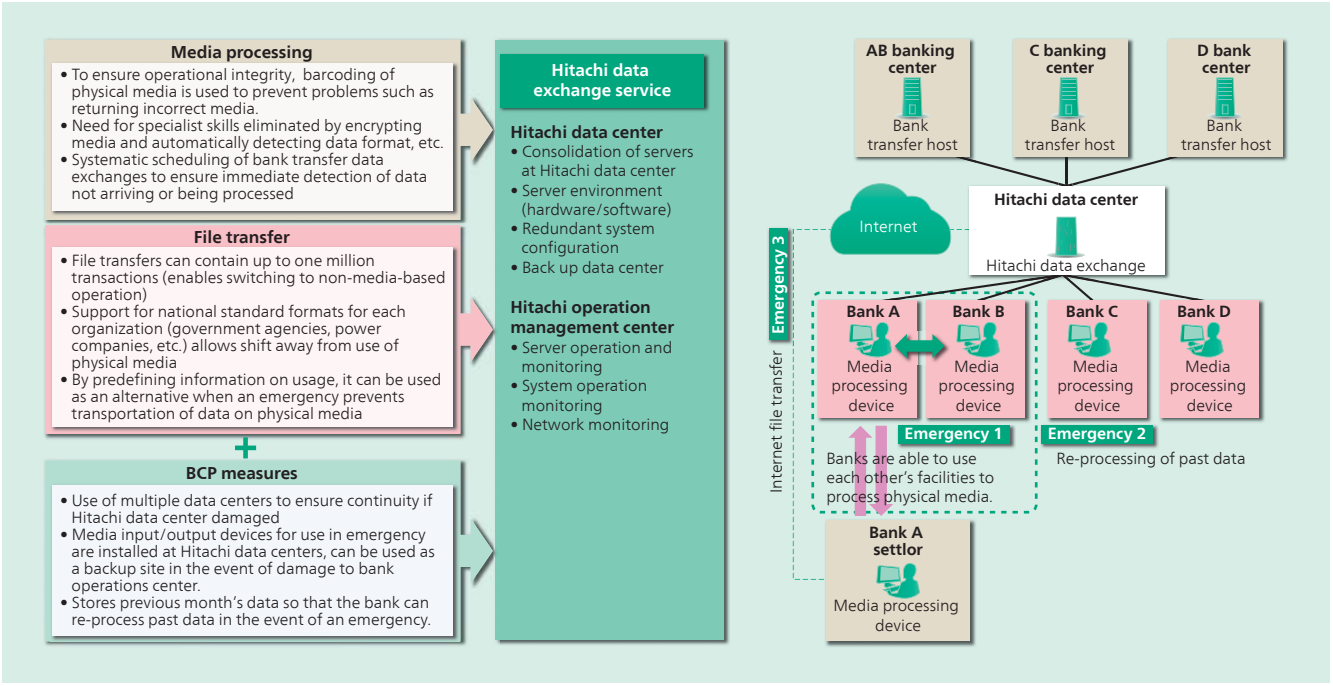
7 Web-based consultation using Hitachi's lifestyle change program's remote advice service (top) and web reservation screen (bottom)

8 Hitachi Data Exchange Service

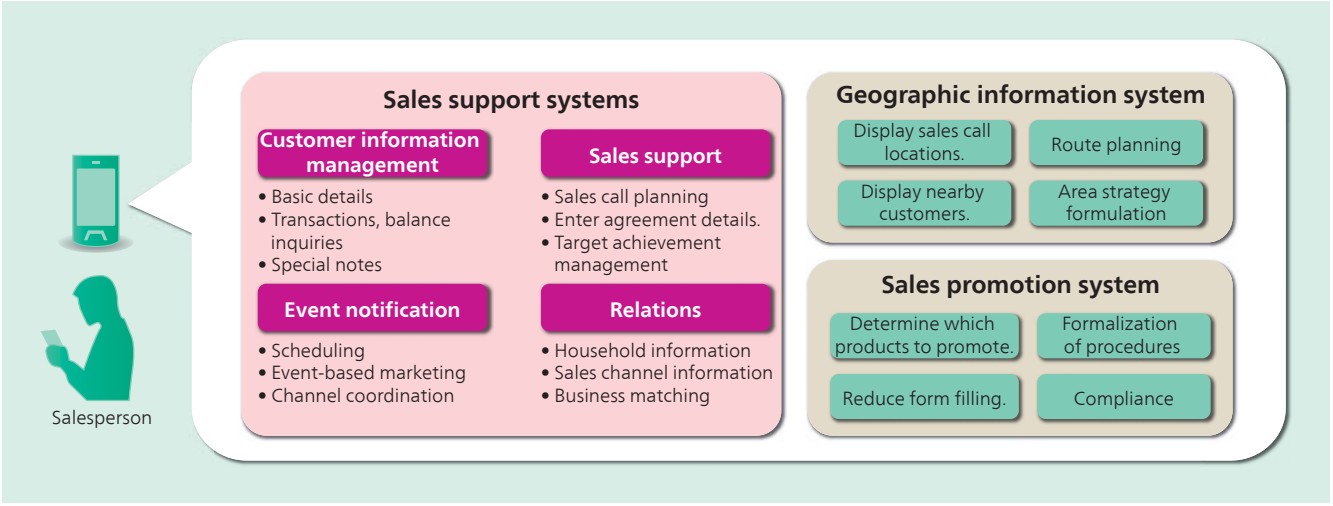
Bank transfers made by the automatic debiting of funds from a bank account are widely used in Japan as a convenient way of making payments. Accordingly, financial institutions are taking steps to strengthen their business continuity plans (BCPs), which ensure that these transfers continue to take place even in the event of a disaster or major fault. However, media that are now out of production, such as cartridge magnetic tape (CMT) and floppy disks (FDs), are still widely used for data exchange between companies and banks.

The Hitachi data exchange service provides the ability for companies and banks to exchange bank transfer data in the form of a Hitachi cloud service, enhancing BCPs without changing the current practice of exchanging data on physical media. To deal with a possible large-scale disaster, cooperation between financial institutions that have adopted this service means they can use each other's facilities to process physical media in an emergency such as a disaster or fault. The exchange of bank transfer data can also be performed by sending files across the Internet. Because it can handle the transmission of files containing around a million transactions, which posed a problem for previous services, file-based data exchange is used to eliminate the need to transport physical media.

In the future, Hitachi intends to help ensure reliable operation and greater efficiency in bank transfers by supplying the Hitachi data exchange service.



8 Overview of Hitachi data exchange service (left) and interconnection with participating banks (right)



9 Sales support solution for financial institutions using mobile devices

9 Sales Support Solution for Financial Institutions Using Mobile Devices

Past practice by sales staff at financial institutions has been to use their branch systems to prepare for making a sales call, perform follow-up tasks on their return, and execute complex financial transactions in their offices. For such users, Hitachi supplies a sales support solution that allows the use of mobile devices instead.

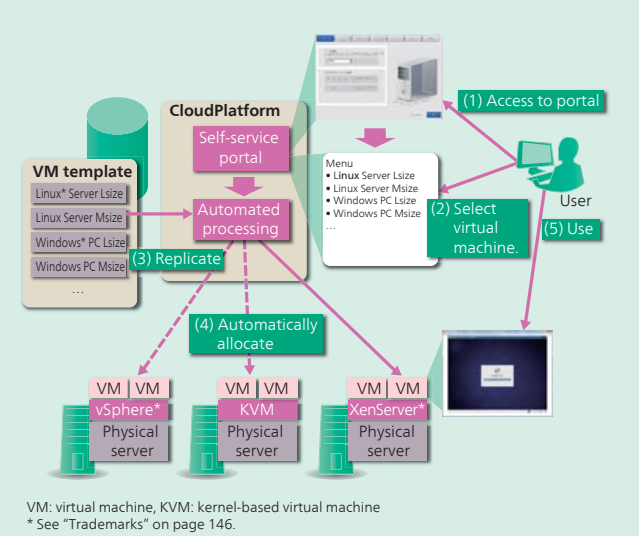
Using mobile devices to access the sales support system reduces the amount of preparation required for a sales call by allowing customer information to be viewed when out of the office. Furthermore, because agreements reached during a sales call can be entered on the spot, it also speeds up the availability of information and reduces the work to be done on returning to the office. Directions for getting to the sales call can also be obtained easily by using a geographic information system. Since other nearby customers are shown on the map, visits can be planned and executed with greater efficiency. Using mobile devices to access sales promotion systems that previously were only available in the office also allows complex financial transactions to be executed during the sales call.

Together, these features support more efficient sales and increase sales opportunities.
(Hitachi Solutions, Ltd.)

10 Hitachi Cloud Platform Solution

In recent years, private clouds have attracted attention for their ability to satisfy both corporate governance and security requirements, and the convenience of the cloud (rapid response for demand). The Hitachi cloud platform solution is a service that implements private clouds that provide infrastructure as a service (IaaS) and desktop as a service (DaaS).

Since the core cloud management software (Citrix* CloudPlatform*) is able to work with various virtualization software and, moreover, able to be controlled and customized by application



VM: virtual machine, KVM: kernel-based virtual machine
* See "Trademarks" on page 146.

10 How cloud platform is used

programming interface (API), this service can provide a private cloud that satisfies user needs.

By introducing the Hitachi cloud platform solution, it is possible to simplify operation of virtualization management software, reduce the IT administration department workload by automating many aspects of operation, and provide users with computing resources such as PCs and servers rapidly. Usually, users have to wait several days after sending a request to use resources, but this service can provide resources in about 10 or 20 minutes and allows users to start developing their research immediately.

This service is installed in many universities and research institutions, and Hitachi is planning to supply it to a wide range of public sector agencies in central and local government.

* See "Trademarks" on page 146.

11 Family Register Backup Data Management System for Ministry of Justice

The family register originals for four municipalities in Miyagi and Iwate Prefectures were destroyed by the tsunami that followed the Great East Japan Earthquake in March 2011. Although the original were able to be recreated from backup copies held by the relevant Legal Affairs Bureaus, there is a risk that a future major disaster could result in the loss of both original and backup copies. Accordingly, the Ministry of Justice of Japan initiated a project to build a family register backup data management system that will hold data backups to prevent the complete loss of these family registers.

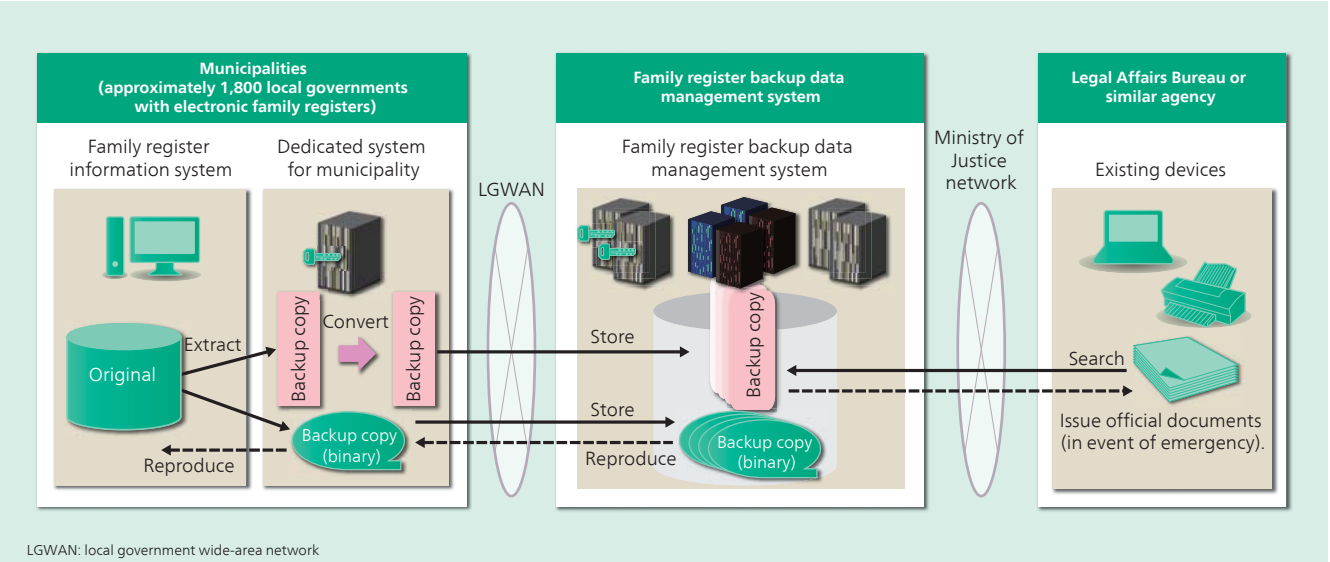
Although the practice in the past was for each municipality to send backup data annually on magnetic media to its nearby Legal Affairs Bureau or similar agency for safekeeping, the new system will daily send any updates to the family register at each municipality to a remotely located family register backup data management center via a network. By preventing the complete loss of this information even if a major widespread disaster destroys both the municipality and its associated Legal Affairs Bureau, this will maintain the integrity of what is the sole family register system for publically recording family relationships and citizenship for the people of Japan. In the event of a disaster, the Legal Affairs Bureau can also issue identity documents on behalf of a municipality.

Hitachi was awarded the contract in August 2012 and completed the system in September 2013. The system is in operation and the Ministry of Justice has been using it to hold backup data for all municipalities (apart from some exceptions) since April 2014.

The family register backup data management system is one of the BCP measures being considered throughout the country since the Great East Japan Earthquake that has been adopted in practice. In the future, Hitachi intends to deploy the technology used in this system in other applications, not limited to the public sector.

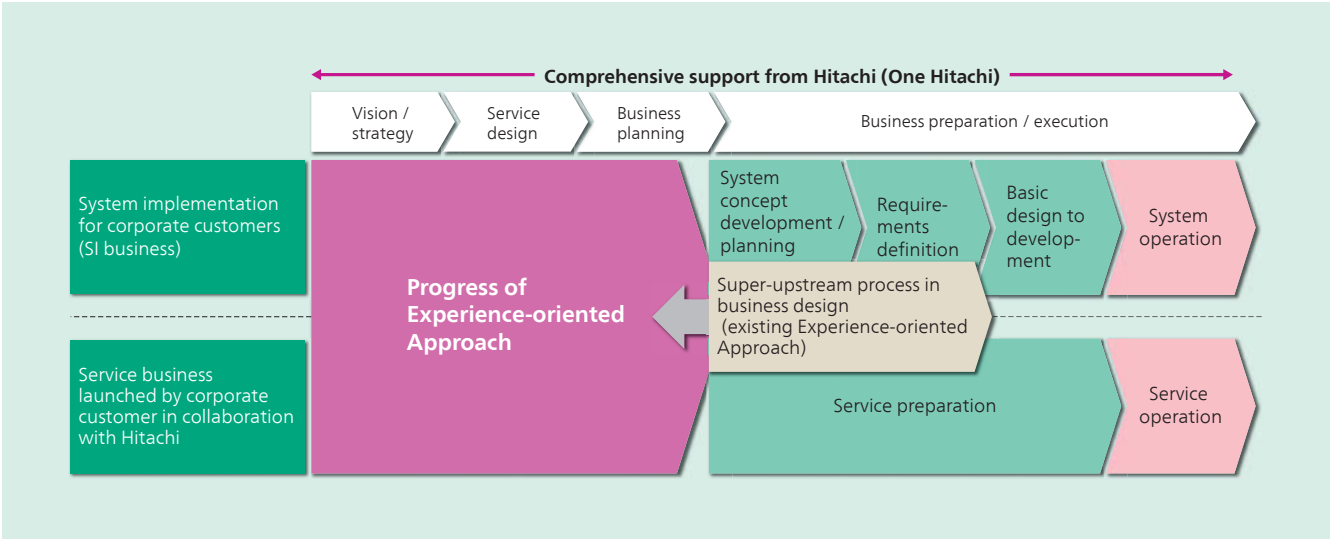
12 Experience-oriented Approach Outlook

The Experience-oriented Approach is a technique used by Hitachi for the conceptual planning of systems. Proprietary to Hitachi, the Experience-oriented Approach combines the technologies and know-how that Hitachi has acquired on information system implementation projects with techniques built up by its design



LGWAN: local government wide-area network

11 Family register backup data management system for Ministry of Justice



12 Experience-oriented Approach outlook

divisions for enhancing "customer experience." Hitachi uses this technique to work with customers from a variety of industries and types of business to create new customer experience and business innovation.

The rise in recent years of mobile, social networking, and big data technologies has made the provision of services to end users an essential part of business success. This means that systems integrators (SIs) require the ability not only to build information systems but also to work with the customers who use these systems to establish and operate services. Hitachi intends to draw on its experience using the Experience-oriented Approach to pick up the pace of business activities undertaken in collaboration with customers.

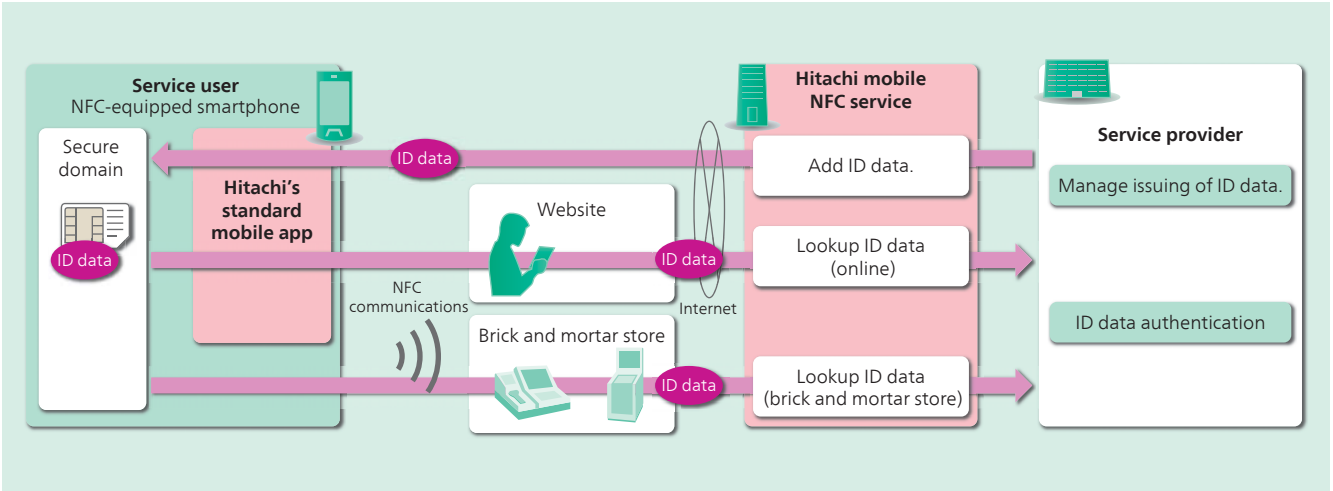
13 Mobile NFC Services for Service Providers

Near field communication*1 (NFC), a way of transferring data by passing a device over a reader, has been increasingly incorporated into smartphones in recent years. Hitachi plans to launch a cloud-based service for implementing mobile NFC services on behalf of service providers. This service will provide for the secure addition of functions for reading data by NFC in retail applications (such as online or at brick and mortar stores) to the universal integrated circuit card*2 (UICC) secure domain on NFC-equipped smartphones.

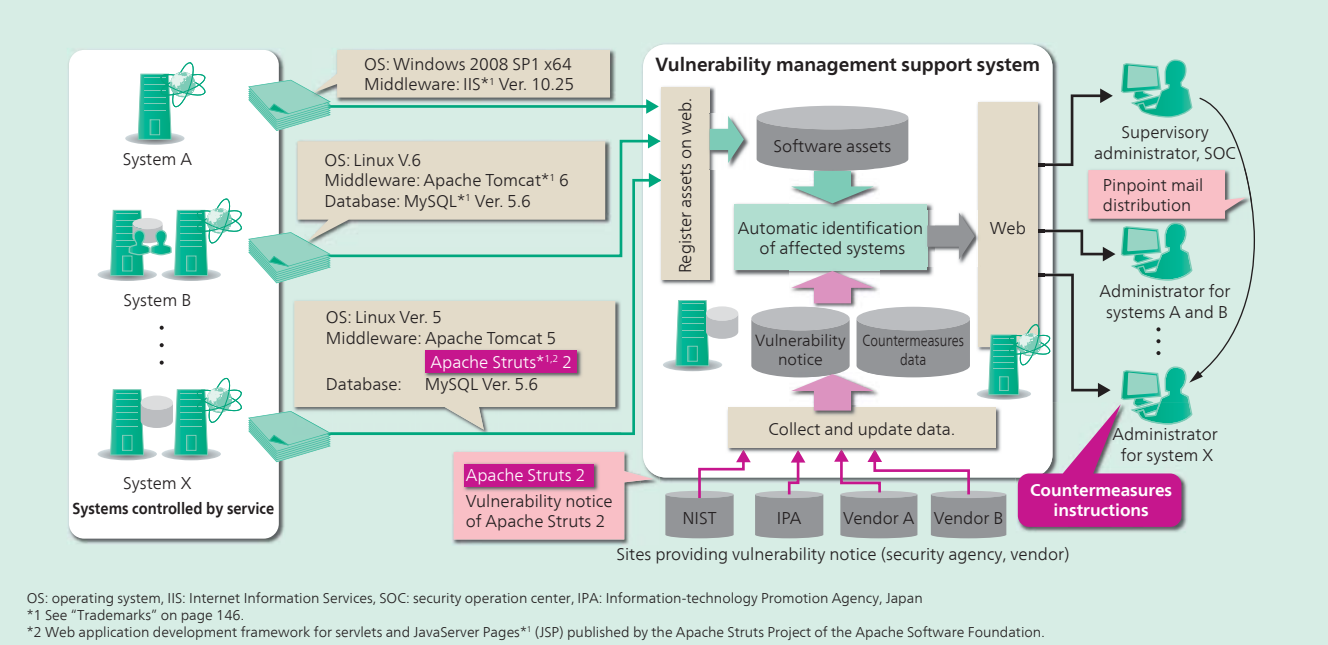
The service uses Hitachi technologies such as those for encryption and authentication to provide security features such as blocking unauthorized smartphone applications, ensuring the security of communication links to service providers or other destinations, and preventing spoofing. It also provides a standard mobile app (a smartphone application that interacts with the service) that ensures secure NFC services can be established quickly, eliminating the need for service providers to develop smartphone applications or conduct their own testing for different smartphone models.

In the future, Hitachi plans to supply this service for authentication and other applications in the electronic money, loyalty card, and related markets.

*1 A short-range wireless communications standard defined in ISO/IEC 21481.
*2 A smartcard used to store a unique identification (ID) number that determines the subscriber's telephone number.



13 Mobile NFC service for service providers



OS: operating system, IIS: Internet Information Services, SOC: security operation center, IPA: Information-technology Promotion Agency, Japan
*1 See "Trademarks" on page 146.
*2 Web application development framework for servlets and JavaServer Pages*1 (JSP) published by the Apache Struts Project of the Apache Software Foundation.

14 Vulnerability management support system

14 Vulnerability Management Support System

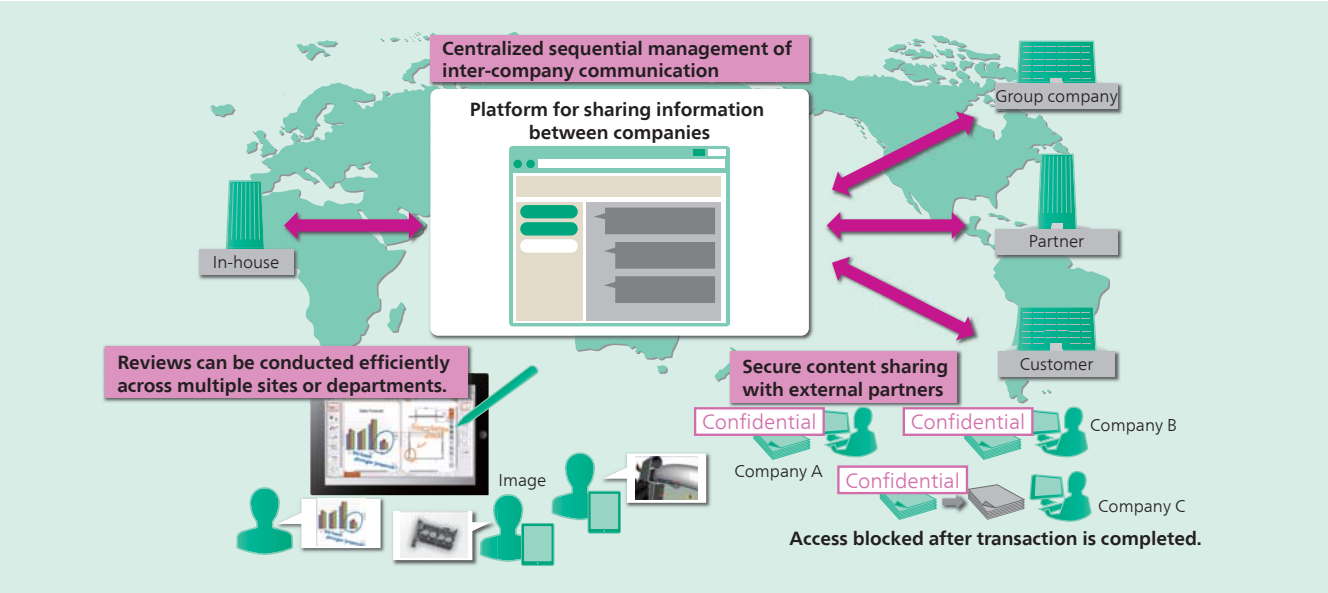
With cyber-attacks that exploit vulnerabilities in IT systems continuing unabated, the US National Institute of Standards and Technology (NIST) issues approximately 5,000 vulnerability notices annually. While the management of vulnerability risk has conventionally been handled by system administrators with detailed knowledge of the software used in a system, the risk of overlooking vulnerability information or not implementing patches means there is a need to eliminate human error from the process.

Accordingly, Hitachi has developed a vulnerability management support system that automatically accesses information about the administration of software resources and information from sites that publish vulnerability notice, and provides notifications of pertinent information. This allows system administrators to reduce their workloads and implement comprehensive vulnerability risk management simply by approving the actions taken in response to the vulnerability notice that the system provides.

Hitachi already supplies a cybersecurity solution that provides comprehensive support for cyber-attack countermeasures and is working to progressively expand the range of service options to keep pace with the increasingly sophisticated nature of attacks. In the future, Hitachi intends to extend its services by utilizing this vulnerability management support system to provide vulnerability notice that is relevant to customers' systems in realtime.

15 Family of Products that can Take Free Advantage of Business Content

As an increasing number of companies pursue business innovations such as globalization, new working practices, and opera-



15 Sharing information between companies using a family of content management products

tional reforms, they face the major challenge of how to bring together skills, knowledge, and ideas from across the organization. As a result, many companies are looking for ways to provide flexible use of relevant "business content," meaning documents, drawing data, forms, images, and movie. The ability to make full use of this business content can be expected to let companies achieve their maximum potential by facilitating knowledge synergies and new forms of co-creation.

To meet these expectations, Hitachi provides a family of content management products, including an inter-company information sharing platform that can take free advantage of business content. By ensuring quick and secure inter-company and inter-departmental communication, this helps grow the business by facilitating co-creation with overseas sites and other partners.
(Hitachi Solutions, Ltd.)

16 Production Setup Solution for Manufacturers

There has been a growing trend toward Japanese manufacturers setting up operations overseas, influenced by economic conditions in Japan in recent years. For these Japanese manufacturers to succeed in overseas markets, there is a recognized need to change their existing manufacturing *kaizen* improvement practices to avoid problems such as overemphasizing cost reduction in on-site capabilities, or proceeding with cost improvements without specifying the accurate standards (indicators) to target.

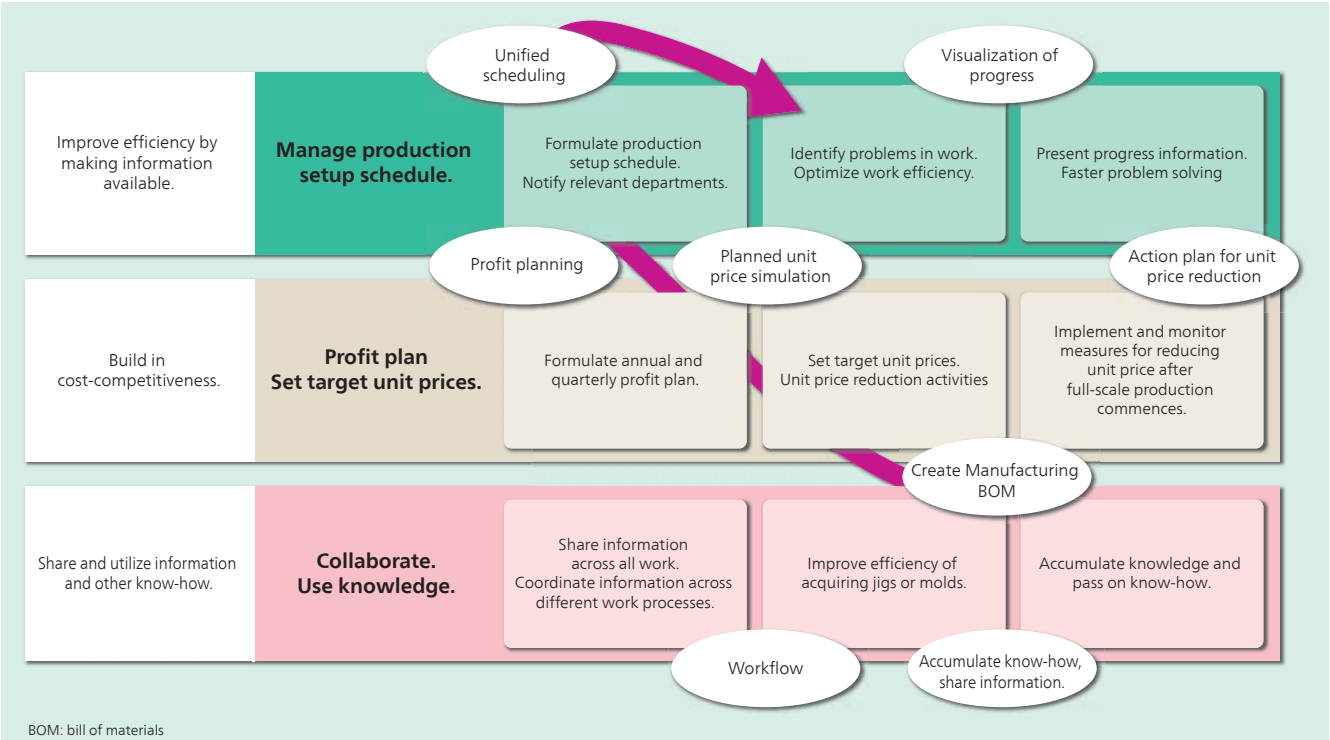
Hitachi's production setup solution for manufacturers is used to build in cost-competitiveness at the development and production setup stage, and has the following features.
(1) Improves efficiency by making information on production setup schedules and progress available in the lead-up to the commencement of full-scale production over a short timeframe and involving a wide range of departments.
(2) Builds in cost-competitiveness by formulating profit plans, establishing accurate and achievable target unit prices required to achieve the planned revenue, and utilizing work on reducing unit prices after full-scale production commences.
(3) Shares and utilizes information and other useful know-how to reduce costs.

These benefits and the functions that provide them deliver comprehensive support for achieving cost structures that are superior to those of competitors.
(Hitachi Solutions, Ltd.)

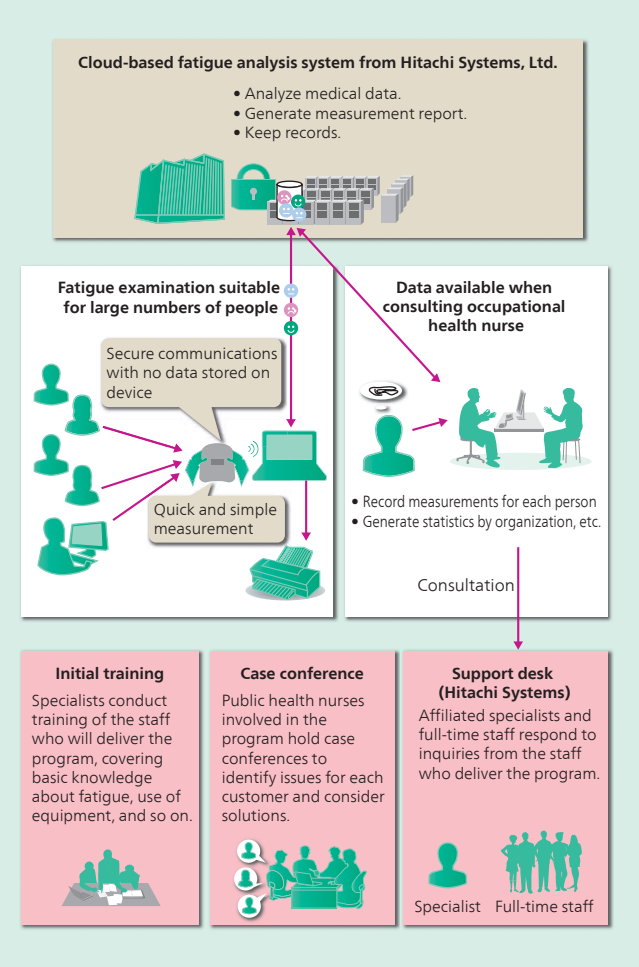
17 Fatigue and Stress Measurement System

People are among the most valuable assets of a company and a strong emphasis has been placed on things like preventing death from overwork and conducting stress checks to protect their health, with legal requirements also being introduced in Japan. While fatigue, like pain or fever, is an important warning sign of health problems, currently it can only be assessed by subjective measures such as a medical examination or consultation. In preventing death from overwork and conducting stress checks, objective fatigue biomarkers (quantitative techniques for identifying fatigue) are needed to deal with issues that are not apparent unless raised by the patient themselves, or to identify fatigue of which the patient is not personally aware.

Existing fatigue biomarkers include such physiological biomarkers as assessments of activity levels, the sleep-wake rhythm, and autonomic nerve function, and biochemical biomarkers such as blood and saliva tests for oxidants, metabolites, amino acids, and so on. The assessment of autonomic nerve function is one of the simpler of these to obtain.



16 Three benefits provided by the production setup solution for manufacturers, and the functions used to provide them



17 Use of fatigue and stress measurement system

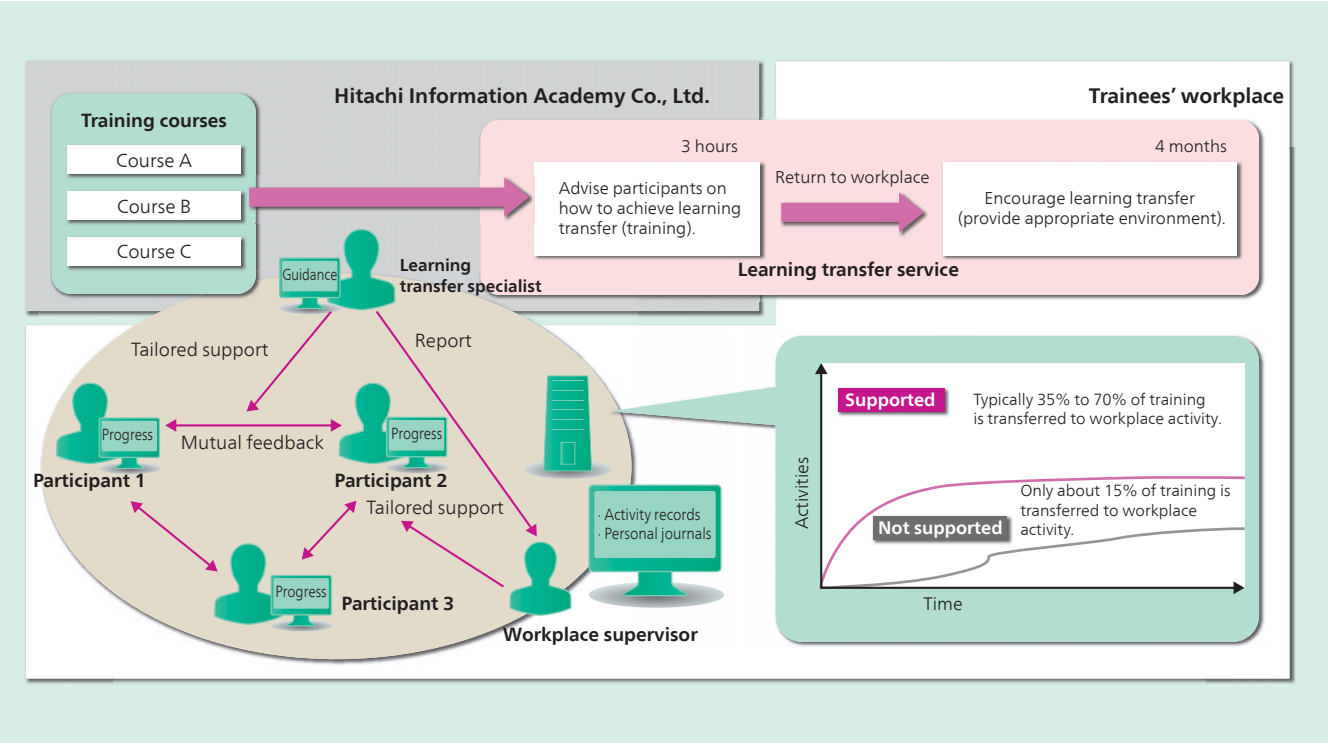
By looking at heart rate variability to provide an indication of autonomic nerve balance and activity levels, the fatigue and stress measurement system helps make possible preemptive medical interventions that take account of how prone people are to fatigue. (Hitachi Systems, Ltd.)

18 Learning Transfer Service

The term "learning transfer" refers to taking explicit knowledge acquired in a classroom and applying it to work to create tacit knowledge in an organization.

The learning transfer service of Hitachi Information Academy Co., Ltd. provides ways of monitoring this process and encouraging it in an efficient way. First, an instructor from Hitachi Information Academy gathers together the participants involved after their training has been completed to provide guidance on how the learning transfer is to be achieved. Then for four months after they return to the workplace, they are provided with a special cloud-based application to use as a forum for facilitating the process. The participants use this application to start utilizing their new knowledge based on individual plans covering their activities and how to incorporate the knowledge into their routines, providing each other with encouragement through mutual feedback until the new knowledge is assimilated and more desirable activities are developed. This is monitored by their supervisors who can provide support as required.

Hitachi Information Academy uses records of participants' activities, their personal journals, and associated statistics to assess the progress of learning transfer and reports this to the stakeholders. This helps improve the return on investment for training by ensuring solid progress is made on tasks that are heavily dependent on the person performing them by having participants assist each other.
(Hitachi Information Academy Co., Ltd.)



18 Learning transfer service

IT Platform

1 Hitachi IT Platform Strategy

Leading organizations are evaluating, buying, and deploying technology according to a new model of Business-Defined IT, where information technology (IT) and business teams operate seamlessly together toward shared goals.

Within Hitachi's businesses and among our thousands of customers, we see this partnership increasingly focused on delivering unique value and solutions for improving the following three points:

(1) Mobility

Increasing productivity with secure access to critical data anytime, anywhere, via any device

(2) IT economics

Offering strategies to reduce cost and increase profitability

(3) Insight

Providing meaningful and actionable direction based on realtime data analysis to improve competitive advantages

Helping our customers succeed with this new model is a driving force behind Hitachi's IT Platform strategy.

Business-Defined IT can only flourish if there is a seamless flow of data and knowledge throughout the organization. Hitachi solutions for data mobility increase productivity and our vertical-expertise and strength in analytics help provide the key business insights our customers need to stay ahead of their competition.

The foundation of all of this, however, is a stable, programmable and adaptable IT infrastructure that can change to meet new business requirements. This Continuous Cloud Infrastructure brings new levels of availability, automation and agility to IT teams, so they can focus on growing their partnership with the business, and not dealing with recurring limitations of outdated IT infrastructure.

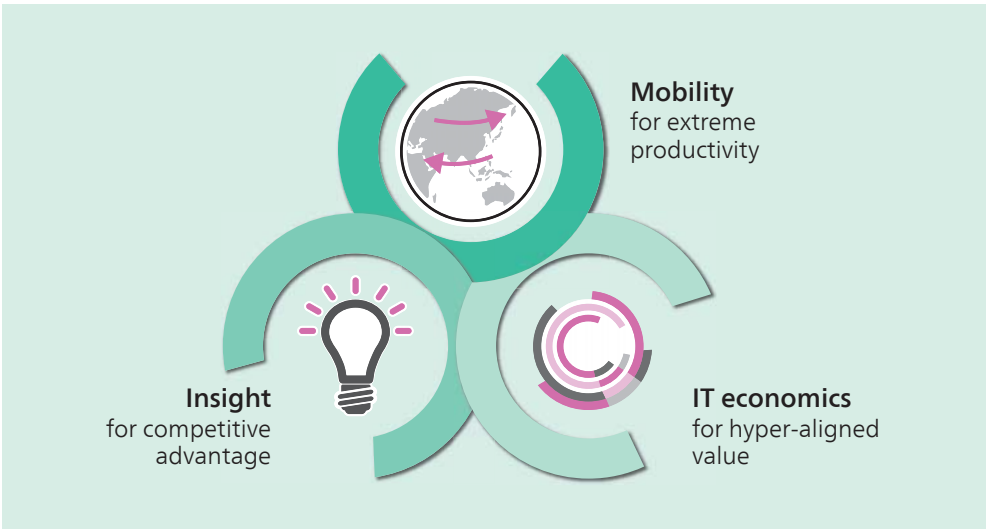
Hitachi development is leading this effort. In its new efforts, Hitachi is also focusing on enhanced software and solutions capabilities to reduce complexity and increase automation. Hitachi's new hardware platforms push new technologies like flash storage to the forefront and challenge old ways of thinking about how server and storage systems are designed. These innovations come together into complete computing stacks that reduce cost and speed time to productivity.

Tomorrow's leading companies are moving toward Business-Defined IT today, and need new, agile IT infrastructure technologies to power them forward. Hitachi is developing and delivering those technologies, today.

2 Hitachi Unified Compute Platform

The Hitachi Unified Compute Platform is an integrated platform solution that bundles management software with server, storage, and network hardware.

As a pre-configured solution for private clouds, it provides ease-of-installation and shortens the time it takes for users to get an IT system up and running (the "service-in" time). Along with reducing administration costs by providing management software that simplifies and automates the use of virtualization, the Hitachi Unified Compute Platform also provides highly dependable hardware to ensure reliable system operation and ease of system installation to ensure that the system can adapt quickly to changes in the business. It also includes an integrated platform orchestration function, meaning that hardware that in the past was



1 Business-defined IT

LAN: local area network, FC: Fibre Channel

2 Hitachi Unified Compute Platform (left) and integrated platform orchestration function (right)

managed separately by server, storage, and network administrators, respectively, can now be centrally managed by a virtual machine (VM) administrator.

Drawing on experience from its system solution business, Hitachi's aim is to create integrated platforms that do not require configuration.

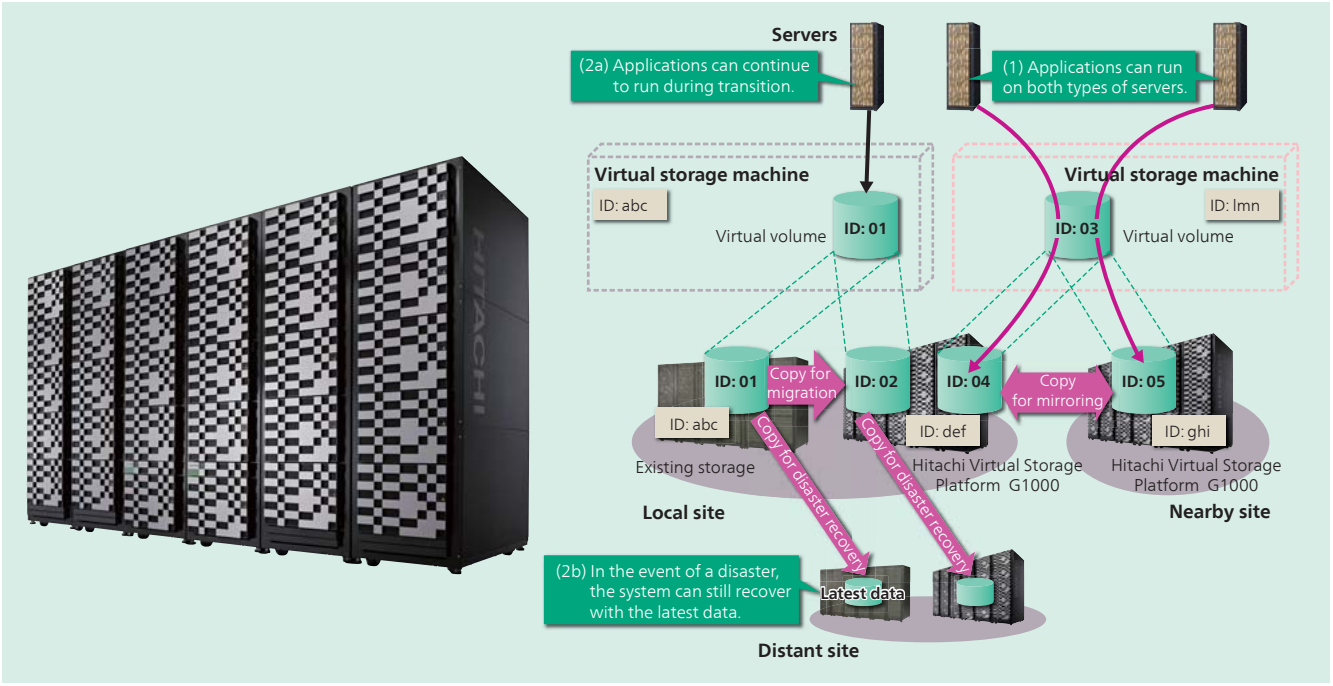
3 Hitachi Virtual Storage Platform G1000

In recent years, corporate activity has been called on to respond to rapid changes in the business environment, including not only increasingly globalized markets but also the 24-hour, 365-day delivery of services and the use of big data to create new business value. Against this background, the Hitachi Virtual Storage Platform G1000 has been released on the market as a highly reliable cloud platform that utilizes newly developed storage virtualization technology. Hitachi Virtual Storage Platform G1000 is a storage platform that can respond flexibly to changes in the business environment, allowing personnel and other IT resources to be redirected toward the creation of new business value without concern for things like IT system administration and operation.

In past system configurations that have involved duplication across different sites, the inability to access data held on subsidiary storage system hardware has made it difficult to operate business applications on subsidiary systems. The newly developed global storage virtualization technology provides a way to treat multiple storage systems as a single storage device. Because master and subsidiary storage systems are collectively treated as a single device, applications can run equally well on either type of server and access data from both types of storage systems. This improves business productivity by simplifying such tasks as server load sharing and server maintenance, and by making it possible to migrate virtual servers between master and subsidiary systems. Hitachi Virtual Storage Platform G1000 also supports rapid switching between master and subsidiary systems to allow rapid system recovery after natural disasters.

In the past, migration to new storage hardware has required a system shutdown to perform the switchover. Because the new technology treats both existing* and new storage systems as a single device, the transition to new hardware can take place without interrupting service delivery or other business activities. The existing and new hardware can also maintain a disaster-tolerant configuration during the transition to ensure that, if a disaster were to occur, the latest data would still be available to the system after recovery.

In the future, Hitachi intends to continue supplying and enhancing its IT platforms that can respond flexibly to changes in the business environment without being held back by IT system management and operation considerations, and that can help



3 Hitachi Virtual Storage Platform G1000 (left) and new global storage virtualization technology (right)

create new business value through the use of big data.

* Hitachi Virtual Storage Platform, Hitachi Universal Storage Platform V, and Hitachi Universal Storage Platform VM.

4 Compute Blade 2500

In recent years, corporate activity has been called on to respond to rapid changes in the business environment, including not only increasingly globalized markets but also 24/7 non-stop service delivery and business value creation through the use of big data. Against this background, Hitachi released the Compute Blade 2500 in October 2014 as an IT platform that supports the environment in which customers operate, with the reliability and availability to ensure business continuity, the high performance for faster processing of big data, and the flexibility to adapt quickly to changes in the business.

4 Compute Blade 2500

Supporting a symmetric multi-processing (SMP) configuration with up to eight blade sockets, the Compute Blade 2500 can achieve high-performance systems with a maximum of 120 processor cores and up to 6 Tbyte of memory. The extensive input/output (I/O) capacity provided by the 28 Peripheral Component Interconnect (PCI) slots on the rear side of the chassis means that redundant configurations can be used despite the Compute Blade 2500 being a high-density blade server. To satisfy the increasingly strict security requirements of users such as government agencies and social infrastructure, the system has also been made more robust by the inclusion of secure account management and functions for preventing unauthorized access. Compute Blade 2500 can also be used as a cloud platform that delivers reliable performance to each tenant by using logical partitioning feature (Hitachi's hardware based logical partition capability, which the standard installation has) for the exclusive allocation of resources such as central processing units (CPUs) and memory. It improves the robustness and utilization of cloud platforms, both by ensuring security across multiple tenants and by making effective use of resources.

5 Hitachi Content Platform Anywhere

Mobility of devices, workforces, data on premise and off premise and among locations across the globe, creates many new business opportunities. However, mobility also presents new challenges for the IT professionals responsible for the protection and governance of the data content.

Hitachi Data Systems Corporation offers a tightly integrated content mobility solution designed for the enterprise and built by a single, well-respected vendor. Integration by design gives the solution of Hitachi Data Systems robust security and ease of

* See "Trademarks" on page 146.

5 Hitachi Content Platform Anywhere for PC, Mac*, Android*, iOS*, Windows Phone* and Internet browsers

implementation, and keeps IT efficient and in control of corporate data while allowing mobile workers to be more productive.

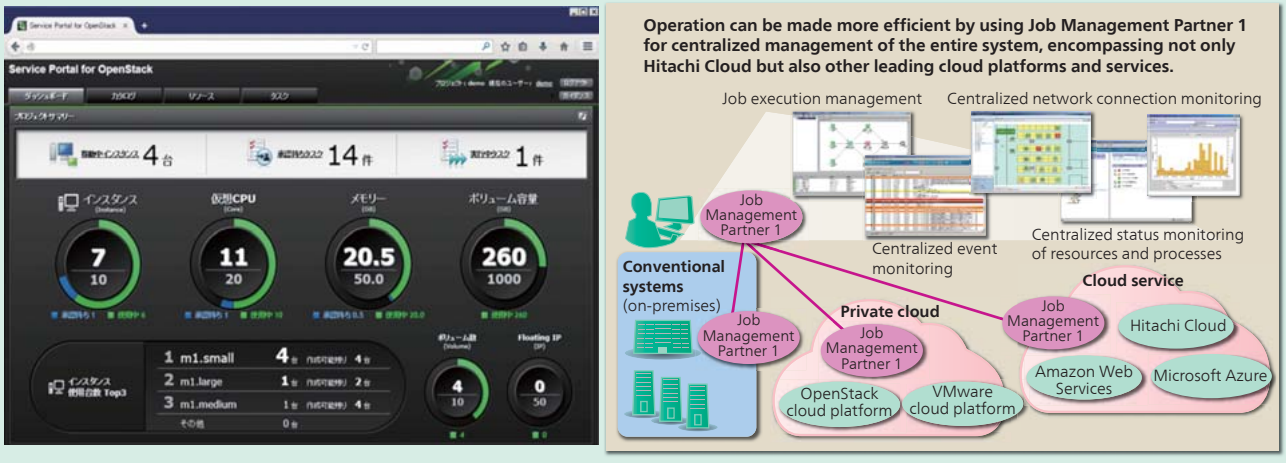
Hitachi Content Platform Anywhere provides mobile access to enterprise network-attached storage (NAS) data as well as file synchronization and sharing for user data. The combination of Hitachi Content Platform Anywhere with the hybrid cloud Hitachi Content Platform object store, empowers mobile workers by going beyond file syncing and sharing to provide mobile access to data in existing Hitachi NAS and Hitachi Data Ingestor systems, so they have secure access to cloud and enterprise data from anywhere, on any device, at any time. Hitachi Content Platform Anywhere also lets users pick from multiple languages for their client systems and offers efficient syncing of large, open and duplicate files. These capabilities extend existing investments in NAS environments and help IT bridge the gap between traditional NAS and 'next generation file services.'
(Hitachi Data Systems Corporation)

6 Integrated Systems Management Job Management Partner 1 V10.5

The growing practical use of the cloud makes it important that system-wide operation (including conventional on-premises systems) be performed efficiently under a multi-cloud environment that utilizes a number of cloud systems as and where needed.

Hitachi has enhanced support for key cloud platforms and cloud services in its Job Management Partner 1 V10.5 integrated systems management. Job Management Partner 1/Service Portal for OpenStack has been added to provide efficient operation of private clouds using OpenStack*, which is expected to become more widely used in the future. It provides functions that are essential for corporate use, such as approvals processing and the recording of and access to activity logs, and portal screens for cloud users that are intuitive and very easy to use. For private clouds based on VMware vSphere*, it also features enhanced interoperation between the Job Management Partner 1/Integrated Management integrated console and cloud platform monitoring products from VMware, Inc. This provides centralized management of all aspects of data center operation from cloud platforms to the operational status of applications.

With features that include improving the operation of such cloud service environments as Amazon Web Services and Microsoft* Azure*, Job Management Partner 1 will continue to



6 Example screen from Job Management Partner 1/Service Portal for OpenStack, a service portal for making OpenStack operation more efficient (left), and use of Job Management Partner 1 for centralized management of an entire multi-cloud environment (right)

boost the operational efficiency of multi-cloud environments in the future.

* See "Trademarks" on page 146.

7 Hitachi Integrated Middleware Managed Service

Initiatives are being undertaken to deal with rapid changes in the business environment, such as variable demand, by enhancing use of the information that supports business activity to improve the speed and accuracy of decision-making. An important part of this is the collection of up-to-date data generated both inside and outside the enterprise, and its analysis from a variety of perspectives. However, because factors such as mergers and acquisitions (M&A) and the globalization of enterprises has given rise to a collection of disparate business systems to which improvements are made in isolation, the workload associated with initial system implementation and subsequent upgrades has been exacerbated by the need when working with this data to incorporate additional processing for its collection in different formats and conversion to a common format. Problems with out-of-date data also arise when the use of batch processing means that data is only collected periodically.

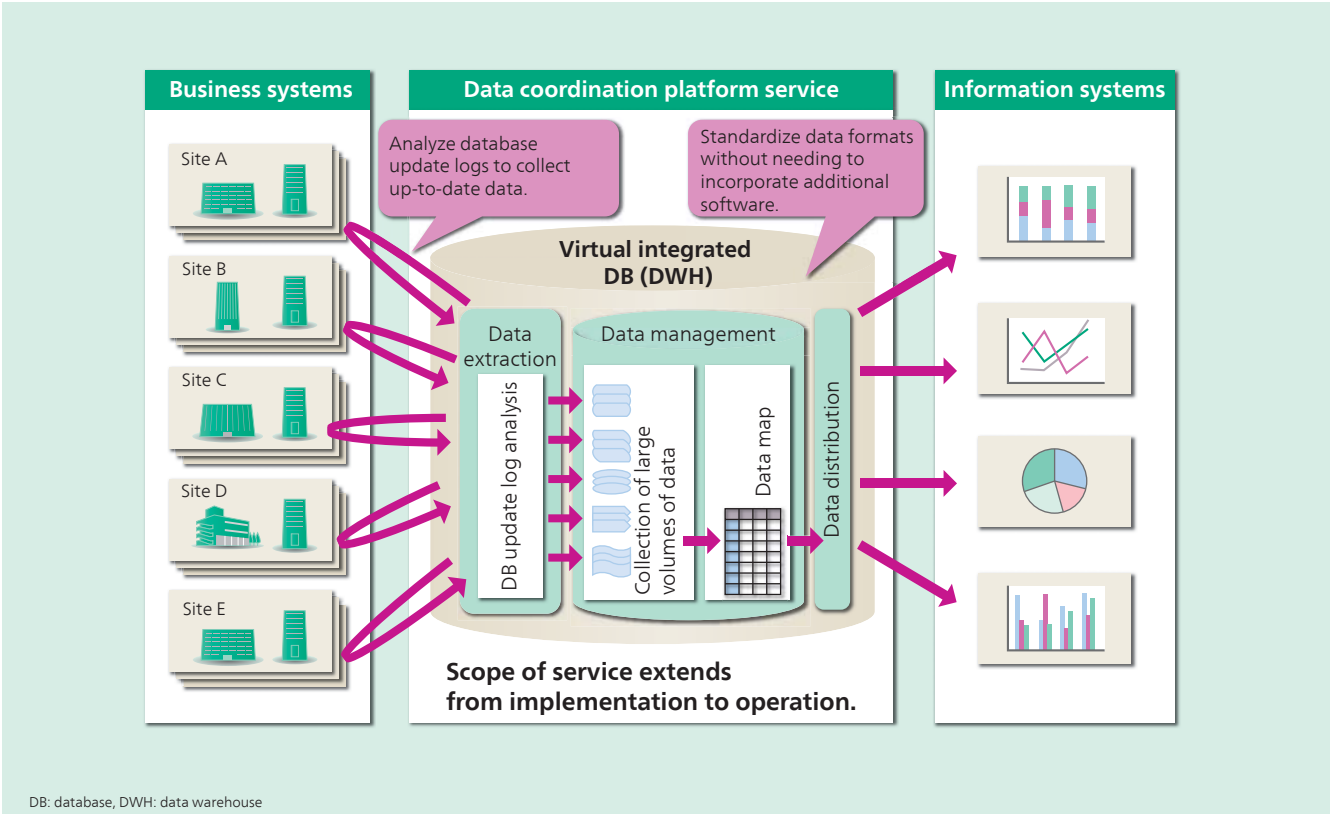
The data coordination platform service provided by Hitachi Integrated Middleware Managed Service uses a virtual integrated database to overcome these problems. Utilizing Hitachi's accumulated experience with middleware technology, this involves the analysis of database update logs to collect data as soon as it is generated, and the standardization of data formats without needing to create a program. This can consolidate up-to-date information from different systems in the same way as if an integrated database had been installed. It is provided in the form of a service operated by Hitachi that extends from system platform implementation to live operation, and is billed on a monthly usage fee system.

8 Use of Hitachi High-speed Data Access Platform at Retailer

Since the tallying up several hundreds of million items of sales data every time can take a long time when analyzing sales data in the distribution industry, the practice of creating a large number of pre-calculated data marts was developed as a means to overcome that problem. Unfortunately, because a new data mart design is required each time the basis of data analysis is changed, and because this takes several months, the problems with using data marts in data analysis include an inability to adapt to changes in the basis of analysis and data becoming out of date.

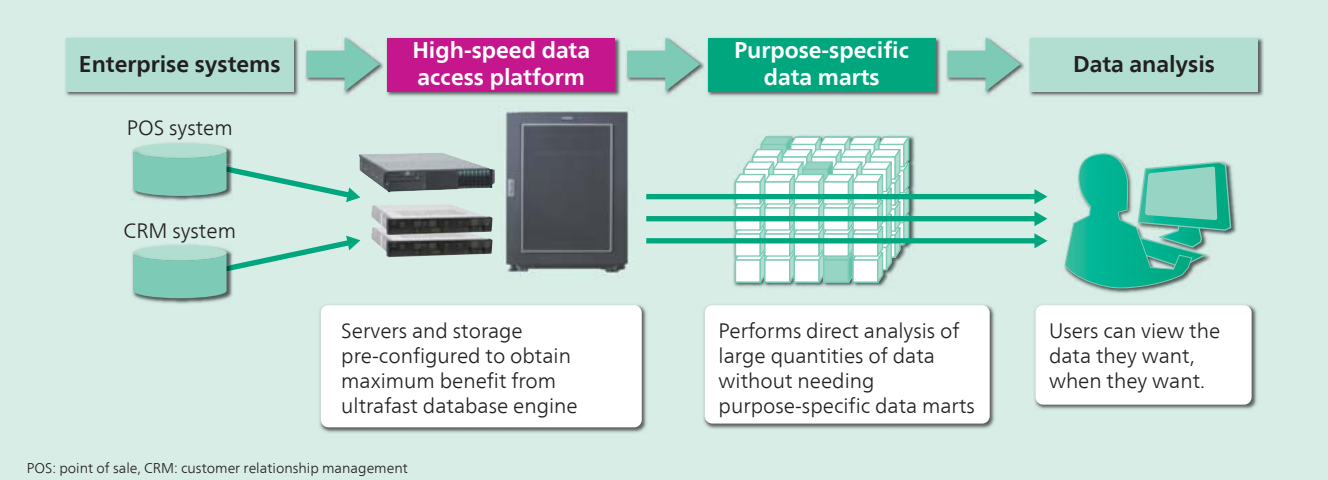
To overcome this problem, Hitachi developed an ultrafast database engine that incorporates an out-of-order execution mechanism*1 that can extract sales data and calculate basic statistics at high speed without using data marts. The Hitachi high-speed data access platform*2, which combines this engine with Hitachi hardware, was released to make it possible to provide timely analytics with high quality and a short system installation time. When installed at one retailer, the high-speed data access platform succeeded in reducing the time taken for sales data analysis from 40 minutes to 22 seconds, and the number of data marts from 165 to six.

Hitachi intends to continue helping customers expand their businesses by providing IT platforms that accelerate the pace of this new value creation.



DB: database, DWH: data warehouse

7 Use of information via Hitachi Integrated Middleware Managed Service, a data coordination platform service



8 Application of Hitachi high-speed data access platform

*1 A mechanism devised by Masaru Kitsuregawa, a Professor at The University of Tokyo and Director General of the National Institute of Informatics, and Project Associate Professor Kazuo Goda of The University of Tokyo.

*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).

9 Telecom Network Analytics Solution

Billions of data metrics related to network and service performance are collected hourly by service operators that could enable them to improve network efficiency, service delivery, and/or create new services. Regrettably, most of this data goes untapped due to inadequate tools to extrapolate the value in realtime or correlate it to past trends for proactive and predictive insight.

Realtime network big data analytics can play a powerful role in shaping and improving the delivery of telecom services, including 4G/LTE services from mobile operators, triple play services from broadband service providers, and a variety of X-as-a-service (XaaS) offerings from cloud hosting providers.

Hitachi is introducing a solution optimized for fine grain, realtime performance. The Live Insight for Telecom solution from Hitachi is a highly granular, scalable, adaptive and open analytics solution that empowers service providers to take control of their network's performance with realtime, microscopic level visibility to improve quality of experience (QoE) with enriched services, and elevate their business value with new analytics-as-a-service (AaaS) offers. Key elements include:

(1) A live analytic and data processing engine that can ingest up to a million events per second per core from network probes and devices.

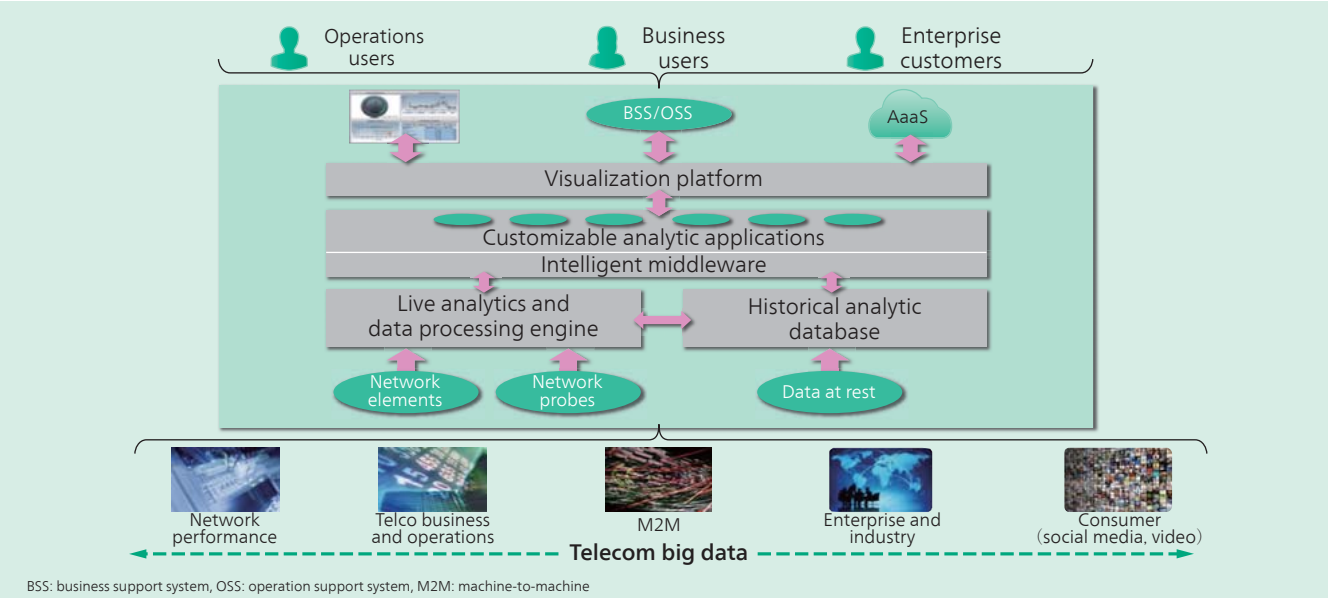
(2) A time series optimized historical analytic database built for rapid data access and correlation.

(3) Intelligent middleware to enable predictive insights and realtime optimization

(4) Customizable analytic applications supporting operations, business or enterprise use cases

(5) A rich visualization platform that transforms powerful big data algorithms into user friendly dashboards and reports

(Hitachi Data Systems Corporation)



9 Telecom network analytics solution architecture

Network Systems

1 Hitachi's Networking Business

The spread of new technologies such as the Internet and smartphones is bringing major lifestyle changes, making networks an essential part of people's lives. It is anticipated that this will improve quality of life and help create a safe and secure society by connecting people and a wide variety of different objects into networks and then taking the value derived from the collected data and redistributing it throughout society. In addition to the greater reliability and speed required to stabilize and accommodate this rapid expansion in networking, what is needed to achieve this is a "value reproduction ecosystem" platform for networks that can collect information and redistribute value.

Based on its core business concept of "IT × social infrastructure," Hitachi is helping create the network systems needed to cope with this social change.

In the information technology (IT) and telecommunication network sectors, Hitachi is supplying network solutions and other products that combine economic performance with the reliability and high speed of social infrastructure. Hitachi's traffic management solutions are examples of such products that can efficiently handle the rapid growth in mobile traffic without compromising speed.

For the social infrastructure sector, Hitachi utilizes technologies and know-how it has acquired in the telecommunication network sector to supply applications in the energy, transportation, logistics, public works, and other sectors with sensors that collect real-world data, platforms for the efficient transmission of sensor data, and network solutions and products for the data centers used to store and analyze the collected big data. Utilizing wireless technology developed for telecommunications carriers, Hitachi is also developing next-generation wireless systems for use in new air traffic control and other social infrastructure systems.

In the future, Hitachi intends to contribute to the transformation of society by developing leading-edge technology for the network solutions that support society, and by supplying solutions and other products.

2 Traffic Management Solutions

The objective of traffic management solutions (TMSs) is to build optimal and reliable systems through the visualization, analysis, and control of the various different networks used in social infrastructure.

The main features of a TMS solution are as follows.

(1) Realtime analysis

Enables the realtime analysis and control of traffic on a network. The realtime visualization and control of a network can provide an instantaneous view of how the network changes in response to control operations.

(2) Big data analysis

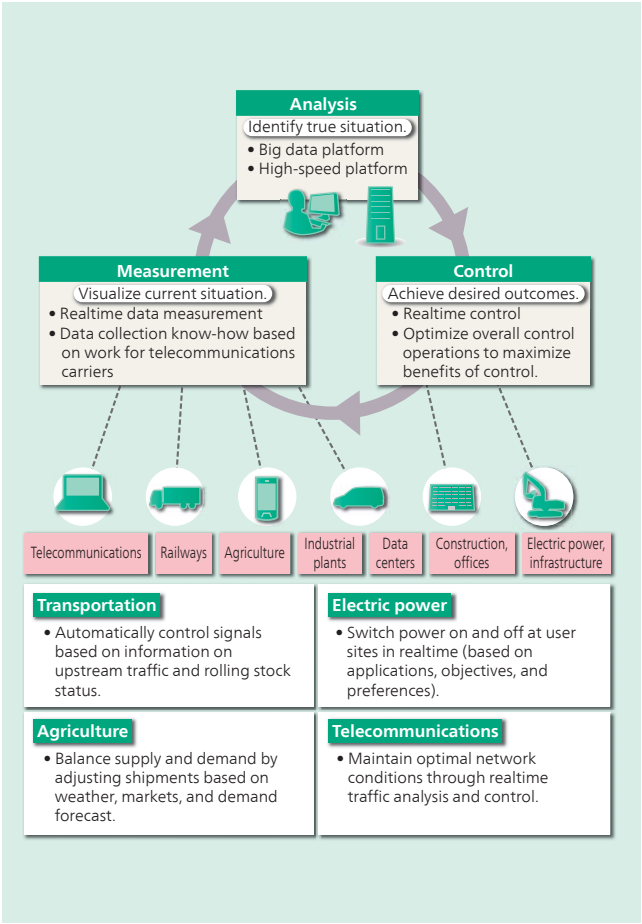
The collection and analysis of large amounts of data on the network can unlock the new value it contains.

(3) Investment optimization

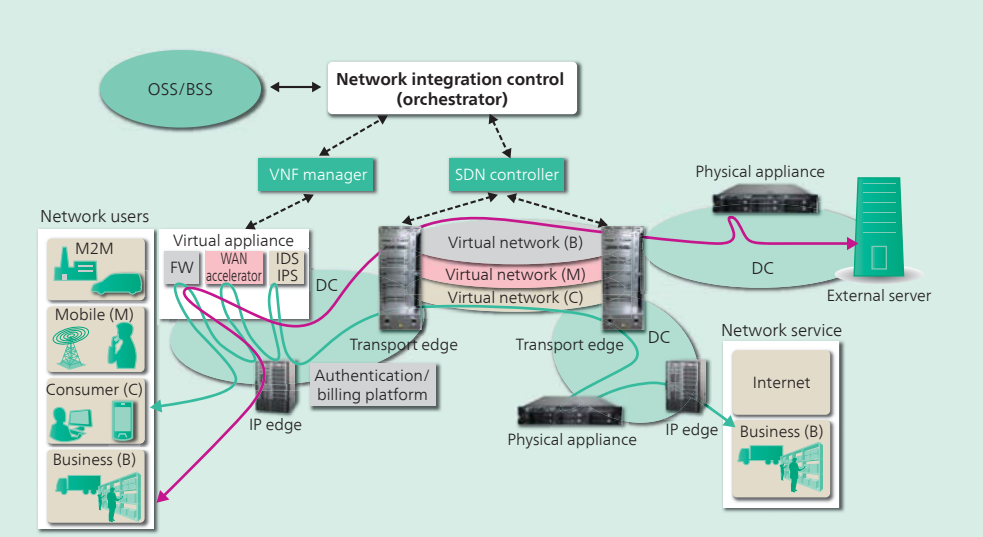
Supports the formulation of optimal investment plans by identifying system bottlenecks from the results of realtime analysis and big data analytics.

Potential uses for TMSs exist in transportation, agriculture, and electric power as well as telecommunications. In the case of telecommunications, Hitachi implemented a system for a telecommunications operator in 2013 that controls traffic based on the level of congestion in the network and is now in full commercial operation.

Hitachi plans to deploy the technology in other sectors in the future.



2 Traffic management solution concepts



OSS: operation support system, BSS: business support system, DC: data center, M2M: machine to machine, FW: firewall, IDS: intrusion detection system, IPS: intrusion prevention system

3 Telecommunication network incorporating NFV/SDN solution

3 NFV/SDN Solutions

Hitachi is developing products that support network functions virtualization (NFV) and software-defined network (SDN) for building next-generation networks that provide efficient operation through the integration of fixed, mobile, and leased-line networks, and fine-grained quality and service levels through the use of end-to-end management and control.

The main features of NFV/SDN solution are as follows.

(1) NFV

This promotes the provision of new services through the addition of virtual appliance functions such as firewalls, wide-area network (WAN) acceleration, and the prevention of unauthorized access by implementing service chaining based on Internet protocol (IP) edge mechanisms that integrate with a user authentication and billing platform.

(2) SDN

Uses an orchestrator for the efficient operation of an integrated network by collecting information on server usage from a virtual network function (VNF) manager and traffic levels from SDN controller, and by the management and control of a virtual network based on user requirements.

In the future, Hitachi intends to expand functionality to facilitate deployment in mission-critical social infrastructure networks in fields such as electric power, transportation, finance, and healthcare.

4 Firewall Administration Solution Based on Virtual Network Platform Software for Data Centers

The data center firewalls used for public clouds and private corporate clouds carry a heavy administrative workload with numerous settings updates, and where emergency actions in response to a fault might result in a mismatch between the settings on specific hardware and what is specified in the master management data.

To deal with this, Hitachi supplies a firewall administration solution that uses virtual network platform software for data centers. The solution is based on the use of a master record of management data that specifies the firewall rules (policies), and has the following features.

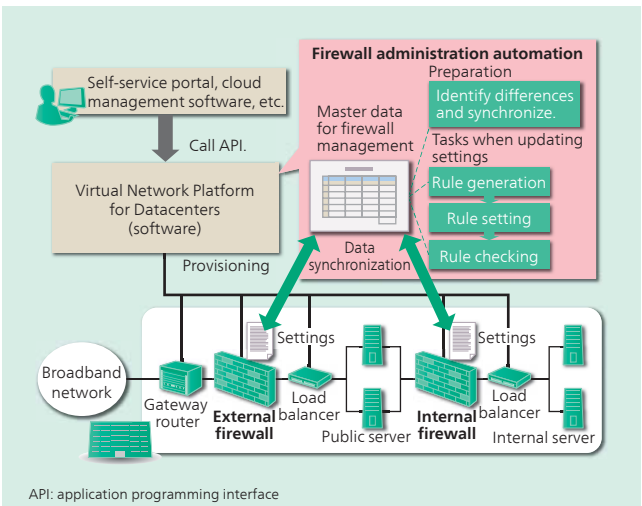
(1) Allows identification of hardware rule settings that do not match the master data.

(2) Allows changes in master data to be loaded and automatically applied to hardware.

(3) Automatic post-update confirmation that rule settings on hardware match the master data.

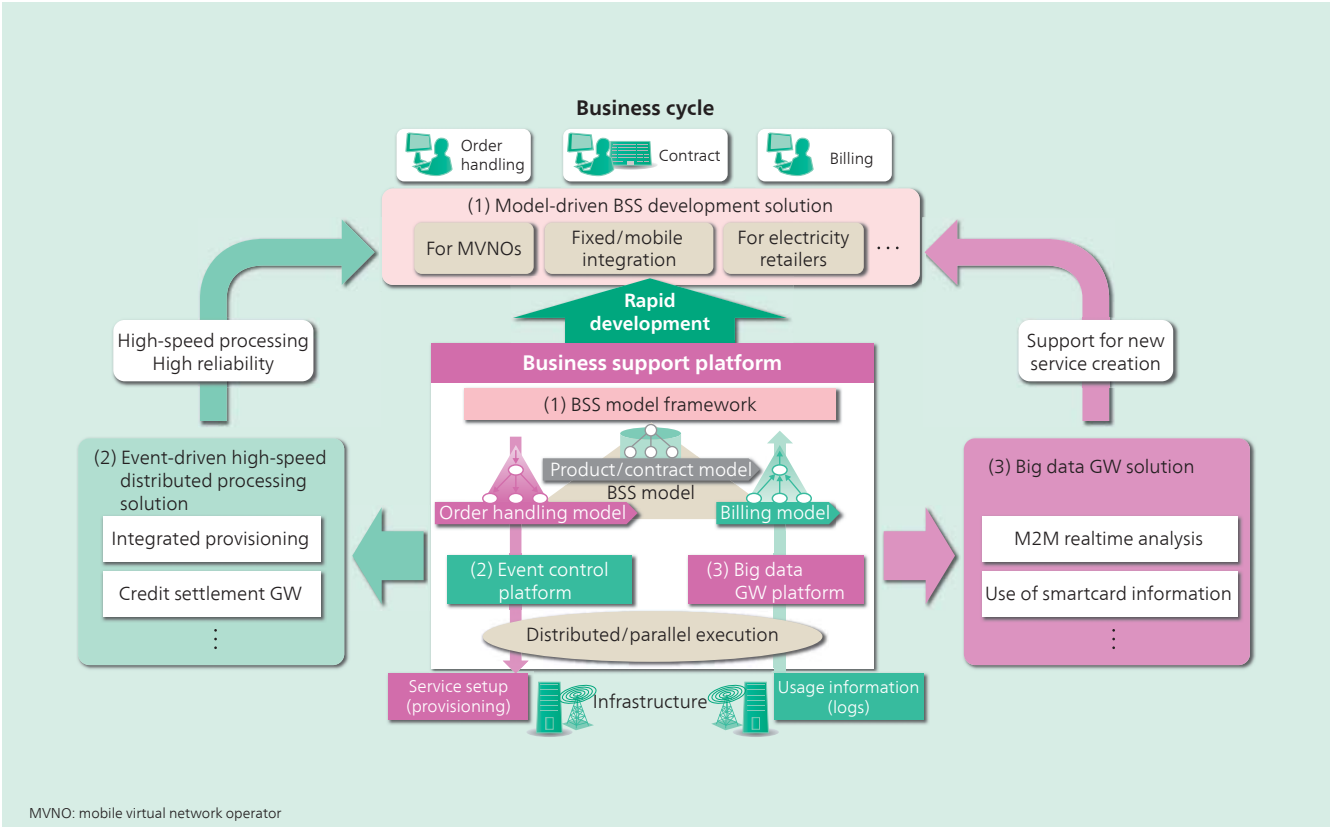
This reduces the amount of work associated with firewall setup and improves quality by automating not only the hardware setting process but also the associated tasks of making the settings more reliable.

In the future, Hitachi plans to undertake further work on operational automation to improve reliability through the automating of tasks up to and including operational checks on hardware.



API: application programming interface

4 Firewall administration solution based on virtual network platform software for data centers



MVNO: mobile virtual network operator

5 Solution based on a business support platform

5 Business Support Platforms

The ongoing ability to implement new services quickly so as to maintain and improve user satisfaction is an important competitive advantage in the telecommunications industry. To achieve this, Hitachi's business support platforms incorporate three platform technologies: a BSS model framework for the rapid development of BSSs that support the business cycle of having users apply to join the service, contract sign up, and billing; an event control platform that guarantees the reliability needed for core activities; and a big data gateway (GW) platform that facilitates new service creation. Hitachi is utilizing the features of these platform technologies to deploy three solutions that ensure the ongoing and timely provision of services that satisfy user needs.

The main features of a business support platform are as follows.

(1) Model-driven BSS rapid development solution

The use of a BSS model framework that stipulates design techniques that derive from the service strategy, together with modeling of the BSS's data structures and work flows, enables the rapid development of a BSS that conforms to the service provider's strategy.

(2) Event-driven high-speed distributed processing solution

This provides an event control platform that uses distributed execution and provides guaranteed handling of event-triggered transactions. It is used for high-speed processing of operations such as provisioning and credit settlement, which demand a high level of reliability.

(3) Big data GW solution

Analyzes information from M2M data and smartcards to expedite the creation of new services by using a big data GW platform with parallel execution for realtime conversion of large amounts of generated information into a valuable format.

In the future, Hitachi intends to expand deployment of these platforms beyond the telecommunications industry to other industries associated with social infrastructure that have a growing demand for business reliability and speed.

6 M2M Traffic Solutions

M2M traffic solutions consist of M2M devices designed for expandability and a cloud service for collecting, managing, and making available workplace data and performing centralized control of M2M devices and networks. Hitachi provides comprehensive services extending from consulting on installation to system design, network implementation, cloud service operation and maintenance, and integration with business applications.

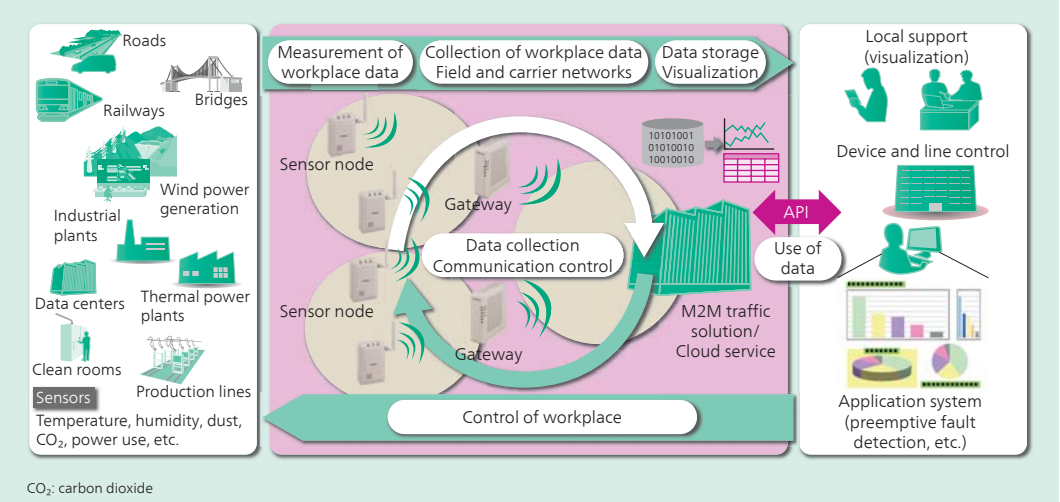
The main features of an M2M traffic solution are as follows.

(1) Efficient data collection that limits increases in telecommunications costs even for large M2M networks by consolidating measurement data in gateways for efficient transmission.

(2) In addition to providing a view of the workplace, a cloud service provides the functions required to optimize operations, such as network control and monitoring of the equipment used in the M2M system platform.

(3) APIs for interoperation with other systems are provided in the cloud. This enables interconnection with other customer systems, such as business systems or big data analytics tools.

In the future, Hitachi intends to expand its network platform



6 Overview of M2M traffic solution and products

products and services that help companies adopt M2M, and to work with overseas telecommunications carriers to deploy its M2M business globally.

7 Information and Telecommunication Core Package Solution

Along with the transition of social infrastructure to IT-based systems, expeditious implementation of system developments is required in the industrial arena.

The Information and Telecommunication Core Package Solution provides previously designed and validated technological assets as reference designs to simplify the development of products. The Information and Telecommunication Core Package Solution helps engineers concentrate their efforts on creating differentiated and compelling upper layer applications.

The main features of the Information and Telecommunication Core Package Solution are as follows.

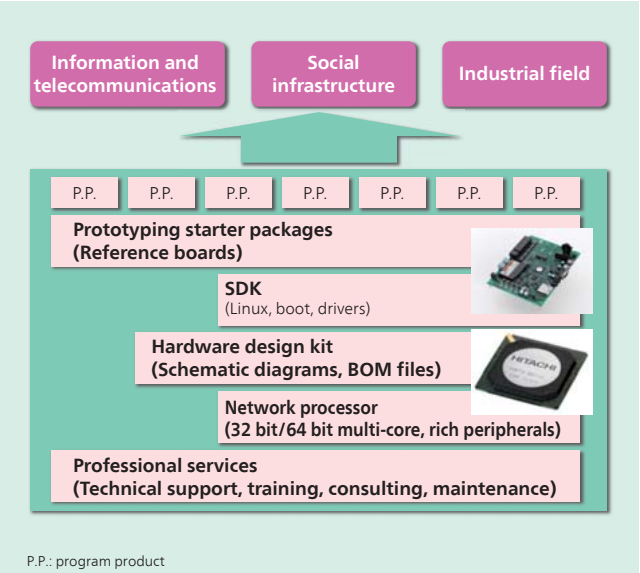
(1) Various types of program products and software development kits (SDKs) designed for developing telecommunications and other industrial equipment.

(2) A hardware design kit that consists of a network processor, reference design, schematic diagrams, and bills of materials (BOM) for various types of products to shorten the design period.

(3) Prototyping starter package that consists of an evaluation board, program product, and SDK to enable engineers to promptly start evaluating a prototype.

(4) Professional services that provide technical support, training, consulting, and maintenance support.

In the future, Hitachi intends to continuously enhance reference designs and to extend its applicable industrial fields to contribute to the speedy implementation of social infrastructure improvements.



7 Main elements of Information and Telecommunication Core Package Solution

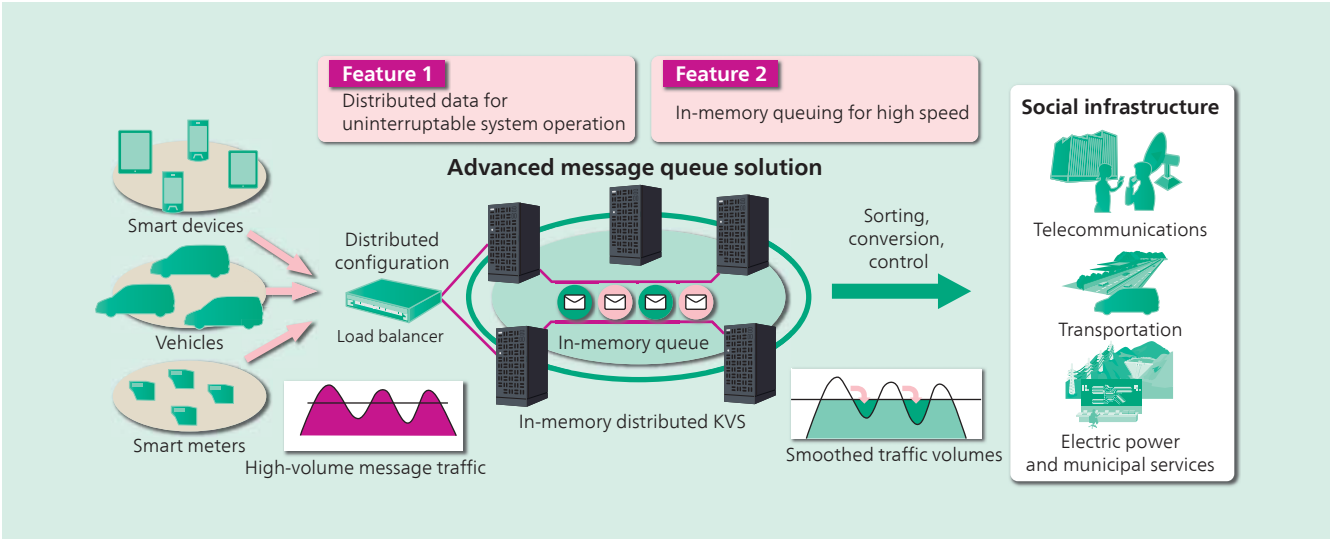
8 Advanced Message Queue Solutions

Along with the increase in communication data volumes that has accompanied the spread of smart devices in recent years, there is a growing demand for service continuity and faster speeds in the communication systems of social infrastructure companies. Since past communication systems used for message distribution have been based on message queuing, they suffered from performance bottlenecks when accessing external storage with a queue. Advanced Message Queue (AMQ) and its solutions provide the following features to overcome this problem.

(1) Uninterruptable system operation is achieved by using a key-value store (KVS) configuration in which duplicate message data is spread across multiple servers to eliminate the need for restoring data in the event of a fault.

(2) High-speed processing of large quantities of messages using in-memory queuing whereby the queue is held in an in-memory distributed KVS.

Having earned a strong reputation for the technology it has developed for telecommunication carriers, Hitachi now plans to supply this technology to mission-critical social infrastructure companies in fields such as telecommunications, transportation, electric power, and municipal services.



8 Advanced message queue solution

9 TCP Optimization Software

Today, everything is connected to a network. Efficient use of network infrastructure is a key to success. With Transmission Control Protocol (TCP) data transfer, performance is reduced significantly due to round-trip delay time and packet loss*. TCP optimization software reduces the data transmission time of large data that is updated frequently, which is difficult to optimize with typical caching technology. It is based on the high-speed communication technology of the Hitachi WAN Accelerator family of products and uses Hitachi's proprietary algorithm to optimize TCP data transfer performance and maximize the use of physical bandwidth. In addition, it is easy to install in existing environments. Deployment is only required at data centers. There is no need to install anything on user devices. It is beneficial to all users who use download services from the data center via Internet and mobile network environments as well as WAN.

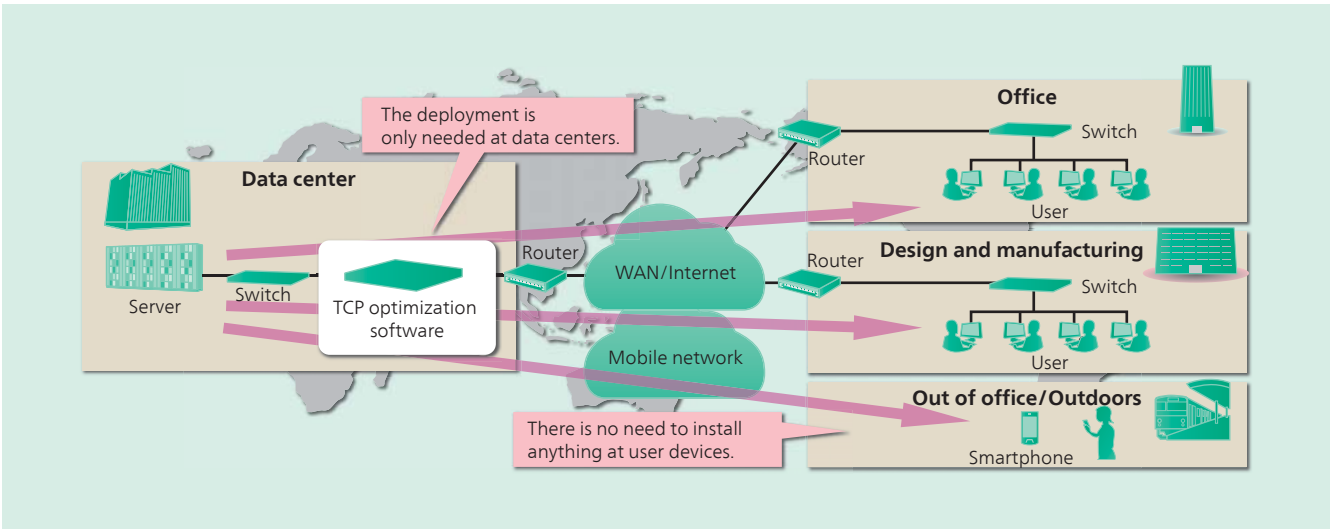
Hitachi will continue to provide wide range of solutions to improve global business efficiency and the productivity of companies.

* A packet is a small package of data used in communications between computers with control information such as the destination address. Packet loss occurs when data is lost within a network and fails to arrive at the destination.

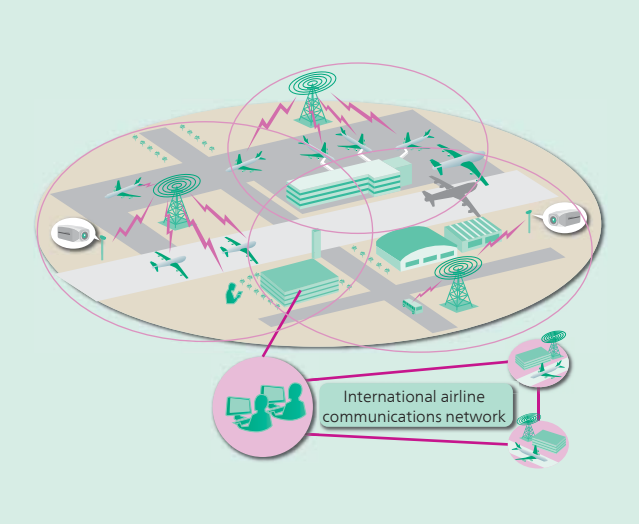
10 AeroMACS Technology for Next Generation Air Traffic Control Systems

Innovation in airport infrastructure is needed to cope with the rapid growth in demand for air travel that has accompanied the emergence of low-cost carriers (LCCs) since the turn of the century. The key to achieving this lies in air traffic control that can improve the safety and regularity of flight. The Aeronautical Mobile Airport Communication System (AeroMACS) is recognized for its potential as an airport surface data communication network technology for the next generation air traffic control systems that use mobile broadband to link the aircraft, support vehicles, and other equipment that operates on airport runways.

AeroMACS uses IEEE802.16e-compliant communications in accordance with a 2007 recommendation issued by the International Civil Aviation Organization (ICAO) of the United Nations. This provides communication speeds that are two or more orders



9 TCP optimization software



10 Airport runway using AeroMACS

of magnitude faster than the very-high-frequency (VHF) digital link (VDL) runway data communications used for air traffic control up to date. By enabling the provision and exchange of data such as weather or aircraft maintenance information and the development of highly efficient flight readiness services and visual monitoring data, it is possible to increase the frequency of takeoffs and landings while also improving safety and punctuality.

As well as being an active participant in the standardization of AeroMACS, Hitachi has embarked on prototype development in advance of the international standard being finalized and is involved in trials at public research institutes in North America and Japan. In the future, Hitachi intends to provide further support to encourage the adoption of this technology by countries and regions around the world.

11 Indoor Mobile Antenna Sharing Solutions

The growing use of smart devices has highlighted the difficulty of establishing mobile phone connections and the associated problem of slow communications in indoor spaces such as shopping centers or office buildings. In response, Hitachi has launched indoor mobile antenna sharing solutions that can provide a reliable mobile communications environment without disrupting the operation of outdoor wireless base stations.

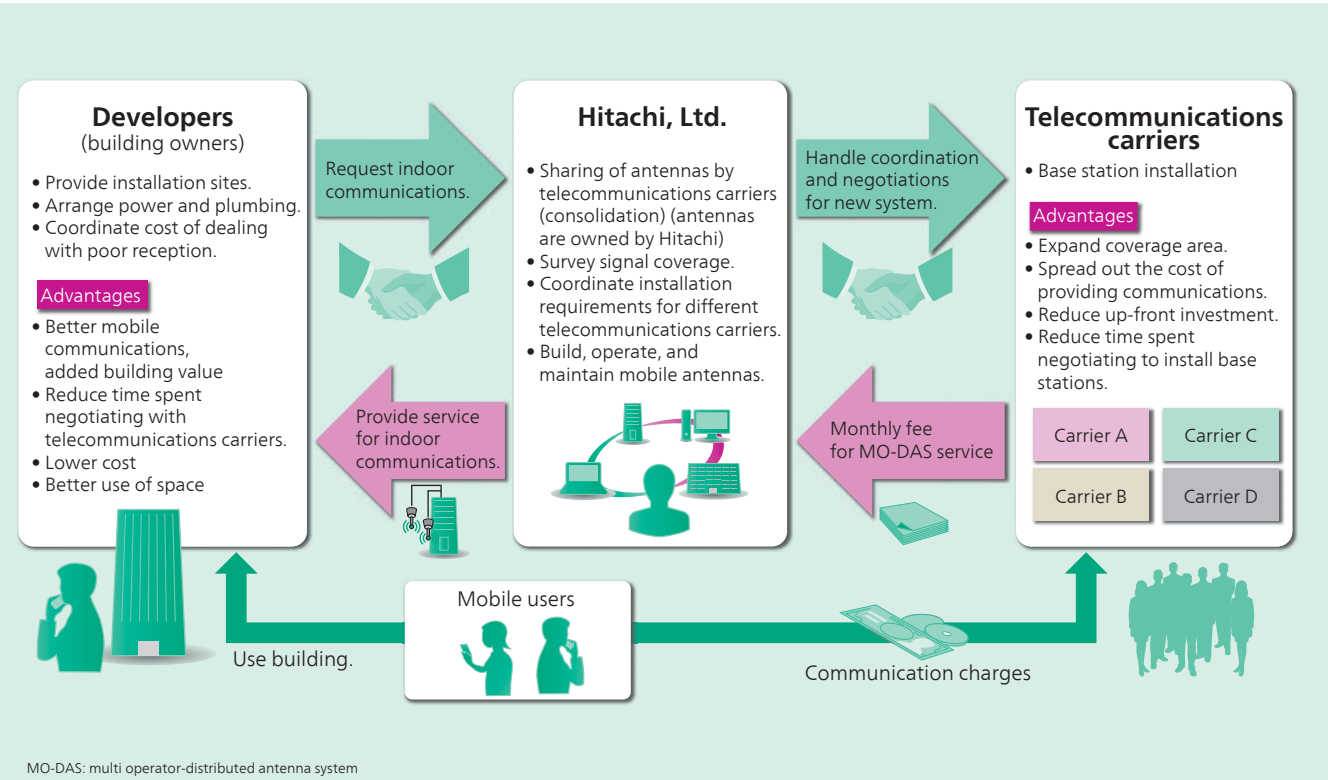
The main features of an indoor mobile antenna sharing solution are as follows.

(1) Installation of a distributed antenna system owned by Hitachi that allows antenna sharing by different telecommunications carriers.

(2) Adds value to buildings by facilitating the establishment of a high-quality mobile communications environment that supports bring your own device (BYOD) and other flexible working practices. The solution also saves space since Hitachi acts as a single point of contact for dealing with multiple telecommunications carriers.

(3) Provides the telecommunications carrier with an efficient way to establish an indoor communications environment. Hitachi handles all of the complicated arrangements needed to achieve this, including the negotiation for obtaining base station and antenna sites, installation work, and monitoring (including 24-hour/365-day fault response).

In addition to its use of techniques for communication quality optimization and installation work design, Hitachi also intends to strengthen its relationships with property developers to expedite improvements in indoor radio transmission environments.



11 Indoor mobile antenna sharing solution

Energy Solutions

1 Trends in the Energy Solutions Business

The business environment surrounding the world's electricity markets has been changing dramatically in recent years, with growing awareness of environmental problems, the development of alternative energy sources such as shale gas, increasing urbanization, and an expansion in demand for power generation capacity in emerging markets that is set against the aging of infrastructure in developed economies. This background has set the scene for debate on a shift from existing centralized power plants and large distribution networks operated by vertically integrated regional monopolies toward distributed generation, smart grids, and the entry of new operators made possible by progress on electricity system reform.

Including Japan's electricity market, these changes in the business environment affect on the energy value chain from upstream to downstream. Since the new value chain is characterized by many more stakeholders than in the past, it is expected to deliver the following new business opportunities.

(1) Businesses made possible by energy market liberalization

There has been ongoing debate over electricity system reform, including the separation of generation and transmission, that seek to reduce electric power charges by introducing competition. It is anticipated that energy market liberalization will increasingly see participants from outside the industry joined in the new electricity business including existing power companies. Hitachi plans to provide end-to-end supports from the procurement of power resource to the general works needed for power producer and supplier (PPS) operators.

(2) Renewable energy (RE) and other distributed energy resource (DER) businesses

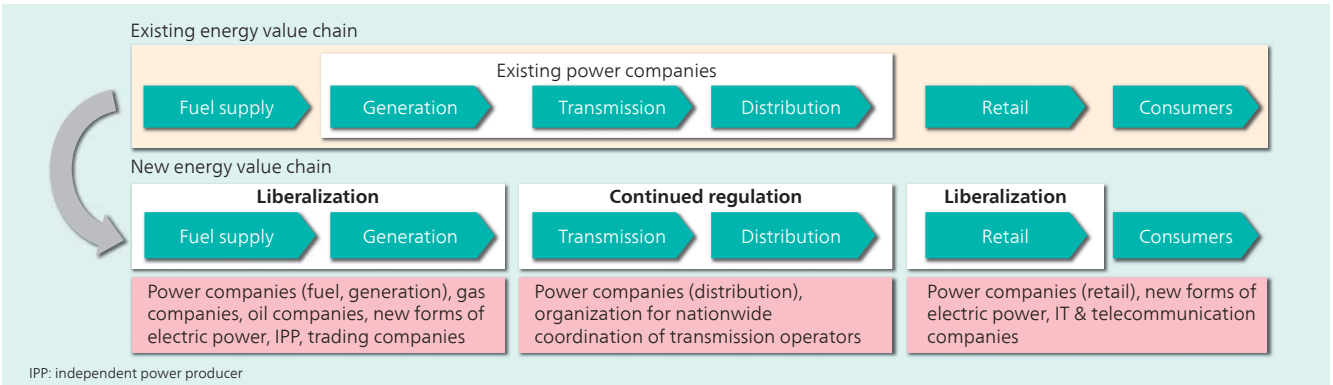
Energy security considerations are recognized as prompting growth in demand for locally-produced and locally-consumed business model in place of large centralized power plants. In addition, from the viewpoint of reducing the CO_2 emissions, photovoltaic, wind, and other forms of renewable energy will be also increasingly spreading.

(3) Businesses that combine information technology (IT) and operation and maintenance (O&M) with existing products

Along with its existing business of supplying equipment in accordance with customer specifications, Hitachi sees the potential solutions that include the use of big data for predictive diagnosis systems and maintenance, and the outsourcing of power plant operations.

The secret to the development of the solution business lies in a three-way strategy of differentiating from competitors by offering distinctive solutions, by categorizing expected market size, and by operating the business based on a global perspective. While the solutions that are too distinctive will compromise the market size by restricting them to a limited number of customers, it is difficult to differentiate from competitors when aiming for too wide of a market. In this respect, the keys to the success of the solution business are an ability to think in global terms from the outset, and the establishment of a business development organization that can work rapidly through the cycle of testing and discarding numerous potential business models.

In October 2014, Hitachi, Ltd. established its Energy Solutions Division as a "front engineering" (technical sales) organization, under the direct jurisdiction of the President, providing optimum solutions to energy and power system markets that are being reformed in Japan and throughout the world in a one-stop format that extends from power generation to power transmission and distribution and end-user systems. By consolidating engineering divisions from across Hitachi that are involved in the energy solutions, distribution, and renewable energy businesses, the new division will establish the infrastructure for the timely supply of one-stop solutions tailored to the needs of power companies and other stakeholders in the energy and power system markets.



1 Reforms to energy value chain in the Japanese electricity market

Power Generation Equipment and Systems

1 Overview of NYPA's Niagara Power Project (Lewiston is the power plant at the top) (left) and new pump-turbine runner under assembly (right)

1 New 42-MW Pump-turbine Runners Commence Operation at Lewiston Pump-Generating Plant of New York Power Authority

An upgrade to the first 42-MW pump-turbine was completed at the New York Power Authority's (NYPA) Lewiston Pump-Generating Plant, located downstream of Niagara Falls, and commenced commercial operation in September 2013. The plant features a maximum head of 36.6 m, which is very low for a pumped-storage hydro power plant. At the same time, the head range is about 18 m, which is large in proportion to the 36.6-m maximum head for these pump turbines.

The project to improve the characteristics of the existing pump-turbines, which were supplied by a different manufacturer and entered service in 1961, included runner replacement, changes to the shapes of the guide vanes and stay vanes, and refurbishment of the embedded components. These improved efficiency by about 2 to 5% in turbine mode, depending on the head, and increased turbine output by 8 to 20%, again depending on the head. Pump efficiency was also increased. The replacement runners have an outer diameter of 5.3 m. To ensure that the new runners would deliver a high level of hydrodynamic performance, Hitachi used stainless steel castings produced in Europe. The assembly; welding of the crown, band, and blades; and the machining and balancing were performed at Hitachi Works. Operational testing at the Lewiston plant confirmed the unit can operate reliably across the entire operating range, in accordance with the model test.

Refurbishment has also been completed on the second unit, which commenced commercial operation in May 2014, with on-site work on the third unit currently underway. The plant has 12 pump-turbines, with refurbishment of all units expected to be completed in 2020.

(Hitachi Mitsubishi Hydro Corporation)

2 20.6-MW Kaplan Turbines and Generators for Cheongpyeong Hydro Power Plant Units 1 and 2 of Korea Hydro & Nuclear Power Co., Ltd. Commence Operation after Major Overhaul

A major overhaul of Unit 1 and Unit 2 was undertaken at the Cheongpyeong Hydro Power Plant of Korea Hydro & Nuclear Power Co., Ltd., with Unit 1 recommencing commercial operation in May 2014 and Unit 2 in June of the same year.

The vertical-shaft Kaplan turbines and generators at the plant first entered service in 1943, with an upgrade to the turbine runners and the stator coils and cores of the generators being undertaken in 1993. The latest overhaul consisted mainly of repairs (machining) to the flow surfaces of the turbines and upgrades to the stainless steel guide vanes, as well as to the generator rotor, governor, exciter, unit control panels, and other electrical equipment.

The main features resulting from the upgrade are listed below.

(1) Improved turbine efficiency as a result of repairing the turbine flow surfaces and upgrading the stainless steel guide vanes

(2) Elimination of harm to the environment due to oil leaks as a result of adopting water bosses and water-lubricated bearings for the turbines

(3) Adoption of environmentally conscious digital governor that is compliant with the Restriction of Hazardous Substances (RoHS)

2 Cheongpyeong Hydro Power Plant Unit 1 (in the back) and Unit 2 (in the front) of Korea Hydro & Nuclear Power Co., Ltd. after completion of major overhaul

3 Unit 1 (top front) and Unit 2 (top back) of the Shuparo Power Plant of Hokkaido Bureau of Prefectural Enterprises, and Yubari Shuparo Dam and power plant (bottom)

(standard Hitachi Mitsubishi Hydro Corporation product)

(4) Better bearing reliability and lower losses as a result of using plastic bearings in generators

Hitachi Mitsubishi Hydro Corporation intends to continue supplying products for major overhauls of existing power plants, including features such as lower environmental risks and better maintenance and performance.

(Hitachi Mitsubishi Hydro Corporation)

3 New Hydro Generation Equipment for Shuparo Power Plant of the Hokkaido Bureau of Prefectural Enterprises

The installation of new hydro generation equipment at Unit 1 (24,800 kW) and Unit 2 (1,800 kW) of the Shuparo Power Plant of the Hokkaido Bureau of Prefectural Enterprises has been completed and commissioning has commenced with the aim of completing the project by March 2015.

This hydro power plant is located in Yubari, Hokkaido in Japan and is powered by water from the Yubari Shuparo Dam.

The main features of the hydro power plant are as follows.

(1) Highly efficient turbine runners designed using the latest techniques in computational fluid dynamics

(2) Air-cooled generator bearings that eliminate the need for cooling water supply

(3) Water-lubricated turbine bearings that do not require lubricating oil (Unit 1)

(4) Electrically operated guide vane, inlet valve and brake that eliminate the need for a hydraulic system

In the future, Hitachi Mitsubishi Hydro Corporation intends to contribute to new hydro power plant projects and scrap-and-build projects at existing plants by making better use of renewable energy, reducing environmental risks such as oil leaks, and providing easier maintenance.

(Hitachi Mitsubishi Hydro Corporation)

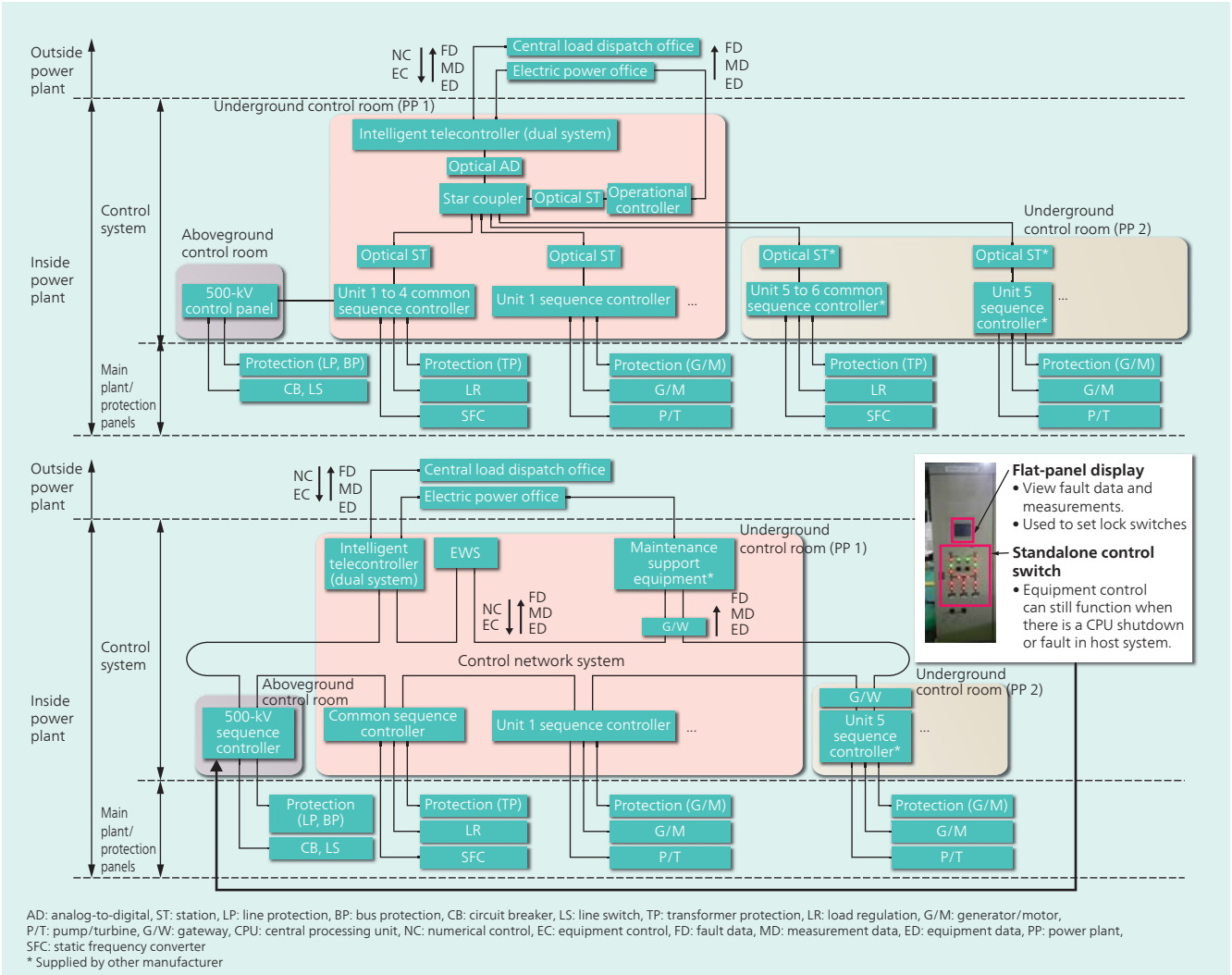
4 Replacement of Automatic Control System at Okumino Power Station of Chubu Electric Power Co., Inc.

The automatic control system at the Okumino Power Station of Chubu Electric Power Co., Inc. has been in use since the plant entered commercial operation in 1994. This project will replace the 500-kV sequence controller, common sequence controller, Unit 1 and Unit 2 sequence controller, engineering workstation (EWS), and intelligent telecontroller (ITC).

Installation of controllers occurred in early October 2014 following integration testing of the complete system at the factory. On-site commissioning started in November 2014, with Unit 2 scheduled to commence commercial operation in March 2015 followed by Unit 1 in May 2015. The common control functions of Units 3 through 6 will be made operational coincident with replacing them.

The main characteristics of the project are as follows.

(1) The plant's local area network (LAN), which is currently



AD: analog-to-digital, ST: station, LP: line protection, BP: bus protection, CB: circuit breaker, LS: line switch, TP: transformer protection, LR: load regulation, G/M: generator/motor, P/T: pump/turbine, G/W: gateway, CPU: central processing unit, NC: numerical control, EC: equipment control, FD: fault data, MD: measurement data, ED: equipment data, PP: power plant, SFC: static frequency converter
* Supplied by other manufacturer

4 System configuration of automatic control systems at Okumino Power Station of Chubu Electric Power Co., Inc. before (top) and after (bottom) replacement

based on existing star couplers, has been partly replaced with a 1,000-Mbit/s control network system to provide the data communication with high-reliable and fast-speed between controllers (there is a long distance between each control room).

(2) Monitoring and control of the 500-kV system have been changed from analog to digital, and an integrated monitoring and control system for transformation and generation has been created by designing on the same network with other sequence controllers.

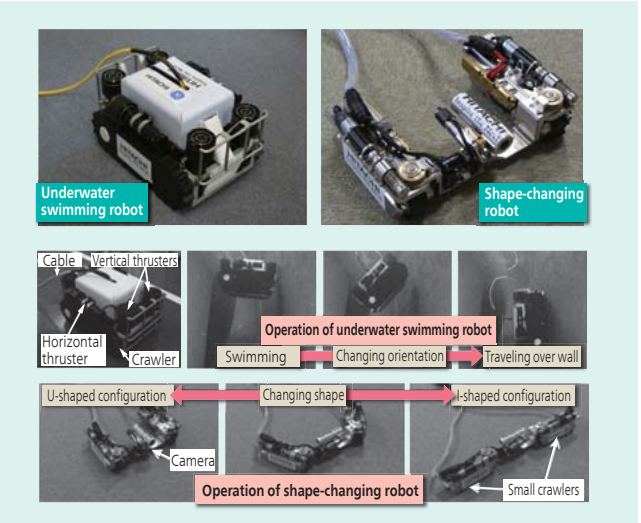
(3) The power system monitoring and control board have been changed from a mechanical board to an EWS with liquid crystal display (LCD), improved operation has been realized in terms of monitoring the power system, with an easy-to-use note-taking function for equipment shutdowns.

(Hitachi Mitsubishi Hydro Corporation)

5 Exploratory Robots for Use in the Removal of Fuel from Fukushima Daiichi Nuclear Power Station

Hitachi has developed two robots for use in the removal of fuel from Fukushima Daiichi Nuclear Power Station. The robots can conduct remote surveys over large areas, being able to change their shape and orientation to avoid obstacles, even in confined spaces.

The underwater swimming robot is used in the water-filled reactor building to perform underwater surveys for identifying the location of leaks of the pooled water. A feature of this robot is its ability to travel both over dry land and through water, being



5 Exploratory robots for use in the removal of fuel from Fukushima Daiichi Nuclear Power Station (top) and robot operation (bottom)

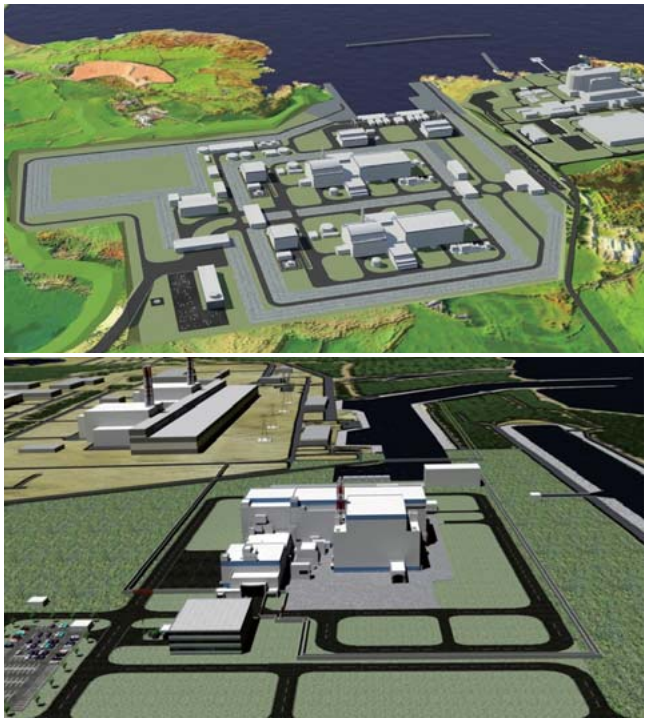
equipped with six thrusters (four vertical and two horizontal) and one set of crawlers. It entered use at the plant in July 2014.

The shape-changing robot, for use in highly radioactive environments, is able to enter the reactor containment vessel through a 100-mm diameter pipe and conduct extensive surveys. The robot consists of three articulated sections (the main body and two small crawlers) that form an I shape to pass through pipes and a U shape for travel over flat ground. This combines stable movement with the ability to enter through narrow access ways. It is scheduled to enter use at the plant in April 2015.
(Hitachi-GE Nuclear Energy, Ltd.)

6 Construction of New Nuclear Power Plants in Europe

In August 2014, Hitachi-GE Nuclear Energy, Ltd. commenced stage three of the Generic Design Assessment (GDA) conducted by the UK Office for Nuclear Regulation of the advanced boiling water reactors (ABWRs), which Horizon Nuclear Power Limited plans to build at Wylfa on the island of Anglesey and at Oldbury-on-Severn, South Gloucestershire. The GDA is progressing well and is scheduled to be completed by the end of 2017. The UK's first ABWR should commence generating electric power in the early 2020s.

With regard to the project to construct an ABWR at Visaginas in the Republic of Lithuania, meanwhile, following an agreement by all parties in the Lithuanian parliament to proceed with the project, Hitachi, Ltd. and the Lithuanian Ministry of Energy have agreed on a memorandum of understanding and are negotiating the establishment of an operating company. The Republic of Latvia and the Republic of Estonia also plan to participate in the project, which is scheduled to commence generation in the 2020s.
(Hitachi-GE Nuclear Energy, Ltd.)



6 Artist's impressions of completed Wylfa Nuclear Power Plant in the UK (top) and Visaginas Nuclear Power Plant in Lithuania (bottom)

7 5.0-MW Wind Power Converter

Hitachi first entered the Chinese market for wind power converters in 2008, having supplied 1.5-MW, 2.0-MW, 3.0-MW doubly fed (DF) models, and a 2.0-MW permanent magnet generator (PMG) model.*

In Japan, a 2.0-MW DF converter commenced field tests in January 2014. Hitachi has now developed a 5.0-MW PMG converter for use with large offshore wind turbines.

The main features of these converters are as follows.

(1) Water-cooled, direct-current (DC) 3.3-kV three-level inverter [capacity: 5,310 kVA (grid-side) and 5,460 kVA (generator-side), rated voltage: 1,800 V (grid-side) and 1,980 V (generator-side), and rated generator frequency: 132 Hz]

(2) Designed for use in offshore environments of vibration or salt-induced corrosion to allow offshore installation

(3) Fault ride-through capability for maintaining operation during grid voltage drops (0% of rated voltage, 0.15 s) and frequency fluctuations (rated frequency ±10%) (compliant with JEAC 9701-2012 grid connection standard)

(4) 3,200 mm wide × 1,800 mm deep × 2,300 mm high (excluding filter and protruding parts), weight: 5,700 kg

(5) Uses vector control with no position sensor. This simplifies maintenance by eliminating the need for an encoder on the generator.

Utilizing the experience it has gained with offshore wind power generation in Japan, Hitachi aims to expand its overseas market share.

* The 1.5-MW DF model was released on the Chinese market in October 2010, the 2.0-MW DF model in July 2013, the 3.0-MW DF model in October 2013, and the 2-MW PMG model in December 2012.

7 5.0-MW wind power converter

8 1-MW container-type energy storage system for ancillary services (left) and 500-kW power conditioner (right)

8 Energy Storage System for Ancillary Services

Countries around the world are installing photovoltaic power generation and other forms of renewable energy in response to considerations such as environmental protection and security of energy supply. However, the weather-dependence of power output has led to concerns about the detrimental effects that these power plants have on grid stability and power quality.

In the USA, an ancillary services market has been established that reimburses operators for the charging and discharging of energy storage systems to help maintain frequency stability. With the aim of entering this market, Hitachi has developed a 1-MW container-type energy storage system.

The main features of this energy storage system are as follows.
(1) 1 MW/450 kWh of high-output, high-density lithium-ion batteries are packaged in a 40-foot container (12.2 m approx.).
(2) A chopper-less, three-level power conditioner ensures efficient charging and discharging of lithium-ion batteries.
(3) A battery management system provides integrated data collection and control of the status of the large number of lithium battery modules.

Based on technology it has developed, Hitachi is going to use energy storage systems to support the installation of renewable energy in Japan and elsewhere.

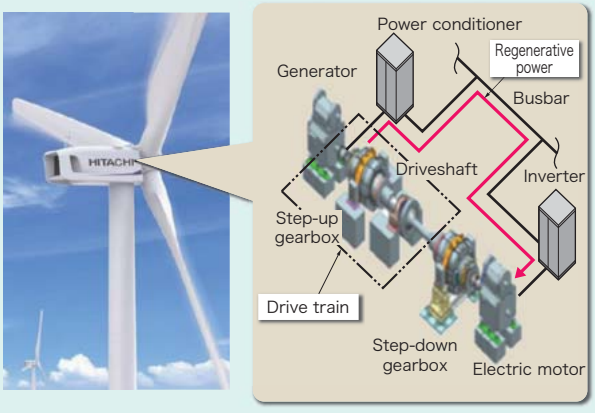
9 Large 5-MW Offshore Wind Turbine

Along with the accelerating pace of renewable energy development over recent years, it is hoped that offshore wind power generation in particular can form an important part of Japan's domestic energy supply. Against this background, Hitachi is working on the development of a large wind power generation system with a rated output of 5 MW.

Like the 2-MW wind turbine that is the current mainstay of Hitachi's product range, the 5-MW model has a downwind configuration with the rotor positioned on the downwind side of the tower. This provides a form of inherent safety that reduces the wind load by allowing "free yaw," meaning that the wind force causes the nacelle to reflexively orient itself during strong and gusty winds. Hitachi has also made the system lighter and more compact, and improved its reliability, through the combination of a newly developed permanent magnet synchronous generator and a medium-speed gearbox.

Prior to commencing commercial production, Hitachi is building a demonstration model of the large 5-MW wind turbine for testing the turbine's performance. Full load testing, in which the drive train was loaded up to test its performance and behavior, has already been completed, and nacelle assembly has commenced in readiness for product shipments.

A demonstration model will be constructed at a waterfront location in Kamisu City in Ibaraki Prefecture, and will commence trial operation during the 2014 fiscal year.



9 Full load testing of drive train for 5-MW wind turbine (top) and system configuration (bottom)

Electric Power Transmission Equipment and Systems

1 Meihoku Load Dispatch Control Center of Chubu Electric Power Co., Inc.

The supervisory control and data acquisition (SCADA) system supplied to the Meihoku Load Dispatch Control Center at the Nagoya Branch of Chubu Electric Power Co., Inc. performs monitoring and control of approximately 80 substations. The project involves the complete replacement of the second-generation load dispatch system installed in 1998 with the third-generation common application software for load dispatch control centers that Chubu Electric Power has been installing since 2002, and means that all 11 branch load dispatch systems at Chubu Electric Power now use the common software.

Development of the common software was split across a number of different vendors and provides the company with standard application software, which in the past was different at each load dispatch control center depending on the supplier. This has achieved uniform load dispatch system operation and reduced development times.

(Commencement of operation: February 2014)

2 Transmission Line Protection Relay

It has been four years since the first of the new series of digital relays entered service, during which time Hitachi has been working on the development and supply of standard transmission line protection relays for low-voltage power systems (with resistive grounding).

Now, Hitachi has developed and supplied Tokyo Electric Power Co., Inc. with transmission line protection relays (using a 54-kbit/s communication system) for main-line power systems (with direct grounding).

The main features of these relays are as follows.

(1) Faster current differential relay operation and integration with circuit breaker operation to achieve disconnection in three cycles.

(2) Computation method for reverse phase over-voltage and zero phase over-voltage relays that is in principle unaffected by third and fifth harmonics.

(3) Uses Hitachi's transmission line protection relay to reduce the number of central processing unit (CPU) boards to one-third as many as the previous system.

1 Meihoku Load Dispatch Control Center of Chubu Electric Power Co., Inc.

2 275-kV current differential protective relay panel

(4) Stainless steel housing frame that helps reduce carbon dioxide (CO_2) emissions by eliminating the need for painting.
(Commencement of deliveries: August 2014)

3 SCADA System for JR Kyushu

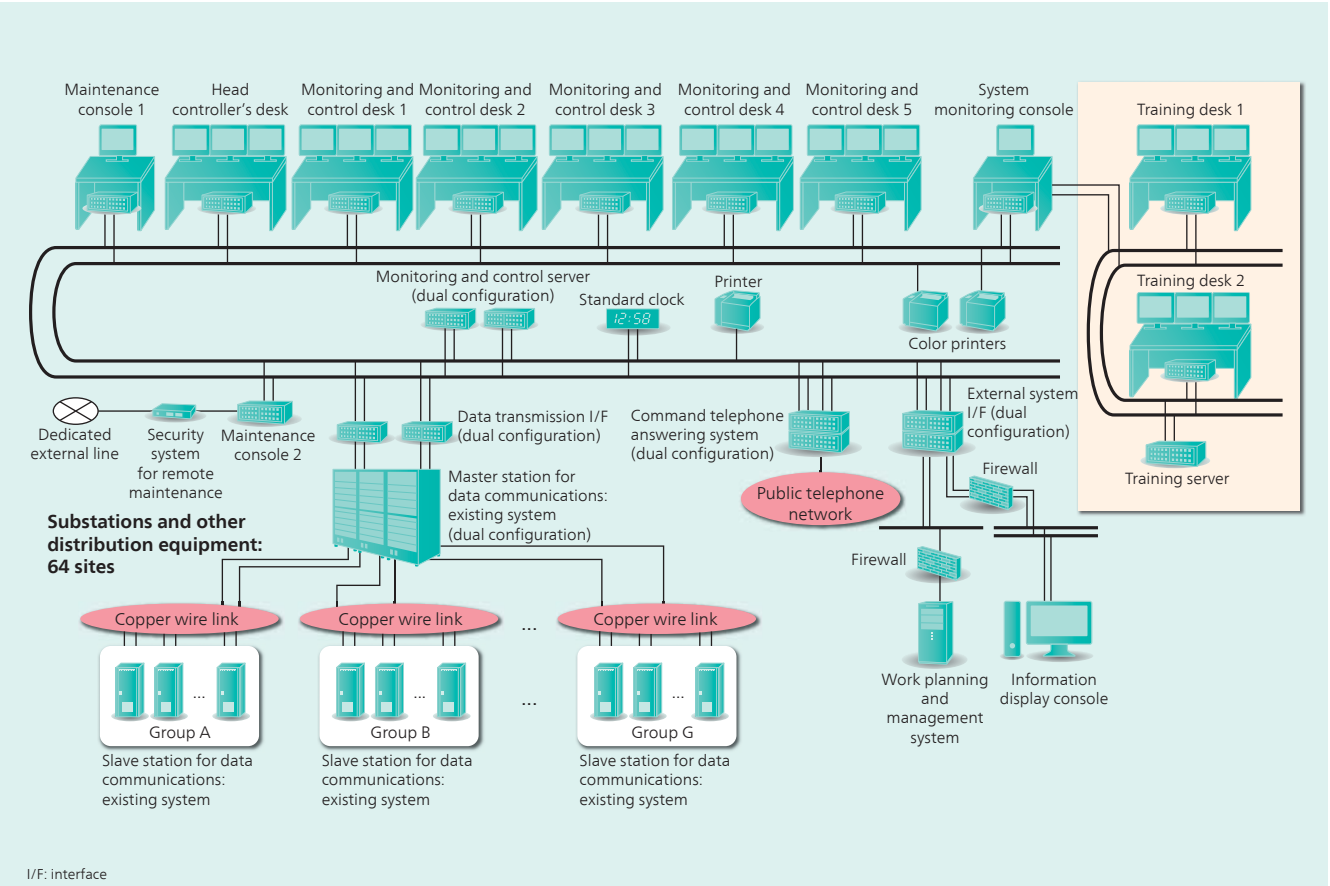
Hitachi has received an order for an electrical SCADA system for the main control center of Kyushu Railway Company (JR Kyushu) that will replace a system supplied by a different vendor, and is working on building the new system. Final commissioning tests are currently in progress prior to the commencement of operation, which is scheduled for March 2015.

The system is used for the monitoring and control of substations and other distribution equipment across 64 sites. It maintains the same operational format as the existing system, while also incorporating Hitachi's know-how in power management systems for railways. To ensure reliability, the system is based on a redundant configuration for both the network and servers, including the monitoring and control servers.

The main features of this system are as follows.

(1) With the requirement for a system configuration that permits the connection of existing remote control devices to ensure the reliability of SCADA data for existing equipment, Hitachi developed a data transmission and interface function for the remote control devices that was commissioned without major problems through a repeated process of thorough on-site testing and factory testing of connections to these devices.

(2) Control staff work efficiency was improved by equipping them with wide monitoring and control desks with three monitors that enabled such operational enhancements as a newly added ability to display images across multiple monitors and a wider display scope for the grid monitoring screens.



3 Block diagram of JR Kyushu SCADA system

(3) A dedicated training system was supplied to provide a training environment for control staff. The training system provides a training environment that is as close as possible to the actual operation of field equipment, including the addition of a simulation function that interoperates with field systems and a fault registration function.

4 Completion of Compliance Testing for New JEC Standard and Initial Product Deployment of 550-kV GCB for Japanese Market with Oil-immersed Hydraulic Operating Mechanism

Gas circuit breakers (GCBs) are protection devices for power systems that can perform rapid switching of high power at high voltage. Amid growing demand arising from the replacement of aging equipment in Japan in recent years, Hitachi has released a 550-kV GCB that complies with the latest standard and has undergone type approval testing.

The main features of the GCB are as follows.

(1) Uses an oil-immersed hydraulic operating mechanism to improve equipment reliability and maintenance. In a move toward maintenance-free operation, the oil-immersed hydraulic operating mechanism has been made more compact and its component count reduced by housing the mechanism inside the case that holds the hydraulic fluid.

(2) To satisfy market requirements, the GCB has been confirmed to be compliant with the relevant JEC-2300 standard for alternating current (AC) circuit breakers, which was revised in 2010, including changes to the interrupt duty such as faults on long-distance lines.

(3) Data for assessing the life of components with respect to factors such as the weakest point for insulation and the frequency of operation has been collected to improve reliability and maintenance. In the future, Hitachi intends to continue supplying reliable equipment with high added value for such applications as gas-insulated switchgear (GIS) and meeting the increasing demand for the replacement of aging equipment.

(Commencement of deliveries: April 2014)

4 Installed 550-kV GCB

5 72/84-kV C-GIS with Magnetically Operated VCB

Hitachi has developed a cubicle-type of gas-insulated switchgear (C-GIS) with a magnetically operated vacuum circuit breaker (VCB).

The C-GIS has a rated voltage of 72/84 kV, rated current of 1,200 A, rated interrupting current of 25 kA, and rated sulfur hexafluoride (SF_6) gas pressure of 0.07 MPa. It has passed type testing, which includes a short-circuit test, a dielectric test, a temperature rise test, short-time withstand current and peak withstand current test, and a mechanical operation test.

The main features of the C-GIS are as follows.

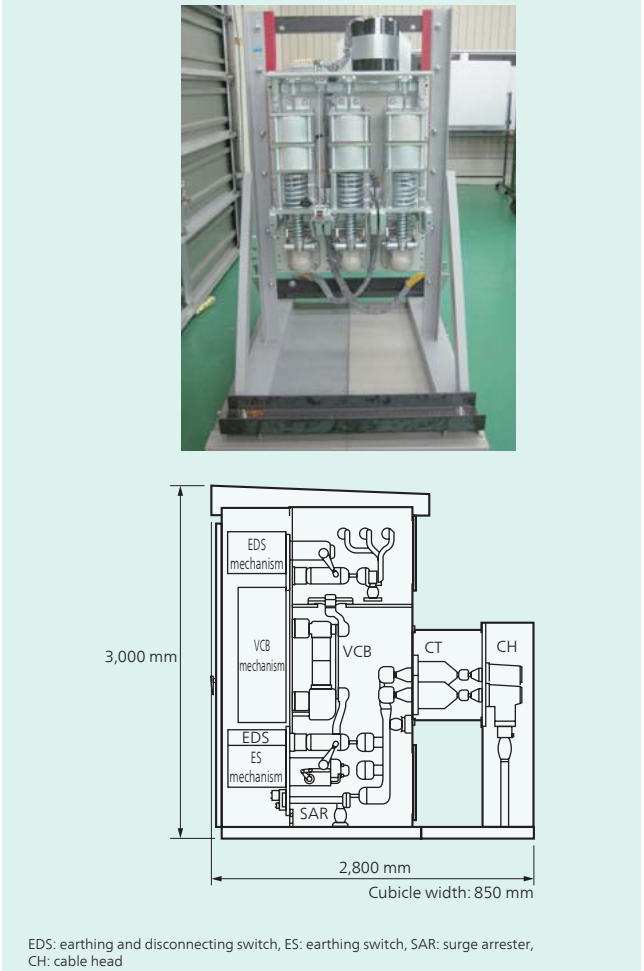
(1) Allows designs with fewer components and maintenance requirements than previous motor-operated spring-charged mechanism VCBs.

(2) Reduces on-site maintenance of network connection point current transformer (CT) by fitting multiple CTs in the gas tank that work with the standard model.

(3) Reduces cost as a result of sharing components (including the gas tank) between the network connection unit and transformer primary unit.

(4) Achieves short delivery times by consolidating unit manufacturing.

In the future, Hitachi plans to expand sales of electrical distri-



EDS: earthing and disconnecting switch, ES: earthing switch, SAR: surge arrester, CH: cable head

5 Magnetically operated VCB (top) and internal design of C-GIS (network connection unit) (bottom)

bution equipment for different uses, including factories, office buildings, transportation, and the public sector.

6 Train-mounted VCB Capable of Withstanding Low Temperatures and High Altitudes

Hitachi has been supplying high-voltage VCBs for commuter and Shinkansen railways since the 1970s. Hitachi has also developed models for use in high-speed railways in China, having supplied several thousand units since 2005.

Although most high-speed railways in China to date have operated between the coastal cities, the extension of this network to inland regions is planned. Accordingly, Hitachi has now developed a VCB for the line that has the most stringent environmental requirements and runs between Lanzhou and Xinjiang. The major differences are those required to cope with the temperatures, air pressures, and other environmental factors encountered at altitudes of 3,000 m or more.

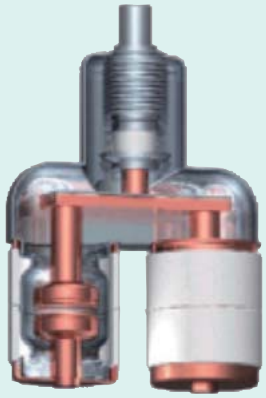
Measures adopted to ensure reliable operation in a harsh environment included materials that can withstand low temperatures and an insulation design that takes account of the high altitude. To maintain the 300,000-cycle operating life that is one of the features of existing models, Hitachi is also conducting field testing of VCBs in operational trains, as well as performing a variety of in-house testing that includes environmental testing and continuous operation testing.

While seeking to win orders for use of its newly developed low-temperature/high-altitude VCBs on the Lanzhou-Xinjiang Railway line, Hitachi also plans to market them for use on other railway lines in inland China.

No.	Parameter	Standard model	New low-temperature/ high-altitude model
1	Rated voltage	30 kV	←
2	Rated current	200 A	←
3	Operating life	300,000 cycles	←
4	Storage temperature	–25 to +40°C (same temperatures as in operation)	–40 to +40°C (–25 to +45°C in operation)
5	Altitude	< 1,500 m	< 3,610 m (testing conducted at 4,000 m) (4,000 m requires 1.38 times the pressure tolerance of 1,500 m)

6 Train-mounted VCB capable of withstanding low temperatures and high altitudes

Single-function vacuum valve



World-first* multi-function C-VIS vacuum valve

* Based on research by Hitachi, Ltd.

7 Use of vacuum valves in high-voltage applications

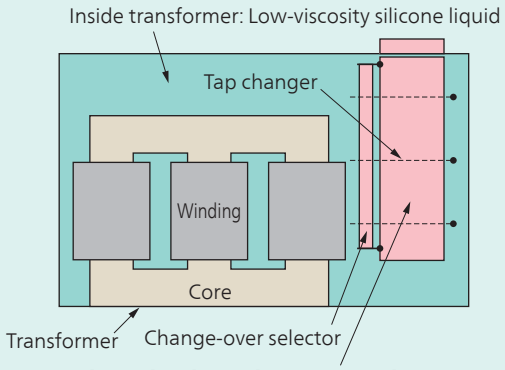
7 Use of Vacuum Valves in High-voltage Applications

Hitachi has been producing vacuum valves for 46 years since commencing production in 1968. Vacuum valves are widely used as a core component in the VCBs that play a critical role in electric power distribution systems in the electric power and electrical machinery sectors. Now, Hitachi has constructed a new factory that commenced operation in August 2014 with the aim of utilizing VCBs with low environmental load and easy maintenance, not only in medium-voltage (1 to 52 kV) but also in high-voltage applications (72/84 kV or higher).

Hitachi has sought to add value to its vacuum valves in a variety of ways in the past, including incorporating multiple functions and extending their operating life, while also supplying models that can be used with confidence in harsh environments such as in the power system equipment installed in trains, ships, or tropical regions. Hitachi also intends to continue working on research and development so that it can provide a greater number of customers with excellent products that incorporate its vacuum valves.

8 Low-viscosity Silicone Liquid-immersed Transformer with On-load Tap Changer

Targeting green innovation, Hitachi has developed a low-viscosity silicone liquid-immersed transformer (66 kV, 25 MVA, with



25-MVA, 64.5-kV low-viscosity silicone liquid-immersed transformer with on-load tap changer

8 Internal structure and exterior of low-viscosity silicone liquid-immersed transformer with on-load tap changer

on-load tap changer) that is designed for fire safety, low environmental load, and energy efficiency, and which is intended for use in the on-site electrical conversion system at the National Institute of Advanced Industrial Science and Technology.

The main features of the low-viscosity silicone liquid that serves as the main insulator in the transformer are as follows.

(1) Has a high flash point (250°C) to allow use as a "designated combustible material."

(2) Complies with Japanese Industrial Standards (JIS), with a high degree of oxidation stability for long life.

(3) Has low environmental load (hydrolyzable), is recyclable, and is not a greenhouse gas.

(4) Allows for smaller transformer design (with an installation footprint approximately 80% of a gas-insulated transformer).

The insulator in the insulation cylinders of the on-load tap changers (important ancillary components) is suited to the sliding operation performed when changing taps. The maintenance and running costs have also been reduced by eliminating the liquid filter unit, instead using a vacuum valve design with a synthetic ester that has a high flash point (300°C) and low environmental load (biodegradable).

In the future, Hitachi intends to continue developing highly reliable power transformers that satisfy customer needs.

9 154-kV-class Earthquake-resistant Transformer for Tohoku Electric Power Co., Inc.

Prompted by the considerable damage to social infrastructure caused by the Great East Japan Earthquake, there has been growing demand for improvements to the seismic performance of power system transformers in the 154-kV and higher classes. Given these needs, Hitachi has developed a 154-kV/150-MVA earthquake-resistant transformer for Tohoku Electric Power Co., Inc.

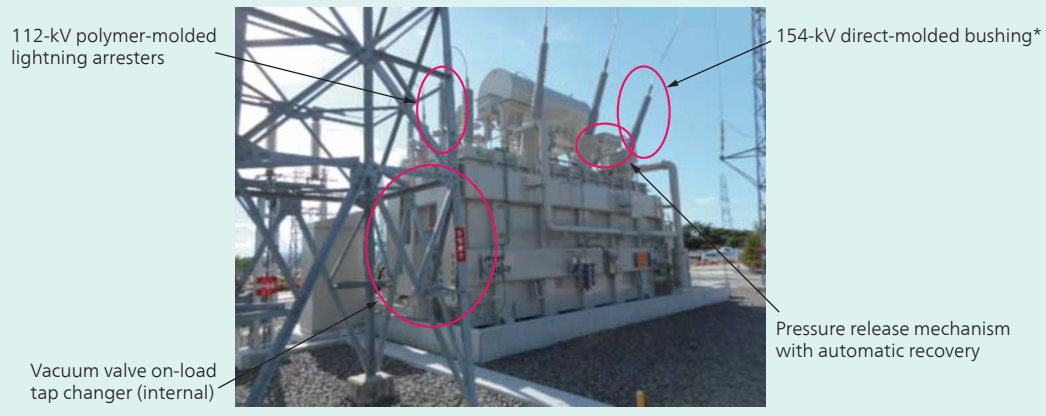
The main features of the transformer are as follows.

(1) Uses small and lightweight direct-molded bushings made of a new material and polymer-molded lightning arresters to prevent resonance with the dominant frequency of earthquakes by increasing the natural frequency of individual components. Earthquake resistance has also been improved by lowering the center of gravity of the transformer.

(2) Improvements to the internal integrity of the transformer by use of a pressure release mechanism with automatic recovery to release the pressure resulting from any oscillation of the insulating oil inside the transformer during an earthquake and immediately self-recover.

(3) As another new technology for improving seismic performance, it uses vacuum valve on-load tap changers, which improve maintenance by eliminating the need for a live line oil cleaner.

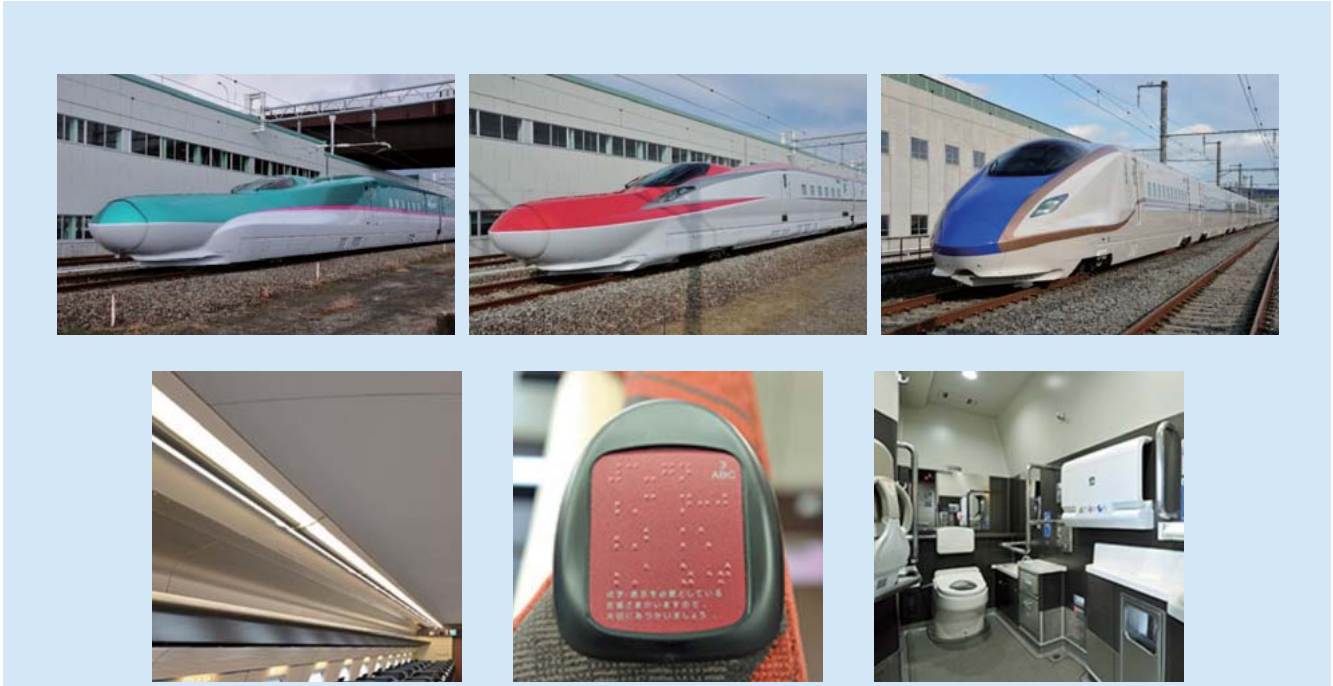
In the future, Hitachi intends to continue developing highly reliable power transformers that satisfy a variety of needs.



* Jointly developed by Hitachi, Ltd. and SWCC Showa Cable Systems Co., Ltd.

9 154-kV-class earthquake-resistant transformer for Tohoku Electric Power Co., Inc.

Transportation Systems



1 Latest Shinkansen rolling stock and interior fittings

1 East Japan Railway Company and West Japan Railway Company Rolling Stock for Hokuriku Shinkansen

The Series E5 rolling stock for the Hokuriku Shinkansen and the Series E6 for the Akita Shinkansen have entered service, becoming the first such trains in Japan to achieve 320 km/h in commercial operation. Meanwhile, the Series E7 and W7, which will be introduced in March 2015 when the Hokuriku Shinkansen is extended to include services to Kanazawa will operate at 260 km/h, with E7 services to Nagano being introduced first. These new Shinkansen rolling stock have been supplied to the East Japan Railway Company and West Japan Railway Company.

The Series E7 and W7 Shinkansen rolling stock incorporate a variety of new technologies, including improvements to ride comfort and stopping performance. Of particular note is that the Hokuriku Shinkansen rolling stock needs to use both 50-Hz and 60-Hz power systems on different sections of track. In addition to the use of light-emitting diode (LED) lighting throughout the trains, interior comfort has been improved by the use of universal design, the provision of power sockets on all passenger seating, and barrier-free multi-function toilets. The addition of these new fittings provides for comfortable long-distance journeys.

2 Series 60000 Rolling Stock for Tobu Railway Co., Ltd.

Hitachi has supplied new Series 60000 rolling stock to Tobu Railway Co., Ltd. for the Tobu Urban Park Line (Noda Line).

The trains are the first new series to be added since the line commenced operation. Their design is based on the Series 50000 and builds on its concept of building next-generation trains that are kind to people and the environment, adding improvements to comfort and environmental performance along with barrier-free

2 Series 60000 rolling stock for Tobu Railway Co., Ltd.

(accessibility) features.

The carbodies have a double-skin aluminum alloy structure that reduces weight without compromising strength. The traction drive system uses small and lightweight inverters and highly efficient fully enclosed fan-cooled electric motors to significantly improve energy efficiency. The trains are fitted with the autonomous train integration (ATI) train information and control system, which provides continuous monitoring of all equipment together with a range of inspection and test functions to reduce the workload for train crew and maintenance staff. In the driving cab, the operating console uses a color liquid crystal display (LCD) to display the speedometer and other operational indicators and is designed for visibility and ease-of-use by the driver.

3 Traffic displays and control desks for traffic management system of Fukuoka City Subway

3 Traffic Management System for Kuko and Hakozaki Lines of Fukuoka City Subway

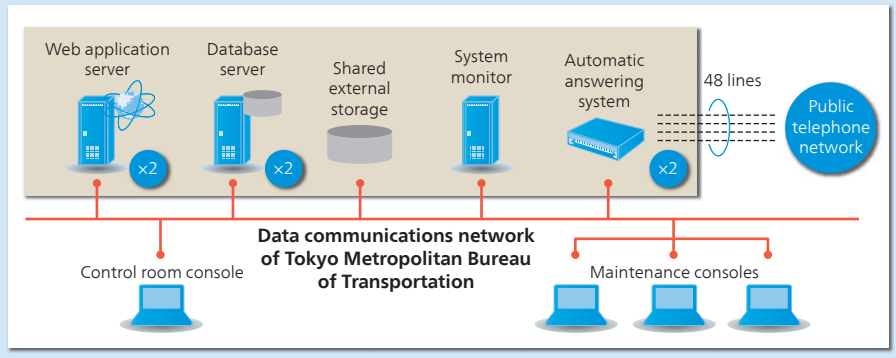
The traffic management system for the Kuko and Hakozaki Lines of the Fukuoka City Subway commenced operation in October 2014.

The system completely replaced the aging existing system, including the central computer in the central control room, man-machine interface, control staff training system, and scheduling support system. As the primary system managing the operation of trains on the Kuko and Hakozaki Lines, it is intended to improve passenger service and traffic management productivity by automating various operations. It also performs monitoring and control of train operation and associated equipment, with a high degree of interoperation with other related systems. The Kuko and Hakozaki Lines have a through service with the Chikuhi Line of the JR Kyushu Railway Company via Meinohama Station, with trains also utilizing the Meinohama Depot. They also connect with the Kaizuka Line of Nishi-Nippon Railroad Co., Ltd. at Kaizuka Station.

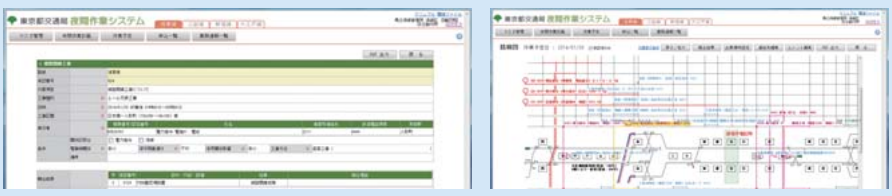
In the future, Hitachi intends to work with its customers to provide a safer and more comfortable subway system that serves as a major artery in the political, economic, and transportation hub of the Kyushu region, supporting the region's largest population.

4 Overnight Work System for Tokyo Metropolitan Bureau of Transportation

The overnight work system supplied to Tokyo Metropolitan Bureau of Transportation improves coordination of maintenance, inspection, construction, and maintenance vehicle driving tasks on the work sections on the four Toei subway lines (65 sections on



System configuration



Job request screen

Maintenance vehicle route screen

4 Block diagram and example screens from overnight work system for Tokyo Metropolitan Bureau of Transportation

the Asakusa Line, Mita Line, Shinjuku Line, and Oedo Line, including maintenance sections and the control center) and ensures that on-site work is performed safely and efficiently.

The versatility of the system has been improved by providing the ability for all tasks such as job entry and requests and approvals to be entered via a web browser from existing devices. It also uses work-use personal handyphone system (PHS) devices to update work progress in the system, thereby reducing the reporting workload and ensuring timely work management. It also improves the convenience of work start times through interoperation with the traffic management system at the control center.

In the future, Hitachi intends to satisfy a variety of needs by seeking to improve the safety and convenience of overnight work, including through connections to other systems and improvements to usability.

5 Information Display System for East Japan Railway Company Yokohama Line and Nambu Line

The increasing sophistication of devices such as flat panel displays and processors resulting from progress in information and communication technology (ICT) in recent years has led to growing use of LCDs for displaying information to passengers on commuter trains.

Hitachi has been developing passenger information displays with a highly reliable system architecture that use the autonomous decentralized concept developed in the field of traffic management, and that are based on the concept of user-oriented experience design. They present information in a form that the diverse range of people who use commuter trains find easy to read and interpret, and present a wide range of timely information in an interesting way. By using open system interfaces and software-based functions, they are also designed for lower lifecycle costs by providing a total system encompassing both on- and off-train components that can avoid obsolescence and grow over time.

The new system is now in operation, having been progressively rolled out during FY2014, first to the Yokohama Line and later to the Nambu Line of East Japan Railway Company.

6 Control consoles of ATOS system for District 2 after upgrade

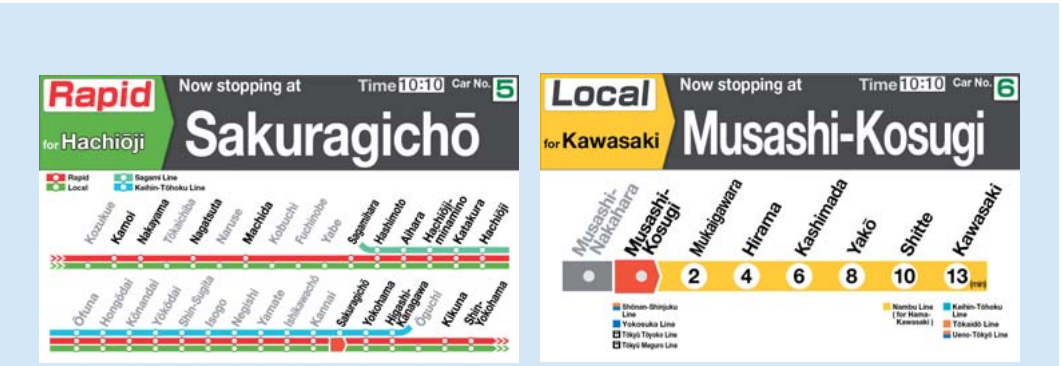
6 Upgrades to District 2 Railway Lines of ATOS (Yamanote Line and Keihin-Tohoku/ Negishi Line)

In September 2014, upgrades to the District 2 railway lines of the Autonomous Decentralized Transport Operation Control System (ATOS) for the Tokyo region were installed for the central systems of the Yamanote Line and Keihin-Tohoku/Negishi Line.

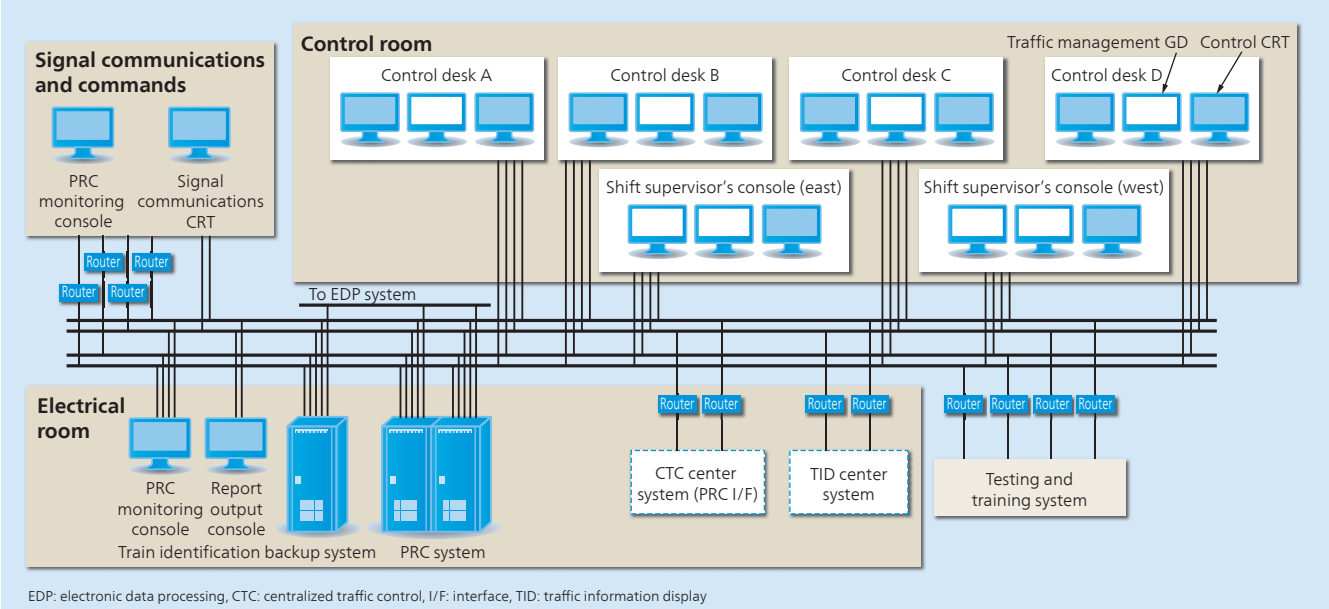
To satisfy recent customer demands for faster recovery from timetable disruption and more sophisticated information and control, the project included the addition of an operation coordination function to improve passenger services and greater provision of information for related activities.

The operation coordination function for improving passenger services included in the upgrades to the District 2 railway lines is based on the use of computational logic (constraint logic) to model train operation included in the District 1 railway line (Chuo Main Line) and achieves more reliable operations by controlling the timing of delays and departures at each station so they are more uniform. To provide more information for related activity, the system improves the accuracy of activity on subsequent sections of line by collating information about the locations of trains, not only on the sections of line being controlled, but also on other connected sections of line.

As with the District 1 railway line, the switchover to the new system proceeded smoothly. Hitachi intends to continue contributing to safe and reliable railway operations, including during the rollout to additional lines.



5 Passenger information displays used on East Japan Railway Company Yokohama Line and Nambu Line



7 Block diagram of traffic management system for Tokaido Line of Central Japan Railway Company

7 Tokaido Line PRC System for Nagoya Control Center of Central Japan Railway Company

The programmed route control (PRC) system for the Tokaido Line of Central Japan Railway Company is a centralized traffic management system that performs monitoring and control of railway traffic on the Tokaido Main Line (Nagoya section).

The new system replaces the existing system. To improve reliability, it includes a train identification backup system to augment the PRC system that performs automatic route control (which has a dual configuration). The backup system ensures that train monitoring and control can continue to function even if both of the PRC systems go down. To improve the efficiency of traffic management, the operation consoles used by the control staff are fitted with traffic management graphic displays (GDs) that display train schedules in numeric format and control cathode ray tubes (CRTs) that display train statuses and allow remote manual control of station routes. The training functions provided by the testing and training system have been enhanced by the addition of a function for recreating past situations from operational records and a scenario function that can be used to run exercises that simulate timetable disruptions.

The system commenced operation in October 2014. Hitachi intends to contribute to further progress in railway systems by utilizing the technologies and functions developed for this system in future upgrades of the traffic management system for the Nagoya region.

8 Functional Upgrade of Tokyo Region Equipment Command System (Control System)

The Tokyo region equipment command system of the East Japan Railway Company was installed in 1995 to improve the efficiency of command and control activities by automating the monitoring and control of power supply, power system, substation, and other facilities used for railway operation in a region encompassing Tokyo city and eight surrounding prefectures. Since a hardware replacement and development project in 2011 in response to the aging of control center systems, Hitachi has undertaken further development covering functional coordination with ATOS and integration with power distribution supervision aimed at extending the system's functions and strengthening command activities.

In addition to setting and clearing signal inhibits that automatically shut off traction power (power supply), the functional coordination with ATOS consists of automating and simplifying the approval procedures for controlling the turning on and off of traction power by switching from a manual procedure between control staff to one that works by interoperation between systems to ensure that the first and last few trains of the day routinely run on time. This improves safety and dependability, with the associated functions commencing operation in November 2013.

The integration of power distribution supervision into the equipment command system involves connecting station power supply equipment to a data network and was done to cope with the expansion in electrical distribution systems and monitored stations associated with the expansion of the lifestyle services business. This has resulted in an integrated system that provides centralized management from the power plant to station power supplies. The upgrade commenced operation in December 2013.

8 Tokyo region equipment command system (control system)

Public Sector Systems

1 Monitoring and control system for Sorami Sludge Recycle Center of Nagoya City Waterworks & Sewerage Bureau

2 Central control room of monitoring and control system at the Water Supply Management Center of Niihama City Waterworks Bureau

1 Monitoring and Control System for Sorami Sludge Recycle Center of Nagoya City Waterworks & Sewerage Bureau

The sludge produced by Nagoya City's sewage treatment centers is collected together and processed at three sites: in Yamazaki, the Shibata Sludge Processing Plant, and the Sorami Sludge Recycle Center.

The Sorami Sludge Recycle Center was constructed between FY2008 and FY2013, and started processing sludge in October 2013. It processes an average of 5,000 m^3/day. The sludge is first concentrated and dried and then completely incinerated.

The system supplied by Hitachi is intended to perform centralized monitoring and control of the concentration, drying, and incineration equipment. It has the following main functions.

(1) Client-server configuration with dual servers to improve reliability

(2) Dual configuration for controllers and control local area network (LAN) to improve reliability

(3) Transmits signals through Internet protocol (IP) communications with a communications controller at the Hojin Water Treatment Center, which takes the plant's sludge return flow water, and performs realtime monitoring of important signals between the two plants. The communications controller also has a dual configuration to ensure reliability.

(Commencement of operation: October 2013)

2 Monitoring and Control System for Water Supply Management Center of Niihama City Waterworks Bureau

The monitoring and control system supplied to the Water Supply Management Center of Niihama City Waterworks Bureau performs centralized management of information from the water distribution system that consists of 22 water sources located around the city, nine pumping or relay stations, nine distribution reservoirs, and 21 water quality and flow monitoring stations installed at the outer edges of the distribution network. The system was reconfigured to provide reliable and economic operation of the water infrastructure and deal with challenges to the efficiency of maintenance work. To achieve this, the new system includes a demand prediction function, operational functions for pumps and distribution reservoirs, and functions for maintenance that utilize mobile devices such as smartphones or tablets.

The main features of the system are as follows.

(1) Simulations of pump and distribution reservoir operation plans can be calculated using control parameters from currently operating pump control panels.

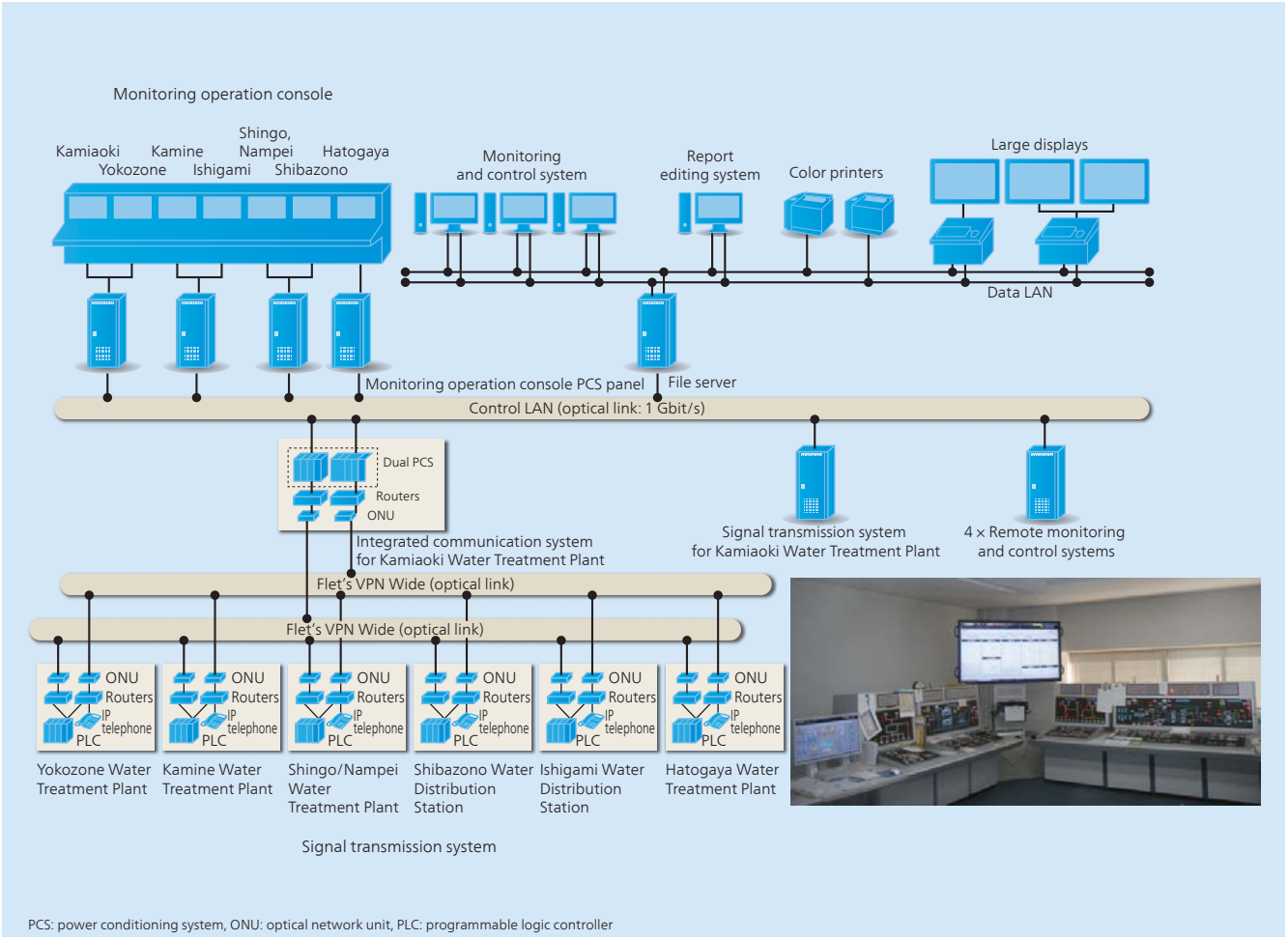
(2) The ability to receive notification of equipment faults via e-mail and display graphics showing equipment status and message screens on a mobile device means that infrastructure managers can determine the status of the water infrastructure quickly, regardless of time or place.

(Commencement of operation: April 2014)

3 Monitoring and Control System for Kamiaoki Water Treatment Plant of Kawaguchi City Water Service Bureau

The Kamiaoki Water Treatment Plant of the Kawaguchi City Water Service Bureau commenced operation in 1952. It has a capacity of 50,200 m^3 of water per day, which is drawn from the prefecture and from its own wells.

The monitoring and control system performs remote monitoring of water quality and distribution at the Kamiaoki Water Treatment Plant, Kamine Water Treatment Plant, Shingo Water Treatment Plant, Yokozone Water Treatment Plant, Hatogaya



PCS: power conditioning system, ONU: optical network unit, PLC: programmable logic controller

3 Monitoring and control system for Kamiaoki Water Treatment Plant of Kawaguchi City Water Service Bureau

Water Treatment Plant, Ishigami Water Distribution Station, Shibazono Water Distribution Station, and Nampei Water Distribution Station. The system has a client-server configuration with remote monitoring cables that were upgraded to a dual optical digital line.

The main features of the system are as follows.

(1) Dual optical communication system that combines IP.LINK modules*1 with Flet's*2 VPN Wide*2,*3 to deal with indirect lightning strikes and provides redundancy in the communication link.

(2) Minimizes the impact of router failures by using IP telephony with private phone books.

*1 Data transmission modules for IP communications

*2 See "Trademarks" on page 146.

*3 A best-effort service that provides simple private networks between subscribers to the Flet's Hikari Next*2, B Flet's*2, Flet's ADSL*2, and Flet's ISDN*2 services of Nippon Telegraph and Telephone East Corporation and Nippon Telegraph and Telephone West Corporation

4 Central Monitoring and Control System for Hinumagawa River Water Purification Plant of the Ibaraki Prefectural Public Enterprise Bureau

The Hinumagawa River Water Purification Plant of the Central District Waterworks Office of the Ibaraki Prefectural Public Enterprise Bureau has the capacity to treat 24,000 m^3 of water per day. Water is drawn from the Hinumagawa River, which is sourced from the Iida Dam, treated using high speed sedimentation and rapid filtration, stored in a reservoir, and then supplied via pumps to three cities and one industrial complex.

The central monitoring and control system performs centralized monitoring and control using three monitoring and control operation desks and two large displays. It commenced operation in October 2014.

The main features of the system are as follows.

(1) High-volume and high-speed communications is achieved by connecting the controllers directly to the 1 gigabit control LAN.

(2) All of the operation desks used in the past that have built-in mini-graphics panels have been replaced with liquid crystal

4 Central monitoring and control system for Hinumagawa River Water Purification Plant of the Ibaraki Prefectural Public Enterprise Bureau

display (LCD) monitors. Dual configurations are used for the water intake, pumping, and chemical treatment equipment controllers in particular, and LCDs are fitted in the controller panels to allow monitoring and operation to be performed from the electrical room as well.

(3) Controllers and modems are used to connect to the central monitoring and control system at the prefecture's Central District Waterworks Office (at the Mito Water Treatment Plant). This was done to enable monitoring and operation to continue to be performed from the Central District Waterworks Office after the system upgrade.

5 Remote Monitoring and Control System for Koriyama Monitoring Center in Sendai City

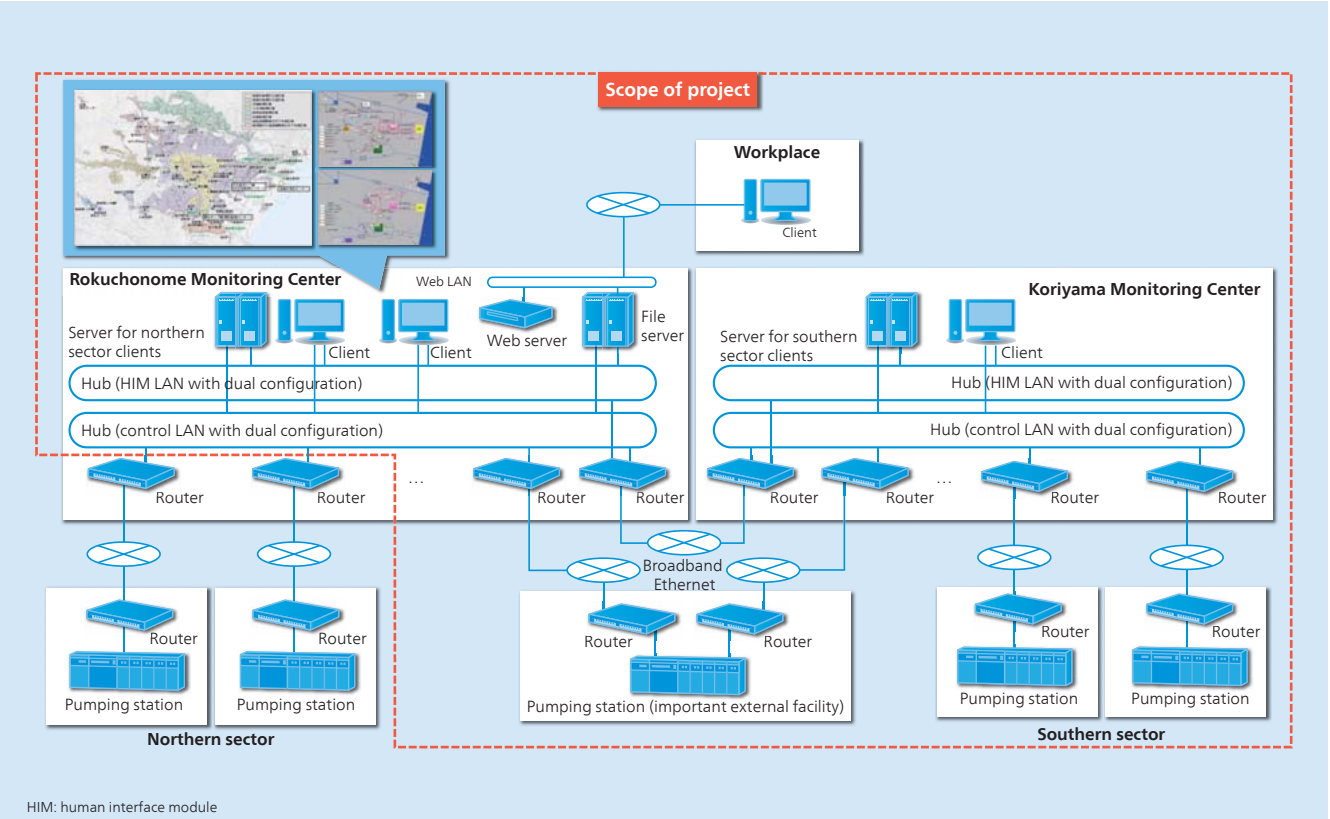
The storm water and sewerage pumping stations in the Sendai City wastewater system are divided into separate northern and southern sectors, with centralized monitoring and control performed from the Rokuchonome Monitoring Center. With the aim of spreading the risk in the event of a disaster, Hitachi has installed a monitoring and control system for the southern pumping stations at the Koriyama Monitoring Center that incorporates a system for centralized management of the pumping stations in both the northern and southern sectors.

The two monitoring centers are linked by broadband Ethernet. In addition to being able to perform centralized monitoring and control from the Rokuchonome Monitoring Center, as in the past, the new system also allows the same monitoring and control to be performed from the Koriyama Monitoring Center. Reliability has also been improved by using dual communication systems that connect to both the Rokuchonome and Koriyama monitoring centers for three pumping stations that serve as important external facilities. Ease of use has also been improved and additional functions provided for the web system used to share information with sewage system facilities such as the Minami-Gamo sewage treatment center and city office by installing the new platform system for web services.

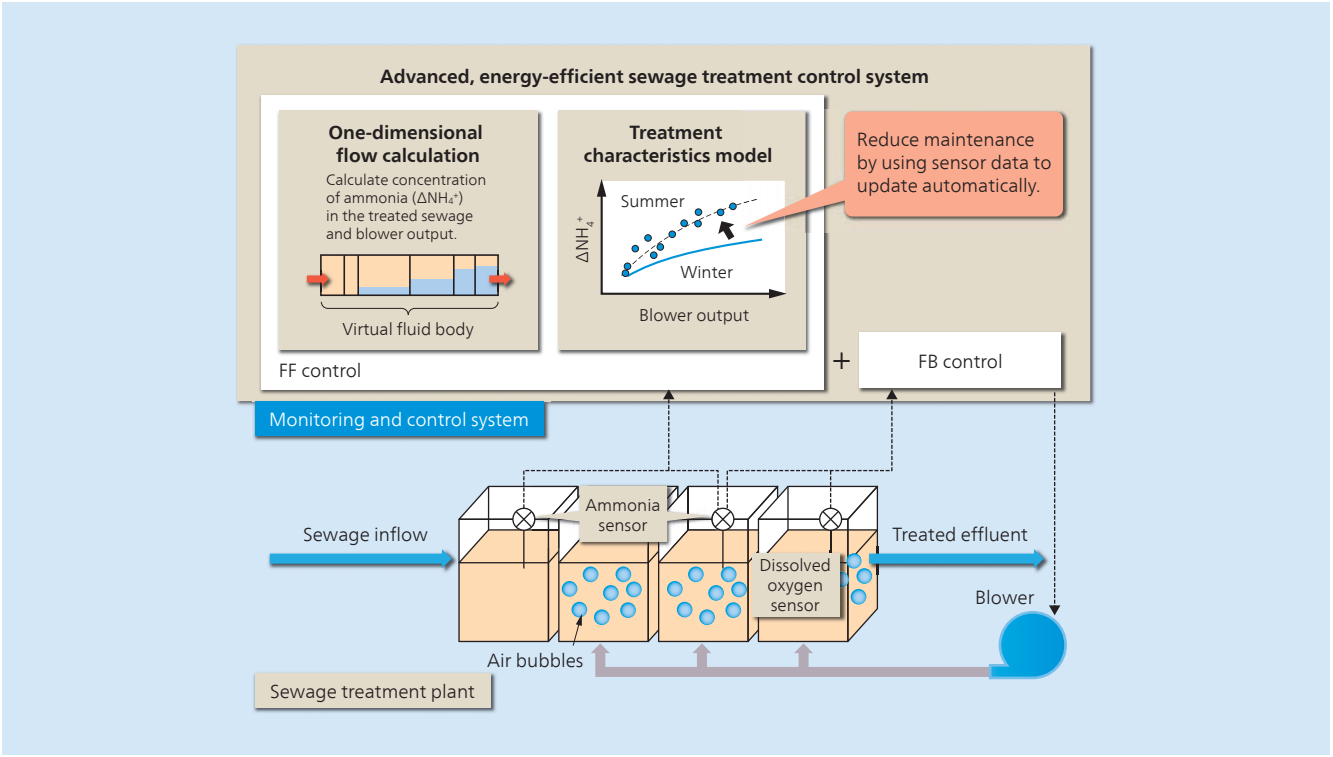
6 Advanced, Energy-efficient Sewage Treatment Control System

Hitachi, Ltd. and Ibaraki Prefecture are working with the National Institute for Land and Infrastructure Management to "demonstrate efficient nitrification control with information and communications technology (ICT)," one of the objectives of the FY2014 "Breakthrough by Dynamic Approach in Sewage High Technology Project" (B-DASH project) of the Ministry of Land, Infrastructure, Transport and Tourism, the aim of which is to achieve energy-efficient water treatment and a high level of effluent water quality. The work involves modifying some of the treatment systems at the Kasumigaura Sewage Treatment Plant (with a treatment capacity of approximately 6,500 m^3/day) to trial control techniques and collect plant operation data for assessment.

This demonstration will achieve both water quality and energy-efficiency using sensors and control technology as the information and communication technology. Ammonia sensors located midway through and upstream of the aerobic tank play an important role in the work. The system incorporates model-based feed-forward (FF) and feedback (FB) control techniques, functions for visualizing the treatment characteristics, and the automatic updating of control parameters. These are used to



5 Block diagram of remote monitoring and control system for Koriyama Monitoring Center in Sendai City



6 Advanced, energy-efficient sewage treatment control system

control ammonia levels in the treated sewage and cut power costs by reducing blower use.

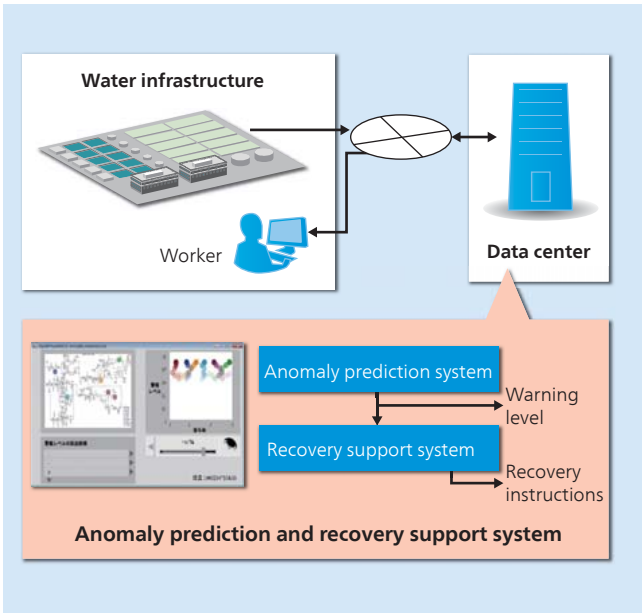
7 Anomaly Prediction and Recovery Support Technology for Water Infrastructure

Anomalies due to age or other factors in the equipment and machinery used in the water infrastructure such as water and sewage treatment plants have been a cause of significant losses for both the public and industry. The challenge of preventing this is to detect potential anomalies pre-emptively and to deal with them before they become a problem.

In response to this challenge, Hitachi is developing technology to support anomaly prediction and recovery based on operating data from equipment and machinery. This consists of two techniques. The first technique is to use statistics to display variations from normal conditions in the form of a warning level. The second is a semantic network technique that can identify the location of the root cause of the variation from a flowchart of the plant and output recovery instructions.

Used together, these techniques make it possible to act quickly and to prevent equipment and machinery anomalies pre-emptively. This minimizes not only anomalies in the monitored equipment and machinery, but also adverse flow-on effects to other processes.

The technology is very versatile and Hitachi plans to deploy it on outside facilities in the future.



7 Block diagram of anomaly prediction and recovery support system

8 Traffic Conditions Display Panel System for Miyagi Prefectural Police Headquarters

Having suffered considerable damage in the Great East Japan Earthquake, the Miyagi Prefectural Police Headquarters commenced operation of a new traffic conditions display panel system in April 2014.

The aim of the system is to ensure safe and trouble-free road traffic by displaying and monitoring the status of traffic signals and information display boards, as well as traffic congestion based on traffic information and video from industrial television (ITV) and other sources. The display panel consists of 40 (five rows × eight columns) 70-inch digital light processing (DLP) projectors that can display images in windows overlaid on a traffic conditions map, where the window images can be selected from among 32 channels of traffic monitoring cameras or television images and eight channels of personal computer (PC) screens, and displayed in any size or location.

8 Traffic conditions display panel system for Miyagi Prefectural Police Headquarters

Given the growing concern from the public about disaster prevention and mitigation, Hitachi intends to continue enhancing systems that contribute to providing safety and security, not only during disasters or other emergencies, but also under normal conditions.

9 Large Display for Communication and Command System for Miyagi Prefectural Police Headquarters

The Miyagi Prefectural Police Headquarters commenced operation of a new communication and command system in March 2014.

The system is intended to improve communication and command activities by overlaying a map of the entire Miyagi Prefecture with windows showing emergency (110) call information and police car locations on a 72-inch multi-display unit (12 screens). It also includes a sub-system that assists decision making by providing video feeds to six 70-inch LCDs and ten 19-inch monitors on the dispatcher desks in the central control room.

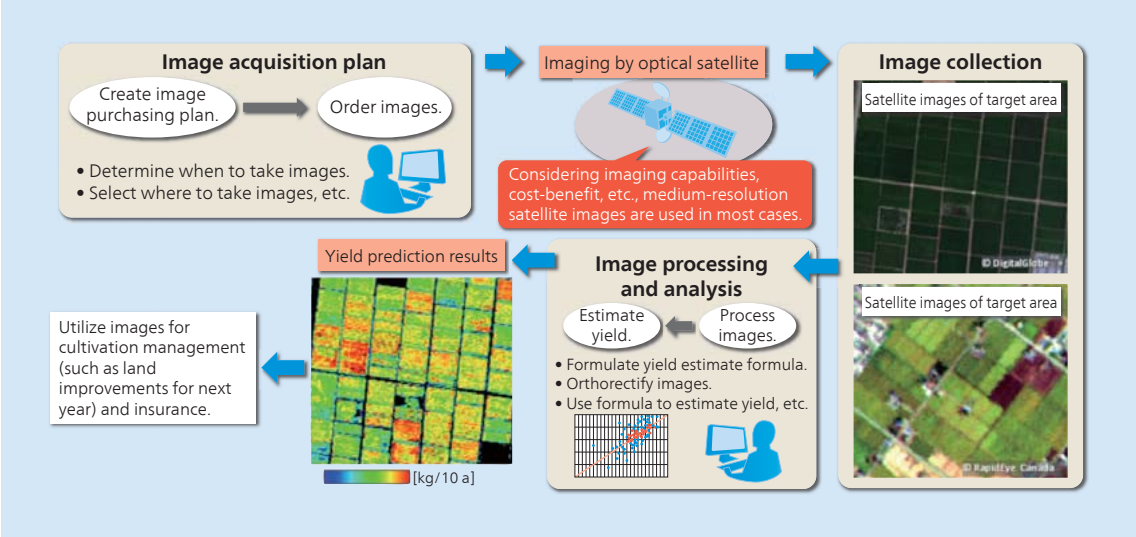
The multi-display unit uses DLP projectors with the latest light-emitting diode (LED) light sources. The average lifetime of the LED light sources is approximately 80,000 hours*, more than six times that of the high-pressure mercury lamps used in the past. This reduces the frequency of routine replacement of consumables. Also, the video control and operation software supports the efficient operation of the large display unit with functions such as selecting the screen display pattern or videos to display, centralized control of audio, and turning equipment on or off.

In the future, Hitachi intends to continue working on longer equipment life and higher reliability, these being important factors for the systems that underpin the social infrastructure.

* The average lifetime is defined as the mean time for LED brightness to fall to half of its initial level.

9 Large display for communication and command system for Miyagi Prefectural Police Headquarters

Security Technologies for Social Infrastructure



1 Rice paddy harvest assessments made using satellite images

1 Satellite Imaging Solution for Agriculture

The world's population is forecast to grow from 6.5 billion now to reach nine billion in 2050, prompting predictions of imbalances in the supply and demand for food on a global scale.

The monitoring of large areas of a nation's land, including farmland, can be performed using images taken by Earth-imaging satellites 500 to 700 km above the Earth. Applying its precise analysis techniques to these satellite images, Hitachi believes it can provide information for correcting imbalances in supply and demand for food by assessing rice paddy harvests and using these assessments as a basis for undertaking yield improvements.

In the future, Hitachi intends to continue contributing to the resolution of global-scale food supply problems through basic information delivery services that provide satellite images and rice paddy harvest assessments made by sophisticated processing and analysis of those images.

2 Cabinet Office Disaster Information Portal

The disaster information portal of Japan's Cabinet Office retrieves disaster information that needs to be released from an Integrated Disaster Management Information System and makes it available to regional agencies and other organizations involved in disaster prevention, and also to the general public.

Ensuring both the confidentiality of the Integrated Disaster Management Information System and the convenience of the disaster information portal requires a system design that takes issues like the ability to withstand disaster, responsiveness, and security into account. To achieve this, Hitachi adopted the following three measures.

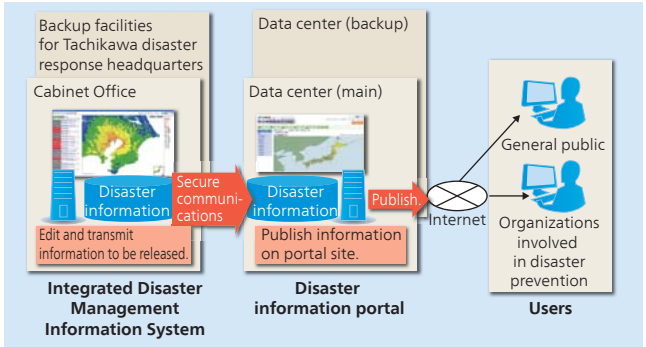
(1) Use of a redundant system configuration (using two separate data centers) to increase the ability to withstand disaster

(2) Low-overhead display format to allow for heavy traffic loads during a disaster

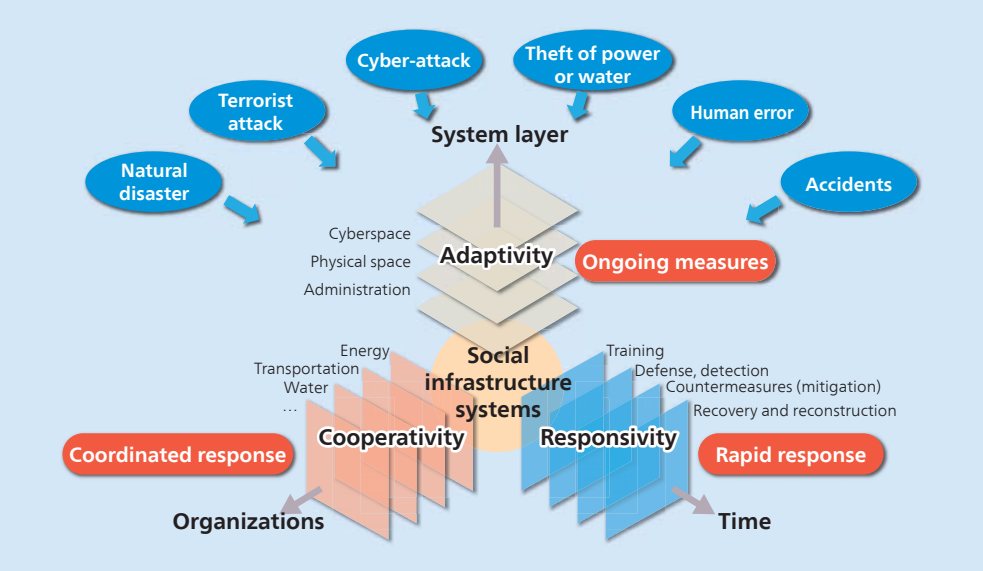
(3) Secure communication of information to be published on the portal site and robust security protections against cyber-attack

Through the operation of this highly reliable portal site, Hitachi is contributing to the reliable distribution of disaster information and the strengthening of regional disaster prevention capabilities.

With growing uncertainty about disaster risks, Hitachi intends in the future to continue strengthening its disaster prevention and mitigation solutions that ensure public safety and peace of mind by providing two-way communication between central government and the local government agencies that handle on-site disaster response.



2 Overview of Cabinet Office disaster information portal



3 Application of Hitachi's concept to crisis management security

3 Crisis Management Security Solutions

The tendency when natural disasters, accidents, terrorism, or other crises have occurred in recent years has been for the impact to be exacerbated by unanticipated consequences and flow-on damage. When dealing with a crisis, obtaining a rapid awareness of the situation and ensuring different organizations are able to coordinate their activities smoothly become matters of urgency. An international standard (ISO 22320) has been formulated for this purpose. Hitachi already supplies a wide range of security solutions that support activities such as situation awareness and incident response.

Hitachi has defined the concept for social infrastructure security based on "adaptivity," "responsivity," and "cooperativity" in recognition of the need to augment information across different organizations and to rapidly obtain situation awareness and allocate responsibilities in order to mount a rapid response to unanticipated consequences and flow-on damage, and is working on expanding crisis management security solutions in accordance with ISO 22320. In particular, it is possible to minimize capital and operating costs while also seeking to enhance interoperation between organizations by adopting a framework that provides for sharing of information between systems and flexible additions and extensions to the sequence of monitoring, decision-making, and action.

Hitachi intends to strengthen crisis management throughout society by supplying security solutions for all types of social infrastructure systems, including facilities used to stage national events and critical infrastructure.

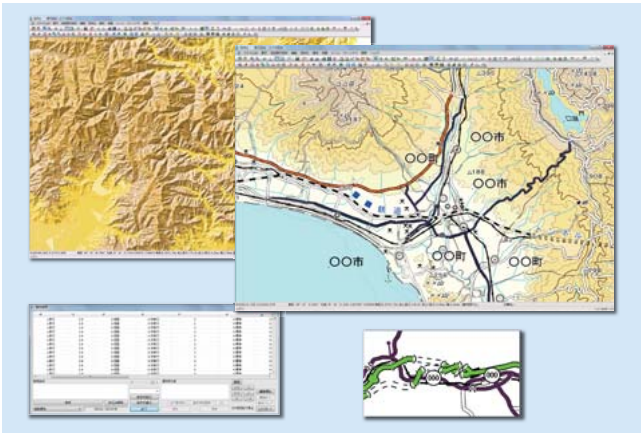
4 Geospatial Information Platform System

Fast-growing regions such as the nations of Asia require reliable geospatial information in order to provide a platform for national activity.

The geospatial information platform systems supplied by Hitachi, especially their core map production systems, are able to manage map quality, including the elimination of inconsistencies, while still representing the complex geographic features characteristic of Asia, and are used for the efficient production of extensive national maps. This enables the creation of maps that are suitable for uses such as infrastructure planning and regional government activities, and facilitates the updating of maps to keep them up to date with changes in a region over time.

Hitachi is also participating in standardization activities to facilitate the sharing and utilization of geospatial information across multiple government agencies and the private sector. This includes co-chairing a working group on moving features data exchange formats for the sharing of location information between mobile phones, vehicles, and other systems for the Open Geospatial Consortium (OGC), an international standards body for geospatial information, and also serving as an advisor to the board of the Japan National Committee for ISO/TC 211.

In the future, Hitachi intends to continue contributing to the development of different regions by proposing comprehensive geospatial information platform systems, including satellite imagery and surveying techniques.



4 Map production system for national-level geospatial information platforms

Elevators

1 Drive unit for 20-m/s elevator and artist's impression of completed CTF Finance Centre

1 World's Fastest Elevator (20 m/s)

Hitachi will supply the world's fastest elevator*, with a speed of 20 m/s, to the CTF Finance Centre, which is due to be completed in Guangzhou, China in 2016. For the new elevator, Hitachi developed a 330-kW permanent magnet (PM) motor winch, the largest class used in an elevator; a 2,200-kVA control system consisting of two inverters connected in parallel, each of which has four insulated-gate bipolar transistors (IGBTs), also connected in parallel; a brake with heat-resistant braking material; a high-strength rope approximately 30% stronger than the rope used for ultra-high-speed elevators in the past; and a four-stage telescopic shock-absorber with an installed size that is approximately 40% smaller than the previous buffer design.

Hitachi has conducted research at the G1TOWER, a 213-m high elevator test tower, aimed at ensuring low levels of vibration and noise when elevator cars are traveling at very high speeds. This has included research on a streamlined cover for reducing wind noise at very high speeds, and an active guide unit that significantly reduces elevator car vibration due to rail bending.

Hitachi intends to utilize the technologies for drive, control, safety, and comfort that it has built up through this development work to continue supplying elevators that are reliable, comfortable, and convenient.

* As of April 21, 2014. Based on research by Hitachi, Ltd.

2 New Model of Standard Elevator

Hitachi released a new model of its standard elevator in May 2014. This is the first new product released since Hitachi, Ltd. undertook measures to strengthen the company in April 2014 and transferred its Japanese elevator business to Hitachi Building Systems Co., Ltd. The main features of the new elevator are as follows.

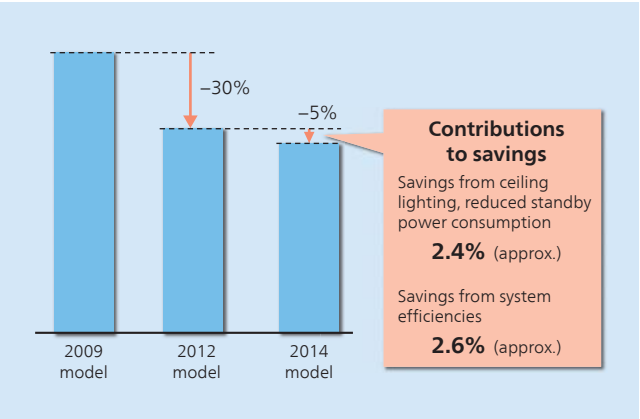
(1) A 5% improvement in energy efficiency compared to the previous model;* achieved by reducing the power consumption of the electrical and electronic components, including the winch brake and ceiling light-emitting diode (LED) lights.

(2) New design features and functions that take advantage of the capabilities of LED lighting. These include the addition of wall line lighting to provide a greater sense of spaciousness and high quality by giving the impression of light entering the elevator car through a window, and an automatic lighting tone adjustment function that switches between a lively white light during the day and an elegant artificial lighting feel during the night.

(3) Improved reliability achieved by incorporating programmable electronic safety technology into the elevator's safety systems to reduce the use of other components such as mechanical devices (switches, etc.), relays, and contactors.

(Hitachi Building Systems Co., Ltd.)

* Compared to the model released in 2012 during normal operation (based on research by Hitachi Building Systems Co., Ltd.). Actual performance will depend on operating conditions.



2 Energy efficiency comparison with previous model

3 Expanded Maintenance Service for New Model of Standard Elevator

Coinciding with the release of the 2014 model of its standard elevator, Hitachi has expanded the range of options it offers in its building care network maintenance service that was first introduced for the 2012 model. This service allows building managers to modify certain elevator settings from a personal computer (PC) via the Internet. These include such control settings as which floor the elevator waits on when not in use, and information display settings for the liquid crystal display (LCD) indicators in the elevator cars.

The main functions are as follows.

(1) Control settings for six additional functions, including whether to provide express service or stop at every floor.

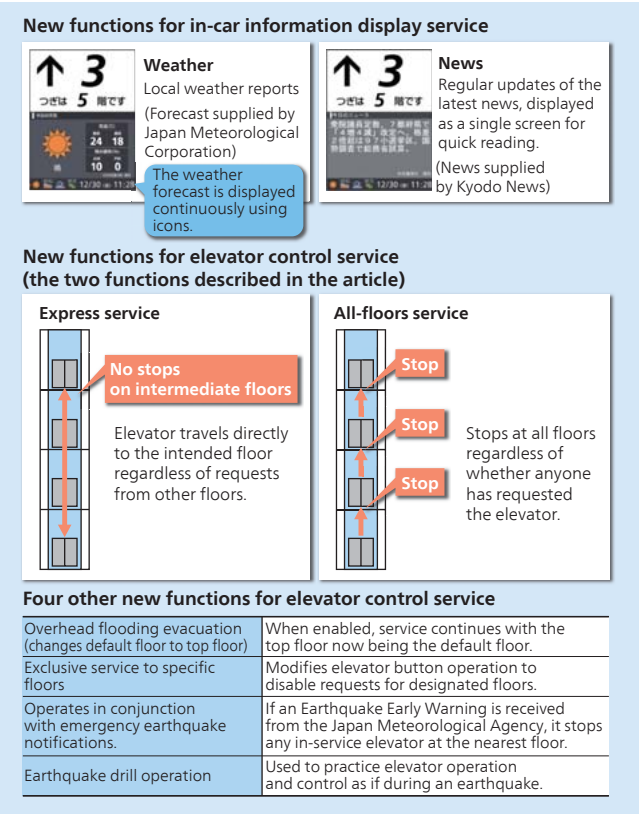
(2) New digital signage function for the elevator car display information, including news and weather.

(3) Greater convenience, including the ability to perform operations from a smartphone and a service for specifying settings on the customer's behalf.

The new model also features a reduction to an average of three minutes (previously six minutes) in the response time required to respond remotely to people who are stuck in an elevator. This was made possible by the adoption of Internet protocol (IP) networking for remote monitoring, enabling high-speed communications and simultaneous transmission of voice and data.

In the future, Hitachi intends to keep pace with changes in the needs of building managers and other users so that it can continue developing new products with enhanced competitiveness.

(Hitachi Building Systems Co., Ltd.)



3 New options offered by the building care network service

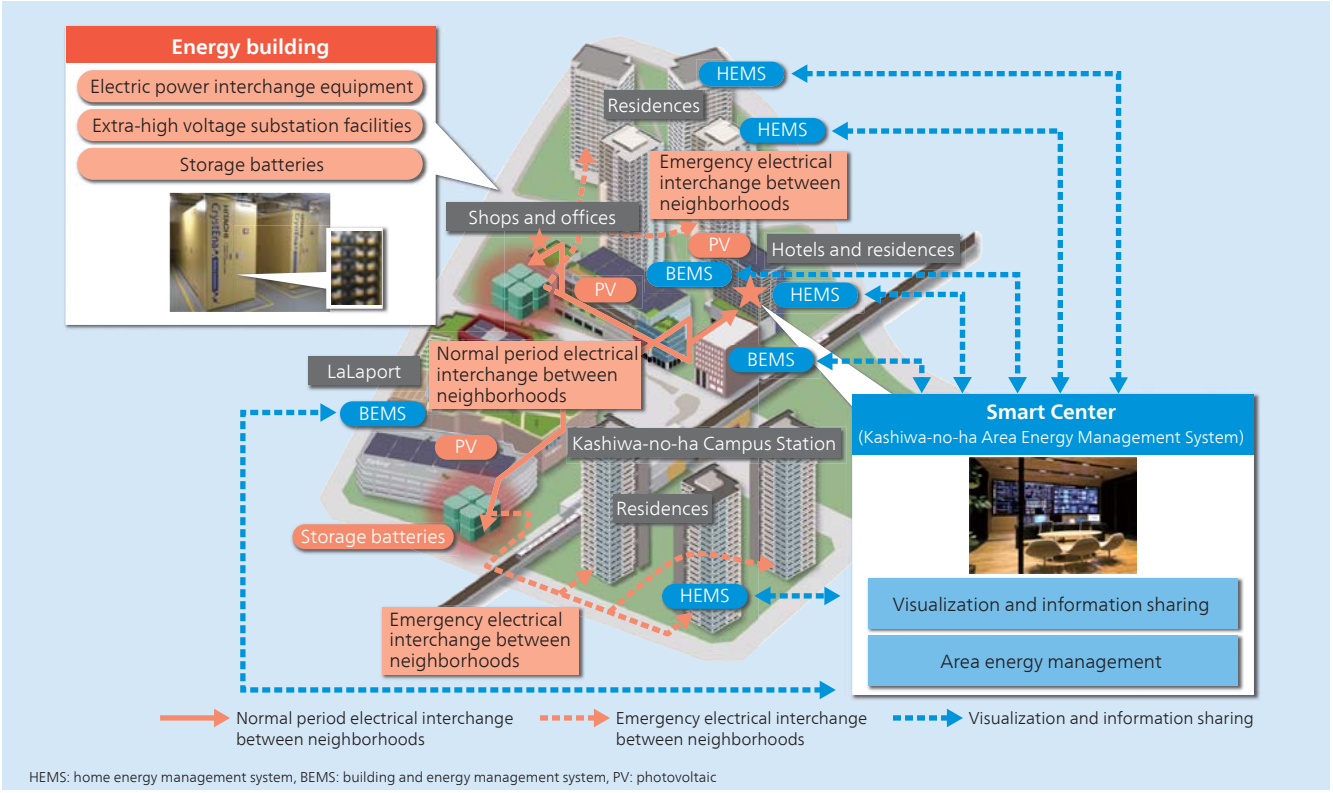
4 India's Fastest Elevators for High-rise Residential Building in Mumbai

Hitachi is going to supply 14 elevators, including four ultra-high-speed models, to Nathani Heights, a 72-story high-rise residential building project in central Mumbai on India's west coast that is scheduled to be completed in 2016. The 72-story residence will be one of the tallest residential buildings in Mumbai. In addition to the residential units, the luxury complex will also include retail stores, a fully equipped gym, a swimming pool, a mini theater, and other amenities.

Hitachi will supply 14 elevators in total, including four ultra-high-speed models with a speed of 360 m/min, making them India's fastest*. The ultra-high-speed elevators feature an earthquake emergency system that enables elevators to evacuate rapidly to the nearest floor when its sensors detect that the building is swaying as the result of an earthquake. Another feature enables users to pre-select their destination floor before the car arrives so that elevators can be allocated to users based on their destination floor. By combining passengers going to the same destination floors, this system alleviates congestion and increases overall vertical transport efficiency in the building. Hitachi is also going to supply seven high-speed elevators, including a glass elevator with a speed of 240 m/min that will also be the fastest of its type in India*.

* As of May 2014, based on research by Hitachi, Ltd.

4 Artist's impression of Nathani Heights



1 Management of energy across multiple neighborhoods by the Kashiwa-no-ha Area Energy Management System

1 Area Energy Management System for Kashiwa-no-ha Smart City

The Kashiwa-no-ha Area Energy Management System commenced full-scale operation in July 2014, coinciding with the opening of Kashiwa-no-ha Smart City being developed by Mitsui Fudosan Co., Ltd.

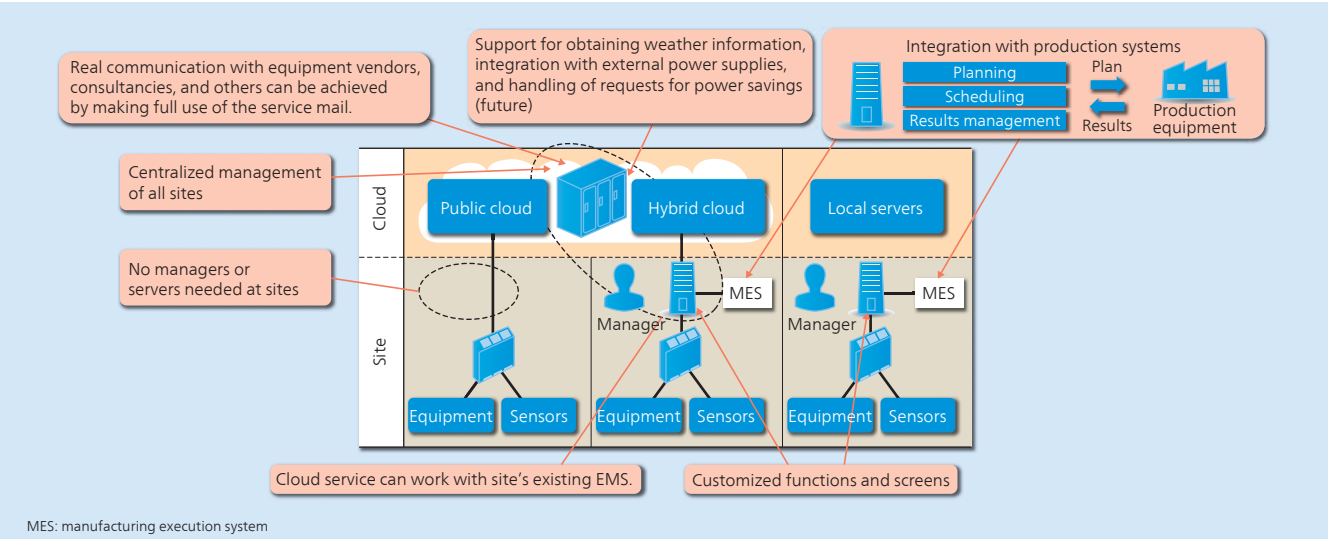
The system consists of a private power grid that incorporates renewable energy, Japan's largest lithium-ion storage batteries, a system for sharing electric power between neighborhoods, and an information system that performs centralized supply and demand management for residences, offices, and shopping centers throughout the city. It seeks to reduce power bills and carbon dioxide (CO_2) emissions through measures that include providing specific advice on how to save energy based on actual usage, and peak-cutting power sharing arrangements between facilities that experience peak demand at different times.

Reductions in peak demand at shopping centers were successfully achieved during the city's first year through the sharing of green energy. The project also succeeded in involving residents in reducing energy use by issuing power savings requests (based on demand predictions) for an incentive scheme in which users earn regional points. It is creating new civic value by sharing the essential energy supplies required by consumers and businesses across the city in the event of a power outage caused by a disaster, for example.

2 Integrated Energy and Equipment Management Service

Against a background that includes a series of major disasters and a shortage of specialist managers due to the falling population, consumers have come to recognize the potential of cloud services that offer centralized management of energy and equipment operation information at a low price for a variety of different facilities, such as offices, factories, and shops.

A feature of the integrated energy and equipment management service is that it provides access rights to Hitachi's "service mall" not only to consumers, but also to retailers, equipment vendors, and others. It eliminates the need for consumers to enter into a separate contract for each equipment vendor's cloud service, and provides equipment vendors with online access to analytical data without the need to set up their own infrastructure. Use of the service mall improves the convenience and operational efficiency of both problem analysis and equipment upgrade planning. The service also offers an energy efficiency guidance function (an



2 Service mall concept

optional service for factories) that works through integration with production planning systems.
(Date of service commencement: February 2015)

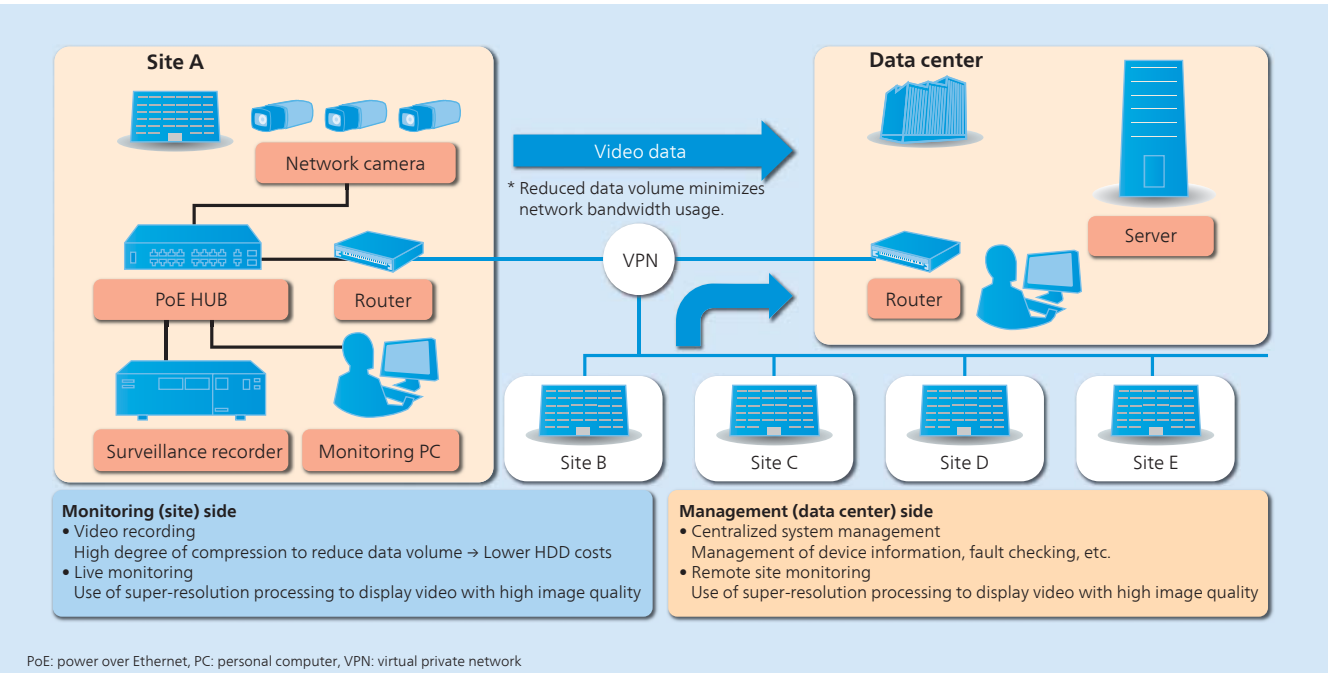
3 Use of High-level Compression and Super-resolution Processing in Video Surveillance System

The shift to networked cameras with high image quality and resolution has been accelerated in recent years by the wider use of networks and the adoption of digital video. However, because of the increase in data volume that accompanies higher image quality and resolution, this has also created problems that include the rising cost of providing additional hard disk drive (HDD) capacity and the increased load on the networks used to transmit this data.

Now, Hitachi has developed a video surveillance system that reduces data volume by performing a high degree of compression in the camera and uses software-based super-resolution processing*1 to display video with high image quality. This reduces data volume to between one-third and one-quarter the original size*2, thereby helping reducing HDD costs and network bandwidth usage.

It is anticipated that future systems will become increasingly networked and that demand will grow for large cloud-based systems that provide centralized management of video data at a data center. To satisfy this demand, Hitachi intends to develop products that incorporate compression, image processing, and other advanced techniques and supply a wide variety of security solutions, including remote surveillance services that utilize the cloud.
(Hitachi Industry & Control Solutions, Ltd.)

*1 A signal processing technique for producing images with higher resolution than the transmitted image.
*2 When compared to images stored in super extended video graphics array (SXVGA) resolution (1280 × 960 pixels).



3 Block diagram of video surveillance system

4 5-MW-PMG generator

5 25-MW synchronous motor

4 5-MW Wind Turbine Generator

A 5-MW downwind offshore wind power generation demonstration system is currently being built at a waterfront site in Kamisu City in Ibaraki Prefecture to meet demand for larger offshore wind power generation systems. To make the offshore wind turbine smaller and lighter, and require less maintenance, the system uses a permanent magnet generator (PMG).

The main features are as follows.

(1) Uses a PMG to reduce weight.

(2) Uses water cooling for a more compact design.

(3) Has fewer permanent magnets due to the use of finite element method (FEM) analysis for optimal generator design.

(4) Reduces maintenance requirements by using permanent magnets (PMs) to eliminate the need for an exciter with rotor slip rings and brushes.

In addition to the use in future offshore wind turbine design of operating data from the 5-MW offshore wind turbine and the 2-MW model developed previously, Hitachi also intends to continue working to commercialize offshore wind turbines to make them larger and to contribute to the global environment by conducting trials of the 5-MW downwind offshore wind power generator.

5 25-MW Synchronous Motor

The oil and gas market has continued to grow in recent years, with growing demand for natural gas, which is cleaner than other fossil fuels. While standard practice in the past has been to use gas turbines to power the compressors used in oil and gas plants, there has been a progressive shift toward electric drives along with heightened requirements for energy efficiency and CO_2 emissions reduction.

While synchronous motors and induction motors are the two main forms of compressor drives, there is a tendency to use synchronous motors in the 10-MW or higher range because of their power factor advantages. Accordingly, Hitachi has been developing a compact and lightweight synchronous motor in the 25-MW class. By adding synchronous motors to its existing series of induction motors, Hitachi is expanding its product range and the scope of its business.

6 Application of Modular Power Conversion Unit for a UPS

Hitachi has developed a 100-kVA uninterruptible power system (UPS) that incorporates a modular power conversion unit, which features power modules that are cooled on both sides to achieve excellent cooling performance.

The main features are as follows.

(1) The UPS unit has been made smaller by using an all-in-one

6 100-kVA UPS

design that includes a bypass circuit and maintenance bypass circuit. The result is an about 30% smaller installation footprint and an about 30% smaller volume than the existing Hitachi UPS with the same capacity. It also has a panel design that features the same installation footprint regardless of whether external cabling is routed from above or below.

(2) The new UPS adopts the same concept as previous Hitachi models by allowing units to be connected in parallel, enabling system configurations that satisfy user requirements such as reliability, ease of maintenance, expandability, and future upgrades. The new UPS has also been designed to allow it to be retrofitted into an existing system.

(3) The rectifier/inverter/chopper circuits at the heart of the UPS have a modular design made up of standard units, thereby reducing the number of spare parts required.

(4) The UPS has a high output, with a rated power factor under load of 0.95 for an input voltage of 200 V, and 1.0 for an input voltage of 210 V, making it compatible with the increasingly common practice of operating with high-load power factors.

In the future, Hitachi intends to utilize the technology developed for this model in 200-kVA and 300-kVA UPSs.

7 Cyber Security Solutions for Control Systems

Hitachi supplies products and services for maintaining security and preventing cyber-attacks on the key industrial systems that underpin the social infrastructure in the form of total solutions.

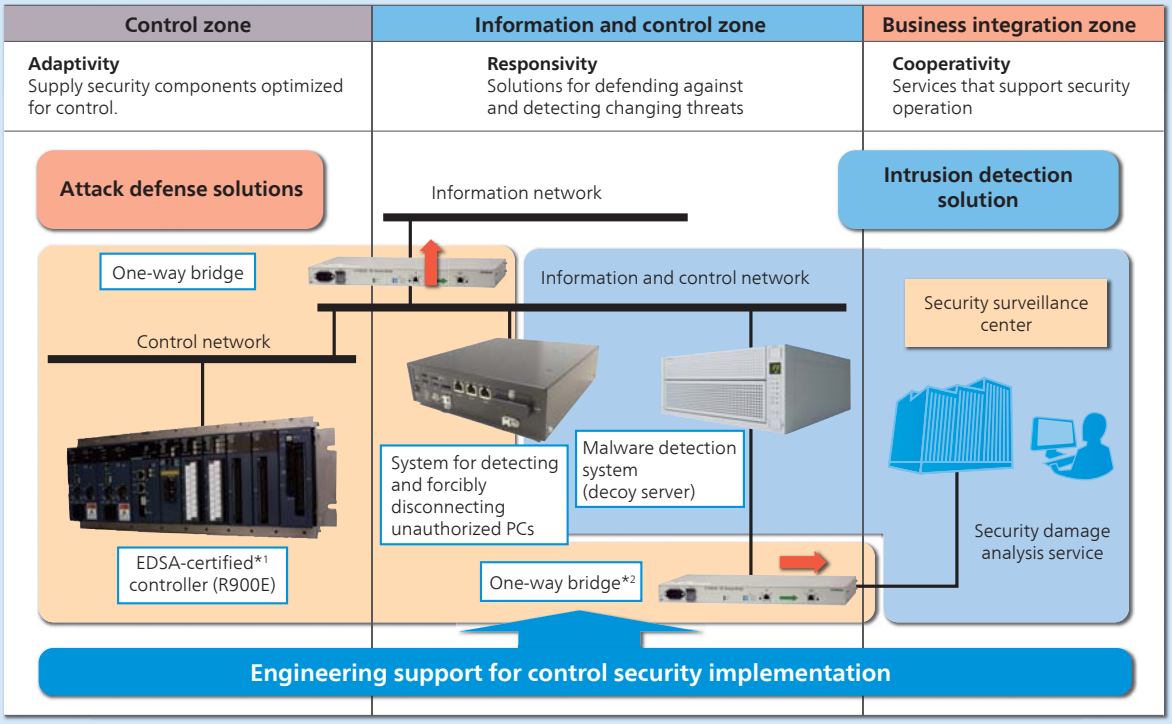
Specifically, this involves supplying systems for detecting and forcibly disconnecting unauthorized PCs, one-way bridges, and controllers with ISASecure Embedded Device Security Assurance (EDSA) Certification* in the form of attack defense solutions that protect control systems from security incidents. Other intrusion detection solutions supplied by Hitachi include systems for detecting and forcibly disconnecting unauthorized PCs, systems for the early detection of malware intrusions, and a security damage analysis service.

Utilizing these solutions, Hitachi provides engineering support for control security implementation that complies with standards such as IEC 62443 and also considers "responsivity" for effective implementation of the plan, do, check, and act (PDCA) cycle required by control systems, "adaptivity" for working rapidly through the observe, orient, decide, and act (OODA) loop, and integration and "cooperativity" between multiple systems.

* A security certification program for embedded systems in control equipment (controllers, safety controllers for safe instrumentation systems, and programmable controllers) developed by the International Society of Automation (ISA) Security Compliance Institute (ISCI)

8 Obtaining ISASecure EDSA Certification for a Controller

Hitachi is working to enhance the security of control equipment components and to comply with international standards by offering attack defense solutions that protect control systems from security incidents. One of Hitachi's main controller products, the plant controller, was certified in July 2014 under the ISASecure



*1 ISASecure EDSA 2010.1. Level 1 certification number: CSSC-C00002
*2 Configuration of equipment used to notify of detections differs depending on notification methods and where they are sent. The diagram shows the overall configuration. Additional peripheral devices are required when using a one-way bridge.

7 Cyber security solutions for control systems

8 Plant controller (top) and EDSA certificate (bottom)

EDSA international standard for security certification in the control equipment field.

ISASecure EDSA Certification for control equipment verifies whether it satisfies the requirements for each of a number of predefined security levels*. The Hitachi plant controller obtained certification because it satisfies the applicable requirements.

In the future, Hitachi intends to contribute to building the secure control systems essential to social and industrial infrastructure through the development and supply of control equipment components that comply with security requirements.

* EDSA Certification defines requirements to be assessed at a number of security levels, covering communication robustness testing (CRT), functional security assessment (FSA), and software development security assessment (SDSA).

9 One-way Bridge

Hitachi has developed a one-way bridge that improves control system security.

The bridge protects mission-critical systems by transmitting required information from the system to an external destination while also physically blocking unauthorized access and malware intrusions. This makes it possible to provide services that utilize data from power plant control systems or railway traffic management systems, for example, by enabling the safe delivery of the latest detailed information from the system.

The one-way bridge has an IN port for receiving packets from the mission-critical system and an OUT port for forwarding the packets to an external destination. The bridge is able to forward outbound packets only one way, while still maintaining the ability to establish connections using Ethernet's widely used autonegotiation procedure by using a physical layer control function developed by Hitachi (patent pending) to provide the connection through each port.

Following installation on a nuclear power plant system, Hitachi intends to deploy the technology in a wider range of industries in the future, including transportation systems.

9 One-way bridge

10 System for Detecting and Forcibly Disconnecting Unauthorized PCs HJ-7725

The importance of security is growing for control systems just as it is for information systems. To provide security products for control systems, Hitachi has developed the HJ-7725, a ruggedized system for detecting and forcibly disconnecting unauthorized PCs that incorporates the network monitor software for this purpose.

The main features are as follows.

(1) A fully enclosed design with no slits or other openings to improve tolerance against dust.

(2) Easier maintenance achieved by locating all connectors and status lights on the front panel.

(3) No fan or HDD, thereby eliminating parts that require periodic replacement.

The HJ-7725 enables the function to scan for unauthorized PC connections and forcibly disconnect them even in the sort of environments found in industrial plants. In the future, Hitachi plans to further extend the range of environments in which the system can be used, including making it smaller and giving it a wider temperature range (−10°C – +60°C).

10 HJ-7725 system for detecting and forcibly disconnecting unauthorized PCs

420 (W) × 450 (D) × 176 (H) mm

High-performance CPU

- Intel* Xeon* E3-1225 v2 (3.2 GHz, 4 cores/4 threads)

Compatible with previous models

- Physical dimensions are compatible with previous models to facilitate upgrades to new model
- Eight extended PCI bus slots (5 × PCI Express*, 3 × PCI slots) to enable continued use of existing PCI boards

Reliable long-term operation

- Designed for 10 years of continuous 24-hour operation
- Six times the operating life of a conventional office PC (8 hours/day × 5 years)
- Maintenance support for up to 12 years

* See "Trademarks" on page 146.

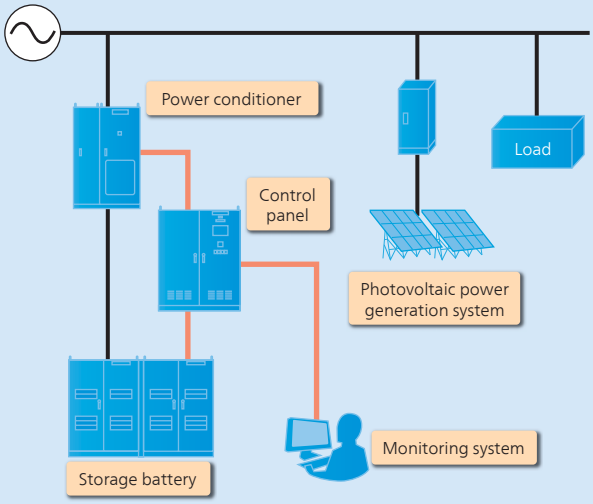
11 HF-W7500 Model 40 industrial computer

11 Industrial Computer HF-W7500 Model 40

Featuring long life and long-term availability, the HF-W series of industrial computers are increasingly being deployed in the information and telecommunications field, including such applications as monitoring and control and in disaster prevention systems. Now, Hitachi has developed the HF-W7500 Model 40 as part of its top-end HF-W7500 series of models. The Model 40 features approximately double the performance* of the previous model and has entered service in applications such as instrumentation and semiconductor inspection equipment.

The HF-W7500 Model 40 is designed for performance, with a high-performance central processing unit (CPU) (approximately double the performance of the previous model*) and a maximum 32 Gbyte of error checking and correcting (ECC) memory capacity (also double that of the previous model*). With the same physical dimensions as previous models, it is compatible with existing systems and has continued support for the Peripheral Component Interconnect (PCI) bus. Hitachi intends to expand the scope of applications for the computer even further in the future, offering new interfaces such as Universal Serial Bus (USB) 3.0, a multilingual user interface, and support for overseas standards.

* Compared to the Hitachi HF-W7500 Model 30.



12 Example configuration of an industrial energy storage system

12 Industrial Energy Storage System

Hitachi has added to its range of energy storage systems with the development of a new mid-range model for general industrial use.

In addition to smoothing power use by cutting peaks in demand and ensuring that energy is used effectively by operating in tandem with photovoltaic power generation, the system also plays a role in business continuity planning (BCP) by supplying electric power during power outages. It achieves high reliability by continuously monitoring battery status, and can be configured as required, with a choice of battery types (lithium-ion or lead-acid) and selectable capacity determined by varying the number of connected batteries.

The main benefits of installation are as follows.

(1) Reduce electricity bills by using nighttime (off-peak) power and avoiding the risk of demand exceeding the contracted level.

(2) Maintain power to selected loads during a power outage by switching to standalone operation.

(3) Store excess photovoltaic power during non-emergency conditions, and use generated power to charge batteries during a power outage.

(Hitachi Industrial Equipment Systems Co., Ltd.)

13 Super-high-efficiency Transformer

As part of the shift to Top Runner 2014 transformers that comply with the second round of Top Runner standards under the April 2014 Act on the Rational Use of Energy, with the designation "super-high-efficiency" being used for those transformers that achieve 115% of the Top Runner requirement, Hitachi has fully revamped its range of energy-efficient models and commenced sales under the super high efficiency transformer series brand. In addition to energy efficiency performance, the new models also

13 Oil-filled transformer (top) and molded transformer (bottom)

feature a design that can withstand seismic vibrations to enhance tolerance for earthquakes.

To satisfy a wide range of customer needs, the range of oil-filled transformers is divided into a premium series with extremely low losses, a super series with significantly reduced losses, and a compact series designed to minimize installation dimensions. The molded transformer range, meanwhile, is divided into the super and compact series.

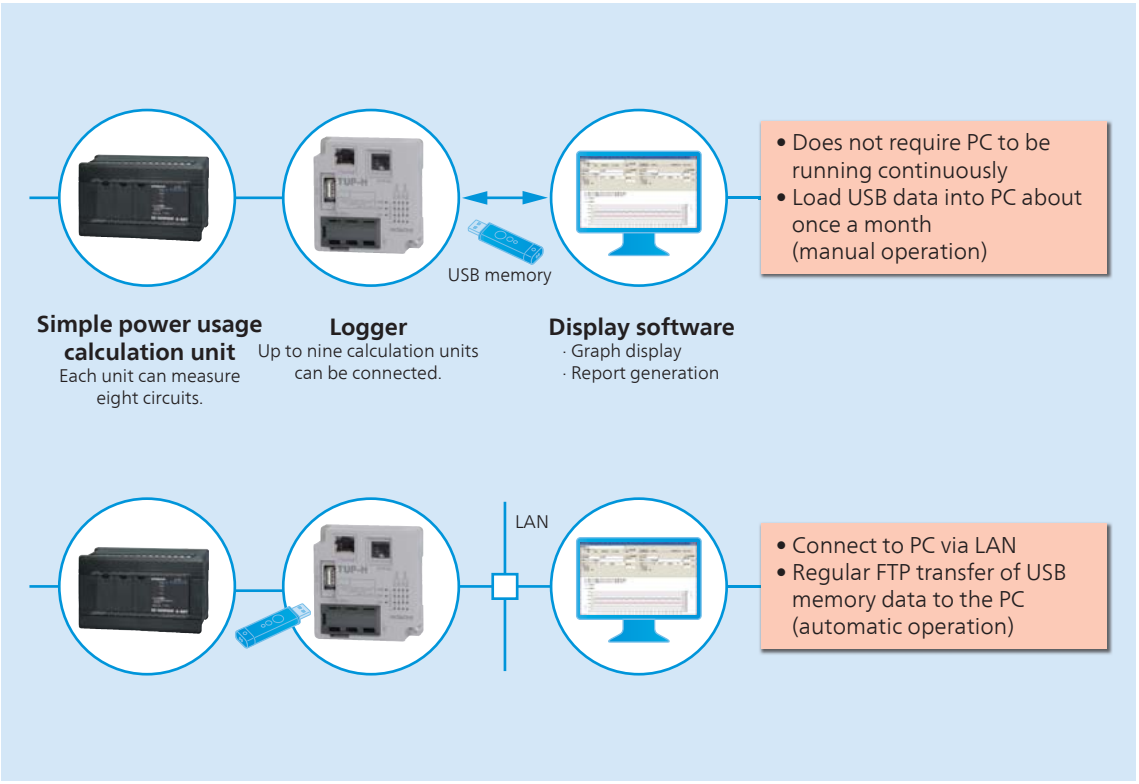
(Hitachi Industrial Equipment Systems Co., Ltd.)

14 Simple Energy Monitoring System

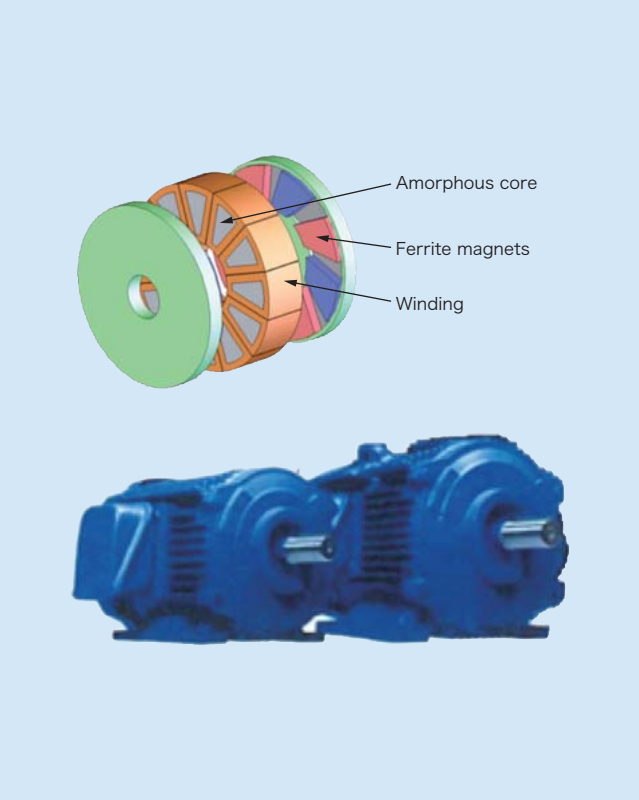
To facilitate energy savings using an energy management system (EMS), Hitachi power distribution and utility monitoring system supplies data collection software for general-purpose PCs together with multi-circuit units and clamp-on current sensors to provide energy consumers with an economical way of collecting environmental and energy efficiency data.

Hitachi began supplying this simple monitoring system in 2013, providing an easy way to monitor energy use without requiring a PC to be running continuously. The logger collects data at one-minute intervals and regularly saves it on USB memory. The data display software can read the recorded data from the USB memory and use it to produce trend graphs and daily, monthly, or yearly reports, and export it in a standard comma-separated value (CSV) file format. The collation and analysis of data can also be performed easily using macro software specifically designed for this purpose. It is also possible to set up a simple monitoring program that is even easier to use by connecting the logger to the PC via a local area network (LAN) and having the data display software use the file transfer protocol (FTP) to obtain the data without any manual handling of the USB memory.

(Hitachi Industrial Equipment Systems Co., Ltd.)



14 Components of a simple energy monitoring system



15 Axial gap structure of highly efficient amorphous motor without rare earths (top) and motor bodies (bottom)

16 NJ600B inverter for overseas markets

15 Highly Efficient Amorphous Motor without Rare Earth Metals

While industrial motors have become more efficient over recent years in response to factors such as the growing international demand for energy efficiency and increasingly stringent motor efficiency rules, the market is demanding even greater energy savings and higher efficiency. In response, Hitachi has developed a range of highly efficient PM electric motors, rated between 3.7 and 11 kW, that use amorphous alloy but not rare earth metals (neodymium and dysprosium).

The motors feature a new core design with a laminated structure made from a low-loss iron-based amorphous alloy, and enhanced manufacturing techniques to facilitate mass production. To achieve high efficiency, Hitachi has also optimized the design of the double-rotor axial gap structure with ferrite magnets. In addition to satisfying the requirements of the IE4 (super premium efficiency) motor efficiency class of the International Electrotechnical Commission (IEC) despite being smaller than a standard induction motor, the motors also reduce the supply risk for rare earths.

(Hitachi Industrial Equipment Systems Co., Ltd.)

16 Inverters for Overseas Markets

Since approximately 60% of inverters manufactured by Hitachi are sold overseas, along with the need to develop technologies that improve basic performance, the inverters also need to satisfy the requirements of diverse overseas markets.

The NJ600B inverter for overseas markets incorporates the functions of the current L700 series of export models. All steps from development to production were undertaken by Hitachi Industrial Equipment (Nanjing) Co., Ltd., which is based in China. Along with a product range that extends from 18.5 kW to 355 kW, models that are certified as complying with European and American standards are built on a separate production line to achieve a balance between cost and performance.

Although the inverters have been manufactured for the Chinese domestic market to date, shipments to parts of Southeast Asia will commence in 2015. To satisfy regional requirements for Southeast Asia, the inverters include a sleep mode for shutting down fan or pump operation if the output frequency is too low and can be customized using a simple sequence programming function (EzSQ) available on standalone inverters.

(Hitachi Industrial Equipment Systems Co., Ltd.)

17 New Oil Flooded Screw Compressor

Amid the growing severity of environmental problems such as global warming over recent years, Hitachi has released 22/37-kW oil flooded rotary screw compressors as next-generation products that contribute to the environment and society by saving energy. Based on the same development concepts as the current models, the new models feature greater added value that includes even better energy efficiency.

The main features are as follows.

(1) An improvement of up to 3% over current models in free air delivery is achieved through enhancements that include the

17 New oil flooded rotary screw compressor (22/37-kW air cooled model)

development of airend with new rotor profile and a new oil supply mechanism.

(2) Upgraded standard specifications to allow the operation up to an ambient temperature of 45°C achieved through enhancements to the cooling system that provide higher unit cooling efficiency, improvement of cooling performance due to the change of the cooler, and the development of a new dryer.

(3) 7.5% lower power consumption*1 is achieved through new energy-saving control functions which are provided as standard features that include predictive control of terminal pressure.

(4) All models are equipped with color touch panel and a communication board developed by Hitachi. A USB connector is provided for operational data logging and to enable data recognition and setting change from a mobile device via Bluetooth*2 dongle. Modbus*2 communication is also supported.

(5) Equipped with a motor complied with Top Runner standard (IE3 or more under IEC standard) which enters force in FY2015 as a standard feature.

(Hitachi Industrial Equipment Systems Co., Ltd.)

*1 At 60% load with 0.15-MPa pressure loss to discharge port

*2 See "Trademarks" on page 146.

18 Pump with Built-in PM Motor and Integrated Controller

To meet demand for smaller and more energy-efficient pumps, Hitachi has released a range of pumps with built-in PM motors and integrated controllers (motor capacity: 1.5 kW to 3.7 kW).

The PM motors are more efficient than similar induction motors (IMs). By taking advantage of the smaller size of PM motors, Hitachi has combined the PM motor and controller in a single unit (the PM motor controller is fitted around the motor). This results in a motor that is the same size as an IM, and Hitachi has developed the new product by fitting it on a general-purpose pump.

The pump incorporates a variety of pump control functions that Hitachi has built up through past experience with water pumps. These include controlling for constant estimated end pressure to achieve energy-efficient operation, a function for alternating between pumps that automatically shuts down pumps when water volume is low and alternates between pumps when restarting, and a function for operating two pumps in parallel for cases when there is not enough water. Hitachi has also provided ways of operating pumps to avoid interruptions to water supply, including switching between pumps such that, if a pump goes out of service due to a fault, a different pump is started instead. Further development is continuing, including the ability to operate with even greater energy efficiency by increasing the available motor capacities up to 7.5 kW.

(Hitachi Industrial Equipment Systems Co., Ltd.)

18 Inline pump (model codes: JLH and JLSH) (top) and centrifugal pump (model code: JDH) (bottom)

19 High-speed hoist rated for 30-t loads

19 High-speed Hoist Rated for 30-t Loads

For rated loads of 10 t or more, the proportion of electrically operated hoists used in overhead cranes and similar machinery is about 40%. Because electric hoists will need to outperform crab cranes if their share of the market is to expand, the major challenge is to increase speed. Also, while electric hoists typically use inverters to provide continuously variable speed drive and reduce the effect of mechanical shock during operation, in the past the regenerative energy produced while lowering a load has been dissipated as heat through a resistor.

Now, Hitachi has developed a high-speed electric hoist with a regenerative converter with the aim of saving energy by feeding regenerative energy back into the power supply. It is anticipated that demand for energy efficiency and higher speeds will continue to grow strongly in the future, not only in the Japanese market, but also internationally.

The main features are as follows.

(1) Achieves faster speeds and smaller size by using a drive system with two motors and reduction gears.

(2) Is able to detect when no load is present and operate at twice the normal rated speed.

The new model is a traversing unit rated for lifting loads of 30 t. Hitachi plans to release further models in the series in the future.

(Hitachi Industrial Equipment Systems Co., Ltd.)

20 Development of PLC Communications Module Board

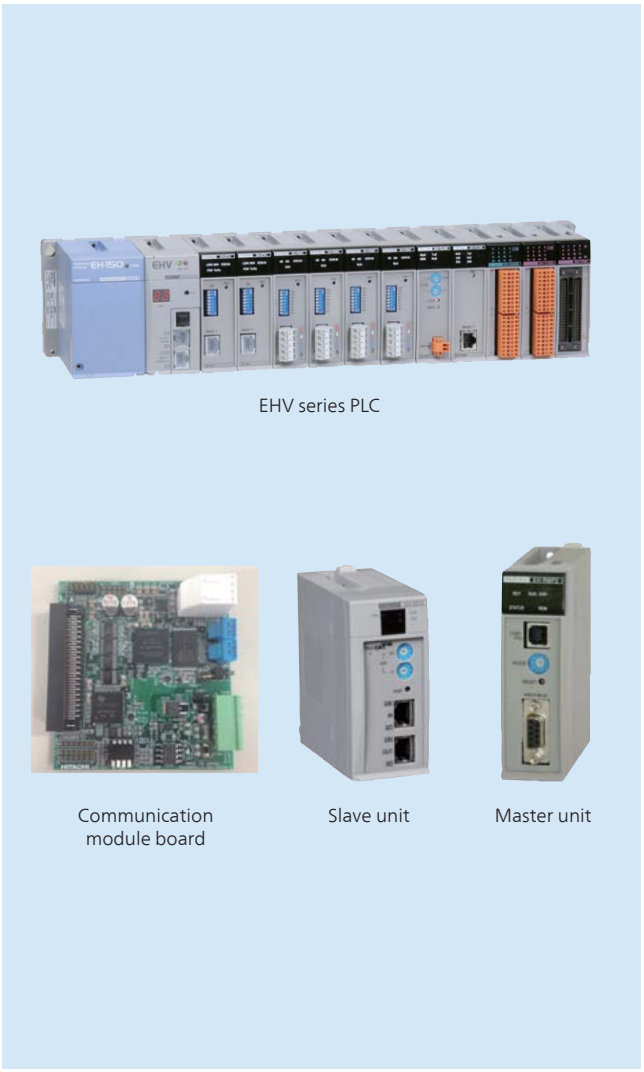
Since 1999, Hitachi has released a series of communication modules that support the PROFIBUS* and DeviceNet* open field networks for programmable logic controllers (PLCs). To get the product to market quickly, the models released as a result of the initial development were based on a separate configuration for each field network. However, this required multiple boards and levels of shared memory and therefore made it difficult to optimize both performance and price.

In recent years, there has been growing demand from both the end users and vendors of control systems to minimize the installation cabling requirements and cut the cost of maintenance, with sensors and actuators increasingly being connected to the network. The use of variable-speed motor control to save energy has also been growing, as has the installation of energy monitoring systems. Responding to demands from major customers that are planning to restructure their operations around globally distributed production sites, Hitachi has established a platform that uses processors with built-in support for industrial field network protocols and that can incorporate a variety of different communication modules at low cost.

The first product to be released, in August 2013, was an EtherCAT* slave unit, followed subsequently by a PROFIBUS/DeviceNet slave unit. The range is also being expanded to include master units for FL-net and DeviceNet.

(Hitachi Industrial Equipment Systems Co., Ltd.)

* See "Trademarks" on page 146.



20 Development of PLC communications module board

21 LTE unit for M2M communications

21 LTE Unit for M2M Communications

Hitachi has released a packet communications unit that uses the Long Term Evolution (LTE) standard for mobile phone networks for machine-to-machine (M2M) communications.

The Internet of things (IoT), meaning the networking of a variety of different devices via the Internet, has started to make its presence felt in the industrial sector, resulting in growing demand for communication devices that support LTE, which is a major new-generation mobile phone network that provides high-speed communications. Because of its high reliability, Hitachi's new M2M communication adapter is used in social infrastructure and other industrial applications, where it is used for M2M communications over the mobile phone network of the KDDI Corporation in Japan.

The main features are as follows.

(1) Equipped with a built-in LTE communications module that enables communications from any location that is covered by KDDI's LTE mobile phone network.

(2) Supports a variety of routing protocols, meaning it can be used as a LAN router as well as for LTE wireless communications.

(3) Has the same high reliability as other products in the CPTrans series, which are used for such applications as social infrastructure monitoring.

The new product can satisfy a wide range of needs, with other features including an RS-232C interface and a business plan with an inclusive communications contract.

(Hitachi Industrial Equipment Systems Co., Ltd.)

22 Three-dimensional Position Sensor

The existing image collecting Hitachi data acquisition system sensor system used to control the movements of materials handling robots includes a function for using laser range-finders to create a two-dimensional map, and a function for detecting the robot's position on the map. The aim of the research and development of the new three-dimensional position sensor was to utilize the same principles as two-dimensional position detection to create a three-dimensional map and use it for position detection.

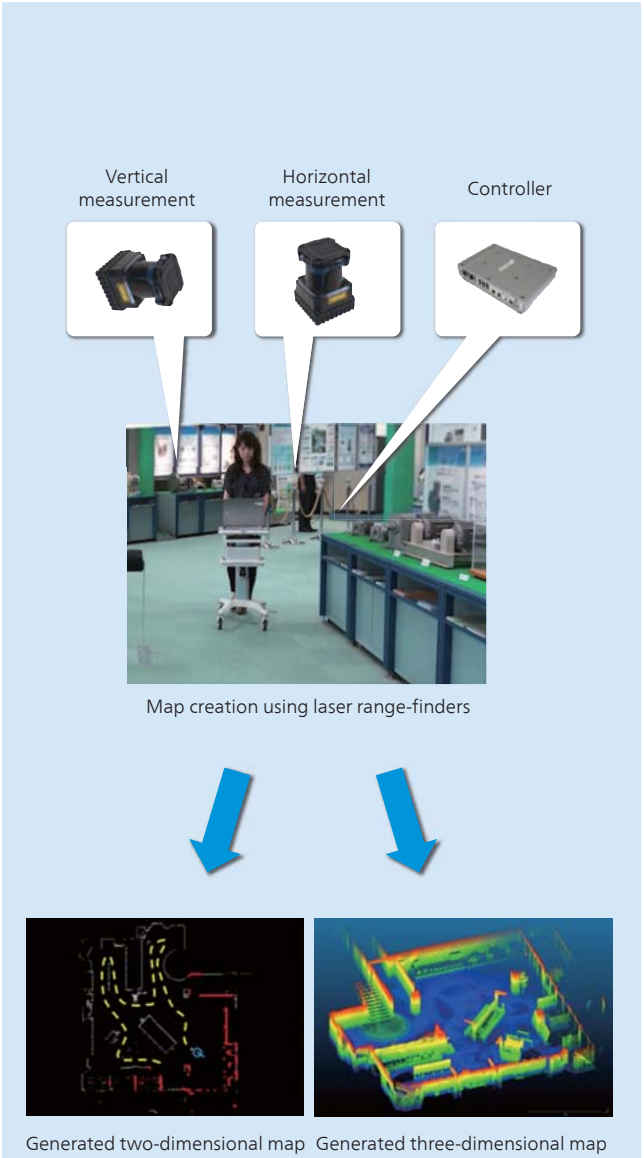
The main features are as follows.

(1) Like Hitachi positioning system, the three-dimensional map is created from measurements collected by moving the sensor around on a trolley or other vehicle.

(2) Because it uses laser range-finders, position detection is not influenced by lighting conditions as would happen with a camera.

(3) The use of two general-purpose two-dimensional laser range-finders reduces the cost compared to using a special-purpose three-dimensional laser sensor.

(Hitachi Industrial Equipment Systems Co., Ltd.)



22 Three-dimensional position sensor

RAS-AP560DN1 outdoor unit

23 "Low Ambient Model" series outdoor unit for cool-climate multi-split air conditioning systems for buildings (56.0-kW model)

23 "Low Ambient Model" Series Outdoor Units for Cool-climate Multi-split Air Conditioning Systems for Buildings

Hitachi has updated the product range for its "Low Ambient Model" series of outdoor units for cool-climate multi-split air conditioning systems for buildings, adding 33.5-kW, 40.0-kW, and 50.0-kW models to the existing 22.4-kW, 28.0-kW, 45.0-kW, and 56.0-kW models, extending the range to seven models in total, and also adding seven new upgrade models that are able to reuse existing plumbing.

The main features are as follows.

(1) Heating capacity increased by approximately 50% over Hitachi's standard multi-split air conditioner for buildings, meaning that the rated heating capacity (heating capacity for an outdoor temperature of 7°C) can be maintained for outdoor temperatures down to −10°C.

(2) Improved comfort levels when operating in heating mode thanks to a frost level detection function that reduces the frequency of defrosting by more accurately detecting the presence and level of frosting, and a new defrosting system that can switch between two different defrosting methods (hot gas bypass defrosting and reverse-cycle defrosting).

(3) Lower annual power consumption thanks to an improved freezing cycle and better use of freezing cycle control*.

(Hitachi Appliances, Inc.)

* 8% reduction compared to previous 28.0-kW model

24 Hitachi Acquires Certification of Large-scale Water Injection Pump from Saudi Arabian Oil Company

Hitachi has acquired Saudi Arabian Oil Company (Saudi Aramco) certification of its large-scale water injection pump by demonstrating high reliability and availability through successful site trial testing for more than 13,000 hours attained by applying the latest technologies, and in compliance with API 610 as well as Saudi Aramco specifications.

This water injection pump is a large capacity, high pressure, multi-stage pump, driven by an approximately 28,000-kW gas turbine (ISO rating), which delivers a high rated pressure of commingled water (seawater + brine water) at approximately 200 bar (approximately 20 MPa), and reaches deep into the oil reservoir to enhance oil production as well as to maintain oil reservoir pressure.

The main features of the Hitachi water injection pump are as follows.

(1) Ensures high reliability using a corrosion-resistant, high-intensity duplex stainless steel material for handling commingled water.

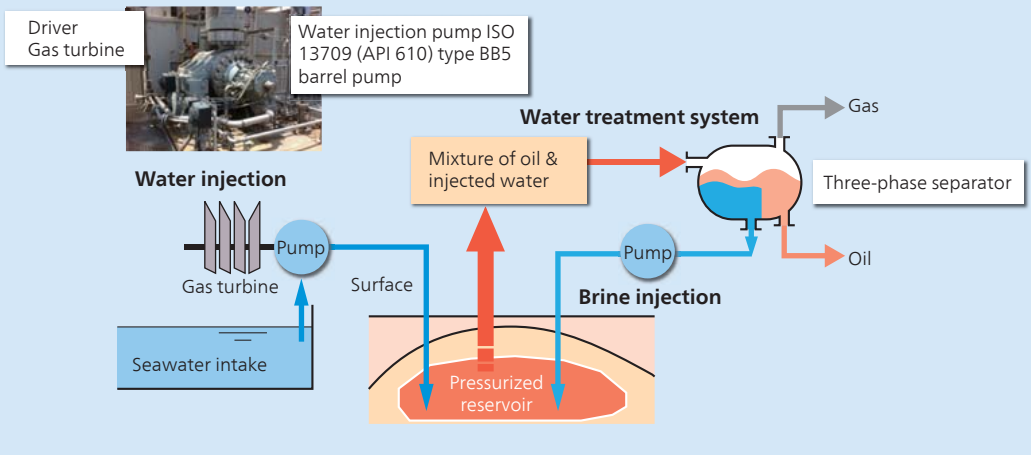
(2) Achieves better life cycle cost (LCC) with high-precision computational fluid dynamics (CFD) technology.

(3) Ensures stable operation that results in very low vibration levels, using precise rotor dynamics verification.

(4) Adoption of cutting-edge technology for shaft seals and bearings achieves compactness and longer lifetime of auxiliary equipment.

Hitachi understands the importance of providing pumps of various specifications, optimizing customer satisfaction, since each water injection pump has its own requirements that will depend on the properties of the pumped liquid and characteristics of the crude oil reservoir.

Based on this achievement, Hitachi will continue to contribute



24 Water injection system and operating condition of large-scale water injection pump (left above)

to a worldwide stable energy supply by providing reliable and efficient water injection pumps to the oil and gas industry.

25 Large-capacity Pumps for the Yellow River Water Conveyance Project

Hitachi manufactured and delivered eight main pump units for Wanjiazhai as part of the Yellow River Water Conveyance Project, one of the large-scale projects on which the Chinese government is focusing for industrializing the northwest districts of China. The pumps intake water from Wanjiazhai, a town located in the watershed of the Yellow River, and provides water to major cities in northwestern China through 400 km of water channels.

The main features of the pumps are as follows.

(1) Adopting a proprietary flow analysis method developed by Hitachi utilizing know-how gained from CFD and visualization of the internal current, the large-scale pumps have an output of 6,500 kW/12,000 kW, achieving high efficiency exceeding the customer's requirements and contributing to the reduction of life cycle costs.

(2) With an optimized coating utilizing CFD erosion prediction, the pumps can withstand the particularly abrasive characteristics of the Yellow River and operate for a long time.

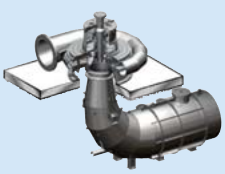
(3) High reliability is ensured by weld construction impellers that adopt steel plate vanes.

(4) Serviceability is ensured by the application of large split-type shaft seals.

The pumps have already been completely installed/commissioned, and provide a stable supply of water.

Hitachi intends to continue contributing to the development of water infrastructure through active participation in future water conveyance projects around the Yellow River based on this significant experience.

Item	High-lift pump specifications	Low-lift pump specifications
Type	Vertical-shaft, single-suction volute pump	Vertical-shaft, single-suction volute pump
Diameter	ϕ2,000 mm	ϕ2,000 mm
Capacity	6.45 m^3/s	6.45 m^3/s
Design head	140 m	76 m
Rotation speed	600 min^{-1}	500 min^{-1}
Efficiency	≥91%	≥91%
Electrical output	12,000 kW	6,500 kW
Quantity	6 units	2 units



25 Specifications (top) and exterior (bottom) of high-capacity pump for the large-scale Yellow River Water Conveyance Project (China)

26 Compressor rotor with 13 impeller stages

26 Development of a 13-stage Centrifugal Compressor

In 2013 Hitachi received an order for a hydrogen recycle gas compressor for a hydro treatment plant in Russia, with final contract delivery in 2014. The hydro treatment plant is used for removing sulfur, nitrogen, oxygen and metal from oil using a special catalyst with hydrogen. Usually for this type of API617 compressor in a hydrogen recycle service there are six or seven impeller stages in the casing to satisfy the required pressure rise in the machine. However, in this project, the hydrogen content is higher than other plants of similar design, it is 2.03 compared to a more common value of approx. 4-5. As a result, it is necessary to use 13 impeller stages to achieve the discharge pressure.

The train usually has two compressor casings, each with six or seven impeller stages but Hitachi designed a single casing compressor which applies the following technologies.

(1) To maintain the required separation margin at the 2nd critical speed, the shaft was designed with optimized stiffness.

(2) High efficiency was achieved by using a wedge type impeller developed by Hitachi.

(3) Hitachi modified the rotor assembly work and dynamic balance work, to reduce the residual unbalance of the rotor.

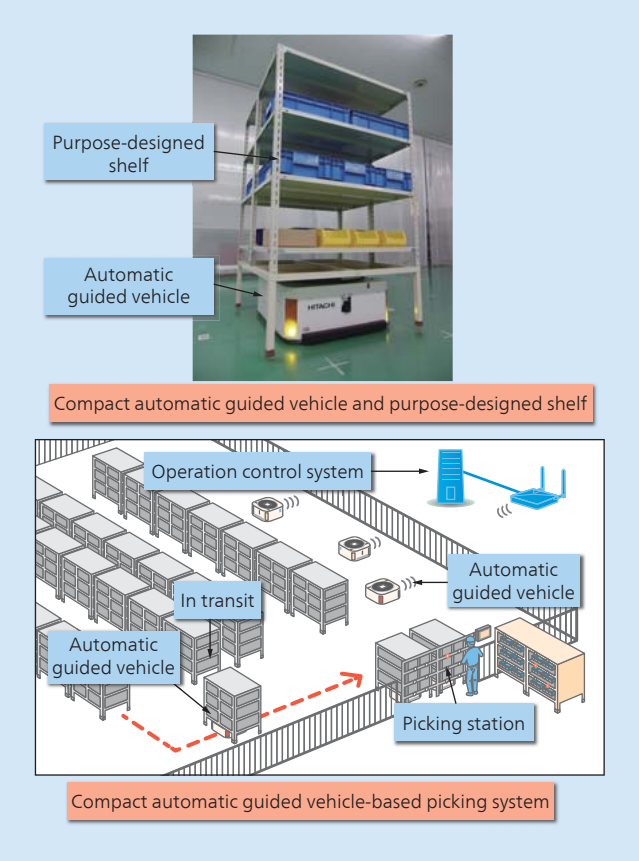
(4) Hitachi inspected the mechanical stability of the machine by carrying out an actual load and actual speed test (full load, full speed test) in our factory.

27 Picking System that Utilizes Compact Automatic Guided Vehicle

Hitachi released its newly developed compact automatic guided vehicle in September 2014.

The normal practice at a factory or warehouse is for the workers to move about on foot to pick parts, products, or other inventory from the shelves with reference to a list. The automatic guided vehicle travels to the designated location of the shelf containing the required parts or other products and brings the shelf to the worker instead of the worker doing this himself. This provides an approximate three-fold improvement in system-wide picking productivity because it allows the worker to concentrate on this task without having to move around.

The system also features other functions for improving materials handling efficiency, including locating shelves where they can be quickly retrieved based on frequency of use, or selecting a route that avoids congestion. Also, the installation cost is reduced by about 30%* of an automatic warehouse system that uses special-



27 Picking system that utilizes compact automatic guided vehicle

purpose vehicles that can insert and remove parts or products on shelves entirely automatically.

In the future, Hitachi intends to market the product actively, overseas as well as in Japan.

* Compared to an automatic warehouse system supplied by Hitachi.

28 Supply Chain Change Management Service

Pharmaceutical manufacturers make ongoing additions and changes to things like their suppliers, manufacturing methods, and sales channels with aims that include achieving sustained growth, reducing costs, and improving quality. One of the challenges facing global companies in particular and others with operations that span multiple regions is the requirement for numerous checks for the purposes of business practice consistency, legal compliance, and other matters relating to the revisions to business processes associated with these changes.

Recognizing that this challenge is one that applies to all manufacturers, not just those in the pharmaceutical sector, Hitachi is planning a service to support users in manufacturing utilizing the business know-how and information technology (IT) it has built up through consulting for manufacturers.

The service is intended to support complicated business activities by supplying, via a cloud environment, information (operation procedures, document formats, legal requirements, guidelines, etc.) that supports routine tasks and information that supports tasks that depend on know-how (past projects, past failures, analyses and predictions, etc.).

Through this service, Hitachi will help resolve problems that are shared across the manufacturing sector while also enabling individual companies to speed up their operations and improve quality (avoid problems and reduce risk).

(Service release date: FY2015)

29 Business Process Re-engineering

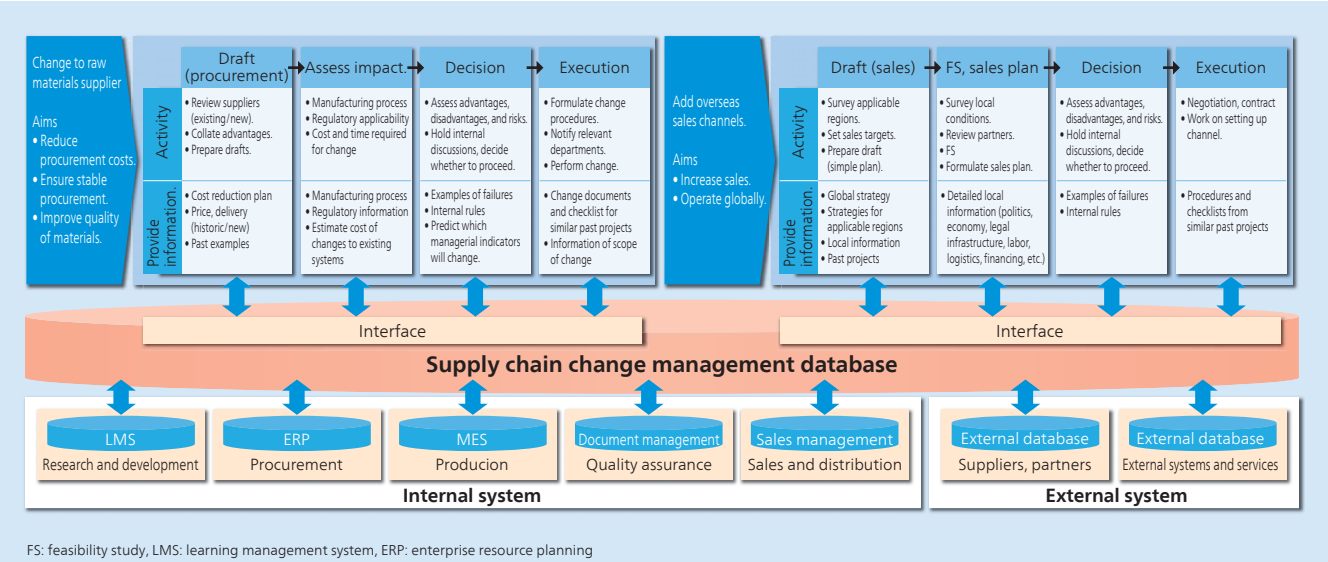
The following three points are among the challenges that are shared by global manufacturers.

(1) Faster management decision-making through earlier identification of changes

(2) Greater cost-competitiveness to take on global markets

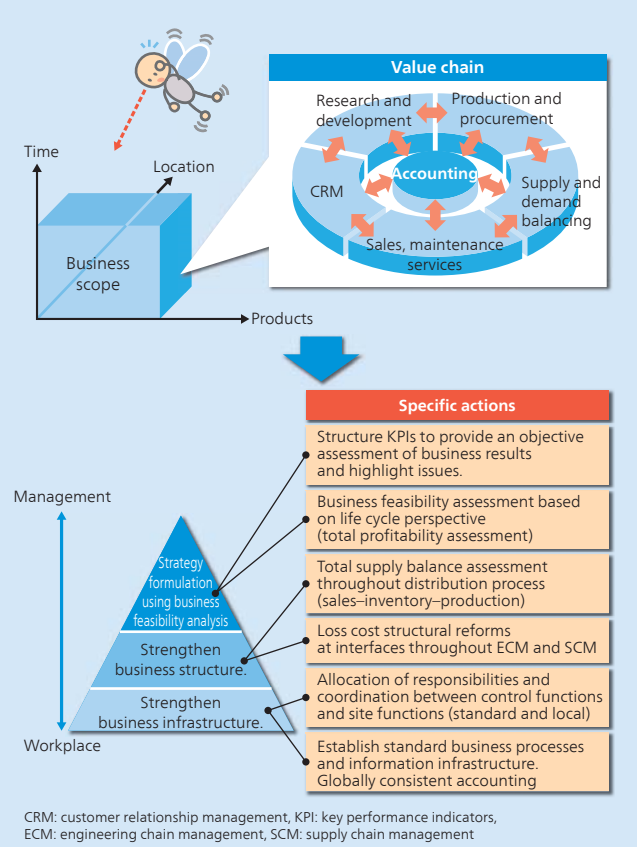
(3) Stronger governance for the effective improvement of group-wide profitability and competitiveness

The difficulties with overcoming these challenges include the broad scope of considerations, with inter-business coordination and the nature of the issues being complex, making it difficult to identify specific actions to take.



FS: feasibility study, LMS: learning management system, ERP: enterprise resource planning

28 Supply chain change management service



29 Example of key challenges for a manufacturer identified using the problem structure analysis method of business process re-engineering

Business process re-engineering is a methodology used by Hitachi to solve these difficulties. To resolve interrelated issues, it is necessary to take an objective bird's-eye view of the overall nature of the issues throughout the product supply value chain from research and development to sales and maintenance services, and to conduct a problem structure analysis. The method consists of consulting various different departments about the issues within the scope of the business being looked at (the scope may encompass the entire company, a factory, or supply chain reform, for example) to produce a single relational diagram that shows the problems throughout the scope, while also utilizing Hitachi's know-how to identify latent issues.

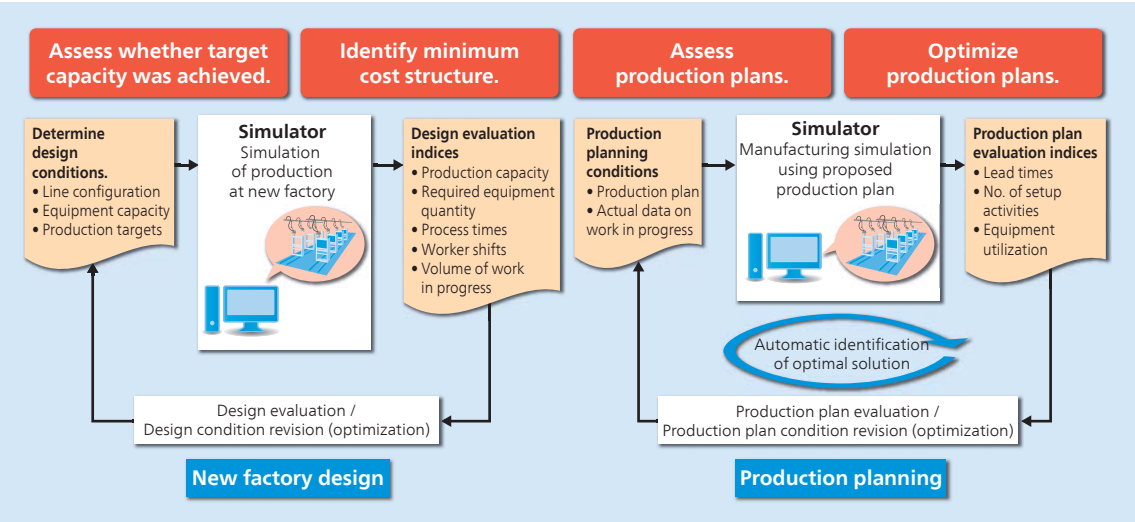
To successfully implement pragmatic reforms, it is important to obtain an accurate understanding of how things stand from the current problem structure, and to establish a realistic action plan aimed at reaching the desired outcomes.

30 Production Line Simulator

With manufacturers facing an increasingly severe environment that includes the cost reductions needed for global price competitiveness, and with factories and other facilities being located throughout the world, challenges such as improving production efficiency and cutting transportation costs have become a concern. Since factory design in the past has mainly involved settings and assessments based on experience, resulting in cases where equipment was proven to be inadequate or in excess of the requirements after the factory commenced operation, an emphasis has come to be placed on the use of simulation to assess things like target production capacity in advance.

By simulating the flow of goods, the production line simulator can be used to devise production line configurations and production plans that achieve the target throughputs and lead times, and are also appropriate in terms of resources and cost. Also, the simulator makes it easy to model processes that correspond to various different production methods by selecting and setting up elements that represent assembly and materials handling processes, setup, and other tasks. These make it possible during the design of a new production line to shorten the time taken to confirm benefits, reduce actual costs and risks at the site, and make situation assessments that do not depend on the experience of the person making them in terms of operational aspects such as assessing plans in advance, making production predictions, and devising catch-up plans that take account of work in progress.

Drawing on its know-how as a manufacturer, Hitachi supports the production line design process and operation efficiency improvement process by using production line simulation techniques that improve production line efficiency from consulting to practical application.



30 Example application of the production line simulator

Plant and Factory Equipment

1 Aluminum tandem hot rolling mill for CSAC of Taiwan

1 Aluminum Tandem Hot Rolling Mill for CSAC of Taiwan

An electrical control system for an aluminum tandem hot rolling mill supplied to the C.S. Aluminum Corporation (CSAC) of Taiwan* has commenced production and is operating reliably. The new mill was installed by CSAC downstream from an existing roughing mill with the aims of increasing production capacity and reducing production costs, with the first coil being produced only six months after Hitachi started electrical work. This contributed to an early commencement of production.

Hitachi developed mathematical models that can unify the rolling phenomena of a wide range of grades, from soft pure aluminum to hard alloy aluminum, and the system has achieved stable rolling and high strip thickness accuracy by optimizing the rolling force and roll gap, interstand tension, and other control commands. To reduce the workload associated with quality control, development, and maintenance after the plant commenced operation, Hitachi supplied a system with excellent ease-of-use and ease-of-maintenance that includes an integrated human-machine interface (HMI) that is used for operation and display by both the controllers and the information and control servers, and a network-connected 1-ms process data analysis (PDA) system that includes a coil-by-coil data collection and storage function.

* The first electrical control system for an aluminum tandem hot rolling mill (including installation) to be supplied by Hitachi outside Japan.

2 Use of New Controller for Steel Rolling Mills

Hitachi has supplied its newly developed controller for use in steel rolling mills.

In addition to combining eight circuit boards into one, including the three high-speed processing unit (HPUs) boards designed for control use that were used on the previous model, and having the capacity to install numerous modules using units, the newly developed controller uses HPU virtualization, which allows it to operate as if it had three separate HPUs. Along with a processing speed of 9.4 ns for bit instructions and support for the accelerated execution of large software, the control is also designed for improved reliability with the ability to duplex process input/output (PI/O) cabling. The new controller is also compatible with

2 New controller

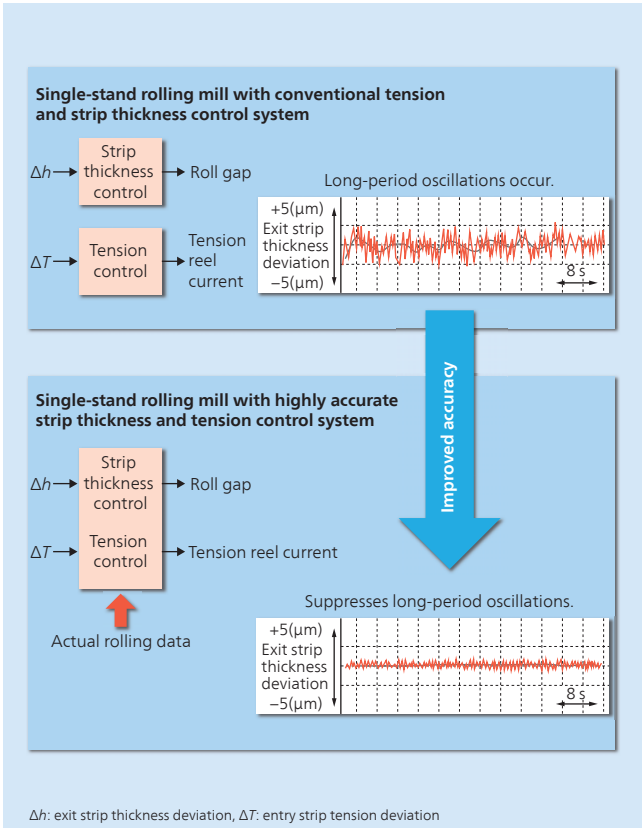
previous models in terms of both hardware and software, simplifying the re-use of PI/O and software.

It has already been installed and commissioned at a number of sites in Japan, with trial operation planned at overseas cold rolling mills and other plants.

3 Highly Accurate Strip Thickness and Tension Control System for Cold Rolling Mill

A problem that occurs when rolling thin strip at high speed on a single-stand rolling mill is long-period oscillations in the exit strip thickness (ranging from several seconds to ten or more seconds). This has made it difficult to combine the strip thickness accuracy required for product quality with the high-speed rolling needed to improve productivity. While Hitachi has dealt with this problem in the past by imposing constraints on the mechanical configuration, growing demand for high-speed rolling of products with tight product tolerances has resulted in cases where it has not been possible to meet the exit strip thickness accuracy requirements.

Now, Hitachi has conducted an analysis of the problems with conventional control techniques and has developed a highly accurate strip thickness and tension control system in which the strip thickness control and tension control used on the mill perform effective control of the roll gap and tension reel current based on actual rolling data. The control system suppresses the deviation of long-period oscillations in the exit strip thickness that occurred with conventional control techniques and improves exit strip thickness accuracy during high-speed rolling.



Δh: exit strip thickness deviation, ΔT: entry strip tension deviation

3 Highly accurate strip thickness and tension control system and its benefits

4 High-voltage, Large-capacity IGBT Inverter Drive System for Hot Rolling Mills (Second Generation)

Hitachi has supplied high-voltage, large-capacity insulated-gate bipolar transistor (IGBT) inverter drive system to new and existing hot rolling mills in Japan and elsewhere. To better satisfy the needs of users throughout the world, Hitachi has now developed a newly designed second-generation high-voltage, large-capacity IGBT inverter drive system. The system dimensions and range of available capacities have been completely revised.

The main features are as follows.

(1) Achieves long-term product availability and large output capacity by adopting the global standard 3.3-kV/1.5-kA (3.0-kAp) IGBT devices and a more advanced technique for connecting the IGBTs in series.

(2) Smaller system dimensions resulting from a simple circuit configuration. Panel width dimension is 50% less compared to similar conventional inverters (with 15-MVA capacity).

(3) The main circuits can be connected together in parallel to offer a range of different capacities and supply drive systems that match user needs. The maximum capacity is 22.0 MVA (44.0 MVA in a two-bank configuration).

(Commencement of production: October 2014)

15.0-MVA converter/inverter

Parameter	Specification				
Circuit type	NPC three-level inverter				
Compatible motors	Three-terminal			Six-terminal	
No. of converter panels	1			1 × 2 banks	
No. of cell units in parallel	1	2	3	2 × 2	3 × 2
Rated output capacity (MVA)	8.0	15.0	22.0	30.0	44.0
Rated output voltage (Vrms)	4,500				
Cooling	Water-cooled (pure water)				
Overload specifications	150%/1 min				
Conversion efficiency	98% or higher (converter + inverter)				

NPC: neutral point clamped

4 Photograph and specifications of high-voltage, large-capacity IGBT inverter drive system for hot rolling mills (second generation)

5 HITPHAMS Installations in China

The HITPHAMS* (Hitachi pharmaceutical manufacturing execution system) is one of Japan's most widely used manufacturing execution system (MES) that is compliant with good manufacturing practice (GMP), and has been supplied to approximately 140 sites in Japan (as of September 2014).

In response to the 2010 revisions to China-GMP, China Food and Drug Administration (CFDA) has required all pharmaceutical manufacturers to introduce production procedures and associated records management by 2015. Anticipating an increase in demand for MES from the more than 6,000 pharmaceutical manufacturers in China, Hitachi established an engineering center in Beijing in 2013 with the aim of entering this market. To satisfy the needs of local companies, Hitachi is working with local partners on promotional and networking activities such as participating in trade shows and holding seminars.

The first HITPHAMS installation was successfully completed at the Chinese site of a Japanese company in 2013. Installation of HITPHAMS at major Chinese pharmaceutical manufacturer has also commenced, with the first system being installed in April 2014.

In the future, Hitachi intends to take full advantage of its successes with installing HITPHAMS and on its specialist know-how in validation consulting to contribute to high-quality pharmaceutical manufacturing by companies in Japan, China, and the rest of the world.

* HITPHAMS is a registered trademark of Hitachi, Ltd. in the United States, China and Japan.

5 Use of HITPHAMS at the site of a Japanese company in China

6 High-pressure Hydrogen Filling System for Hydrogen Stations

Measures aimed at creating a "hydrogen society" that makes full use of hydrogen as an energy source are accelerating. As a future basis for "secondary energy" (usable energy produced from other primary energy sources), hydrogen is characterized by having a low load on the environment, and work is proceeding with applications such as fuel cell vehicles. Now, Hitachi has supplied a high-pressure hydrogen filling system for hydrogen stations as part of its hydrogen distribution infrastructure business.

Consisting of a high-pressure, high-capacity compressor [45 MPa, 1,500 m^3/h(Normal)], accumulator (4 m^3), and dispenser, the supplied system enables the distribution of hydrogen to filling stations on a large scale using high-pressure hydrogen tanker trucks. Handling large quantities of hydrogen at high pressure requires pipework made of high-strength materials that are resistant to hydrogen embrittlement, and Hitachi has been striving to enhance existing techniques for installation work to improve safety.

In the future, Hitachi intends to contribute to the creation of a hydrogen society in a variety of ways, including through the supply of this system, for which demand is expected to grow as use of fuel cell vehicles becomes more widespread.

6 High-pressure, high-capacity compressor (top), accumulator (middle), and dispenser (bottom)

7 Factory testing of fuel removal and transportation crane for Unit 4 at Fukushima Daiichi Nuclear Power Station (the orange object is the spring shock absorber)

7 Crane for Fuel Removal and Transportation from Unit 4 at Fukushima Daiichi Nuclear Power Station

Hitachi has developed a crane (rated load: 100 t, crane span: 21.1 m) for the removal and transportation of spent fuel from Unit 4 at the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Co., Inc.

The crane is located inside the new enclosure built around the reactor building (which has appeared from time to time in the Japanese media), where it is used to lift out steel casks that contain spent fuel and transport them out of the reactor building. A major feature of the crane is that it has been fitted with a large spring shock absorber that was designed specifically to minimize the effect of shocks to suspended casks that might occur during an earthquake. Hitachi worked with the spring manufacturer to conduct a series of design studies and verification tests to develop a new large spring shock absorber of a type never before used in an overhead crane.

The entire process from design to installation of a crane in a reactor building normally takes about five years. In this case, however, the people involved were galvanized by a strong sense of purpose, and together with cooperation from companies across the Hitachi Group, they succeeded in delivering the crane to the site in little more than a year, and had it in operation within a total elapsed time of less than two years.
(Hitachi Plant Mechanics Co., Ltd.)

8 Industrial LED Lighting

With demand over recent years for energy efficiency and electricity savings in all areas of society, the use of light-emitting diode (LED) lighting with low power consumption and long life is steadily growing in the home, and in retail, office, and other commercial buildings. There is also growing demand for the installation of LED lighting at industrial sites such as factories or in overhead cranes. Demand is also forecast for the replacement market as restrictions on mercury vapor lighting imposed by the Minamata Convention on Mercury come into force in 2020. In order for LEDs to be used for industrial lighting, however, it is essential to minimize the negative effects on products of harsh environmental conditions that include vibration, shock, dust, and wide temperature variations.

To satisfy these requirements, Hitachi has been working on LED lighting that has excellent tolerance for such environments, and by making various design improvements, has succeeded in developing a new and highly reliable LED lights for industrial uses. The development included performance testing for vibration and shock (vibration: 0.5 G, shock: 5 G), dust tightness (IP6X protection rating), proofing against water immersion (IPX7), high temperatures and humidities [60°C, 95% relative humidity (RH)], heat cycle (−30°C to 60°C), and electrical noise tolerance [1 μs ± 1,500 V during operation (in-house standard time) and 1 μs ± 2,000 V when not in operation (in-house standard time)]. This succeeded in developing lights that have a long design life of 60,000 hours.
(Hitachi Plant Mechanics Co., Ltd.)


8 Industrial LED lights installed on a crane

Medical Equipment and Systems

1 SCENARIA (left) and simple dose report screen (right)

1 64/128 Slice CT System SCENARIA

64/128 slice CT System SCENARIA*, released in 2012, realizes 0.35 s/rot scans not only for cardiac scanning but also for whole body scanning with a high-speed data sampling technique and CORE method (3D reconstruction algorithm) which enables high pitch scans. Furthermore, the image noise reduction technique applied by the iterative reconstruction technology was integrated as a standard function.

Recently, there is increased concern regarding medical irradiation all over the world due to the Japanese nuclear power plant disaster in 2011, and a research paper about the possible increase of cancer risk from pediatric computed tomography (CT) scans published in Lancet, the British medical journal in 2012.

Therefore, Hitachi Medical Corporation released a new version of its software and applied it to SCENARIA, which realizes not only the improvement of performance and diagnosability for high speed scan and cardiac examination, but also the optimization of image quality and dose amounts, and controlling the dose information of each patient. In this new version of the software, a simple dose report function is integrated for transferring the dose information as a secondary capture to a picture archiving and communication system (PACS) after CT scan. By the use of an image viewer, it enables the requesting doctor to check the clinical images with dose information easily.

(Hitachi Medical Corporation)

* SCENARIA is a trademark of Hitachi Medical Corporation.

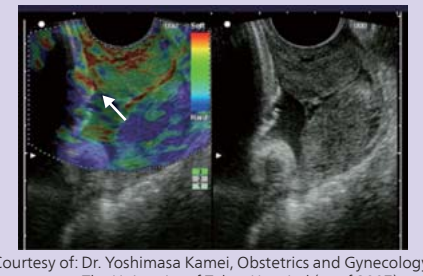
2 Development Technology for Diagnostic Ultrasound Systems Used to Manage Health of Mother and Fetus

Advances in the technology for diagnostic ultrasound systems used for perinatal care are creating applications that have the potential to obtain new knowledge by expanding the uses for these systems.

Early pregnancy
Fetus is represented as a silhouette with a light source located behind it.

Early pregnancy (twins)
The relative positions of the two fetuses are shown using shading.

Late pregnancy (baby's face)
The baby's face is represented using a light source from above to show the hollows around the eyelids and the shaded contours of the nose and mouth.



Courtesy of: Dr. Yoshimasa Kamei, Obstetrics and Gynecology, The University of Tokyo Hospital (as of 2007)

Case of threatened premature delivery
The anterior lip of the cervical canal is shaded from green to red (see arrow) and appears softer than is normal for a mid-term pregnancy.

2 4D fetus (left) and elastography (right)

4D fetus enhances brightness and shading using a rendering technique with a virtual light source, producing realistic representations of the fetus's face, expression, and skin texture. Fetal images that replicate a naked-eye view through an endoscope can promote a mother's sense of attachment to her child and help foster maternal feelings.

Hitachi Medical Corporation led the world in announcing elastography, a technology for generating realtime images of the elasticity of tissue. The technology has potential as a technique for detecting and predicting premature delivery and other fetal conditions by viewing the hardness of the fetus's lungs, kidneys, and other organs, and of the mother's cervix.

Hitachi believes that it can provide a high level of reassurance to expectant mothers and other patients by contributing to clinical advances in perinatal care through technologies that support maternal risk management and the diagnosis of fetal disease.
(Hitachi Aloka Medical, Ltd.)

3 Four New Applications Added to Hitachi 1.5T Superconducting MRI System

Hitachi has enhanced the Hitachi superconducting magnetic resonance imaging (MRI) system, creating new system software including four additional Hitachi's original applications designed to deliver new clinical benefits.

The first application is intended to make it easier to see changes in hemodynamics (blood circulation), which are caused by stenosis or other factors. Hemodynamics is determined by selectively suppressing the blood flow signal, using the application combined with time-of-flight (TOF) imaging of a pencil beam pre-saturation pulse that uses regional excitation. By performing imaging with the pencil beam pre-saturation pulse set on a specific blood vessel, the blood flow signal from the blood vessel can be suppressed, and then the hemodynamics of the specific area can be described. This can be done using a technique similar to magnetic resonance digital subtraction angiography where the difference between images with and without a pencil beam saturation pulse is taken and visualized in black and white inverted display.

The second application is Veins and Arteries sans Contrast – Fast Spin Echo (VASC-FSE), one of the non-contrast magnetic resonance angiography (MRA) methods for the lower limbs, which is created based on the difference of blood flow speed between systole and diastole phases.

The third application is a fat/water separation application which applies the Dixon method of fat suppression based on the difference in frequency between water and fat.

The fourth application is T2 map which improves the ability to identify tissue degeneration by using a color map to display changes in the T2 value.

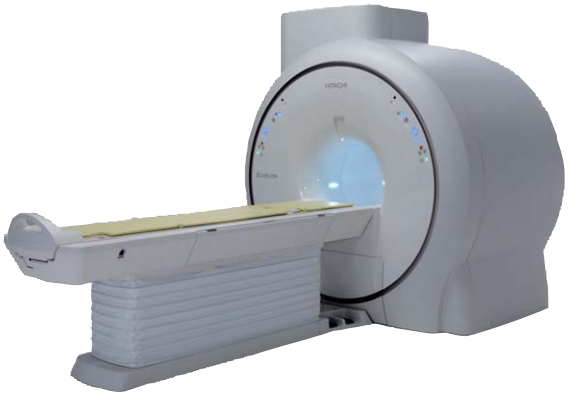
In the future, Hitachi intends to continue using Hitachi's own technologies to develop MRI systems in pursuit of enhanced clinical benefits.
(Hitachi Medical Corporation)

4 Mobile X-ray System with Wireless FPD

As X-ray systems increasingly shift toward digital technology, mobile X-ray systems are also adopting digital radiography (DR) using flat panel detectors (FPDs) in place of computed radiography (CR) using an imaging plate (IP).

DR is able to provide on-the-spot images without the need to swap cassettes in order to take additional images or multiple images, and can achieve higher throughput when fitted with a wireless FPD. This not only makes it easier to take X-rays of patients in the ward, it also expands the scope of uses to encompass situations such as emergency first aid, disasters, operating theatres, or the response to an infectious outbreak.

The increasing number of female technologists in recent years has also created a need for light and compact systems that are easy to operate. To meet this need, Hitachi has developed the system, which includes all of the features of the series of mobile X-ray systems, including Hitachi's proprietary pantographic arm technology and "mono-tank" X-ray generator, and also has a wireless FPD for faster throughput and the ability to display images within 3 seconds of exposure.
(Hitachi Medical Corporation)



3 Four New Applications Added to Hitachi 1.5T Superconducting MRI System

4 Mobile X-ray system (left), wireless FPDs (top right), and 15-inch monitor (bottom right)

Measurement/Analysis Equipment

1 SU5000 FE-SEM

Field emission-scanning electron microscopes (FE-SEMs) are used in a wide range of research and development and industrial applications. While there has been steady improvement in the performance and functionality of these systems in recent times, the wider range of users has also created a demand for systems that can acquire data at a level that reflects this performance, regardless of the user's skill.

The newly developed SU5000 features a new user interface that can acquire images that suit the intended purpose regardless of the user's skill level. Instead of having users determine the measurement conditions themselves, images with high resolution and contrast can be obtained without the need for complicated system operation by having the user specify the purpose (such as surface information or material distribution), and then automatically applying the settings needed to achieve this. For experienced operators, on the other hand, the interface still allows the system settings to be specified directly.

To suit a wide range of observation and analysis applications, the system can deliver a high level of maximum current (200 nA). Hitachi intends to contribute to leading-edge materials development and research by satisfying requirements for materials observation and analysis that will become increasingly diverse in the future, such as its newly developed backscattered electron detector and secondary electron detector in low vacuum conditions.
(Hitachi High-Technologies Corporation)

1 SU5000 FE-SEM

2 TM3030Plus tabletop microscope

2 TM3030Plus Tabletop Microscope

Hitachi's series of tabletop microscopes use low-vacuum observation that provides higher magnification than optical microscopes and can be used for energy dispersive X-ray spectrometry (EDX) analysis (available as an option) to view insulators or other samples that contain moisture or oils without the need for special preparation. With automatic functions and a design that pays careful attention to simple operation, the series of microscopes are suitable for people who have never used an electron microscope before.

While the main role of these tabletop microscopes in the past has been to provide an easy way to make observations at a higher magnification than is possible with an optical microscope, electron microscopes have in recent years also come to be used for screening purposes.

To satisfy these increasingly diverse needs, a secondary electron detector has been added to the newly developed TM3030Plus. While past models have used backscattered electron imaging to view the sample's structure or contours, the highly sensitive secondary electron detector for use in low vacuum conditions that is included in high-end models, allows the use of secondary electron imaging to view microscopic features on the sample surface.

Hitachi is contributing to fields such as research and development and quality assurance by satisfying the increasingly diverse needs of the growing market for tabletop microscopes.
(Hitachi High-Technologies Corporation)

3 Chromaster 5610 MS detector for high-speed liquid chromatographs (left) and interior view (atmospheric-pressure ion filter) (right)

3 Chromaster 5610 MS Detector for High-speed Liquid Chromatographs

Mass spectrometers are an important form of detector used to obtain information about material mass (mass spectrum) primarily in research and development in the pharmaceutical, chemical, and food industries. Large mass spectrometers suffer from a number of issues, including uncertainty about how to operate and maintain them, with special requirements as to where they can be installed.

Designed to be lighter, more accurate, and compact, the new Chromaster* 5610 mass spectrometry (MS) detector is intended for high-performance liquid chromatograph (HPLC) users and features a quadrupole mass spectrometer that, by obtaining mass information, can deliver significant improvements in the reliability of qualitative analysis. It provides greater flexibility in terms of where it can be installed, the same installation footprint as the Chromaster high-speed liquid chromatograph, the ability to operate on a 100-V alternating current (AC) mains power supply, and reduced use of nitrogen gas. With the significant improvement of maintenance through the inclusion of a newly developed atmospheric-pressure ion filter, the Chromaster 5610 MS detector is helping to satisfy new analytical requirements by avoiding the problems of large mass spectrometers and overcoming their installation difficulties.

(Hitachi High-Tech Science Corporation)

* Chromaster is a trademark of Hitachi High-Technologies Corporation.

4 STA7200RV Simultaneous Thermogravimetric Analyzer

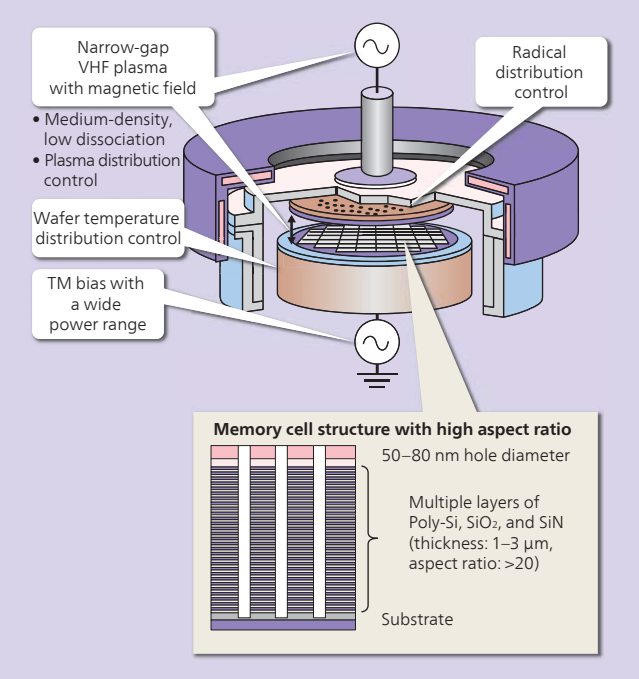
Thermal analyzers measure the thermal properties of materials. They are widely used in applications such as materials research and development, quality assurance to perform analyses such as differential thermal analysis (DTA) (which measures the heating and cooling of a material), differential scanning calorimetry (DSC), thermogravimetry (TG), thermo-mechanical analysis (TMA), and dynamic mechanical analysis (DMA).

The STA7200RV simultaneous thermogravimetric analyzer includes a "sample observation option" that uses a charge-coupled device (CCD) camera to observe visible changes in the sample while it is also undergoing TG and DTA measurements. This means that visible changes in the sample that occur during heating, and that are not evident during conventional thermal analysis, can be observed and assessed along with the measurement results. Also, a new heating furnace design with a sample observation window (view port) makes it possible to measure and observe samples at temperatures up to 1,000°C, allowing the visual observation of such processes as the decomposition of organic polymers or the melting or transition to glass of inorganic materials.

(Hitachi High-Tech Science Corporation)

4 STA7200RV simultaneous thermogravimetric analyzer fitted with sample observation option (top) and heating furnace design with view port (bottom)

Semiconductor Manufacturing and Inspection Equipment



1 Plasma etching technology for multiple layers with high aspect ratio

1 Plasma Etching Technology for Multiple Layers with High Aspect Ratio

Non-volatile memory has underpinned the spread of such technologies as smartphones, tablets, and cloud computing. Now, three-dimensional memory, in which memory cells are layered vertically, has reached the stage of commercialization for this application. In addition to working with high aspect ratios, the etching process for layered memory cells also requires a technology that can simultaneously perform high-speed vertical processing of the layers of different materials, including polycrystalline silicon (poly-Si), silicon dioxide (SiO_2), and silicon nitride (SiN).

To achieve this, Hitachi has developed an etching technology that uses a very high frequency (VHF) plasma with magnetic field to process multiple layers with a high aspect ratio. The technology is able to perform high-speed vertical processing of high-aspect ratio structures using a medium-density plasma in which low dissociation is generated by a parallel plate reactor with a narrow gap, and time modulation (TM) bias with a wide power range for ion energy control. By using technologies such as magnetic field control of the plasma distribution, radical distribution control, and wafer temperature distribution control, the technology also achieves high productivity by improving the uniformity of the etching speed, shape formation and other processes on the wafer surface.

(Hitachi High-Technologies Corporation)

2 Next-generation LS9300 Wafer Surface Inspection System

The ongoing shrink in design over recent years of the memory, processors, and other semiconductor devices used in smartphones, tablets, and personal computers has further increased the importance of reducing wafer defects and contamination in the semiconductor manufacturing process.

The LS9300 wafer surface inspection system can detect defects on unpatterned wafers with a mirror-finished surface. Applied technology of throughput laser scattering achieves high sensitivity and high detection of small contaminants and various types of defects on wafer surfaces prior to patterning. Defects such as discontinuity or shallow scratch flatness defects, water marks, epi stacking faults, protrusions by the polishing process, and flatness defects caused during deposition cause problems in next-generation processes. The LS9300 achieves high sensitivity by detecting the light scattered from defects while suppressing background noise from the wafer surface. It is widely adopted to control contamination in the manufacturing of semiconductors on the 10-nm scale, and for delivery and incoming wafer quality control.

The main features of the LS9300 wafer surface inspection system are as follows.

(1) Short-wavelength laser and a new highly efficient design of optical detector achieve 24-nm*1 sensitivity

(2) High productivity with a throughput of up to 80 wafers per hour*2

(Hitachi High-Technologies Corporation)

*1 Sensitivity varies depending on the nature of the wafer surface. Quoted sensitivity is for standard polystyrene latex particles on a bare Si wafer.

*2 In high-speed mode with 32-nm sensitivity at 300-mm wafers

2 Next-generation LS9300 wafer surface inspection system

Electronic Equipment and Power Tools

1 SK-UHD4000 4K broadcast camera

1 4K Broadcast Camera for the Next Generation of Broadcasting

Test transmissions have commenced using the new 4K broadcast standard with four times the resolution of high definition (HD).

Hitachi has developed the SK-UHD4000, a 4K broadcast camera that provides the same ease of operation and maintenance as HD and allows broadcasters to continue using their HD lenses even when operating at 4K resolution. By resolving the problems associated with 4K broadcasting, such as reduced sensitivity, this groundbreaking 4K broadcast camera facilitates program production, especially live sports coverage.

The main features of the SK-UHD4000 are as follows.

(1) The camera can use existing HD lenses without the need for an adaptor or the special lenses previously required for shooting in 4K, thereby allowing broadcasters to continue using their valuable stock of HD lenses.

(2) Uses a 2/3-inch metal oxide semiconductor (MOS) sensor with high sensitivity and low noise and a precise technique for optics alignment to achieve 4K resolution, realistic color reproduction, and the same high sensitivity and wide dynamic range as an HD camera.

(3) Camera unit uses proprietary digital image signal processing, optical transmission, and a highly efficient power supply to achieve low power consumption similar to that of Hitachi's HD cameras.

(Hitachi Kokusai Electric Inc.)

2 Highly Practical Nailer and Durable, Heavy Duty Air Compressor with High Operating Pressure

Pneumatic nailers that operate on compressed air are widely used in housing construction. In Japan, the construction quality requirements related to earthquake and fire safety have been strengthened since the Great Hanshin Earthquake, including the use of more fastening nails to improve seismic strength and the use of hard materials to improve fire safety. Accordingly, nailers must be capable of continuous reliable operation.

In response, Hitachi has fitted its nailers with an industry-first*1 three-level pressure setting that reduces air consumption by allowing the user to change the nailing force as they work to suit the size of nail being used. Hitachi has also improved the basic performance of the high-pressure air compressor by providing it with a class-leading*2 tank capacity to ensure a reliable supply of compressed air, and a new compressor unit that features excellent durability. Because of problems with theft due to the compressor being located away from the user, it is also fitted with an anti-theft function.

The main features of the NV65HR nailer and EC1445H2 high-pressure air compressor are as follows.

(1) The NV65HR nailer has an industry-first three-level pressure setting to eliminate wasteful air use by allowing the user to select an appropriate nailing force as they work (30% reduction in air consumption).

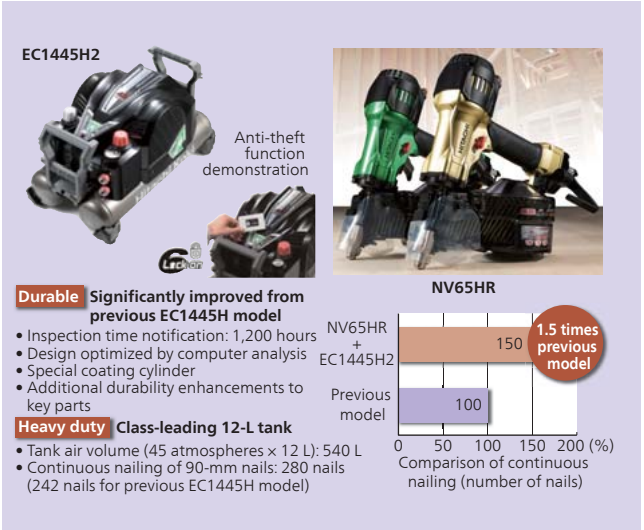
(2) EC1445H2 high-pressure air compressor has a class-leading tank capacity (540 L) to deliver reliable pressure, and improved durability due to use of a new compressor unit (2.4 times more durable than previous models). It is also fitted with an anti-theft function based on near field communication (NFC).

(3) Used together, the NV65HR and EC1445H2 provide a significant improvement in capacity for continuous nailing (1.5 times previous models).

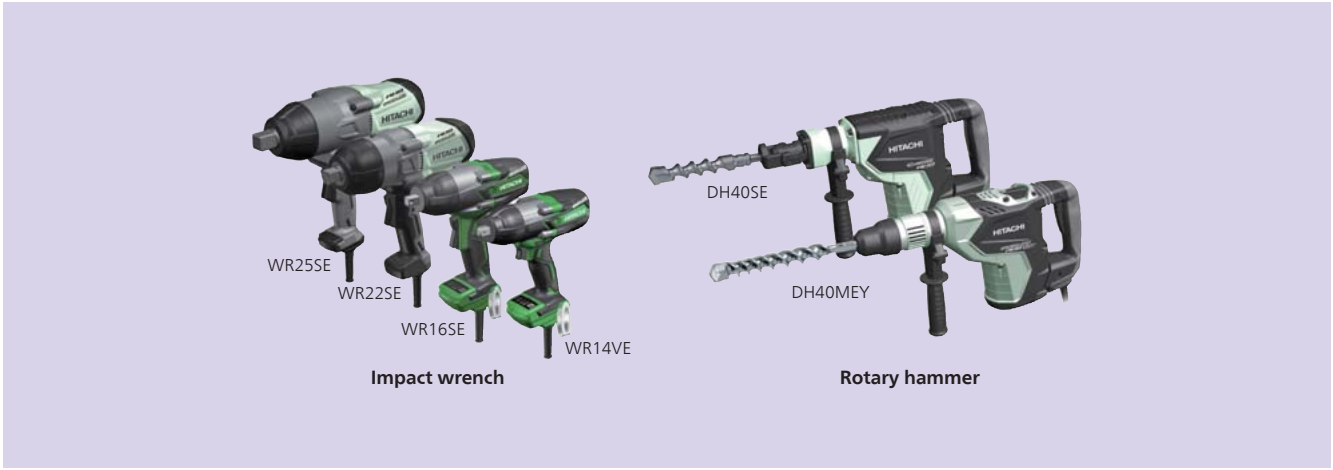
(Hitachi Koki Co., Ltd.)

*1 As of September 2014, among Japanese pneumatic tool manufacturers (researched by Hitachi Koki Co., Ltd.)

*2 As of February 2014, for 16-kg-class high-pressure air compressors made by Japanese power tool manufacturers (researched by Hitachi Koki Co., Ltd.).



2 Highly practical nailer and durable, heavy duty air compressor with high operating pressure



3 Impact wrench (left) and rotary hammer (right) with AC brushless motors and double-insulated aluminum housings

3 Impact Wrench and Rotary Hammer with AC Brushless Motors and Double-insulated Aluminum Housings

Impact wrenches are used for tightening bolts in the construction of buildings and other infrastructure, and rotary hammers are used for concrete drilling and chipping. In addition to being small, lightweight, and durable with a long life, these tools require better performance in situations with poor power supply quality and the ability to operate from an engine-powered generator.

New models from Hitachi feature a highly efficient industry-first*1 alternating current (AC) brushless motor and double-insulated aluminum housings (a die-cast aluminum body and inner plastic sleeve*2) for small size, light weight, durability, and long life, along with Hitachi's proprietary electronic control technology to ensure reliable operation when using an extension cord or engine-powered generator.

The main features of these power tools are as follows.

(1) Highly efficient industry-first AC brushless motor and double-insulated aluminum housing for small size and light weight (motor is 20% smaller) together with durability.

(2) Proprietary electronic control technology detects voltage and adjusts output to compensate for voltage drops. Capable of operating from an engine-powered generator.

(3) Maintenance-free, with durable long-life motor that does not require replacement of carbon brushes.

(Hitachi Koki Co., Ltd.)

*1 As of November 2014, among power tool manufacturers (researched by Hitachi Koki Co., Ltd.)

*2 Excluding WR14VE and WR16SE

4 Portable Cordless High-pressure Washers

The household use of high-pressure washers has grown in recent years, with further demand growth anticipated from leisure, agricultural, and other cleaning applications where no power supply is available, and from cleaning services as the numbers of the very elderly and households in which both partners work continue to grow. In response, Hitachi has developed industry-first*1 portable cordless high-pressure washers that use lithium-ion batteries designed for power tools.

The high-pressure washers have a maximum discharge pressure of 2.0 MPa (roughly seven times mains water pressure) and excellent water conservation performance, and are capable of operating using only one-sixteenth as much water as washing with mains water. The new models are intended not only for household use, but also for the commercial cleaning market, with a variable pressure setting that makes the units suitable for a wide range of applications, and a highly efficient brushless motor that ensures durability and a long battery life.

The main features of the high-pressure washers are as follows.

(1) Very portable, with a compact, lightweight, all-in-one design that does not require a nearby power or mains water supply.

(2) Powerful cleaning performance with a maximum discharge pressure of 2.0 MPa during cordless operation, and a variable pressure setting to suit a wide range of applications.

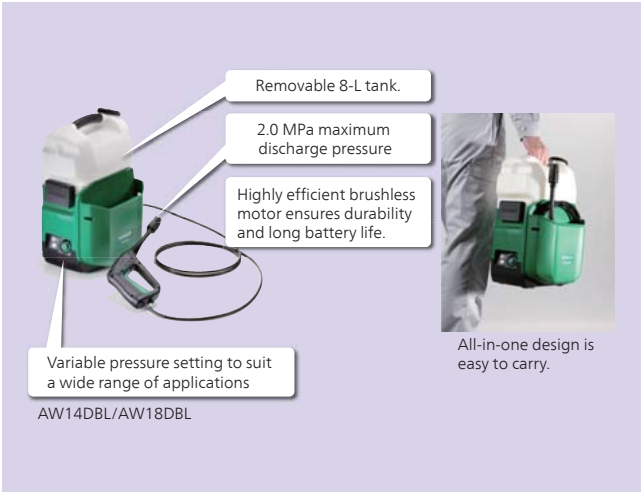
(3) Highly efficient brushless motor ensures durability and long battery life*2.

(4) Continuous operation using either the mains water supply or its own removable 8-L tank.

(Hitachi Koki Co., Ltd.)

*1 As of November 2014, among Japanese power tool manufacturers (researched by Hitachi Koki Co., Ltd.)

*2 Operating time per battery charge is approximately 30 minutes for the AW14DBL and 35 minutes for the AW18DBL.



4 Portable cordless high-pressure washers

Construction Machinery

1 Hybrid wheel loader ZW220HYB-5B

1 Hybrid Wheel Loader ZW220HYB-5B

In order to respond to the market demand for "environmentally-conscious construction machinery," Hitachi developed the world's first*1 mass-produced medium-size ZW220HYB-5B hybrid wheel loader, employing the power electronics technology that it cultivated.

This product employs a series-hybrid configuration that combines a diesel engine and an electric motor for the running system. In addition, since the product uses electrical energy instead of the conventional torque converter and transmission for its drive-train, energy efficiency is higher.

The main features are as follows.

(1) Reduces fuel consumption by 26%*2 compared with the ZW220-5B (which uses a torque converter) of the same class.

(2) Significantly reduces ambient noise through a smaller engine with a lower-rotation per minute (RPM) motor made possible through hybridization.

(3) Variable speed enables stress-free driving operability.

(4) Driving and loading operations can be independently controlled, enabling higher operability for driving and machine work.

(Hitachi Construction Machinery Co., Ltd.)

(Scheduled production start date: Spring of 2015)

*1 According to a study by Hitachi Construction Machinery Co., Ltd.

*2 Comparison based on company evaluation standards.

2 Wheel Loader that Complies with Japan, Europe, and USA Emission Standards ZW140/150-5B

The ZW140/150-5B wheel loader, which is now being sold, reduces environmental load while achieving a high level of workability, and complies with the latest emission standards in Japan, Europe, and the USA.

The product is equipped with an engine control system that determines the operating condition by using various sensors installed on the vehicle, and achieves low fuel consumption. It achieves a 10% reduction in fuel consumption compared to conventional loaders. In addition, the built-in cab has the same basic design as the European model, which emphasizes comfort, increasing the marketability of this product. For example, the quality of the panels inside the cab has been improved, and the noise level has been significantly reduced.

Other features are as follows.

(1) Two modes are available: standard mode, which reduces wasteful energy loss, and P mode, which emphasizes acceleration and heavy-duty excavation.

(2) Comes equipped with a first-gear speed limit switch that simplifies operation at narrow sites.

(3) Comes equipped with a muffler filter that collects and burns particulate matter (PM) in an exhaust gas after-treatment device.

(4) Is equipped with an eco-mark indicator that promotes fuel-efficient operation.

(Hitachi Construction Machinery Co., Ltd.)

2 Wheel loader ZW140-5B (left), ZW150-5B (right)

3 Operational Test of Hybrid Hydraulic Excavator Using only Next-generation Algae Biofuel

The significant issue with biofuel, which contributes to the reduction of carbon dioxide (CO_2) emissions, is how it competes with food. In recent years, microalgae that produces oil has been gaining attention as a material that can be used to solve this issue. The oil production efficiency of microalgae is some dozen to several hundred times higher compared to other oil-producing crops. Therefore, it is looked upon favorably as a method to reduce the dependency on fossil fuels without impacting the food supply.

As part of research conducted regarding fuel diversity, attention was given to next-generation biofuels produced from algae, and verification tests were performed accordingly. Among a dozen companies in the world, Solazyme, Inc.'s Soladiesel$_{RD}$*1,2 was chosen as the fuel for this test, and information required to perform the test was collected through analysis of fuel properties and basic examination of related parts.

In the verification test, Koriyama Plied Timber Factory of Maeda Road Construction Co., Ltd. helped operate the hybrid excavator ZH200. By using Global e-Service, a satellite communication system, the operating status was continuously monitored and the goal of 500 operation hours (specified in November 2013) was achieved.

(Hitachi Construction Machinery Co., Ltd.)

*1 Soladiesel$_{RD}$ is microalgae fuel that is supplied by Solazyme, Inc.
*2 See "Trademarks" on page 146.

4 Tire Roller ZC220P-5

Tire rollers are used for rolling compaction work at various sites, for instance, road construction sites, and ZC220P-5 is the latest tire roller model by Hitachi Construction Machinery Co., Ltd. This tire roller is environmentally conscious, and complies with the emission regulations for Non-road Special Motor Vehicle Act of 2011. It also satisfies noise regulations for construction machinery specified by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. The main features of the ZC220P-5 are as follows.

(1) Safety

Its large three-tiered steps make getting on and off easy. In addition to satisfying the "1×1 m" European vision standard, it is equipped with a backward guard sensor as an additional safety

3 Exterior of the testing vehicle (ZH200) (left) and microalgae sample (right)

4 Front (left) and back (right) of tire roller ZC220P-5

device that detects people and obstacles.

(2) Workability

It is equipped with a hydrostatic transmission (HST) enabling the vehicle to start and stop smoothly. A new water sprinkling control function is employed that allows the appropriate amount of water to be sprinkled depending on to the vehicle speed. In addition, it also employs a solution spraying function that allows solution (equivalent to one tire revolution) to be sprayed by pressing a single switch.

(3) Maintainability

The water sprinkler and solution spray nozzles can be attached and detached by pushing a single switch. Filtering functions are grouped next to the three-tiered steps for convenience, reducing the maintenance load.

(Hitachi Construction Machinery Co., Ltd.)

5 Hydraulic Excavator that Complies with Japan, Europe, and USA Emission Standards ZX120-5B, ZX135US-5B

The ZX120-5B and ZX135US-5B are 12-t weight class excavators that comply with the regulations for reducing CO_2 to control global warming and the emission regulations in Japan, Europe, and the USA (Non-road Special Motor Vehicle Act of 2011, Stage III B, iT4). For the hydraulic system, these excavators employ excavation speed acceleration and boom regeneration systems to achieve both workability and fuel efficiency. As a result, they achieve a 5% to 7% reduction in fuel consumption while maintaining the same operability as conventional excavators. Also, the PM discharged from the engine is collected inside the muffler filter and effectively processed using a unique emission temperature control. This results in about 90% PM reduction. In addition, with a variable type turbocharger and high-capacity cooled exhaust gas recirculation (EGR) system, nitrogen oxide (NOx) is also reduced.

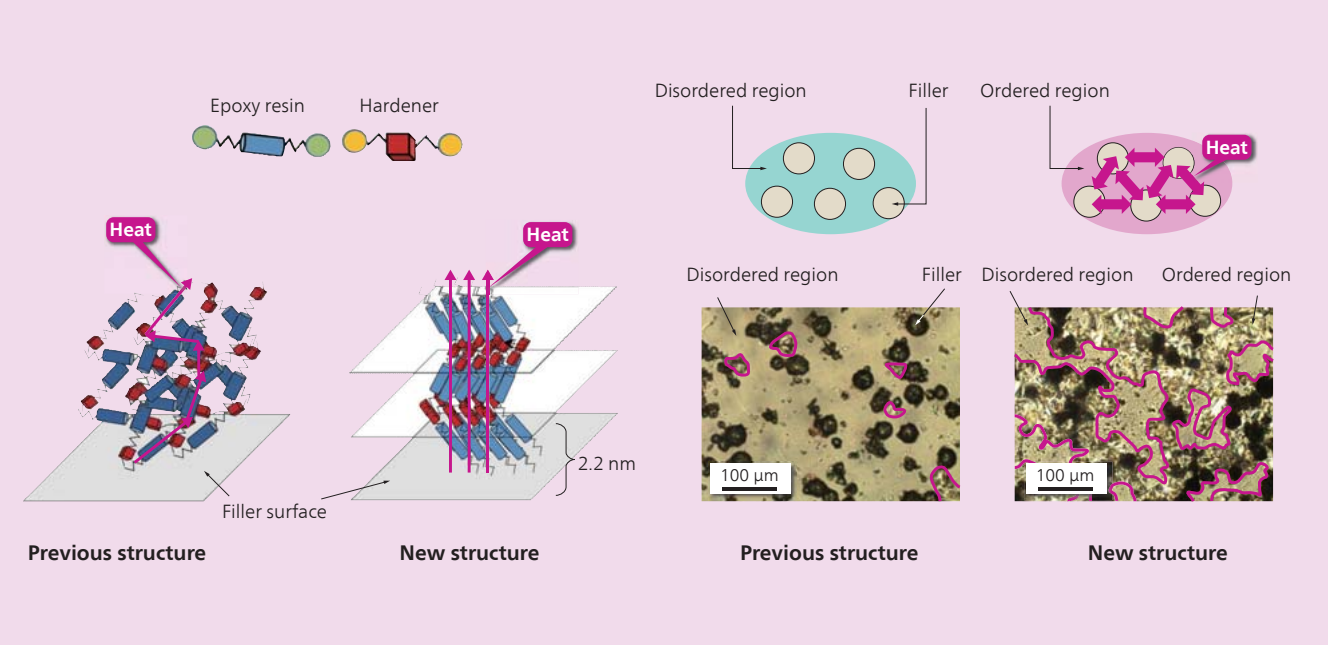
For safety, the excavators comply with the roll-over protective structures (ROPS) specified by the International Organization for Standardization (ISO), adding an extra layer of safety for operators. They are also equipped with a rear monitor that allows the operator to check the safety of the surroundings.

(Hitachi Construction Machinery Co., Ltd.)

[(Release date: April 2014 (Japan), January 2013 (Europe), June 2012 (USA)]

5 Hydraulic excavator ZX120-5B (left), ZX135US-5B (right)

High Functional Materials & Components



1 Filler/resin interface structure of new composite (left) and structure around filler (right)

1 High-thermal-conductivity Composite Insulator with Reduced Thermal Resistance at Filler/Resin Interface

This high-thermal-conductivity composite consists of epoxy resin and ceramic powder (filler) and is used for insulating adhesive sheets, molding materials, and other insulators in electrical and electronic equipment. The smaller size and higher output densities of electrical and electronic equipment require these insulators to have high thermal conductivity.

Hitachi has been researching composites formed from ceramic powder and an epoxy resin that exhibits high thermal conductivity due to a structure that self-organizes at a molecular level during hardening. When this self-organizing resin has been mixed with nitride filler in the past, it has failed to exhibit sufficient thermal conductivity because of the thermal resistance resulting from the resin structure becoming disordered at the filler interface.

In response, Hitachi has developed a technique that uses a filler surface treatment to maintain an ordered resin structure at the interface. Oxidizing the filler surface, controls the surface free energy and gives the hardened resin an ordered structure at the filler interface, with a period of 2.2 nm in the direction roughly vertical to the interface. Furthermore, the ordered structure is formed over a wide region so as to fill up the space between filler particles. This has succeeded in reducing the thermal resistance at the filler/resin interface and increasing the thermal conductivity of the high-thermal-conductivity composite.

2 High-toughness Nano-composite Resin for Molding Machines and its Associated Design and Analysis Techniques

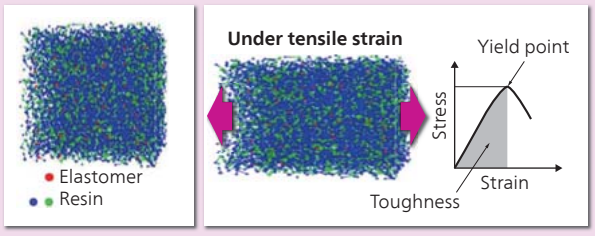
Hitachi has developed a nano-composite resin for molding machines that has excellent fracture toughness (an indicator of resistance to cracking).

Fine elastomer particles were chosen as the toughening agent. Hitachi also made full use of the following computational methods in the development process.

(1) The molecular orbital method was used to calculate the interactions between the nanoparticles and resin.

(2) The calculated interactions were used in coarse-grained molecular dynamics.

(3) The stress-strain characteristics under tensile strain were obtained using (2) and the fracture toughness was predicted.



2 Computational model for coarse-grained molecular dynamics (left) and toughness calculation method (right)

This calculation found that the fracture toughness with an elastomer particle size of 100 nm was 50% higher than the resin on its own. Fracture testing was then conducted on a test piece made of epoxy resin mixed with 100-nm elastomer particles to confirm that the experiment agreed with the calculated prediction.

The new technology represents a combination of coupled micro-macro computational methods with experimental material testing with the aim of improving molding machine performance. The molecular orbital method was developed by Hitachi, and the coarse-grained molecular dynamics calculation was performed using the OCTA high functional materials design platform.

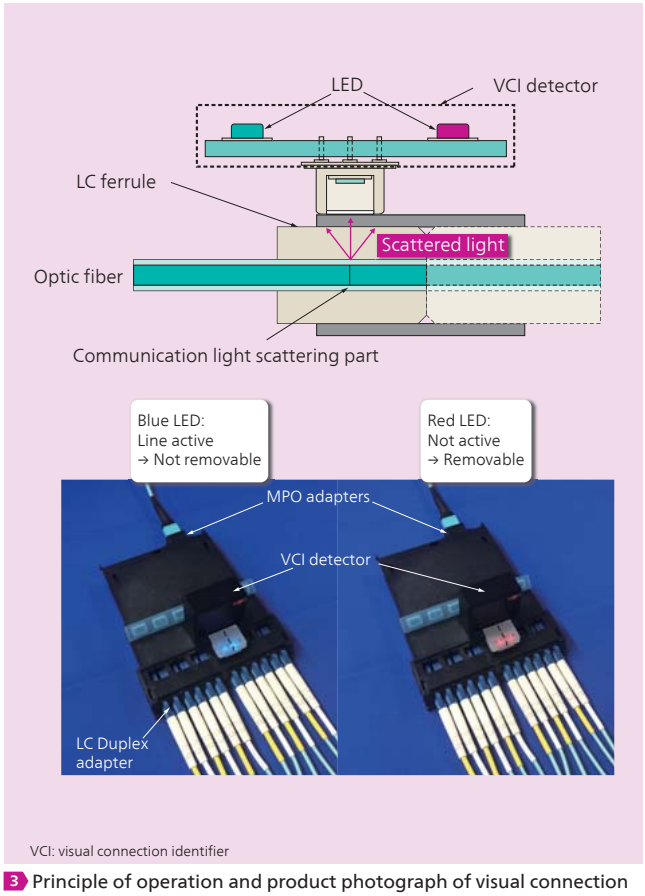
3 Visual Connection Identifier Module for LC Duplex Connectors

The rapid increase in transmission bandwidth means that work on optical cabling needs to be done efficiently.

There is a risk of major losses if an optical connector carrying heavy communications traffic is inadvertently unplugged when modifying or uninstalling communication cabling. The visual connection identifier module provides a simple visual indication of whether an optic fiber is in use, and has gained an excellent reputation as a product that enables the safe unplugging of connectors. Hitachi has previously released visual connection identifier modules for use with square connectors (SCs), local connectors (LCs), and Simplex optical connectors.

Now, Hitachi has developed an additional module for use with the LC Duplex optical connectors that are widely used outside Japan. Housed in a compact case, the module has six LC Duplex adapters (12 cores) on the front and a 12-core multiple-fiber push-on/pull-off (MPO) adapter on the rear. The small amount of scattered signal light that leaks from the LC ferrule is detected by a photodetector, and light-emitting diodes (LEDs) are used to provide a simple visual indication of the presence or absence of an optical signal (a blue LED illuminates to indicate a signal, and a red LED illuminates to indicate no signal). The photodetector has two sensors to enable simultaneous detection of two cores.

In the future, Hitachi intends to expand the product range and market the product widely in Japan and elsewhere.
(Hitachi Metals, Ltd.)



3 Principle of operation and product photograph of visual connection identifier module for LC Duplex connectors

4 Rare Earth Magnet Recycling Technique Using Carbothermal Reduction

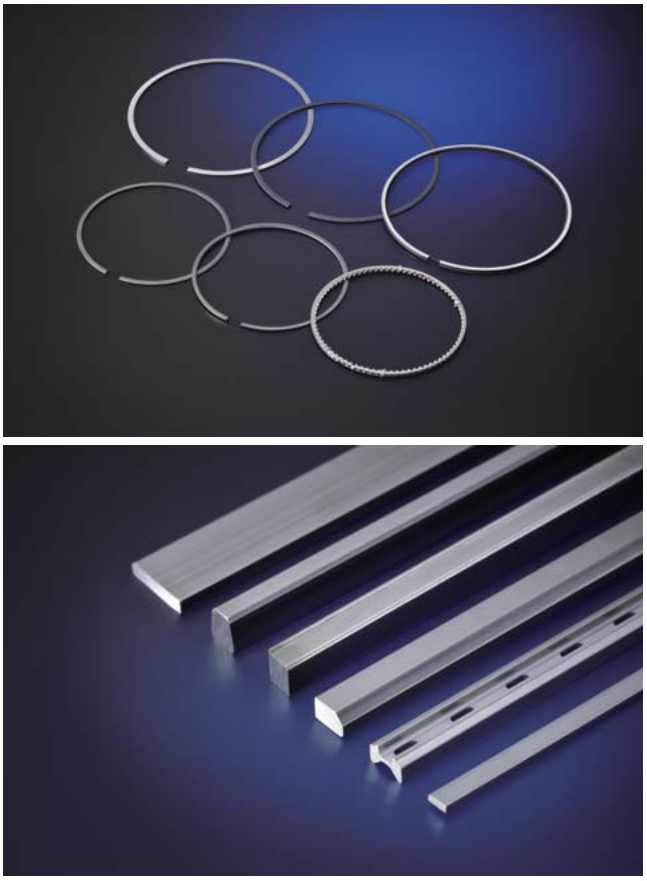
The manufacturing process for NEOMAX* rare earth magnets, composed of neodymium (Nd), iron (Fe), and boron (B), produces sludge as a by-product. Since this sludge contains valuable rare earth elements, reusing rather than disposing of these presents an important challenge for the efficient use of resources. While the conventional method for extracting rare earth elements from sludge involves dissolving in acid and precipitation, this imposes a significant load on the natural environment because of the large amount of iron oxide residue that results.

Hitachi's new technique, however, dramatically reduces the use of acids and alkalis and reduces this environmental load by applying the carbothermal reduction method used in the steel industry to burned sludge, from which the rare earth elements can be recovered as slag and iron elements can be recovered as valuable pig iron. Furthermore, in experimental testing, this method achieved a higher yield of rare earth elements than the existing method.

Full-scale production using the new technology is scheduled to commence in April 2015.
(Hitachi Metals, Ltd.)

* NEOMAX is a trademark of Hitachi Metals, Ltd.

4 Material produced by carbothermal reduction of magnet sludge



5 Stainless steel piston rings (top) and stainless steel piston ring wire (bottom)

5 Shaped Wire Material for Precision Piston Rings

Piston rings are key components of automotive engines, providing the seal that converts the energy of combustion into motive power. Because they are in direct contact with hot combustion gases and in constant sliding motion against the cylinder, the requirements for piston ring materials include resistance to both heat and wear. Meanwhile, with steps being taken to deal with environmental problems and save on the use of resources, the trend in vehicle engines is toward downsizing and the adoption of turbocharged direct injection to reduce emissions and increase output. This has led to a growing need for higher strength and higher shape accuracy in piston rings.

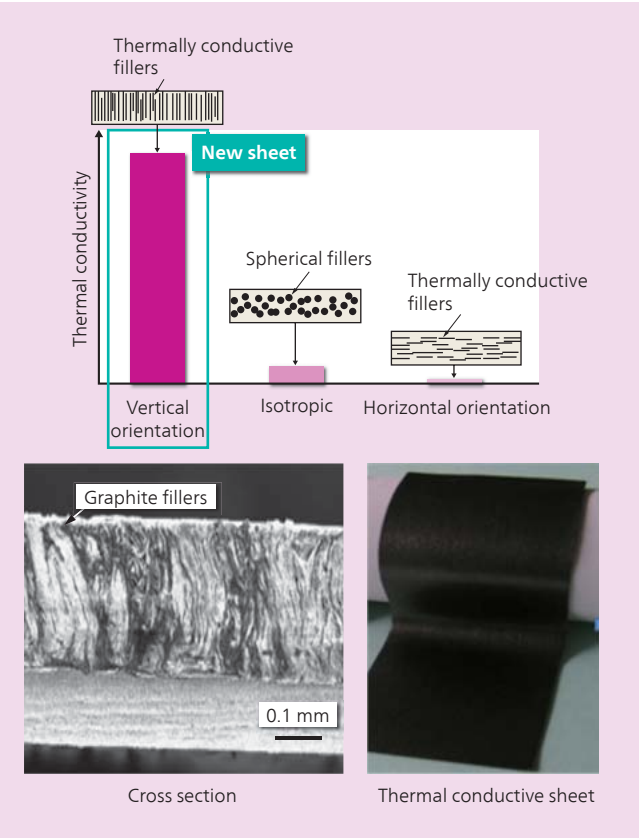
Hitachi Metals' martensitic stainless steel alloys containing 8 to 17% chromium (Cr) were developed as a specialty steel grade for use in piston rings. Featuring a strength-to-weight ratio significantly higher than conventional castings, these alloys have now entered mass production. The demand for increasingly complex cross sections with tighter tolerances means that shape accuracy in the order of microns is required for "near-net" wire. To achieve this, Hitachi employs a precision shaped rolling technique that helps reduce machining times for piston ring manufacturers.
(Hitachi Metals, Ltd.)

6 Thermal Conductive Sheet with Vertically Aligned Graphite

The higher heating density resulting from the smaller size and greater integration of semiconductor packages has required the electronic device field to focus on cooling techniques that can limit rises in device temperature. Thermal conductive sheets are used to increase the efficiency of heat transfer from heat source to heat sink and therefore require high thermal conductivity across the thickness of the sheet and the flexibility to be compliant with the warpages between components. As the trade-off between these two properties makes this a very difficult criterion to satisfy in the same material, Hitachi has utilized composites and the control of material structure to achieve both.

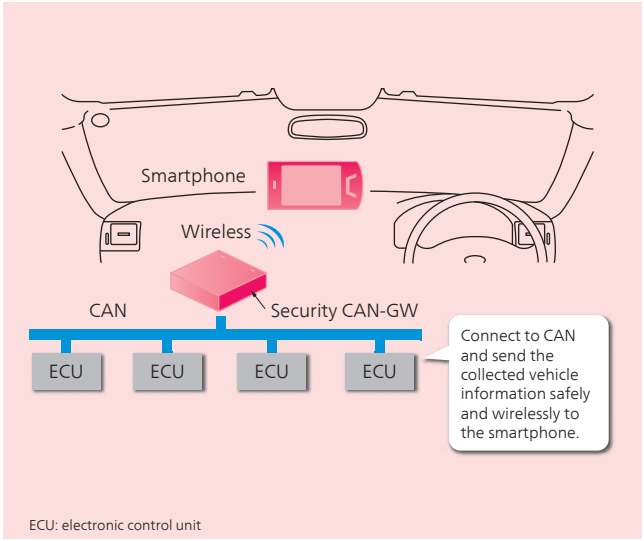
The new thermal conductive sheet combines a technique for aligning anisotropic fillers with graphite and soft resin to achieve both high thermal conductivity across the thickness of the sheet (90 W/mK) and flexibility. The use of this new material is expected to assist with heat dissipation design and enable electronic device to be made compact, with longer life, quieter operation, fewer components, and saving energy.

It is available in a range of variations with enhanced functions, including a reusable type, high-strength type, and high-compression type. In the future, Hitachi plans to market it for a wide variety of applications in Japan and elsewhere.
(Hitachi Chemical Co., Ltd.)



6 Concept of structure control for sheet with vertically aligned graphite (top), and a cross section and appearance of the sheet (bottom)

Automotive Systems



1 Security CAN-GW system configuration

1 Security CAN-GW

Security controller area network—gateway (CAN-GW) is an onboard gateway device that can provide the vehicle information that is flowing on the CAN onboard network, safely, and matched to the user's purpose. With the enhancement of network environments and the spread of smartphones in recent years, ways of connecting cars to the Internet and of using the vehicle information, such as sensor information, that is available on cars are being considered. On the other hand, connecting cars with various networks has raised the issue of ensuring information security, in the same way as other information technology (IT) devices.

Security CAN-GW addresses this issue with security functions that are based on the results of security analysis produced using Hitachi's proprietary methods, and on the study of risk countermeasures to ensure safety.

The main functions are as follows.

(1) Vehicle information collection and transmission functions

Connect to the vehicle's CAN and collect vehicle information. Transmit the collected information wirelessly to a smartphone.

(2) Security functions

Perform device authentication and smartphone app authentication between security CAN-GW and the smartphone, and encrypt data.

(3) Gateway functions

Select vehicle information, convert formats, and edit data.

(Hitachi Automotive Systems, Ltd.)

(Start of mass production: August 2014)

2 Inverter and DC-DC Converter for P-HEVs, for Daimler (S-Class)

Hitachi has developed the P2-85 inverter and direct current (DC)-DC converter for the S-Class S550 plug-in hybrid from the high-end German brand, Mercedes-Benz*.

This plug-in hybrid electric vehicle (P-HEV) system is a high-output, low fuel consumption system that combines a gasoline engine and an 85-kW electric motor to deliver a maximum output of 325 kW/650 Nm at 35.7 km/L (European combined mode fuel consumption).

The newly-developed inverter controls motor drive and regeneration, to deliver a maximum rating of 432 V/ 290 Arms by using in-house power modules with double-sided cooling as the heart of the system. The structure is built to last for 15 years in an onboard environment of 105°C and the IPX7 immersion specification.

The DC-DC converter converts power from the high-voltage battery to run the low-voltage (LV) system. It is essential for electrified vehicles. This newly-developed product is compact but has a maximum output of 3 kW (14 V, 210 A), and achieves 94% efficiency.

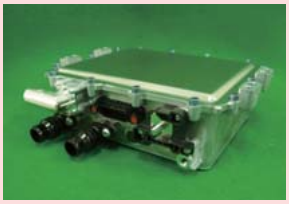
In the future, Hitachi plans to expand the variations that are available and extend them to new models.

(Hitachi Automotive Systems, Ltd.)

(Start of mass production: June 2014)

* See "Trademarks" on page 146.


P2-85 inverter


P2-85 DC-DC converter


Power module
with double-sided cooling

2 Inverter and DC-DC converter for P-HEVs, for Daimler AG (S-Class)

3 Stereo Camera

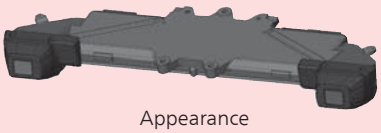
Hitachi supplies stereo cameras to FUJI HEAVY INDUSTRIES LTD. as sensors for external recognition and driving systems that are able to recognize the outside world and the vehicle's driving conditions. These systems are intended to prevent car accidents and mitigate damage by detecting objects such as pedestrians and bicycles, and controlling the brakes.

Next-generation cameras employ high-definition color imaging elements and a newly-developed 3D image processing engine to expand the detection area by approximately 40%, while also enhancing the functions of various recognition applications.

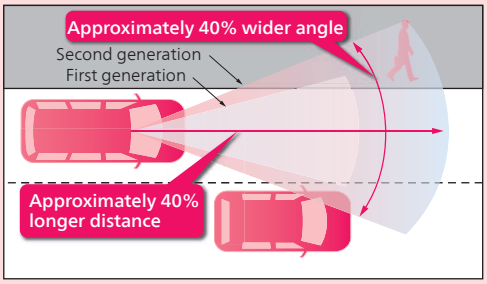
In the future, Hitachi will continue to pursue development towards higher precision and higher functionality as well as more compact components.

(Hitachi Automotive Systems, Ltd.)

Onboard status



Appearance



Comparison of detection areas

3 Stereo camera

4 Motorized VTC Systems

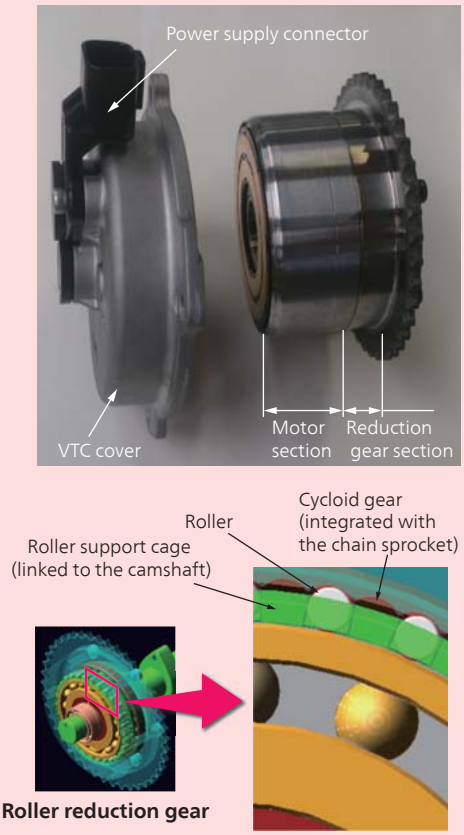
As environmental and fuel consumption regulations are being toughened, there is demand for higher engine efficiency, including in the base engines of hybrid electric vehicles (HEVs). This creates a growing need for motorized valve timing control (VTC) as a highly functional variable valve device that is able to achieve that enhanced efficiency.

Hitachi's motorized VTC is the world's first system* to combine a DC brush motor and roller reduction gear in a single unit, achieving a compact size, low price, reduced power consumption, and reduced friction. Integration of the motor and reduction gear makes the system more compact, while eliminating the following drive for the rotation of the motor camshaft saves power and achieves a high level of responsivity. This drive load reduction also enables the use of an inexpensive brush motor. The reduced rolling contact of the roller reduction gear reduces friction, and combines with the flattening of the structure to reduce size and save power.

Since 2014, Hitachi has been mass producing these systems to supply to Hyundai Motor Company. Hitachi plans to expand its application as a key technology for future variable valves in order to meet customer needs globally.

(Hitachi Automotive Systems, Ltd.)

* Investigated by Hitachi Automotive Systems.



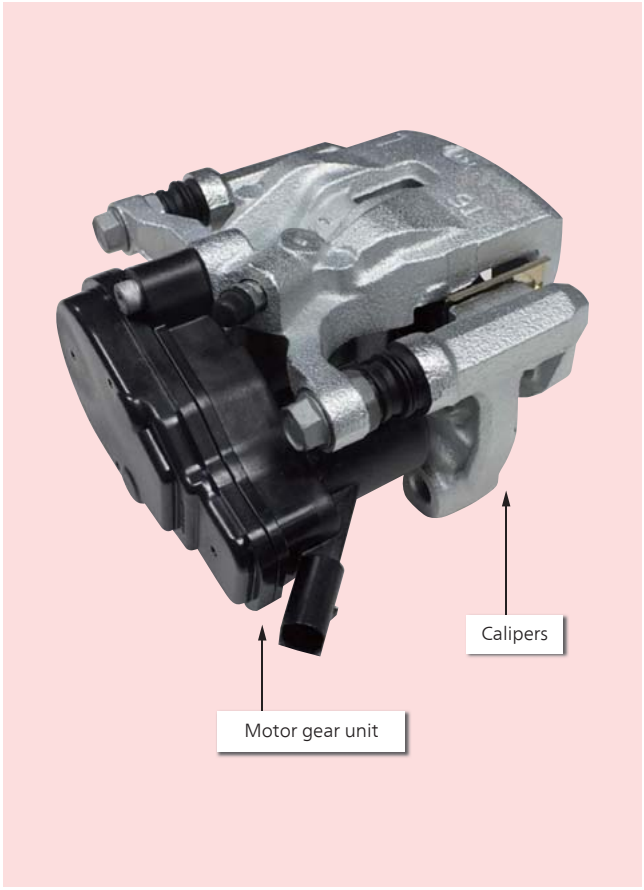
4 Integrated structure for a motorized VTC system with a DC brush motor and roller reduction gear (top) and roller reduction gear (bottom)

5 Electric Parking Brakes

In recent years there has been growing market demand for electric parking brakes in order to meet requirements for freer car interior layouts, safety, environmental performance, and greater convenience. Hitachi has addressed this need with a fusion of braking technologies it has built up in built-in calipers, compact vehicular motor technology, and electronic control unit (ECU) control technology. The result is motorized parking brakes characterized by small size, low current consumption, high responsivity, and low braking noise, which are now in mass production.

Electric parking brakes must provide frequent parking operations in diverse situations. Low current consumption reduces power consumption, high responsivity improves linkage with the hydraulic brakes, and low braking noise allows repeated use without annoyance. These benefits contribute to broader vehicular applications. Also, linking this with electronic stability control (ESC), a system to prevent the vehicle from skidding sideways, stereo cameras, the power train, and other vehicular systems maintains vehicle stop-holding, enabling improved safety, fuel economy, and convenience.

In the future, Hitachi will expand the product lineup and the range of applicable vehicles through even higher performance, and through compliance with functional safety regulations and German Association of the Automotive Industry (VDA) standards.
(Hitachi Automotive Systems, Ltd.)
(Start of production: October 2014)



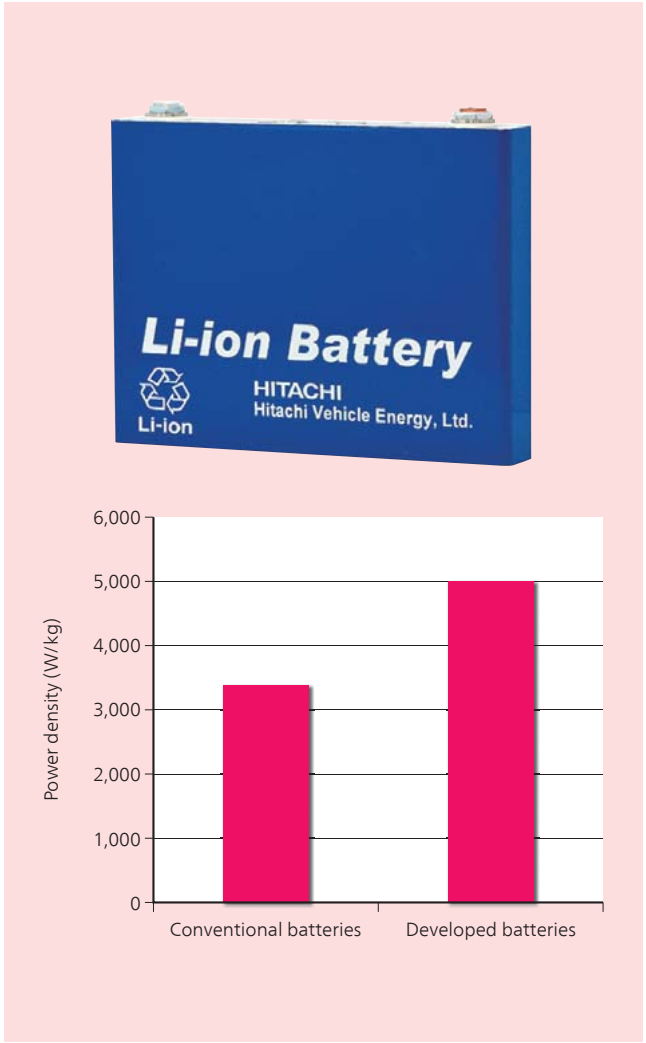
5 Electric parking brakes

6 Lithium Ion Batteries for Electric Vehicles

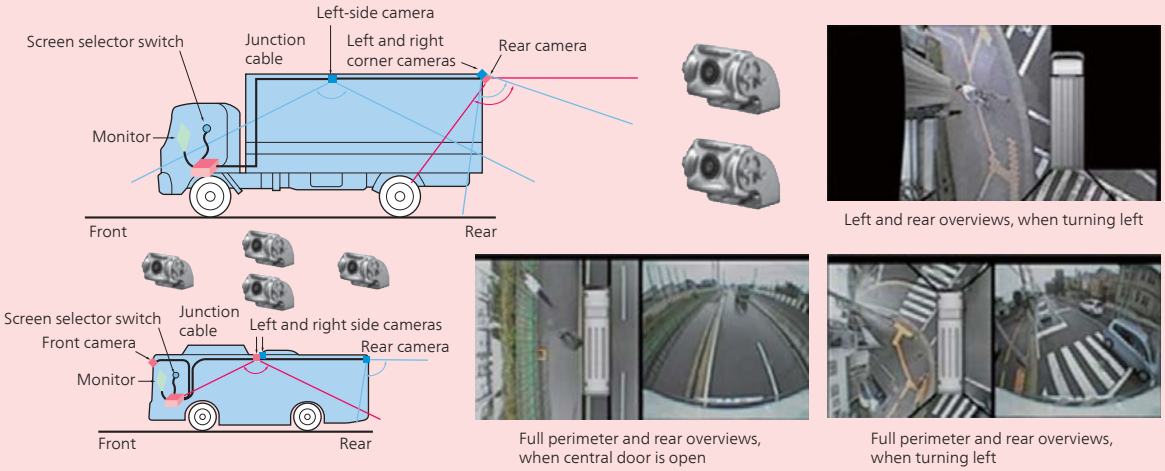
Hitachi Vehicle Energy, Ltd. began mass production of lithium ion batteries for hybrid vehicles in 2005. As of now, it has a track record of mass-producing over five million cells for over 120,000 vehicles. As environmental regulations are being toughened in many countries, lithium ion batteries for hybrid cars are being asked to deliver higher power to expand the range of motor assistance.

One effective way to increase power is to reduce cell internal resistance by making the electrodes thinner, however, simply thinning the electrodes increases the volume ratio of materials such as separators, reducing the storage capacity accordingly. Hitachi has applied high-capacity anode and cathode materials to achieve both power and capacity at the same time. Now, Hitachi has developed a high-power cell that increases the power to 1.5 times the previous level while keeping capacity on a par with the highest levels in the world. It does so while continuing to maintain charge-discharge cycle lifetime and safety.

In the future, Hitachi will roll out the developed cells globally while meeting customer needs.
(Hitachi Automotive Systems, Ltd., Hitachi Vehicle Energy, Ltd.)



6 Lithium ion batteries developed by Hitachi, and their power characteristics



7 SurroundEye two-camera system and four-camera system

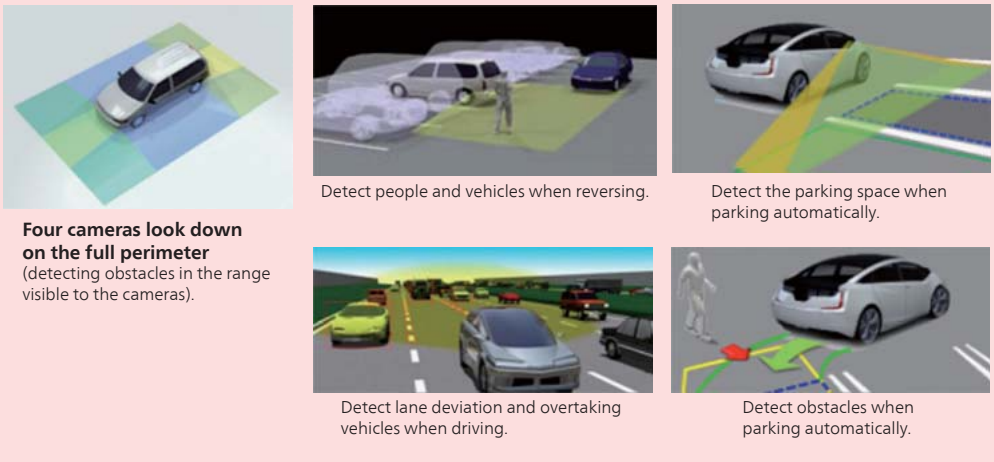
7 SurroundEye and Full Perimeter Sensing

SurroundEye was registered as a trademark by Clarion Co., Ltd. in January 2014. It consists of multiple vehicle-mounted cameras to check the vehicle's surroundings and a monitor that combines and displays the images from the cameras. The system assists with safe driving by showing the driver the areas that are in blind spots. It had been only commercialized for use in cars, however, systems for trucks and route buses were announced in May 2014.

The basic version is a two-camera system consisting of two cameras, mounted on the passenger side and at the rear, an ECU that combines the images, and a 7-inch monitor. Supplementary information for the rear left, which is a blind spot from the driving seat of a truck, helps to prevent trapping accidents due to inner wheel differential, accidental contact with vehicles to the rear left, etc. For route buses, the system uses four cameras mounted on the front, left, right, and rear, to provide a 360° overview of the surrounding area. The system helps to check for safety around its parked position when stopping and departing, to check vehicle positioning when approaching guard rails and road shoulders when stopping, to check for bicycles approaching from the rear, and to check the status and safety of passengers boarding and alighting near the central doors. All of these operations are performed with mirrors and line of sight from the driving seat.

For passenger cars, a system has been commercialized that applies image recognition technology to the camera images in order to detect obstacles around the vehicle and to warn the driver. Four cameras on the front, left, right, and rear provide 360° sensing around the car. Even with only the rear camera, the system is able to notify the driver of the approach of vehicles or people when parking or departing, warn the driver of lane deviation while driving, and issue warnings in situations such as when being overtaken by a vehicle from the rear. This 360° sensing was made more advanced in 2013, and applied to automatic parking systems. These systems recognize the parking boundaries to identify the parking space, detect pedestrians and other obstacles during automatic parking, and can pause the vehicle's motion. The control systems were developed jointly between Hitachi Automotive Systems, Ltd. and Clarion.

In the future, Hitachi will evolve the system further and develop 360° sensing functions that can be used in automatic driving.
(Clarion Co., Ltd.)



7 Full perimeter sensing

Consumer Appliances

1 Big Drum Washer-dryer and Big Drum Slim Washer-dryer

Hitachi has released two new front loading washer-dryers, the big drum washer-dryer (BD-V9700), and the big drum slim washer-dryer [(BD-ST9700), width: 60 cm], with improved washing ability that ensures laundry comes out strikingly white, and reduces coarsening and darkening.

The main features are as follows.

(1) To reduce laundry coarsening and darkening*1 more efficiently, the powerful high flow rate wide shower distributes plenty of water at a maximum flow rate of approximately 80 L/min, which is four times more than the previous model.*2

(2) Newly equipped with a misting function that sprays warm air and heated mist at a high speed to wash and completely remove sebum residue from garments. Sebum is known to cause yellowing in clothes.

(3) Comes equipped with the new wind iron function, which combines a 300 km per hour*3 high-speed air drying function that smoothens out wrinkles with a humidity control drying function that maintains a high humidity inside the drum. New wind iron function enables more effective smoothing of wrinkles around areas like sleeves.

(Hitachi Appliances, Inc.)

*1 Compared to previous model BD-V9500 (2012 model) without high flow rate circulation wash.

*2 Maximum shower flow rate of previous model BD-V9500 (2012 model) without high flow rate circulation wash: 20 L/min.

*3 Calculated from nozzle size and air flow.

1 Big drum washer-dryer [BDV9700L (N)] (left), big drum slim washer-dryer [BD-ST9700L (S)] (right)

2 IH rice cooker [RZ-VS2M (N), width: 21.7, depth: 26.0, height: 17.5 (cm)] (left), IH jar rice cooker [RZ-VW3000M (N), width: 27.5, depth: 36.1, height: 24.6 (cm)] (right)

2 IH Rice Cooker

Hitachi has released two new rice cookers, the 2-cup (0.36 L) induction heating (IH) rice cooker (RZ-VS2M) that enables small quantities [less than 2 cups (0.36 L)] of rice to be cooked deliciously and allows the top cooking container component of the heating base unit to be detached from the heating base, so it can be taken it to the dining table; and the 5.5-cup (1.0 L) IH rice cooker (RZ-VW3000M) that allows 1, 2, or even 5.5 cups of rice to be cooked as desired.

The 2-cup (0.36 L) type can maintain high temperature with its full heat-insulated structure (the thick thermal sprayed iron pot with high thermal storing characteristics is insulated with flexible vacuum insulation panel) which helps to steam and cook rice more efficiently. In addition, the top cooking container can be detached from the base heating unit, allowing hot rice to be served at the table as required.

The other 5.5-cup (1.0 L) type features a new technology using a higher output side heater, in addition to Hitachi's unique pressure and steam function that generates steam at the raised boiling point of 107°C at 1.3 atmospheric pressure, as well as a vacuum heat insulation container. These features ensure that the temperature of the empty space around the inner pot is kept appropriately, and helps rice to be cooked deliciously*, even for small quantities of less than two cups of rice.

(Hitachi Appliances, Inc.)

* When using the white rice finest springiness setting.

3 Air Purifier & Humidifier

Hitachi has released the air purifier & humidifier (EP-KVG900). It utilizes a wide and speedy dust collection system that draws air

3 Air purifier & humidifier [EP-KVG900 (N)]

from a wide area at the rear side of the unit, and blows purified air out at the top. This appliance can clean the air in 13-m² room in about seven minutes.

The main features are as follows.

(1) Applicable floor spaces*1 up to 68-m²*2 with improved air ducts, a new motor and high-efficiency compact fan, along with an enlarged air-intake area on the rear side. Dust collection is faster — for example, it can purify the air in 13-m² room within only seven minutes, which is approximately 1.7 times*3 faster than the previous model.

(2) Easy to handle and scratch resistant with reinforced glass used in the front area of the unit. A touch operation system makes it easy and simple to control. The display buttons only light up when needed, and only the humidity, temperature, and cleaning monitor are displayed in standard operation mode.

(3) Pursues the cleanliness of the inside of the unit, the stainless clean system that was adopted in previous models has been retained. The system uses antibacterial*4 stainless steel for pre-filters, flaps, and air ducts.

(Hitachi Appliances, Inc.)

*1 Based on a standard room size (calculated with a ceiling height of 2.4 m) that can be purified within 30 minutes, under the "JEM 1467" specification set by The Japan Electrical Manufacturers' Association.

*2 When purifying the air

*3 Comparison between 2013 model EP-JV700 (applicable floor space: up to a 40-m² room, cleaning duration: 12 minutes for 13-m² room) and the new model EP-KVG900 (applicable floor space: up to 68-m² room, cleaning duration: Seven minutes for 13-m² room).

*4 It is not possible for all bacteria in the air to be eliminated by the air purifier. The antibacterial effect is achieved with (1) stainless pre-filter, (2) stainless flap, and (3) stainless net (outlet). Test laboratory: (1) and (2), Boken Quality Evaluation Institute, (3) Kitasato Research Center for Environmental Science. Test method: JIS Z 2801 (film contact method). Test target: Attached bacteria. Elimination method: With metal ion in stainless steel. Test results: 99% of bacteria eliminated after 24 hours.

4 Fully Automatic Natural Refrigerant Heat-pump Water Heater

Hitachi has released the natural refrigerant (CO_2) heat-pump water heaters for home use (BHP-FV37PD, BHP-FV46PD), a high-energy saving and earthquake-resistant water heater. The urethane foam has been adopted as an insulation material for its hot water storage tank unit.

The main features are as follows.

(1) Unlike previous models*1, which were insulated with expanded polystyrene, this new model has been improved with the urethane-insulated storage unit in which the space between the outer wall and the tank is filled evenly with high insulating urethane foam. Connected with a high-efficiency heat pump cycle, the unit achieves the highest annual water heating and heat-retention efficiency rates*2 of (JIS) 3.9 (BHP-FV37PD) and 3.8 (BHP-FV46PD).

(2) The rigidity of the hot water storage tank unit has been improved by including urethane foam in its bottom area, which is attached to the tank. With this design, the highest level of earthquake resistance, class S*3 is supported.

(3) Employs the rapid hot water filling system. This system enables hot water to be filled twice as fast compared to standard filling speeds. It can fill a bath with a capacity of 180 L in about five minutes and 45 seconds*4. In addition, jet bubble bath function provides a comfortable and bubbly bath setting*5. The system is also compatible with home energy management system (HEMS)*6.

(Hitachi Appliances, Inc.)

*1 2013 products BHP-FV37ND and BHP-FV46ND.

*2 As of November 16, 2014. Applicable as a home use water heater at a normal temperature (1) At a hot water storage capacity of at least 320 L and no more than 460 L, the annual water heating and heat-retention efficiency (JIS) of the BHP-FV37PD is 3.9. (2) At a hot water storage capacity of at least 460 L and no more than 550 L, the annual water heating and heat-retention efficiency (JIS) of the BHP-FV46PD is 3.8. The annual water heating and heat-retention efficiency (JIS) is a value that is calculated according to JIS C 9220:2011, and it varies depending on the region, environment, operation setting, operating circumstances, and other conditions.

*3 Can withstand an earthquake with an intensity of 2.0 based on the "Standard Seismic Scale for Planning of Building Facility Equipment, Calculated by Seismic Intensity Method" specified by the "Seismic Design and Construction Guide for Building Equipments" (issued by The Building Center of Japan).

*4 Pipe diameter of 15 A. 5 m straight pipe. Water supply pressure of 300 kPa. Hot water temperature in the tank is 80°C. Cold water temperature is 17°C. Filling hot water temperature is 40°C. Capacity of bath is 180 L. Approximately five minutes and 45 seconds. Hot water filling time may vary depending on the installation conditions.

*5 Requires the circulation adaptor, sold separately.

*6 Requires a HEMS adaptor for Hitachi water heaters, sold separately.

4 Exterior of Natural Refrigerant Heat-pump Water Heater (BHP-FV46PD) and remote control units for kitchens and bathrooms

5 LED ceiling light (LEC-AHS 1810CC) (left) and light guiding ring type LED ceiling light (LEC-DHS1230C)

5 LED Ceiling Light for Home Use

Hitachi released eight new light-emitting diode (LED) ceiling lights. The units are equipped with the easy viewing function, which provides brighter and more natural lighting that is similar to sunlight, making text and color appear more clear and vivid.

The main features are as follows.

(1) Adjustable brightness with the easy viewing function button, which increases the brightness by approximately 1.2 times compared to a fully lit room. In addition, blue and green light is added to make small text appear more clearly, and the color of photographs to be more vivid with higher contrast.

(2) Achieves both more light and energy-savings. For brightness, the 30-m² room type model*1 provides 8,000 lm, which is the highest class*2 in the industry. For the 10-m² to 23-m² room type model, the maximum brightness*3 is achieved according to the corresponding room size standard. For energy-savings, it achieves a high level of intrinsic-energy consumption efficiency*4 between 123.1 to 125.8 lm/W.*5

(3) Light guiding ring type LED ceiling light, which is equipped with Hitachi's newly developed clear lighting technology, is included in the new product lineup. This model has a sleek design with a height of just 72 mm, and provides large area of sparkling light.

(Hitachi Appliances, Inc.)

*1 Standard for 30-m² room type model, set by Hitachi Appliances, Inc.

*2 Applies to the home LED lighting market in Japan. Rated luminous flux of LEC-AHS1810CC 8,000 lm. As of November 16, 2014.

*3 Under the "Residential Catalog Applicable Room Size Standards" (Guide 121:2011), issued by the Japan Lighting Manufacturers Association.

*4 Excluding LEC-DHS1230C.

*5 Energy consumption efficiency is calculated as rated luminous flux divided by rated power consumption.

6 Room Air Conditioner

The room air conditioner has been released with a multi-monitoring system that uses a newly developed "Near-infrared Camera" function in addition to a previous "Imaging Camera" (which captures visible images) and "Thermal Imaging Camera" (which capture surrounding temperature of people and objects), "Near-infrared Camera" function captures near-infrared images with a combination of the "Imaging Camera" and near-infrared LED, whereby the position and shape of furniture in a room can be detected and the path of air flow can be recognized.

The main features are as follows.

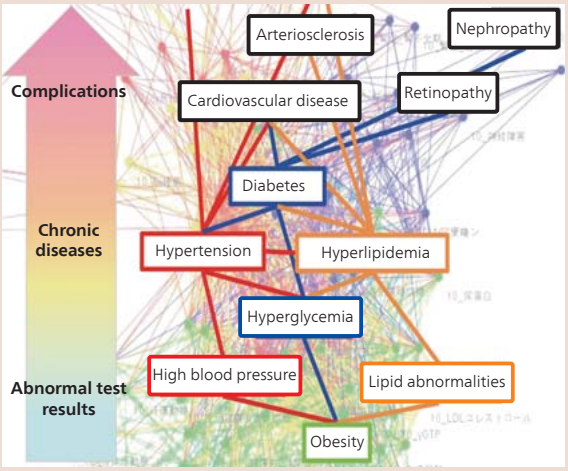
(1) Equipped with a multi-monitoring system which detects the position of furniture, its shape, and gathers information regarding the size of the room and position of people in the room. The path of air flow can be recognized and controlled more finely using the three-way front flap. Warm air reaches the feet in the winter, and in the summer, cold air circulates efficiently throughout the room. Altogether, it achieves a flexible air flow control system.

(2) Pursues cleanliness, anti-bacterial and anti-fouling stainless steel is used inside the unit, in the air duct, flaps, and filters. This clean system has been used in previous models.

(3) The floor heating system that heats the area around the feet (5 cm above the floor, 3 m away from the air conditioner unit) to around 36°C has been improved. In addition, it is equipped with features from previous models such as the hot air supply setting, which circulates hot air of 55°C continuously for approximately 30 minutes, and the rapid heating setting, which blows warm air within approximately 30 seconds.

(Hitachi Appliances, Inc.)

6 Room air conditioner



The graph shows the process of chronic disease onset and progression based on an analysis of actual data. Green indicates lifestyle, red indicates high blood pressure, blue indicates high blood sugar, orange indicates lipids, and black indicates complications.

1 Example of a model built using the new technology to predict chronic disease

1 Model for Predicting Incidence Rate of Chronic Diseases and Medical Costs Based on "Specific Health Checkups" and Prescription Data

To enable health insurance societies (health insurers) to establish highly cost-effective health maintenance businesses, Hitachi has developed a model for predicting the future incidence of chronic diseases and associated medical costs from the data that insurers hold on "specific health checkups" (checkups that focus on assessing the patient's risk of chronic disease) and medical claim data.

To model the processes through the onset and progression of disease, the new technology uses machine learning to automatically identify the patterns hidden in data to calculate the correlations between a large number of parameters, including test results, consultation records, diagnoses, examination and treatment details, and point allocations. Unlike conventional disease-specific models, this provides the model with a structure that is able to consider how different diseases interact, such as the interrelationships between diabetes, hypertension, and hyperlipidemia (abnormal lipid levels), for example.

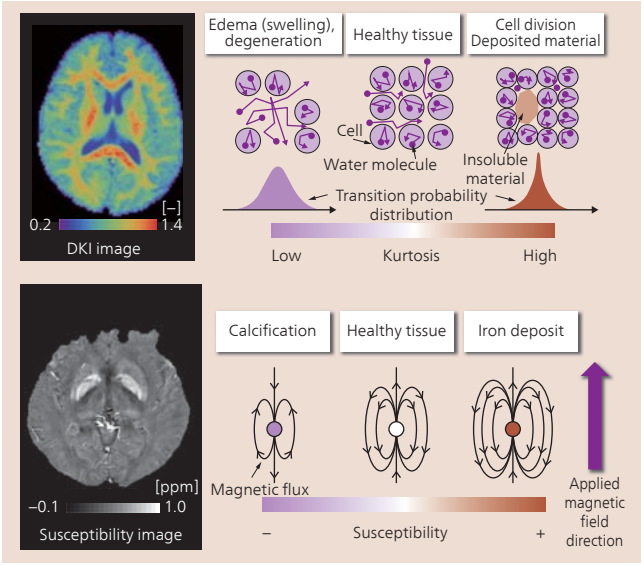
When the validity of the new technology was assessed against data held by Hitachi Kenpo (Hitachi's health insurance arm) on approximately 110,000 people, it was found that total healthcare costs for chronic diseases could be predicted with a mean error of less than 5%. This enables health insurers to better control medical costs by using the model for things like identifying the health issues faced by people who are enrolled in their insurance schemes, or selecting health maintenance activities based on future medical costs.

2 MRI Measurement Technique for Early Detection of Neurodegenerative Brain Diseases

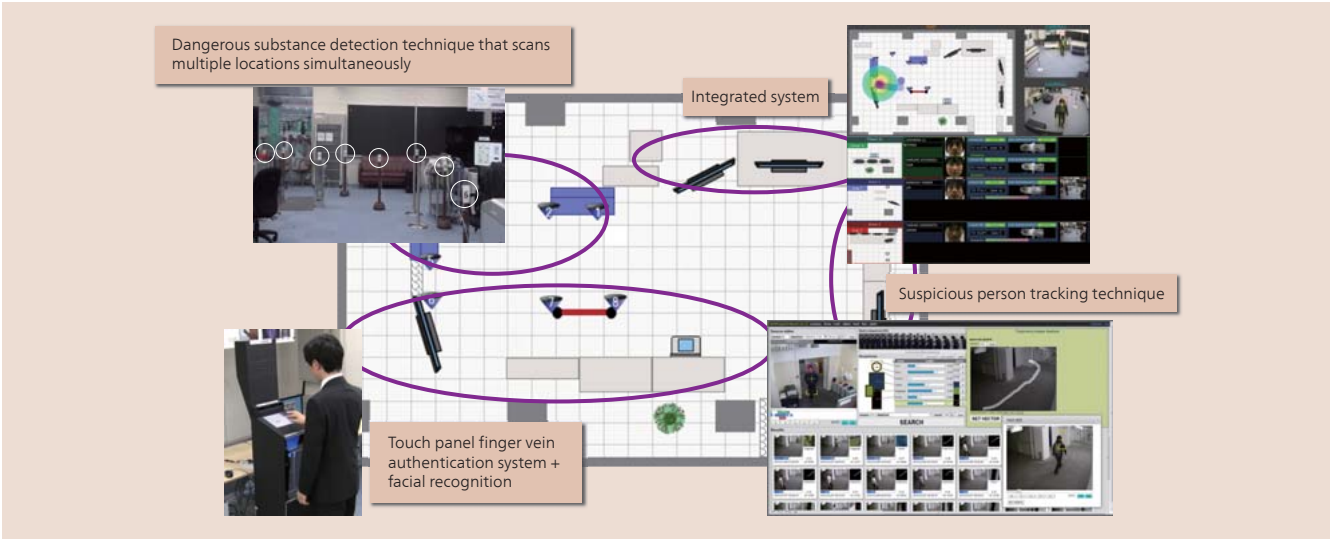
Hitachi has developed diffusion kurtosis imaging (DKI) and quantitative susceptibility mapping (QSM), two diagnostic applications that use magnetic resonance imaging (MRI) for the early detection of neurodegenerative brain diseases.

Many neurodegenerative diseases such as Parkinson's and Alzheimer's have similar physiological symptoms in their early stages, creating a need for diagnostic techniques that can distinguish them from each other. In the past, these diseases have been diagnosed from MRI scans in which the brain has undergone major morphological changes, meaning that a differential diagnosis could not be performed until the diseases had well progressed.

DKI uses the kurtosis (peakedness) of the transition probability distribution to determine the extent to which the diffusion of water molecules is restricted by tissue structure, allowing it to be used for imaging properties such as increases or decreases in the cell density or level of insoluble material in tissue. QSM, on the other hand, is a quantitative method for calculating the local variability of magnetic fields (magnetic susceptibility), and can be used for imaging things like changes in the concentration of iron in tissue. It is anticipated that the use of DKI and QSM analysis for the imaging of small changes in white matter and grey matter structures that occur in the early stage of disease will enable the development of techniques for the comprehensive early differentiation between various neurodegenerative diseases. To transform the new technology into a routine clinical test, Hitachi has developed a high-speed, high-precision image processing



2 Overview of DKI (top) and QSM (bottom)



3 Prototype traceable physical security

algorithm that uses error propagation analysis to reduce the scanning time by identifying the scanning conditions that minimize computational errors, and that suppresses artifacts (false images) generated by the imaging calculation.

Joint clinical research currently in progress with Iwate Medical University is verifying the viability of the technique for early differential diagnosis.

3 Technology for Personal Identification, Dangerous Substance Detection, and Suspicious Person Tracking for Large-scale Critical Facilities

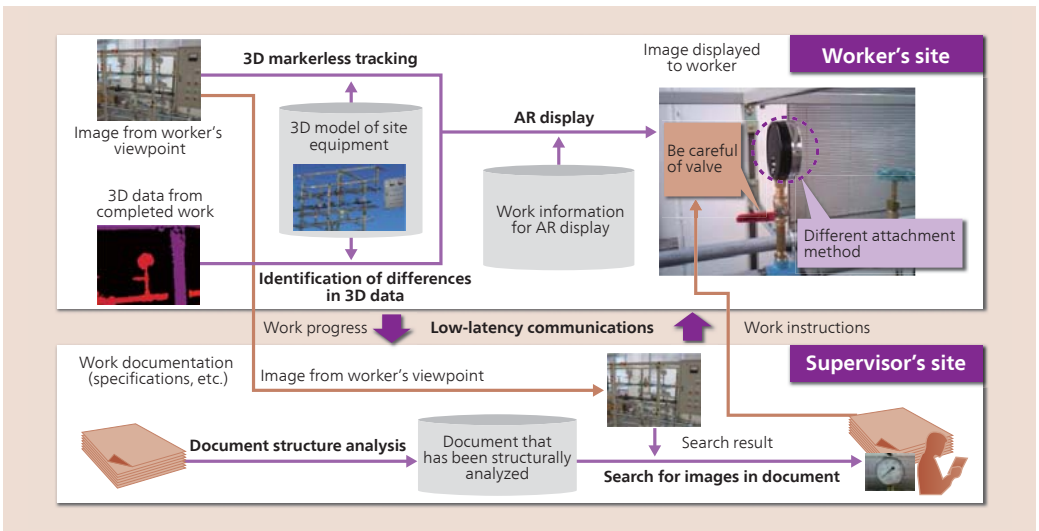
The prevalence of terrorist and criminal acts in the modern world places strong demands on the security systems that ensure public safety and security. The requirements for this include ways of verifying the safety of people and goods, and for rapidly extracting the relevant information from collected data.

Anticipating that these will be implemented at large public facilities, Hitachi has investigated the functions needed to combine the conflicting characteristics of high security and convenience in such applications. Ways of ensuring the safety of people have been consolidated under the concept of "traceable physical security." In the prototype, Hitachi included a personal authentication technique that integrates facial recognition with a touch panel finger vein authentication system, a system for detecting explosives within an area using multi-point sampling, an integrated information viewer for the centralized management of the security situation within the area, and multi-perspective search for identifying suspicious persons in collected surveillance camera video.

4 Remote Work Support Technology Using AR and 3D Data Processing

Recent years have seen growing demand from organizations wanting to support overseas engineers and other workers from Japan, leading to interest in remote work support technology that provides a way to meet this need.

The remote work support technology developed by Hitachi uses augmented reality (AR) that provides workers with a heads-up information display to allow on-site workers and remotely located supervisors to share AR video and work progress information in realtime. It can provide a heads-up display of work instructions,



4 Remote work support system using AR and 3D data processing

information from manuals, and other material retrieved by the supervisor using images of equipment or parts in the AR video as search keys. It also helps the supervisor check the work by using a technique that compares three-dimensional (3D) data of what the completed work should look like with 3D data acquired at the site, thereby providing a realtime assessment of whether the work has been carried out appropriately.

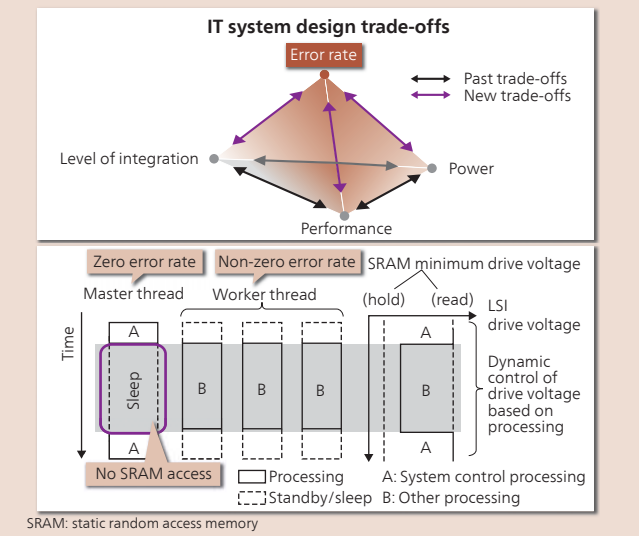
In addition to enabling support of remote work to be conducted with precision, there are concerns about the decreasing number of experienced engineers, and the new technology is also recognized as having the potential to help pass on their skills and know-how.

5 Power-saving Technique for IT Systems that Adjusts LSI Drive Voltage Based on Permitted Error Rate

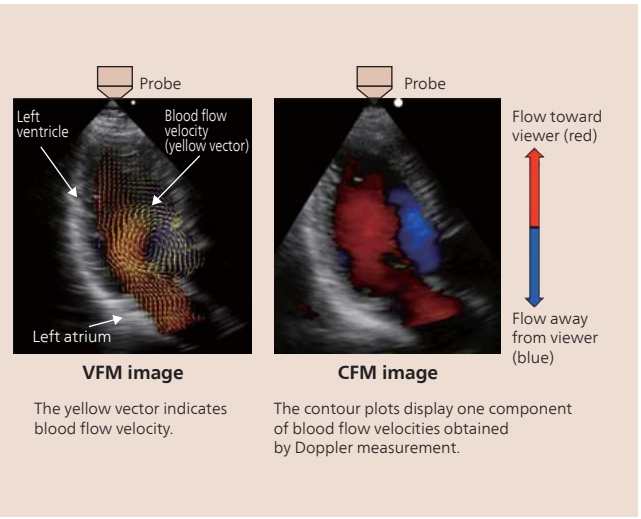
The miniaturization of large-scale integration devices (LSIs) that has underpinned improvements in the performance of information technology (IT) systems is now approaching the order of nanometers. This has led to problems with bit errors caused by the variation in internal transistor characteristics. While bit errors can be avoided by driving LSIs at a high voltage, this is an obstacle to reducing power consumption.

Given this background, Hitachi has devised a design criterion for IT systems that looks at the data error rate (permitted error rate) needed to maintain the application service value as well as the considerations of performance, power, and level of LSI integration that were taken into account in the past, using this as a parameter for optimizing the LSI drive voltage to improve energy efficiency. To achieve this, Hitachi developed a processing technique that makes more efficient use of power without causing system faults by maintaining the drive voltage at a level that ensures an error rate of zero during system control processing but reducing the drive voltage for other processing based on the permitted error rate.

This new technique can significantly reduce power consumption by IT systems despite the unavoidable physical device variation associated with future increases in the level of LSI miniaturization.



5 IT system design criterion (top) and processing technique for controlling LSI drive voltage based on the permitted error rate (bottom)



6 Blood flow imaging showing the flow of blood from the left atrium to the left ventricle

6 VFM Technique for Cardiac Ultrasound

Hitachi has commercialized*1 ultrasonic vector flow mapping (VFM), a non-invasive technique for imaging blood flow velocity vectors inside the heart that can be used for the early diagnosis of heart disease.

While the existing technique of color flow mapping (CFM) can only measure blood flow velocity in one direction, VFM overcomes this problem by combining the results of CFM measurement with a fluid mechanics model to calculate the blood flow vector.

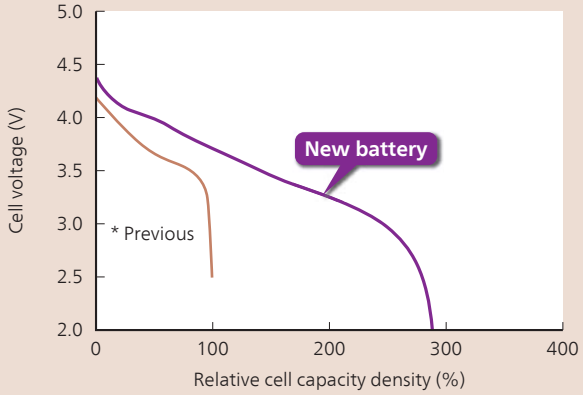
In commercializing VFM, Hitachi needed to conduct experimental validation to confirm the accuracy of the calculated velocity vector, but no such method exists for accurately measuring blood velocity in the heart. Accordingly, Hitachi constructed an experimental system consisting of an optically transparent*2 model heart with a beating motion that enabled a laser to be used to determine the vector field for internal blood flow, allowing a comparison of ultrasound and laser measurements. This enabled the commercialization of VFM to make a significant step forward.

In the future, Hitachi intends to provide greater value to doctors and patients by further enhancing VFM based on feedback from clinical use.

*1 Product released by Hitachi Aloka Medical, Ltd. in July 2013.
*2 The simulated heart had the same refractive index as the simulated blood.

7 High-energy-density Lithium-ion Battery for Electric Vehicles

By developing technologies for achieving high energy density in lithium-ion batteries for electric vehicles, Hitachi has succeeded in improving cell capacity density by a factor of approximately 2.8. The technologies comprise high-capacity anode and cathode materials that improve the cell capacity density, and a thick electrode structure that increases the number of lithium-ions available for charging and discharging and increases the energy density.



* Based on data from a Research and Development for High-Energy-Density Lithium Ion Battery with High-Power Capability funded by NEDO in which Hitachi, Ltd. and Hitachi Vehicle Energy, Ltd. participated.

7 Discharge characteristics of newly developed lithium-ion battery with high energy density

An energy density of 335 Wh/kg and a power density of 1,600 W/kg were achieved for the 30 amp/hr-class cell applied in these technologies. This energy density is higher than previous performance by a factor of 2.6, and has the potential to significantly extend the driving range of electric vehicles.

In the future, Hitachi will continue with research and development aimed at developing lithium-ion batteries that incorporate these new technologies adopted for use in electric vehicles by conducting long-term reliability and other testing, and by seeking to resolve any outstanding problems.

Note that this research was conducted as part of the Applied and Practical Lithium Ion Battery Development for Automobile and Multiple Application Project of the New Energy and Industrial Technology Development Organization (NEDO).

8 Technology for the Inherent Safety of Nuclear Reactors

Hitachi has been developing inherently safe technologies for nuclear reactors to minimize the risk of radioactive material release into the environment even in a large scale natural disaster by enabling the long-term cooling of the reactor without electricity to drive pumps, fans, and other machineries. Specifically, Hitachi is researching systems that combine air cooling driven by the natural circulation of air with water cooling that does not involve the use of electric power to drive pumps and other machineries.

Since the heat removal ability of air is generally low, realizing an air cooling system in practice requires improvements to the cooling performance of air so that the air-cooled heat exchanger can be reduced to a reasonable size. Accordingly, Hitachi has developed technologies that roughly double the ability of air heat removal performance by forming tiny micrometer-sized undulations (micro-fabrication surface) in the heat transfer tubes of the heat exchanger, and also by forming millimeter-sized protrusions that act to stir the air flow (turbulence-enhancing ribs), and vertically oriented heat-transfer fins that do not obstruct the air flow.

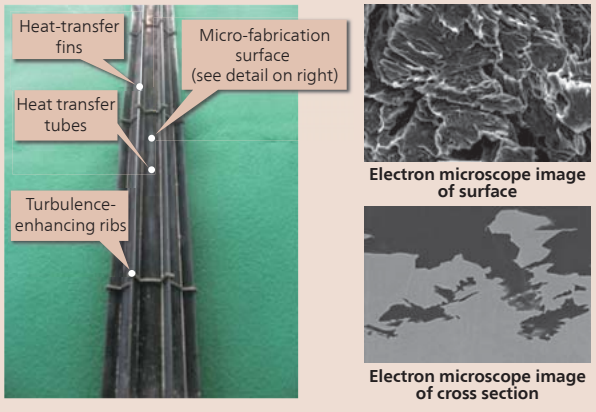
This technology roughly halves the number of heat transfer tubes required for reactor cooling and shrinks the air-cooled heat exchanger to a more reasonable size.

9 Miniature Superconducting Bulk Magnet

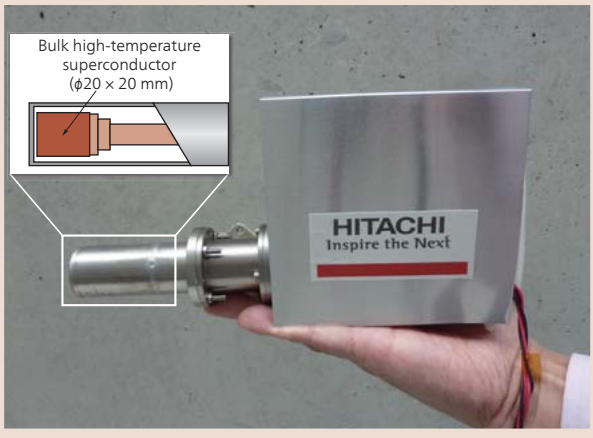
Hitachi has developed a palm-sized superconducting magnet with potential applications in magnetic drug delivery systems (MDDSs).

MDDSs use drugs that contain magnetic material. They work by applying a magnetic field to the affected site in the body so that the drug will concentrate in this region, thereby improving the drug's efficacy. Because this involves guiding the movement of nanometer-sized magnetic particles, it requires miniature superconducting magnets that can generate an intense magnetic field while still being easy to handle. Accordingly, bulk high-temperature superconductors (which become superconducting at higher temperatures than conventional superconductors) are used because they can work with small cooling systems that have a low cooling capacity. This has enabled the production of a miniature (palm-sized) superconducting bulk magnet that is able to produce a 3-T static field, similar to that of a medical MRI system.

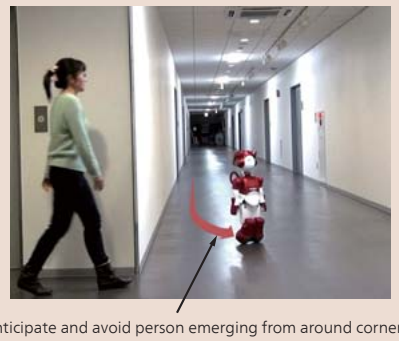
In the future, Hitachi intends to investigate using the magnet for other applications in addition to MDDSs.



8 Heat transfer tubes incorporating techniques for improving the ability of air to remove heat



9 Miniature superconducting bulk magnet



Anticipate and avoid person emerging from around corner.

The robot uses the microphone array and camera in its head to recognize the speech and gestures of the person it is interacting with.

10 How the humanoid robot avoids blindspots around corners (left) and an example of interactivity (right)

10 Human Symbiotic Robot

A humanoid robot (shown in the figure) has been developed to act as a guide in public places in Hitachi. To improve the ability of the robot to operate around people, Hitachi has used machine learning to upgrade its avoidance and interactivity technology.

With the upgraded avoidance technology, the robot learns the location and speed of pedestrians in the space through it is moving and is able, not only to avoid those pedestrians that are visible through its sensors, but also to anticipate and avoid people who could potentially emerge from around corners or other blindspots where its sensors cannot see. When the robot's path requires it to approach a blindspot, it decelerates for safety.

The upgrade to its interactivity technology, meanwhile, enables the robot to provide flexible responses to questions. Using a question interpretation model that has been adapted using deep learning, the technology can provide an appropriate answer to even unanticipated questions by identifying its subject and attributes. It can also estimate how well the person it is speaking to has understood based on nodding or tilting of the head, and respond naturally.

In the future, Hitachi will keep working to develop technologies that enable practical services.

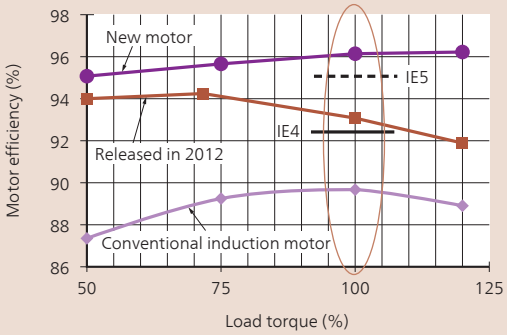
11 Amorphous Motor that Achieves IE5 International Efficiency Standard

Rising public concern in recent years about global warming and other environmental problems has led to interest in technologies that boost the efficiency of electrical equipment. As a result, there is growing demand from countries around the world for the use of highly efficient electric motors to save power in industrial equipment and other applications, with the USA requiring electric motors to meet the IE3 standard or better since 2010, and Japan introducing the same requirement from FY2015.

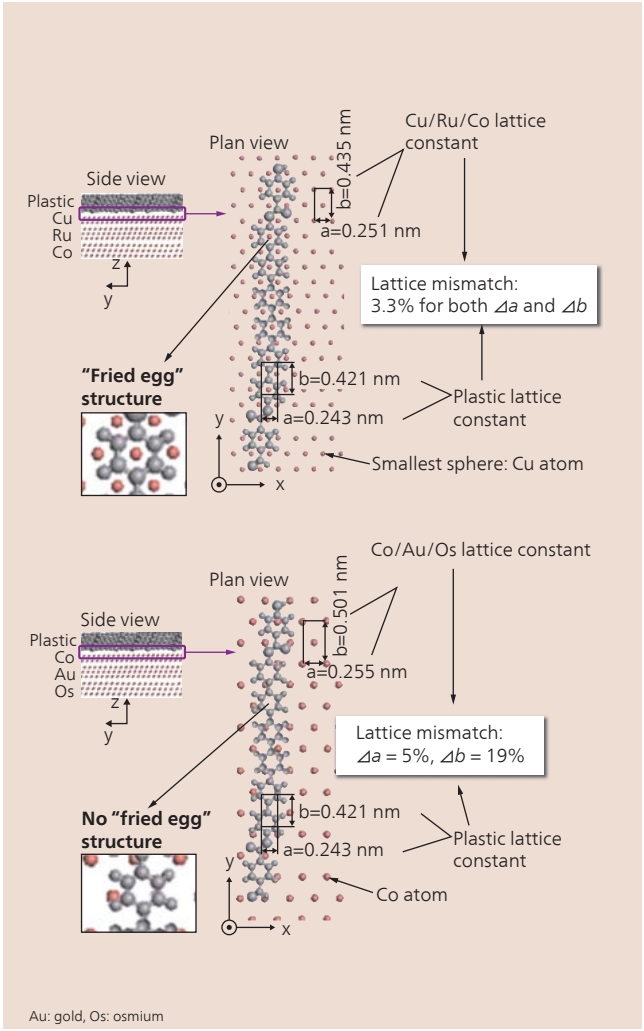
Hitachi has been working on the development of axial gap motors that use an amorphous alloy core to significantly improve motor efficiency. This work included the successful production in 2012 of a prototype 11-kW amorphous motor that achieved an IE4*-compliant energy efficiency of approximately 93%. Now, Hitachi has developed an amorphous motor that achieves the maximum IE5* level of the international efficiency standard for industrial motors. The prototype 11-kW amorphous motor has demonstrated an efficiency of 96%, and despite its smaller size has further reduced losses by 30% compared to the previous IE4-class motor.

Note that some of the technologies used in the new motor were developed to satisfy demand for further power savings through a product development process funded by the "Rare Metal Substitute Materials Development Project" of the New Energy and Industrial Technology Development Organization (NEDO).

* Motor efficiency guidelines defined by the IEC 60034-30/31 standard of the International Electrotechnical Commission (IEC).



11 Prototype 11-kW motor that achieves the IE5 efficiency level (top) and comparison of efficiencies of 11-kW prototype motors (bottom)



12 Results of atomic array calculation for high-adhesive-strength interface between plastic and Cu/Ru/Co (top) and low-adhesive-strength interface between plastic and Co/Au/Os (bottom)

12 Increased Adhesion of Plastic/Metal Interface Utilizing Orthogonal Arrays and Molecular Simulation

Because of their light weight, plastics are used in a wide range of products from electronic components to electrical equipment. In many cases, however, they suffer from poor adhesion to metals, ceramics, and other inorganic materials. In response, Hitachi has developed a technique that combines orthogonal arrays and molecular dynamics simulation for the efficient design of metals with excellent strength of adhesion to plastic.

Using the technique, a study of the most important factors in increasing the strength of adhesion found that the lattice mismatch between plastic and metal was crucial, and that the smaller the mismatch is, the stronger the adhesion will be. Lattice mismatch is a parameter that expresses the degree of inconsistency between atomic arrays, with the relative differences between the short edge (a) and long edge (b) of the unit cell being defined as Δa and Δb. When used to design a laminated metal film with excellent adhesion to the polyphenol resin used in semiconductors, a small lattice mismatch with the resin of only 3.3% was achieved by layering copper (Cu), ruthenium (Ru), and cobalt (Co), giving an adhesive strength 30% higher than that of a thin film made of Cu only. The mechanism by which the stronger adhesion is achieved involves using a repeating "fried egg" structure consisting of Cu atoms inside a benzene ring to strengthen the inter-molecular bonds.

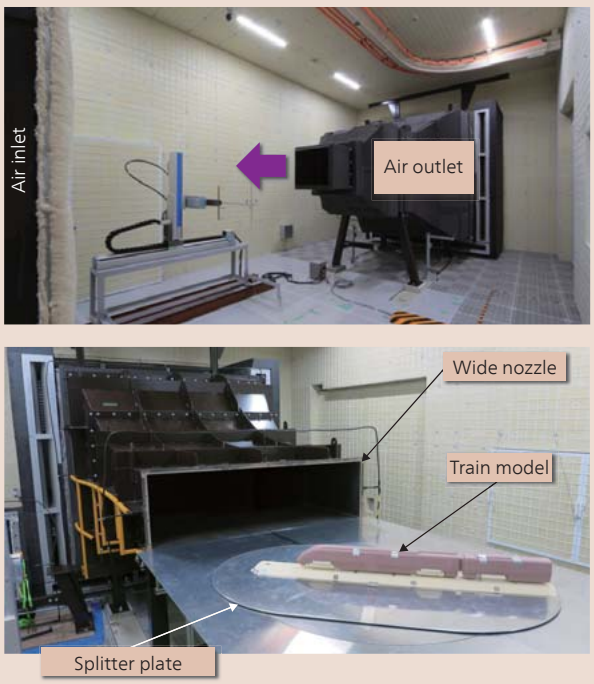
In the future, Hitachi intends to utilize the technology in the design of components such as enamel wire for motors or electrodes for lithium-ion batteries.

13 Wind Tunnel to Enhance Development of Rolling Stock for High-speed and European Trains

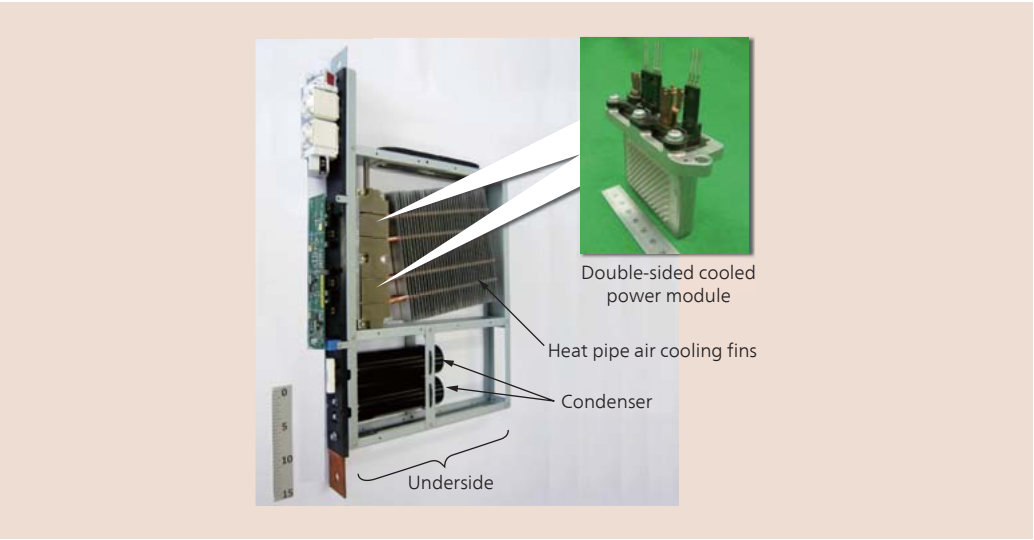
Hitachi has developed a wind tunnel for uses that include reducing aeroacoustic noise on high-speed rolling stock and improving the safety in crosswind of rolling stock for the European market.

The wind tunnel can predict the level of aeroacoustic noise by reproducing the air flow over moving rolling stock. The maximum air speed was increased from 180 kph previously to 420 kph by increasing the performance of the blower used to generate the flow of air and by optimizing the flow path shape from the blower to the air outlet. This can reproduce conditions similar to those of a high-speed train traveling at maximum speed and predict the level of aeroacoustic noise with good precision. The wind tunnel also includes a rolling stock safety test apparatus that complies with the safety testing requirements stipulated in the EN 14067-6 European standard to enable it to be used for the preliminary safety testing of rolling stock in crosswind required during development for the European market.

In the future, Hitachi intends to use this new facility for the development of rolling stock that is safer, more comfortable, and energy-efficient.



13 Measurement chamber of new wind tunnel (anechoic chamber) (top) and rolling stock safety test apparatus (bottom)



14 Modular power conversion unit (left) and double-sided cooled power module (right)

14 Technology for Reducing the Size of Industrial Power Converters Using Double-sided Cooled Power Modules

Using double-sided cooled power modules to achieve excellent cooling performance, Hitachi has developed standard modular power conversion units that can be fitted into a variety of systems.

The main requirements in the development of power converters over recent years have included making equipment smaller in order to save space and reducing maintenance times in order to increase equipment utilization. By using low-volume double-sided cooled power modules, which have superior heat dissipation compared to the power modules with single-sided cooling that were used in the past, Hitachi has succeeded in making its power conversion units smaller while also standardizing the main circuit components across different models. By using a proprietary heat dissipation system that runs heat pipes with excellent thermal transfer characteristics across both sides of the power modules for double-sided cooling, the newly developed modular power conversion unit halves the volume of the fins compared to previous models, allowing a thin 5-cm-wide design that facilitates side-by-side installation.

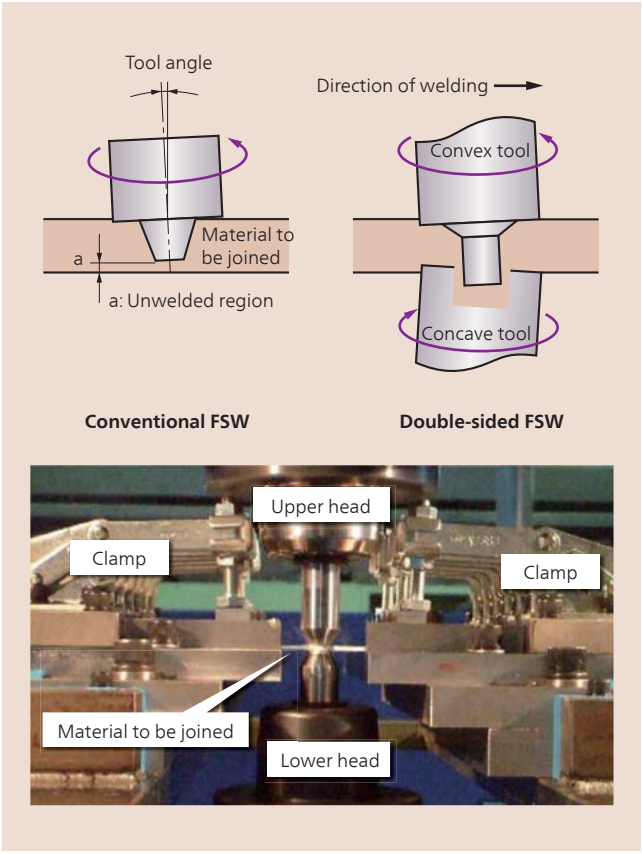
The modular power conversion units have been used in the development of a new generation of uninterruptible power systems (UPSs), providing easier maintenance when replacing parts and achieving a 30% smaller volume than previous Hitachi UPSs.

15 Double-sided FSW

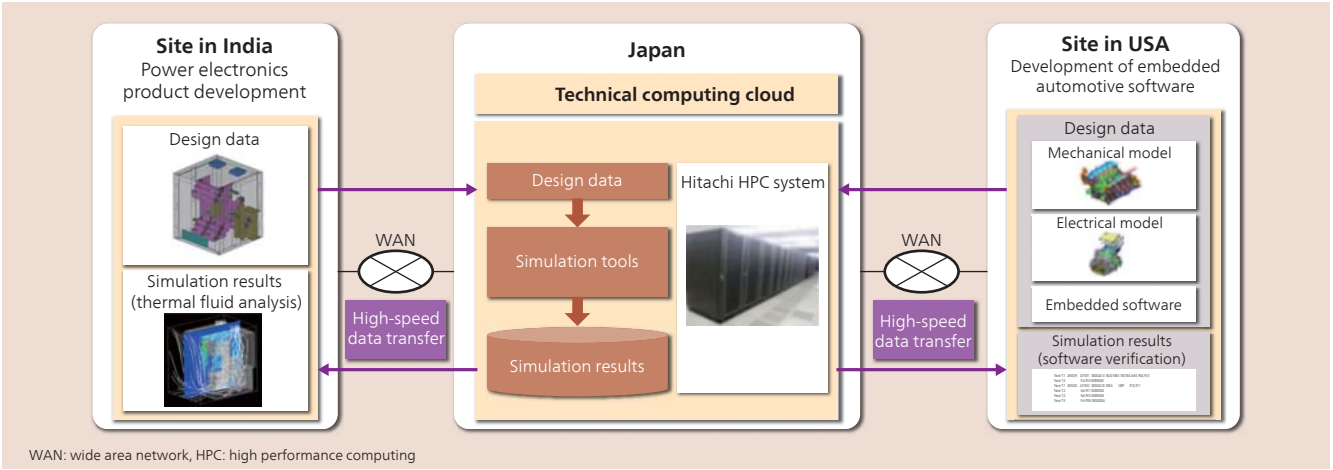
Friction stir welding (FSW) is a method used for joining materials that works by inserting a rotating cylindrical tool between the materials to be joined, and running it along the seam of the joint. The heat generated by friction between the tool and the materials causes them to soften, and the rotation of the tool causes the materials to mix, thereby forming a weld.

One feature of double-sided FSW is that it sandwiches the materials to be joined between convex and concave tools. Because the gap between the tools and their respective directions and speeds of rotation can be chosen at will, double-sided FSW can also weld more quickly than conventional FSW, and can be used to weld thin sheet metal of 1 mm thickness or less. Its most important feature, however, is that it does not leave any regions unwelded, making the weld less likely to fail under complex loads that combine both bending and tension. Because this makes it possible to roll the welded material, the technique is suitable for welding machines used to achieve continuous rolling.

The technique is currently being considered for use in a metal forming machine for aluminum alloy plate at Mitsubishi-Hitachi Metals Machinery, Inc.



15 Diagram of welding process (top) and welding in progress (bottom)



16 Design cloud configuration

16 Core Technology for Making Japanese Technical Computing Environment Available to Overseas Users

When undertaking design, development, and research work at overseas sites, it is important to ensure the reliability and other performance factors of overseas products, and this requires that the same level of design and technical computing environment be provided as is available in Japan.

This has led Hitachi to develop core technology for providing overseas design, development, and research sites with a similar level of access to a Japan-based technical computing environment such as supercomputers, etc. (the design cloud) as is available to Japanese users. By combining Hitachi's network acceleration and engineering data compression technology, this achieves communications more than 100 times faster than before, not only over the wide-bandwidth connection between facilities in Japan and the USA, but also over the narrow-bandwidth link between Japan and India. This enables the technical computing environment located in Japan to be used from other countries such as the USA and India.

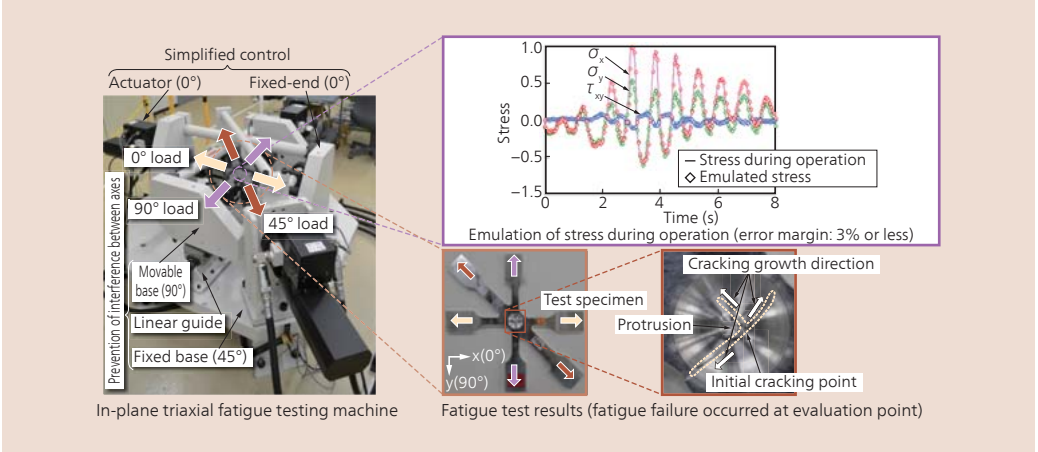
In the future, Hitachi will proceed with the global standardization and consolidation of IT and business systems at design, development, and research divisions by testing and implementing this environment in other countries around the world.

17 Tri-axial Testing Technique for Emulating the Fatigue Phenomenon that Occurs on Structures during Operation

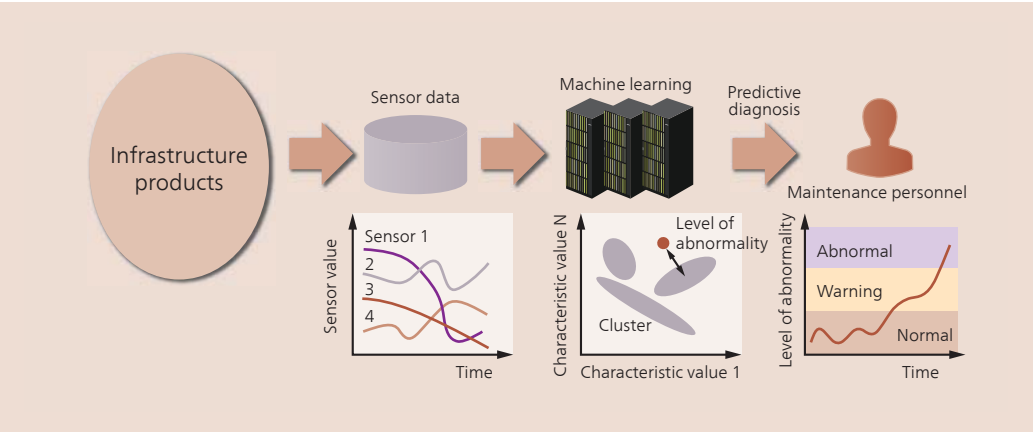
The complex loads that occur on transportation machinery, etc. during operation accelerate the fatigue phenomenon in their mechanical structures. To elucidate the fatigue phenomenon with complex loads, Hitachi has developed a testing technique that can emulate the stresses (in-plane stresses) that are generated on the machinery surface where fatigue failure occurs.

Since in-plane stresses consist of three stress components, a major feature of the new technique is its ability to emulate any in-plane stress, thanks to a design that allows loads to be applied independently in three different directions (0°, 45°, and 90°). By using one-sided actuators to simplify control and linear guides to prevent interference between different axes, the technique is able to generate maximum stress in the center of the test specimen. When used to emulate complex stresses measured on construction machinery during operation, the new technique was able to do so with an error margin of less than 3%. In fatigue testing, it was found that fatigue failure occurred at the evaluation point.

In the future, Hitachi will contribute to the development of highly reliable products for the social infrastructure sector by devising techniques for predicting with high accuracy the fatigue phenomenon with complex stresses that are generated on structures during operation.



17 Emulation of fatigue phenomenon that occurs on structure during operation



18 Use of machine learning to enhance maintenance services for infrastructure products

18 Analytic Technique Used by Maintenance Service for Infrastructure Products

In order to provide more advanced and efficient maintenance services to meet the requirements of infrastructure products, particularly in emerging economies, Hitachi has developed the vector quantization clustering (VQC) predictive diagnosis technique based on machine learning.

The technique can help with preventive maintenance because of its ability to detect abnormalities in products with greater accuracy than the previous practice of using individual threshold criteria for each type of sensor data. To assess product condition, the technique learns normal behavior in the form of clusters for each state, and then converts the relationship between cluster and current state into a single abnormality metric.

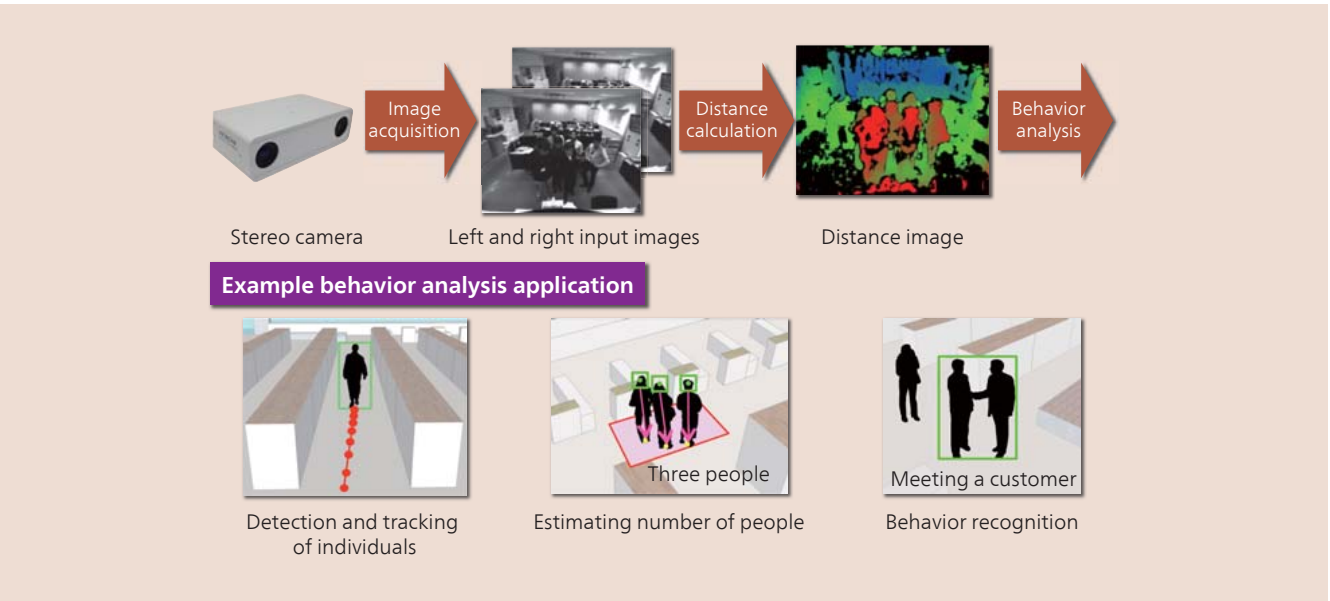
The fast processing speed of the newly developed technique means that on-board diagnosis can be built into the product itself, making it suitable for situations that lack reliable communications. It is possible to provide maintenance services that are tailored to individual products while also performing centralized management of a wide variety of infrastructure products by linking to the cloud.

19 Use of 3D Video Analysis for Human Behavior Analysis

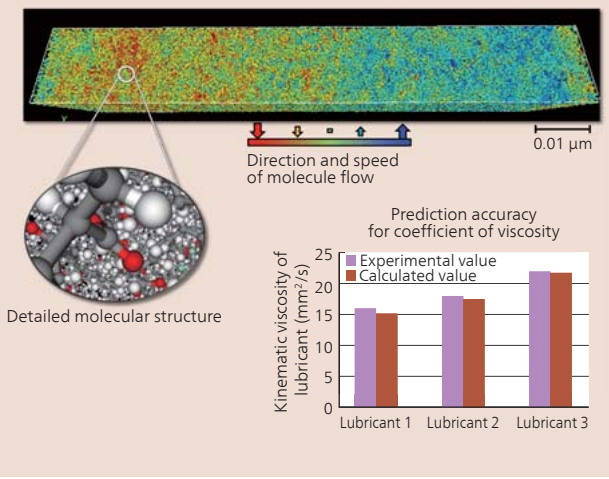
Services that identify new value by measuring the movement and other behavior of people in spaces such as offices or shopping complexes have attracted interest in recent years.

Now, Hitachi has developed a technique that uses 3D analysis of video from stereo cameras to analyze human behavior. Past techniques for analyzing video from mono cameras suffered from significant reduction of recognition performance under certain imaging conditions. Because it can obtain 3D information about the captured scene by using the left and right stereo camera images to determine distance, the new technique can be used for applications such as detecting and tracking individuals, estimating the number of people, or identifying particular types of behavior. By using 3D information to improve the robustness of tasks such as position measurement or differentiating between different people, it can more reliably measure human behavior.

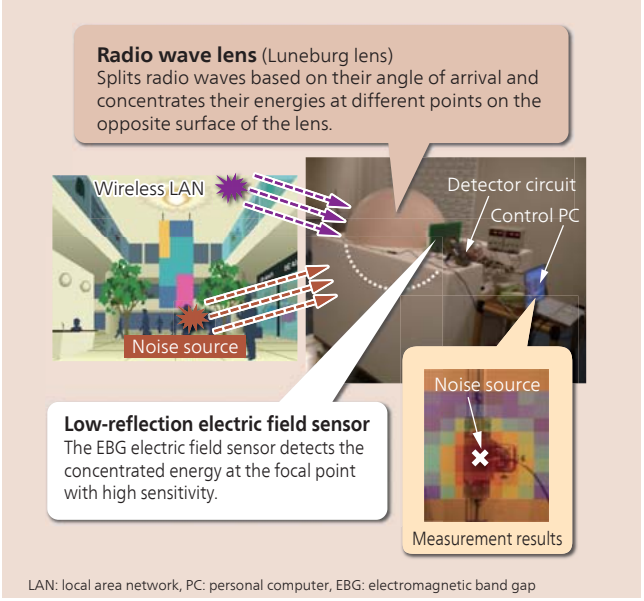
In the future, Hitachi will continue to contribute to the supply of solutions with high added value, such as the use of human behavior analysis for improving productivity or for security systems at stores or offices.



19 Behavior analysis application using stereo cameras



20 Use of molecular-scale flow calculations for lubricant to elucidate phenomena and predict properties



21 Radio direction finder

20 Large-scale Molecular Simulation Technique for Predicting Lubricant Properties in Sliding Parts

Amid worsening energy problems, reducing the energy losses in the sliding parts of drive machinery is an important concern. Practices adopted to achieve this include improving the quality of sliding surfaces and appropriate selection of lubricants and additives. The ability to visualize the molecular-scale flow behavior of a lubricant on sliding interfaces (regions in the order of 0.01 μm to 10 μm at the interface between sliding surfaces and lubricant) is also useful when designing for higher levels of energy efficiency.

Using a supercomputer, this newly developed technique is able to predict how the physical properties of a lubricant vary in response to environmental factors such as the pressure or temperature at the interface between sliding parts by visualizing sliding interfaces that are difficult to observe experimentally. The kinematic viscosity of lubricant calculated using the technique agreed with experiment to an accuracy within 10%.

In the future, Hitachi will analyze detailed molecular structures with the aim of making more appropriate material selections by predicting the properties not only of lubricants on sliding interfaces but also the effect of mixing them with additives. Hitachi will also contribute to product design and shorter development times by seeking to elucidate the phenomena that occur at the sliding interface.

21 Technique for Identifying Direction of Incoming Radio Waves

The spread of smart communities in recent years has seen increased use made of wireless communications for data collection and management services that use the collected data. Accordingly, a need has emerged for techniques that can identify the location of noise sources at installation sites in order to minimize interference between radio devices and provide uninterrupted wireless communication services.

In response, Hitachi has studied how the human eye determines the direction of incoming light rays and has developed a technique for identifying and displaying the location of radio sources that consists of a radio wave lens (Luneburg lens) that functions in a similar way to the lens of an eye, and an electric field sensor that acts like the retina. A Luneburg lens focuses at a different point depending on the direction of arrival of incoming radio waves, and the technique uses this property to achieve a high sensitivity of –65.6 dBm/m² by concentrating the weak radio energy at the focal point. It also achieves high angular resolution of 2.54° by positioning a low-reflection electric field sensor consisting of a tiny metal cell at the focal point.

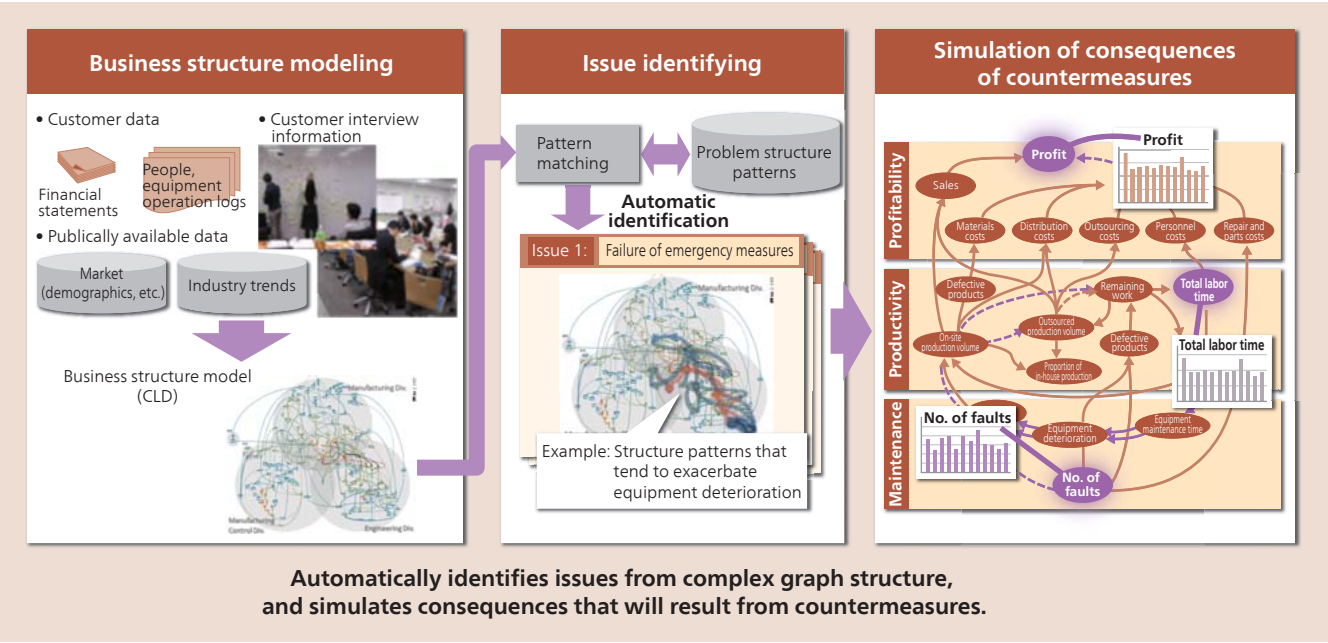
In the future, Hitachi intends to test the technique at actual radio installations with the aim of improving the reliability and safety of the social infrastructure that incorporates wireless communications.

22 Business Dynamics

The changing background of market globalization and cross-industry mergers and acquisitions (M&A) has placed a growing importance on rapid decision-making in business. However, this decision-making is complicated by ongoing changes associated with the interaction between a variety of different factors in the environment in which people operate.

Business Dynamics* is a way of identifying the structures that give rise to these changes. It is a technique for identifying changes in advance by using a business structure model of the cause and effect relationships between the factors that influence business to determine structural characteristics.

The business structure model collates information that can be viewed from a variety of different perspectives, including customer data, publically available data, and information from customer interviews, and represents it as a type of directed graph known as a causal loop diagram (CLD). Because of the large and complex structure of a CLD, Hitachi has developed a function that uses pattern matching techniques to automatically identify issues. It



22 Sequence of steps in business dynamics analysis

also performs quantitative simulations of what flow-on changes will arise from the measures used to deal with the identified issues in order to determine when and to whom consequences will result, and whether they will turn out to be counterproductive.

Although this technology has been applied in about 30 cases up until now, including manufacturing, finance, logistics, and power generation, Hitachi intends to brush it up based on actual applications in the future.

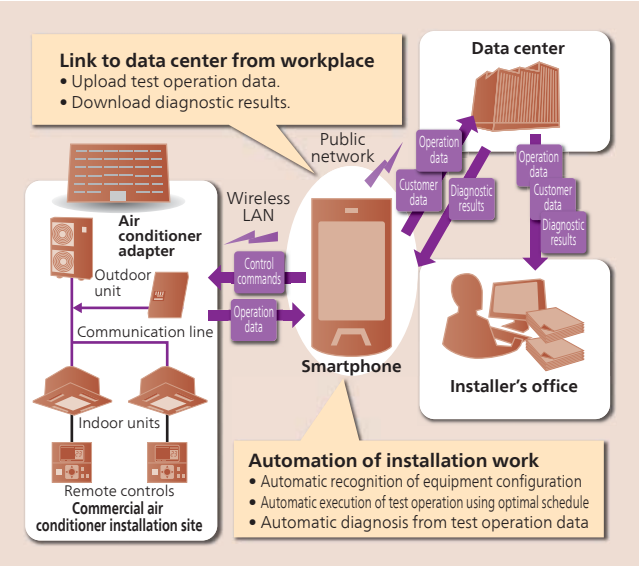
* Developed by Massachusetts Institute of Technology (MIT) in the USA. Hitachi has rich experience in applying this technique and, with the unique know-how to apply this technique quickly and easily, it is developing software and templates for each industry, etc.

23 Installation Support System for Commercial Air Conditioners

Commercial air conditioners consist of indoor units, outdoor units, and remote controls. A major obstacle to reducing the cost of installation is the difficulty of performing the work efficiently without having specialist knowledge.

Given this situation, Hitachi is developing an installation support system for commercial air conditioners that facilitates installation work by using air conditioner adapters to connect to a communication line for commercial air conditioners, and integrating smartphones that act as general-purpose interfaces.

The system simplifies each step of the work by automating such activities as recognizing the configuration of multiple air conditioners, executing test operation in accordance with an optimal schedule, and performing diagnosis from test operation data, and is able to do so by using a smartphone as a relay for linking to a data center from the workplace if the commercial air conditioner itself is unable to get a network connection to the data center. This can help make installation by workers who lack specialist knowledge more efficient.

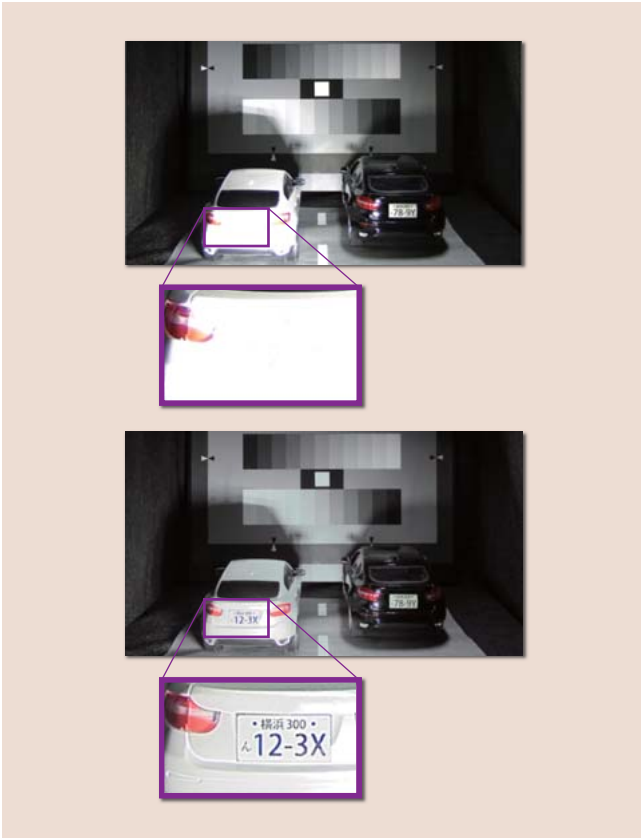


23 Installation support system for commercial air conditioners that uses smartphones and air conditioner adapters

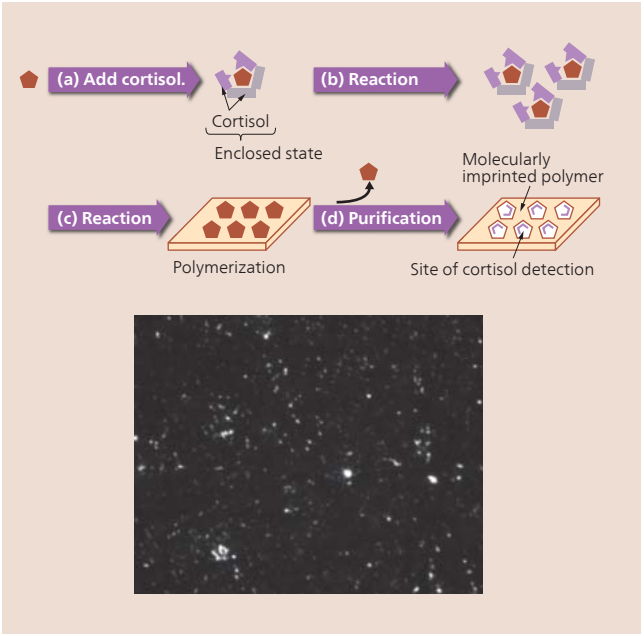
24 Camera Technology for Instantaneous Correction of White-out due to Bright Light

Growing concern for public safety and security in recent years has created demand for surveillance cameras to provide clear images even under conditions that make it difficult to see what is happening, such as in darkness or when reflections are present.

Now, Hitachi has developed technology for enhancing visibility that can cope with difficult conditions with strong backlighting, such as headlights or headlight reflections in the dark, by combining instantaneously adjusting exposure techniques, noise reduction techniques, and contrast stretching techniques that make dark regions appear less dark. By instantaneously adjusting exposure to reduce white-out and performing correction without using the composition processing techniques used in the past, the technology can produce clear images with a processing time of no more than 0.23 s even when a bright object appears suddenly in



24 Comparison of uncorrected image (top) and image after performing instantaneous correction for white-out without blurring (bottom)



25 Overview of how molecularly imprinted polymer is manufactured (top) and fluorescence microscope image of fluorescent labeled cortisol (whiter regions have a higher level of fluorescence) (bottom)

the shot.

The technology is included as one of the functions on the surveillance camera modules supplied by Hitachi Industry & Control Solutions, Ltd. to markets in North America and Europe (released in September 2014).

In the future, Hitachi intends to build surveillance cameras and video surveillance solutions that can provide clear video images by making further improvements to contrast stretching and noise reduction techniques.

25 Manufacturing Technique for Molecularly Imprinted Polymer Used in Testing Kits for Stress-related Hormones

Hitachi has developed a manufacturing technique for a molecularly imprinted polymer that is able to detect cortisol, a stress-related hormone, with high sensitivity.

A molecularly imprinted polymer has a surface that is specially designed to recognize a particular target molecule based on its physical structure and other properties (a polymer is a high-molecular-weight material formed from many molecules linked together). In developing the manufacturing technique for the molecularly imprinted polymer, which has excellent recognition ability, Hitachi's aim was to enable the point-of-care testing of cortisol.

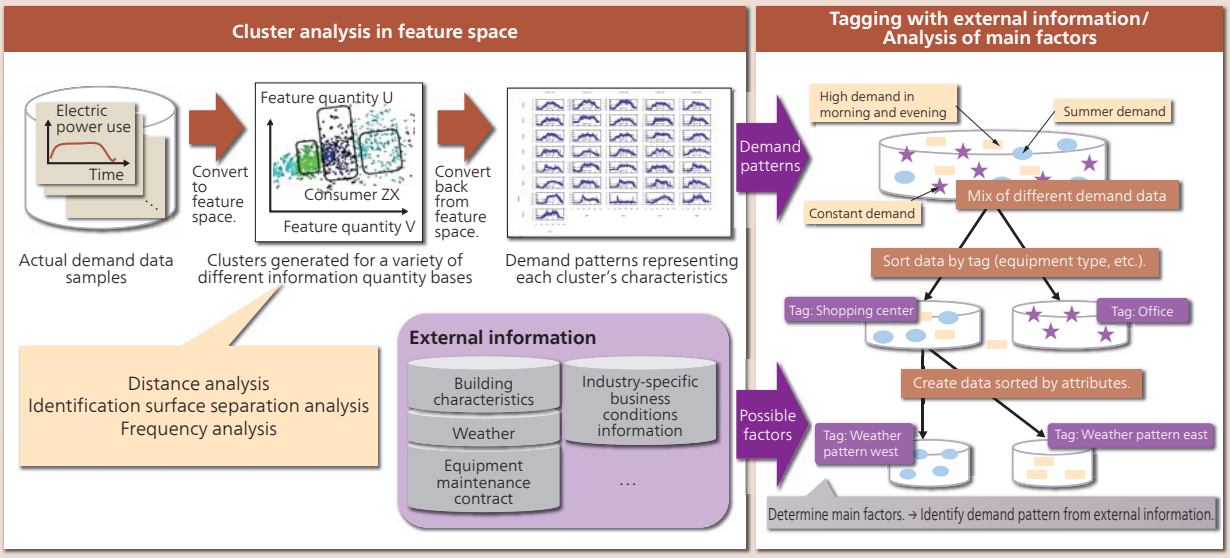
Achieving the point-of-care testing requires a method for determining whether cortisol has become bound to Hitachi's manufactured polymer. To achieve this, Hitachi also established a technique for synthesizing cortisol with a fluorescent labeled molecule, which is a known method for achieving highly sensitive detection. Combining the fluorescent labeled cortisol with the molecularly imprinted polymer provides a quantitative indication of how much cortisol has bound to the polymer.

Because the new technique can detect cortisol with high sensitivity and without the need to separate protein antibodies from living organisms and purify them, as in the past, it opens up the potential for commercializing a kit for the point-of-care testing of stress-related hormones in saliva.

26 Electricity Demand Analysis Technique

In readiness for the comprehensive liberalization of the Japanese electricity retail market beginning in 2016, the companies that produce and sell electric power are expected to offer a range of billing options that suit the different types of consumers around the country, and that make economic sense while also promoting energy efficiency without imposing a burden. Rather than just broadly classifying demand into industrial and residential, achieving this requires analysis of the actual characteristics of electricity demand (when and how much).

The electricity demand analysis technique converts actual consumption data into feature space data and generates clusters from data with similar characteristics over time periods of between several tens of minutes and an entire year. By determining the dimensionality of the feature space and the number of clusters according to a variety of different information criteria, good-quality demand patterns that represent just enough of the demand characteristic can be obtained from the clusters. It is also possible to use external demand information to perform a simple analysis of electricity demand for consumers from outside the sample by tagging the external information for the samples that belong to each cluster and using this information to analyze the main factors involved in demand pattern generation.



26 Electricity demand analysis technique

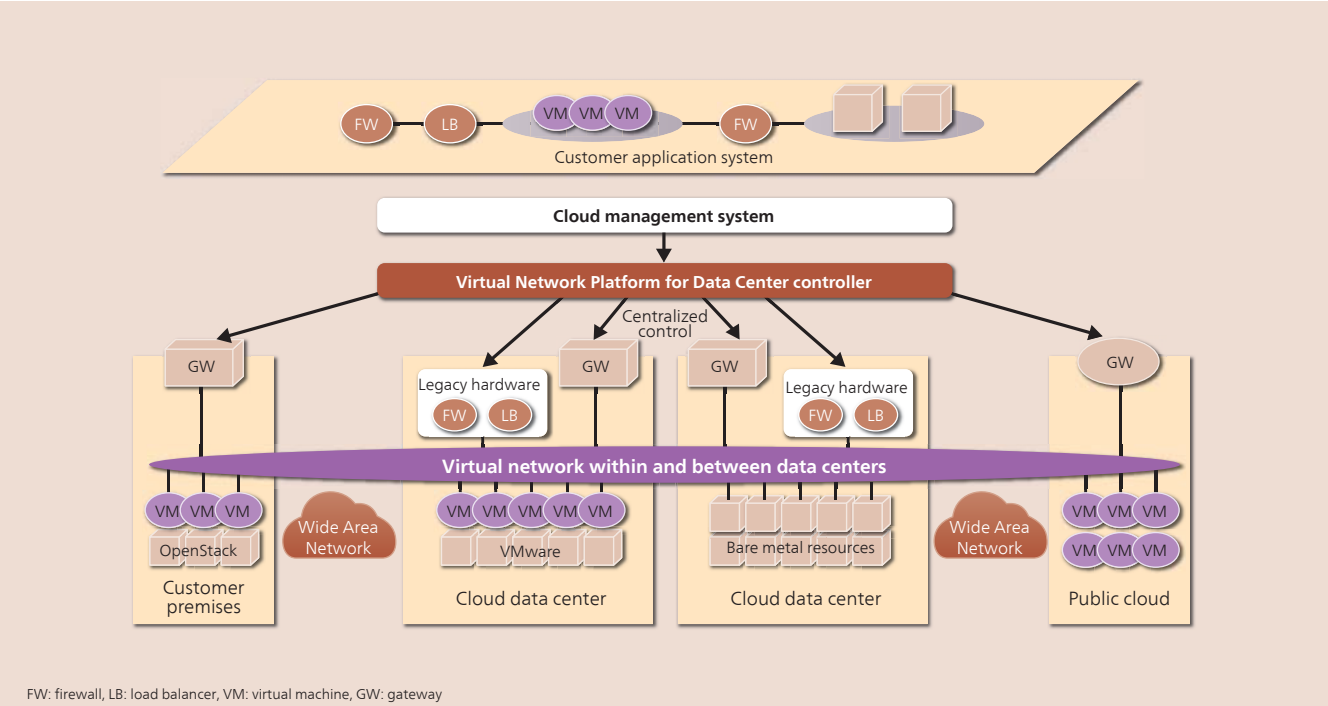
27 SDN Technology for Cloud Data Centers

Software-defined networking (SDN) (virtual networking with centralized control) is increasingly being recognized for its potential to reduce the workload and risk of human error associated with manually performed network configuration changes at cloud or other corporate data centers. In the past, however, SDN has only been available at data centers equipped with hardware that complies with new standards such as OpenFlow* or that used server virtualization from a specific vendor.

The new SDN technology for cloud data centers developed by Hitachi, on the other hand, is able to provide centralized control of a wide variety of legacy hardware through the abstraction modeling of firewalls, load balancers, and other devices. It also implements flexible virtual networks that are not dependent on the server virtualization technology by performing centralized control of gateways that encapsulate communications to provide connections between data centers or between clouds. This provides a way to automate network configuration changes that previously took anywhere from several hours to several days in environments that contain legacy hardware systems and multiple data centers or clouds of different types.

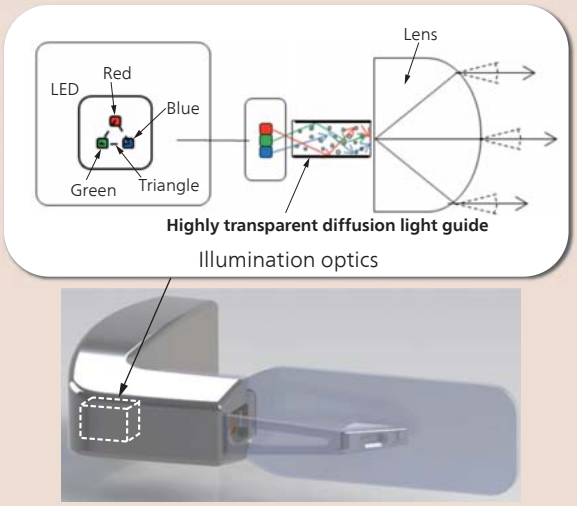
These new technologies will be progressively rolled out in the Virtual Network Platform for Data Center (VNP-DC) software of Information & Telecommunication Systems Company, Hitachi, Ltd.

* See "Trademarks" on page 146.



FW: firewall, LB: load balancer, VM: virtual machine, GW: gateway

27 SDN technology for cloud data centers



28 Multiple refraction light guide

28 Small, High-brightness Optical Engine for HMDs

The increasing complexity in recent years of tasks in production line, maintenance management, stocktaking, and other work environments has led to demand for improving productivity and reducing errors. To achieve this, it is important for workers to share information and issues in their workplace with managers in realtime. This has led to interest in the use of head-mounted displays (HMDs) that can be used for hands-free information sharing that does not interrupt the work being done. However, considering factors such as working hours and use in outdoor work, these HMDs need to be able to operate continuously for eight hours and provide sufficient brightness to be read in 100,000-lx direct sunlight.

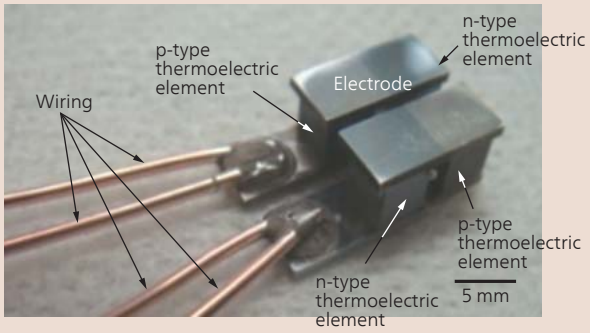
The new optical system that Hitachi has developed for HMDs combines high optical efficiency with uniform brightness achieved by superimposing reflected light. It achieves eight times* the optical efficiency of competing products thanks to its low-loss optics, which use a high-order aspherical lens and an industry-first* highly transparent diffusion light guide jointly developed by the Yokohama Research Laboratory of Hitachi, Ltd. and Hitachi Chemical Co., Ltd. This makes it possible to build an HMD with both low power consumption and a display that is easy to read even under outdoor conditions.

In the future, Hitachi intends to undertake trials of HMDs fitted with the new optical system in collaboration with application users, and to deploy the technology in a wide range of fields.

* Based on research by Hitachi, Ltd.

29 Thermoelectric Conversion Module Able to Withstand High Temperatures

Thermoelectric conversion works by converting waste heat from power plants, factories, vehicles, or other sources into electric power. Despite rarely ever being used in the past, it has attracted attention as a way of generating electric power that is environmentally conscious.



29 Two-pair thermoelectric conversion module

While the generation efficiency of a thermoelectric conversion module increases the greater the difference in temperature is between its top and bottom surfaces, the major challenge when operating at high temperatures is how to ensure the reliability of the joints between the thermoelectric elements and electrodes. Accordingly, Hitachi has investigated a highly reliable bonding technique that uses aluminum as the bonding material.

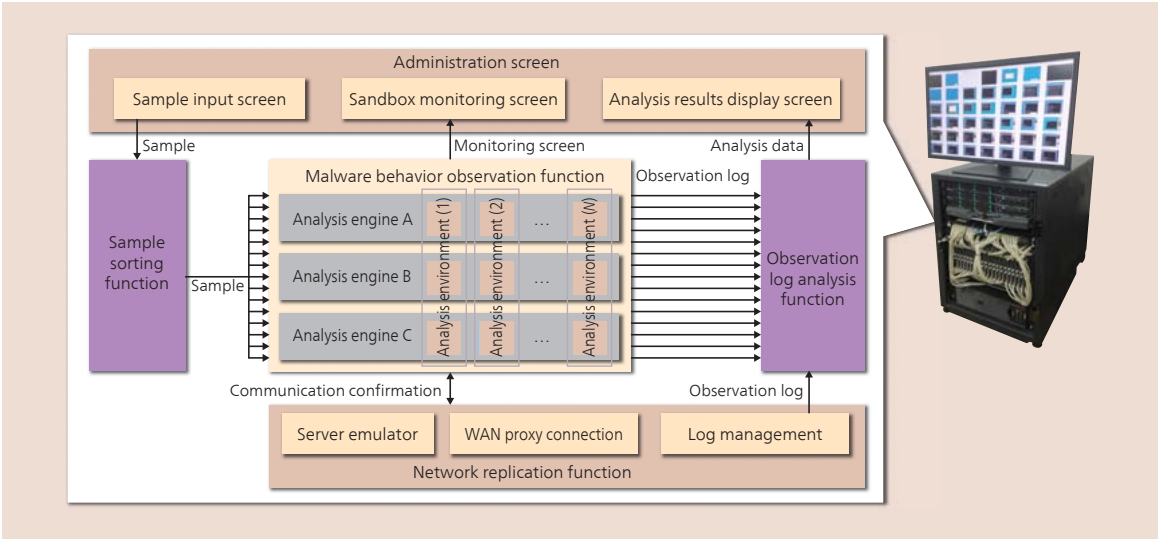
One feature of the technique is that it causes the aluminum to form intermetallic compounds during the bonding process so the joint will not melt again even if the temperature subsequently reaches the melting point of aluminum (933 K). When Hitachi used the newly developed technique to build a prototype two-pair thermoelectric conversion module made up of four elements, it demonstrated a joint strength four times the previous method and generated an output of 1,000 mW at 923 K. It is anticipated that this will provide a major boost to the commercialization of thermoelectric conversion modules that can be used at high temperatures.

Hitachi intends to continue with structural optimization and other enhancements in order to develop highly efficient modules with a view toward a product release.

30 Automatic Malware Analysis Techniques for Multiple Environments

Recent years have seen increasingly frequent cases of organizations being infected by malware that cannot be detected by existing measures. In such cases, it is necessary to identify the characteristics of the malware and quickly implement countermeasures to prevent further losses. One method used to identify malware characteristics is dynamic analysis, whereby the malware is run on a special analysis system to observe its behavior. In the case of recent malware, unfortunately, an increasing number are of a type that evades analysis by only running in certain environments.

This has led to the research and development of techniques for analyzing malware in a variety of different ways by using a number of different types of dynamic analysis environments. When implementing the environments, published vulnerability information, attack patterns, and so on are used as a basis for selecting those



30 Dynamic malware analysis system for multiple environments and an overview of its functions

environments in which it is easy to get the malware to run and to observe its behavior. Hitachi has also developed a technique for automatically identifying malware behavior from observations by incorporating its know-how about malware analysis into scripts. By simplifying the identification of network connections or other unauthorized actions by the malware, the technique helps avoid losses and helps prevent them from being exacerbated.

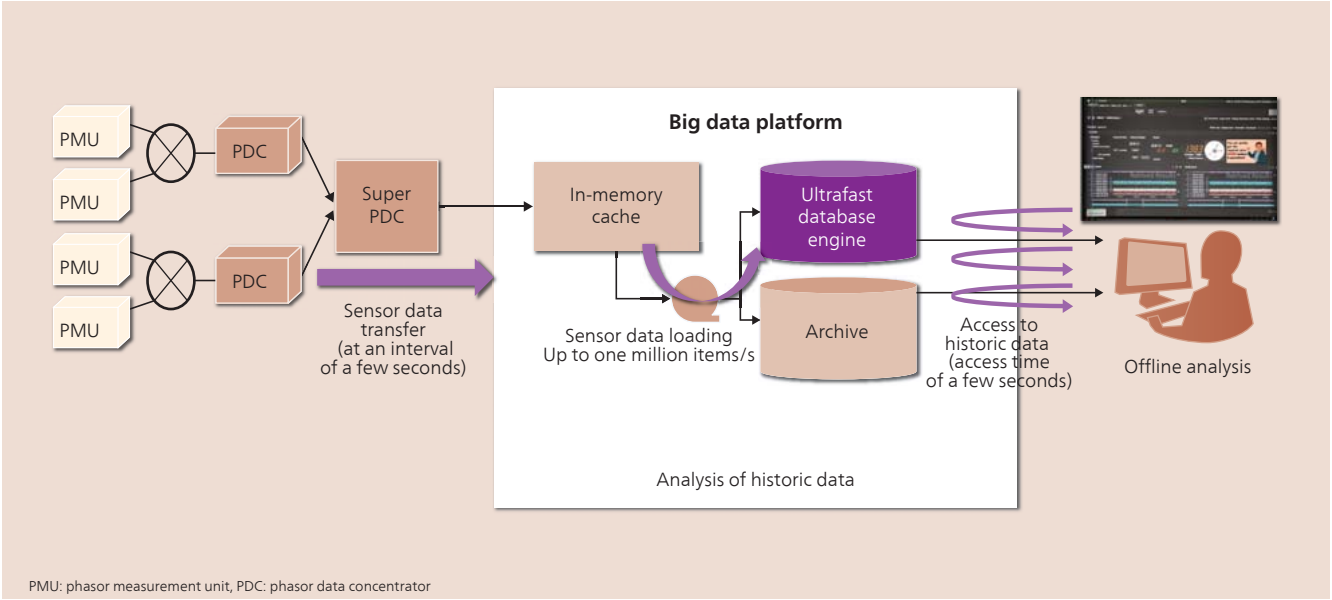
31 Big Data Platform for Large Quantities of Time Series Data

There is growing demand for the use of large quantities of time series data such as the analysis of sensor data made possible by the spread of the Internet of things (IoT). Hitachi has now developed a big data platform that can collect large quantities of time series data as it is generated and make it available for immediate retrieval.

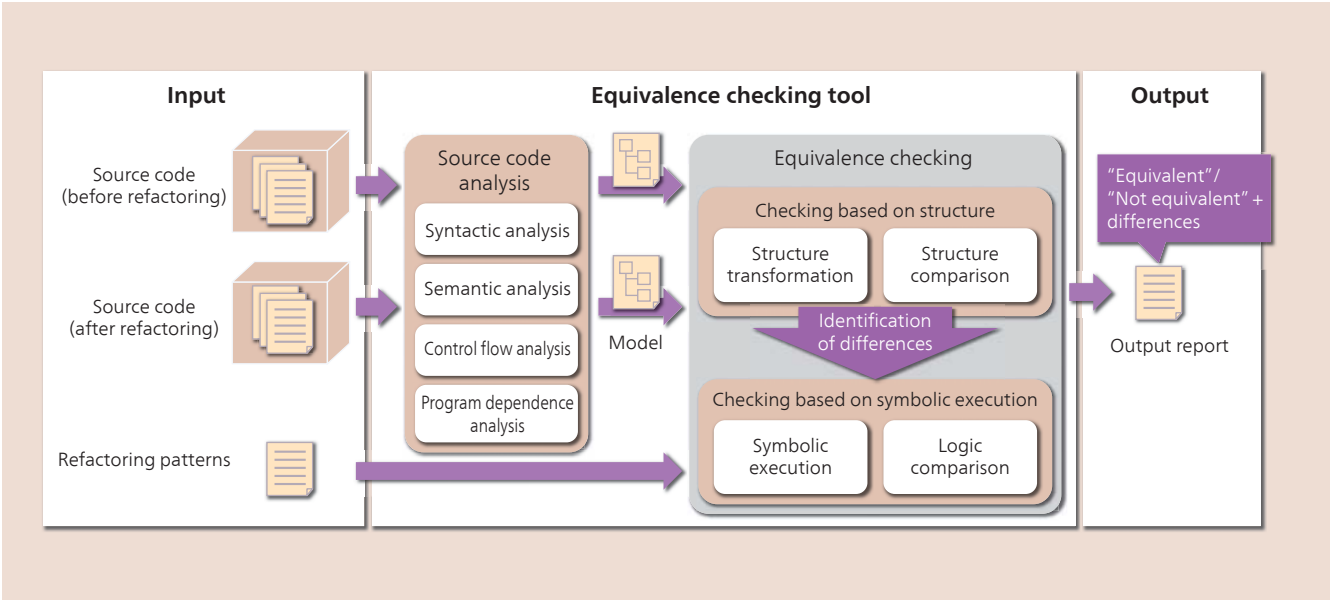
The new platform technology temporarily stores the data coming in with high frequency in in-memory cache before loading it in blocks into the ultrafast database engine*. This enables both high-speed loading and immediate retrieval of stored data (loading of one million or more items per second of sensor data collected at intervals of a few seconds, and retrieval of required historic data with a retrieval time of a few seconds). The database engine also has a function for accessing archived data using a single structured query language (SQL) query. These features have reduced the cost of storing large quantities of sensor data by an order of magnitude.

Hitachi is currently working on incorporating the newly developed platform into a wide-area power grid monitoring system targeted at overseas grid operators. As it works toward commercialization, Hitachi intends to market systems to customers and continue enhancing the technology.

* 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).



31 Big data platform



32 Program equivalence checking using symbolic execution

32 Program Equivalence Checking Technique

The key to efficient software development lies in keeping software structures clean. Accordingly, growing use is being made in product development of refactoring, which means improving program structures, to achieve this. However, changing a program carries a risk of introducing bugs, and this also applies to making structural improvements by refactoring.

In response, Hitachi has developed a technique for analyzing source code before and after refactoring to check whether the changes affect its behavior. The technique uses a method called symbolic execution to check the logical equivalence of the programs' inputs and outputs. To enable its use on large programs, it can efficiently narrow-down the checking scope by transforming and comparing structures according to refactoring patterns.

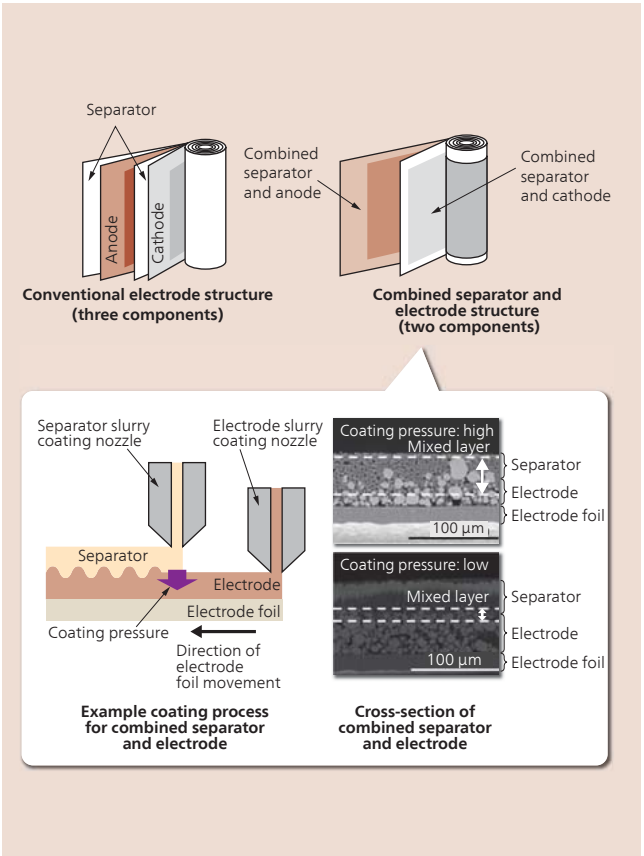
When deployed on server product software, the new technique was able to correctly check 75% of refactoring. This reduces the risk of bugs being introduced by refactoring and provides an effective way to make structural improvements to software in product development.

33 Innovative Manufacturing Process for Lithium-ion Batteries

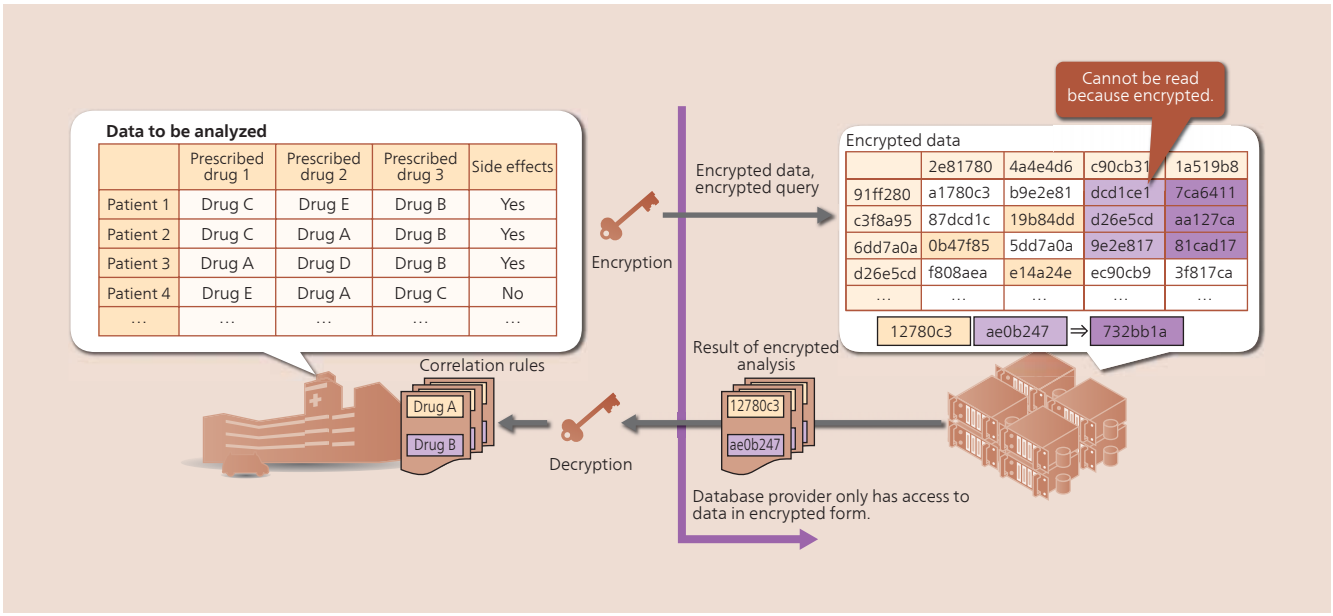
Rapid growth in the use of lithium-ion batteries is driving demand from users for lower costs. One way to cut costs is to reduce the component count from that of the current electrode structure, which consists of three components: the anode, cathode, and separator.

In contrast, a newly developed fabrication process reduces the component count to two by coating the separator onto the electrodes. In the new fabrication process, separator slurry coating is performed immediately after electrode slurry coating, creating a layer in which electrode and separator are mixed. Since a short circuit between anode and cathode may occur if this mixed layer becomes too thick, the challenge is to make the mixed layer thinner. Hitachi's new process succeeds in controlling the mixed layer thickness by optimizing separator coating pressure control and the composition of the separator slurry. As a result, it is able to keep the mixed layer of the combined separator and electrode thin enough that no short circuit will occur.

The new process has been implemented in a development system belonging to Hitachi High-Tech Fine Systems Corporation where it is being tested in readiness for commercialization.



33 Comparison of conventional and new electrode structures, and example of new coating process together with electrode cross-section



34 Configuration of confidential analysis system

34 Confidential Analysis Technique

Recent years have seen frequent cases in which large amounts of data, including confidential information, has been stolen from databases, creating an obstacle to the use of big data. While data encryption is one way of dealing with this, the problem is that analysis and other processing cannot be performed on encrypted data.

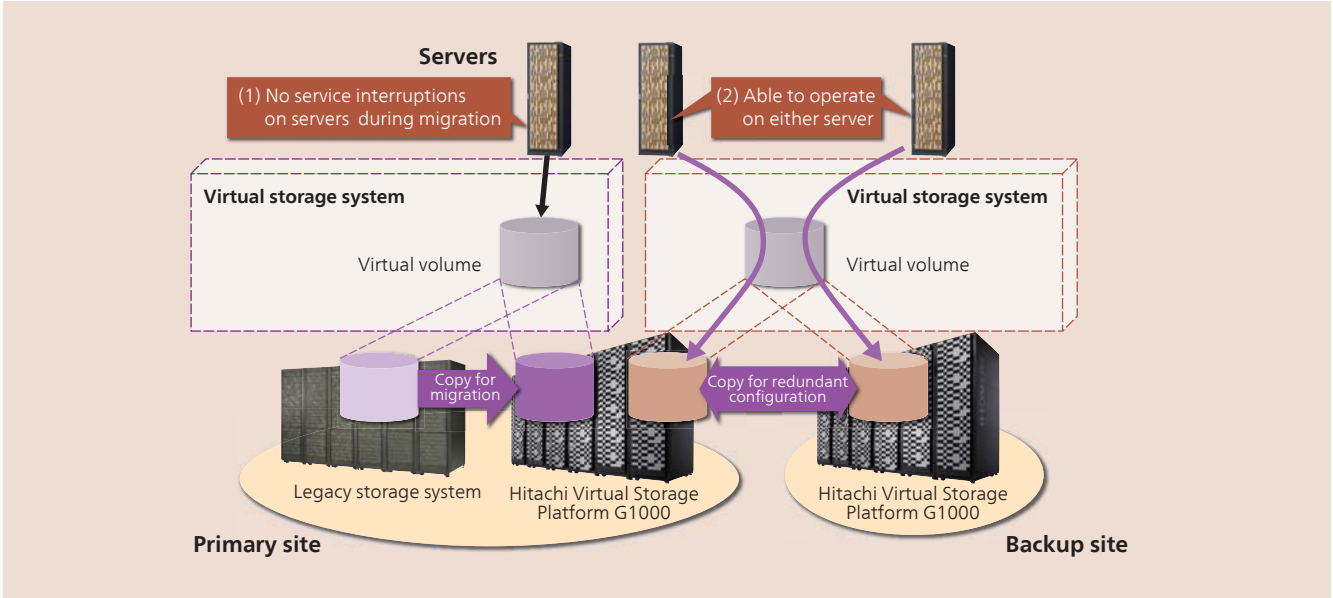
To overcome this problem, Hitachi has developed a confidential analysis technique that can perform tasks such as the analysis of basic statistics and correlation rules using searchable encryption, whereby comparisons can be performed on encrypted data without first decrypting it. In an experiment, correlation rule analysis was performed on 100,000 records of encrypted data in about 10 minutes, demonstrating that analyses can be performed in a realistic time frame. The technique can be used to perform analytical processing without revealing the original data to the database provider, enabling the data to be used in big data applications while also reducing the risk in the event it is stolen.

35 New Storage Virtualization Technology with Enhanced Availability

The increasing globalization of markets is creating a need for companies to deliver continuous 24-hour/365-day services, and this requires that storage systems achieve high levels of availability (uninterrupted operation).

Now, Hitachi has developed a new storage virtualization technology that makes multiple storage systems appear to servers as a single virtual device. This improves availability in the following two ways.

(1) Virtualizing legacy and new storage systems as a single device eliminates the need to shut down servers when making storage



35 New storage virtualization technology

system changes, enabling migration to new systems to occur without any service interruption.

(2) In redundant configurations that duplicate systems across sites, virtualizing the storage systems at both sites as a single device enables routine operation to continue on the backup site servers and increases the speed of system switchover in the event of a fault or disaster.

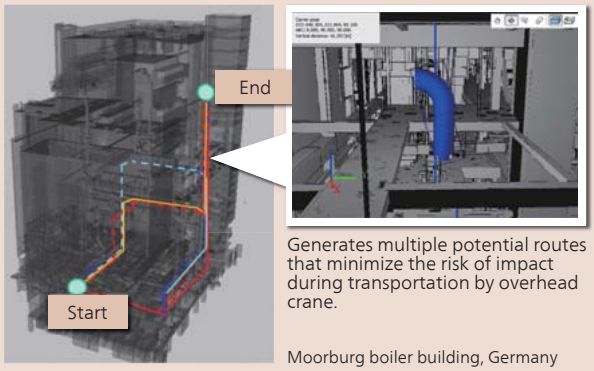
The new technology has already been incorporated into the Hitachi Virtual Storage Platform G1000 enterprise storage system, and Hitachi plans to deploy it in mid-range storage in the future also.

36 Route Finding System for Transporting Industrial Equipment

Planning how to transport major items of equipment into and out of plants during maintenance and replacement tasks is expensive and time-consuming.

In response, Hitachi has developed a route finding system that uses three dimensional models of the building and equipment as inputs and uses a computer to automatically calculate the spatial requirements for avoiding collisions. This enables it to rapidly and automatically determine the route and orientation that minimizes the risk of collision between building and equipment to transport. This reduces the time taken to determine the route in the past from five hours to a single minute, and succeeded in reducing the installation costs for equipment replacement at an overseas coal-fired power plant (in 2013) by 25%. A feature of the route finding technique is that it performs prioritized optimization of multiple objective functions, such as the risk of collision and number of times the equipment needs to be switched from one crane rail to another.

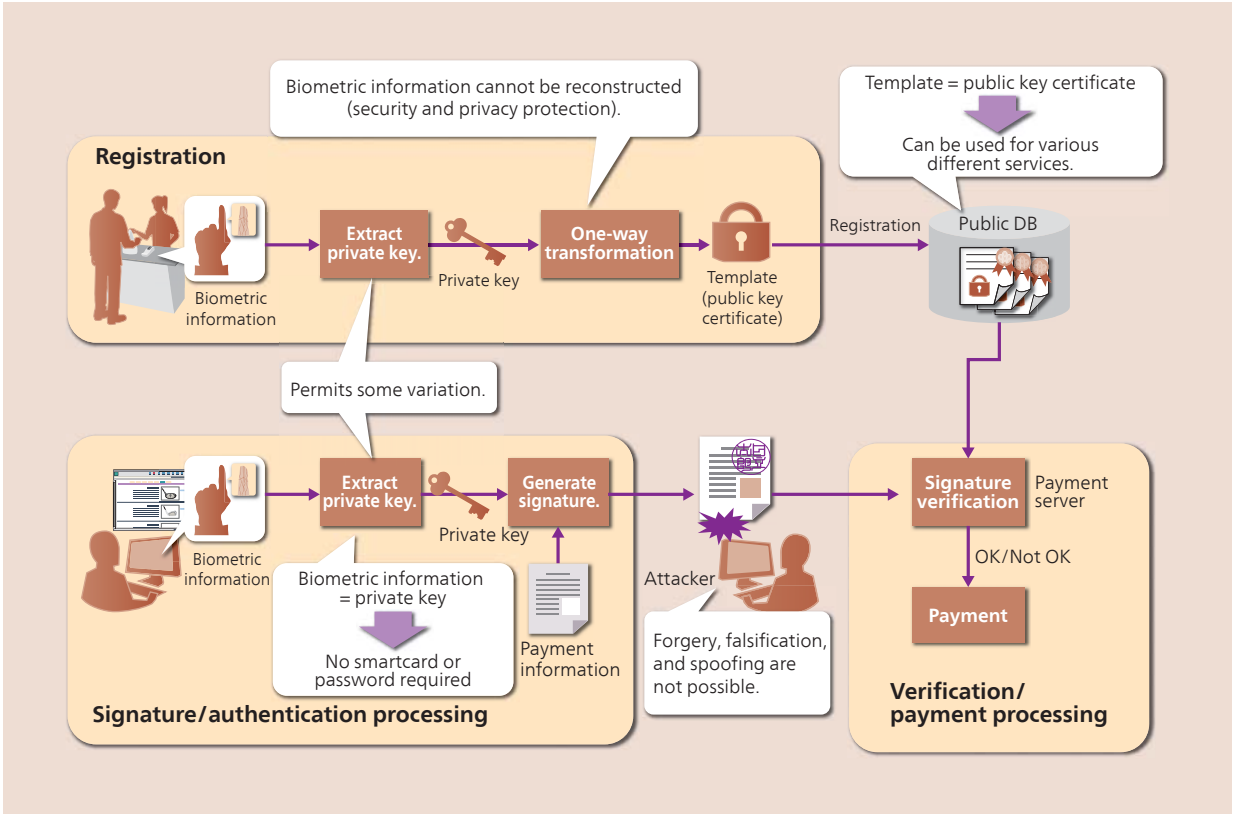
In the future (2017), Hitachi plans to use the technique to generate routes that minimize contamination in the transportation of waste in nuclear power plant decommissioning and maintenance.



36 Example use of route finding system for transporting industrial equipment

37 Public Biometrics Infrastructure (PBI) for Electronic Payments

As the volume of electronic payments over the Internet continues to increase, so do losses due to unauthorized transactions. Along with countermeasures against malware, the use of mutual authentication based on public key infrastructure (PKI), and digital signatures to prevent the falsification of transaction data also play



37 Secure and convenient electronic payments using PBI

important roles in preventing this. However, since key management requires the use of smartcards and hardware tokens, it incurs less convenience and increased costs.

Accordingly, Hitachi is pursuing the research and development of public biometrics infrastructure techniques that eliminate the need for key management by using biometric information such as finger vein patterns for the private key to realize convenient and low-cost implementations of PKI. Specifically, Hitachi has developed the algorithm for digital signature (biometric signature) technique that uses fuzzy data (such as biometric information) as its private key with mathematically provable security. It has also achieved a practical level of authentication accuracy (one in one million false acceptance, 0.2% false rejection) by developing a feature transformation technique that can take finger vein data and generate feature data with less error suitable for use in biometric signatures. The technology has been deployed in a finger vein authentication system and used to build a prototype electronic signature system for payments that uses finger vein information as the private key.

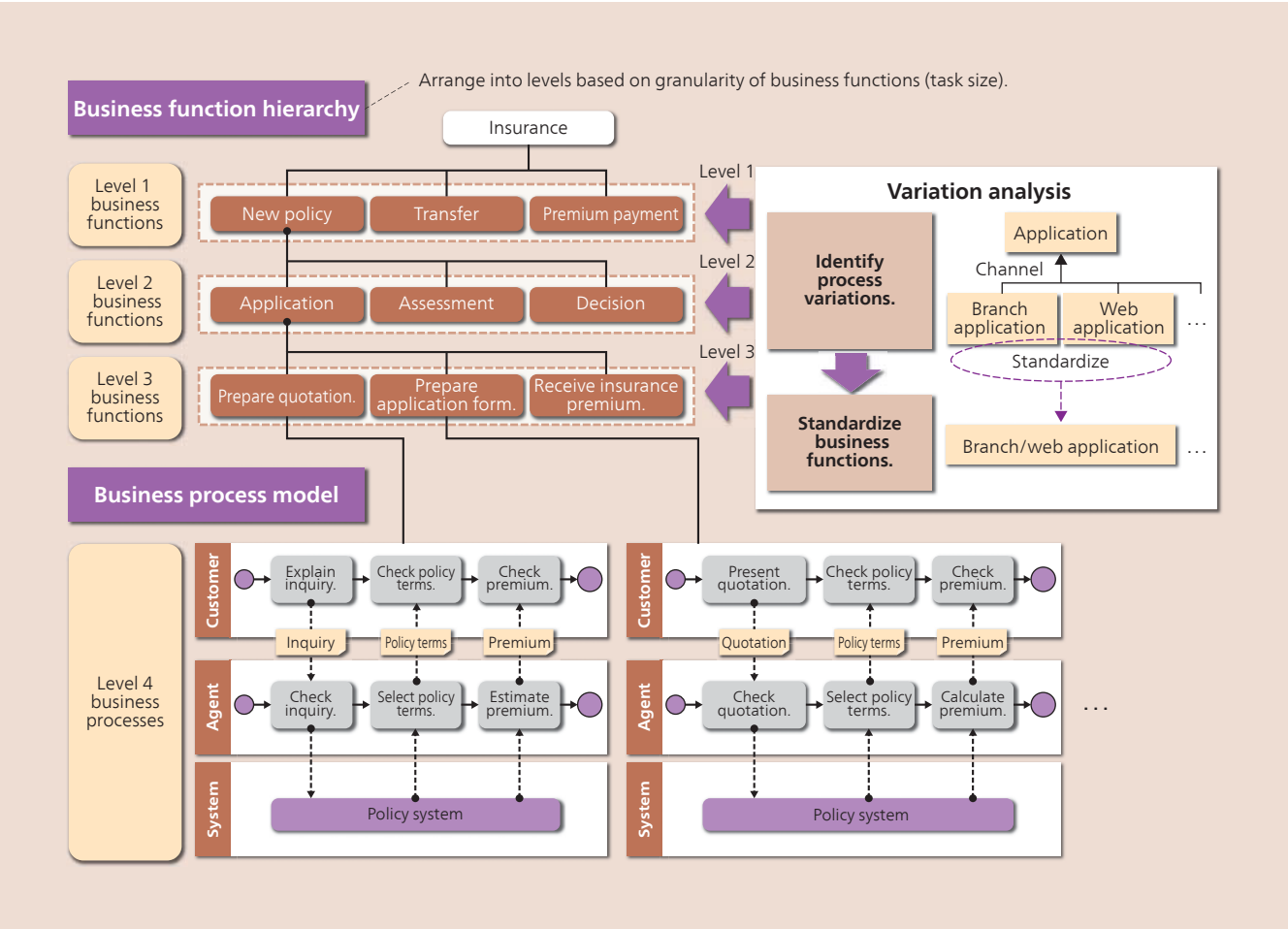
These results indicate the potential for using PBI to make secure and convenient electronic payments.

38 Business Process Modeling Technique Using Hierarchical Process Variation Analysis

Improving the quality of business requirement definitions during system development is important because errors in these definitions can lead to major cost increases in the downstream development processes. Business modeling, which represents business processes and defines their structure in the form of a model, is seen as a technique for achieving this. The problem with this is the large amount of work required to model complex business processes in industries such as finance.

In response, Hitachi has developed a labor-saving technique that focuses on process variations, one of the factors that causes modeling to require so much work. Specifically, the technique looks at the hierarchical structure of business functions and establishes perspectives for identifying process variations according to the granularity of each level so as to identify all process variations without missing any, thereby reducing the need for modeling rework. It also avoids the duplicated development of similar process models by looking at factors such as the information handled in each process and the role of the staff responsible in order to analyze the similarity of business processes and standardize similar business functions that result from process variations. When used in a system development project for an insurance company, the technique reduces the amount of work required for modeling by 30%.

In the future, Hitachi aims to further improve modeling productivity by collating business knowledge built up in projects that use this technique in the form of reference models.



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