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HITACHI
Inspire the Next

Intelligent Operations Solutions for Utilizing Information to Accelerate Social Innovation Business

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From the Editor

The social environment is approaching a turning point. The aging of social infrastructure is driving up maintenance costs in developed economies, which also face challenges such as the aging of people with advanced skills and know-how. Emerging economies, meanwhile, are experiencing a skills shortage in engineering along with rising investment in response to unprecedented growth in demand. Although their circumstances differ, both face the difficult challenge of maintaining and developing high-quality societal systems at low cost. Additionally, in the industrial sector, there is growing activity in such areas as optimizing decision making all along the value chain and creating new services, one example being the Industrie 4.0 national initiative in Germany.

Technologies for utilizing information are essential to achieving all of this. As expressed in such concepts as the Internet of things (IoT) and big data, it involves collecting diverse forms of information from the field both to obtain an accurate situation assessment and to predict with a high degree of accuracy what is likely to happen next, and formulating and implementing business plans that achieve the optimal allocation of resources (people, goods, and money). New value will be created through business innovations that utilize these information technologies (IT). In other words, the role of IT is changing from a tool for improving productivity to an enabler that creates value.

Hitachi is working to create value in a variety of different fields, having chosen the banner of Intelligent Operations for its suite of initiatives like those described above that utilize information for business innovations. This issue of *Hitachi Review* describes a number of these initiatives that create value in the workplace.

This issue's Expert Insights carries an article about the use of information and communication technology (ICT) in the restructuring of social systems contributed by Professor Osamu Sudo of the Graduate School of Interdisciplinary Information Studies at The University of Tokyo, someone with deep knowledge in social innovation. In Technotalk, Professor Michitaka Kosaka of the Japan Advanced Institute of Science and Technology, a leader in the field of service research, and Keiichi Shiotsuka, a Vice President and Executive Officer of Hitachi, Ltd. (CEO of Systems & Services Business, Information & Telecommunication Systems Company), discuss the creation of customer value. Other articles describe work in fields as diverse as healthcare, equipment maintenance, mining, energy, transportation, retail, and agriculture.

I hope this issue will help you learn more about the work being done at Hitachi and open up opportunities to work together on creating new value in your businesses and other parts of society.

Editorial Coordinator, "Intelligent Operations Solutions for Utilizing Information to Accelerate Social Innovation Business" Issue.

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Intelligent Operations Solutions for Utilizing Information to Accelerate Social Innovation Business

With the increasing globalization of the economy and changing social structure, there is also increasing demand for companies to invest in sustainable growth and the resolution of social issues in their corporate activities.
The key to contributing towards a sustainable society while increasing competitiveness as a company is innovation in the business arena.
Utilizing advanced information technology (IT) to extract knowledge from the diverse range of data existing in the business arena, Hitachi has created a system of service and product solutions called Intelligent Operations for integrating that knowledge into management and operations.
By helping to maximize on-site problem-solving and service value in various areas through the supply of Intelligent Operations, Hitachi is leading the innovation of business and society.

10 Fields that Make up Intelligent Operations Vertical Services

1. Healthcare
2. Community
3. Agriculture
4. Facilities
5. Mining
6. Manufacturing
7. Retail
8. Logistics
9. Mobility
10. Energy

*All are images

Prototype screen example created for the proof of concept project for the joint development of new healthcare services in Greater Manchester, UK

Image of the people flow analysis dashboard created for the Smartphone Probe Demonstration Project in Fukuoka

Utilizes results of social experiment conducted as part of member activities by the Fukuoka Directive Council.

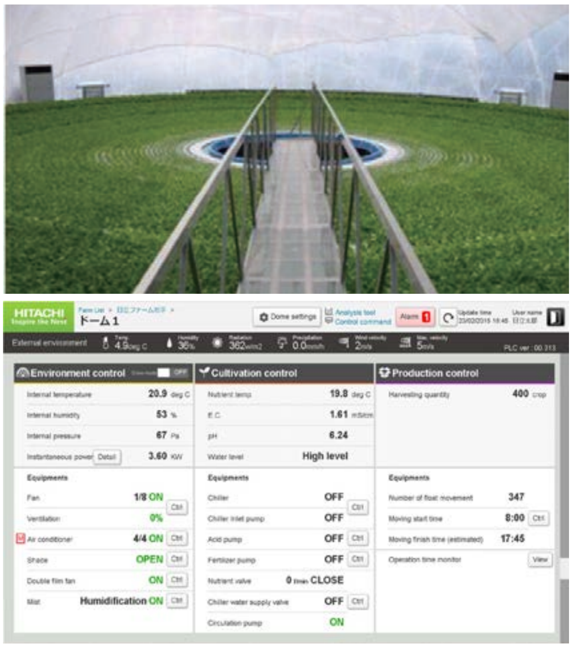

Image of the inside of the air dome-type plant factory and monitor screen example of the plant factory production support cloud service

Hitachi Unified Compute Platform

Compute Blade 2500

Hitachi Virtual Storage Platform G1000

Expert Insights

Open Innovation Accelerating Social Innovation

Professor Osamu Sudo, Ph.D.

Dean and Professor of the Interfaculty Initiative in Information Studies and Graduate School of Interdisciplinary Information Studies, The University of Tokyo

Graduated with a doctorate from the Graduate School of Economics at The University of Tokyo. Following positions including associate professor at Shizuoka University, he was appointed a professor at The University of Tokyo in 1999. He is also currently visiting professor at the National Institute of Informatics, president of the Next Generation Television & Broadcasting Promotion Forum (NexTV-F), and a member of the OECD Global Science Forum Expert Group.

Doctor of Economics (The University of Tokyo). His specialties are in social informatics, healthcare informatics, and information economics.

His appointments include chairing the government's e-Government Evaluation Committee, Planning Committee on Information Security of Information Security Policy Council (ISPC), the Study Group Considering Use of Numbering Systems by Regional Public Agencies of the Ministry of Internal Affairs and Communications, the ICT Lifestyle Resource Measures Committee of the Ministry of Internal Affairs and Communications, the Olympic and Paralympic Hosting Group of the Ministry of Internal Affairs and Communications, and the Future Vision Study Group for Use of Vehicle-related Information of the Ministry of Land, Infrastructure, Transport and Tourism.

Private use of the Internet has now been with us for around 20 years. It is fair to say that the world has experienced considerable change during this time. From the perspective of innovation, however, I believe that information and telecommunication networks have yet to fully demonstrate their inherent capacity for change.

As noted by Joseph A. Schumpeter (in The Theory of Economic Development, 1926), innovation means generating value through combining the means of production, resources, and labor in new combinations. One area of vigorous activity in recent times has been open innovation. In contrast to innovation that relies only on one's own resources, open innovation is achieved through a number of parties working together, with information networks used as a platform for making effective use of external resources. Putting this in the context of modern society, rather than a talented individual working alone to create value, open innovation means the creation of new value by using information and telecommunication networks to combine a variety of technologies, and taking advantage of the synergies between a number of parties with potential creative and collaborative capabilities.

In terms of one of the serious issues faced by Japan, namely the "super-aging society" (a term used in Japan to refer to the advanced aging of its population), significant problems will have arisen by 2025 due to the rapid rise in the number of elderly belonging to the baby boom generation, who by then will be age 75 or older. National healthcare spending will rise from 34.8 trillion yen in FY2008 to 52.3 trillion yen in 2025, with spending on the very elderly rising from 11.4 trillion yen to 24.1 trillion yen over the same period.

According to the report published by the ICT Super-aging Society Design Council of the Ministry of Internal Affairs and Communications in 2013 (chaired by Hiroshi Komiyama, Chairman, Mitsubishi Research Institute, Inc.), a continuation of present trends will see not just an increase in social security spending, but also greater demands on families to provide nursing care and a worsening of social isolation among the elderly living alone. Consequently, the report noted that the super-aging society also requires the bringing about of a paradigm shift in society so that all generations can feel secure and live active lives.

What are needed are radical investigations into the best forms of healthcare and nursing care systems and preventive medicine, and the establishment of new social systems. This will require the restructuring of a wide range of social systems, including the nature of regional communities and regional government, with support from computers and information and telecommunication networks.

Given the current need for innovation, not only in healthcare and welfare systems, but also in other existing social systems such as those used by government or to manage the supply and demand for resources and energy, we need to pick up the pace of open innovation by actively seeking to use information and communication technologies (ICT) that incorporate sensor networks, machine learning, and other forms of intelligence.

Technotalk

Contributing to Social Innovation through Services that Create Customer Value

Michitaka Kosaka, Dr. Eng. Professor, School of Knowledge Science, Japan Advanced Institute of Science and Technology
Keiichi Shiotsuka Vice President and Executive Officer, CEO of Systems & Services Business, Information & Telecommunication Systems Company, Hitachi, Ltd.

Hitachi's Social Innovation Business draws on its many years of experience in social infrastructure and its information and telecommunication technologies. The business includes initiatives that create value together with customers by seeking to overcome societal challenges, and these in turn demand an approach based on service creation that is unlike the product-focused business activities of the past. Hitachi intends to redirect both its organization and its attitude toward service creation, and to contribute both to sustainable growth and to overcoming the challenges of global society by expanding its Social Innovation Business as a provider of services.

Three Secrets of Services

Shiotsuka: Hitachi's Social Innovation Business supplies safe and secure social infrastructure throughout the world that is enhanced by information technology (IT). The meaning of "enhanced by IT" goes beyond traditional IT solutions that involve using IT to resolve clearly-identified customer issues. The Social Innovation Business works together with customers through all steps from identifying challenges to creating value for the customer, with IT playing a vital role in making this possible.

The concept of "service-dominant logic," which means treating all economic activity as a service, has attracted interest in recent years. Our Social Innovation Business can be described as being based on this logic because, rather than the products themselves, what we are selling is a process in which Hitachi and its customers work synergistically to create value.

The Systems & Services Business of Information & Telecommunication Systems Company, Hitachi, Ltd. was established from such a background, with an explicit focus on supplying IT services that support social innovation. Our purpose today is to get advice from Professor Mitchitaka Kosaka, a leader in service research, about the keys to succeeding at this service business.

Kosaka: The way we interpret the word "service" has changed over time. First-generation services are those for which we typically use the word. These include services like accommodation, transportation, education, and maintenance with products that are intangible. Second-generation services are those that emerged in the 1990s and that apply to IT and other information businesses, examples include IT web services and outsourcing services. Then there are the ways of

Michitaka Kosaka, Dr. Eng.

Professor, School of Knowledge Science, Japan Advanced Institute of Science and Technology

Joined Hitachi, Ltd. in 1977 after completing a master's degree in applied mathematics at the Graduate School of Engineering of Kyoto University. After positions managing the Systems Development Laboratory and ID Solutions Division, he took up his current appointment in 2008. Dr. Kosaka's specialties include research and development management, system engineering, and service innovation. Major publications include authoring "Progressive Trends in Knowledge and System-Based Science for Service Innovation" (published by IGI Global).

creating value for customers you referred to earlier. These are third-generation services. While service-dominant logic treats goods as one form of service, the services we are talking about today involve an all-encompassing consideration of such questions as what value can be provided to customers (including in the form of goods), how can those customers be satisfied, and how can income be generated?

Shiotsuka: The difficulty with third-generation services for a manufacturer is that, while we understand the concept, we still face the question of how to incorporate it into our current framework in order to increase earnings.

Kosaka: During my research into service science at the Japan Advanced Institute of Science and Technology (JAIST), I worked with the famous Kagaya Ryokan (inn) at the Wakura hot springs in Ishikawa Prefecture, which led to former chairman Sadahiko Oda telling me about the three secrets of services.

The first secret is to take a rigorous approach to being among the best. Technology or other services will never be accepted by customers if they are inferior to the competition. Accordingly, hotel staff whose job is to provide hospitality are given the opportunity to experience world-leading service as part of their training. The second secret is to satisfy customers. Achieving this involves collecting feedback from customers that can provide the basis for improvement. The third secret is to ensure that you are paid appropriately. These three points represent the basics of service.

Shiotsuka: Maintain service quality and set a price that reflects the satisfaction delivered. That turns into a virtuous circle. Although very basic, I can see that what you have said is actually quite profound.

Kosaka: Yes. The Kagaya Ryokan makes a great effort to work through these basics. As a result, they attract a particular class of customer, with the aim of satisfying them with top-class service so that they will come back again and again.

In a manufacturing context, this means having top-level products, technologies, and systems engineering (SE) staff for dealing with customers, and delivering customer satisfaction, meaning customer value, so as to be able to charge prices that reflect this. It also means maintaining a long-term relationship where possible with customers who recognize the quality of your technologies, services, and other strengths. This results in a virtuous circle whereby new challenges are identified through your work, enabling new value to be delivered. This is something I believe Hitachi's business has put into practice.

Shiotsuka: That's right. However, rather than system integration (SI) services of the sort that have been supplied in the past, which are based on problem-solving, what is needed now are services that involve the ongoing delivery of added value in some form. This approach should produce solutions that facilitate the creation of customer value by analyzing data from business activities to extract knowledge, with examples of this including working with customers at financial institutions to help improve convenience for end users. To achieve this, Hitachi has consolidated the products and services on which the provision of such solutions is based under the banner, "Intelligent Operations." We provide services for a wide variety of industries, extending from system implementation to operations, and come bundled with early-stage consulting and IT platform services, covering such fields as healthcare, community, agriculture, machinery, mining, manufacturing, distribution, logistics, transportation, and energy. Through these services, we are seeking to build customer value in the form of greater business efficiency and higher service levels.

Keiichi Shiotsuka

Vice President and Executive Officer, CEO of Systems & Services Business, Information & Telecommunication Systems Company, Hitachi, Ltd.

Joined Hitachi, Ltd. in 1977. His appointments include General Manager of the No. 5 Financial Systems Department of the Financial Systems Business Unit in 2001, Deputy Manager of the Financial Solutions Business Unit in 2003, Manager of the Financial Systems Business Unit of the Information & Telecommunication Systems Company in 2010, and COO of the System Solution Division of the Information & Telecommunication Systems Company in 2012. He took up his current position in April 2013.

Treating Customer Value as Central to Globalization

Shiotsuka: Along with services, the word "global" is also key to the Social Innovation Business. We are actively working on steps that will enable service solutions to be deployed globally, such as the acquisition of local companies and the establishment of big data laboratories, and while general-purpose platforms will be essential to future business expansion, one of the challenges is how to achieve a balance between general applicability and localization. How do you think we should go about overcoming these challenges?
Kosaka: In the sense of platforms, Hitachi's TWX-21* is an excellent example of a cloud service that I believe makes a suitable common platform for services. Providing the Global e-Service of Hitachi Construction Machinery Co., Ltd. on TWX-21 is an excellent initiative. The Hitachi Group includes many businesses outside the IT sector, each of which should be accumulating know-how in its own field. Implementing platforms that combine this know-how with infrastructure like TWX-21, and then supplying it in the form of a service business, should open up new business possibilities. I doubt there are any other companies in the world able to achieve this.
Shiotsuka: It is heartening that you should say so. Starting with Global e-Service on TWX-21, we are inviting other Group companies to participate. TWX-21 was set up more than a decade ago to provide capabilities such as electronic data interchange (EDI) within the Group, and since then has grown into a major portal involving roughly 50,000 companies, increasing the value of participation. Similarly, the joint center service for personal Internet banking, which was established a decade ago, has now grown into a large payment infrastructure handling a monthly turnover in the vicinity of 2 trillion yen. We are committed to making careful use of these platforms and the associated know-how.
Kosaka: Because the platforms that underpin services require features such as reliability and security, the stronger these are the better. For customers, however, the source of value lies not just in the excellence of the platform but in whatever is built on top of it. Because global service solutions also require localization to take account of technological, cultural, and other factors specific to the countries or regions where they are used that have arisen against a background of circumstances specific to those places, collaboration with local companies is also essential. I believe it is important that Hitachi acts as an integrator and builds a framework that integrates with those in a strong position.
Shiotsuka: To achieve this, we are working with companies from outside Hitachi both in Japan and elsewhere. One example from overseas is our acquisition of Prizm Payment Services Private Ltd., a company that supplies payment services to financial institutions in India. By utilizing the company's customer platform and its payment and cash handling systems for financial institutions, we are expanding their comprehensive service business for automated teller machines (ATMs) in India, while also strengthening our global deployment of service businesses using this as a positive example.
Kosaka: Rather than sticking to the sort of detailed business plans used at product businesses, service businesses progress by taking on challenges and paying attention to the responses from end users and other customers.

In my work at JAIST, we have devised a model of service value creation. This is called the KIKI model, and it draws on the well-known socialization, externalization, combination, and internalization (SECI) model of knowledge creation devised by Professor Ikujiro Nonaka. The initial "K" stands for "knowledge share," meaning the sharing of requirements and other knowledge between providers and customers. The "I" following it stands for "identification," meaning utilizing the shared knowledge to identify which services are needed. The second "K" stands for the "knowledge creation" needed to establish the service, and the consideration of which specific technologies and knowledge this will require. The final "I" is for the "implementation" where the service is provided and assessed. Working through this cycle can create the service value that customers need.

When I set this model against my own experiences of working at Hitachi, and also the past successes and failures of mid-career students, I note there is a common pattern among development failures of omitting the initial "K" and "I" steps. However impressive the functions may be, they are only meaningful if customers recognize their value, and therefore assigning a central role to customer value is essential both in globalization and elsewhere.

Developing Service Professionals and Shifting Attitudes

Shiotsuka: Human resource development is one of the challenges in putting this customer value creation into practice.
Kosaka: In the creation of service value, the people responsible in the past for identifying latent needs through regular interaction with customers and then presenting these in a conceptual form have been what we call "super SEs." Super SEs have a variety of networks within the company and act like a concierge at a hotel, drawing

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

on these in-house networks to come up with a solution when inspired by a customer's "keyword." This is truly a case of co-creation.

Shiotsuka: While we are taking steps within the company to train service professionals in order to develop as many people as possible with those capabilities, the truth is that this training takes time.

Kosaka: At JAIST, we have established the Innovation Management of Service and Technology Course with the aim of training people who can deal with the three elements, namely service, science and technology, and value to lead the creation of innovations. Ultimately, people are the key to service businesses, and that makes it important that training and other forms of learning take place at institutions like JAIST and within companies. However, many of the capabilities of these people arise from informal rather than formal knowledge. For this informal knowledge, although it takes time, I believe the best approach is an apprentice system whereby people with the right qualities are able to learn by working alongside highly skilled SEs.

Shiotsuka: In other words, there is no substitute for doing things the right way.

Kosaka: Even with the passage of time, you cannot escape the fundamentals, nor should you try. All Hitachi SEs should have an innate attitude of being customer-oriented and of working alongside customers to create value. Along with being rigorous about enhancing this aspect, it is also important that, across the company, there is a shift in attitudes away from goods and toward services.

Shiotsuka: From budgeting to the attitudes of its staff, the corporate practices of a manufacturer are built on the basis of "monozukuri" manufacturing. While we are taking steps to change this paradigm, such as business reforms in our accounting management systems and elsewhere, a shift in attitudes is also essential. Keeping in mind the three basics you talked about, we aim to contribute to the Social Innovation Business by expanding service businesses that work with customers to create value. Thank you for your time today.

Overview

Business Innovation through Workplace Use of Information

—Intelligent Operations—

Toshiyuki Moritsu, Ph.D.
Keiko Fukumoto
Takeshi Ishizaki
Masaharu Akatsu, Ph.D.
Katsuya Koda

USE OF INFORMATION IN WORKPLACE TO BOOST CORPORATE COMPETITIVENESS

THE need has arisen in recent years for business optimization, new business development, and other measures for companies to improve their competitiveness by utilizing information from a variety of different workplaces, including those for service delivery and for the production, distribution and sales, operation and maintenance, and disposal of products.

This development has prompted a re-evaluation of interactive businesses. Along with ongoing globalization and the spread of the Internet, there has been progress on restructuring to take advantage of lower-cost overseas labor for things like modularized products and standardized services. Given this situation, attention has been directed at sophisticated products and services that deliver higher added value and that are provided through the interplay of knowledge and ideas held by the various different participants in the workplace. One of the challenges of operating an interactive business is to take advantage of the knowledge and other skills of workplace experts. The falling number of production workers, specialization and segmentation of business activity, and a more mobile workforce are making it difficult to pass on the knowledge of highly specialized experts, creating a need for mechanisms that use information technology (IT) to help accomplish this.

Meanwhile, advances in enabling technologies, specifically mobile, social networking service (SNS) and M2M[(a)] technologies, are making it possible to gain a realtime overview of things like people's activities or the statuses of plants and equipment. There has been growing activity in recent years involving the active use of this data for business improvement or to create new businesses.

WORKPLACE INNOVATION PROCESSES

Achieving the workplace innovations described above requires mechanisms for collecting multifaceted information from the field, utilizing it in decision-making, and providing it as timely feedback to the workplace.

The process for achieving this starts with the centralized collection of data on the people in a workplace (their activities, know-how, etc.), the plant and equipment (operational status, problems, etc.), and the business environment (supply and demand, reputation, etc.) (see Fig. 1). Next, modeling of the data is used to turn it into systematic information. Intelligence (knowledge) is then extracted from the information by analyzing it and using this as the basis for prediction and decision-making. Finally, the knowledge is utilized in operations, either at the workplace or in management.

Hitachi has combined the products and services it supplies to different industries under the banner of Intelligent Operations to help use IT to make this series of processes more efficient.

INTELLIGENT OPERATIONS SYSTEM

This section describes the implementation step of business innovation and the Intelligent Operations system that supports it.

(a) M2M
An abbreviation of "machine to machine." It includes the autonomous collection of data, remote monitoring, and sophisticated remote control achieved through the exchange between machines of sensor and other information via wireless or other communication networks.

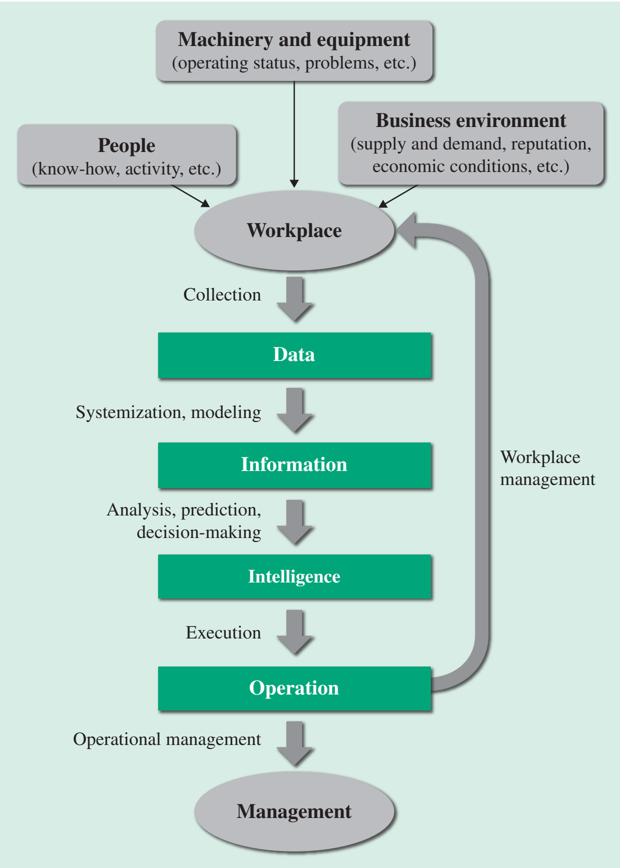

Fig. 1—Data Use Process in the Workplace.
The process extracts knowledge (intelligence) from the various types of workplace data and integrates it into operations.

Since workplace innovation is a new challenge for the companies that attempt it, the benefits often remain unknown at the outset. Accordingly, the implementation step is envisaged as part of commercialization (see Fig. 2).

Step 1 involves undertaking a proof of concept (PoC) to assess the effectiveness and viability of a new service in collaboration with early adopters in the industry.

During this phase, a multifaceted assessment is performed of the profitability and social impact of the service, the ease-of-use of the systems that provide it, and so on. If the results of the assessment indicate that the service is worth implementing, the next step is to move on to the commercialization phase. Since the verification phase needs to identify latent needs and establish the service concept, it consists primarily of consulting. In cases where it is necessary to demonstrate the service using a prototype, this can be achieved using system integration (SI) services.

On proceeding to step 2 (commercialization), the work consists mainly of system implementation, using an SI service to implement the actual system with the business requirements specified in more detail. It also involves undertaking work with the aim of enabling users to improve business efficiency and focus resources on core activities.

Once the effectiveness of the service has become recognized and similar services have started to be set up for other users or different industries, the process proceeds to step 3, which supports the expansion of the service by packaging it and implementing it in the cloud.

Intelligent Operations supplies a suite of solutions that support these three steps. Fig. 3 shows how this is organized.

The Intelligent Operations solutions system is divided into three layers, consisting of the Intelligent Operations Suite IT platform services that provide common platforms, the vertical system implementation and operation services for specific industries, and the consulting services for identifying issues, formulating solutions, and supporting operations.

The vertical services use information on people's activities, equipment operation, and the environment to improve efficiency and service levels in specific

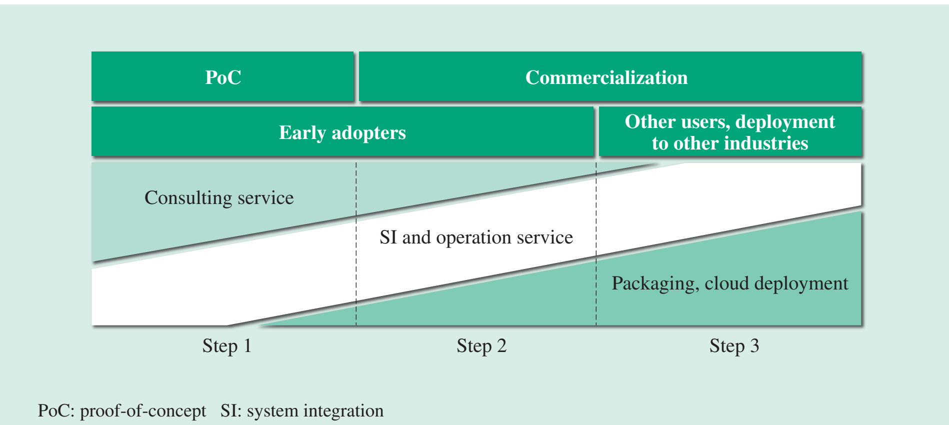

Fig. 2—Implementation Step in Business Innovation and Required Services.
A group of services that cover everything from PoC to commercialization.

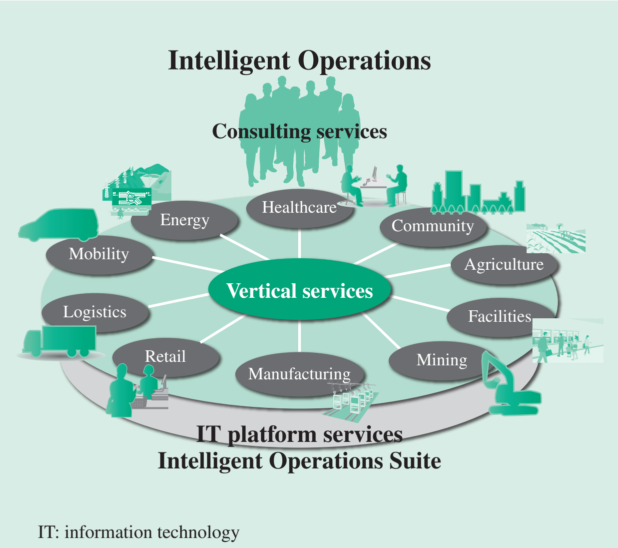

Fig. 3—Intelligent Operations Solutions System.
The Intelligent Operations solutions system is organized into three layers: consulting, vertical, and IT platforms.

industry sectors. Specifically, the services belong to the following 10 categories (see Table 1).
(1) Use of medical information for applications such as insurance and drug development (healthcare)
(2) Local health promotion services for the elderly and others (community)
(3) More reliable production and higher value crops (agriculture)
(4) Safety of social infrastructure equipment, equipment for reducing maintenance costs (facilities)
(5) More efficient operational management and maintenance of equipment (mining)
(6) Support across entire product life cycle (manufacturing)
(7) Support for product development and distribution based on demand prediction (retail)
(8) Support for globalizing supply chains (logistics)
(9) Transportation that is optimized at a city-wide level (mobility)
(10) Use of renewable energy, grid stabilization, and so on (energy)

ACTIVITIES BY HITACHI

Hitachi continues to deliver results by working in collaboration with customers on introducing workplace-focused innovations in a wide range of business sectors, from lifestyle to social infrastructure. The following sections describe a number of leading examples that are covered in this issue of *Hitachi Review*.
(1) Healthcare service in UK
How to moderate the dramatic rise in medical costs associated with the increase in the number of people suffering from chronic health conditions in recent years is a challenge. While diabetes is among the leading causes of death due to chronic illness internationally, it is also known that there are cases where testing can easily identify people before they develop symptoms (while still asymptomatic),

Table 1. Summary of Intelligent Operations Vertical Services
These services expedite the provision of solutions in 10 industry sectors.

Vertical service	Summary
Intelligent Operations for Healthcare	Used to deliver services to insurers, drug companies, and others by utilizing the highly secure collection and analysis of data held by healthcare institutions
Intelligent Operations for Community	Delivery of programs that promote the health of the elderly to contribute to providing an aging society with desirable places to live
Intelligent Operations for Agriculture	Stabilizing crop prices and improving distribution efficiency by making agricultural production more reliable and transforming it into a “senary industry” (a term used in Japan to refer to the added-value production and distribution of agricultural goods) against a background of concerns about food shortages or poor harvests caused by population increase and abnormal weather
Intelligent Operations for Facilities	Use of advanced sensing technology and big data to improve safety and cut maintenance and replacement costs for aging social infrastructure facilities
Intelligent Operations for Mining	Productivity improvement through more sophisticated operational management and efficient maintenance of mining equipment
Intelligent Operations for Manufacturing	Total support across the installation, operation, and maintenance of products with direct links between customers, workplaces, production lines, and development centers
Intelligent Operations for Retail	Support for demand prediction, product strategy, and development in response to more diverse product ranges and shorter life cycles
Intelligent Operations for Logistics	IT services that support management strategy and improvements to supply chain efficiency in response to factors such as growing demand in emerging economies and the shift of production facilities overseas
Intelligent Operations for Mobility	City-wide optimization service for trains, cars, and other means of transportation
Intelligent Operations for Energy	Building smart grids that facilitate energy efficiency, the adoption of renewable energy, and the balancing of supply and demand for electric power

and that lifestyle improvements such as diet and exercise can prevent these symptoms from appearing. Through a combination of knowledge and technology acquired from its work with Hitachi's lifestyle change program[(b)], Hitachi believes that measures such as lifestyle improvement and high-quality advice can be provided to these asymptomatic diabetes patients. This issue includes a case study that describes a PoC project being undertaken in Salford in the Greater Manchester region of the UK (see p. 18).

(2) O&M cloud service for improving efficiency of operation and maintenance of plant and equipment

Along with the globalization taking place in different industries, there is growing demand for operation and maintenance (O&M) services that improve the efficiency of the operation and maintenance of various types of plants and equipment. Hitachi supplies Global e-Service on TWX-21[(c)], which was developed by adapting the equipment life cycle management system of the Hitachi Construction Machinery group (which has a long experience of operating in the global market) for general use so that it could be used in industries other than construction machinery. An article describes the operational benefits of the service and the technical features that support them (see p. 24).

(3) Cloud-based mining operation management system

The mining business has been shifting away from past management strategies that concentrated on expanding production to focus instead on efficiency based around reducing operating costs and improving productivity. Against this background, Hitachi has conducted a PoC trial of a cloud-based mining industry fleet management system (FMS) to determine its technical viability in terms of parameters such as system performance. It is anticipated that using a cloud-based FMS will eliminate the need to install the system at isolated mine sites and other locations and overcome the challenges of system maintenance and management, which include the recruitment of system technical staff and power supply reliability (see p. 29).

(4) Use of EAM[(d)] for operation and maintenance of electric power distribution equipment

With the aging of the electric power distribution systems installed or built in North America prior to the 1970s, using efficient maintenance and management to enhance power distribution quality is an important challenge. Power companies in Japan, meanwhile, have built up know-how through their use of advanced maintenance technologies and systems that utilize the collection and analysis of equipment fault data and power distribution systems based on IT. With a view to deploying their operational know-how outside Japan, Japanese power companies and Hitachi are working together on advanced operation and maintenance initiatives for power distribution systems, the EAM system at the core of their services, and machinery operation systems. This issue of *Hitachi Review* contains an article describing this activity (see p. 35).

(5) M2M solution for building energy efficiency and comfort

The M2M market is demanding a shift from vertically integrated systems that are customized for particular industries to horizontally integrated systems that are capable of interconnecting with each other. An article in this issue presents a case study of the energy savings and comfort achieved by the use in an office building of an energy efficiency system that complies with the IEEE 1888 international communication standard for ensuring multi-vendor interconnectivity between the equipment and applications used in building energy management systems (BEMSs) (see p. 41).

(6) Spatial data management for more advanced facilities management

Many city, venue, and retail spaces operate on the basis of predicted or planned parameters. A spatial data management platform supplied by Hitachi can predict what will happen in the future and take appropriate measures by performing control based on

(b) Hitachi's lifestyle change program
A lifestyle change program devised by the Hitachi Health Care Center that aims to achieve weight loss of 5% over 90 days and to maintain it over the next 90 days. It is provided using a cloud-based service for tailored health maintenance advice and lifestyle improvement. It supports weight loss through measures that include setting targets in 100-kcal increments; providing remote consultations via the Internet with health advisors, nutritionists, and others; and sending advice by e-mail.

(c) Global e-Service on TWX-21
A software-as-a-service (SaaS) life cycle support service for machinery intended for Japanese companies with machinery manufacturing and sales operations in the global market. It provides life cycle management of machinery by collecting and storing information on processes such as their manufacture, sale, operation, and maintenance, and by sharing and otherwise using this information. It provides the functions of Global e-Service on Hitachi's TWX-21 business-to-business media service, where Global e-Service consolidates the operational know-how built up by Hitachi Construction Machinery Co., Ltd. (Hitachi's construction machinery subsidiary) through the operation of its service business in the global market. TWX-21 is a trademark of Hitachi, Ltd.

(d) EAM
An abbreviation of "enterprise asset management," a method for companies to manage their equipment assets. EAM achieves improvements by collecting a wide range of operational, fault, materials, and other equipment information, and by performing centralized management throughout the equipment life cycle to maximize asset value and improve the visibility and efficiency of the associated activities.

what is actually taking place in these spaces. An article describes a specific example involving Hitachi's efforts toward visualization and improvement focused on "pulling power," "holding power," and "sale-closing power" at the Hitachi Innovation Forum 2013, a large trade show (see p. 47).

(7) City management platform using big data from people and traffic flows

The next generation of cities will require the optimization and efficient management of social systems, including more sophisticated transportation systems, reductions in carbon dioxide (CO_2) emissions, and the upgrading of aging infrastructure. To achieve this, it is important to determine and record the flow of people and traffic in ever-changing cities and to utilize this information in urban development. Hitachi is developing city management platform solutions that support efficient city operation through the collection and analysis of big data from people and traffic flows obtained using smartphones, smartcards, and various sensors. An article describes example system applications in the form of a smartphone probe demonstration project in Fukuoka and a taxi probe demonstration project in Bali in the Republic of Indonesia (see p. 52).

(8) Hitachi's solution for analyzing distribution data

The retail industry in recent years has experienced an accelerating increase in the quantity and types of information required for analyzing things like customer behavior and which products are the strongest sellers because changes in the purchasing behavior of consumers have been accompanied by other changes such as greater segmentation of customer needs and more diverse sales channels and promotions. Hitachi's solution for analyzing distribution data is a system package that combines a merchandise analysis system, a customer analysis system, and a big data information platform to enable the combined analysis of products and customers, and to present analyses and problem solving processes in story form. An article uses two customer case studies to describe Hitachi's solution for analyzing distribution data and the advantages it provides (see p. 58).

(9) Cloud service for plant factory production

Being heavily influenced by weather conditions, the uncertainties of conventional agriculture (particularly outdoor cultivation) make it difficult to manage. Being underpinned to a large extent by the experience and intuition of producers, it is also a difficult field for younger generations to participate in, with a falling and aging farming population and an increasing number of fields and rice paddies being abandoned and no longer cultivated. In response, Hitachi supplies a cloud service for the integrated management of "plant factories" (closed growing systems). The service transforms the experience of farmers into data to make agricultural management more predictable and to assist new entrants into the industry. The system has been installed at actual plant factories and provides integrated monitoring and control in realtime by using monitor screens at a control center to display information from multiple remote plant factories (see p. 63).

(10) IT platform solution for social innovation

Achieving social innovation calls for the creation of new services that utilize the large amounts of data generated by infrastructure systems. This makes it essential to provide advanced IT platforms that achieve a fusion of resources such as the use of IT for ultra-high-speed big data analytics and operational knowledge derived from experience. An article describes an example IT platform for the mining industry (see p. 69).

INTELLIGENT OPERATIONS FOR BOOSTING SOCIAL INNOVATION BUSINESS

This article has described Hitachi's Intelligent Operations solutions system for achieving innovation in the workplace, and some leading examples of its use in practice.

Achieving innovation in the workplace needs to start with the sharing of information about the practical challenges faced by users, and to undertake the feasibility trials and the phases leading up to commercialization in an efficient manner. In parallel with specific projects involving early adopters, Hitachi is also accelerating its Social Innovation Business by providing the Intelligent Operations suite of solutions required to overcome these challenges.

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Featured Articles

Proof of Concept Project for a Diabetes Prevention Service in Greater Manchester, United Kingdom

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OVERVIEW: Healthcare costs are on the rise in all countries around the globe, but perhaps the most concerning are those associated with the increased prevalence of long term conditions such as diabetes and hypertension. The NHS in Salford, Greater Manchester, and Hitachi have come together to discuss possible collaboration in developing new healthcare services that leverage information and communication technology (ICT) in Greater Manchester. The partnership found that improvement of the IGR Care Call Programme in Salford was a perfect opportunity, generating synergy between the academic track record and clinical expertise of the NHS, and Hitachi's experience and knowhow of delivering lifestyle change programmes leveraging ICT. IGR POC projects were conducted from September 2013 to March 2014 in order to explore and evaluate proposed improvements in delivery efficiency, patient engagement, and accessibility of the IGR Care Call Programme, and found great potential for improvement of the programme in those areas.

INTRODUCTION

HEALTHCARE costs are on the rise in all countries around the globe, but perhaps the most concerning costs are those associated with the increased prevalence of long-term conditions such as diabetes and hypertension. This is due to factors such as an ageing society and a more sedentary lifestyle contributing to the prevalence of such conditions, as well as an increase in the cost of drugs and treatment. Japan and the United Kingdom are no exceptions to this trend, and both countries are eager to address this increasing burden.

PROJECT BACKGROUND

Type 2 Diabetes is a chronic disease that is often preventable, yet causes one of the biggest burdens in healthcare today; the estimated cost of this disease in the United Kingdom ranges from £3.9 billion(1) to £13.8 billion(2). In spite of differences in healthcare economy model, ethnic mix, diet, and mentality, there is much to be gained from collaboration between Japan and the United Kingdom.

There have been prominent studies that have shown that lifestyle intervention for people with Impaired Glucose Regulation (IGR)*1 can reduce the number who go on to develop Type 2 Diabetes by as much as 58%(3), (4). However, there are very few standardized implementations of diabetes prevention programmes that are proven to be clinically effective, highly accessible, and have evidence showing visible cost savings.

Based on an earlier successful trial of a telephone-based glucose control support service in 2005, the NHS*2 in Salford, Greater Manchester, has been at the forefront of developing an implementation of such a service since 2010, aimed at curbing the apparent increasing prevalence of diabetes and improving the quality of life of patients. The IGR Care Call and subsequent IGR Care Call implementation projects showed that around half of the patients succeeded in reverting back to normal glucose control as a result of a six month telephone-based intervention. Moreover, the 18-month follow-up of the patients from the first year showed that the number of people who had normal glucose control remained at around half, suggesting that the clinical outcomes and lifestyle changes were lasting. Fig. 1 shows the pathway of the original IGR Care Call Programme.

*1 Impaired Glucose Regulation includes the two conditions Impaired Glucose Tolerance (IGT) and Impaired Fasting Glycaemia (IFG) and is commonly called pre-diabetes. Patients with IGR are not able to process glucose in their blood normally, and are at high risk of developing type 2 diabetes.
*2 The National Health Service (NHS) provides publically funded healthcare services in the UK and aims to ensure that patients have equal access to these services.

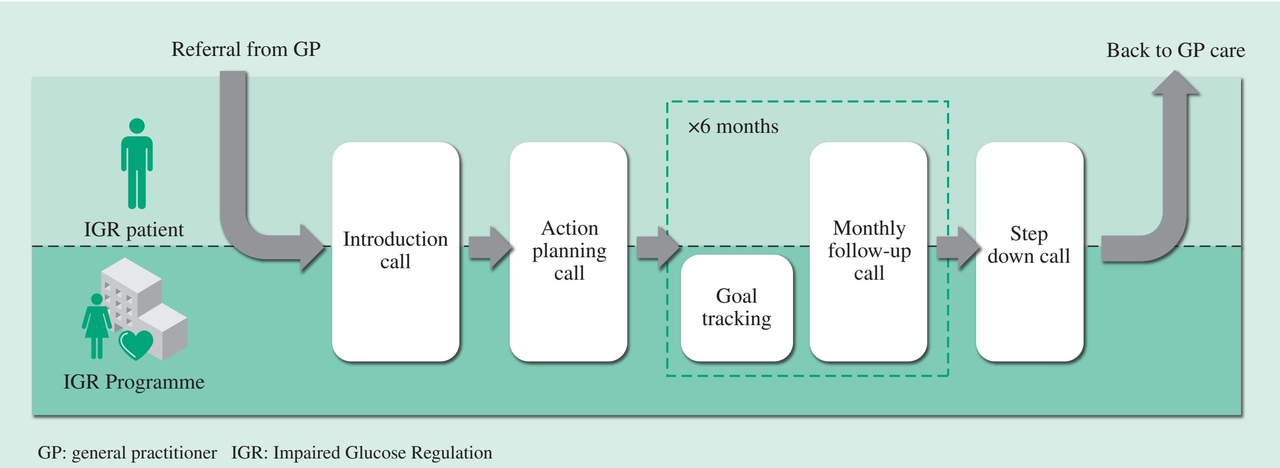

Fig. 1—IGR Care Call Pathway.
The process for the original IGR Care Call Programme in Salford is shown.

In Japan, Hitachi has an established lifestyle change programme targeted at employees of Japanese companies, including Hitachi Group companies, who have metabolic syndrome[*3]. Hitachi's programme has been in commercial service since 2009, and has since helped thousands of participants improve their lifestyles. Hitachi's programme leverages information technology (IT) and telecommunications to deliver the service efficiently at scale, as well as ensure the standard (and consistency) of quality.

Upon coming together to discuss possible collaborations in the joint development of healthcare services leveraging ICT in Greater Manchester, it was easy to see the great synergy between the academic track record and clinical expertise of the NHS, and Hitachi's experience and knowhow of delivering lifestyle change programmes leveraging ICT in this project.

IGR POC PROJECTS

The direction for the project was to build upon the track record of the IGR Care Call Programme by leveraging the experience and knowhow from Hitachi's programme, thus it was not merely a localization and deployment of Hitachi's programme to the United Kingdom. Therefore, the purpose of the proof of concept (POC) projects was to evaluate concepts that could improve the delivery efficiency, patient engagement, and accessibility of the IGR Care Call Programme. The introduction of these new concepts would lead to an improved IGR Care Call Programme, which would still be based on the proven, evidence-based care pathway.

The following concepts were to be evaluated:

Self-assessment Before Action Planning

The intervention began with a telephone call between the patient and a Diabetes Specialist Nurse (DSN), where an action plan was created based on the patient's current lifestyle. This was the most time-consuming and expensive part of the programme, and likely to be the least scalable. The proposed concept adds a web-based Self-assessment questionnaire prior to the action planning call to save the time of the DSN in interviewing the patients to get a picture of their current lifestyles. The Self-assessment needs to be robust, but also intuitive so that useful information can be collected from patients who may have little or no clinical, nutritional, or fitness knowledge. Fig. 2 shows the prototype Self-assessment.

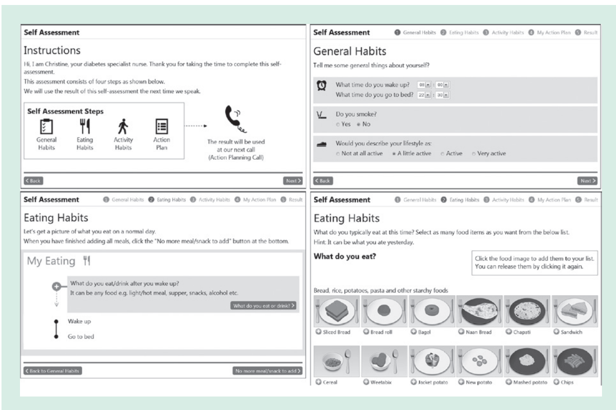

Fig. 2—The Prototype Self-assessment.
The simple, visual interface is highlighted.

*3 Metabolic syndrome is a condition which increases a person's risk for cardiovascular diseases.

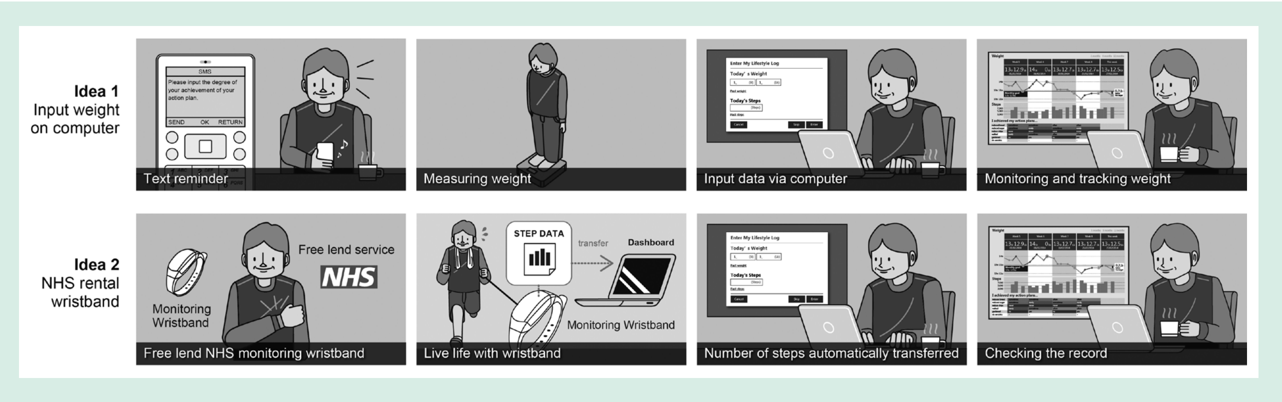

Fig. 3—Examples of Life Log Entry Scenarios.
The scenarios are presented to and discussed with patients who have already undertaken the IGR Programme.

Patient Life Log and Process Tracking

Once an action plan was created, patients would try to follow it and were encouraged to record the achievement of their action plans on a provided recording sheet. Patients would then receive monthly follow up phone calls from Diabetes Health Advisors (Health Advisor) who would discuss and give feedback on progress. However, patients found it difficult to remember all the events of the month in between calls, and many did not use the recording sheet. The proposed concept adds a web-based dashboard where patients are encouraged to record not only the achievement of their action plans, but their weight, activities (number of pedometer steps), and food intake. The log will help the Health Advisors gain a better understanding of how the patients are progressing, and make the follow-up calls more productive and engaging. The web dashboard needs to be intuitive and engaging, so a system of automated encouragements based on the life log was also proposed. It should also be suitable for patients with various levels of technological literacy, from the novice Internet user to tech enthusiasts. Fig. 3 shows examples of the life log entry scenarios created for feedback and evaluation.

Health Advisor Dashboards

The action plan and progress of the patient were recorded throughout the programme as notes in the Electronic Patient Record (EPR) system at Salford Royal NHS Foundation Trust (SRFT). This system allowed the recorded information to be shared with the patient's general practitioner (GP)[*4] and any other healthcare professionals who needed to access it. However, the patient-generated data from the previous two concepts would require a separate system for storing and interacting with the data, given that patients are unable to insert information into the SRFT EPR. This provided an opportunity to create custom web-based dashboards for the Health Advisors, enabling them to see all the log entries by patients and therefore further streamline their workflow, and save time during follow-up calls. The dashboards need to be tailored to fit the pathway and workflow, while having a visual layout similar to the patient dashboard to facilitate smooth conversation during calls. Fig. 4 shows the prototype Health Advisor dashboard.

The above concepts were iteratively refined by creating prototypes, getting feedback from stakeholders, and improving the prototypes. The final

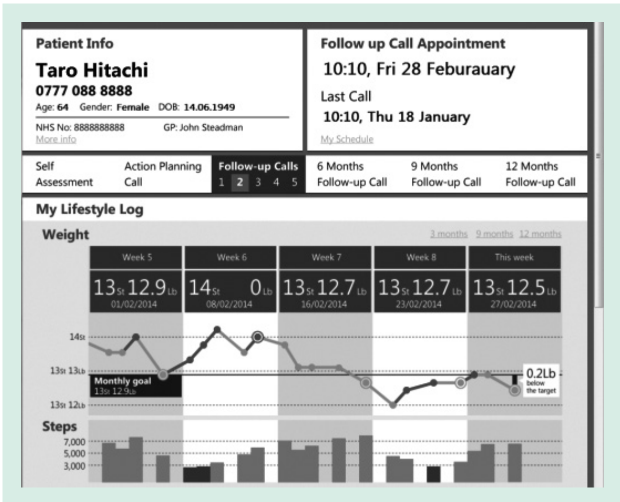

Fig. 4—The Prototype Health Advisor Dashboard.
This dashboard enables Health Advisors to see all the log entries by patients and therefore furthers streamline their workflow, and saves time during follow up calls.

*4 General Practitioner, a primary care physician, or sometimes known as a family doctor.

prototypes were evaluated by their intended users and data was collected to measure the key performance indicators (KPIs).

POC OUTCOME

Through early interviews with previous patients from the IGR Care Call Programme, we learned that although many patients owned and used smartphones and mobile devices, their primary interaction with IT was with their PCs; therefore the prototypes were designed to be used on PCs, with a user interface (UI) design that could easily be ported to mobile devices in the future.

Evaluation of the final prototype was conducted with focus groups consisting of each concept's intended users. Eight IGR patients were recruited for the Self-assessment, six recent graduates of the IGR Care Call Programme were recruited for the Patient Life Log, and three Health Advisors were recruited for the Health Advisor Dashboard evaluation. Finally, DSN staff from the Diabetes Team role-played the part of the patients in order to evaluate the Health Advisor dashboard, since recruiting from the public was not appropriate. Participants also engaged in focus groups to provide deeper insights into the proposed improvements and suggestions for future enhancements.

Efficiency improvements were apparent with the introduction of the Self-assessment, reducing the time required for the action planning call by 33%, to 40 minutes[*5]. Patients found the Self-assessment to be intuitive, so 7 out of 8 completed the Self-assessment without technical help from staff. The confidence levels for the quality of the Self-assessment tool and the action plan created from the assessment were 8.4/10 and 8.9/10 from patients and DSNs, respectively. The visual format of the Self-assessment questionnaire and the process by which patients set their own goals and later had it confirmed by the DSNs were powerful devices in ensuring engagement and confidence in setting goals. Fig. 5 shows an example of a completed Self-assessment.

The confidence levels for patients using the Life Log dashboard were also high, ranging from 8.2 to 9.3, and all patients interviewed reported that the tracking would be motivational in achieving their action plans. There were clear preferences regarding how to input their weight and activity data, where most patients favoured the ability to input data on the web dashboard and short message service (SMS), rather than using commercially-available smart devices such as wireless scales and activity bands, where preferences were split.

The introduction of Health Advisor dashboards also brought significant efficiency improvements, improving the time required for the follow up call by 44%, to 28 minutes. The learning curve for Health Advisors to use the prototype systems was surprisingly low; most were able to operate the screens with only a short briefing on the day of the trial. Confidence levels for the use and benefits of Health Advisor dashboards were lower, at 7.3/10 and 8.0/10, respectively. The focus group interview revealed that the Health Advisors found the dashboard improved workflow by aggregating information and was helpful as a communication platform between the patient and the Health Advisor, but identified room for improvement.

The introduction of these concepts into the IGR Care Call Programme brings minor changes to the care pathway shown in Fig. 6, while preserving the fundamental structure of the programme. It was also identified that because the patient is asked

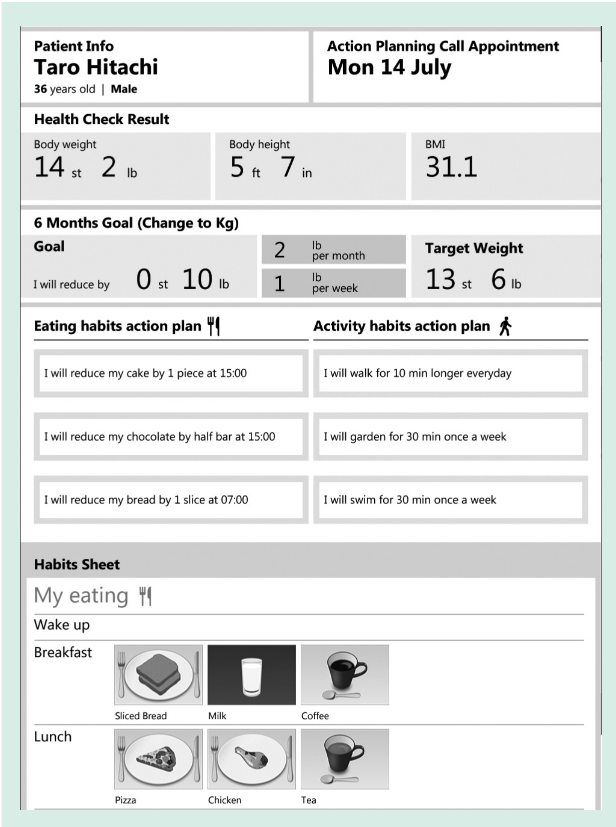

Fig. 5—Example of a Completed Self-assessment.
Web-based Self-assessment questionnaire of lifestyle prior to the action planning call saves the time in interviewing the patients.

*5 This includes the time for preparing for the call, the actual call, and administrative tasks following the call.

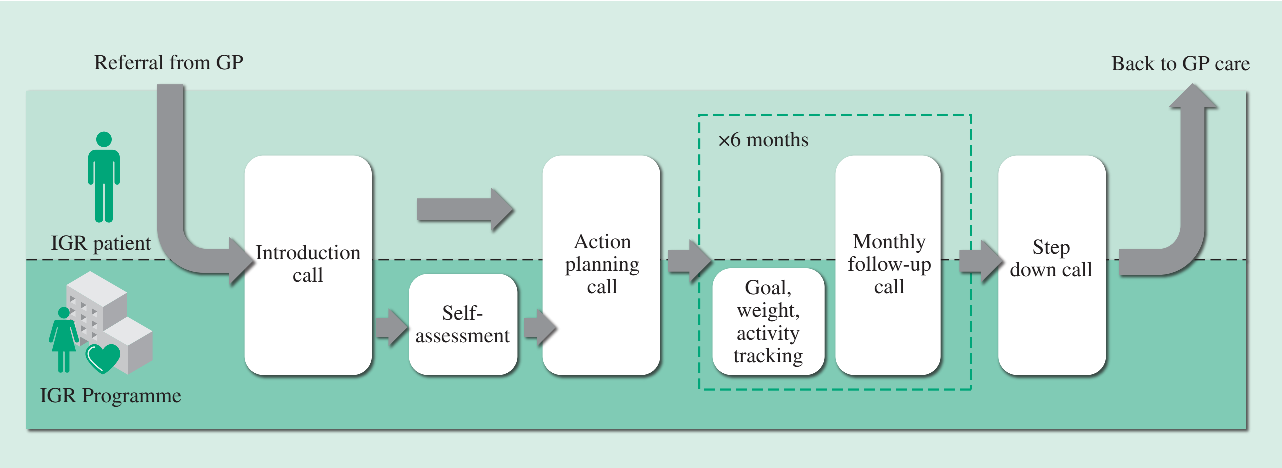

Fig. 6—New IGR Care Call Pathway.
The new pathway incorporates the Self-assessment step and changes to the patient life log.

to complete the Self-assessment before the first contact with a DSN, the patient needs to have proper understanding of IGR and the aim of this intervention. It is recommended that this should be appropriately explained at the time of diagnosis and referral by the primary care health professional.

NEXT STEPS

The POC projects provided insight into the feasibility of the concepts, and deepened our understanding of the IGR Care Call Programme, including its challenges. One of the most prominent challenges faced is the process of recruiting and entry into the programme. Evidence from previous IGR Care Call projects and Hitachi's programme both suggest that a motivated patient who enters the programme with a good understanding of IGR and the importance of making a lifestyle change would perform significantly better in the programme than someone who enters without it. This issue is being explored in the next phase of collaboration between Hitachi and the NHS, where we explore what can be done at the time of diagnosis and referral to improve patient readiness.

While we continue to investigate ways to improve the service, work has already begun to develop the concepts into real world ready systems to be deployed for a field trial of the "new" IGR Care Call service. Meanwhile, the IGR Care Call Programme has now been officially commissioned by NHS Salford Clinical Commissioning Group (CCG), thus becoming one of the first programmes to move out of development, and into a fully commissioned service. Hitachi will also continue to work with the NHS to investigate the long-term economic effect of this programme, to arm ourselves with the evidence to spread the IGR Care Call Programme to the rest of the world.

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Featured Articles

O&M Cloud Service for Expediting Business Innovation

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Hideyuki Sakai
Takao Baba

OVERVIEW: There is growing demand from a variety of industries for O&M services that can make the operation and maintenance of equipment and machinery more efficient, and there are strong global trends associated with the expectation that this will become a key concept behind a new industrial revolution. Hitachi supplies the Global e-Service on TWX-21 cloud service, which draws on the experience and know-how in equipment life cycle management that it has established through its global business operations over many years. Hitachi is contributing to the new industrial revolution by delivering benefits to manufacturers in the form of increased product sales, improved productivity, and higher income from after-sales services.

INTRODUCTION

THERE has been growing international demand from a variety of industries in recent years for services that improve the efficiency of the operation and maintenance (O&M) of equipment and machinery.

General Electric Company (GE) has coined the term "Industrial Internet" for the service concept of improving productivity by offering cloud-based functions for the collection and analysis of data from equipment and machinery[1]. Similarly, the German government has adopted the term "Industrie 4.0" for a technology strategy that uses information and telecommunications technology to improve factory productivity while also reducing energy consumption and improving the work-life balance of workers[2]. Both of these concepts incorporate the strong hope that O&M services will bring about a new industrial revolution, and so there is increasing global activity in the research, development, and commercialization of the control, information, telecommunications, and other technologies that are key to O&M services.

Against the background of these global trends, Hitachi supplies O&M services that match the diverse needs of customers through its Intelligent Operations suite of products, services, and consulting that incorporates its advanced information and telecommunications technologies and practical know-how. Manufacturing is one of the industries to which this diverse collection of customers belong and is characterized by having products that are covered by after-sales services, and that are spread around the world. The wide range of equipment and machinery used by the industry, together with other factors such as its diversity of workplaces, mean that experience and know-how in particular are needed for their management. In response, Hitachi supplies Intelligent Operations for Manufacturing as a way of directly linking product users, the places where products are used, production lines, and development centers.

This article gives an overview of a cloud service for the equipment life cycle, one of the services of Intelligent Operations for Manufacturing, describing its business benefits, features, and examples of its use.

OVERVIEW OF CLOUD SERVICE FOR EQUIPMENT LIFE CYCLE

Along with the practical experience and know-how of equipment life cycles it has built up over a decade of business operations, Hitachi has also been identifying and enhancing new business values that arise out of maintenance services. These new business values cover, (1) increasing product sales, (2) improving productivity, and (3) higher income from after-sales services. Achieving these constitutes business innovation for the manufacturing industry.

Global e-Service on TWX-21* is an O&M cloud service for the equipment life cycle that is supplied by Hitachi against this background in order to expedite business innovation in manufacturing (see Fig. 1). The service has been adapted from the Global e-Service equipment life cycle management system of Hitachi Construction Machinery Co., Ltd., which has a long

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

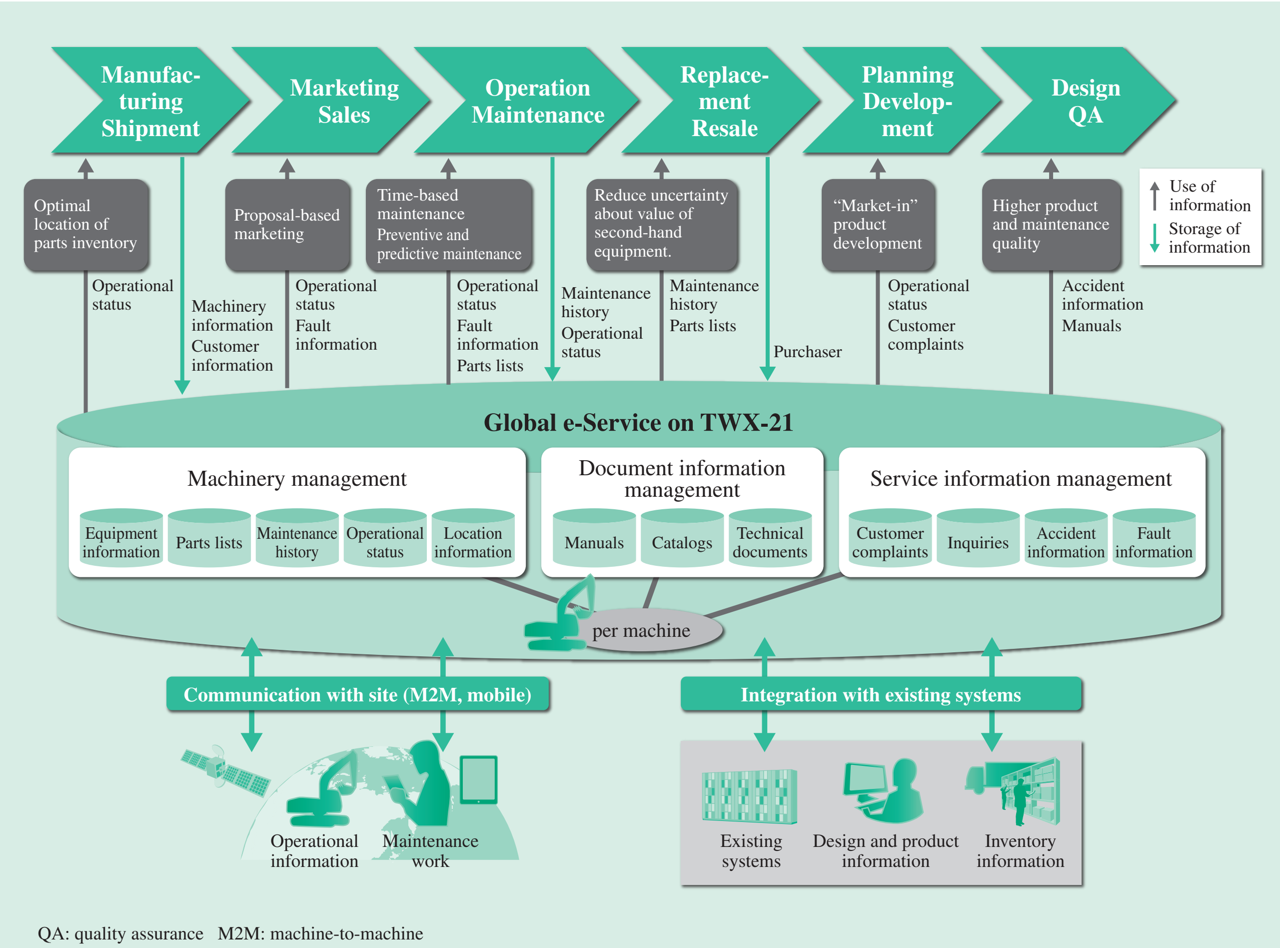


Fig. 1—Overview of Global e-Service on TWX-21 Equipment Life Cycle Cloud Service.
Global e-Service on TWX-21 delivers business benefits across the entire equipment life cycle, contributing to increased product sales, productivity improvement, and higher income from after-sales services.

experience of operating in the global market. It has been made more general-purpose so that it can be used in other industries, being particularly suited to businesses that handle a large number of products that are distributed globally through agents.

Global e-Service on TWX-21 comprises a diverse collection of business functions based on experience and know-how built up through global business operations. Using these functions, manufacturers can adopt best practices for equipment life cycle management in the form of templates. By supplying equipment life cycle management functions that are proven in use throughout the world in the form of a cloud service, Global e-Service on TWX-21 is contributing to business innovation in manufacturing, and also to bringing about a new industrial revolution.

The following sections describe the business benefits of Global e-Service on TWX-21 that contribute to realizing the value delivered by O&M cloud services, and the features that underpin these.

Realizing Value Delivered by O&M Cloud Services

This section describes the business benefits of the Global e-Service on TWX-21 that contribute to the three values from the O&M service described above based on the utilization in each business phase of the information collected across the life cycle, starting from equipment manufacturing and shipment.

(1) Increase product sales

The service helps increase product sales in both the planning and development and the marketing and sales phases of the equipment life cycle.

It makes it possible to adopt a "market in" approach to product development that takes market needs into account during the planning and development phases by analyzing information about customer complaints and other operational data categorized by product and location. In the marketing and sales phases, it implements a timely proposal-based style of marketing that wins a high proportion of orders by viewing operational data and records of repairs and faults for each machine.

(2) Improve productivity

The service helps improve productivity in both the design and quality assurance (QA) and the operation and maintenance phases of the equipment life cycle.

It improves product and maintenance quality in the design and QA phases by sharing incident data, response details, electronic manuals, and other information categorized by product so as to prevent similar problems and shorten the recovery time. In the operation and maintenance phases, it speeds up the handling of customer complaints and other inquiries by sharing information about customer complaints, electronic manuals, and other information categorized by product.

(3) Higher income from after-sales services

The service helps increase income from after-sales services during both the manufacturing and shipment and the operation and maintenance phases of the equipment life cycle, and subsequently in the replacement and resale phases.

In the manufacturing and shipment phases, analysis of operational data categorized by product and location can indicate where best to maintain parts inventory. In the operation and maintenance phases, the viewing of operational data, records of repairs and faults, and parts lists for each machine can be used to implement predictive maintenance practices to prevent failures before they happen. These include time-based maintenance, whereby the replacement of parts is determined based on operating time, and condition-based maintenance, whereby the replacement of parts is based on their condition when inspected. In the replacement and resale phases, by including maintenance history and parts lists along with other information provided with second-hand machines, these can be re-sold at a higher price by reducing uncertainty about their value.

Solution for Enhancing O&M Cloud Service

Global operations for manufacturing require enhancements to equipment life cycle management. This section describes the Global e-Service on TWX-21 solution for these needs.

(1) Realtime operation monitoring

Whereas the operational data utilized in each phase of equipment life cycle management has conventionally been gathered during on-site maintenance, global operations result in equipment being spread out around the world and this makes it difficult to collect accurate information. In response, Global e-Service on TWX-21 provides realtime operation monitoring, using machine-to-machine (M2M) functions for the automatic remote collection of information on equipment operation. This reduces the amount of on-site maintenance and helps in performing anomaly detection, as envisaged by the Industrial Internet concept.

(2) Secure, high-speed sharing of electronic documents worldwide

While the common practice for sharing of electronic documents in the past has been to send them as e-mail attachments, global business operations hinder productivity due to unstable network environment and bring an increased risk of information leaks due to poor staff morale. In response, Global e-Service on TWX-21 provides secure, high-speed sharing of electronic documents throughout the world using fast and reliable Internet communications based on multi-route communication technology, and electronic document stores with such security functions as download restrictions and version control. This helps establish the information-sharing platform required for an O&M cloud service that can be used globally.

Features Underpinning O&M Cloud Service

Operational and other business issues need to be resolved in order to implement global equipment life cycle management. This section describes the features of Global e-Service on TWX-21 that help achieve this.

(1) Integration of different data sources linked to equipment

While it is desirable to use all of the functions provided by Global e-Service on TWX-21 to implement equipment life cycle management, there are also cases when a company will already have its own business systems for the equipment life cycle.

Storing the same information across a number of different business systems not only increases workloads, it also increases the number of data entry errors. Since Global e-Service on TWX-21 is a cloud service with functions that can also be supplied individually, this problem can be overcome by exchanging data with existing systems. This integration links the equipment life cycle data managed by each system to specific machines so that groups of data can be viewed together using a particular machine as the key, while also ensuring that the customer’s existing systems can remain in use.

In the operation and maintenance phases, for example, this contributes to higher income from after-sales services by allowing consolidated use of information such as the operating status or maintenance history of the equipment concerned.

(2) Appropriate access control based on complex distribution channels

The global distribution channels used in manufacturing require the sharing of information across a large and diverse range of stakeholders, for example, it is not uncommon for headquarters and local agencies to be operated by different companies that are based in different countries. In response, Global e-Service on TWX-21 can facilitate the sharing of information across company and national boundaries and provide secure control of information release for each task associated with a particular product category by not only linking these companies by product category, but also providing multilingual support for each business function.

In the operation and maintenance phases, for example, this can improve productivity by ensuring a rapid response to inquiries from stakeholders around the world.

(3) Hierarchical delegation of authority

Since the global distribution channels used by manufacturers involve large numbers of stakeholders spread across different countries and companies, ranging from headquarters to local agencies located around the world and including domestic business divisions and overseas subsidiaries, it is difficult for managers at headquarters to keep up with what is happening to all stakeholders and manage their work appropriately. In response, Global e-Service on TWX-21 can reduce the workload for managers at headquarters by delegating managerial authority over business functions to the managers of subordinate stakeholders. It can also collect, store, and utilize information at a detailed level, particularly regarding small overseas operations, through the appropriate delegation of authority based on conditions at the local site.

In the marketing and sales phases, for example, this can help increase product sales by creating an environment in which the information required for local sales activities can be acquired and utilized in a proportionate manner.

EXAMPLE APPLICATIONS AND BENEFITS

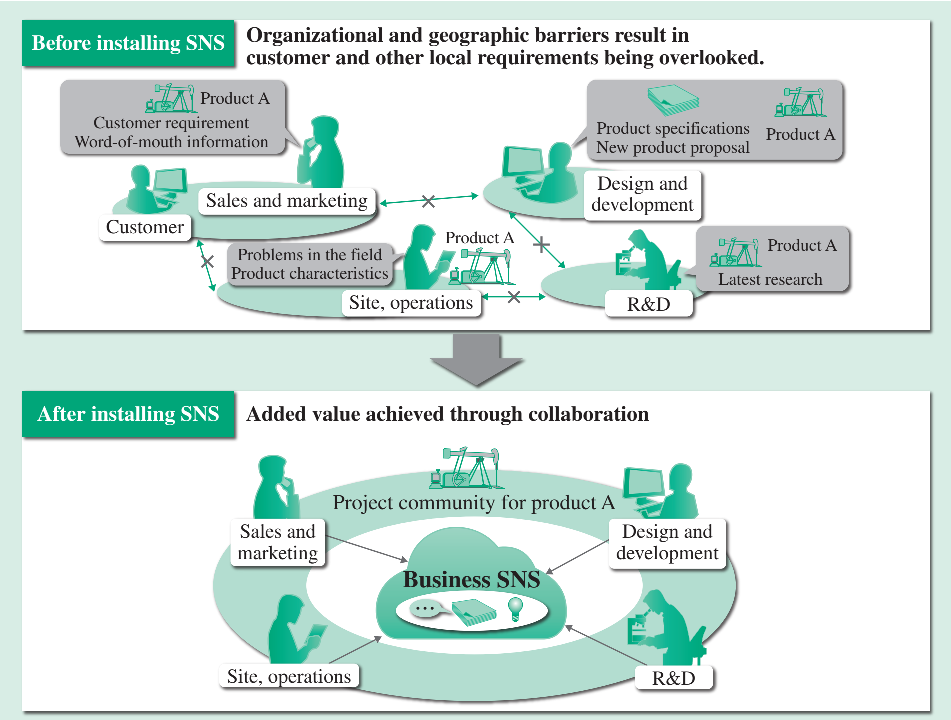
Global e-Service on TWX-21 has been adopted in manufacturing applications outside the construction machinery industry. This section describes improvement techniques used in the design and development phases by a particular manufacturer to ensure that product development reflects local needs in terms of the challenges associated with establishing a working environment to accompany global deployment.

This particular manufacturer identified a need for information sharing practices between engineers at local and overseas development centers that would allow the exchange of information about both common functions and functions specific to particular regions or customers, and also relevant background information, and that would also permit consultation with experts based on experience of similar work undertaken in the past.

However, foreign customs need to be taken into account when establishing such a global working environment. In Japan, for example, design and development work is subject to rigorous QA, with the tasks associated with equipment life cycles being undertaken in accordance with formalized workflows. Europe and America, in contrast, have a culture of working without QA, accompanied by the frank sharing of information between sales and the workplace, making the global deployment of Japanese working environments difficult.

While Global e-Service on TWX-21 provides work information management functions that utilize the formalized workflows familiar to Japanese manufacturers, it also takes account of the requirements of other countries and, in a new initiative, has utilized the social networking service (SNS) platform of salesforce.com, inc. to build a business SNS that provides a forum for discussion and information sharing that transcends organization, time, and place (see Fig. 2). Hitachi has added an “article function” to the SNS platform that collects comments on each topic, integrating these with the global electronic document store to provide an SNS suitable for use in business that can be used as a communication tool to augment meetings, e-mail, or other exchanges. Moreover, Hitachi has strengthened security to ensure that exchanges have appropriate scope and content, and has added a multilingual function for building synonym dictionaries to increase the speed of global information sharing.

The benefits of deploying these functions include spreading knowledge and know-how across the organization and allowing a vigorous exchange of views among engineers and other experts working on a particular product, accompanied by their sharing past work via the electronic document store within a secure closed group.



SNS: social networking service R&D: research and development

Fig. 2—Overview of Business SNS Use.
SNS provides a forum for discussion and information sharing that transcends organization, time, and place to allow the sharing of knowledge and know-how and the vigorous exchange of views.

CONCLUSIONS

This article has given an overview of Global e-Service on TWX-21, a cloud service for the equipment life cycle, describing its business benefits, features, and examples of its use. In the future, Hitachi intends to provide seamless management and utilization of people, things, and events, including through the integration of a business SNS with equipment operational data collected through M2M functions.

Global e-Service on TWX-21 is being developed as an information and telecommunications service for O&M services that seek to bring about a new industrial revolution. As a cloud service with exceptional functional expansion, Hitachi also aims to turn it into an attentive, genuinely useful service by building up experience and know-how through its use by a variety of customers, and growing steadily alongside those customers.

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Featured Articles

Cloud-based Fleet Management System Proof of Concept

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OVERVIEW: In recent years, management strategies in the mining business have been shifting away from direct investment in expanding production, and focusing instead on efficiency by reducing operating costs and improving productivity. It was against this background that Hitachi undertook a proof of concept project using cloud technology for a mining industry FMS being developed, implemented, marketed, and maintained by Wenco International Mining Systems Ltd. This project involved implementing an FMS system platform on Hitachi's cloud (data centers) and testing its performance when offered as a cloud-based service via the Internet. Hitachi is using the project to assess its technical viability and identify where future improvements are required, with the intention of offering the service commercially in the future.

INTRODUCTION

THE mining business involves extracting minerals from mines and selling them. Factors such as the volatility of commodity prices and increasing extraction costs in recent years mean that one of the management challenges for mining companies is how to achieve stable earnings from this business. Past management strategies based around direct investment in expanding production are now giving way to a focus on efficiency with the aim of reducing operating costs and improving productivity. Mining companies are facing steadily rising operating costs, which are a consequence of factors such as compliance with environmental regulation and operating deeper mines. The aging of experienced staff and the rapid increase in personnel costs due to the difficulty of recruiting operators are also becoming increasingly pressing issues. With regard to productivity, the challenge when it comes to making improvements is how to make the best use of existing equipment in an environment in which new investment is constrained, given that equipment utilization in mining has traditionally been lower than that of other industries.

The mining industry fleet management system (FMS) supplied by Wenco International Mining Systems Ltd., a Canadian subsidiary of Hitachi Construction Machinery Co., Ltd., manages the status of dump trucks, excavators, and other mine site equipment. The dispatchers use the FMS to implement productivity by directing vehicle operators where to go. Whereas separate FMSs have traditionally been installed at each mine site, mine sites at isolated locations, for example, tend to face numerous system management challenges that include recruiting technical staff and ensuring a reliable supply of electric power. Because system outages reduce productivity, ensuring reliable FMS operation is an important issue for mining companies.

Hitachi, meanwhile, supplies operation and maintenance (O&M) cloud services that extend from on-site preventive maintenance applications to use in operation and management through the collection and analysis of operational and maintenance information from its social infrastructure businesses. These services help the operators of social infrastructure to achieve reliable and flexible operation and maintenance.

For the mining business, Hitachi believes that supplying the Wenco FMS as a cloud service will enable mining companies to overcome the operational challenges described above. Accordingly, it has conducted a proof of concept (PoC) project in conjunction with Wenco, with aims that include overcoming the technical issues associated with shifting the FMS to the cloud, and assessing its performance. This article describes the project and its results.

CONCEPT BEHIND CLOUD IMPLEMENTATION OF FMS

This section describes the structure and features of the current Wenco FMS, the concept behind implementing it in the cloud, and the associated challenges.

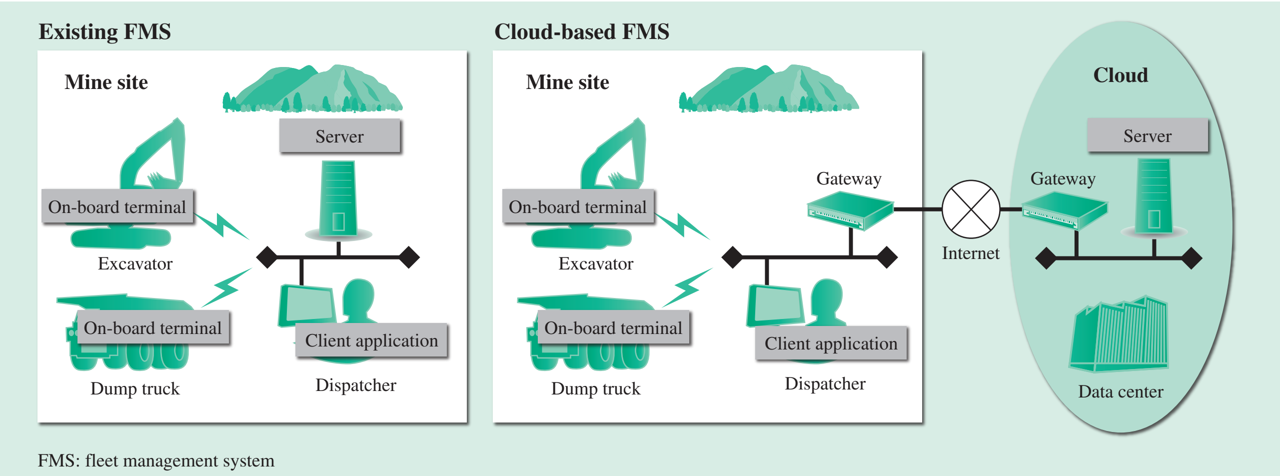

Fig. 1—Block Diagrams of Existing FMS and Cloud-based FMS.
The cloud-based FMS uses on-board terminals and client applications at the mine site that connect via a gateway and the Internet to a server located in the cloud.

Operating Environment of Current FMS

The FMS consists of a server that runs the FMS software, on-board terminals installed in each vehicle, and the client applications that the dispatchers use for their work. The on-board terminals connect to the server via a wireless local-area network (LAN). The dispatchers use their client applications to monitor vehicle status and issue commands to the vehicle operators. The server stores production data as it is collected from the extraction process, including production totals and details of vehicle operation. The server is commonly installed in a room at the mine site, where its operation is managed by on-site system technicians.

Advantages of Introducing Cloud-based FMS

Fig. 1 shows block diagrams of the existing and cloud-based FMSs. In the latter case, the server that was previously located at the mine site has been shifted to the cloud, with the on-board terminals and client applications connecting to it via a gateway and the Internet.

Hitachi sees the cloud-based configuration as having the following five advantages.

(1) Remote dispatching

Because the on-board terminals, server, and client applications connect via a gateway and the Internet, a cloud-based configuration means client applications can be located away from the mine site to allow dispatching to be performed from a remote command center (see Fig. 2). For example, since things like recruiting and stationing staff at mines in isolated locations often pose a problem, the cloud-based configuration makes it possible to set up the FMS based on remote dispatching by having a city-based command center.

(2) Ease of installation

Because there is no longer any need to set up a server at the mine site, the FMS can be installed quickly and at low cost. By reducing up-front costs, this should encourage the adoption of FMSs.

(3) Reliability and stability

Setting up the server on a robust cloud platform helps provide reliable server operation and reduces the risk of system faults.

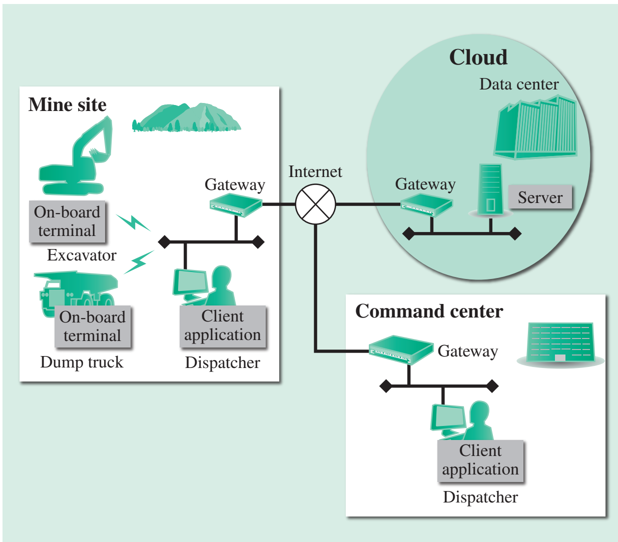

Fig. 2—Example System Configuration for Remote Dispatching Using Cloud-based FMS.
Remote dispatching allows operating instructions for vehicles at a distant mine site to be issued from a city command center.

(4) On-demand use

The ease of adding server capacity means that, in situations such as preliminary testing, the system can be used only when needed, and only to the extent needed.

(5) Access from mobile devices

Production data collected by the server can easily be accessed as required from mobile and other devices. This should help in ways that include faster management decision-making.

Challenges and Solutions of Cloud Implementation

Shifting the FMS to the cloud brings new challenges that do not arise with the current FMS, which is limited to the mine site. The following section lists three major challenges and how to overcome them.

(1) Stronger data security (confidentiality)

Because a cloud-based FMS needs to communicate via the Internet between the mine site and cloud, the system design requires adequate provision for data security.

Accordingly, it uses virtual private network (VPN) functions such as data encryption, tamper detection on communication circuits, and access authentication to deal with the potential interception of communication data.

(2) Change of communication control protocol

The current FMS is designed on the assumption that its communication is restricted to a LAN. Since most communications between the on-board terminals and the server are via wireless, communication control between these uses a non-session-based protocol that allows for the frequent packet loss that occurs in wireless communications. However, the use of Internet communications that accompanies the shift to the cloud requires that both the mine site and cloud change to a session-based protocol to allow the firewall to perform access control and to facilitate address conversion.

To achieve this, Hitachi added a new gateway function at the mine site to implement the change in communication control protocol (see Fig. 3).

(3) Reduction of communication delays

Implementing FMS in the cloud results in communication delays that are proportional to the physical distance between the mine site and the cloud. The round trip time (RTT) delay typically ranges between several tens and several hundreds of milliseconds. The addition of the new functions associated with the two challenges described above also introduces processing delays at both the mine site and the cloud. Furthermore, one of the features of the FMS is that it is a realtime system. The data on the on-board terminals, server, and client applications needs to be kept synchronized without delays. This is the most significant technical challenge to be overcome when implementing the system in the cloud.

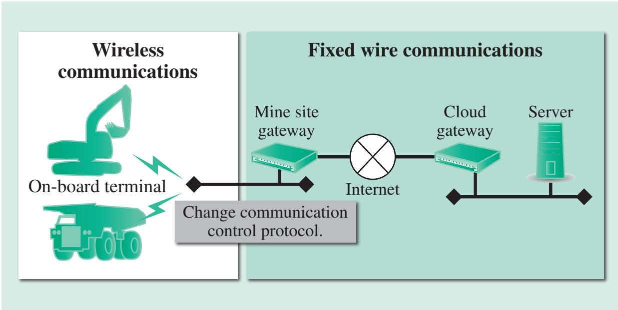

Fig. 3—Change of Communication Control Protocol for Cloud-based System.

The shift to a cloud-based system required a change from a non-session-based communication control protocol that assumed wireless communications with frequent packet loss to a session-based protocol that allows the firewall to perform access control and facilitates address conversion.

Accordingly, the project included testing of the benefits of installing wide-area network (WAN) acceleration, a notable technology of Hitachi's, to reduce communication delays. This WAN acceleration technology increases the speed of transmission control protocol (TCP) communications. In the past, it has commonly been installed to boost the speed of high-volume data transfers, such as for the sharing of files between multiple locations. In this case, however, it was used for the frequent but low-volume data transfers typical of machine-to-machine (M2M) communications.

In the PoC project, Teck Resources Limited of Canada handled testing of how users perceived system operation. With a view to future deployment, the project also encompassed the technical evaluation of long-distance communication between Canada and Japan.

PROOF OF CONCEPT WITH TECK

Overview

This testing assessed whether the system was viable for practical use at a mine site, looking from a customer's perspective at things like practicality and the changes in ease-of-use associated with the architectural change from an on-premises system to a cloud system.

TABLE 1. FMS Use Cases for Testing
A total of 10 test cases were identified to represent the main uses of the FMS in normal operation.

Client application	Example use case	Example operation
Fleet management application (4 use cases)	Dispatch truck to excavator	Issue notification to truck to go to different excavator for loading.
Location information application (4 use cases)	Edit mine map.	Edit map data indicating locations of extraction, storage areas, and routes.
Data management application (2 use cases)	Report generation	Output reports containing operating records or statistics.

The cloud server was set up at a data center in North America and the client applications and on-board terminals were installed at a Teck site in British Columbia in Canada. The evaluation was conducted by a team of five Teck staff who worked at the site, including dispatchers and their supervisors.

The testing covered 10 use cases for three client applications and encompassed core FMS tasks that are used on a routine basis (see Table 1). The evaluators operated the FMS in accordance with the procedures specified for each use case and scored the operation of the system using a four-point scale (perfect, good, not good, or bad) based on factors such as how it responded to these operations.

Test Results and Investigation

The scores were collated for each application and color-coded in accordance with the assessments (see Fig. 4). The following three conclusions were drawn from the dispatchers' assessments.

(1) The operation of the dispatching application was good, remaining unchanged from the non-cloud system.

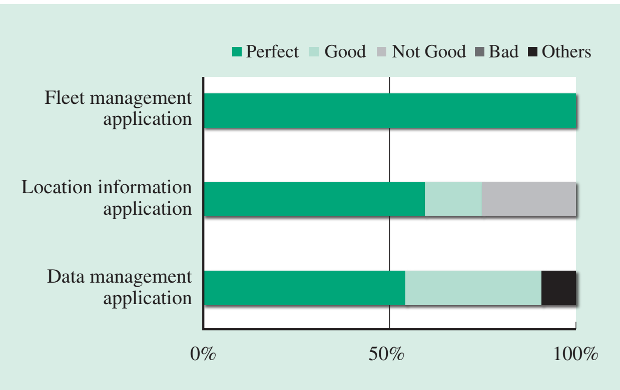

Fig. 4—Results of Dispatcher Assessments.
The assessments identified a problem with certain operations in the location information application taking too long.

(2) The location information application was deemed "not good" in 25% of responses. This highlighted a problem with particular operations taking too long as a consequence of using the cloud.

(3) In the case of the data management application, although the shift to the cloud made some operations slower, this was not by so much as to cause a problem in practice.

The deterioration in the ease-of-operation of the location information application was found to be caused by the longer time taken to synchronize data between the server and client applications after adjustments to map data. While it was initially assumed that this synchronization of adjustments to map data would not occur often, the users indicated that it would be a problem in practice because the function was in fact frequently used.

An analysis of network communications to further investigate the problem found that blocks of data were being sent at times when operation was impaired. A quantitative assessment and investigation based on these measurement results identified the following three measures that could minimize this problem in the future.

(1) Modify the client application design to allow users to continue working unimpeded while data is being synchronized.

(2) Shorten synchronization time by synchronizing data selectively to minimize the volume of data transfers between server and client application.

(3) Shorten synchronization time by making appropriate use of Hitachi's WAN acceleration technology to improve network speed and reliability.

PROOF OF TECHNOLOGY OF COMMUNICATION BETWEEN CANADA AND JAPAN

Overview

Some mining companies operate multiple mines that are separated by long distances in places such as North America or Australia, and there are cases when it is not possible to install the cloud server close to all mines. Particularly in the case of long-distance configurations involving intercontinental communications, the WAN RTT may be several hundred milliseconds or more, meaning that the FMS will likely experience major delays in its response time. Accordingly, Hitachi conducted operational testing of the FMS using long-distance communications between the mine site in Canada and the cloud server in Japan.

TABLE 2. System Configuration for PoC

The bandwidth bottleneck in the network was the 5-Mbit/s maximum capacity of the DSL. Its mean actual throughput was measured at 3 Mbit/s.

Item	Value
Cloud server location	Japan
Site location	Canada
Distance from server to site	8,000 km (approx.)
WAN	Internet
Access line to site	DSL
Mean throughput between server and site*	Downlink: 3 Mbit/s, Uplink: 3 Mbit/s
Mean RTT*	0.17 s

PoC: proof of concept WAN: wide-area network DSL: digital subscriber line
RTT: round trip time
* The mean server-to-site throughput and RTT measurements were made prior to implementing the enhancements described in the article.

In addition to the main FMS functions, the test system incorporated the three enhancements described above, namely the use of a VPN, new FMS functions, and WAN acceleration. The main objectives of the tests were to look for any problems with dispatch system operation and to conduct comparative testing to assess the delay improvement provided by the WAN acceleration technology.

Table 2 lists the system configuration. The bandwidth bottleneck in the system's network is the 5-Mbit/s maximum capacity of the digital subscriber line (DSL) to the mine site. The mean actual throughput was measured at 3 Mbit/s.

Testing

The following three steps were defined as representing a typical FMS operation.

(1) The operators use the on-board terminals on specific mine site vehicles to modify their operating status manually.

(2) Details of the modified vehicle operating status are sent to the cloud server.

(3) Details of the modified vehicle operating status are sent to the client application at the mine site and displayed on the screen.

The response time, defined as the time taken for these three steps, was measured. Also, the acceptable response time for dispatchers using the cloud FMS was set at 2 s or faster based on research into how long websites take to respond to user operations and what impression this creates(1).

Results

Fig. 5 shows the measured response times for the typical FMS operation. The response time became much longer when the VPN and new FMS functions added for the cloud implementation were included (indicated by "VPN and new FMS functions" in the figure). While these techniques are essential for operating a WAN over the Internet, they have a major negative impact on the response time. However, when Hitachi's distinctive WAN acceleration technology was incorporated (indicated by "VPN, new FMS functions, and WAN acceleration" in the figure), the mean response time for the typical FMS operation was reduced to about one-third of the previous value, and the maximum to about one-eighth. As a result, the response time was brought down below the acceptable limit for dispatchers using the system, demonstrating the effectiveness of the WAN acceleration technology.

CONCLUSIONS

This PoC project provided information about the technical viability of the cloud-based FMS. While a number of issues were identified that need to be resolved before a commercial service can be introduced, the work also provided an indication of how these can be overcome. Hitachi intends to market the service to customers and is actively preparing for introducing it commercially.

A developing trend at mining companies in recent years has been the use of information technology (IT) to make improvements in management efficiency.

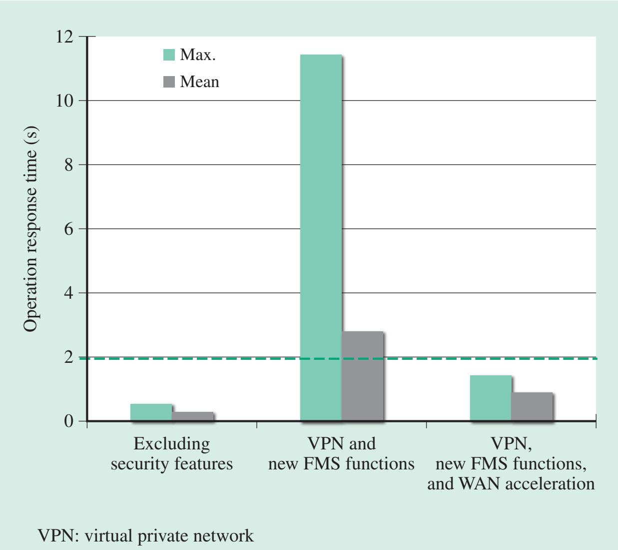

Fig. 5—Response Time between Canada and Japan for Typical FMS Operation in Proof of Concept Project.

Use of WAN acceleration technology shortened the response time for a typical FMS operation, bringing it under the acceptable limit for system operation by dispatchers.

Hitachi plans to offer smart information services to the mining business by seeking to fuse IT with operation technology (OT). Since the FMS server collects mine operation and management data, Hitachi also believes that it can identify the hidden challenges faced by mining companies and offer further business improvements by analyzing this data. Hitachi will continue to offer services with high added value from a customer's perspective.

ACKNOWLEDGEMENTS

The authors would like to take this opportunity to express their sincere thanks to everyone concerned for the cooperation received from Teck Resources Limited during the PoC project.

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Featured Articles

Use of EAM and Equipment Operation Technology for Sophisticated Operation and Maintenance of Electric Power Distribution Equipment

Kazuhiro Hiraki
Shigehiro Eda
Yuichi Mashita
Yoshio Maruyama
Shinichi Imai

OVERVIEW: With the aging of electric power distribution systems that were installed or built in North America prior to the 1970s, the use of efficient maintenance to enhance power distribution quality is an important challenge. Tokyo Electric Power Company, Inc. and Hitachi are working together to overcome this problem by utilizing the information they have and the associated operating technologies to identify faulty equipment and analyze signs of potential failure. In particular, Hitachi intends to combine EAM technology with the equipment operation technology and maintenance management know-how of TEPCO to develop new solutions and deploy them in North America where demand is strong.

INTRODUCTION

IN the 1960s and 70s, North America experienced a period during which the growth in population led to an expansion in suburban living. A large amount of electric power distribution equipment covering a wide area that was installed on the basis of the industrial policies of that time is now reaching the end of its product life. The maintenance staff recruited during that period are also approaching retirement age. Electric power distribution equipment, which was installed at great cost, requires measures for dealing with aging so that it can withstand natural disasters such as frequent tornados. Meanwhile, the installation and operation of new "smart grid" distribution equipment based on recent industrial development policies is ongoing, making distribution systems more diverse and creating a need for new maintenance and management arrangements to be put into place.

The increasing scale and diversity of distribution equipment mean that the run-to-failure (RTF) approach of dealing with maintenance after the equipment has failed is now reaching its limit. It is anticipated that information and operational technologies can be utilized to overcome this challenge. Accordingly, Japanese power companies have built up know-how through their operation of power distribution systems based on information technology (IT) and advanced maintenance technologies and systems that utilize the collection and analysis of equipment fault data. They are now taking steps to deploy this accumulated operational know-how outside Japan.

This article describes advanced maintenance and operation initiatives for power distribution equipment being undertaken jointly by Tokyo Electric Power Company, Inc. (TEPCO) and Hitachi, as well as the enterprise asset management (EAM) and equipment operation systems that play a core role in services.

ISSUES AND CHALLENGES FACING POWER DISTRIBUTION EQUIPMENT MANAGEMENT

Challenges

Electric power must be supplied to consumers reliably, and within predetermined voltage ranges. Achieving this requires not only distributing power correctly, but also new measures for maintenance management that do not impact on the distribution of power itself by determining and managing the equipment status, and repairing or replacing it before it fails in cases when warning signs are present. Industrial development policies in the USA refer to smart grids that are designed to improve the reliability and quality of the supply of electric power, and emphasize the emerging problem of how to deal with aging infrastructure so that smart grids can be built (see Fig. 1).

In response, Hitachi has recognized that measures for dealing with aging equipment constitute a market where there is scope for the application of Japanese

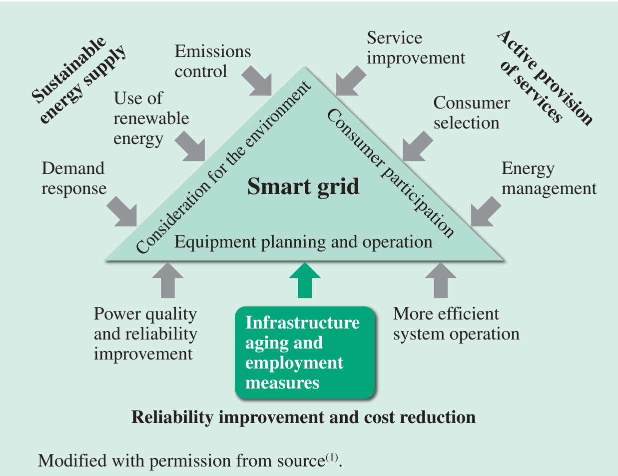

Fig. 1—Smart Grid Challenges.
The figure shows the challenges for smart grids defined in terms of equipment planning and operation, consumer participation, and consideration for the environment.

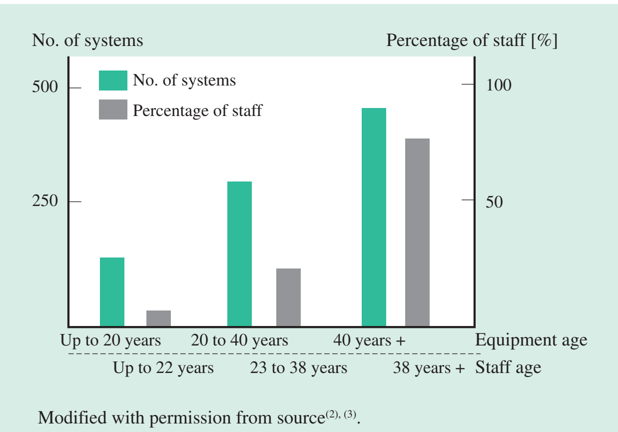

Fig. 2—Distribution of Key Equipment and Maintenance Staff Ages in North America.
More than 50% of distribution equipment has been in service for 40 years or more. Likewise, experienced maintenance staff are due for retirement, raising concerns about workforce shortages.

technology, systems, and operation in collaboration with Japanese power companies, and has conducted a market analysis. This analysis has identified the following five challenges.

(1) Dealing with the aging of large amounts of equipment installed over a wide area

The existence of a large amount of aging power distribution equipment makes efficient maintenance and management essential in North America.

Fig. 2 shows the age of distribution equipment in one particular state in the USA. Since the lifespan of distribution equipment is typically about 40 years, the graph shows an imminent need for the upgrade of equipment at the end of its life. However, the large quantity of this equipment and the fact that it is installed over a wide area make it difficult to upgrade all at the same time. To achieve this, it is important to determine the condition of equipment accurately and to manage maintenance in a planned and efficient manner.

(2) Measures for building new distribution infrastructure

Smart grids feature the interoperation of existing distribution infrastructure with renewable forms of energy such as photovoltaic power and wind power. This means managing the maintenance of new distribution infrastructure along with existing distribution equipment.

(3) Passing on maintenance management know-how to the next generation of maintenance staff

Maintenance staff recruited at the time when the equipment was originally installed are now approaching retirement. This means it is important to transfer the know-how and skills in maintenance management that has been built up over this time to the next generation. However, because the total number of younger maintenance staff is insufficient due to the lower birth rate and aging population (see Fig. 2), there is a need for efficient ways of passing on large amounts of maintenance management know-how. Also, the presence of a large amount of aging distribution equipment means that there is a limit to how far the RTF approach of dealing with equipment after it fails can be applied, making it important to identify any warning signs of potential failure early so that something can be done before a problem occurs.

(4) Dealing with increasing prevalence of natural disasters

Climate change in recent years has increased the prevalence of natural disasters such as lightning strikes and tornados, increasing the impact these have on distribution equipment also. This makes it necessary to identify quickly where damage has occurred so that maintenance staff can be dispatched promptly and repairs implemented efficiently.

(5) Measures for improving the cost-benefit ratio for maintenance and management expenses

Electricity market deregulation in North America has encouraged the upgrading of distribution equipment and has caused spikes in the purchase price of electric power. This has led to the use of regulation to limit rises in the purchase price of electric power, together with a need to take account of severe cost-benefit requirements in the maintenance and management of distribution equipment.

Solutions to Challenges

What is needed to overcome the challenges described above is the ability to identify the condition of distribution equipment at an early stage, and to respond promptly when a problem is found. To this end, Hitachi intends to deploy the following three key solutions based on new information and operation technology (IT & OT).

(1) Centralized management and utilization of information on distribution equipment

Distribution equipment comes in many types and is supplied by a large number of different vendors. Distribution equipment will also be used in more complex configurations in the future, with a need to incorporate information on renewable energy systems. This involves using databases to store diverse information about distribution equipment so that information about the best ways to go about repairing or replacing it can be obtained quickly, and also so that correlations between equipment can be identified. It also makes it possible to keep databases updated and to obtain up-to-date information about equipment condition by using the latest mobile devices to obtain this information and store it in a database.

(2) Use fault prediction as a basis for implementing preventive maintenance

When dealing with large amounts of distribution equipment spread over a wide area, only responding to failures after they occur is bad for power supply reliability and quality improvement. Accordingly, what is needed is to identify the warning signs of potential failures so that action can be taken before they occur. In the past, information about failure warning signs has largely relied on the informal knowledge of maintenance staff, with inadequate use being made of this information. In response, Hitachi uses databases to store and utilize information such as that obtained from monitoring sensors attached to distribution equipment or the large amounts of accumulated information on maintenance and management know-how. This information takes the form of big data based on accumulation over time. This allows accurate maintenance to be performed by analyzing big data on maintenance and management to identify similarities between problems and the warning signs of potential failures.

(3) Integration of maintenance, management, and operation

A fragmented market means that power distribution companies in North America are often small. This has led to cases of inadequate investment in distribution equipment and insufficient maintenance staff. One way to overcome this is to allow the outsourcing of distribution equipment maintenance and management to specialist companies. This makes it possible to implement efficient measures for dealing with aging equipment by passing on and integrating equipment information from different power distribution companies. It can also optimize the allocation of the outsourcing company's maintenance staff and reduce maintenance and management costs for the power distribution companies.

EAM SOLUTION

The following sections describe the technologies and systems developed and operated to implement the solutions described above.

Hitachi is developing an EAM solution package. By providing centralized management of information about a company's equipment assets throughout their life cycle, the package consists of business improvement solutions that provide visibility, standardization, and greater efficiency for this equipment and the tasks associated with it.

The aims of EAM are to maximize and optimize the value of a company's equipment assets by balancing the trade-offs between equipment quality (risk), economics (cost), and utilization (performance).

Main Functions of Hitachi EAM Solutions

Hitachi's EAM solutions have both plant-based and area-based functions to suit different types of social infrastructure, such as electric power or railway transportation. Plant-based functions apply to specific sites and area-based functions apply to equipment that is spread over a wide area. The main functions for power distribution companies that operate over a wide area are listed below (see Fig. 3).

(1) Equipment management

This provides a common platform for the centralized management of such information as equipment use and installation details. To provide centralized data management and make operation easier, it features a geographic information system (GIS) as a user interface so that equipment information can be viewed on a map.

(2) Fault analysis

This function supports analysis and report generation using information on equipment faults.

(3) Maintenance management

This function manages maintenance planning, execution, and outcomes based on periodic inspections

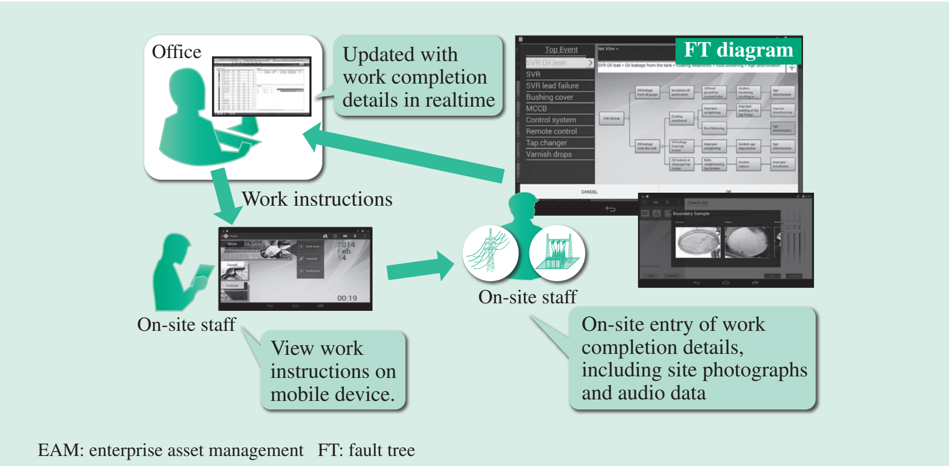

Fig. 3—Overview of Hitachi EAM.
Hitachi is developing EAM products for the efficient management of equipment maintenance and modifying them for use by power distribution companies that operate over wide areas.

and equipment condition, and with reference to previous performance and maintenance results.

(4) Work resource management

This function manages all work and provides centralized management of such things as the procedures for each task; equipment, personnel, and other resources; and also cost. It manages the location and circumstances of staff dispatched to work in the field, and calculates appropriate staff numbers and work allocations when new tasks arise.

(5) Work design support

This function uses a map-based user interface to support equipment work planning. It automatically generates information on materials and tasks based on equipment standards, and calculates the cost of work.

(6) Equipment investment support

This function performs statistical analysis of data on different items of equipment to support decision making on equipment investment and maintenance strategies.

These six functions can be downloaded to a mobile device for use in the field.

Fault Analysis Function

This section describes a distinctive function of EAM solutions provided by Hitachi that supports the collection and analysis of information on equipment faults.

Mobile devices such as tablets are used to collect fault information. Field staff carry the mobile device with them so that they can access equipment information while they work. Templates are used to indicate the information to be collected when a fault occurs on a particular type of equipment, ensuring that all necessary information is acquired. Collected fault information is forwarded to those responsible for identifying and analyzing the cause, and information on the progress of fault-finding is shared among the people involved.

The fault analysis function includes the ability to manipulate a fault tree (FT) diagram generated by the analysis of fault causes and effects. The FT diagrams produced for each type of equipment are stored, and newly arising faults can be analyzed in a variety of ways by relating them to the causes in the FT diagram. Hitachi intends to enhance this function further by drawing on know-how from TEPCO, as described below.

EQUIPMENT OPERATION SYSTEM

To reduce costs in response to more stringent investment constraints since the deregulation of high-voltage distribution systems in the 1990s, and to deal with the fall in workforce numbers due to the wholesale retirement of maintenance staff, TEPCO has sought to install new IT equipment and adopt more sophisticated operating arrangements. Its Equipment and Engineering (E&E) Center has a core role in these operations. The following provides an overview of the E&E Center and its main functions.

Overview

TEPCO established the E&E Center in 1998 to implement more advanced preventive maintenance practices for distribution equipment in anticipation of factors such as more complex field maintenance resulting from the installation of new IT equipment. Since then, it has established a database of information on distribution equipment and set up mechanisms for the collection, analysis, use, and management of fault information. It has put in place a system for identifying the causes of faults by collecting and analyzing fault

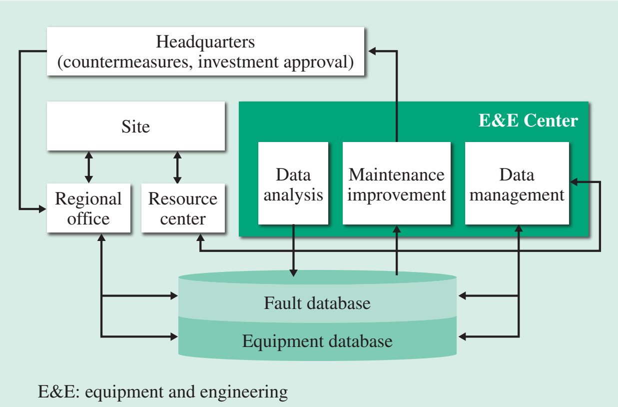

Fig. 4—Structure of E&E Center.
The E&E Center collects and manages distribution equipment information and analyzes it for potential equipment faults. The information is used for preventive maintenance.

information. It has also defined which maintenance management information needs to be stored, and established procedures for collecting fault information and analyzing causes together with flow charts that specify how it is to be used.

In particular, the center is responsible for identifying equipment weaknesses through the analysis of the major causes of faults, identifying issues with maintenance and management, and proposing things like revisions to maintenance, installation, and inspection methods; improvements to equipment; and training practices (see Fig. 4). The costs and benefits of proposed requirements are assessed to determine whether they should be implemented in practice and then deployed at each regional office.

Main Functions

The main functions of the E&E Center are as follows.

(1) Data management

The Center maintains and manages a database containing information collected by maintenance staff, such as details of equipment faults and inspection results. Data quality is checked periodically.

(2) Maintenance improvement

Information stored in the fault and equipment databases is used to consider improvements to patrols and inspections, work practices, reuse, and equipment specifications.

(3) Data analysis

This involves using large amounts of fault data to analyze the main causes of equipment faults and propose countermeasures.

CONCLUSIONS

This article has described the business challenges facing electric power distribution in North America, and their solutions. It has also described Hitachi's EAM system and the TEPCO E&E Center, both of which offer solutions to these challenges.

In the future, Hitachi intends to combine the IT used for EAM with the operational technologies of the E&E Center that are based on its maintenance schemes and know-how and offer it in the form of IT&OT systems that are customized for North America. In particular, Hitachi intends to contribute to things like the construction of smart grids and the reliable supply of electric power by deploying these together with consulting services that extend from identifying workplace issues to deciding what to do about them; and are based around maintenance and management services for dealing with aging power distribution equipment, which is the biggest challenge facing North America.

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Featured Articles

M2M Solutions that Use IT for Energy Efficiency and Comfort in Offices

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OVERVIEW: M2M communications, a field that has played an important role in the development of social infrastructure, makes extensive use of the Internet. Reflecting this trend, Hitachi has developed M2M solutions based on the Internet model specified in the IEEE 1888 international communication standard. The solutions feature seamless interconnectivity between infrastructure equipment and the services provided by ICT management systems; a database-centric architecture designed for use with web services; and superior flexibility, expandability, and speed. They also take advantage of this speed in the control of infrastructure equipment to contribute to the energy efficiency of buildings without compromising comfort. Similarly, the flexibility is utilized to minimize the need for new installations by facilitating the connection of existing equipment and other devices. An estimate of the cost savings achieved in buildings that adopt the solution indicates a payback period of three years.

INTRODUCTION

GROWTH in the market for machine-to-machine (M2M) communications since the late 1980s has been concentrated in particular niches such as the monitoring of infrastructure in commerce and industry.

Along with wider use of Internet technology in recent years, however, use of M2M technologies is expected to broaden to encompass applications that support public infrastructure. To achieve this, there is a need for solutions that, in addition to overcoming challenges such as improving productivity, are also designed for easy installation and future expansion.

This article presents an overview and gives examples of M2M solutions that focus on office productivity and on delivering both building energy efficiency and comfort.

M2M SOLUTIONS

Market Trend and Issues

Growth in the M2M market has been based on vertically integrated solutions designed for specific fields. Accordingly, the business model has focused on customization, bringing with it the associated problem of the high cost of adding and enhancing functionality.

Overcoming this problem will require a shift away from vertically integrated solutions toward horizontally integrated solutions that support interconnectivity.

This leads to the following three requirements:

(1) Use of an Internet model that supports interconnectivity and wide-area operation.

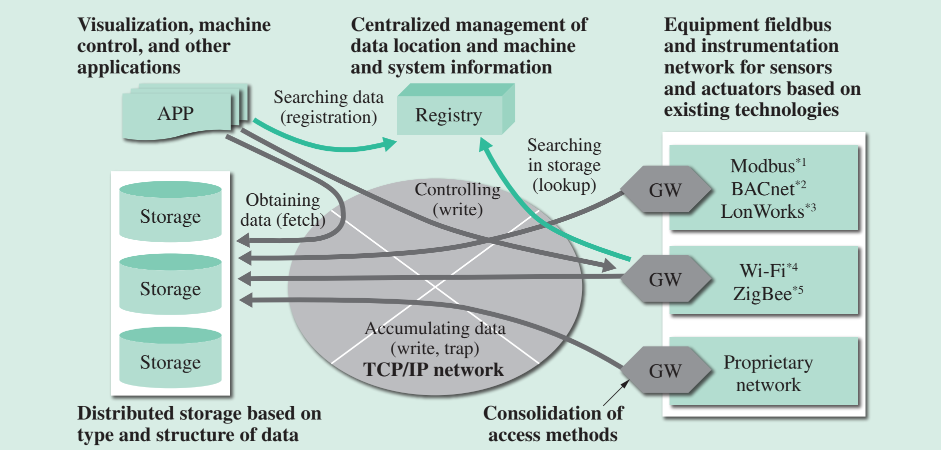
(2) Integration of standards and existing systems.

(3) Database-centric architecture with centralized management of information collected from sensors.

Architecture and Features

To develop solutions that satisfy these requirements, Hitachi has adopted the IEEE 1888 international communication standard. IEEE 1888 was developed by the Green University of Tokyo Project[1] (GUTP), an industry-academia consortium, and formalized as an international standard in 2011. It standardizes multi-vendor interconnectivity between equipment and applications used in building energy management systems (BEMSs).

The IEEE 1888 standard defines four functions for the efficient collection and management of the large amounts and different types of information from sensors in ways that take account of equipment control. The "gateway" function is used to deal with differences between existing systems and



APP: application TCP/IP: Transmission Control Protocol/Internet Protocol GW: gateway
*1 Modbus is a trademark or registered trademark of Schneider Electric and/or such related companies.
*2 BACnet is a registered trademark of American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
*3 LonWorks is a trademark of Echelon Corporation registered in the United States and other countries.
*4 Wi-Fi is a trademark of Wi-Fi Alliance.
*5 ZigBee is a trademark for the ZigBee Alliance.

Fig. 1—Architecture of IEEE 1888.
The storage, gateway, and application functions provide the write, fetch, and trap communication protocols and the registry function provides registration and lookup.

communication protocols, and to make sensor data available on the Internet. The large quantity of sensor data collected via the gateway is then stored on the Internet for long-term archiving (the "storage" function). "Applications" are used to visualize data and for processing, analysis, and control. The "registry" manages the distributed components of the system such as gateways, storage, and applications (see Fig. 1).

Intended for systems that handle time-series data, IEEE 1888 uses a simple protocol based on the reading and writing of time-stamped data using extensible markup language (XML) and the simple object access protocol (SOAP). Its features include high development productivity, ease of data administration and use, suitability for multi-vendor applications, and the flexibility for use in large systems.

Use at Hitachi Omori 2nd Building

Hitachi Information & Telecommunication Engineering, Ltd. initiated a proof-of-concept (PoC) experiment to test the M2M solution on one of its own buildings in 2012[(2)]. In July of the same year, Hitachi also started full commercial operation of an energy efficiency system for air conditioning control and data visualization at its Hitachi Omori 2nd Building (O2 Building) in the Shinagawa district of Tokyo.

One of the concerns when installing an energy efficiency system is that it might damage productivity by subjecting office staff to unpleasant levels of heat or cold. Accordingly, the objectives for the project included improving comfort levels inside the building as well as cutting energy costs. The project also set a return on investment target of three years to assess the system installation costs.

Since the O2 Building has multiple air conditioning units, rather than replace these with energy-efficient models, the upgrade involved fitting information and communication technology (ICT) to the existing systems to provide information on energy use and environmental conditions and to allow integrated management.

System Configuration

Fig. 2 shows the overall system configuration. In addition to the use of Hitachi products, existing building systems were used wherever possible.

Temperature, humidity, and carbon dioxide (CO_2) density measurements transmitted via ZigBee wireless systems (an environmental sensor network system manufactured by Hitachi, Ltd.) installed on each floor, and energy use information from meters installed on the air conditioners, were collected on a 1888 gateway server [a Hitachi personal computer (PC) server] via 1888 gateways (floor controllers manufactured by Hitachi Information & Telecommunication Engineering, Ltd.) and analyzed using a data visualization tool from Hitachi Plant Services Co., Ltd. The analysis results were then used as the basis for on/off control of air conditioners manufactured by Hitachi Appliances, Inc., which was performed via digital input/output (I/O) modules by an air conditioning

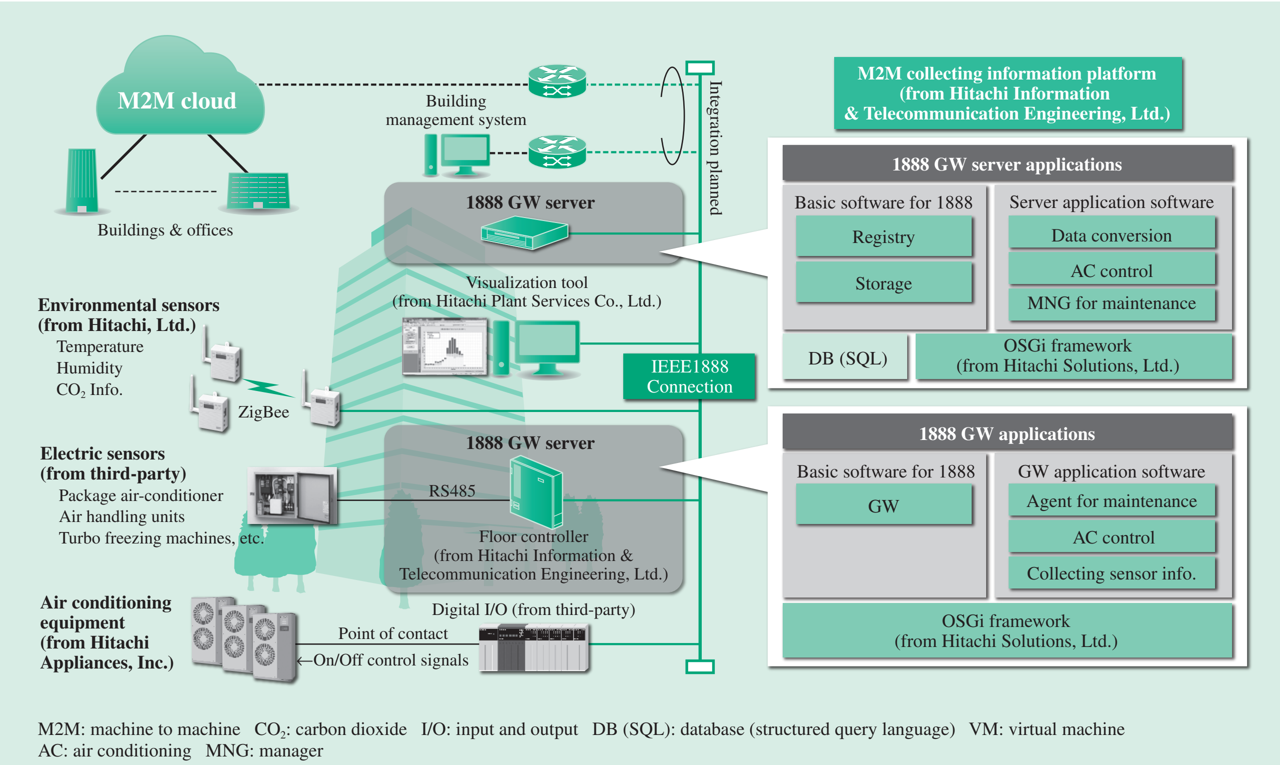


Fig. 2—Configuration of Energy Efficiency System for O2 Building and 1888 GW Software.
The installation cost was kept to a minimum by using existing products and minimizing customization, with new applications only being developed for the 1888 GW server and 1888 GWs.

control application on the 1888 gateway server. The O2 Building project included the installation of 188 sensors, with a total of 896 measurement points. Collecting environmental data with the sensors and measuring points helped to achieve great degrees of comfort inside the O2 Building.

The M2M data collection platform was an IEEE 1888 component developed by Hitachi Information & Telecommunication Engineering, Ltd. and ran on the 1888 gateway server and 1888 gateways. The management platform was an OSGi*6 framework from Hitachi Solutions, Ltd.

DEVELOPMENT TECHNIQUES

Energy Efficiency Control Techniques

The O2 Building has both a central building air conditioning system, installed at the time of construction, and a number of standalone air conditioners that were retrofitted at later times as required. While the central air conditioning system included a control system for energy-efficient operation, control of the standalone air conditioners was largely left to users, with only a subset of functions being controlled from the central operation room.

Accordingly, when considering scenarios for how to reduce energy costs, the focus was on control of these standalone air conditioners rather than on the central system. Since the central system is less energy efficient than the standalone systems, energy costs were successfully reduced and the building-wide air conditioning efficiency was enhanced by making more use of the standalone systems and less use of the central system (see Fig. 3).

The specific scenario involved reducing energy use by changing the cooling water temperature and air blower settings for the central system while using the standalone systems to make up for any resulting deterioration in the indoor environment. In addition to this compensatory role, intermittent operation of the standalone systems based on environmental information was also used to reduce their energy use.

The operation also utilized the availability of energy and environmental data to identify waste and take appropriate countermeasures. An operational committee comprising the facility administrator, operators, and human resources and accounting staff was established to work through the plan, do, check,

*6 OSGi is a trademark or a registered trademark of the OSGi Alliance in the United States, other countries, or both.

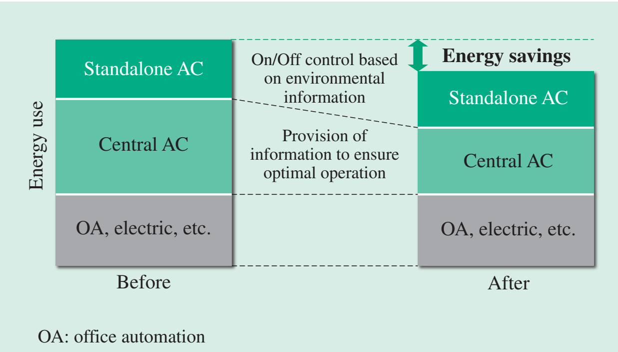


Fig. 3—Energy Saving Scenario for O2 Building.
Energy use by the central air conditioning system was reduced through measures such as changing the cooling water and air blower temperature settings and through intermittent operation of the air conditioners. The increased energy use resulting from more frequent use of the standalone air conditioning systems was minimized by using intermittent operation based on environmental information collected by the system.

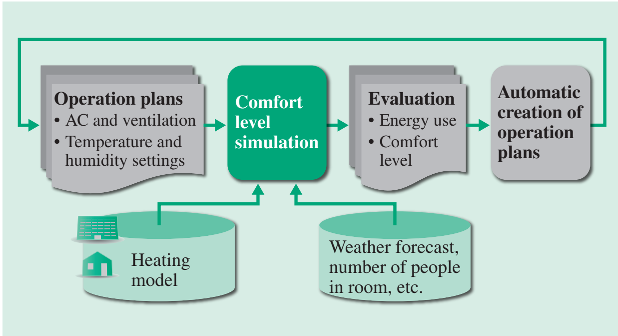


Fig. 4—Comfort Control Algorithm.
A rough operation plan is generated the day before based on the forecasted external air temperature. The plan is then updated at 30-minute intervals during the day based on actual environmental information.

and act (PDCA) cycle of formulating an operating plan (plan), implementing it (do), checking the outcomes (check), and revising the operation (act).

Techniques for Improving Environment

Using the temperature sensors on each floor to calculate and display average floor temperatures demonstrated that significant temperature differences existed. To address this issue, the settings on the central system were adjusted to minimize these differences.

Techniques for Controlling for Comfort

While BEMSs are intended to deliver major benefits through the well-balanced control of air conditioning systems, being designed to deliver both energy savings and a better environment, the initial installation costs are high. As a result, they are mainly installed in large new buildings(3) rather than in existing buildings.

To install a BEMS in an existing building such as the O2 Building, Yokohama Research Laboratory, Hitachi, Ltd. and Hitachi Information & Telecommunication Engineering, Ltd. represented the procedures for combining energy efficiency with comfort in the form of a knowledge-base and used this to develop comfort control algorithms that feature both lightweight and a wide range of applications(4) (see Fig. 4).

This uses the following framework:
(1) Prepare a range of operation plan options for the building.
(2) Use a comfort level simulator to predict the outcome of each operation plan.
(3) Evaluate the operation plans and select the best plan that combines comfort and energy savings.
(4) Implement the selected plan in the building.

This succeeded in producing an air conditioning operation plan that combines comfort and energy efficiency by using procedures for predicting power consumption and comfort level changes that require a minimal amount of mathematical operations.

EVALUATION AND RESULT OF ADOPTING THE SYSTEM

Ability to Combine Energy Efficiency and Comfort

The energy savings from installing the system in this building, which includes both central and standalone air conditioning systems, are anticipated to be up to 14%.

Moreover, providing information on average floor temperatures reduced the floor-to-floor temperature differences from 3.5°C to 2.3°C, and reduced the maximum average room temperature from 27.5°C to 26.9°C. The improvement in comfort during working hours was also demonstrated in terms of the temperature-humidity index (an indicator of room comfort level) (see Fig. 5).

Ease of Installation

Hitachi succeeded in reducing the cost of equipment by adopting IEEE 1888 to facilitate interoperation with existing systems and the continued use of existing communication standards and equipment. Since installation primarily involves information technology (IT) equipment, it can be completed without interfering with business operations in the building.

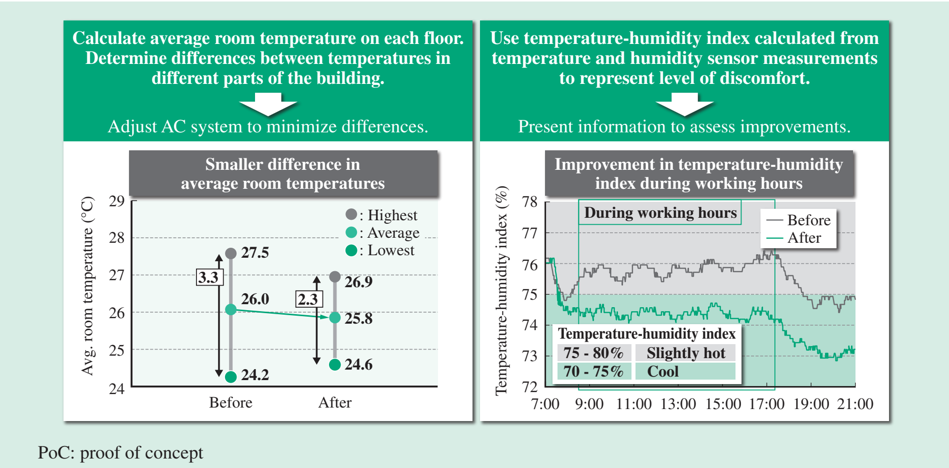


Fig. 5—Improvement in Office Environment.
The PoC experiment successfully combined energy efficiency and comfort, and succeeded in reducing both the difference in average temperatures between workplaces and the level of discomfort in the workplace (as measured by the temperature-humidity index).

As a result, installation was completed only two and a half months after receiving the order, with an anticipated investment payback period of only three years based on the energy savings described above.

System Expandability

While the example described here involves installing the system in a single building, there is also potential for the centralized management of multiple sites over a wide area.

Specifically, Hitachi Systems, Ltd. has developed a cloud-based system that uses its own M2M network services[5]. Hitachi Systems, Ltd. has demonstrated that the system can provide seamless centralized management of sites that are spread across the world by utilizing the Internet compatibility of IEEE 1888. The plan for the future is to expand the scope of integration with other Hitachi services and products in response to customer needs.

CONCLUSIONS

This article has described work on a horizontally integrated M2M solution that uses IEEE 1888.

Its major feature is the flexibility to connect existing infrastructure and sensors together with ICT management systems that supply a variety of services. This is based on the use of an open Internet model with a wide range of applications, providing rapid system configuration and the expandability to progressively roll the system out to buildings at distant locations.

It also supports use of the combined analysis of different types of data to provide timely feedback control from a nearby location, as demonstrated in the proof-of-concept test of energy efficiency and comfort control.

Hitachi believes that its M2M solution can meet the needs of customers, not just in energy applications, but in any field where its flexibility, expandability, and speed will be of benefit.

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Featured Articles

Spatial Data Management for More Advanced Facility Management

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OVERVIEW: While urban, venue, and retail spaces are becoming increasingly sophisticated and complex, this progress is taking place without an understanding of what is actually happening on the ground, and therefore improving the sophistication of the IT and other social infrastructure that provides ongoing support for this activity poses a challenge. Hitachi is working to build a society that combines economics with safety and security by accelerating innovation in IT and other social infrastructure using spatial data management platforms that collate and manage a variety of information on the makeup of public spaces to determine what is happening in these spaces, now and in the immediate future, and providing this information as feedback to the infrastructure.

INTRODUCTION

THE urban, venue, and retail spaces in which people go about their activities are becoming increasingly sophisticated and complex. The behaviors of the people who use these spaces are continually changing. For example, it is a regular occurrence for small changes, such as a specific advertisement or an accident in some distant location, to have a major effect on the movement of people.

However, the information technology (IT) and other social infrastructure that provides ongoing support for these spaces operate in accordance with predicted or planned numbers, and improving their sophistication to the extent that control can be performed based on the actual situation on the ground poses a challenge.

Crowding in railway stations is a familiar example. This crowding can arise for a variety of reasons, such as an accident on another line or at some other distant location, and frequently results in a buildup of people on platforms at other stations. If it were possible to identify indications in the movement of people before this unfolding situation occurs, and to predict what will happen next so that appropriate measures such as limiting entry to the station can be implemented before the situation worsens, it should be possible to improve safety and security.

This has created a need for the establishment of new methods for dealing with spaces, people, and social infrastructure that combine economics with safety and security by making quantitative assessments of ever-changing public spaces and the behavior of the people who use them, and providing this as feedback to IT and other social infrastructure.

WAYS OF DEALING WITH SPACES AND PEOPLE

This section uses commercial facilities such as shopping centers or large exhibition venues as examples to describe methods for dealing with spaces and people.

When dealing with spaces and people at commercial facilities, the influence those spaces have on people can be broken down into the following three processes (see Fig. 1).

(1) Attracting people to the space (pulling power)
(2) Getting people to stay and look around (holding power)
(3) Encouraging people to make purchases (sale-closing power)

By breaking down the influences that spaces have on people in these terms, and by identifying what is currently happening in each process, it becomes possible to take appropriate steps to achieve the desired outcomes.

ACTIVITIES BY HITACHI AND POSSIBILITIES IDENTIFIED

To provide examples of pulling power, holding power, and sale-closing power when considering these as methods for dealing with spaces and people, the

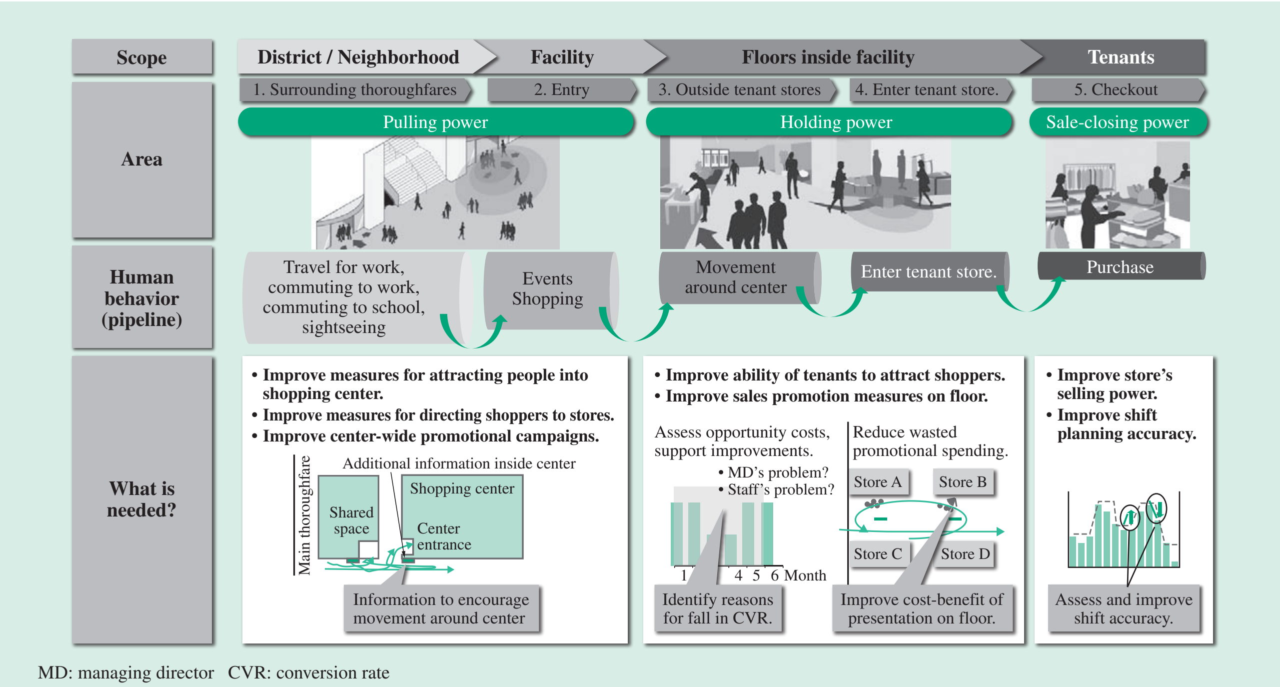


Fig. 1—Behavior Model for Inside a Shopping Center.
By using quantitative assessment to identify behavioral tendencies in the different processes that lead up to a purchase at a shopping center, appropriate measures can be taken to deal with each process.

following section describes the measures taken at Hitachi Innovation Forum 2013, a large trade show.

Activities by Hitachi

Hitachi Innovation Forum 2013 was a Hitachi Group trade show staged over three days at a 5,000-m^2 venue, attracting more than 40,000 visitors.

Sensors were installed at 13 locations inside the venue to measure the behavior of people in realtime and provide "visibility" as to what was happening there. Effectiveness measurements were made of the venue's pulling power, holding power, and sale-closing power, and this "visibility" was utilized to work through the plan, do, check, and act (PDCA) improvement cycle.

Pulling Power: Ability of Event Staging to Attract Visitors

Since the Forum is intended for promotion, its ability to inform people about Hitachi's products is an important management indicator. Accordingly, how effective events (measures taken to attract visitors to each of the spaces at the Forum) were at attracting visitors was assessed by defining key performance indicators (KPIs) for pulling power, namely the number of visitors and whether they stayed for long (ability to attract visitors = total time spent by visitors at the event) (see Fig. 2).

The analysis of the ability of each event to attract visitors found that their effectiveness varied widely depending on their location within the venue. In particular, while venue-wide events naturally have the greatest ability to attract visitors, being large and located close to the entrance, events 1 to 3 were all located along the same main thoroughfare and the analysis found that their ability to attract visitors diminished the farther into the venue they were located. This demonstrates that, for the same outlay, the cost-benefit varies widely depending on location at the venue.

Next, an analysis of the behavior of visitors to the venue-wide events with the greatest ability to attract visitors indicated that people moved in ways that were not originally envisaged. The venue is designed such that visitors who pass through the entrance will follow a one-way route that first takes them past the venue-wide events and then into the venue interior. However, an analysis of changes in people entering and exiting (moving in the opposite direction) at the start of an event found that, contrary to expectations, within three minutes of it starting, people were moving back through the venue in the opposite direction and gathering in groups from a radius of about 20 m around the event. It was calculated that 66% of all visitors turned around to go back to the venue-wide event.

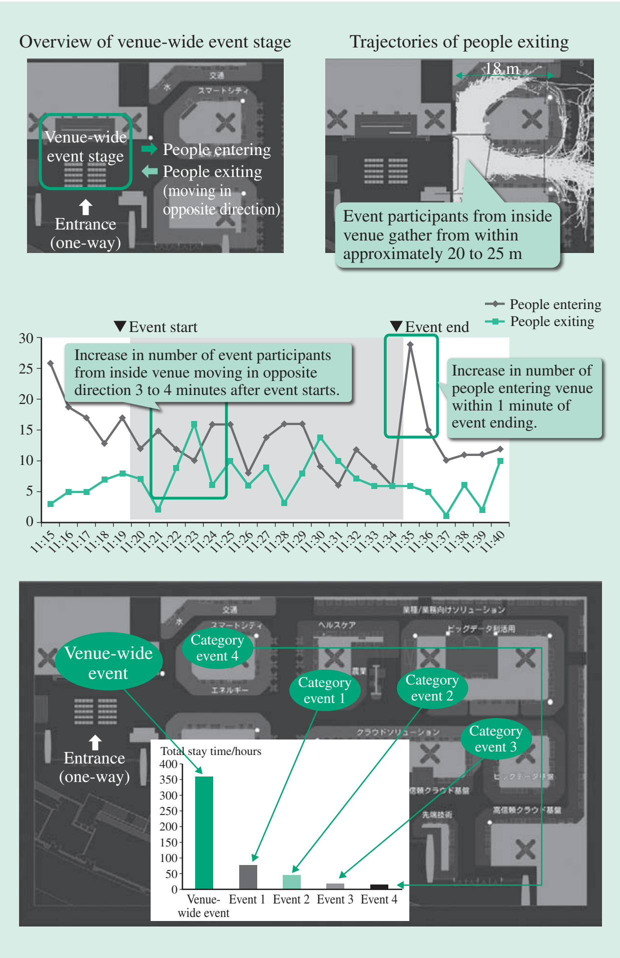


Fig. 2—Pulling Power (Assessment of Ability of Venue-wide Events to Attract Visitors).
It is possible to undertake a quantitative assessment of factors such as the ability of venue-wide events to attract visitors, the time taken for the attracted visitors to gather, and the extent to which they gather.

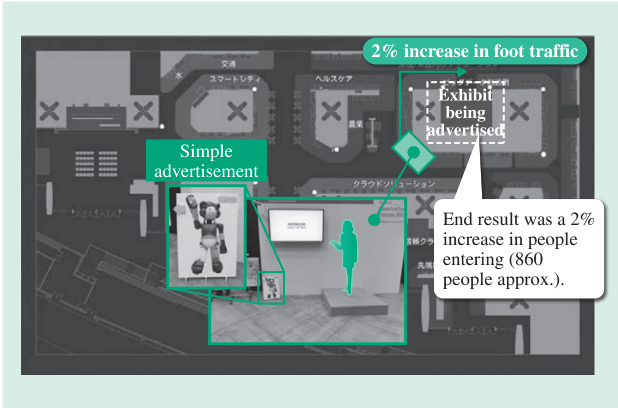


Fig. 3—Holding Power (Ability of In-venue Advertising to Bring Visitors to Exhibits).
The best places to locate advertisements encouraging people to visit a particular exhibit can be determined by analyzing the movement of people through the venue.

Holding Power: Looking around and being Guided through Venue

Similar to tenants at a shopping center, the Forum was organized by exhibitors paying the venue for the right to exhibit. Accordingly, in addition to the ability to attract visitors to the venue, the extent to which visitors were directed to each exhibit (tenant) (ability to bring visitors to an exhibit = proportionate increase in number of visitors passing exhibit) was defined as one KPI for holding power and used to assess the effectiveness of promotional activities at bringing visitors to exhibits (see Fig. 3).

Specifically, to measure how effective measures were at bringing visitors to exhibits, an experiment was conducted to assess the level of benefit achieved by a simple advertisement promoting a specific exhibit. The movement of people through the venue was analyzed to identify the main thoroughfares and an intersection was chosen as the best place for an advertisement. As a result of this choice, it was found that the intersection (shown as the colored box in the figure), which was some distance from the exhibit being advertised, acted as a branch point in people's movements. Although proceeding in the upward direction from the intersection (in terms of the map in Fig. 3) would quickly bring a visitor to the exhibit, only a very small 18% of visitors turned in the way intended.

When a simple advertisement was placed at the intersection to counter this, the number of people turning increased by 6% (to 24%), resulting in a 2% increase in the ability to bring visitors to the exhibit (2% increase in foot traffic past the booth). This demonstrates that advertising at facilities such as shopping centers can achieve a high cost-benefit ratio if an appropriate location is chosen.

In another approach to holding power, meanwhile, an assessment of which factor had a large impact on the ability of exhibits to attract visitors found that it was the layout of the venue (see Fig. 4).

The analysis found that exhibits located opposite places where the layout protruded into a thoroughfare were seven to 20 times better at attracting visitors than other exhibits, and that the number of visitors diminished the farther away an exhibit was from the protrusion. This demonstrated that layout is a major factor influencing the ability of exhibits at a venue to attract visitors. Although this is something that has been known empirically, the quantitative analysis and assessment have reinforced this conclusion.

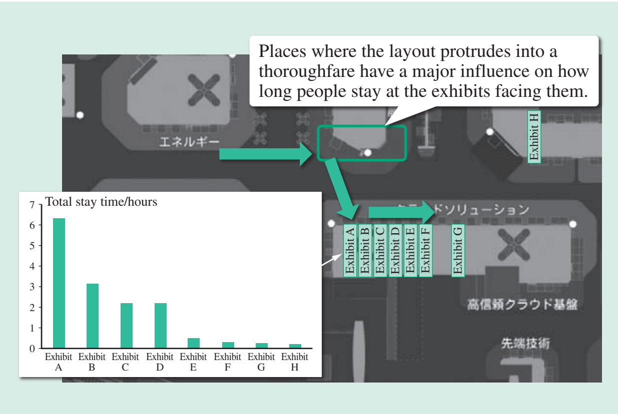


Fig. 4—Holding Power (Effect of Layout on Ability to Attract Visitors).
An analysis of how people move and gather at a venue found that places where the layout protrudes into a main thoroughfare have a significant influence on the ability of the exhibits facing them to attract visitors.

Sale-closing Power: Encouraging Visitors to Enter Exhibit

At a shopping center, sale-closing power means the ability to get a shopper to enter a store and make a purchase. Accordingly, for this example, the KPI for sale-closing power was defined as whether potential visitors passing an exhibit are persuaded to enter (number of visitors entering exhibit as a proportion of passing foot traffic), and the PDCA cycle was worked through to make improvements to a display at the entrance to the exhibit, while monitoring in realtime the proportion of passers-by who entered. What was found was that the simple measure of placing a desk with pamphlets in front of the exhibit increased this proportion by about 4%, and that this was sustained over two days (see Fig. 5).

PDCA and Feedback for Venues

These experiments assessed the effects that venues have on people by breaking them down into the pulling power, holding power, and sale-closing power processes, and demonstrated that even small improvements can deliver benefits by working through the PDCA cycle in an appropriate manner.

Hitachi utilized the knowledge obtained from these experiments at Hitachi Innovation Forum 2014, which involved implementing the PDCA cycle for the venue (see Fig. 6). While a variety of measures had been adopted based on the knowledge gained in 2013, in addition to working through the PDCA cycle for a physical space, Hitachi also intended to have visitors try out how this could be done in tandem with social

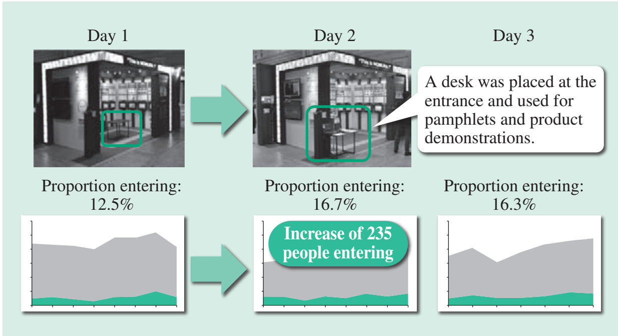
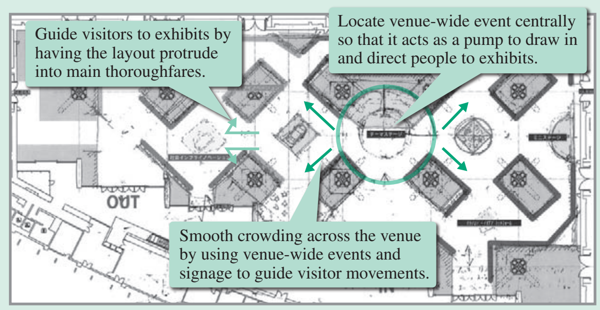


Fig. 5—Sale-closing Power (Increase in Proportion of Visitors Entering Exhibit due to Promotion of Exhibit).
Small changes in an exhibit's display can produce a sustained increase in the proportion of passers-by who enter the exhibit.



PDCA: plan, do, check, act

Fig. 6—Working through PDCA Cycle for Venue.
The analysis of human behavior at a venue can be used as a basis for working through the PDCA cycle to identify the most effective factors and decide what to do next.

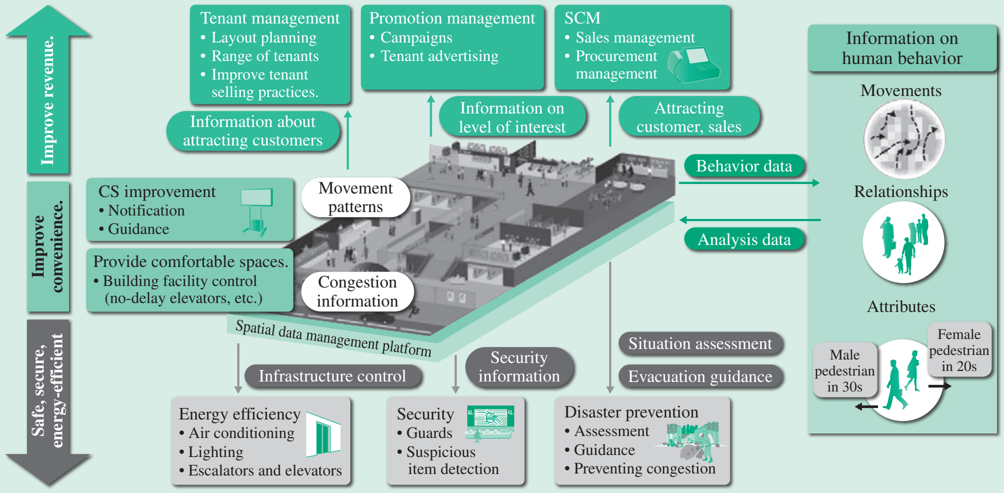
infrastructure in the form of Hitachi's Intelligent Operations, which will be used to create future public spaces.

CONCLUSIONS

This article has described methods for making improvements at venues by using a variety of techniques to determine what is currently happening on the ground, something that could not previously be measured.

Hitachi plans to launch a spatial data management service in FY2015 that will collate this analytical know-how and present the results of analyzing such things as promotion effectiveness and the state of health of tenants to customers in the fields of retail center development, tenant management, and the management of joint sales promotions.

Hitachi also plans to create smart public spaces by integrating with new services that deliver higher levels of safety and security. This includes contributing



SCM: supply chain management CS: customer satisfaction

Fig. 7—Smart Venues.
Facility management and venues can be made smarter (such as becoming more energy-efficient) by linking human behavior at a venue to various different business systems and other social infrastructure.

to reducing center-wide energy costs and improving customer satisfaction (CS) by utilizing information obtained from the analysis of human behavior at retail centers in tandem with social infrastructure such as air conditioning, elevators, and escalators, and taking pre-emptive measures to prevent congestion at venues by determining the current situation, predicting how it will develop, and using this information together with signage or other means of directing the movement of people (see Fig. 7).

Meanwhile, as these practices become practical, it also raises the importance of privacy measures. Hitachi is strengthening measures for privacy protection in public spaces and incorporating these into services and solutions so that customers and partner companies can feel more confident about utilizing data without concern for privacy breaches.

In the future, Hitachi intends to work in cooperation with partner companies to help create a better society, not only through analysis but also by including improvements to physical spaces in what it offers to users.

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Featured Articles

City Management Platform Using Big Data from People and Traffic Flows

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Yusuke Mishina
Takayuki Akiyama
Naoyuki Taniguchi

OVERVIEW: In cities in Japan and elsewhere, progress is being made toward the creation of smart cities, with demands for the optimization and efficient operation of social systems that include more sophisticated transportation systems, reductions in CO_2 emissions, and the upgrading of aging infrastructure. The widespread adoption in recent years of technologies such as smartphones, smartcards, and various sensors has made it possible to collect, store, and visualize information on urban activities such as people and traffic flows. As part of its Intelligent Operations, Hitachi is developing city management platform solutions that support the efficient operation of cities by collecting and analyzing this big data from people and traffic flows.

INTRODUCTION

IN cities in Japan and elsewhere, there are demands for the optimization and efficient operation of social systems that include more sophisticated transportation systems, reductions in carbon dioxide (CO_2) emissions, and the upgrading of aging infrastructure. Hitachi operates its Social Innovation Business that seeks to create sustainable smart cities, seeing it as one response to these diverse requirements of cities.

The widespread adoption in recent years of technologies such as smartphones, smartcards, and various sensors has made it possible to collect, store, and visualize information on urban activities such as people and traffic flows. While information on these flows has in the past only been provided in the form of public statistics released once every few years, it is anticipated that providing 365-day availability will expand those sectors that use this information. For example, in addition to administrative areas like urban planning and tourism, it will enable operators of public transportation such as trains and buses to make traffic management more efficient. As part of its Intelligent Operations, Hitachi is developing city management platform solutions that support the efficient operation of cities based around the use of big data from people and traffic flows.

This article describes the concepts behind city management platforms, examples from Japan and overseas, and the prospects for the future.

CONCEPTS BEHIND CITY MANAGEMENT PLATFORMS

Fig. 1 shows the concepts behind city management platform solutions. People and traffic flow data is collected from a variety of social infrastructure operators using technologies such as smartphones, smartcards, and sensors. Similarly, statistical information such as facility data, traffic census data, and population statistics is sourced from national and local governments. This collected data is stored and analyzed on a city management platform database. While the platform is based on geospatial information system technology, it needs to be able to conduct a variety of analyses in terms of time and spatial parameters. Another feature of the platform is that it can model the collected data and use various types of simulation for its visualization.

The benefits provided by the city management platform consist of: (1) convenience and efficiency, (2) profitability and economics, and (3) safety and security. Specific examples of potential applications in the public transportation sector, which includes trains and buses, include the optimization of public transportation and integrated navigation to support smooth multi-modal travel. Possible examples in the tourism and retail sectors, meanwhile, include the analysis of business regions, and effective ways of presenting information based on the analysis of people's patterns of movement. Other possibilities include urban and residential applications for

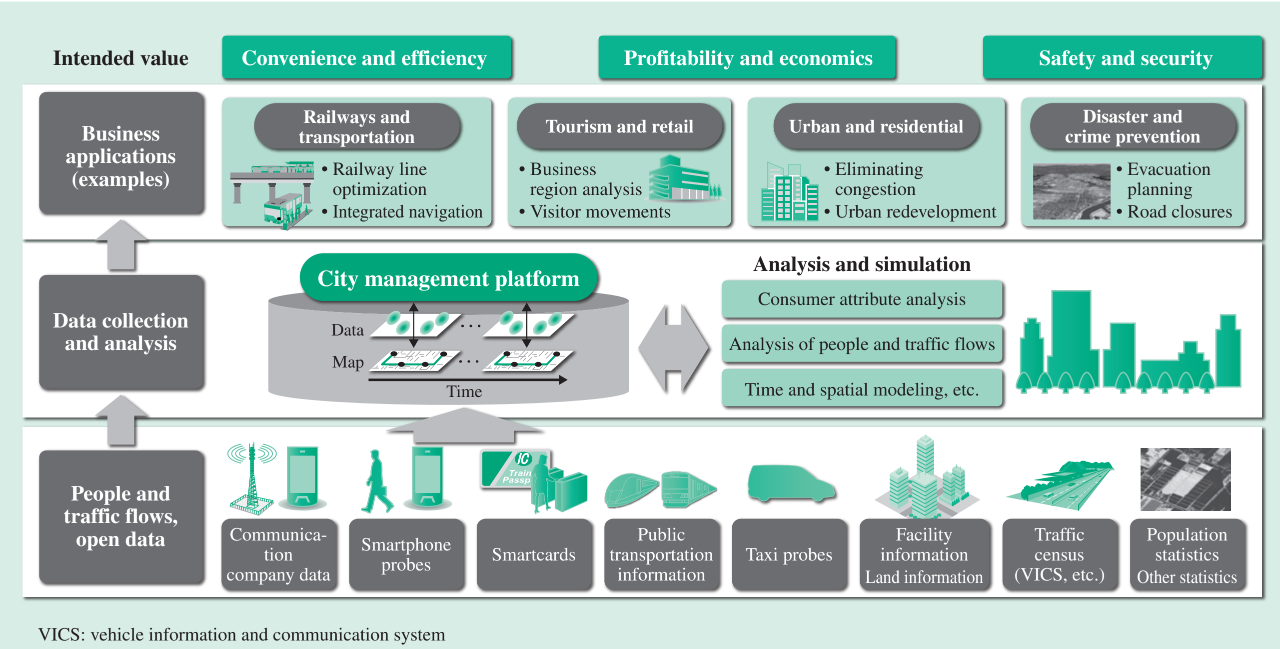

Fig. 1—City Management Platform Solution Concept.
The solution uses smartphones, smartcards, and sensors to collect real-world big data from people and traffic flows. City management platforms based on data collection and analysis are equipped with geospatial information system technology and support the operation of cities using modeling and visualization.

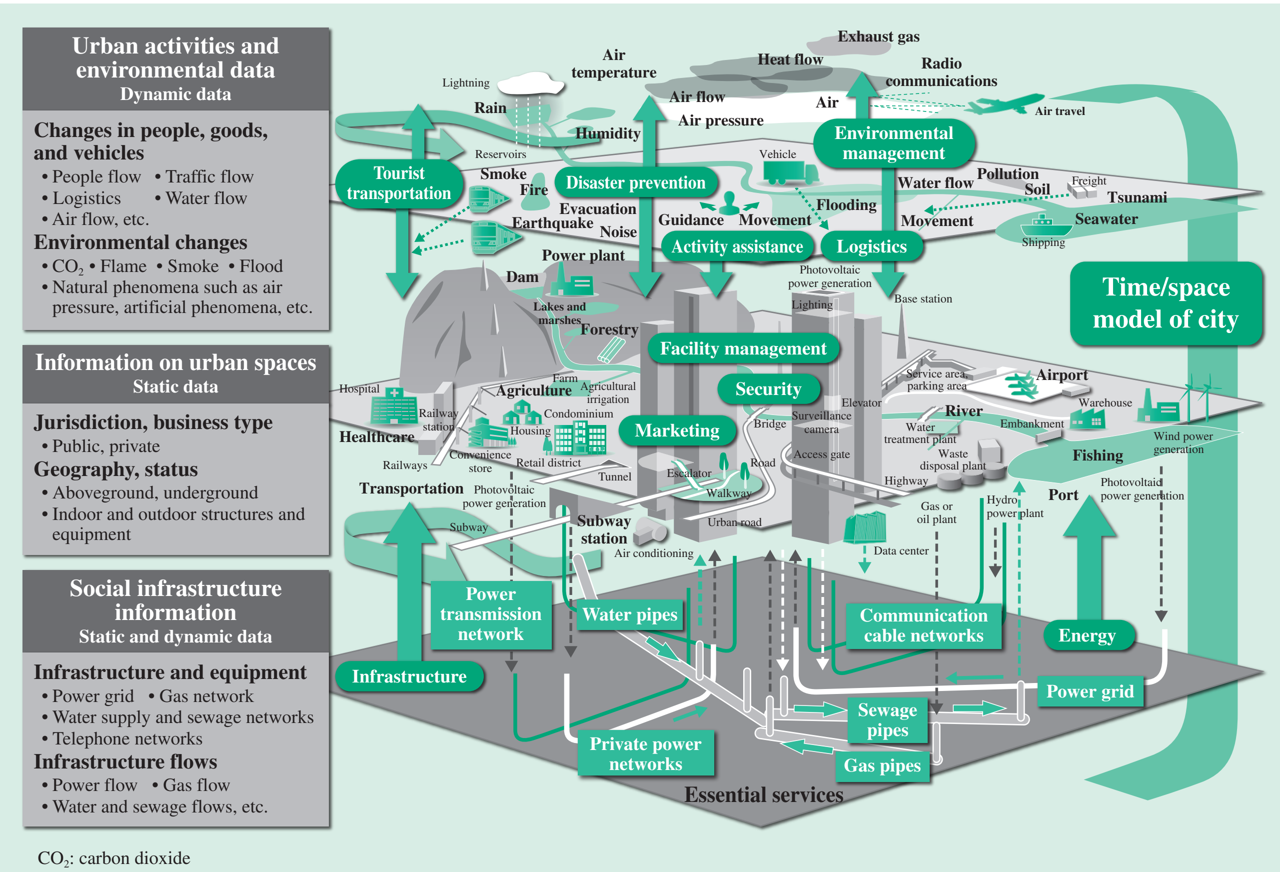

Fig. 2—Three-tier Model of Urban Big Data.
A data model for urban big data. The lowest tier consists of the platforms that support social infrastructure, and the middle tier consists of the urban spaces that are built on this infrastructure, such as buildings, roads, and dams. The top tier consists of dynamic data that is used in urban spaces, such as people and traffic flows.

overcoming traffic congestion or assisting with urban planning, and disaster and crime prevention applications that support evacuation planning or determine road closure information.

A three-tier model can be used for databases that collect and analyze a variety of different forms of big data from cities (see Fig. 2). At the lowest tier are those platforms that support social infrastructure such as the electric power grid or gas, water, and sewage networks. The middle tier contains urban spaces, particularly buildings, roads, dams, and other facilities that are built on this infrastructure. The top tier consists of dynamic data that is used in urban spaces, and it is to this tier that people and traffic flows belong.

EXAMPLE USES OF CITY MANAGEMENT PLATFORMS

Smartphone Probe Demonstration Project in Fukuoka

In 2011, Fukuoka City established the Fukuoka Directive Council, a partnership between industry, academia, government, and the private sector, to formulate a growth strategy for the Fukuoka City region and to investigate smart city policies. The council is made up of five working groups (tourism, environment, food, human resources, and urban development), with Hitachi being mainly involved with the environment working group, including participation in vision-building and demonstration projects aimed at making the Fukuoka City region a leader in smart mobility.

In FY2013, the environment working group undertook a demonstration project for using smartphone probes to obtain information on "people flow." Fig. 3 shows an overview of the project. Project participants who had consented to the collection of their personal data (200 people associated with the Fukuoka Directive Council) were given smartphones and the Hayakaken smartcards issued by the Fukuoka City Transportation Bureau and had their movements recorded for a one-week period in late January 2014. The smartphones were pre-installed with an application that collected global positioning system (GPS) and accelerometer data. With the cooperation of the Fukuoka City Transportation Bureau, the project also collected data from the smartcards on where users got on and off the subway. This data was obtained after the trial period had finished. To visualize information on people's movements, the route traveled and means of transportation were determined automatically from the smartphone GPS and accelerometer data. In the case of subway rides where GPS signals cannot be received, the information was obtained from the smartcard trip records. The demonstration project automatically classified trips into four categories (walking, bus, subway, or other means of transportation).

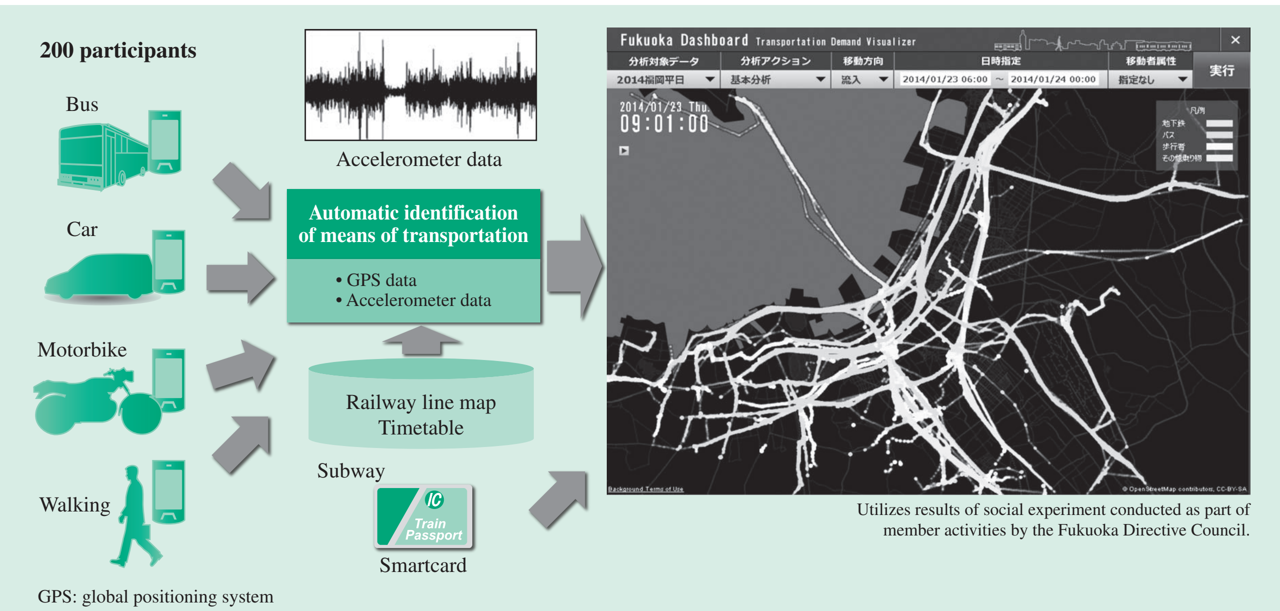

Fig. 3—Overview of Smartphone Probe Demonstration Project in Fukuoka.
The diagram shows an overview of a demonstration project conducted in January 2014. Smartphones and public transportation smartcards were issued to 200 people who acted as monitors and their movements were analyzed over the period of a week.

Fig. 4—Dashboard Screen for People Flow Analysis.
The screen shows a people flow analysis conducted using smartphone probe data. The screen can be used to analyze the numbers of people gathering in particular areas and the means of transportation they used to get there.

The right of Fig. 3 shows a dashboard screen that can be used to present and analyze the demonstration project results. It is designed so that it can be used by the government, infrastructure operators, and others to conduct basic analyses such as showing people's movements, means of transportation, and other information for each time period, or showing the differences between weekdays and holidays.

Fig. 4 shows a dashboard analysis screen. The screen is intended to provide information that is easy to understand and visualize, and can be used by government administrators and others, with the main analysis items being the distribution in the numbers of people gathering in a particular area at different times of the day from morning to evening, their length of stay, and the means of transportation they use to reach the area. The Fukuoka Directive Council showed the dashboard screens produced by the demonstration project to various departments at the Fukuoka municipal government. City officials identified a wide variety of fields with potential applications. These included providing additional data for person-trip studies; use in assessing the current status of vehicle transportation and associated policy-making; and use in meeting, incentive travel, convention, and exhibition (MICE) promotional work to identify what people do when they visit Fukuoka, and to study ways of providing information. Possible uses in the private sector include both use by public transportation operators to make timetables more convenient, review lines and stops, or optimize the locations of station and other staff, and also use by distribution businesses to analyze business regions or customers who are likely to make purchases.

Taxi Probe Demonstration Project in Bali

The province of Bali in the Republic of Indonesia is experiencing worsening traffic congestion, a common problem among members of the Association of Southeast Asian Nations (ASEAN). This is due to economic development triggering a rapid increase in vehicle use by the local population, and chronic traffic congestion in the vicinity of the Denpasar International Airport transportation hub. This was the background to a joint-venture (JV) demonstration project conducted by Japanese companies as part of an FY2012 project funded by the Ministry of Economy, Trade and Industry to promote and study infrastructure system exports. The project aimed to deploy Japanese smart community technologies that use intelligent transport systems (ITSs) to relieve congestion in Bali and to promote its tourist industry by making it easier to travel between tourist sites. Hitachi participated in the system implementation, primarily through the generation of congestion information.

The demonstration project obtained GPS data from 300 vehicles operated by a local taxi company. The data was analyzed to calculate parameters such as travel times and speeds for each section of road and the required time for a particular choice of route. Fig. 5 shows an example of the travel times for each section of road displayed on a map. Techniques for

Fig. 5—Results of Traffic Information Generation Trial during Bali Demonstration Project.
GPS data from a local taxi company was analyzed off-line to calculate parameters such as travel times and speeds for each section of road and the required time for a particular choice of route.

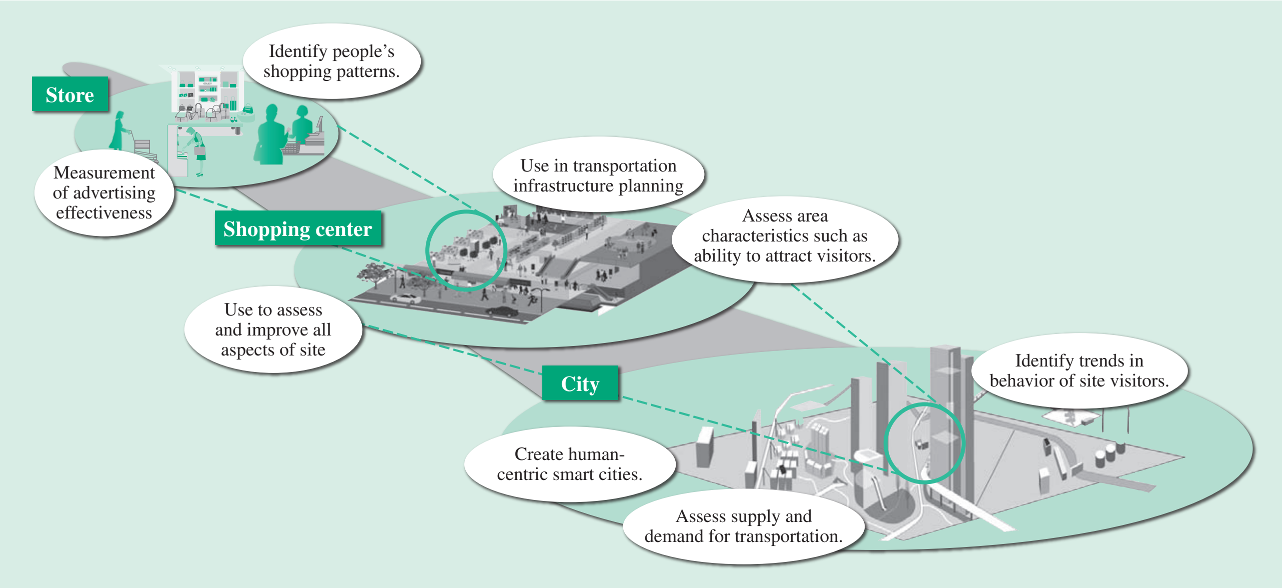

Fig. 6—Seamless Analysis of People Flow, from City to Indoor Level.
There are growing expectations for the use of big data on people and traffic flows on a range of different scales, from localized indoor spaces to large areas of a city.

map-matching the GPS data to the road network and calculating the speeds were used to present the speed on each section of road in color-coded format (green for moving freely, yellow for congested, and red for stationary). The project also selected routes between major tourist sites and compared mean travel times that took account of congestion information at key times such as in the morning, midday, or evening. When approximately 200 local users were surveyed about the idea of providing this information by smartphone or other means, 45% responded that they would use such a service even if they had to pay for it. This demonstrated the demand for this traffic information.

FUTURE PROSPECTS

This section describes where Hitachi intends to go next with its city management platforms based around big data from people and traffic flows.

(1) Extending use of personal data

It is anticipated that society's systems will be capable of generating and storing ever larger quantities of data in the future. It is also anticipated that policies for the use of personal data by business will be clarified in the near future along with amendments to personal information protection laws in Japan.

Given these circumstances, Hitachi is working to improve analysis techniques and the speed of analysis, and to develop methods for analyzing large amounts of collected information to generate new value by identifying hidden relationships. In the future, Hitachi will seek to develop the systems that underpin the social system, including through the integration of big data analytics with the systems that control social infrastructure to assist people's activities, automate driving, and manage the supply and demand for transportation.

(2) Seamless people flow analysis, from city to indoor level

There are growing expectations for the application in a variety of fields of the ability of city management platforms to analyze the flow of people at various different levels, from indoor spaces to city-wide areas (see Fig. 6). People flow analysis can be used at retailers for purposes such as identifying people's shopping patterns or measuring advertising effectiveness. At venues or other facilities, it can be used to assess and improve all aspects of the facility, or to assess different areas for their ability to attract visitors, for example. Across an entire city, meanwhile, it has applications in urban development, such as determining the supply and demand for transportation or identifying trends in the behavior of people visiting particular facilities. Accordingly, Hitachi is seeking to develop the use of its city management platforms, not just by government but also in a variety of business and other fields, by providing seamless analysis of people and traffic flows across large areas of a city and also down to the level of facilities and indoor areas.

CONCLUSIONS

This article has described the concepts behind city management platforms, examples from Japan and overseas, as well as the prospects for the future.

Hitachi operates its Social Innovation Business for solving the problems faced by society with the aim of creating sustainable smart cities. In addition to the further development of city management platform solutions, Hitachi intends to work in collaboration with a wide range of users from both the public and private sectors to implement these in actual society.

ACKNOWLEDGEMENTS

The Fukuoka smartphone probe demonstration project described in this article received considerable assistance from the people involved at the Fukuoka Directive Council and Fukuoka municipal government. Similarly, the taxi probe demonstration project in Bali was conducted under an FY2012 project funded by the Ministry of Economy, Trade and Industry to promote and study infrastructure system exports. The authors would like to take this opportunity to express their sincere thanks.

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Featured Articles

More Advanced Use of Information in Retailing

—Hitachi's Solution for Analyzing Distribution Data—

Hideki Negishi
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Naoya Sugiyama
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Kazumasa Tashima

OVERVIEW: With retail facing increasingly difficult business conditions, consumer purchasing behavior is becoming more diverse and segmented, and the amount of information required is growing in size. While the retail industry has a need for the analysis of customer information, at present this often goes no further than report-level information due to a lack of knowledge about how to perform these analyses and utilize their results. In response, Hitachi's solution for analyzing distribution data is supplied as part of its Intelligent Operations solutions to support the use of product, customer, and other information in the retail industry. The solution supports business improvements through more sophisticated use of information and is supplied in the form of a system that combines a high-speed database with merchandise and customer analysis, where merchandise analysis performs multifaceted analyses of product sales data, and customer analysis supports customer-targeted strategy formulation, execution, and evaluation.

INTRODUCTION

THE retail industry has been experiencing changes in consumer purchasing behavior over recent years. Along with these changes, the industry is facing emerging challenges in the form of a greater diversity in the product sales channels and promotional methods used by retailers, greater segmentation in customer needs and in the points of contact with customers, and an accelerating growth in both the types and quantities of information required for performing analyses. For retailers in the future, an important key to the development of their businesses will be the collection and utilization of the large amounts of data needed for an accurate understanding of the situation around things like sales and customer purchases. Also important for the collection, analysis, and practical application of increasingly large amounts of information will be the scope of use of high-speed processing on big data information platforms.

Hitachi's solution for analyzing distribution data is supplied as a package that combines merchandise and customer analysis systems, which support analysis by retailers, with a big data information platform capable of high-speed processing of point of sale (POS)[*1] data and customer details (such as membership type, age, and gender).

This article presents an overview of Hitachi's solution for analyzing distribution data (which helps retailers overcome the challenges posed by data analysis), describes two case studies of retailers who have installed the solution, and looks at the outlook for the future.

HITACHI'S SOLUTION FOR ANALYZING DISTRIBUTION DATA

Overview

Data analysis by retailers can be broadly divided into "merchandise analysis" of product sales figures and "customer analysis" of the customers who purchased these products. However, the following difficulties mean that many retailers have yet to make effective use of analysis.

(1) Because information is spread across different sales channels (which themselves are becoming more diverse), and because it is common for analysis to be performed independently for each channel, there is a need for a variety of different information to be viewed together.

(2) An inability to make full use of information as the quantity that needs to be collected increases along with

*1 Data collected at the time of sale from the retail store checkout or similar.

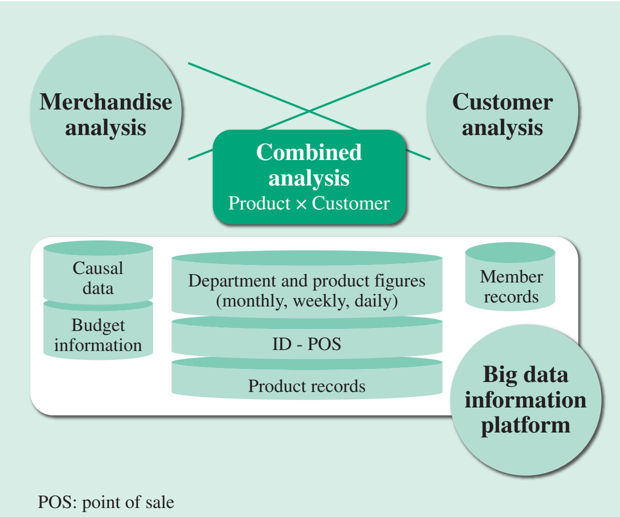

Fig. 1—Overview of Hitachi's Solution for Analyzing Distribution Data.
Hitachi's solution for analyzing distribution data is the name for an integrated system that includes merchandise analysis, customer analysis, and a big data information platform.

the proliferation in points of contact with customers ("multi-channel retailing").

(3) A limit to the ability of existing systems to keep pace with processing this growing quantity of information.

(4) The growing importance of optimal approaches based on a specific understanding of customers achieved not through the report information used in the past, but by looking at information from a variety of perspectives in order to achieve specific objectives such as improving sales or enhancing service.

In response to these difficulties, Hitachi's solution for analyzing distribution data helps overcome the challenges facing retailers by combining merchandise and customer analysis systems with a big data information platform (see Fig. 1).

Unlike past systems, Hitachi's solution for analyzing distribution data uses the same database for both the merchandise and customer analysis systems, integrating data and system operation to allow analysis in ways that combine both merchandise and customer analysis. This can incorporate previously independent analysis functions in the form of scenarios, and implement analyses and problem solving processes in story form.

Features

Merchandise Analysis System

This system uses the results of analyzing not only sales figures but also other actual data including stock levels, procurements, margins, ordering, and transfers for such product-related tasks at retailers as shelving allocation, planned discounting, product procurement, product development, and product selection.

Table 1 lists the different analyses that can be performed using the merchandise analysis system. It supports the plan, do, check, and act (PDCA) cycle for planning and other activities aimed at improving operation, extending from providing basic information on actual margins and sales trends for specific products through to ways of reducing losses due to disposal or price changes, improving margins, and selecting the range of products to offer with consideration for loyal customers.

The merchandise analysis system in Hitachi's solution for analyzing distribution data has the following three main features.

(1) Use as a dashboard

The dashboard appears whenever a user logs into the merchandise analysis system. It allows prompt action to be taken by providing an intuitive representation of sales figures up to the previous week and day, and of progress on improving key performance indicators (KPIs).

TABLE 1. Analyses Provided by Merchandise Analysis System*
The merchandise analysis system provides a range of analyses for retailing, including shelving allocation, planned discounting, product procurement, product development, and product selection.

Merchandise analysis system	Overview
Dashboard	Check business summaries and progress on KPIs by management, department, SV, or store.
Sales and margin analysis	Switch between numerous different analyses to review figures such as sales and margins by department.
Product figures	Switch between numerous different analyses to review figures such as sales and margins by product. Includes ABC analysis and comparison of results by store.
Attribute analysis	Combine and analyze product and store attributes.
Shelving allocation analysis	Analyze sales for each shelving allocation.
Sale (planned discounting) analysis	Analyze sales for each sale.
Analysis by product characteristics	Apparel analyses such as seasonal products, inventory liquidation, and transfers, and food product analyses such as time-of-day and day-of-week.
Customer category analysis	Determine sales by age range, gender, and customer category.
Information sharing with suppliers	Supply POS data to distributors or other suppliers.

KPI: key performance indicator SV: supervisor
*As of October 2014. Includes some planned functions.

(2) Use for analyzing customer categories

Combining merchandise analysis with customer categorization allows the simultaneous analysis of both products and the purchasing behavior of loyal customers, something that has not been possible in the past. For example, the likely benefits include more accurate product selection by identifying which products affect the purchasing behavior of loyal customers, reducing missed opportunities for sales and helping keep loyal customers.

(3) Information sharing with distributors and suppliers

The solution includes functions for sharing information with suppliers. This provides opportunities for retailers to suggest new products and otherwise collaborate with suppliers rather than working on their own.

Customer Analysis System

The customer analysis system provides analysis scenarios that implement customer-driven retail business practices by acquiring information on purchases, which is growing in quantity as customer purchasing behavior becomes more diverse and segmented. Table 2 lists the different analyses that can be performed using the customer analysis system. In addition to information such as customer attributes and membership of loyalty schemes, customer analysis also provides a starting point for supporting activities that extend from the analysis of purchasing trends, merchandise analysis, and customer identification to the formulation and evaluation of ways in which scheme members should be approached.

TABLE 2. Analyses Provided by Customer Analysis System
The system integrates purchase histories and other customer information from multiple channels to support customer-targeted strategy formulation, execution, and evaluation.

Customer analysis system	Overview
Loyalty analysis	Analyze customer categories using decile analysis, decile trend analysis, and RFM analysis.
Event analysis	Analyze response rate for coupons and other promotional campaigns.
Basic member analysis	Graphically display age, gender, and optional group.
Time-series analysis	Assess time-based trends using time-of-day analysis, day-of-week/time-of-day analysis.
Regional analysis	Identify regional characteristics using data such as post code and choice of store.
Cross-selling analysis	Use cross-selling and basket analysis to identify trends in customers purchasing products together.
Trend analysis	Use product cross ABC analysis, Z charts, and other techniques to assess trends in sales figures.

RFM: recency, frequency, monetary

The customer analysis system in Hitachi's solution for analyzing distribution data has the following three main features.

(1) Integration with merchandise analysis

Appropriate measures can be implemented by obtaining customers' purchase histories and using this information to determine their preferences and needs, combining both customer and merchandise analysis. For example, it could be used to increase sales and avoid losing customers by using direct mail (DM) to offer discounts on products frequently purchased by an estranged customer who has not recently visited the store.

(2) Use for analyzing results of activities

The solution includes functions for assessing the results of activities to verify how well they have worked. An improvement process can be established by using the results to perform a new cause analysis and by working through the cycle of planning, action, assessment, and improvement for future plans.

(3) Management of customer information

The functions of the customer analysis system range from customer category analysis functions that do not require personal information to customer selection functions used to generate DM. To ensure that personal information about customers is only available to those who need it, each system user is assigned operation and viewing permissions, with detailed settings that include screen-by-screen control of menu screen display and field-by-field control within screens on which customer record details (name, address, telephone number, and so on) can be viewed.

Big Data Information Platform

The Hitachi high-speed data access platform[*2], which features ultra-high-speed retrieval, is used to support the merchandise and customer analysis systems.

Conventional analysis systems handle large volumes of data such as POS records by creating a separate data mart for each analysis viewpoint. Because of the diversity of retailers, which handle a wide range of products from food and clothing to general household goods, and that operate in a number of different formats such as general merchandise stores (GMSs) or supermarkets, they need to perform analyses from different viewpoints, including those of

*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).

management, merchandising, and stores. The problem with creating a large number of data marts is that it makes it difficult to switch quickly to a different view.

Taking maximum advantage of the high-speed retrieval provided by Hitachi ultrafast database engine, Hitachi's solution for analyzing distribution data is designed to allow flexible changes in the basis of analysis by keeping the number of data marts to a minimum and calculating line item totals in realtime.

UNY CO., LTD. CASE STUDY

Overview

Established in 1971, UNY Co., Ltd. is the third largest general retailer in Japan, operating 226 stores across 20 regional jurisdictions, primarily in the Chukyo Metropolitan Area around Aichi Prefecture, with non-consolidated sales of 771.5 billion yen (year ending February 2014). It has a vision of being a retailer of new lifestyles, with self-managed stores that have close ties to their communities. It introduced the "uniko card," a form of electronic money for the UNY Group, in October 2013 with aims that included improving customer convenience and developing loyal customers, and is seeking to expand further its membership and number of participating stores[1].

Installation of Hitachi's Solution for Analyzing Distribution Data and Future Initiatives

With member and purchase data already available from its existing "UCS card," UNY installed the customer analysis system of Hitachi's solution for analyzing distribution data at the same time as the uniko card, with objectives that included determining customer purchasing behavior, holding on to the loyal customers, and assessing sales campaigns. The system reduced the time taken to perform analyses, being able to complete a recency, frequency, monetary (RFM) analysis for a month's worth of data from one store (approximately 2 million records) in 10 s and from all stores (approximately 200 million records) in 70 s.

UNY is currently setting up a project to increase the number of its loyal customers. Activities include establishing a variety of analytical procedures and performing effectiveness studies using collected data through interoperation between the customer analysis and other systems.

(1) Prevent loss of loyal customers

Identify which products are repeatedly purchased by the loyal customers, and use information on sales at different times of the day to avoid running out of stock during peak periods.

(2) Increase spending and number of store visits (days)

Identify scheme members by specifying conditions from the customer analysis system and issue coupons to them at the checkout. Check the results in terms of the number of days on which they visit a store and the amount that they spend.

(3) Optimize where to circulate advertising flyers

Optimize where to circulate advertising flyers by using map software to display scheme members, sales, and other parameters by area.

With a view to making more use of customer analysis at store-level in the future, they are seeking to set up a cycle of activities whereby not only headquarters but also individual stores are aware of their own customer base. Through the integrated analysis of information from different sales channels [including brick and mortar stores, "net-supers" (online sales with delivery handled from a store (which usually has items in stock) and delivered in a day), and conventional online stores], this enhances customer-targeted retail service and sales capabilities, and facilitates the move to omni-channel sales.

FUJI CO., LTD. CASE STUDY

Overview

FUJI Co., Ltd. was founded in Uwajima City, Ehime Prefecture in 1967. A regional chain, it operates 98 supermarkets and GMSs across six prefectures in the Chugoku and Shikoku regions, with total sales of 309.4 billion yen (year ending February 2014). It's vision is to establish itself as a dominant player with close ties to the community, customers, and way of life in the Chugoku and Shikoku regions where it operates, with commercial practices that are closely linked to its location and customers[2].

Installation of Hitachi's Solution for Analyzing Distribution Data and Future Initiatives

To keep pace with changes in the business environment, FUJI understands the need to link product and customer information so that it can look at its business from a variety of perspectives and obtain detailed information in a more timely manner. The company chose to install Hitachi's solution for analyzing distribution data in recognition of its ability to link information quickly and to implement the PDCA cycle with a high level of accuracy.

Adopting Hitachi's solution for analyzing distribution data solved the following two problems.

(1) Get overall faster display times for search results compared to previous system. The response is up to five times faster than the previous system, making online use practical.

(2) Improve processing performance to reduce the number of data marts and allow data to be stored in more detailed form.

In the future, they intend to expand use of Hitachi's solution for analyzing distribution data across the FUJI group with the aim of making business improvements by utilizing the PDCA approach to problems at a company-wide level while also encouraging wider use of analytics. They are also seeking to increase sales through greater integration of customer information, including measures for analyzing the influence of competition within trading areas and the analysis of "online to offline" (O2O)[*3].

CONCLUSIONS

It is anticipated that analysis systems will become an important part of retailing in the future in order to obtain an accurate understanding of the ever-changing operating environment for retailers. In the future, Hitachi intends to use information technology (IT) to support further advances in retailing by using Hitachi's solution for analyzing distribution data (merchandise analysis system, customer analysis system, and big data information platform) to provide systems that can respond flexibly to changing circumstances, as described in this article.

*3 Measures on the Internet for encouraging people to visit brick and mortar stores.

ACKNOWLEDGEMENTS

The study of installation benefits and business improvements achieved by Hitachi's solution for analyzing distribution data described in this article received considerable assistance from the people involved at UNY Co., Ltd. and FUJI Co., Ltd. The authors would like to take this opportunity to express their sincere thanks.

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Featured Articles

Cloud Services Supporting Plant Factory Production for the Next Generation of Agricultural Businesses

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OVERVIEW: Issues such as the decreasing agricultural workforce and the diminishing proportion of food produced domestically have risen to prominence in recent years. There are also global concerns about the rising imbalance between food supply and demand due to factors such as population increase and abnormal weather causing poor harvests. The use of "plant factories" has attracted attention as one way of solving these problems. In response to these new trends in agriculture, Hitachi intends to supply its Intelligent Operations for Agriculture solutions for more efficient and sophisticated farming that cover everything from the cultivation and production of agricultural products to their sale and distribution.

INTRODUCTION

INTERNATIONALLY, there have been major changes in global food and agriculture sectors in recent years, with rising concerns about the risk of disruption to the balance between the supply and demand for food due to the reduction in cultivated land area caused by rapid population growth together with changes in the global environment; the decrease in the agricultural workforce and its uneven distribution; and also growing demand for safe and high-quality agricultural products particularly among the wealthy in the emerging economies of Asia. In Japan, meanwhile, the structure of the agricultural sector has changed significantly. The total value of agricultural production peaked in Japan in 1984 and has been gradually falling ever since; down to about 8,530 billion yen in 2012. The agricultural workforce is also aging, with an average age of 65.8 years. This has created a need both to reduce the workload for agricultural workers and to increase productivity. Agriculture is also shifting toward the use of information technology (IT) for efficient and highly productive production, with changes to agricultural law now permitting companies to enter the industry, and with an increase in new entrants to the agricultural business in the form of large companies from other industries such as distribution or manufacturing. This article describes an example of "plant factories" (closed growing systems) in Japan, an initiative that is in step with these new developments in the agriculture sector.

HITACHI'S CONCEPT OF AGRICULTURAL IT SERVICES

Background

Being heavily influenced by weather conditions, conventional agriculture (particularly outdoor cultivation) is clearly an uncertain business when considered from a management perspective. Underpinned to a large extent by the experience and intuition of producers, conventional agriculture is also a difficult field for younger generations to participate in. The increasing number of fields and rice paddies that have been abandoned and are no longer cultivated, and the falling and aging farming population are becoming problems for society, reducing the proportion of food produced domestically. One solution is to look for ways of transforming the "knowledge from experience" possessed by farmers into data that makes agricultural management more predictable and to assist new entrants into the industry.

Looking instead at consumers, the market is becoming increasingly fragmented due to the diversity of life styles and preferences together with rising concerns that encompass health, safety, trustworthiness, and self-sufficiency. Together with these consumer needs, a recognition has emerged of the need for farmers to build cooperative and collaborative relationships. In response, Hitachi is seeking to identify ways of conveying data on agricultural product traceability to the people who need it, as well as the information on produce quality

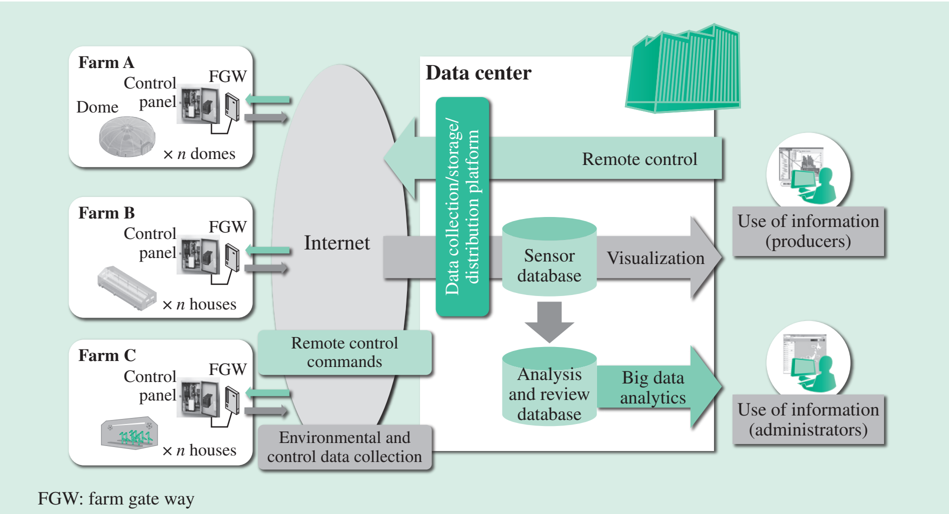

Fig. 1—Overview of Cloud Services Supporting Plant Factory Production.
The service collects data from sensors on plant factory growing conditions and production equipment operation and stores it in an FGW. Along with supplying this information to producers, equipment administrators, and others in realtime, the service can also control growing conditions and production equipment.

and quantity demanded by consumers and retailers. One such initiative aims to support plant factories that can grow produce anywhere by controlling all aspects, including growing conditions, utilizing IT such as sensor networks and the cloud, and modeling that is adapted to the "collect, store, analyze, and utilize" cycle for cultivation and other environmental data.

Objectives

Growing conditions control information is collected by providing the means for the integrated management of plant factories in the form of a cloud service. The time-series analysis of this information can be used to identify the causes of poor harvests and provide farmers with services that support plant factory management. Collecting timely information about the diverse needs of the consumers, processors, distributors, and retailers on the demand-side and then conveying this to farmers (producers) makes it possible to do such things as adjusting the volume of agricultural production or producing agricultural products that people want to buy by providing suggestions for product improvements to things like taste and flavor. In other words, building IT platforms that allow sharing of information between producers and consumers can advance the transformation of agriculture into part of the social infrastructure in Japan and elsewhere in the form of a smart industry that is responsible for the future of food.

CLOUD SERVICES SUPPORTING PLANT FACTORY PRODUCTION

Overview

The establishment of plant factories to provide a reliable supply of agricultural products is currently on the increase. These "factories" ensure reliable production by controlling growing conditions to suit the requirements of the crop. 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" service uses the cloud to collect and manage data on plant factory growing conditions, control data from production equipment, and other information. It can supply management information to producers and equipment administrators in realtime as well as control growing conditions, production equipment, and other aspects of plant factories (see Fig. 1).

Features

Cloud Services Supporting Plant Factory Production is a full-featured service for plant factories that can help improve crop quality and productivity by controlling growing conditions in plant factories, while also providing information from the analysis of these activities. It collects solar radiation, temperature, humidity, nutrient content, pH, electrical conductivity (EC)*1, and other data on growing conditions in plant factories, and also data on the operation of heating and cooling equipment, nutrient solution pumps, shading curtains, and other production equipment. This data is collected from sensors and stored in a farm gate

*1 A quantity that is indicative of the concentration of various different ions in soil or in an aqueous solution. EC measurements are used in agricultural science as indicators of nutrient concentration in soil or in aqueous solutions.

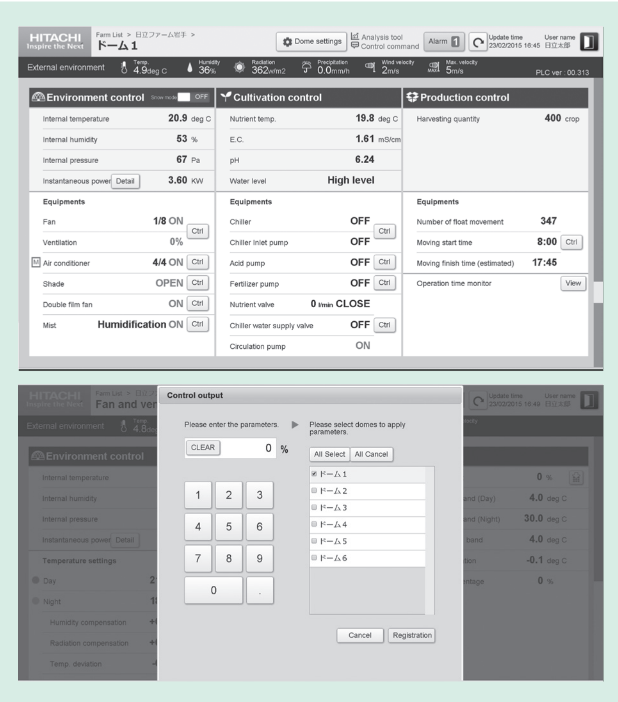

Fig. 2—Example Monitor and Setting Screens.
Collected data is displayed on the administrators' monitor screens via the data collection/storage/distribution platform at the data center. The system can also remotely control settings for sensors and production equipment at the plant factories.

way (FGW)*2, which is a data collection and control device. This data is then sent to the monitor screens of administrators in realtime via the data collection/storage/distribution platform at a data center. The service can also remotely specify control settings for the sensors that collect data on growing conditions and the production equipment. All of the collected data is stored in a database where it can be analyzed and reviewed using business intelligence (BI)*3 tools to optimize growing conditions and provide support for decision-making from a management perspective.

Fig. 2 shows examples of the monitors and setting screens.

Use at Granpa Dome

The service has been adopted for the Granpa Domes*4 developed by Granpa Co., Ltd. (see Fig. 3) and is being progressively deployed to each of the domes.

*2 A data collection and control unit that periodically collects growing conditions, production equipment control, and other plant factory data and sends it to a data center; and also receives commands from the data center and controls production equipment.

*3 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.

*4 Plant factories made from air domes that utilize natural sunlight and an automatic spacing system with circular water tanks.

Fig. 3—Exterior and Interior Views of Granpa Dome.
Cloud Services Supporting Plant Factory Production has been adopted for the Granpa Domes developed by Granpa Co., Ltd.

Before adopting the service, the Granpa Domes collected growing conditions, production equipment status, and other data on control panels located inside the domes. This meant that operations such as viewing the data or changing environmental settings needed to be done on the control panel monitor screens at the dome, making it very difficult to maintain realtime monitoring and control of the multiple geographically separated domes. The service collects approximately 1,000 items per minute of growing conditions, production equipment, and other data from each dome at a data center, and provides consolidated realtime monitoring and control of information from the multiple geographically separated domes on monitor screens at headquarters. Using the service has enabled the company to implement efficient operational management.

TECHNOLOGIES UNDERPINNING AGRICULTURAL CLOUD

Data Collection/Storage/Distribution Platform

The data collection/storage/distribution platform is used to provide unimpeded communications between the plant factories and the data center for the growing conditions, production equipment control, and other data generated by the factories (see Fig. 4).

To perform remote monitoring in realtime, Cloud Services Supporting Plant Factory Production sends operation logs from the plant factories to the data center at one-minute intervals. Because the data collection/storage/distribution platform needs to receive data from a large number of plant factories at frequent intervals, it stores data in memory to eliminate disk access overhead by using a distributed in-memory key value store (KVS) with high-speed data processing capabilities to receive the data. Data reception is handled independently (asynchronously)

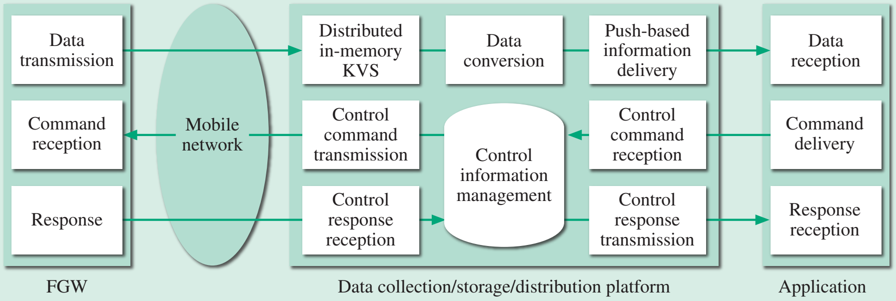

Fig. 4—Overview of Data Collection/Storage/Distribution Platform Functions.
Because of the need to receive data from a large number of plant factories at frequent intervals, the data collection/storage/ distribution platform includes a distributed in-memory KVS with high-speed data processing capabilities. The platform also includes functions for ensuring unimpeded exchange of data between the plant factories and data center, including an ability to define data conversions using only a GUI.

of the transfer of data to applications to ensure that data reception throughput is maintained, and realtime operational monitoring is implemented by passing the received data to applications using push-based information delivery.

To keep the volume of operation logs from plant factories to a minimum, it is transmitted in binary rather than in more bulky text format. Accordingly, a binary-to-text conversion function is required to make the collected data easier to handle by applications and people. The data collection/storage/distribution platform is designed to allow operation logs with different structures to be added without the need for new program development, allowing data conversions to be defined using only a graphical user interface (GUI).

The remote control of plant factories requires both the transmission of control information from applications to the factories and the reception by applications of the results of control operations at the factories. If this were implemented synchronously, it would require the applications to wait when a communication fault or other problem interrupted the return of results from the plant factories. Accordingly, asynchronous communications is also used for control commands issued by applications, which are routed via the data collection/storage/distribution platform. To achieve asynchronous communications, the data collection/storage/distribution platform includes a mechanism for managing whether control information has been sent and whether the result of that has been received. When control results are returned from a plant factory, the data can be forwarded to applications in hypertext transfer protocol (HTTP) format using push-based information delivery.

FGW

The plant factories are controlled by programmable logic controllers (PLCs) that collect sensor data and control equipment at the factory. To provide factory operation logs to local administrators, this information is collected periodically by a data logger device connected to the PLC.

For remote monitoring of plant factories, an FGW is used to send operation logs to the cloud-based data collection platform and to forward factory commands from the data collection platform. To prevent the FGW from being an additional cost, it is designed to combine the functions of the existing data logger device and the connection to the cloud. The functions of the FGW are the collection and storage of factory operation logs, data logging, transmission of collected data to the data collection platform, reception of factory commands from the data collection platform, and the forwarding of these commands to the factory (see Fig. 5).

The interfaces with the PLCs that control the plant factories are implemented using an application bundle based on the OSGi[*5] framework that simplifies changes to equipment configuration associated with factory expansions. To allow the long-term storage of large amounts of data, collected data is stored on the FGW in a database for embedded systems.

A mobile network can be used for connecting to the data collection platform to provide greater flexibility in

*5 OSGi is a trademark or a registered trademark of the OSGi Alliance in the United States, other countries, or both.

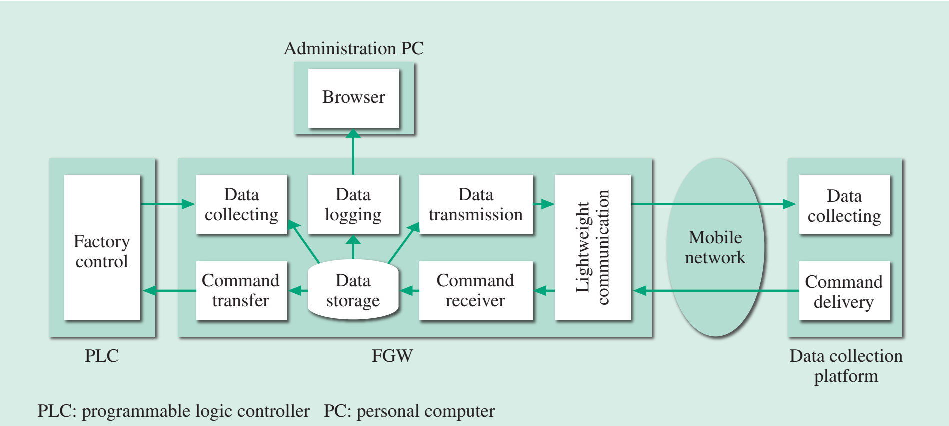

Fig. 5—Overview of FGW Functions.
The FGW functions are a collection of packages supplied by Hitachi Solutions, Ltd.

choice of location, using lightweight communications based on a protocol with small packet size to minimize the data transmission volumes. Although use of a mobile network requires measures to deal with unreliable communications, this is achieved by the queuing of transmission data and retry control.

FURTHER EXPANSION OF AVAILABLE SERVICES

Hitachi supplies products and services for the smart information sector under the banner "Intelligent Operations." Through the development and supply of its Intelligent Operations for Agriculture solutions for agriculture based around Cloud Services Supporting Plant Factory Production, Hitachi is making agricultural production more reliable and transforming agriculture into a "senary industry[3]" (a term used in Japan to refer to the added-value production and distribution of agricultural goods). In the future, Hitachi intends to add new services and to integrate them with other cloud services, including simulating supply and demand for the output of agricultural production, assisting with the acquisition of Global Good Agricultural Practice (GLOBALG.A.P.)[4] certification, and providing cultivation simulations. Hitachi also intends to expand beyond plant factories to offer horticultural services for small and medium-sized operations, as well as services for assisting companies that are deploying these outside Japan.

CONCLUSIONS

This article has described a solution for the next generation of agriculture in the form of a service that supports farm administrators and farmers by collecting environmental and control data from plant factories and making it available via the cloud.

IT is beginning to be adopted for operational and efficiency improvements in agriculture, a field that in the past has made little progress on utilizing IT. In the future, Hitachi intends to improve convenience across society through initiatives such as those that use IT to link producers, processors and distributors, retailers and the hospitality industry, and consumers.

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Featured Articles

IT Platform Solutions for the Social Innovation Business

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Yuichi Mashita
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OVERVIEW: The ability to create new services that utilize the vast amounts of data now generated by infrastructure facilities has gained significant attention in recent years. At the forefront of this technical trend, Hitachi has been supplying highly reliable IT platform solutions that support innovation in business and society. Today, by utilizing the know-how acquired from these experiences and realizing sophisticated IT platforms that will be indispensable for the future evolution of social infrastructure, and which harmonize its accumulated operational know-how with ultrafast big data analysis, Hitachi is further advancing its contribution to the speedy supply of solutions and services to its customers and to society.

INTRODUCTION

SOCIETY is being transformed by the arrival of the Internet of things (IoT), which includes features such as automatic recognition and remote control, and is being created by providing communication functions and Internet connectivity, not just in mobile devices and information and telecommunications devices such as computers, but also in various other real-world objects.

Examples include smart meters, which provide electric power meters with communications capabilities and automatically report power use via the Internet; systems that can identify remotely when parts need to be replaced by fitting sensors and communications to large industrial machinery and using them to collect data on temperature, operation, and other parameters; and systems that collect location data from vehicles in realtime and provide information on traffic congestion. Interest is also growing in the creation of new services that collect, store, and analyze the large amounts of data generated by these social infrastructure systems.

With the ongoing development of systems that are able to collect, store, and process large amounts of complex data in realtime, the spread of cloud services, the explosive growth in smartphones and tablets, and the falling cost of sensors and communication devices, along with the information technology (IT) needed to provide these new services has started to become available over the last few years.

In response to this new environment, Hitachi announced its Intelligent Operations solutions in October 2013. Intelligent Operations is Hitachi's name for a range of product and service solutions that accelerate its Social Innovation Business. The aim is to provide a safe, secure, and comfortable way of life, and to achieve business growth through the use of information in order to innovate social infrastructure. In the field of control and operation technology (OT) in particular, this involves the use of IT to apply people's experience and intuition, which has traditionally been hard to pass on to others, and the results of analyzing large amounts of different types of data, which was thought to be beyond the capability of technology.

This article provides an overview of Hitachi IT platform solutions that use advanced IT to underpin the Intelligent Operations product range, and presents examples of their use.

PAST USE OF HITACHI IT PLATFORM SOLUTIONS

To provide a safe, secure, and comfortable way of life and to achieve business growth through the use of information in order to innovate social infrastructure, the IT systems that underpin this innovation must themselves be a reliable part of the social infrastructure.

For a long time, Hitachi has been a supplier of highly reliable IT platform solutions that support innovation in business and other parts of society. This has included using IT to support social infrastructure in fields such as finance, government, and railways for over 50 years, such as in the development of a railway seat reservation system in 1959, and an online banking system in 1969. As a technology leader, Hitachi has also consistently developed IT platform products with the high reliability needed for mission-critical systems, thereby expanding the scope of products available for system development from mainframes to servers, storage, and middleware. Hitachi also supplies products and support services that draw on its expertise and capabilities for the long-term support of systems that operate 24 hours a day, 365 days a year in the form of products such as the Hitachi Unified Compute Platform (an integrated platform solution) and the Hitachi Cloud (a highly reliable cloud service).

In collaboration with the Institute of Industrial Science, The University of Tokyo, Hitachi has developed an ultrafast database engine that speeds up the use of big data, a field in which interest has grown rapidly in recent years. The database engine was released in June 2012 as part of a high-speed data access platform[*1] that includes Hitachi servers and storage. This makes it possible to keep up with the ever-increasing quantities of data, and provides a significant expansion in the scope of application, from conventional enterprise information systems to the realm of the IoT, with its use of large amounts of data from social infrastructure and various other real-world objects.

To develop future social infrastructure OT into a more advanced form, as described above, there is a need to combine technology for the ultrafast analysis of the large amounts of data from different types of equipment by using the operational know-how that has been built up through many years of experience. By using advanced IT to support OT in electric power, telecommunications, and other social infrastructure systems, Hitachi IT platform solutions represent a step toward achieving social innovation in a variety of different fields.

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

*2 A national research and development program established to undertake world-leading research with the aims of boosting Japan's medium- to long-term competitiveness and underlying capabilities in fields such as industry and national security, and of ensuring that the benefits of research and development flow back to the public and society.

INTELLIGENT OPERATIONS SUITE AS IT PLATFORM SERVICES

Concept

High-speed processing of large amounts of data, long-term archiving, overcoming barriers of distance, accurate repetitive processing, and automatic execution are all inherent characteristics of IT. To date, IT has helped reduce business costs by utilizing these characteristics to perform fast and accurate information processing instead of human operation. In the future, other IT characteristics, such as predictions by the numerical modeling and numerical analysis of public or enterprise activities, and the visualization of complex systems by combining these capabilities, will become more useful by integrating and utilizing big data.

Today, the roles of IT include providing a platform for a safe, secure, and comfortable society by assisting the human intellections necessary for making rapid accurate decisions, and by contributing to increasing enterprise profit and social convenience. More specifically, by numerical modeling with big data of public or enterprise activities, such as production, transportation, and maintenance, situational judgment can be immediately rendered based on quantitative assessments of current circumstances. Furthermore, by utilizing numerical analysis techniques to which IT is well suited, such as combinational optimization or statistical prediction, it is possible to create the multiple possible action plans and to evaluate these alternatives in realtime. This makes it easier for enterprise executives or social constituents to choose the best action plan for maximizing revenue and convenience.

Until now, Hitachi has promoted various types of business with many customers on both IT solutions, such as market risk prediction for the financial firms or supply chain management for manufacturing industries, and operational solutions such as scheduling systems for railway companies and manufacturing execution systems for industrial plants. The Intelligent Operations Suite of Hitachi IT platform services provides these techniques and know-how as services combined with IT platform products (see Fig. 1), by extracting them as common models independently of the specific industries from which the experiences originated. In this way, Hitachi maximizes the delivered benefit and convenience by making it possible to predict and manage the complex behavior of the social infrastructure.

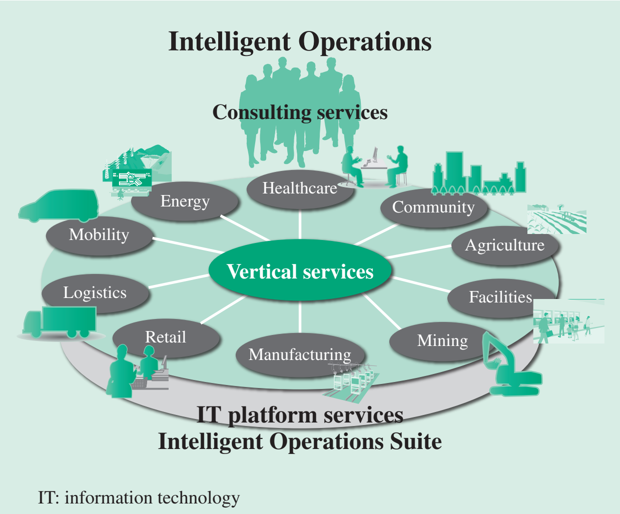

Fig. 1—Intelligent Operations Solutions.
The Intelligent Operations Suite provides IT platform services that underpin Hitachi's range of solutions.

Instances

This section describes an example of service using the Intelligent Operations Suite in the mining business to overcome management challenges and improve operations. The mining business can be roughly categorized into excavation, transportation, and shipping (see Fig. 2). In the excavation process, excavators dig out ore, dump trucks carry it to the crusher site, crushers break it down to the required size, and then loaders load it onto freight trains. In the transportation process, freight trains that consist of more than a hundred railcars transport ore to the shipping port, which may be more than 1,000 km away from the mine. In the shipping process, the ore is formed into piles temporarily at the port while awaiting the arrival of the ore ship. Once the ship has come alongside the designated pier, the ore is reclaimed from the stockpiles and loaded onto the vessel.

Because so many processes – from excavation to shipping – are involved, any accident or incident, such as a facility failure or the late arrival of an ore freight train due to bad weather, can have serious effects on all other processes, and can thereby cause delays in production and shipping schedules. Furthermore, planning and executing both temporary production schedules during repair work and procedures for resuming production impose a high workload. This wastes significant amounts of time and manpower, and can result in a major negative impact on profits.

When dealing with such anomalous situations, our services enable processing of the consecutive collecting, storing and analyzing of the sequential event data – concurrently with business activities – by utilizing IT features extracted from numerical modeling and analysis techniques that are integrated

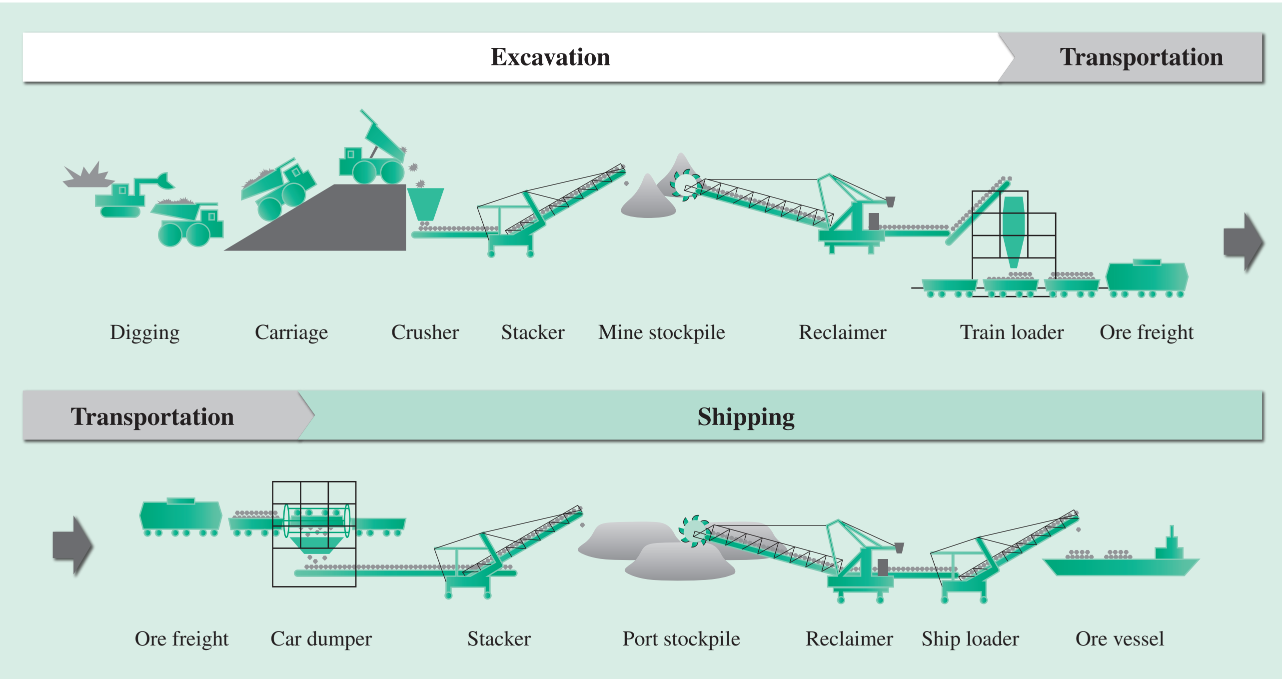

Fig. 2—Overview of the Mining Business.
Since the mining business consists of many processes, which can be categorized into excavation, transportation, and shipping, a single accident occurring somewhere in the many processes has the potential to seriously disrupt all other processes.

with IT platforms, such as the high-speed data access platform. This can dramatically reduce the required intellection frequency and the time that is required for planning the production schedules and comparing them with alternatives, and makes it easier to create production schedules minimizing the impact on profitability.

For example, for minimizing the affect of train delays and creating procedures for resuming shipments, Hitachi's railway scheduling support systems, the utility of which has been proven by numerous railway companies in Japan, can be utilized to generate schedules for resuming operation with minimum delay, while simultaneously preserving the physical constraints (such as the number of locomotives and wagons or the facility locations for interchanging trains) and operational constraints (such as train crew assignments and their boarding times).

Similarly, for rescheduling shipment plans against ship loader difficulties, Hitachi's supply chain management systems, the effectiveness of which has been proven by numerous manufacturing factories in Japan, can be utilized to create the shipping plans that will minimize delivery date impacts by generating stockpiling plans during the trouble and scheduling shipment restart dates after the problem is resolved, as well as by supporting the extraction of bottleneck factors and planning countermeasures against them.

Additionally, Hitachi has numerous achievements related to supporting various customer business activities, including workflow management systems, document management systems, and asset management systems, and so on. It can thereby contribute to the improvement of operations and the enhancement of profit in the mining business by providing its Intelligent Operations Suite, which fully utilizes its practical know-how and the processing logics acquired through such achievements together with the middleware IT platforms and hardware that support reliable high speed processing.

IT PLATFORM SOLUTIONS FOR THE SOCIAL INNOVATION BUSINESS

The above example from the mining industry involved generating production schedules with minimal impact on profitability through modeling and the combination of ultrafast big data analytics (which could not have been performed manually) with the experience, intuition, and the application of know-how that only people can provide. To apply this experience to social innovation in other areas, it is necessary to examine the factors that differ between countries and regions, industries, and business sectors, including the frequency and quantity of generated data, the feedback cycles required by management, and the required output quality. The Intelligent Operations Suite of IT platform services is designed to provide a high level of flexibility and scalability in the data collection, storage, processing, search, and other basic functions required for using big data in order to take account of the best frequency, granularity, and other requirements for data collection identified through experience.

Hitachi has also been working to develop various forms of technology for social infrastructure systems and to optimize them, in terms of operational efficiency and in other ways, by applying the knowledge of staff with practical experience. By using the Intelligent Operations Suite to link information systems and social infrastructure systems, Hitachi intends to provide speedy decision-making and the optimization of business and other social infrastructure systems in the future by integrating business and operational data that, in the past, had been collected and stored separately, and using that data as a basis for data visualization and analysis.

CONCLUSIONS

This article has described the IT platform solutions that support Hitachi's Social Innovation Business. While working on innovation in IT and collaborating with users, Hitachi also intends to support social innovation in various fields of business and other social activity around the world.

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