# Novel IT Platform for Social Innovation

Takeshi Ishizaki
Chikara Nakae
Nobutoshi Sagawa
Yang Qiu Chen

## HITACHI'S ROLE IN SUPPORTING SOCIAL CHANGE

HITACHI in 2010 is celebrating the 100th anniversary of the company's founding. Those 100 years have seen a major shift from an industrial to an information society and Hitachi has applied its technical capabilities to supporting these social changes in the field of infrastructure. The scope of this contribution has extended from social through to IT (information technology) infrastructure. Examples of the former start with the development of an indigenous electric motor in 1910 and include the first large electric locomotive to be produced in Japan (in 1924) and a 100-MW Francis turbine(a) for hydroelectric plants (in 1955). Examples of IT infrastructure include the first crossbar switch(b) to be produced in Japan (in 1955), a railway seat reservation system (in 1964), and traffic control system for the Shinkansen (in 1970).

Society will continue to undergo major changes in the future. This creates a need for further innovation in the infrastructure that supports our society. Hitachi is one of the few corporate groups able to work in the fields of both social and IT infrastructure which opens up the potential for it to play a major role in new social changes. One of the group's initiatives for the 101st year of its existence is to respond to the demand for social innovation.

## WHAT SOCIETY NEEDS NOW

The environment in which we live and work is undergoing major changes. Alongside the threat of environmental problems such as global warming, resource and energy concerns, and issues relating to water and food, the need to deal with economic issues is also of increasing importance. These include the global recession triggered by the financial crisis, the rise of emerging nations such as China and India, and labor shortages in developed nations caused by aging populations and falling birth rates. To create a sustainable society against a background of rapid globalization, it will be essential to find solutions to both these environmental and economic problems, and this brings with it a need to optimize the infrastructure of society (see Fig. 1).

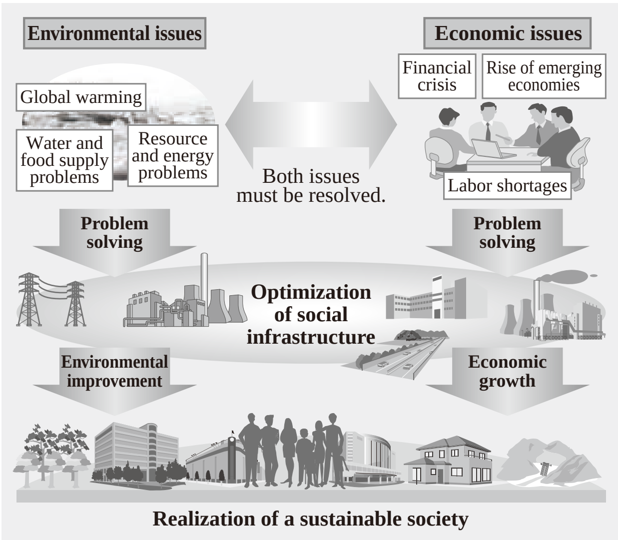


*Fig. 1—Social Infrastructure Innovations that Help Realization of a Sustainable Society.*
*It is necessary to optimize the social infrastructure to address environmental issues while also delivering economic growth.*

(a) Francis turbine
A type of reaction turbine used mainly for hydroelectric power generation. The turbine works by converting the potential energy of the water passing through it into pressure so that power is generated by the reaction force that the water exiting the turbine exerts on the turbine blades. The turbine was invented by the American engineer James B. Francis. The turbines are suitable for sites with high flow rates and medium to high heads of several tens to several hundreds of meters. They are widely used at hydroelectric power plants in Japan.

(b) Crossbar switch
A type of automatic telephone switch. The design consists of a large number of vertical and horizontal bars arranged in a grid with relay-operated metal contactors located at the intersection points. A central control unit opens and closes these connections electrically. The switch stores the dialing information, selects the appropriate vertical and horizontal bars, and operates the relay based on the signal to establish a connection. The name derives from the crossed bars in the switch's design and the crossbar switch was the main type of automatic exchange used until the arrival of computer control.

## Addressing Environmental Concerns without Jeopardizing Economic Growth

The environmental problem seen as most serious at the current time is global warming and there are calls from around the world to mitigate warming by reducing emissions of $CO_2$ (carbon dioxide), a greenhouse gas. However, attempting to reduce $CO_2$ emissions will require us to revise our growth- and development-focused economic activities which are a major factor behind past emissions. At the same time, countries are looking for new growth strategies that can bring them out of the global economic recession, and there are concerns that restricting $CO_2$ emissions will damage economic competitiveness. At the Fifteenth Session of the Conference of Parties to the United Nations Framework Convention on Climate Change (COP 15) held in Copenhagen in December 2009, there was a great deal of contention between developed and emerging nations around the issues of $CO_2$ reduction versus economic development.

To sustain ongoing social progress, what is needed are approaches that can both address environmental issues and deliver economic growth despite the trade-offs between these two objectives. In other words, we need social innovations that can enhance competitiveness in a low-carbon society.

## Solving Problems by Optimizing Social Infrastructure

In seeking both to address environmental issues and deliver economic growth, there is a limit to what individual people, organizations, and companies can do and instead what is required are initiatives that involve a larger framework. To achieve environmental and economic goals simultaneously, there is a need for the broad-based and innovative optimization of a wide range of social infrastructure such as the energy, transport, and communications services that support our society, businesses, and overall way of life and have a major impact on the activities of the individuals, companies, and other entities.

This trend toward greater measures aimed at innovation in social infrastructure is evident in the investments being made in each economy. One survey forecast that international spending on infrastructure investment will grow at an annual average of 5% between 2009 and 2014[(1)]. Investment growth is particularly strong in Asia, a region with a high proportion of emerging economies, with China at 10.5% and India at 8.6% expected to exhibit above-average investment growth. Investment in developed economies is expected to be focused on upgrading aging existing infrastructure, environmental measures, and improving services. In emerging economies, meanwhile, the majority of demand is expected to come from the new infrastructure needed to keep up with rapid economic growth and increasing urbanization. Despite these differing objectives, initiatives are already underway with innovation in social infrastructure being seen as a key pillar in growth strategies for revitalizing economies and boosting national competitiveness.

One example of social infrastructure innovation is investment in the infrastructure required to utilize renewable energy. Figures from the Ministry of the Environment forecast that investment of 13 trillion yen by 2020 in the generation of electricity from renewable energy will deliver economic benefits of approximately 29 trillion yen[(2)]. It is also estimated that this will create 590,000 jobs and reduce $CO_2$ emissions by 47 Mt. In other words, infrastructure optimization initiatives like this that deliver both large economic benefits and $CO_2$ emission reductions hold the key to the creation of a sustainable society.

Hitachi is taking a globally focused approach to infrastructure innovation. One example is the signing in November 2009 of a memorandum of understanding with China's National Development and Reform Commission on a "Cooperative Project for Resource Recycling and the Creation of a Low-carbon Society." Based on this memorandum of understanding, this initiative will promote the establishment of operations in areas such as new energy, smart grids[(c)], transport, water, and recycling, and will contribute to a new collaborative relationship between Japan and China in the fields of resource recycling and the creation of a low-carbon society.

# FUSION OF IT AND SOCIAL INFRASTRUCTURE

To achieve the sorts of innovation in social infrastructure described above while providing services that users find convenient, it will be necessary to achieve a level of integration between social infrastructure systems and their supporting IT systems

---

(c) Smart grid
An electric power distribution system that combines information and communications infrastructure technology with electricity infrastructure. Smart grids are intended to support the coexistence of large centralized generators with distributed power supplies including various new energy sources and to provide a highly efficient electricity supply without jeopardizing security of supply.

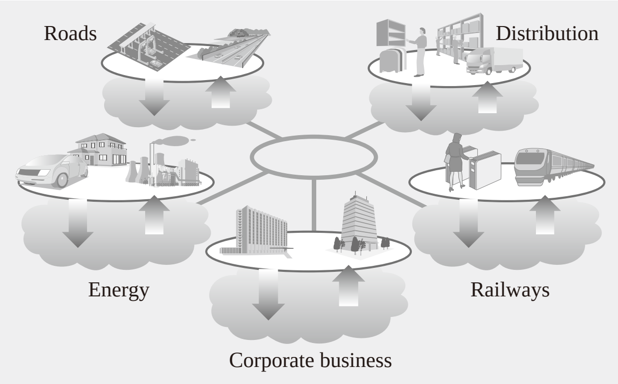


*Fig. 2—IT Supporting Social Infrastructure.*
*Various different innovations in social infrastructure are made possible through the use of the latest IT (information technology) such as cloud computing.*

that is even closer than in the past (see Fig. 2).

Hitachi is focusing its efforts on achieving social innovation by taking maximum advantage of the technologies and know-how that it has built up through its past activities in the fields of social and information infrastructure and by combining these respective resources.

Control systems optimize the operation of machinery and other systems such as electricity generation equipment and rail transport whereas information systems collect data from terminals, sensors, and other devices and then process it to provide information to operators or other human users, and interoperation between these two types of system depends in a large part on on-site work and know-how. Using the latest IT to combine these functions allows the provision of new services that were not possible in the past.

An example from the field of electric power systems is an electricity grid control system that controls the constantly changing supply of electricity power. In addition to billing and invoice generation, recent information systems also include functions such as managing the electricity generated by solar panels installed on people's homes. It is anticipated that the integration of these systems will allow new services such as usage-based adjustment of electricity tariffs or the buyback of excess power.

## BENEFITS OF CLOUD COMPUTING

### Rapid Change in Information Volumes and How the Cloud Can Help

As explained above, the integration of control and information systems is essential if IT is to be used to support innovation in social infrastructure. It is believed that this integration will contribute toward the realization of advanced services like those listed below.

(1) Real-time services that respond instantaneously to changing circumstances to provide appropriate support

(2) Intelligent services that adapt automatically and in detailed ways to users' preferences and other behavior patterns

The provision of services like these that are valuable to users requires IT systems that have been developed to a very high level in terms of their functions, reliability and other performance factors. Because social infrastructure systems are influenced by a wide range of external factors, such as the weather and other aspects of the natural environment or human activity and other social factors, the volume of information they must handle can change suddenly.

For example, the volume of application data that needs to be handled by a transport management system can increase suddenly if an accident or disaster occurs and the system needs to recover disrupted delivery schedules. Similarly, if users caught up in the trouble generate a large volume of information, the operator that handles this information requires a large communication capacity to communicate the situation to the users. To cope with such sudden changes in information volume which are completely different to normal circumstances, the IT systems themselves must be very scalable and be designed in such a way that their configuration can easily be changed.

Cloud computing[(d)] which is currently attracting attention as a new way of using IT can be seen as one technology that unquestionably does have this scalability and flexibility (see Fig. 3).

However, cloud computing as it currently stands still has some shortcomings in areas like security, performance, and availability, and the prospect of its being widely adopted as a platform for supporting social infrastructure is still viewed with some hesitancy.

Hitachi is working on enhancing a range of technologies that will address the reliability, performance, security, and other concerns about cloud computing while retaining its benefits which include

(d) Cloud computing
An approach to computing whereby IT resources such as IT infrastructure, applications, and data are accessed as a service via the Internet or other network. Also, the associated user environment. The term "cloud" derives from how the network is represented by the image of a cloud in system configuration diagrams.

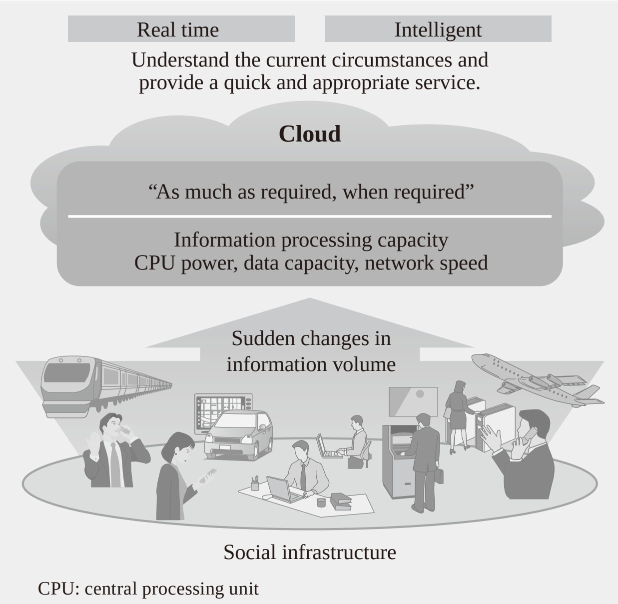


*Fig. 3—Real-time and Intelligent IT Systems.*
*Cloud computing can deliver the required amount of information processing capacity when needed to respond to sudden changes in information volume.*

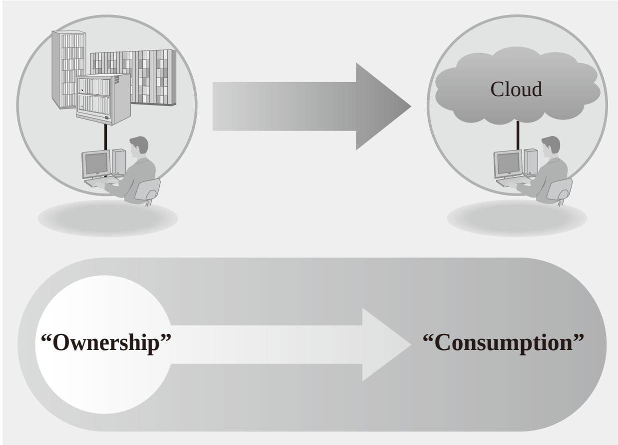


*Fig. 4—Transition from Ownership to Consumption.*
*Cloud computing involves a transition toward consuming services via the network without owning IT resources directly.*

flexibility and scalability. Utilizing this technology, Hitachi has been operating a fully-fledged cloud computing business Hitachi cloud solution since 2009 and supplies a range of solutions from different Hitachi group companies including SaaS[(e)], PaaS[(f)], and private cloud systems[(3), (4)]. The Hitachi cloud solution is a comprehensive solution featuring high reliability, high security, and the environmental consciousness and is backed up by data centers that incorporate the latest power-saving technology, carrier-class network technology, and middleware, storage and other IT platform products. You can read more about these distinctive technologies in the other articles in this issue.

## From "Ownership" to "Consumption"

Cloud computing is transforming IT from something that is owned to something that is consumed (see Fig. 4).

The assumption in a conventional IT environment is that the IT system will consist of servers, storage, and other IT hardware that the user owns and on which they install an OS (operating system), middleware, and other software and develop user programs that are customized for specific applications. Because increasing the processing capacity of such an IT system takes in the order of several months, this model involves the preemptive allocation of resources based on estimates of future demand and requires that a safety margin of performance and capacity be incorporated in the design.

As a result, many companies face a situation in which they operate a number of separate application systems independently which are configured to suit the specific preferences of individual departments, with potential consequences that include less operational efficiency and higher power consumption and operational costs for the overall IT system.

In contrast, cloud computing allows a range of different IT services to be used via the network without the user needing to be concerned about the physical details of the system, such as how many servers are running or where the data center is located. Also, because the system size can be expanded quickly on a time frame of days or hours if additional processing capacity becomes necessary, the efficiency of resource utilization can be significantly improved through measures such as the use of spare resources.

In this way, users can focus on the value being

(e) SaaS
Abbreviation of "software as a service." A service that provides an application over a network making it available to multiple users. Users are able to use only those functions they require and only as much as they need. In addition to speeding up the time taken to implement a system, the potential advantages of SaaS include reducing the cost and workload associated with software administration.

(f) PaaS
Abbreviation of "platform as a service." The provision when delivering an application via a network not only of the software but of the entire platform. Whereas a SaaS service delivers an application via a network, PaaS extends this by providing not only the application but also a platform including a complete development environment so that users can develop or otherwise customize the system to meet their own requirements.

provided by the services without being distracted by tasks such as the daily operational management of IT systems which are becoming increasingly complex. Further, the money that was previously spent on administering the IT system can now be redirected toward core activities that relate directly to the user's business.

### Assisting Business Growth through Collaborative Creation with Customers

In past social infrastructure, advances in the control systems that control the plant and equipment used in the infrastructure and the information systems that act as a human interface took place independently. A wide range of know-how is required to link these two different types of system. Hitachi's aim is to supply systems whose entire life cycle can be acquired from a single supplier by utilizing the system operation, maintenance, and other technologies that Hitachi has accumulated through its long experience in the construction of social infrastructure.

Of course, as an IT vendor, Hitachi cannot realize such systems on its own. Rather, Hitachi seeks to improve service quality and ultimately contribute to business growth at the service operators who are the customers for such systems by the robust integration of these two types of system through "collaborative creations" in which Hitachi works jointly with its customers and takes advantage of their extensive operational know-how.

### Issues Faced by Cloud Computing and Future Directions for IT

Although the shift from ownership to consumption associated with cloud computing brings many benefits, there remain issues around how data is handled.

For both SaaS and private cloud systems, cloud computing involves entrusting valuable data to a data center. In the case of SaaS, the data is held by the SaaS provider, whereas in the case of a private cloud system, data belonging to individual departments is held on a private cloud platform operated by the information systems department.

Entrusting data to a data center brings a variety of risks. If data is lost or loses its integrity due to mistakes in system operation, the losses to the user who owns the data will be significant. Similarly, leaks of personal or other confidential information may result in management's responsibility for administering the data being questioned. Accordingly, the operators and administrators with whom the data is entrusted need to maintain the data safely and reliably, with important data kept secure, while still allowing the data to be accessed efficiently.

On the other hand, there are advantages in keeping data at a data center.

One is to use the extensive processing capabilities of the data center to analyze large volumes of data and extract meaningful information. Examples include the analysis and storage of large volumes of surveillance data collected from sensor networks and search engines that index large amounts of web data to allow rapid searching.

Another is that, by storing different types of data at the same place, the interrelationships between these data sets can be utilized to obtain valuable new information that were previously inconceivable.

It is anticipated that the extraction of meaning from raw data by subjecting it to a wide range of different processing will be an important role for IT in the future. Regardless of the type of business in which they are involved, it seems likely that many companies have data that in the past they have simply collected but have not been able to utilize fully. From a management perspective, transforming this data into valuable information assets can be seen as a role for IT. New business opportunities can be created by putting information assets that have been overlooked in the past to work and treating them as valuable resources. The use of spatial design based on pedestrian flow simulation described in this issue provides a typical example of how information assets can be put to use.

Hitachi is focusing its efforts on the technical developments required to extract the maximum value from these information assets.

The following section describes what Hitachi is doing to utilize IT in new ways.

## FUTURE USE OF IT

Recognizing the trend toward storing a wide range of different data centrally in the cloud, Hitachi has been developing platform technologies aimed at "knowledge extraction processing" whereby information (knowledge) with a high level of added value is extracted from raw data while simultaneously promoting and implementing a KaaS (knowledge as a service) business model in which this technology is provided as a service (see Fig. 5).

The idea is that new services with high added value derived from operating businesses can be created by utilizing real data held by customers, Hitachi, and others. Numerous different business possibilities can

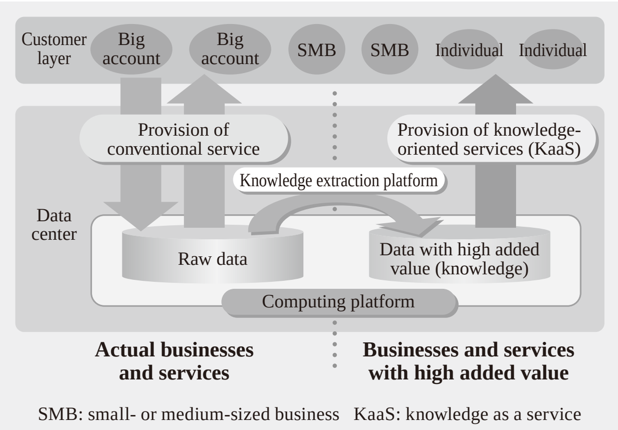


*Fig. 5—KaaS Model.*
*An overview of a business model in which knowledge-oriented services (businesses and services with high added value) are provided by generating added-value data (knowledge) from the raw data collected through the provision of conventional services (actual businesses and services).*

be envisaged such as supplying real-time pricing information for retailers from ordering data obtained from traceability processes, or generating pinpoint CRM(g) data from the electronic ticketing records of a railway operator.

While the delivery of services such as SaaS and PaaS is only now getting underway against the background of this shift from ownership to consumption, KaaS aims to extend this to the "knowledge" layer and enable the provision of services with even greater added value.

## Requirements for Implementing KaaS

The realization of the KaaS model will require a range of measures from the development of ubiquitous devices that can perform real-world sensing to the construction of data centers equipped with extensive IT resources. Of particular importance is the development of knowledge extraction platforms that can extract data with high added value (knowledge) from large volumes of data. In addition to the potential for providing knowledge extraction platforms on its own account, Hitachi is also investigating the service solutions required for customers to install and operate their own knowledge extraction platforms. Combining knowledge extraction platforms and other knowledge engineering know-how from Hitachi with customers' real data will make possible the collaborative creation of new value.

## Knowledge Extraction Platform Concept

Past approaches to knowledge extraction processing have included expert systems (deductive knowledge processing) and data mining (heuristic knowledge processing). In the future, it will be necessary to apply knowledge processing to real data systematically. Compared to past examples, the potential characteristics of real data include large, diverse and unreliable data sets which may be in analog and timeline form and possibly include personal information that needs to be handled with care. Also, the processing requirements will include not only the extraction of patterns and other knowledge from the data but also that processing be executed continuously in real time to detect abnormalities, identify trends, and so on.

Knowledge extraction platforms currently under development have a three-tiered architecture consisting of: (1) a preprocessing phase in which large volumes of real data are converted to structured data, (2) an extraction phase in which patterns, models or other features are obtained from this data, and (3) an application phase in which models are applied to data collected from sensors and similar in real time to obtain knowledge. This development is now aiming for the application stage with work proceeding on the core technologies that will support this large-volume, high-speed data processing, including distributed and parallel data processing, highly effective data compression processing, and stream data processing, and also on operational technologies including access management and security management for dealing with personal information and privacy protection.

## Initiatives for Realizing Beneficial Knowledge Extraction Processing

Hitachi operates businesses that support social infrastructure such as electric power, railways, transport, and water supply and sewage, and through this long experience has developed technologies for creating and extracting high-quality information. Systematically incorporating these diverse information processing technologies that Hitachi has accumulated over time into the knowledge extraction platforms currently under development enables "knowledge integration." Further, subjecting the data stored on

(g) CRM
Abbreviation of "customer relationship management." A management technique that emphasizes the building of long-term relationships with customers through the use of information systems. CRM seeks to retain customers, maintain and improve long-term customer satisfaction, and improve revenue through the unified management of customer information databases, purchasing and maintenance records, call center systems, and so on so that the business can respond to customers' individual needs in an attentive way.

these platforms to high-level processing can transform it into knowledge of high value to customers. The potential is also emerging for customers to utilize Hitachi knowledge extraction platforms to implement their own beneficial KaaS systems. It is not implausible to imagine the creation of virtuous circles in which the provision of beneficial services brings together people, organizations, and data that can be integrated with knowledge processing technologies to form even more beneficial KaaS systems. Hitachi intends to continue extending functionality to make the knowledge extraction platforms behind this movement even more comprehensive.

## REALIZATION OF IT ABLE TO CREATE NEW ADDED VALUE

As this article has explained, Hitachi is working to achieve innovation in social infrastructure and to advance the cloud computing and other information technologies that support it.

Marking the 100th anniversary of the company's founding, Hitachi intends to continue pursuing technology development based on a motto of "moving into the next 100 years with reliable technology." Hitachi is working to realize IT that can create new added value by pursuing the integration of control and information systems and by utilizing real-world data as information assets.

## REFERENCES


(1) "Global Construction 2020," Global Construction Perspectives and Oxford Economics (Nov. 2009).
(2) "Policies for Encouraging the Adoption of Renewable Energy to Help Establish a Low-carbon Society (Proposals)," Ministry of the Environment (Feb. 2009) in Japanese.
(3) T. Ishizaki et al., "Business Cloud and Harmonious Computing towards Intellectual Creation," Hitachi Hyoron **91**, pp. 559–563 (July 2009) in Japanese.
(4) "Hitachi's Cloud Solution: Harmonious Cloud," http://www.hitachi.co.jp/cloud/ in Japanese.
(5) "Harmonious Computing Service Platform Concept," http://www.hitachi.co.jp/harmonious/ in Japanese.


## ABOUT THE AUTHORS


Takeshi Ishizaki

*Joined Hitachi, Ltd. in 1989, and now works at the Business Development Center, Smart City Business Management Division. He is currently engaged in strategy planning and business development for IT platform products and services. Mr. Ishizaki is a member of the Information Processing Society of Japan (IPSJ) and the Association for Computing Machinery (ACM).*

Chikara Nakae

*Joined Hitachi, Ltd. in 1992, and now works at the Economic and Industry Research Department, Hitachi (China) Ltd. He is currently engaged in marketing research and development of business strategy in the Chinese market.*

Nobutoshi Sagawa

*Joined Hitachi, Ltd. in 1985, and now works at the Information Service Laboratory, Systems Development Laboratory. He is currently engaged in research on large-scale IT systems and applications. Mr. Sagawa is a member of the IPSJ.*

Yang Qiu Chen

*Joined Hitachi (China) Ltd. in 1998, and now works at Hitachi (China) Research & Development Corporation. She is currently responsible for strategy planning and coordination of research and development in China.*