IT Solutions and Services

Solutions through information utilization
Intelligent Operations

Situation assessment
Assess workplace resources
(people, goods, money)
in realtime

Future predictions
Visualize the current situation
and predict the future

Problem solving

Action planning
Formulate management strategy
and workplace measures
Control on-site equipment

Provided services

| Consulting services | Vertical services | IT platform services |

• Simultaneously improve work quality of product-using customers and reduce maintenance costs by shifting away from reactive and periodic maintenance and toward pre-emptive maintenance based on situation monitoring.

Manufacturing

Product maintenance

Maintenance service offering utilization guarantee

Situation assessment
• Collect operational data in realtime from sensors mounted on equipment

Future predictions
• Detect signs of potential faults
• Forecast supply and demand for maintenance parts

Problem solving

Action planning
• Formulate workable maintenance plans designed to achieve utilization improvement and maintenance cost reduction

Example of Global e-Service on TWX-21

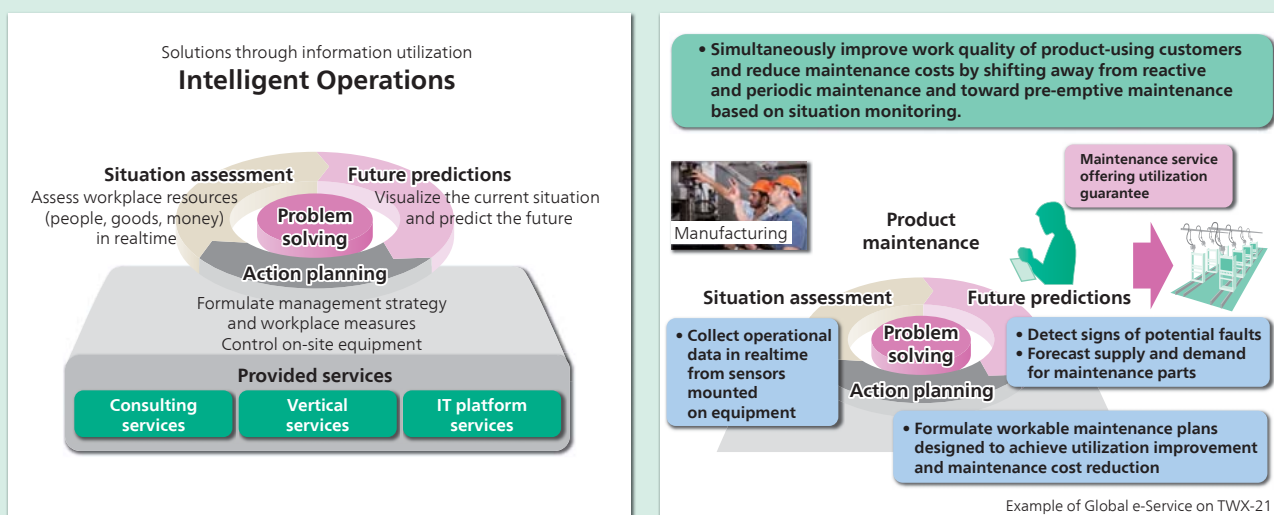**1** Intelligent Operations framework for solutions through information utilization (left) and examples of operational innovation (right)

1

Operational Innovation through Use of Workplace Information Intelligent Operations

Along with increasing corporate globalization and the rapid commodification of products and services, companies are being called on to build more competitive businesses.

Responding to these developments, Hitachi is combining business knowledge built up in the workplace with various forms of data that can now be collected thanks to recent advances in the technology behind the Internet of things (IoT), and is using this to establish solutions for utilizing information to promote new innovations under the framework of Intelligent Operations.

By acquiring and utilizing information in a multidisciplinary manner from a wide variety of business workplaces, including product manufacturing (equipment and work management), logistics (warehousing, distribution), sales and service delivery (customer, sales trends), and operation and maintenance (faults, claims), Intelligent Operations seeks to facilitate business innovation through more sophisticated decision-making on business improvement and development, activities that in the past have relied on the experience and intuition of numerous managers and other experts from each area.

Specifically, by acting as a one-stop provider of consulting

services, vertical services (services for specific industries), and information technology (IT) platform services, Intelligent Operations implements a cycle of collecting workplace information (situation assessment), using this information as a basis for predicting what might happen next (future predictions), and providing timely feedback to the workplace or management in the form of decisions made based on these predictions (action planning).

Hitachi utilizes this Intelligent Operations framework to supply solutions to various different industries, including manufacturing, energy, and healthcare.

Examples include Hitachi Enterprise Asset Management, which optimizes corporate assets by improving the productivity of various maintenance tasks, such as the optimization of equipment inspection plans, status visualization, and the rationalization of inspection work, and the supply of Global e-Service on TWX-21, which adds value to products, including ancillary services, through the global management and sharing of information across the entire product life cycle.

In the future, through the supply of Intelligent Operations, Hitachi intends to contribute to the ongoing progress of society by providing the entire world with better living conditions and business environments.
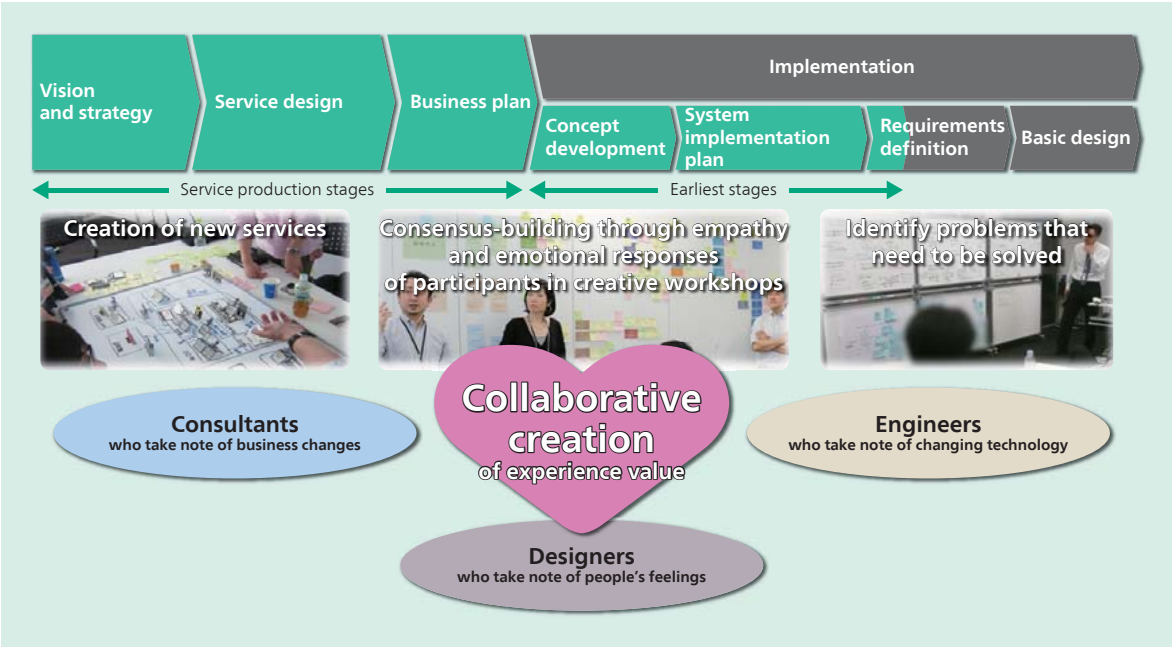
2 Experience-oriented approach for collaborative creation with customers

2

Experience-oriented Approach for Collaborative Creation with Customers

The experience-oriented approach is a technique for collaborative creation that considers people's experiences to determine the system concept and requirements definition in the very earliest stages of a project, and can be used to formulate a new vision for the customer's business, develop strategy, and design services.

It provides a framework under which designers, consultants, and engineers can work together to conduct investigations from a variety of in-depth perspectives. It can deal with a diverse range of cases by combining assorted collaborative creation techniques developed by research institutions with extensive implementation know-how built up through involvement in actual projects. Through creative workshops coordinated by a facilitator, it creates a greater sense of ownership and promotes the building of a consensus on issues such as new services or how to solve problems by drawing on the empathy and emotional responses of the participants together with a mix of quantitative data and qualitative experiences. Proposals for new services or ways of solving problems for which people feel a greater sense of ownership have a higher level of viability because they make it easier to achieve consensus among participants in subsequent implementation processes, resulting in less rework.

3

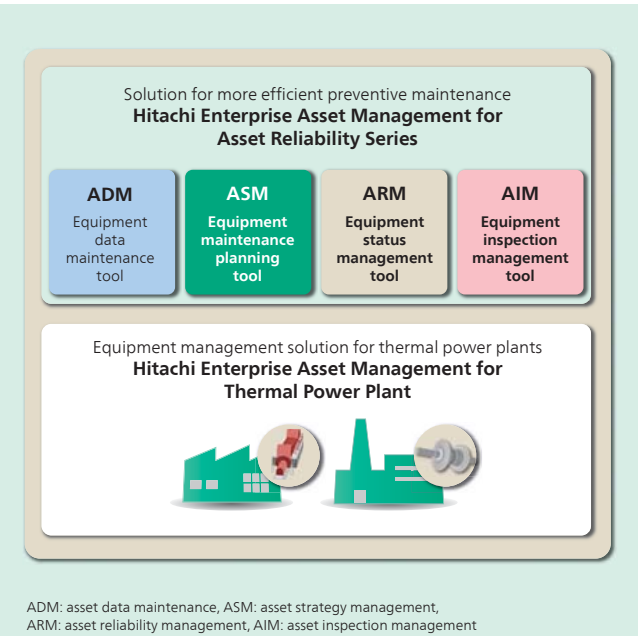### Hitachi Enterprise Asset Management Solution

There is growing demand for solutions that maintain and improve equipment utilization through accurate and efficient preventive maintenance while also minimizing the cost of equipment management. Hitachi Enterprise Asset Management boosts the efficiency with which companies can manage maintenance of their manufacturing equipment and plants. It is available in the following two forms.

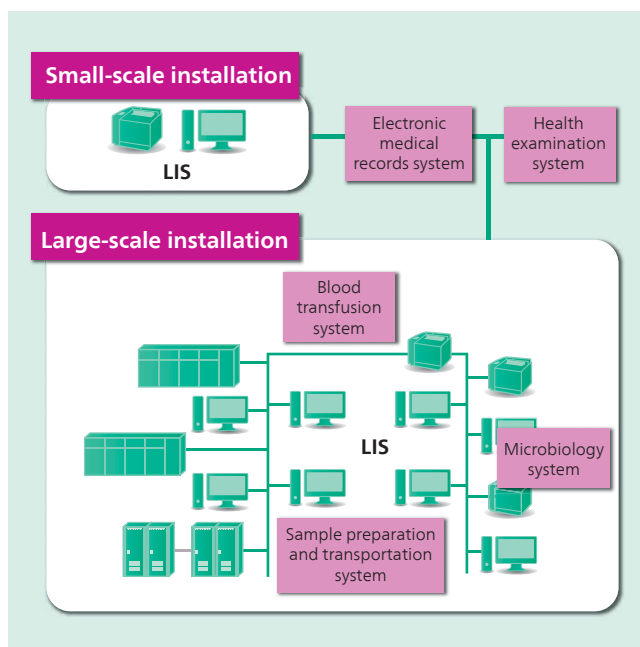(1) Hitachi Enterprise Asset Management for Asset Reliability Series

This solution for more efficient preventive maintenance provides four additional tools for use with existing equipment and asset management systems, supporting preventive maintenance planning, decision making, and inspection for manufacturing equipment and various plants.

(2) Hitachi Enterprise Asset Management for Thermal Power Plant

An equipment management solution for thermal power plants that supports the rapid installation of equipment management systems at thermal power plants by using templates that run on a SAP enterprise resource planning (ERP) module for plant maintenance.

ADM: asset data maintenance, ASM: asset strategy management, ARM: asset reliability management, AIM: asset inspection management

3 Hitachi Enterprise Asset Management Product Lineup

4 Example LIS configuration

4 Clinical Testing System for Medical Institutions LIS

Hitachi has more than 40 years of history with clinical testing systems, with laboratory information system (LIS) being its most recent product. The product is mainly supplied to testing laboratories run by hospitals, medical associations, and external providers and its end users are the laboratory technicians who staff these facilities. The main steps in the workflow for clinical testing are checking the test order entered by the doctor into an electronic medical records system or other similar system; analyzing the content of the blood, urine, or other sample on an automated testing system; and promptly updating the results in the electronic medical records system. The LIS supports team-based healthcare by providing functions to ensure that this workflow is performed smoothly and safely, including interoperation with the electronic medical records system, automated testing

systems, and other systems at the testing laboratory. It contributes to healthcare quality and better working practices through quality assurance that includes the managing analysis data accuracy and providing data on turn-around time (TAT) in terms of the entire process.

In the future, Hitachi intends to work hard to contribute to team-based healthcare and to help improve medical quality by adding additional functions to make the system safer and more secure.

5 Hitachi's Support System for Medical Examinations and Health Guidance

Hitachi's support systems for medical examinations and health guidance refers to three products that support preventive health-care and promotion of health: Hitachi's health checkup system for medical examinations, Hitachi's health checkup counseling management system for giving specific health guidance in the form of a medical checkup for metabolic syndrome, and Hitachi's metabolic syndrome simulator, which provides lifestyle disease risk simulation. The core Hitachi's health checkup system product consolidates know-how acquired through extensive experience and outcomes in the medical examination business going back more than 40 years and provides support for a wide range of healthcare practices, including complete medical checkups and other on-site health checks, mobile examination programs such as routine or resident examinations, and special health examinations.

The product is increasingly being installed at large facilities in particular because of its support for operational activities ranging from contract and reservation management to reception, examination, results output, billing, and operational records; its extensive functions for performing this work; and its flexibility and expandability.

In the future, Hitachi intends to contribute to controlling healthcare costs and to creating a society of health and longevity by incorporating additional functions and greater added value, and by supporting the promotion of health.
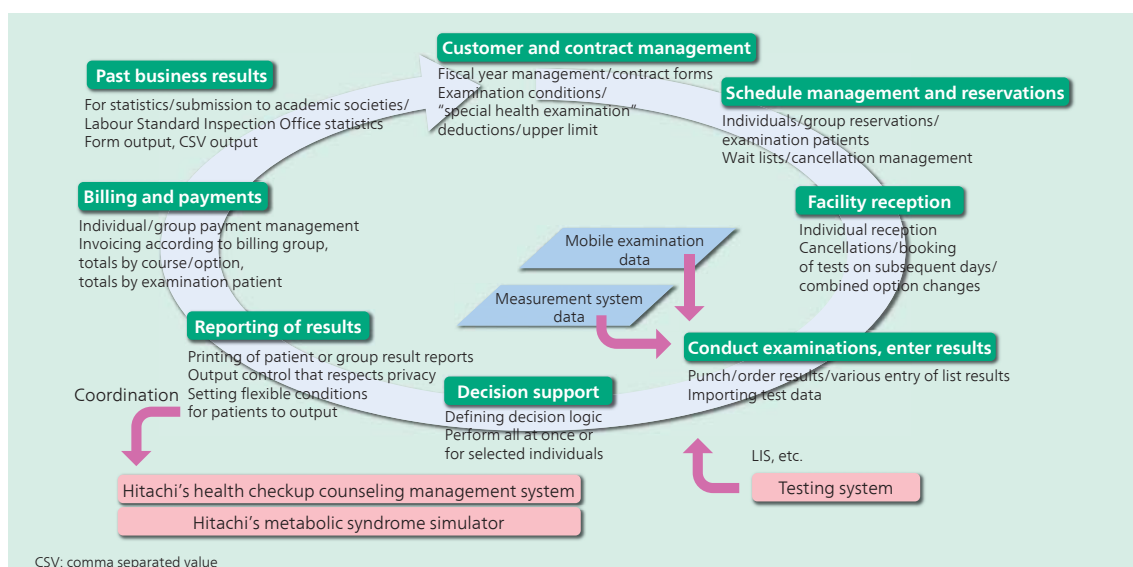
5 Overview of Hitachi's health checkup system functions
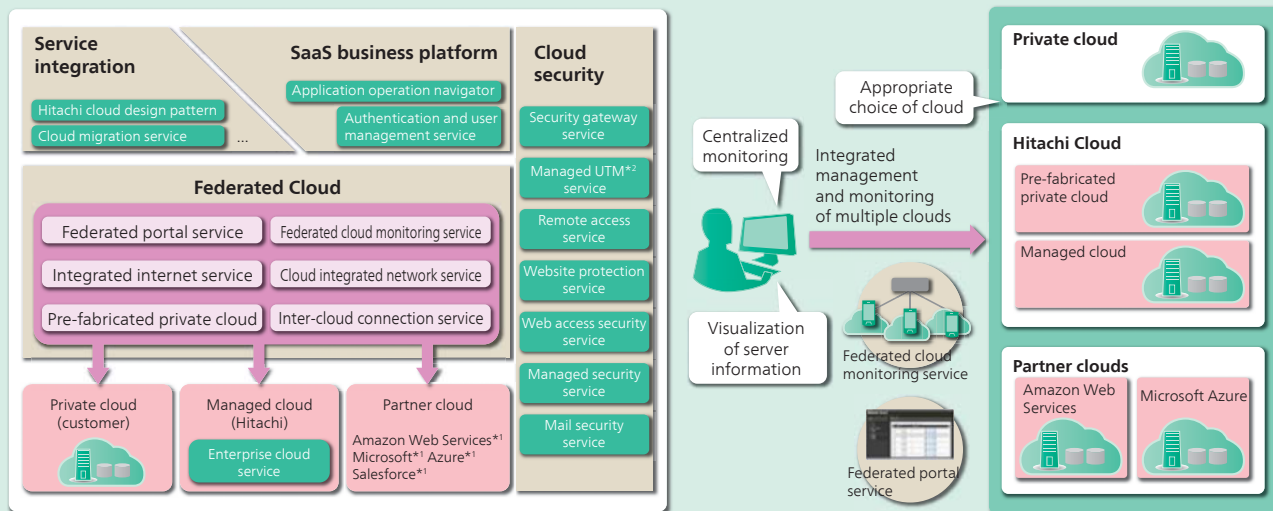
SaaS: software as a service, UTM: unified threat management
*1 See "Trademarks" on page 140.
*2 Integrated management of security functions for detecting and preventing unauthorized access based on firewalls and other measures.

6 Overview of federated cloud services (left) and management portal and monitoring functions (right)

6

Federated Cloud Services

The cloud has been growing in importance in corporate and other IT systems in recent years as a means for deploying systems or making configuration changes in a short period of time with minimal upfront costs, with aims that include global business expansion and the establishment of new businesses as well as reducing the cost of development and administration, and of ensuring reliable operation. On the other hand, a high degree of know-how is required to make appropriate choices when introducing cloud computing based on such factors as operating costs and the objectives and purposes of cloud use, with various options available including the customer's own private cloud, a managed cloud operated and administered by Hitachi, or a partner cloud belonging to a third party.

Since May 2015, Hitachi has been rolling out its federated portal service and federated cloud monitoring service. These services provide centralized management of business systems that operate across a number of clouds. The federated portal service provides capabilities for displaying and administering virtual machines and other platform information spread across multiple clouds from a single management portal with standardized operation. Similarly, the federated cloud monitoring service provides centralized monitoring of alerts from business systems spread across a number of clouds. This achieves the overall optimization of IT investment by enabling the efficient management of the customer's business systems.

Hitachi intends to enhance the global capabilities of Hitachi Cloud while making ongoing enhancements based on customer requirements.
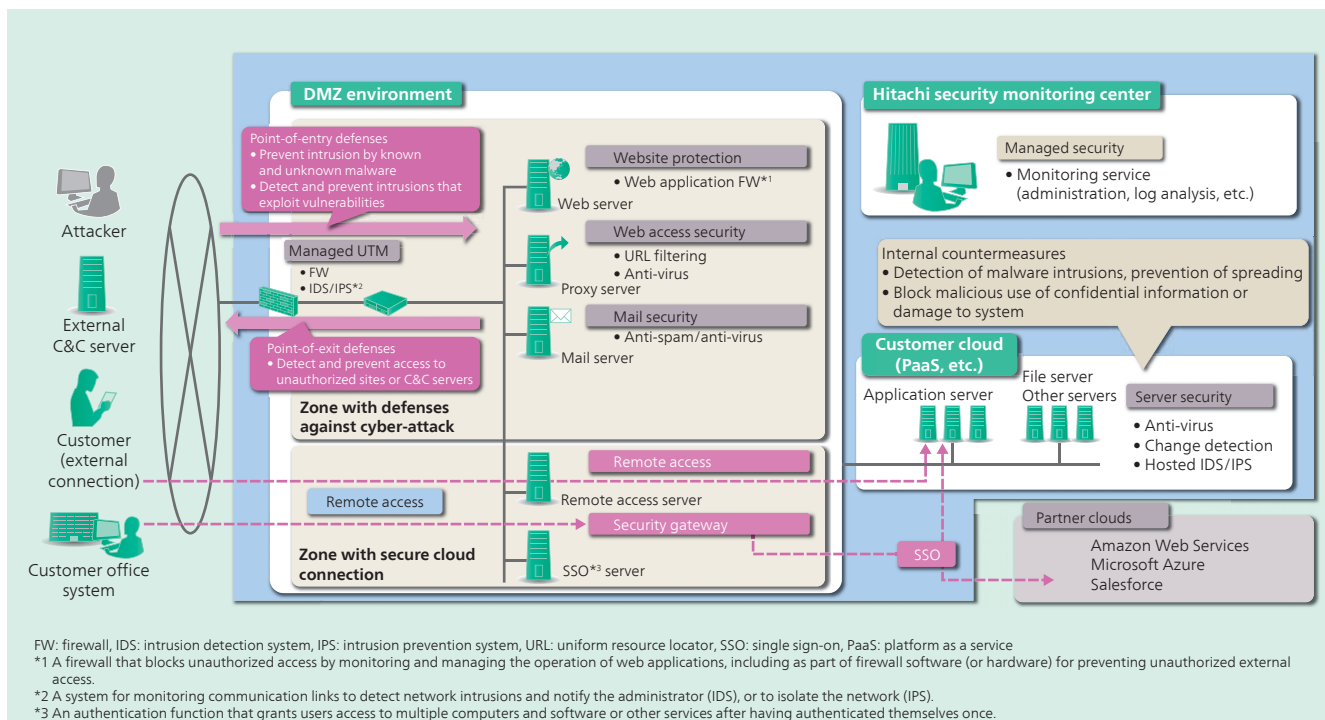
7

Cloud Security Service

Cyber-attacks such as zero-day attacks and increasingly sophisticated targeted attacks have become more advanced in recent years, with growing involvement from organized crime. In parallel with this, wider corporate use of the cloud is driving rising demand for more advanced functions for ensuring that this use is secure.

Hitachi Cloud supplies services that provide effective and timely security countermeasures against cyber-attack. Specifically, these provide defense-in-depth through an effective three-way combination of internal countermeasures and defenses at points of entry and exit. Defense at the point of entry means detecting and preventing malware or other intrusions that exploit vulnerabilities. Point-of-exit defenses detect and prevent access from within the network to unauthorized sites or command and control (C&C) servers[1]. Internal countermeasures operate on the assumption that a malware intrusion has already occurred and act to prevent their spread, and to block leaking of confidential information or damage to the system.

Along with expanding the range of available security services, Hitachi will strive in the future to make customer systems safer and more secure by offering solutions with a high level of added value, such as comprehensive services for the secure defense of "demilitarized zones" (DMZs)[2], which are subject to high risks.

*1 In the case of cyber-attacks that work by an external party co-opting computers within an organization, a C&C server is a computer belonging to the attacker that issues instructions to the co-opted computers in order to carry out the cyber-attack.

*2 A network segment located between untrusted networks (such as the Internet) and trusted networks (such as an organization's in-house network). Servers such as those for the web or e-mail that need to access the Internet are located in DMZs.

DMZ environment

Point-of-entry defenses
• Prevent intrusion by known and unknown malware
• Detect and prevent intrusions that exploit vulnerabilities

Managed UTM
• FW
• IDS/IPS*2

Point-of-exit defenses
• Detect and prevent access to unauthorized sites or C&C servers

Zone with defenses against cyber-attack

Attacker

External C&C server

Customer (external connection)

Customer office system

Remote access

Zone with secure cloud connection

Website protection
• Web application FW*1

Web server

Web access security
• URL filtering
• Anti-virus

Proxy server

Mail security
• Anti-spam/anti-virus

Mail server

Remote access

Remote access server

Security gateway

SSO*3 server

Hitachi security monitoring center

Managed security
• Monitoring service (administration, log analysis, etc.)

Internal countermeasures
• Detection of malware intrusions, prevention of spreading
• Block malicious use of confidential information or damage to system

Customer cloud (PaaS, etc.)

Application server

File server
Other servers

Server security
• Anti-virus
• Change detection
• Hosted IDS/IPS

SSO

Partner clouds
Amazon Web Services
Microsoft Azure
Salesforce

FW: firewall, IDS: intrusion detection system, IPS: intrusion prevention system, URL: uniform resource locator, SSO: single sign-on, PaaS: platform as a service
*1 A firewall that blocks unauthorized access by monitoring and managing the operation of web applications, including as part of firewall software (or hardware) for preventing unauthorized external access.
*2 A system for monitoring communication links to detect network intrusions and notify the administrator (IDS), or to isolate the network (IPS).
*3 An authentication function that grants users access to multiple computers and software or other services after having authenticated themselves once.
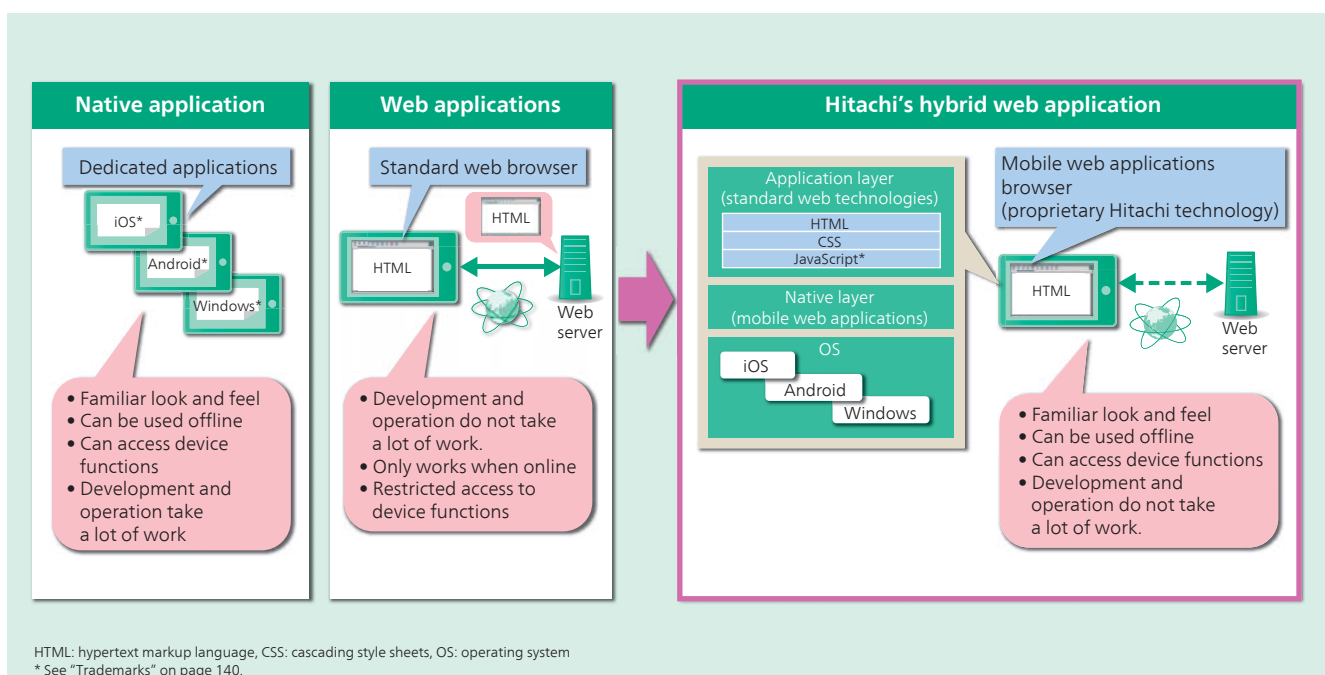
7 Overview of cloud security services

8

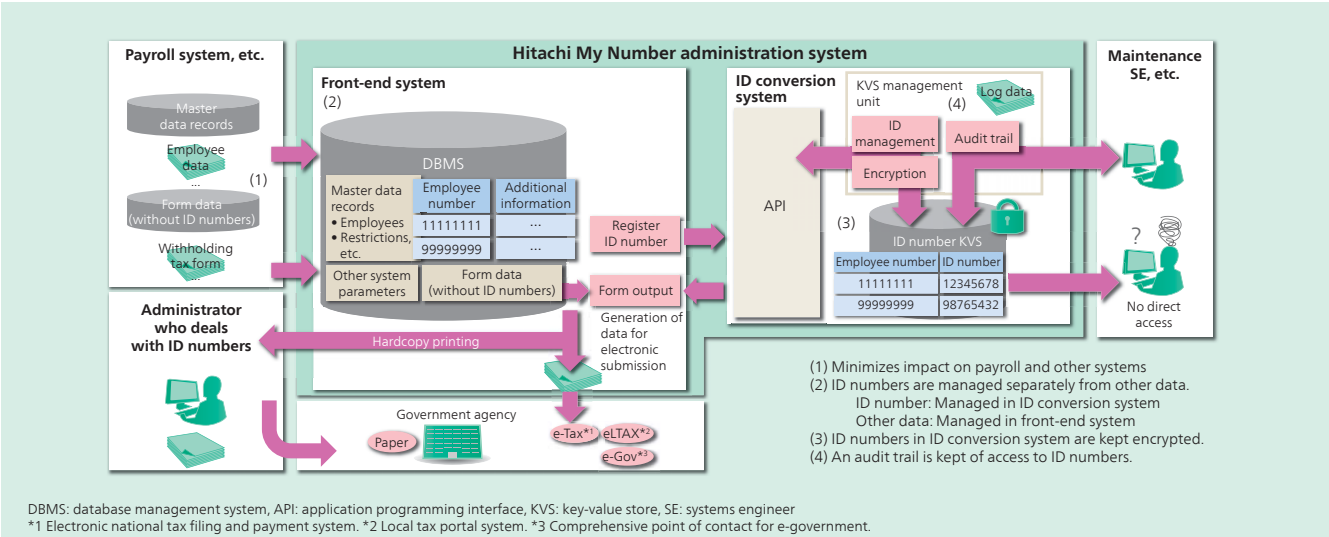### Hitachi Mobile Cloud Service for Financial Institutions

Financial institutions are making greater use of tablet computers to improve service quality, including the effective marketing of products to customers and the adoption of electronic application procedures.

Hitachi is pursuing a hybrid approach for its application architecture for smart devices that combines the use of standard web technologies for image display with the development of native applications for those aspects that need access to device functions or high performance, implementing the architecture in the form of a platform for executing mobile web applications from Hitachi Solutions Create, Ltd. Along with an execution environment for web applications that operates both on- and off-line, this platform provides device integration functions that make tablets a more practical option for business use, including using the camera to capture personal identification documents, using the touch panel for handwritten signatures, and printing application forms from a mobile printer. With the Hitachi mobile cloud service for financial institutions also available, customers can now introduce tablet systems more quickly.

Native application

Dedicated applications
iOS*
Android*
Windows*

• Familiar look and feel
• Can be used offline
• Can access device functions
• Development and operation take a lot of work

Web applications

Standard web browser
HTML
HTML
Web server

• Development and operation do not take a lot of work.
• Only works when online
• Restricted access to device functions

Hitachi's hybrid web application

Application layer (standard web technologies)
HTML
CSS
JavaScript*

Native layer (mobile web applications)
OS
iOS
Android
Windows

Mobile web applications browser (proprietary Hitachi technology)
HTML
Web server

• Familiar look and feel
• Can be used offline
• Can access device functions
• Development and operation do not take a lot of work.

HTML: hypertext markup language, CSS: cascading style sheets, OS: operating system
* See "Trademarks" on page 140.

8 Hybrid web application

9 My Number administration system

DBMS: database management system, API: application programming interface, KVS: key-value store, SE: systems engineer
*1 Electronic national tax filing and payment system. *2 Local tax portal system. *3 Comprehensive point of contact for e-government.

(1) Minimizes impact on payroll and other systems
(2) ID numbers are managed separately from other data.
ID number: Managed in ID conversion system
Other data: Managed in front-end system
(3) ID numbers in ID conversion system are kept encrypted.
(4) An audit trail is kept of access to ID numbers.

9 My Number Administration System for Private-sector Businesses

The Social Security and Tax Number ("My Number") System that entered use in January 2016 requires private-sector businesses to obtain ID numbers for staff and their dependents and to enter them on the official forms they submit to government agencies, such as those for income tax withholding payments in Japan. Because ID numbers are highly confidential, private-sector businesses are expected to handle them with care, and are criminally liable for leaks or other violations, with sanctions that include fines and prison sentences, including for top management.

Hitachi supplies a dedicated system (which it developed itself) for the secure management of ID numbers, including their storage and their entry and printing on official forms. The system incorporates ID conversion system (which Hitachi also developed itself) that uses techniques such as encryption and maintaining an audit trail to provide security measures for preventing leaks and other misuse of ID numbers.

The My Number and other ID number infrastructure has the potential to be extended to other sectors such as banking and healthcare in the future. Through the use of products and technologies such as the systems described here, Hitachi intends to help establish an environment in which ID numbers can be used securely.

10 Digital Textbook Business Targeting 21st-century Skills

The Ministry of Education, Culture, Sports, Science and Technology has formulated "The Vision for ICT in Education" aimed at instilling 21st-century skills. The consortium for the promotion of a digital text platform established by Hitachi and 12 textbook companies has developed a common platform for the digital textbooks that are at the core of this vision. Relying as they do on advanced IT, the development of digital textbooks posed difficult challenges that included supporting multiple operating systems (OSs), standardized operation, group learning, and distributing textbook content. The establishment of the consortium with support from the textbook companies came about after Hitachi proposed an approach that would consolidate these difficulties into a common platform made up of a viewer and server, and leave the textbook companies to focus on content development. The development process involved agreeing on specifications with the textbook companies and running a field trial to assess performance. The platform was introduced in elementary schools

* See "Trademarks" on page 140.   Source: *Gongitsune* (Gon, the Little Fox), a 4th-grade *kokugo* (Japanese) digital textbook published by Mitsumura Tosho Publishing Co., Ltd.
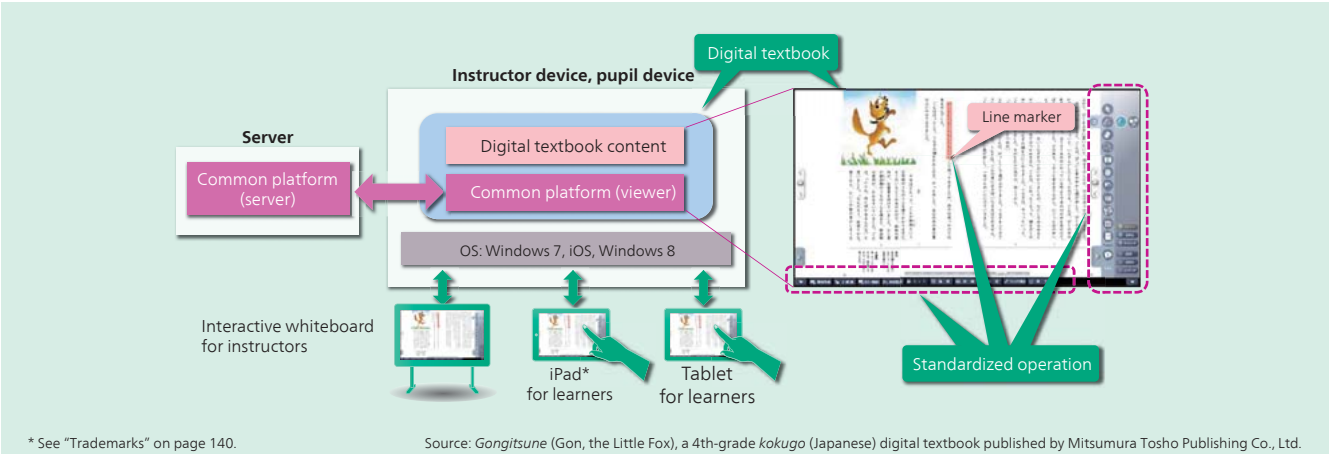
10 Role of common platform for digital textbooks and example screen

throughout Japan beginning in April 2015 and its use is still expanding. The adoption of a common platform has significantly improved the convenience of textbook use in the classroom by providing a standardized user interface in place of the diverse interfaces used in the digital textbooks published by individual companies in the past. It also includes the network distribution of textbook data and license management. Because the common platform looks after important IT components such as support for networks and multiple OSs, it has significantly reduced the development workload at textbook companies.

In the future, Hitachi intends to contribute to society in the form of educational and social infrastructure by making the common platform into a de facto standard and expanding its scope to include junior and senior high schools.

11
Global Design Cloud Service

Differences in the quality of workmanship at different facilities are becoming a problem for manufacturers as they expand their operations globally. Design in particular is highly dependent on the skills and know-how of individuals, making the achievement of consistent quality through work standardization an issue of concern. This has created a demand for design environments that can be used securely from overseas offices, and that enable data sharing and the standardization of design tools.

In response to this demand, Hitachi supplies a global design cloud service that is made up of a three-dimensional virtual desktop infrastructure (3D-VDI) for three-dimensional computer-aided design (3D-CAD) and an engineering data sharing system for sharing drawings between offices. This provides global access to data and to 3D-CAD and other design tools on the same platform. Hitachi also supplies a modeling platform that standardizes the preparation of data using computer-aided engineering (CAE), making it possible to minimize the variability in accuracy resulting from differences in designer skill levels.

In the future, Hitachi intends to add services for sharing design processes between different offices and to make enhancements to manufacturing practices (such as shorter lead times) through integration with supply chain management (SCM), manufacturing execution systems (MESs), and other systems.

ASEAN: Association of Southeast Asian Nations
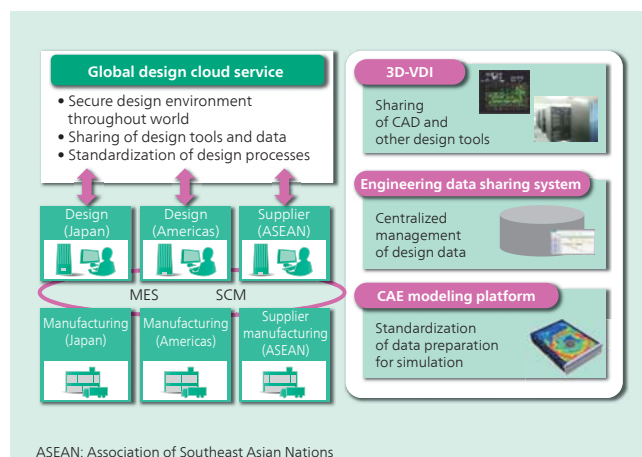
11 Cloud service for global design

Prevent malware infection from spreading
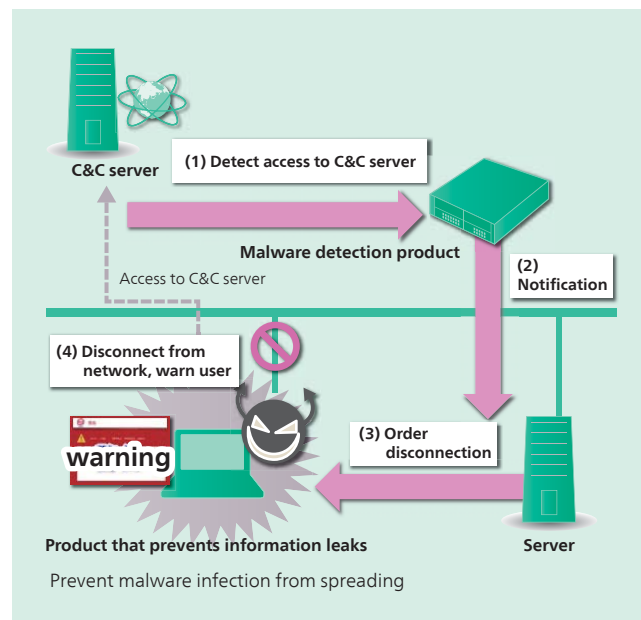
12 Interoperation between product that prevents information leaks and malware detection product

12
Solution that Prevents Information Leaks

While the measures being adopted by companies to prevent information leaks are becoming more diverse in response to changes in things like working practices and IT infrastructure, the potential information leaks that need to be countered are also becoming more complex, extending from the loss or theft of information to internal fraud and malware attacks.

In line with the objective of countering information leaks, this solution uses control of devices and networks, encryption, and information rights management (IRM) to provide the robust security demanded by corporations. Given the increasingly sophisticated malware attacks of recent years, what is important is not only to take pre-emptive steps to block attacks, but also to consider how to extend this to prevent the further spread of damage by quickly identifying and responding to malware infections when they do occur. The product that achieves this solution works with anti-malware products to take actions such as issuing warnings to infected devices or automatically disconnecting them from the network based on the severity of a detected incident. Disconnection from the network prevents the infection from spreading more widely across the internal network.
(Hitachi Solutions, Ltd.)

13
Information Sharing Platform that Supports Open Innovation at Companies

A rising number of companies are adopting open innovations that incorporate a wide range of high-level specialist knowledge and skills so that they can continue to supply products and services that deliver value in a highly competitive environment characterized by markets that are changing at an increasingly rapid pace. However, open innovation requires the sharing of important technical data, intellectual property, and other confidential infor-
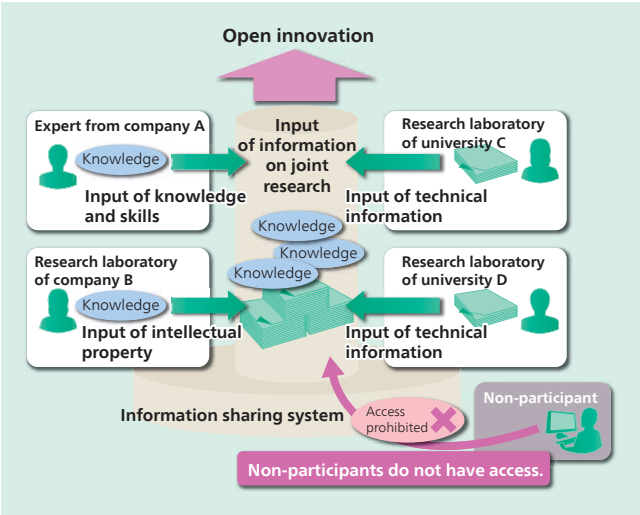
13 Using open innovation in collaborations between industry and academia

mation with partners. Achieving this requires IT infrastructure that allows companies to be confident about sharing this confidential information with external partners.

Hitachi's information sharing platform supports open innovation by combining advanced IT with know-how built up over many years in different fields to provide flexibility in the use of business content, incorporating the management of access rights for content (including after it has been supplied to external partners); document protection that can block further access to documents if necessary; document management designed to let information be updated by a number of different people; high-speed transfer of large quantities of technical data up to several tens of gigabytes in size; and a corporate social networking service (SNS) suitable for sharing information held by the people involved in particular work.

This information sharing platform is recognized for helping

invigorate and speed up the pace of research, having been adopted in joint research involving extensive open innovation between industry and academia as a way of sharing information throughout projects.
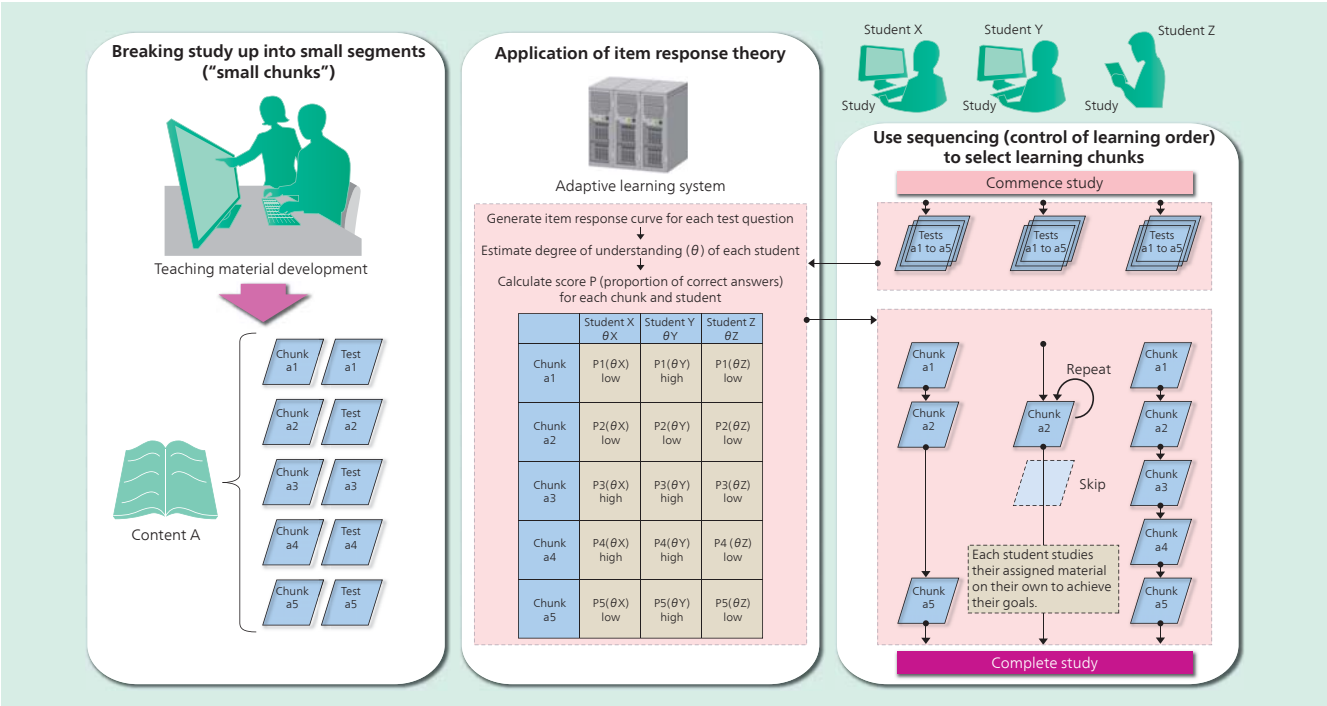
(Hitachi Solutions, Ltd.)

14
Adaptive Learning System Solution for IT Staff Training

While the spread of e-learning has made it possible to study regardless of time or place, the growing diversity of training in recent years is leading to rising demand for providing autonomous learning to students with different levels of experience and skill so that they can all reach certain goals. In response to this challenge, Hitachi has developed an adaptive learning system for determining the proportion of correct answers and selecting and recommending the required learning material based on the use of preliminary tests to obtain an accurate assessment of each student's level of understanding. This involved the service launch in December 2015 of "e-learning with navigation functions," a new e-learning system format that combines techniques such as "chunk learning" (breaking study up into small segments), sequencing (selecting the learning "chunks" based on degree of achievement of learning goals), and item response theory (calculation of preliminary test scores). Rather than following a fixed course of study, the system significantly improves the efficiency with which individual students can acquire their targeted skills by studying material that has been specifically selected for them.
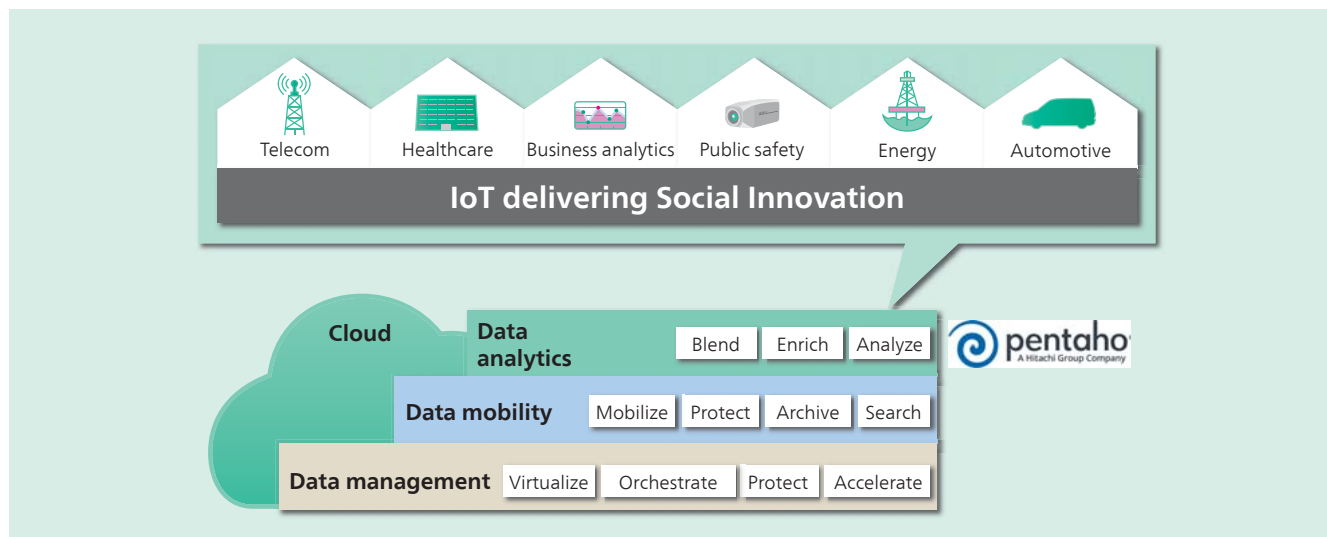
In the future, Hitachi plans to add a learning path recommendation function for utilizing big data collected on learning to provide individual students with recommendations on the mix of material they need to study based on the characteristics of the student themselves, their organization, or other factors.

(Hitachi Information Academy Co., Ltd.)

14 Adaptive learning practices

IT Platform

IoT delivering Social Innovation

Telecom | Healthcare | Business analytics | Public safety | Energy | Automotive

Cloud

Data analytics — Blend | Enrich | Analyze — pentaho A Hitachi Group Company

Data mobility — Mobilize | Protect | Archive | Search

Data management — Virtualize | Orchestrate | Protect | Accelerate

1 One Hitachi vision

1 IT Platform Solution Strategy

What makes smartphones "smart" compared to phones from previous generations is data. Data is the secret sauce for smart devices, smart cities and a smart planet. Hitachi has always believed that data and how it connects possibilities to outcomes is how people transform to thrive. Big data and the Internet of things (IoT) personify the explosion of possibilities. Hitachi has the proven expertise to deliver data-centric solutions to enable its customers to innovate and optimize. All of this is underpinned by the most comprehensive and integrated solution set in the industry.

(1) Data management

Hitachi has a flexible software-defined infrastructure that abstracts data better than anybody else and has the industry's broadest infrastructure automation to accelerate IT as a service.

(2) Data mobility

Hitachi's award-winning content mobility portfolio enables secure data access anytime, anywhere, and with any device, all the way to the cloud.

(3) Data analytics

Hitachi's growing analytics solutions enable customers to turn data into insight to make better decisions and gain competitive advantages.

Data is at the heart of everything. What Hitachi offers is an integrated and secure way to store it, access it, protect it, analyze it, and ultimately turn it into insight to drive better business outcomes.

And, Hitachi is one of the few companies in the world that can

bring a wide breadth of expertise together to ensure holistic solutions with bigger outcomes: it builds many of the things, like sensors, that generate big data; it builds information technology (IT) solutions and manages data for 83% of the Fortune Global 100; and it has deep experience in core business processes, analytics innovation, and operational technology (OT). Furthermore, it aggressively collaborates within industry and throughout society. Combining mature innovation practices and proven delivery teams, Hitachi connects what works for customers now to what is coming next.

2 Hitachi's Framework for Analytics and Big Data Solutions

Hitachi has begun a transformation to become one of the leading companies in the market to provide solutions for big data and the IoT. Social Innovation is the unifying strategy across Hitachi businesses to deliver solutions that enable healthier, safer, and smarter societies.

The company is expanding from an IT systems business to an OT business, targeting markets where it sees competitive advantage. Its strengths come from its own data and information management expertise combined with expertise across all Hitachi product lines, including deep domain expertise in industrial markets, with data scientists in its big data laboratories (Hitachi Live Insight Center of Excellence). Using this combined expertise, the company is developing a shared analytics platform with reusable components and best practices that enable it to accelerate solution development.

Hitachi has developed a framework architecture for delivering

analytics and big data solutions. Designed to incorporate key technology components that combine Hitachi IT platform and essential open source technologies, it creates a solution development framework that offers software services at multiple levels to its customers, technology and channel partners; as well as different business units within Hitachi.

The company provides an open service-oriented framework and architecture that enables full end-to-end business solutions as well as services to be consumed at different levels. These include:

(1) Infrastructure as a service (IaaS)

These services are built on Hitachi's hyper-converged Hyper Scale-Out Platform (HSP) and converged Unified Compute Platform (UCP)—with automated provisioning, monitoring and reporting from individual computing elements [such as virtual machines (VMs)] to full clusters, while abstracting specifics of the hardware so these services can be provided either on-premises or in the cloud.

(2) Big data platform services (BDPS)

These provide big data componentry such as Hadoop, STORM* for realtime processing of stream data, Spark* for in-memory analytics processing, as well as NoSQL data stores such as Cassandra*, etc. BDPS builds atop IaaS and also features automated provisioning, monitoring, and reporting at a cluster level.

(3) Data services

Including search and indexing using Elasticsearch* and Solr*; data orchestration and workflow for designing and deploying analytics solutions; and extract, transform, load (ETL) functions that are built above the platform as a service (PaaS) layer.

(4) Analytics libraries

These will include open source analytics libraries like R and Weka using Pentaho data integration (PDI) server, as well as some Hitachi-built custom analytics for customer-specific or vertical-specific analytics solutions.

(5) Heterogeneous data

Connectors that support import of different data types that can be processed with different analysis techniques. Data types include streaming data (such as network time-series data), log data, performance data (from data center elements), and others. For time-series data, the company leverages the Hitachi Streaming Data Platform managed under a STORM framework. Besides streaming data, unstructured data from text to video can be imported and indexed for future analysis. Structured data from databases and data warehouses that are imported using ETL tools and connectors (via PDI) can be used to extract contextual information as needed for analyses of both realtime streaming as well as unstructured data.

Hitachi is introducing this open framework for analytics and solutions to provide a set of complete technology solutions. With this framework, and the many IoT solutions that Hitachi offers, companies benefit through a greater ability to accelerate implementation of their big data and analytics strategies.

* See "Trademarks" on page 140.

3

Hitachi's IoT Initiatives

The connection of computers, smartphones, and other devices to the Internet has made possible a series of new services—including online shopping, social networking services (SNSs), and video streaming—that have led to significant changes in how people live, making life richer and more convenient. New developments can also be expected in the future from the IoT, which connects a variety of different devices to the Internet, and the data collected from these devices will be used to create a society that is more comfortable, safe, and secure.

In response to these expectations, Hitachi is working on initiatives that combine the cloud, mobile systems, and other IT with equipment OT built up through the development of a wide variety of social infrastructure systems in sectors such as transportation and energy; using these to overcome the productivity improvement and other challenges faced by customers. One example is a machine-to-machine (M2M) traffic solution that utilizes mobile and other IT for the efficient collection of large quantities of data
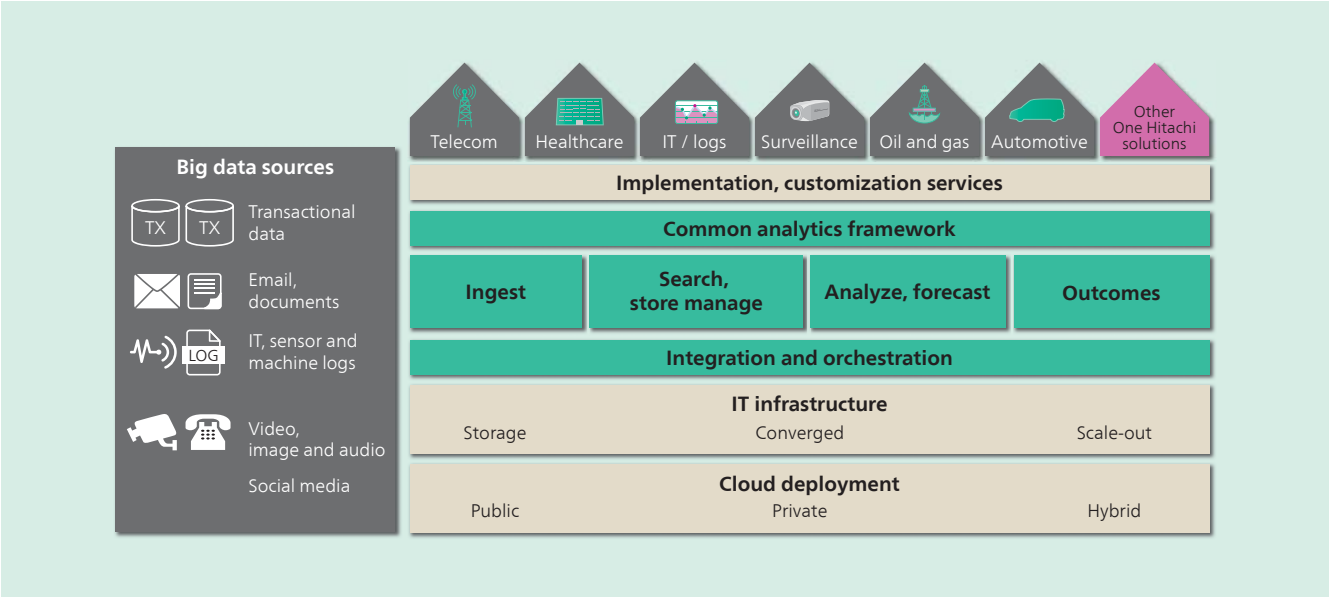
2 Hitachi's framework for analytics and big data solutions
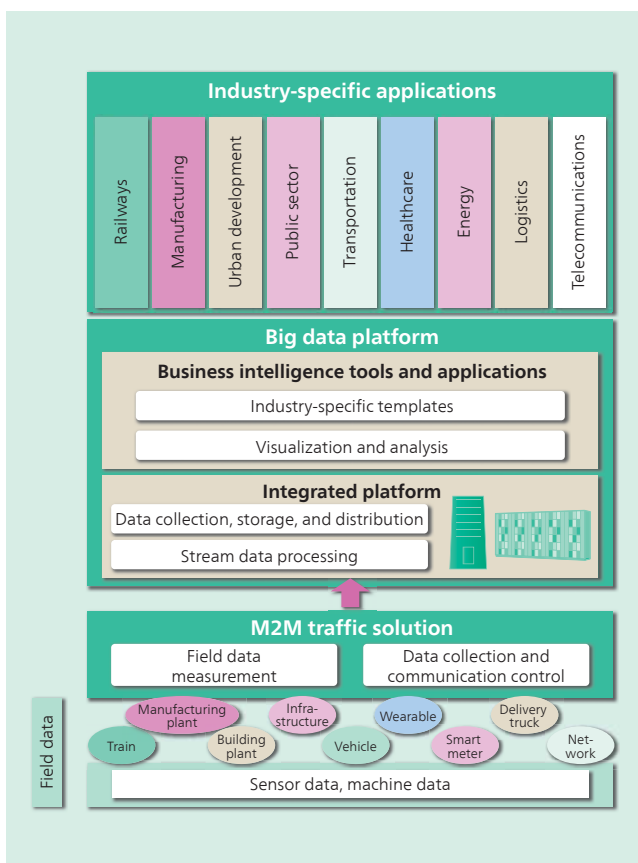
3 Block diagram of system for utilizing IoT

from workplace devices. Hitachi is also seeking to supply IoT solutions that utilize big data platforms for the storage and analysis of collected data, and industry-specific applications based on OT to boost maintenance efficiency in the railway industry and improve data center security.

Hitachi is using the IoT, which utilizes OT and IT as well as related know-how, to contribute to Social Innovation.

4
M2M Traffic Solution
High-volume Data Transfer Service

Hitachi has launched a new M2M traffic solution high-volume data transfer service for IoT that uses mobile communications to provide a secure and reliable data transfer service for large quanti-

ties of collected data in situations where networking has not previously been available.

The main features are as follows.

(1) Large quantities of data can be securely transferred to the cloud. Data stored in the cloud is available to users wherever they are.

(2) A wide-area network (WAN) optimizer incorporating patented Hitachi technology obtains maximum performance from the mobile connection to transfer data reliably and at high speed.

(3) Gateway management and connection status monitoring can be performed remotely via the cloud.

(4) The gateway, which incorporates Hitachi communication technology, can be mounted on a vehicle to provide efficient and trouble-free collection of data from cars, buses, or other vehicles.

Typical applications are as follows.

(1) Image data recorded in a mobile clinic is automatically transferred to the office via the cloud. In addition to boosting productivity by shortening the time taken to transfer images to the data center for storage, it also reduces the risk of data being leaked or lost during transportation.

(2) Data from cameras or other surveillance devices is transferred to the cloud. Remote sites can download data from the cloud as required.

(3) Large quantities of data collected by vehicles or other remote workplaces that otherwise lack network connections are transferred to the cloud (data collection).

(Commencement of service: October 2015)

5
Railway Line Equipment Monitoring System for "Smart Maintenance Initiative" in JR East

The East Japan Railway Company (JR East) is seeking to establish smart maintenance practices that optimize maintenance decision-making based on an analysis of past and present equipment status data. Their railway line equipment monitoring system forms part of this initiative. The key devices of the system are wireless sensors (sensor nodes) and data collection units (mobile gateways) jointly developed by JR East and Hitachi. The solar-powered sensor nodes measure the temperature of compression joints on feeder lines*. Efficient data acquisition is achieved by having mainte-

PC: personal computer, LTE: Long Term Evolution
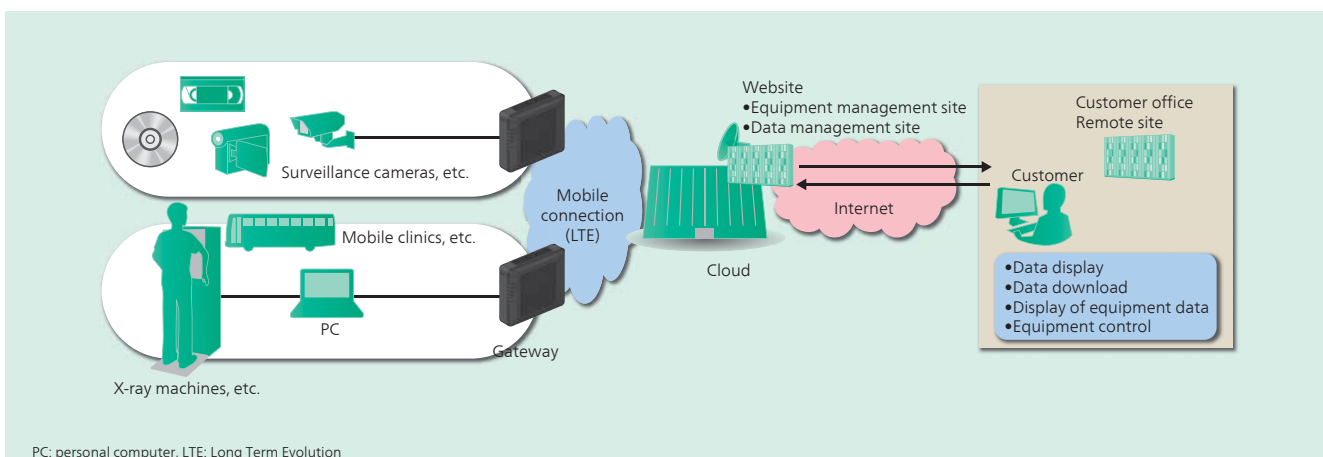
4 Overview of high-volume data transfer service (M2M traffic solution)
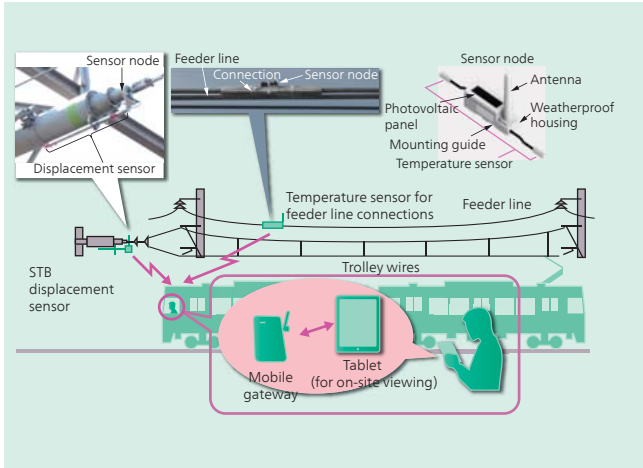
5 Railway line equipment monitoring system

nance staff on the train (maximum speed: 130 km/h) carry the mobile gateways and collect data wirelessly from the large number of sensors they pass along the railway line.

The system was initially installed by JR East on the Joban Line from Kita-Senju Station to Abiko Station in 2015. In addition to temperature, wireless sensors for measuring the spring displacement on the spring tension balancers (STBs) that tension the overhead lines are also being developed.

* A weak point in railway line infrastructure. The temperature is managed to prevent the train's load current from overheating the joints due to degradation with age.

6

Traffic Management Solutions for Data Centers

Growing dependence on use of the Internet has inevitably led to the increasing importance of data centers as part of the social infrastructure. In response, Hitachi supplies solutions that meet the need for security at data centers that control and store information. While intrusion defenses in the past have predominantly focused on the Internet, growing diversity of the form taken by attacks means that there is also a need to be concerned about internal traffic. To help maintain security, Hitachi utilizes cluster
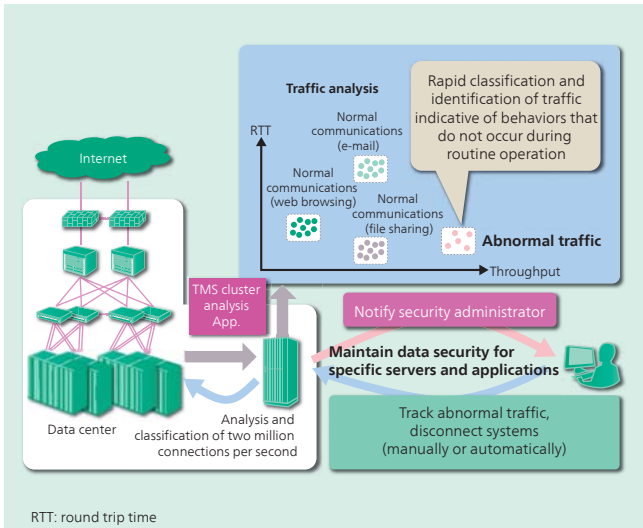
analysis techniques in traffic management solutions (TMS) to rapidly classify and identify traffic patterns that are indicative of behaviors that do not occur during routine operation (analysis and detection of abnormal traffic), and to invoke countermeasures automatically.

Similarities in the respective characteristics of telecommunications infrastructure and data centers include large networks, a high priority placed on reliability and security, the handling of different types of data, and integrated operation and monitoring. Hitachi intends to create robust data centers that form part of the social infrastructure by applying the know-how it has built up in its telecommunications infrastructure business.

7

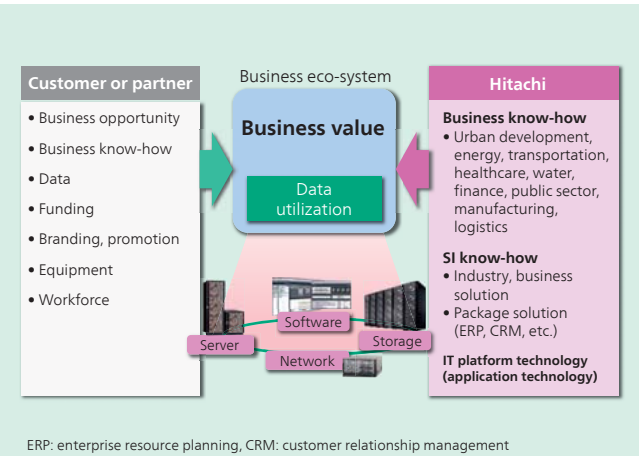### Data Utilization as Opening for Collaborative Creation of Business

With greater use of digital technology in business, large quantities of data are being generated from all forms of business activity. To achieve innovation in this era of digital business, it is essential to utilize the generated data for business purposes to identify and create new value. Hitachi intends to supply services that promote innovation by providing a platform for collecting and utilizing the generated data and linking it to the business in order to achieve the collaborative creation of new value and new businesses with customers and other partners. This means Hitachi is seeking, along with its customers and partners, to establish business ecosystems* in which each party contributes its own business opportunities, know-how, and other resources, and that are based around the new business value generated through the use of data.

Hitachi already supplies know-how that it has acquired through experience from involvement in a wide range of sectors, such as urban development and energy; know-how in system integration (SI) acquired from the implementation and operation of systems for various business processes; and IT platform technology (application technology).

In the future, Hitachi intends to continue working with customers and partners on collaborative creation of business that generates new business value.

The following articles present three examples of data utilization and describe the technologies behind the IT platforms they use.

* A system that expands corporate and consumer markets through the creation of value in a value chain that includes Hitachi and its partners and customers.

6 Example of TMS used for network security

7 Data utilization for collaborative creation of business

Techniques for using DBs

Proposal, requirements definition	System design	System improvement
Propose system configuration that matches the size of a business to satisfy performance requirements	Perform DB and operational design in a way that facilitates backup, monitoring, and data integration	Use operational data to identify cases of slow access and tune the system to improve performance

High-speed data access platform[*1]

Ultrafast database engine based on out-of-order execution principle[*2]

Server

Storage

Storage access trace using new method

Addresses (sectors)

$5\times10^?$
$4\times10^?$
$3\times10^?$
$2\times10^?$
$1\times10^?$

Significant improvement in execution time[*3]

0   1,000   2,000
Elapsed time (s)

○ Task assignment → Perform search ---- Wait for I/O to complete → Disk I/O

I/O: input/output
*1 Utilizes the results of "Development of the Fastest Database Engine for the Era of Very Large Database and Experiment and Evaluation of Strategic Social Services Enabled by the Database Engine" (Principal Investigator: Prof. Masaru Kitsuregawa, The University of Tokyo/Director General, National Institute of Informatics, which was supported by the Japanese Cabinet Office's FIRST Program (Funding Program for World-Leading Innovative R&D on Science and Technology).
*2 A principle devised by Masaru Kitsuregawa, Professor at The University of Tokyo and Director General of the National Institute of Informatics, and Kazuo Goda, Project Associate Professor at The University of Tokyo.
*3 Comparison with existing Hitachi product. Based on a standard benchmark for analytical DBs, it measures execution performance for various data analysis requests.

8 Techniques for using DBs and ultrafast DB engine

8
Example Use of Data for Collaborative Creation 1: Distribution Analysis Solution

The distribution and retail industry needs to deal not only with product sales and overcoming lifestyle challenges in a market beset by a falling birth rate and an aging population, but also with increasingly diverse lifestyles such as marketing based on things like family events or seasonal cuisine. Hitachi already markets a distribution analysis solution that takes a customer-specific approach to handling information held by retailers and offers products tailored to each customer to combine higher sales with greater customer satisfaction.

This solution combines data from such sources as point-of-sale (POS) systems and loyalty cards with companies' accumulated business know-how to enable the timely supply of products by analyzing purchases and customers to keep up with ever-changing customer preferences and other trends, and by linking products and customers together to identify new best-selling products.

The IT platform technology used to implement the system incorporates techniques for using databases (DBs) and an ultrafast DB engine.

Based on know-how that Hitachi has acquired through experience with hands-on involvement in a wide variety of industries, the techniques for using DBs involve offering customers system configurations that match the size of their business and ensure that performance requirements are satisfied; DB and operational designs that facilitate backup, monitoring, and data integration; and using operating conditions in performance tuning.

Rather than performing data access sequentially as in conventional DBs, the ultrafast DB engine uses parallel processing and rigorously improves the degree of concurrency by automatically splitting operations up into blocks that can execute in parallel. A search operation with complex search conditions that was

performed on more than two billion data items that took 40 minutes using a conventional DB was completed in 20 seconds by the ultrafast DB engine.
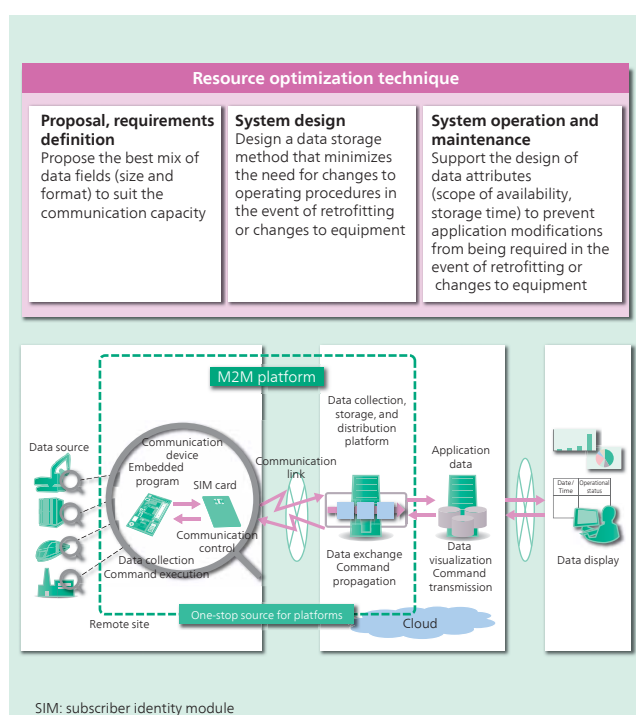
9
Example Use of Data for Collaborative Creation 2: Equipment Lifecycle Management Solution

Hitachi supplies an equipment lifecycle management solution that helps increase sales and decrease costs through the timely acquisition of operational data from equipment at manufacturing plants. The solution involves attaching sensors and communication units to individual items of equipment to collect information such as operational data, position, and fault alarms to determine in advance when to replace parts, and to ensure that replacement occurs before the equipment fails by combining this with monitoring for warning signs based on factors such as actual data from past abnormalities and the know-how of experienced workers.

The requirements for implementing this solution are an ability to collect operational data from many different types of equipment in diverse locations, and an ability to support new models or specification changes at short notice in the event of operational changes or the replacement of machinery at a site.

The IT platform technologies used for this purpose are an M2M platform that serves as a one-stop source for data collection, storage, and distribution platforms together with the communication link to the site where the equipment is located, and a resource optimization technique for ensuring that the large quantities of data that are routinely generated can be collected without interruption in accordance with the nature of the equipment and the data being collected. The M2M platform supplies core functions, from data collection to storage and distribution, as a package that is priced in accordance with factors such as the number of machines and quantity of data. In accordance with customer requirements, the resource optimization technique includes

Resource optimization technique

Proposal, requirements definition	System design	System operation and maintenance
Propose the best mix of data fields (size and format) to suit the communication capacity	Design a data storage method that minimizes the need for changes to operating procedures in the event of retrofitting or changes to equipment	Support the design of data attributes (scope of availability, storage time) to prevent application modifications from being required in the event of retrofitting or changes to equipment

M2M platform

Data source

Communication device
Embedded program   SIM card

Communication control

Data collection
Command execution

Communication link

Data collection, storage, and distribution platform

Application data

Data exchange
Command propagation

Data visualization
Command transmission

Date/ Time | Operational status

Data display

Remote site

One-stop source for platforms

Cloud

SIM: subscriber identity module

9 M2M platform and resource optimization technique

assessing the best mix of data fields to suit the communication capacity, and designing the data storage method so as to minimize the need for changes to operating procedures, applications, and so on in the event of changes to data formats or the addition or removal of data.
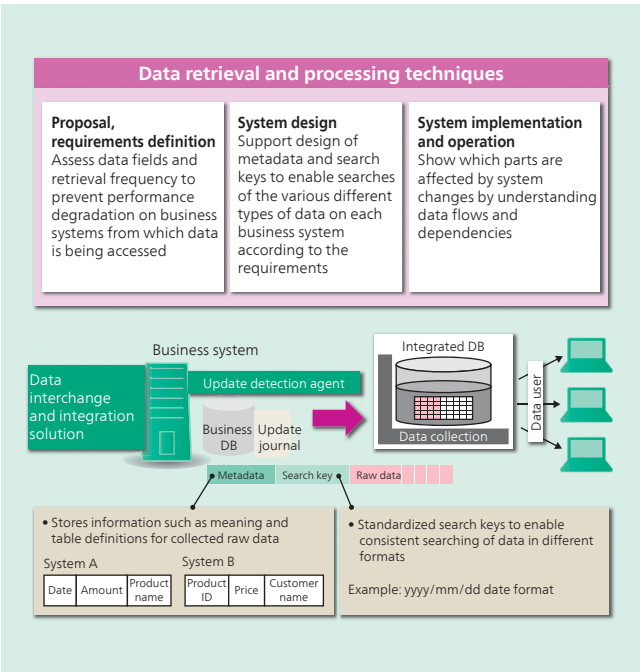
10 Example Use of Data for Collaborative Creation 3: Data Interchange and Integration Solution

Manufacturers that operate multiple sites around the world as a result of mergers and acquisitions (M&A) need timely and accurate access to production, sales, and inventory data that is managed separately by each site so that they can precisely plan production, sales, and inventory throughout the world. In response to this need, Hitachi supplies a solution that supports optimal planning by making production and sales data from sites in different parts of the world available quickly so that demand can be predicted based on sales performance and provided as feedback for production and inventory plans.

The solution provides techniques for retrieving the latest data without affecting the business systems operating at each site, data refining techniques that facilitate searching of the collected data, and services for designing, implementing, and operating the IT platform on which the solution runs.

Data retrieval prevents any performance degradation on the live business system by having an update detection agent monitor the database journal to identify the latest data. Data refining enables flexible data searching by managing the metadata that defines data meaning and the keys for consistent searching together with various types of data.

The services for designing, implementing, and operating the IT platform can show which parts are affected by system changes and help investigate ways of using data by understanding data flows and dependencies.
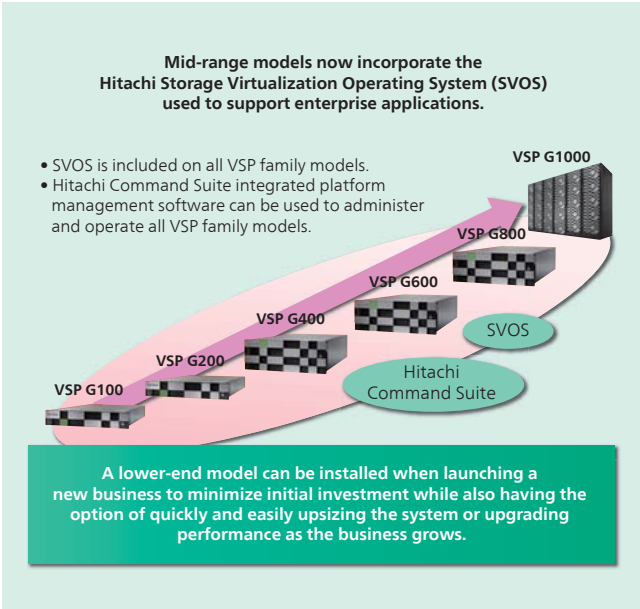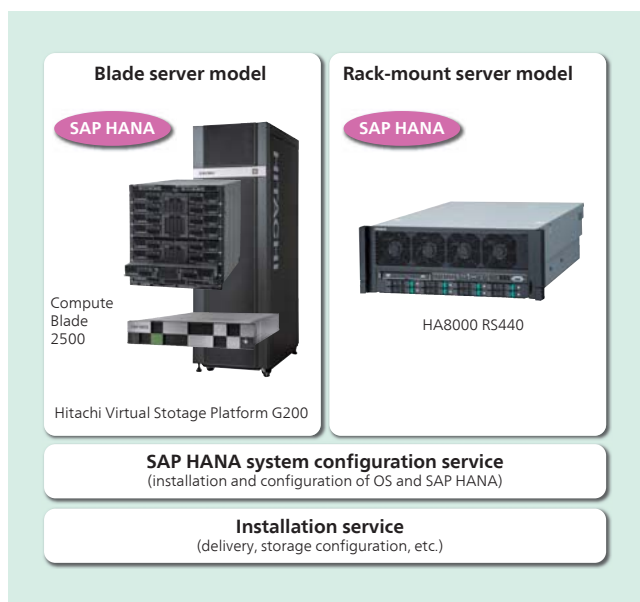

11 Hitachi VSP family

11 Hitachi Virtual Storage Platform G100, G200, G400, G600, and G800

Along with the spread of the IoT, which connects various different devices to the Internet, recent years have also seen an expansion in the use of big data analytics with the aim of creating new value by bringing different types of data together for analysis. The storage systems that provide the platforms for this activity are called on to deliver a high level of expansion and operational capabilities to keep pace with business growth and changes in strategy. The Hitachi Virtual Storage Platform (VSP) G100*, G200, G400, G600, and G800, launched against this background in April 2015, feature the advanced functions of the high-end VSP G1000 disk array system and the Hitachi Storage Virtualization Operating System (SVOS) core storage software, which ensures high reliability. By providing functions such as Hitachi's proprietary advanced virtualization in mid-range systems, these storage systems make the high-level expansion and operational capabilities of high-end systems available in small and medium-sized applications.

As all high-end to mid-range models incorporate SVOS, it is easy to upgrade to more advanced models without changing operation and administration practices. This makes it possible to minimize initial investment by installing a lower-end model when launching a new business, and then upsizing the system or upgrade processing performance quickly and easily as the business grows.

Furthermore, a new technology called "active flash" adopted by the new models increases the speed of data access by dynamically relocating frequently-accessed data on flash storage. As data is automatically relocated in an optimal manner based on data access frequency, it eliminates the past requirement for detailed preliminary system design that involved categorizing stored data, predicting likely increases in quantity, and moving data to accommodate retrofits. This not only makes it easy to add additional flash storage as data quantities grow, but it also enables the system

10 Data retrieval and processing techniques

Blade server model

SAP HANA

Compute Blade 2500

Hitachi Virtual Stotage Platform G200

Rack-mount server model

SAP HANA

HA8000 RS440

SAP HANA system configuration service
(installation and configuration of OS and SAP HANA)

Installation service
(delivery, storage configuration, etc.)

12 Hitachi Unified Compute Platform for SAP HANA

to adapt flexibly and quickly to changes in access frequency that are difficult to predict because they are influenced by factors such as changing market conditions.

* VSP G100 is only sold in Japan.

12

Hitachi Unified Compute Platform for SAP HANA

There is rising demand for realtime analysis of the large quantity of data being generated as a result of advances such as those in cloud computing and sensor technology, and its use to enhance corporate competitiveness. In response, SAP SE supplies SAP HANA*, a dedicated ultra-high-speed in-memory database for the realtime processing of large quantities of data. Hitachi, meanwhile, supplies an integrated platform optimized for SAP HANA that combines high-performance servers and storage called Hitachi Unified Compute Platform for SAP HANA (UCP for SAP HANA).

UCP for SAP HANA provides rapid configuration and operation of customer systems by supplying pre-tested optimal system configurations for SAP HANA. Furthermore, an extensive range of models and model upgrades ensures that the initial

installation is an ideal match with the size of the customer's system, and enables flexible expansion as the business grows. UCP for SAP HANA also supports use of the Hitachi logical partitioning feature mechanism for the logical partitioning of servers, improving the ease of system administration and operation by allowing a number of SAP HANA systems to run on the same physical server. Along with routine operation, a proven disaster recovery function for Hitachi disk array systems for use in emergencies satisfies the customer requirement to minimize corporate losses due to downtime.

In the future, Hitachi intends to support the creation of new value and rapid management decision-making at companies by extending its range of integrated platform solutions like UCP for SAP HANA for use as platforms for the timely and flexible provision of highly reliable clouds, big data, and other applications.
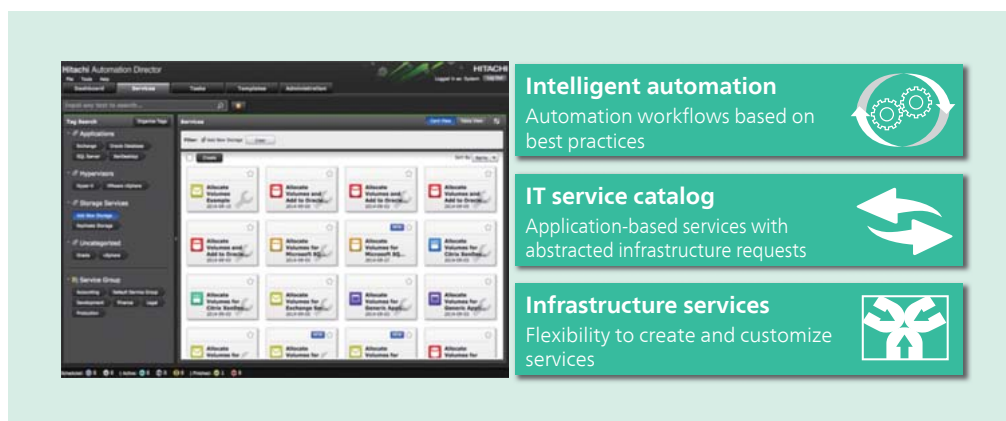
* A high-speed in-memory platform from SAP SE.
  See "Trademarks" on page 140.

13

Hitachi Automation Director for More Efficient and Automated IT Management

In the management of corporate IT infrastructure, implementation and use of cloud computing based on platform virtualization is undertaken to improve responsiveness to the business. On the other hand, common challenges include the operational costs of managing ever-increasing quantities of data appropriately, and the increasing workload being imposed on administrators with high-level skills.

Hitachi Automation Director reduces the administrator workload required for the efficient operation of IT infrastructure and overcomes these problems by abstracting the IT infrastructure and equipping products with the intelligence to select the IT resources that best match the application requirements. This makes it simple to optimize the cost of managing IT infrastructure by providing important applications with best practices in the form of a service catalog based on the characteristics of resource use by the application. Operational efficiency can be further enhanced by using the application programming interface (API) to integrate with the existing management environment, including modifying or adding to service catalog options in accordance with the specific operational requirements of each company.

Intelligent automation
Automation workflows based on best practices

IT service catalog
Application-based services with abstracted infrastructure requests

Infrastructure services
Flexibility to create and customize services

13 Overview of Hitachi Automation Director