

Services & Platforms

1 Driving Digital Innovations with Hitachi's Lumada Platform

With the spread of the Internet of Things (IoT), data is being propagated at an increasingly fast pace by businesses and consumers. This data can be a source of new value. Along with customers in various business areas, Hitachi is currently working on digital innovations to create new value.

Lumada is the product of the ideas that have come out of our collaborative efforts to create innovation. It is designed to let customers create innovations from digital technologies in a speedy and efficient manner by bringing together the wealth of expertise Hitachi has amassed over many years in the areas of IT and operational technology (OT). Lumada is composed of the three elements below.

(1) Co-creation

The customer works with Hitachi to develop data-driven strategies that transform their business, operations, products, and services. Hitachi systematizes the methods, IT tools, and spaces used to enable rapid and efficient co-creation with customers as “NEXPERIENCE.” Through NEXPERIENCE, a customer can share their issues and vision with Hitachi. Then Hitachi develops hypotheses for solving those problems, and their value can be validated through prototyping.

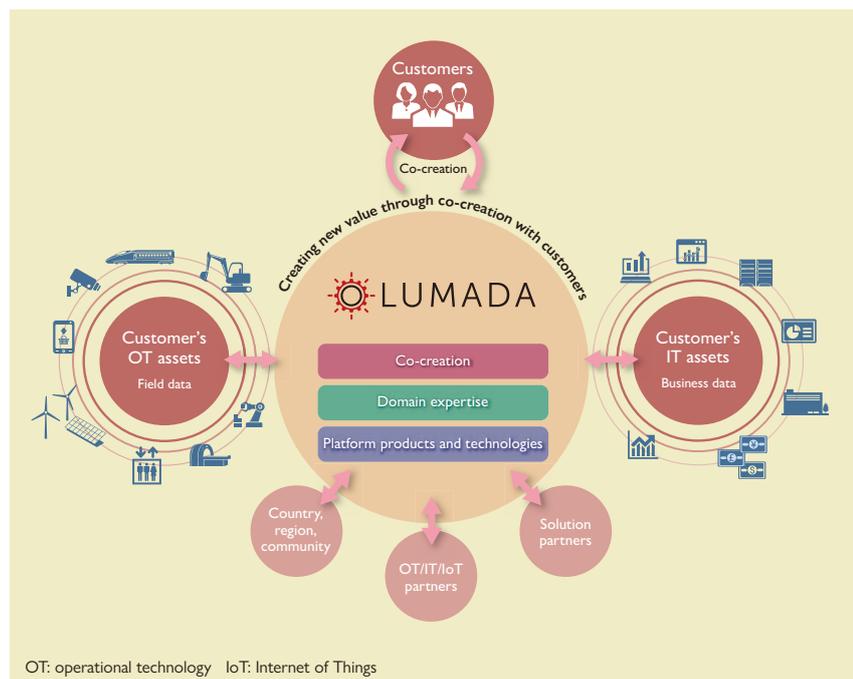
(2) Domain expertise

Hitachi's industry-specific expertise and business process knowledge can be applied customers' digital innovation in phases ranging from planning to design and implementation. Customer cases are created to identify the elements that illustrate how value has been generated from data, and the type of technologies that have been applied to artificial intelligence (AI) and analytics. These customer cases are helpful in creating methods properly tailored to the customer's management issues.

(3) Platform products and technologies (IoT platform)

An open and secure platform that enables a large number of stakeholders to share ideas and data on a larger scale is a vital requirement for rapidly bringing co-creation processes to life. By bringing together expertise amassed over the company's history, Hitachi provides cutting-edge products and technologies designed to enable the customer to rapidly create digital innovations tailored to its needs.

The IoT platform described in item (3) above has a platform architecture enabling the quick development and implementation of advanced digital solutions, and is composed of six main layers. The Edge layer relays device data to IoT systems. The Core layer creates a



1 Three component elements of Lumada

data lake and stores data. The Data Management layer gathers and processes data. The Analytics layer analyzes data using AI and analytics technology. The Studio layer provides visual representations of results. And, the Foundry layer provides IoT system infrastructure such as servers and networks. The IoT platform provides the following four benefits to software platforms:

(a) Intelligence

Advanced analytics, machine learning, and asset avatars to provide a 360 degree view and actionable insights.

(b) Composable

Open architecture to integrate with third-party alternatives and different elements to deliver best outcomes.

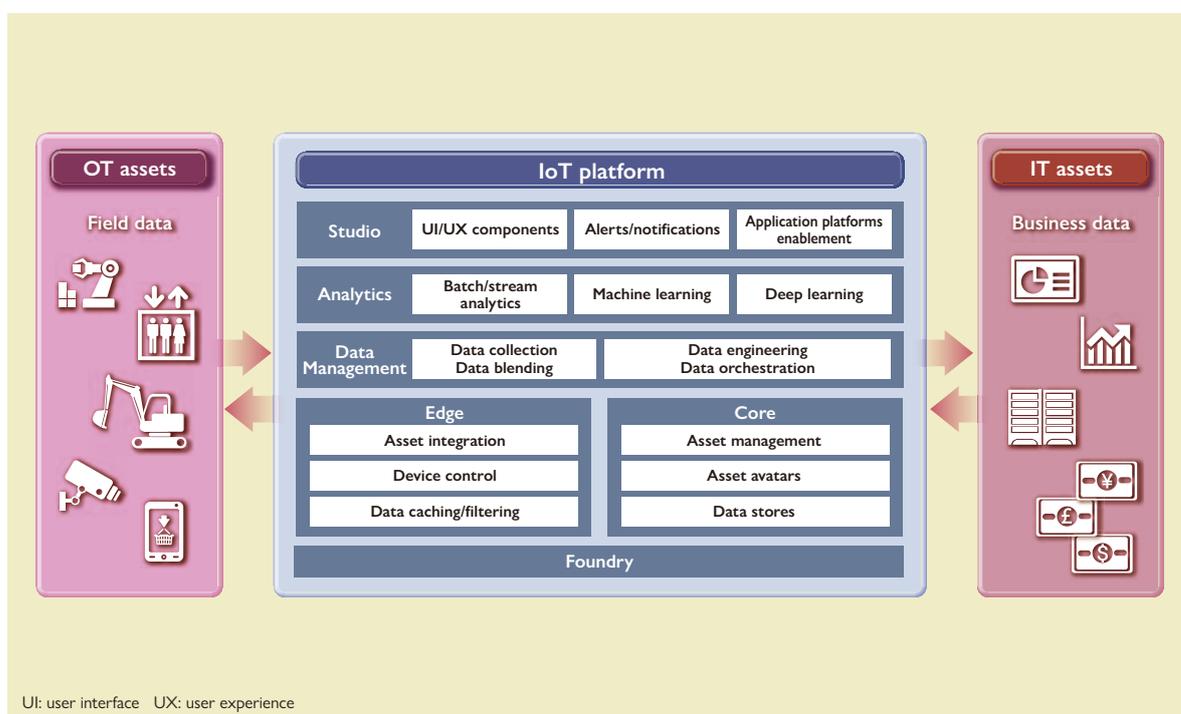
(c) Secure

Security of assets, data, identity, and access management.

(d) Flexible

Runs on-premises and/or on cloud to meet customer's needs.

Recent achievements and results are illustrated below, centering on the IoT platform of item (3) above as an example.



1 Lumada's IoT platform architecture

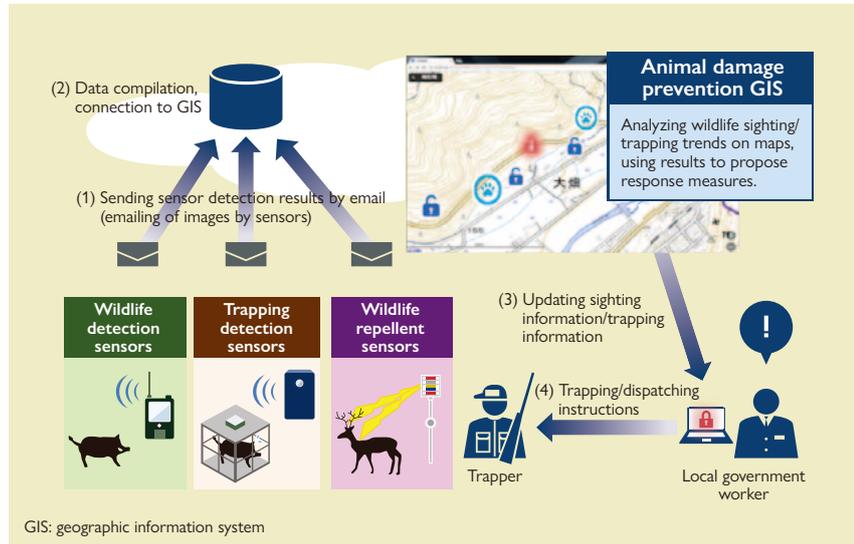
2 Use of ICT-based Wildlife Damage Prevention System in Goto, Nagasaki

The recently expanding habitats of wildlife such as wild boars and deer has increased the severity of crop damage and become a major issue of public concern in rural Japan. With licensed hunters advancing in age, the efficiency of trapping is questionable.

With an urgent need to remedy the crop damage being caused by its local population of wild boars, Goto City in Nagasaki Prefecture has started to use a wildlife damage prevention system provided by Hitachi. The system is connected to information from wildlife detection and other sensors and to a geographic information system (GIS) designed for wildlife damage prevention. The system provides map-based notifications and visual displays depicting the state of wildlife sightings and trappings. It has been able to assist with efficient trap setting and comprehensive planning. The number of wild boars trapped in

Goto has increased more than five-fold relative to the previous year, and trappers have become able to patrol efficiently by getting a clear picture of trap states in advance.

The system is provided as a cloud-based service (the wildlife damage prevention assistance service), enabling a large number of users to start using it rapidly. The system's applications will be expanded in the future by integrating it with services for solving various other problems affecting municipalities and their residents.



2 Overall illustration of wildlife damage prevention assistance service

3 Assisting Total Production Process Optimization with Hitachi Digital-twin Solution for Manufacturing

The recent rise in digitalization has generated manufacturer interest in the creation of efficient production systems through digital twinning¹.

An important requirement for achieving this goal is to compile all of the various types of data generated by factory processes at physically separate locations, and to reproduce all the processes in a digital space. Trial data analysis can then be continuously performed with the aim of total optimization. The solution makes it easy to choose and compile OT/IT data accumulated separately by several different processes. It provides a data usage platform that continuously helps improve productivity through AI analysis and simulations. Specifically, it uses the graph database² concept to create an original data model composed of production operation data and 4M data³. This model makes it easy to obtain visual representations of the connections among all of the many different operations and data spanning every production process. It enables production managers and other staff without IT-expert knowledge to easily extract and integrate the required data when needed, helping speed the data analysis plan-do-check-act (PDCA) cycle.

Before its release, the solution was used in a joint demonstration test done at a model vehicle manufacturing plant. The test was part of Hitachi's collaborative creation⁴ efforts with Toyota Motor Corporation to create a high-efficiency production model.

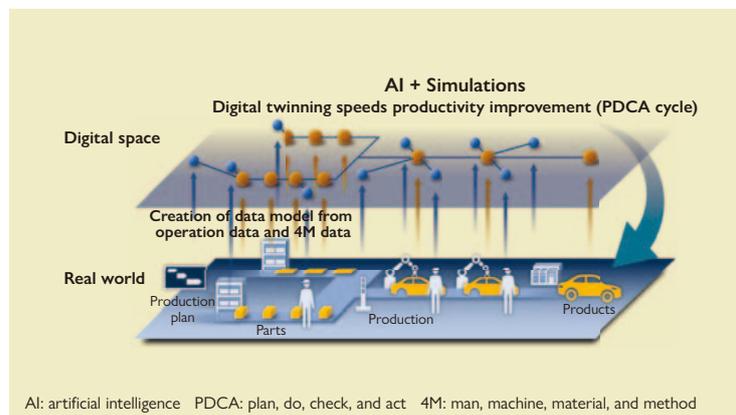
*1 The concept of faithfully reproducing factory- and product-related physical-world events in a digital space in real time. A technique used to model actual production plants and products for delivery.

Facilitates real-world plant control and management by creating a simulation space that imitates the real world, serving as its twin.

*2 A graph-structure database that depicts objects and the connections among them in abstract form. Enables the retrieval of data matching given conditions by tracing the connections starting from a given node (person or object).

*3 Industry term for production data related to personnel, equipment, materials, and methods. 4M stands for man, machine, material, and method.

*4 Hitachi News release: "Toyota and Hitachi Embark on Collaborative Creation Aiming to Build a High-Efficiency Production Model Using IoT Platform," (Oct. 4, 2017) <http://www.hitachi.com/New/cnews/month/2017/10/171004a.html>



3 Hitachi digital-twin solution for manufacturing concept

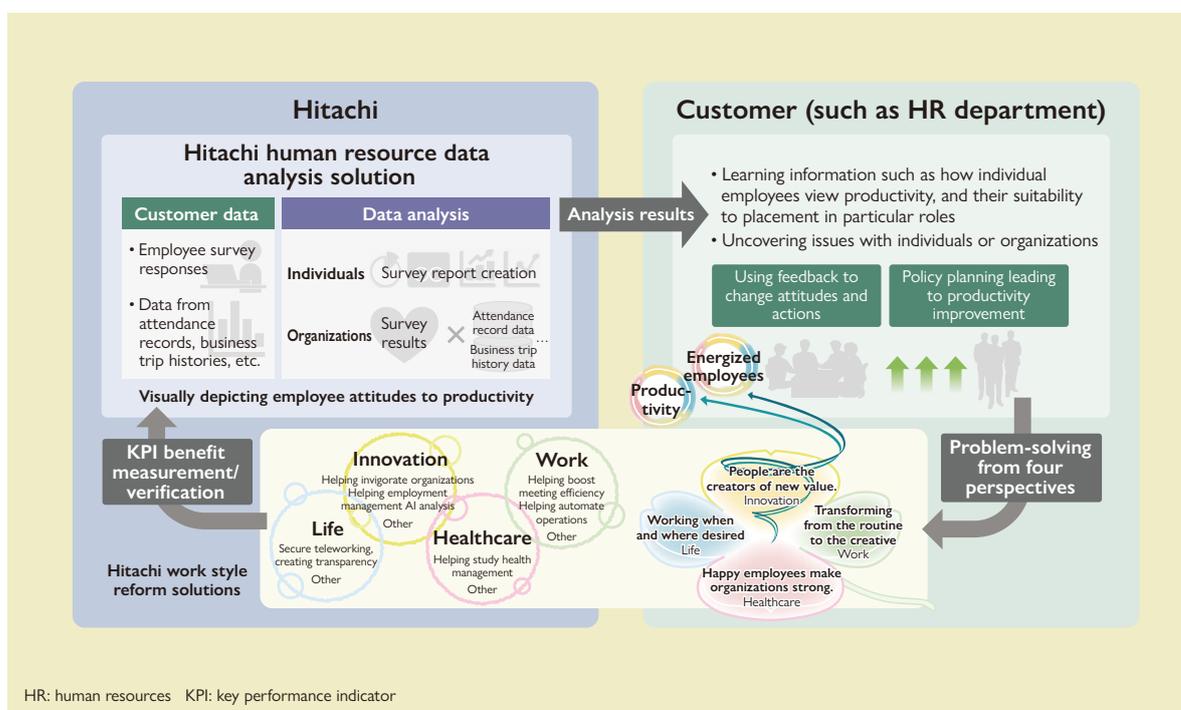
4 Accelerating Work Style Innovation with Hitachi Human Resource Data Analysis Solution

Work style reform has recently been gathering pace in Japan in response to legal reforms on lengthy working hours and the shrinking working population. To stay on top of this trend and ensure their sustained growth, companies need to improve productivity by improving the personal growth of their employees and the strength of their organizations.

The Hitachi human resource data analysis solution provides data that visually depicts knowledge for areas such as individual employee productivity and job placement. The visually depicted knowledge data can be put to uses such as creating more precisely targeted personnel policies or providing the optimum feedback to promote changes in attitude among individual employees.

New factors contributing to productivity improvement can be derived by using AI to analyze the knowledge data uncovered by the solution in combination with action data related to areas such as work attendance records and business trip histories.

The solution can also be used to find the benefits or effects of various work style-related measures such as teleworking and robotic process automation. The results can be applied to the PDCA cycle for more effective work style reform, helping improve employee/organization innovation creation and productivity.



4 Example use of Hitachi human resource data analysis solution

5 Hitachi AI Technology/Warehouse Operational Efficiency Improvement Service

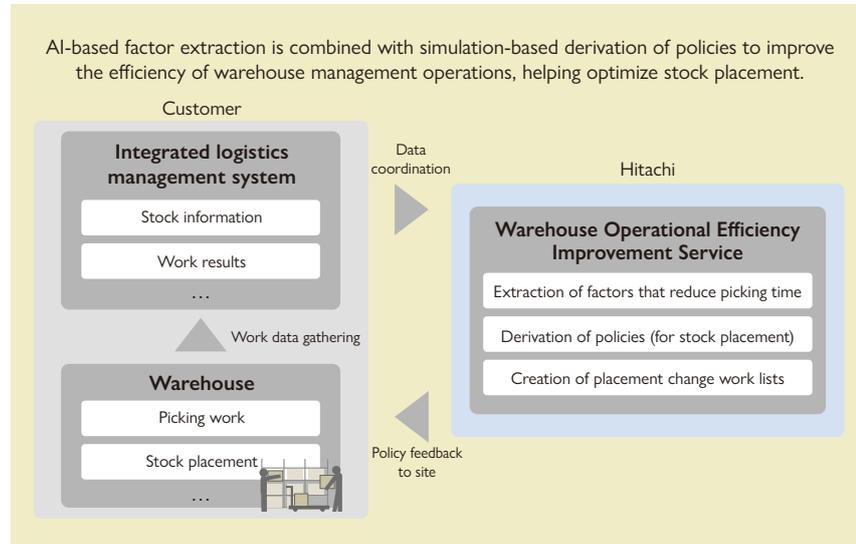
The distribution and logistics industries have recently been generating a growing demand for methods of increasing operational efficiency in response to a number of different management issues now facing them. These issues include an increasingly diverse array of products and services, a shrinking workforce, and heavier workloads being generated by larger quantities of goods resulting from the growing use of electronic commerce.

Hitachi has responded to these issues by examining warehouse operations, which form the hub of the distribution industry. To enable operations to be optimized for warehouse conditions, the company has developed the Hitachi AI Technology/Warehouse Operational Efficiency Improvement Service. The service uses AI to analyze warehouse data and the

work records of operators, and applies the results from the AI to improve operational efficiency on an ongoing basis.

The service uncovers problems such as on-site operational efficiency improvement efforts that are reaching their limit, and operations that are becoming concentrated on particular skilled employees. The AI discovers factors that greatly affect these types of operational problems and that have so far gone unnoticed, and response measures are proposed for them. For example, warehouse slotting plans expected to improve picking work efficiency can be provided along with lists of specific changes in terms of how goods can be positioned better. By providing these resources, the service reduces the time needed for the picking work and helps optimize it continuously.

To provide solutions to customer issues and comprehensive assistance for business growth, Hitachi will consider using the service to augment its lineup of services designed for streamlining areas such as staff placement and stock quantities.

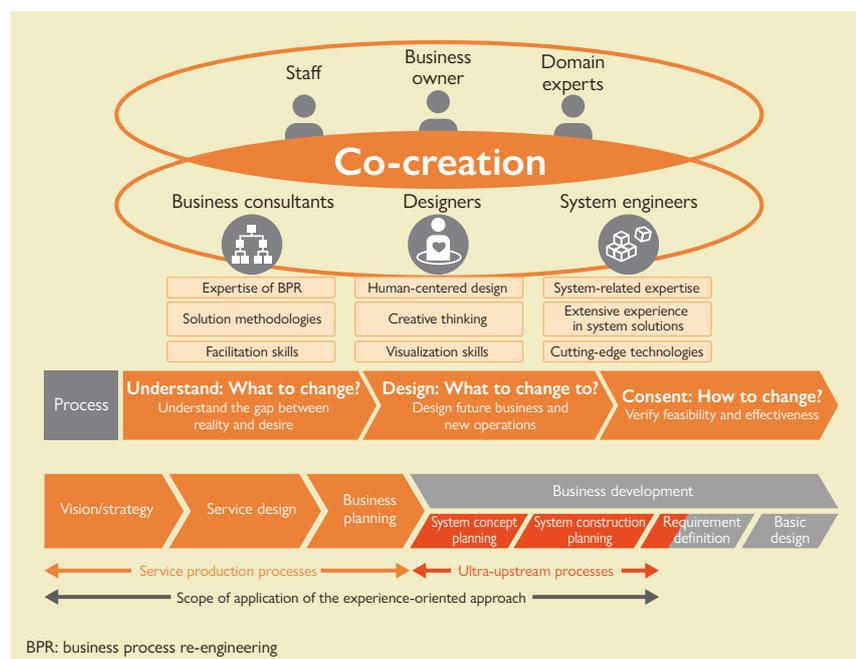


5 Application of Hitachi AI Technology/Warehouse Operational Efficiency Improvement Service

6 Experience-Oriented Approach

Hitachi's experience-oriented approach is a method and set of activities used for supporting customers' business process re-engineering and creating new customer services through co-creation. It focuses on the value of personal experience gained through business operations and services, and on combining the expertise of both the customer and Hitachi. Since Hitachi began working on this experience-oriented approach effort, it has supported the formation of consensus among all the stakeholders during the ultra-upstream process project of building IT systems for a various customers. Through these efforts it has accumulated an extensive track record of achievements that improve business value by developing systems without reworking.

The scope of application of experience-oriented approach has recently been expanded to encompass the further-upstream service production processes done to create new customer business areas and services. In the case of co-creation with Mitsui Fudosan Co.,



6 Experience-oriented approach overview and scope of application

Ltd., for example, Hitachi conducted co-creation among multiple interdepartmental members. This approach was effective for extracting input and feedback about creating new services for office buildings from all the relevant parties, and for deriving the direction of future new services premised on the use of digital technologies.

In the future, Hitachi will continue to contribute to customers' further realization of digital shift by expanding the experience-oriented approach itself, conducting prototyping and demonstration-testing of ideas driven by digital technologies and building on those achievements.

7 Providing Comprehensive Assistance for Data Use with Hitachi Data Science Platform

Manufacturers with plants and public infrastructure providers such as rail, power, and gas utilities are looking toward the use of data for speeding maintenance, optimizing operations, and creating new services, and for use in operations related to the IoT and big data. Corporate data use has the following three issues:

- (1) Data analysis preparation takes up about 80%^{*1} of the man-hours needed for all analysis work.
- (2) OT data^{*2} must be put into a standard format to enable its use.
- (3) IT data^{*3} becomes siloed by organizations, making correlation discovery difficult.

By providing a bird's-eye view of correlations among OT/IT data and discovering data correlations of applicable value, Hitachi data science platform (DSP) can be a useful tool for analyzing data effective for business.

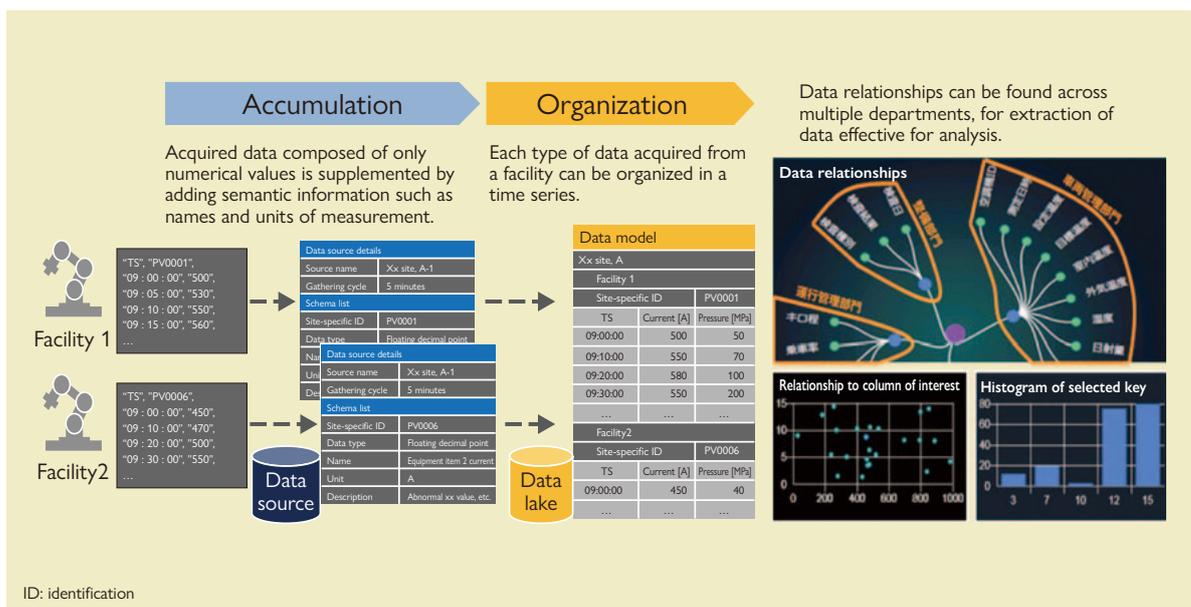
The gathered OT data is stored in an understandable form for analysts and organized chronologically to provide systematic data management. IT data managed in a compartmentalized manner by each department can be viewed together in a single location. Data correlations are also made visible, enabling extraction of data effective for analysis.

DSP creates a bird's-eye view of OT/IT data correlations to discover data connections of applicable value, promote data analysis effective for business, and step up the pace of OT and IT data use across multiple departments.

*1 Value estimated from project experience within Hitachi, based on the amount of time from the start to the end of analysis work.

*2 Many different types of site data obtained from equipment and sensors.

*3 Data from sources such as operation systems.

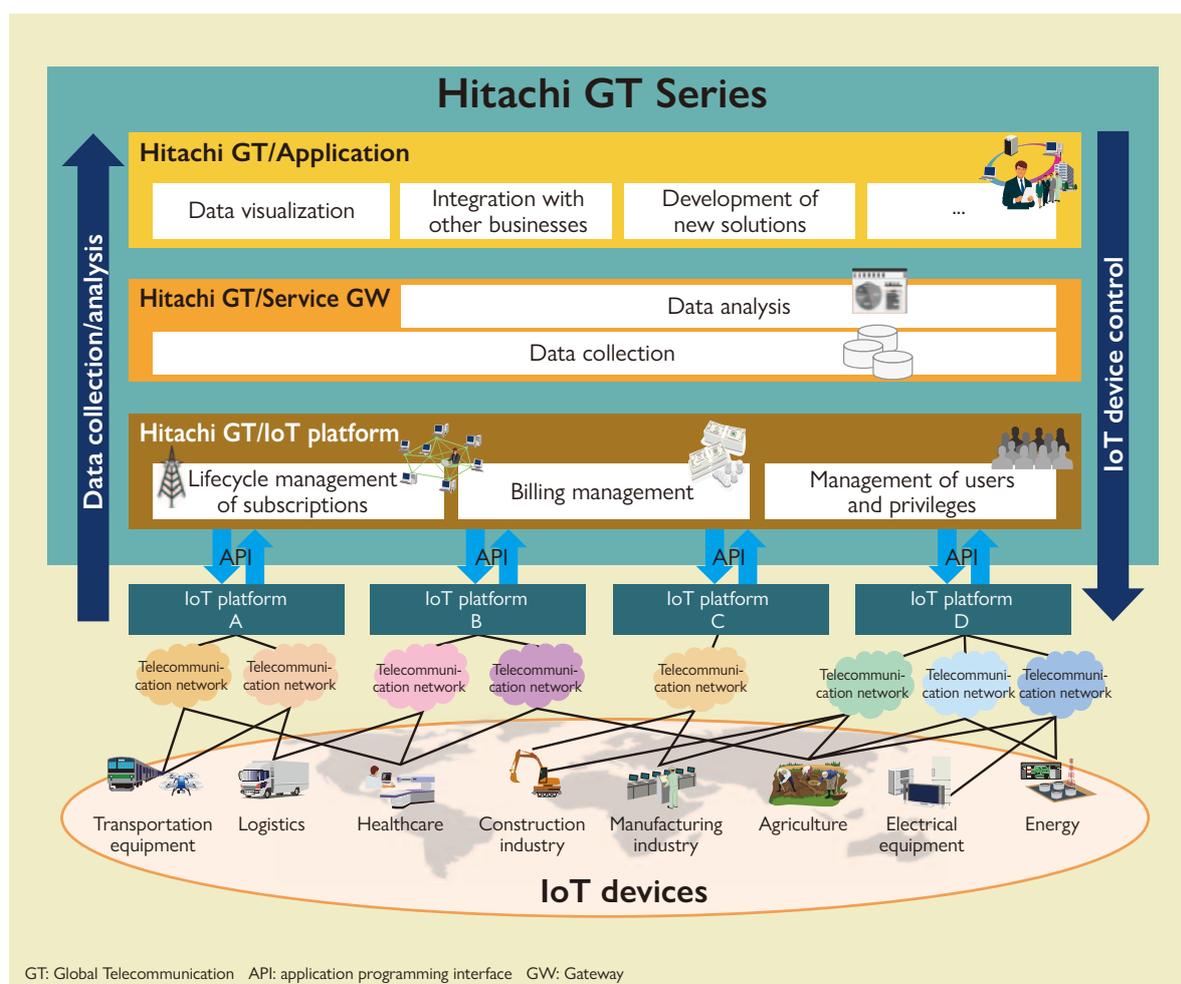


7 Benefits of Hitachi Data Science Platform

Hitachi Global Telecommunication (Hitachi GT) Series is a series of platforms designed to create value for worldwide IoT businesses, providing total IoT solutions to connect, collect, and utilize data on a global scale. Japanese telecommunications giant, KDDI Corporation, is already using Hitachi GT Series as the core of their global IoT platform, KDDI IoT Worldwide Architecture*. Hitachi GT Series enables the creation of unprecedented value, development of new services and solutions, using standard application programming interfaces (APIs) to flexibly connect with IoT devices worldwide, such as vehicles, construction machinery, plant equipment, and a range of other “things”.

The Hitachi GT Series is composed of three layers. Hitachi GT/IoT Platform takes on a major challenge for IoT businesses: worldwide connectivity. It offers service coverage globally and takes care of negotiations with local mobile network operators on behalf of IoT businesses. In addition, it provides lifecycle management of subscriptions, billing management, and management of users and privileges. Hitachi GT/Service Gateway (GW) provides data collection, centralized management, and analysis. Hitachi GT/Application provides several analysis platforms to analyze and utilize operational information visually, providing visualization of data, coordination with other businesses, and helping to create value through the development of new solutions.

* <http://www.hitachi.com/New/cnews/month/2018/06/180607.html>



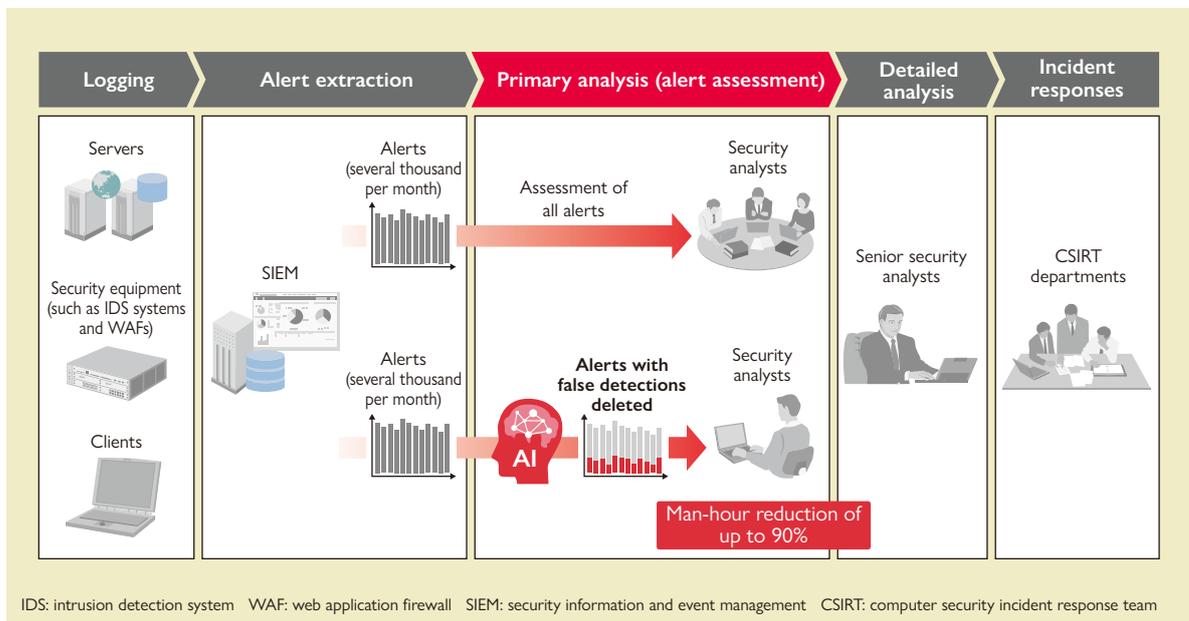
8 Hitachi GT Series overview

9 Use of AI for Increasing Efficiency of Security Surveillance Operations

Today's ever more advanced and complex cyber-attack methods have caused the security industry to shift its focus to early detection and responses through operations such as round-the-clock surveillance and log analysis. At the same time, the growing volume of surveillance targets being generated by the rise of the IoT is causing daily inflation in the volume of alerts from systems. The result is a high workload for the security analysts who handle surveillance operations.

Hitachi's AI solution for increasing security surveillance operation efficiency assists the operations of security analysts by using AI to learn how log or alert information correlates with the results of decisions made by security analysts. The results are then used to make assessments automatically. Alerts generated by cyber-attack detection were previously assessed by security analysts drawing on advanced knowledge and expertise. These assessments can now be made using an AI technology provided by Hitachi (Hitachi AI Technology/H).

The solution has no surveillance target system or log analysis system restrictions, and can be applied to a wide range of security surveillance operations. It helps improve quality while increasing efficiency by providing AI assessment criteria that ensure no incidents are missed.

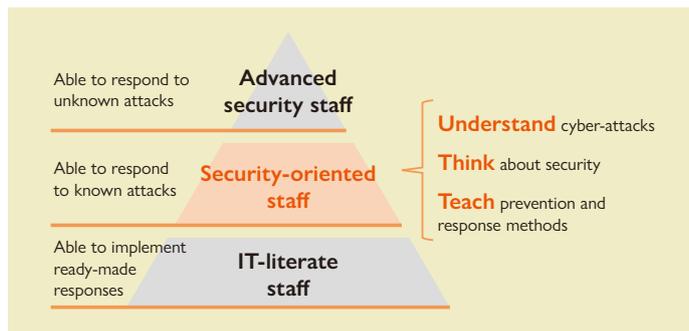


9 Overview of AI solution for increasing security surveillance operation efficiency

10 Reforming Security Organizations by Providing Staff Training Incorporating Hitachi Expertise

The risk of cyber-attacks targeting critical infrastructure or particular organizations has been rising recently, and the attack methods are becoming more advanced and ingenious day by day. Therefore, it is becoming difficult to deal with these cyber-attacks just by technology-based approaches (installing conventional security software), making organization-based responses a vital requirement. However, security staff shortages are an issue for some organizations too, and hence security staff training is an urgent need.

Hitachi categorizes security staff into (1) advanced security staff, (2) security-oriented



10 Security staff categories and skills demanded for each

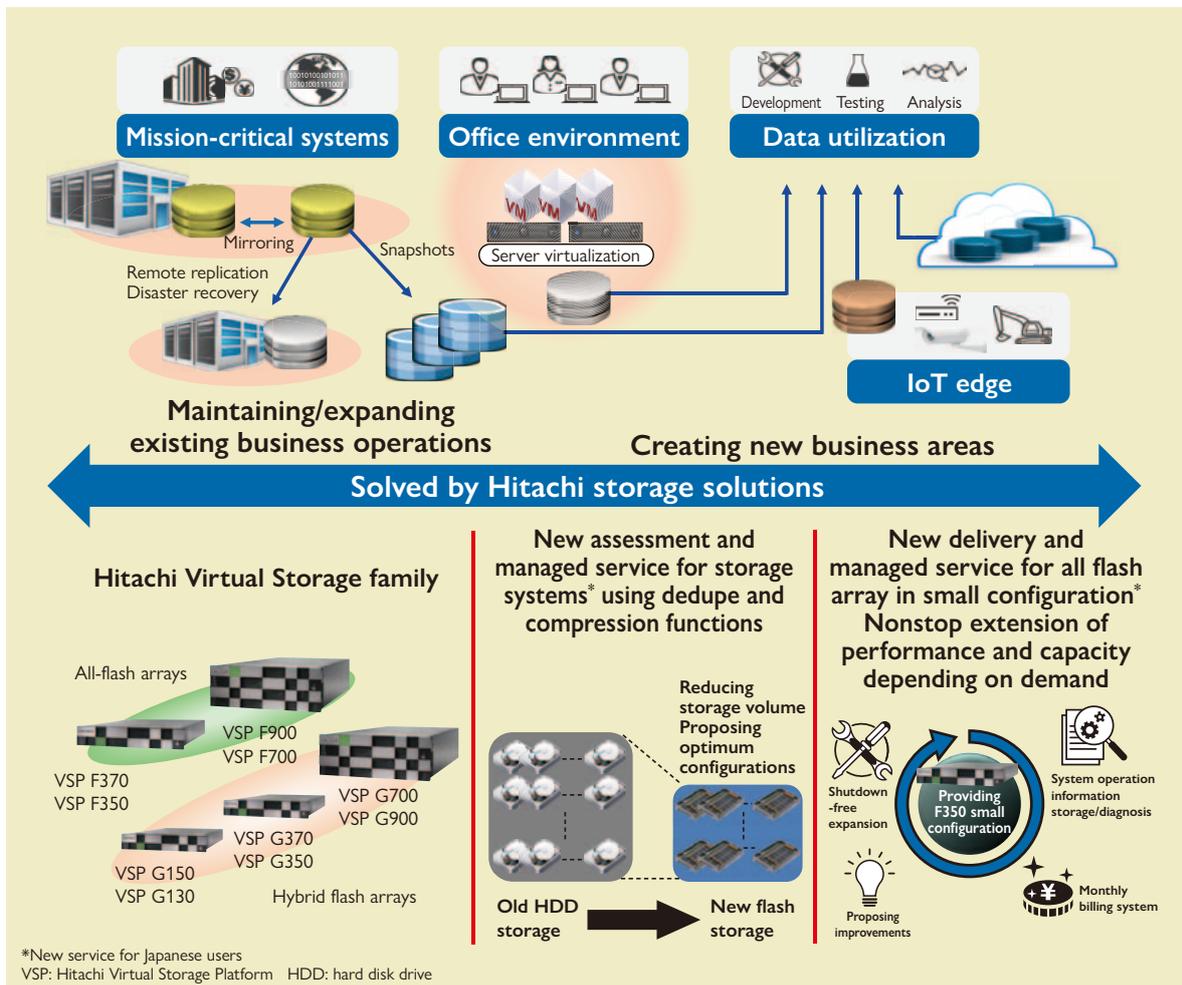
staff, and (3) IT-literate staff, and focuses on providing training for the second category. This staff training is designed to enable adaptation to known attacks. The coursework planned and provided enables participants to (1) understand cyber-attacks, (2) think about security, and (3) teach prevention and response methods. Hitachi intends to plan, study, and provide staff training schemes for IoT and control systems in the future.

11 New models of Hitachi Virtual Storage Platform Family and Related Services

Being able to use massive volumes of data rapidly for reasonable system operation costs is becoming a crucial requirement for increasing corporate competitiveness in today's era of accelerating IoT- and AI-based digital innovation.

To meet these needs, the Hitachi Virtual Storage Platform family was upgraded in May 2018. A total of ten flash storage models have been released, ranging from VSP G130 (optimized for small systems) to VSP F900 (with performance surpassing previous high-end models). The new models feature new architecture that maximizes flash drive high-speed performance, and a new graphical user interface (GUI) that enables storage system construction, management, and use without expert knowledge. The same proven functions used successfully to ensure data reliability and availability in previous models have also been continued.

A new intelligent deduplication/compression function combines high performance with storage volume reduction, while a new service for customers in Japan eases worries over the effect of reducing data storage volumes when moving flash storage systems. Hitachi inspects customers' environments in advance to help them achieve optimum system operation using the deduplication/compression function.



11 Meeting a wide range of customer needs with Hitachi Virtual Storage Platform family

Another new service for customers in Japan reduces excessive investment risk when installing an all-flash storage system. Customers can minimize and even-out their installation cost by starting on a small scale using a monthly payment option. They can enjoy worry-free use of the flash storage system while expanding performance without shutting down operations, and reducing system operation workloads to align with business growth or busy periods.

These new cost performance-enhancing technologies and services enable customers to maximize the profit gained from various types of data, helping create customer business innovations designed for success in the digital era.

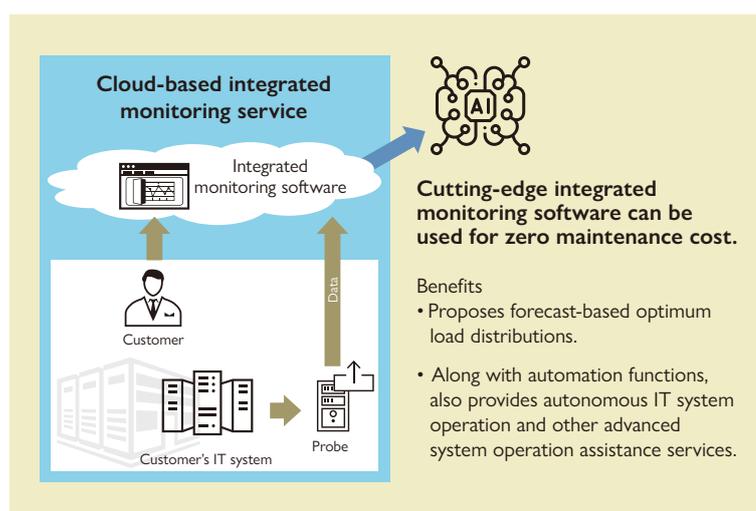
12 IT System Operation Automation Software and Cloud-based Integrated Monitoring Service

With a growing number of companies using IT to create new business recently, the time spent on IT system operation management needs to be minimized to enable IT department staff to focus on developing new solutions.

Hitachi Automation Director is a software product designed to address these needs by automating the operation of IT infrastructure. Automated IT system operation can reduce system operation costs while providing high-quality IT operation by reducing system operation errors. While introducing automation has previously been a challenging process, Hitachi Automation Director makes it easy by providing automation content that incorporates Hitachi's system operation expertise. It also enables customization tailored to the customer's system operations.

Hitachi has also begun offering a service for customers outside Japan that provides cloud-based integrated monitoring of their IT systems, reducing management costs to zero. The service's extensive benefits include rapid installation and increased system operation efficiency through integrated monitoring of multiple IT systems.

Hitachi is planning to add a service that enables autonomous system operation by using machine learning and AI together with learning data sourced from a wide array of system operation records.



12 Cloud-based integrated monitoring service

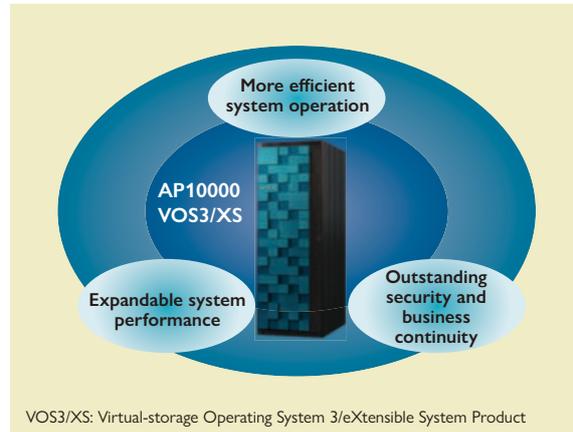
13 AP10000 Enterprise Server New Mainframe for Assisting Core Systems in the Digital Era

The accelerating pace of digitalization is bringing mainframes into focus as another area of interest. In addition to their role in ensuring stable operations for existing core operations, companies are now also looking toward mainframes as tools to help create new business value from legacy core data. But mainframes also need to be reliable enough to securely protect important data from security threats posed by cyber-attacks that are becoming more sophisticated every day.

AP10000 is an enterprise server provided by Hitachi that comes with Virtual-storage Operating System 3/eXtensible System Product (VOS3/XS). It is a high-performance/high-reliability platform that helps ensure the stable operation of core systems. It provides flexible and highly expandable open system connection, and uses advanced technology

to ensure robust security. It helps customers create new business value while benefiting from the use of their existing assets. The AP10000 VOS3/XS system's features are as follows:

- (1) Improves processing performance and enables faster core operations.
- (2) A database encryption function provides a secure system environment.
- (3) Features such as a space-saving housing make system installation easy.



13 AP10000 VOS3/XS features

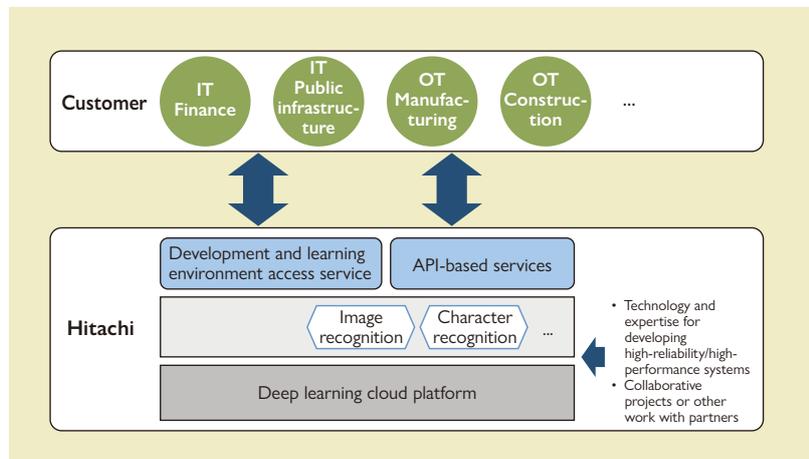
14 Deep Learning Development/Learning Environment Access Service

Hitachi has for many years been embedding deep learning into analysis technology and building up a successful track record in this area. Deep learning is currently used for a wide range of applications such as image and character recognition, and Hitachi is working on developing a number of different applied technologies driven by it.

The company provides a service that gives users access to a development/learning environment for deep learning. The service is designed to enable research into deep learning-based prediction/decision-making models and to provide a development/evaluation environment for services driven by these models. It is a cloud-based service that provides high-performance/high-reliability bare metal servers. The service uses SR24000/DL1 with four high-performance graphics processing units (GPUs). It uses the Ubuntu* operating system and has a lineup of accessory services also available for installation. For a lower initial investment, users can access an environment for deep learning development that can be used easily when needed.

In the future, models developed using the service will be provided in the form of API-driven services designed for use with customer operations via a common deep learning cloud platform.

* See "Trademarks" on page 158.



14 Deep learning cloud platform

15 Highly Reliable Platform Solution Assisting Mission-critical Systems

In recent years, IT teams have faced a need to enhance mission-critical systems, while also streamlining their operations and proactively introducing global standard technologies that are easily connectable to open systems – in an effort to adapt to rapid changes resulting from progress in digitalization. Hitachi responded to these needs in September 2018 with the release of a highly reliable platform solution that assists the long-term stable operation of mission-critical systems. The solution is designed to provide an open and highly reliable

virtualization platform by combining Hitachi's original reliability enhancement technology with VMware's vSphere[®] and a highly reliable Hitachi server. They use technology that has been demonstration-tested in collaboration with VMware[®]. The impact of failures in the virtualization environment can be localized and performance can be stabilized. A special support system created with VMware also enables long-term support and rapid problem-solving when failures arise. A hardware maintenance service of up to 10 years in duration is provided for the server used as the platform, helping ensure the stable operation of mission-critical systems.

The features above enable greater system operational efficiency while providing stable core system operation over the long term. They help customers expand their digital data-based business areas by optimizing IT system investment.

* See "Trademarks" on page 158.



15 Highly reliable server used as platform of highly reliable platform solution

16 Functional Safety Standard SIL 4 Conformant Functional Safety Controller vCOSS S-zero

vCOSS S-zero is a safety controller for protecting mission-critical plant systems, their employees, and local residents, offering a new generation of control systems realizing sophisticated control purely by hardware, with no use of software. vCOSS S-zero has been certified for Safety Integrity Level (SIL) 3 according to the IEC 61508 series international standard for safety systems by TÜV Rheinland Industrie Service GmbH, a globally known German safety inspection company. In order to realize higher safety integrity in a redundant system configuration, fault avoidance measures compliant with SIL 4 have been applied. The use of no software makes malware attacks theoretically impossible. The product has also been certified for Security Level (SL) 1* according to the IEC 62443-4 series international standard for cyber security of system components.

vCOSS S-zero will be used in the safety protection of a nuclear power plant in the UK [UK Advanced Boiling Water Reactor (ABWR)]. During the Generic Design Assessment (GDA) of the UK ABWR by UK safety regulators, completed in December 2017, the product design and development has been accepted as adequate. The product is also expected to be used in various applications requiring a high level of safety and reliability, for example, chemical plants, gas turbines, etc.

* Security Level 1 (SL 1) indicates being able to withstand non-malicious attacks.



16 Exterior of vCOSS S-zero

17 Site Digitalization/Abnormal Sound Inspection Automation

Japan's shrinking workforce is creating a growing demand for simpler equipment inspection operations. The difficulty of gaining experience in performing sense-dependent inspections of abnormal equipment sounds and teaching these skills to others is also expected to make site workloads grow every year.

In 2018, Hitachi started providing an automatic meter-reading service that uses cameras, AI, and a wireless sensor network to replace the eyes of inspectors by digitalizing and automatically gathering numerical values from analog meters such as pressure gauges and fluid level meters. The company will next provide a service that replaces the ears of

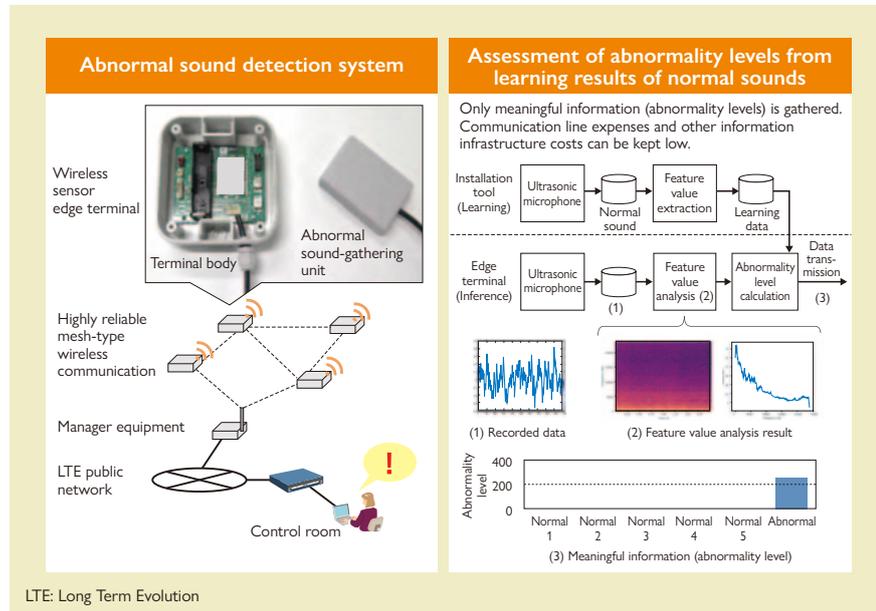
inspectors by automating abnormal sound inspections. The service is assisted by an abnormal sound detection system with the following features:

- (1) Can operate continuously for of at least one year on a single battery*, eliminating the need for power supply installation work.
- (2) The use of highly reliable mesh-type wireless communication enables easy installation in various environments even when the equipment is covered. Eliminates the need for communication equipment installation work.
- (3) Wireless sensor edge terminals use learning results from normal sounds to evaluate sound abnormality levels.

The gathered information can be limited to only high-quality meaningful items, keeping the costs for communication line expenses and other information infrastructure low.

The service will be expanded in the future to include site digitalization as well as just simplified inspection operations. This augmentation will help create higher value by providing condition-based maintenance and increasing the efficiency of consumable parts, materials, and fuels.

* When making one measurement per hour.



17 Technology assisting abnormal sound inspection automation service

18 Information Control Server

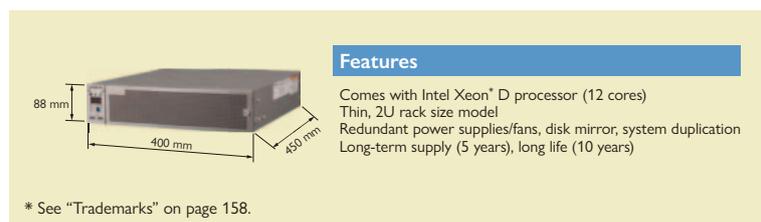
Hitachi's RS90 Series of information control servers feature high reliability, long-term supply, and long-term maintenance. They are suited for information control systems used by a wide range of industries such as power and public transport.

To meet recent demand for high-speed processing in information control systems, the RS90 Series has recently been augmented with the release of the high-end RS90/1100 model.

The product is designed for improved performance, and comes with a high-performance processor (2.1 GHz, 12 cores) and up to 64 GB of memory. It also supports reliability-enhancing functions such as power supply and fan redundancy/online replacement, a solid-state drive (SSD) software mirroring function, and a system duplication function.

Despite its 2U rack size, the server supports a wide range of interfaces and comes with 14 local area network (LAN) ports, six universal serial bus (USB) ports, and four SSDs. The development of an operating system with outstanding real-time performance and failure analysis has resulted in a product that meets function expansion needs while enabling system migration from previous models.

Hitachi is planning to acquire foreign safety standard certification to expand the server's range of applications.



18 RS90/1100 information control server

19 Stable Operation Service for Control Systems

The stable operation service for control systems is a service that Hitachi has started to meet the needs of control systems designed for long-term operation (which require rational approaches to operation and monitoring). The service is an all-inclusive package that helps customers with all their control system needs using the OT Hitachi has accumulated through control system development, along with daily-evolving IT. Its main features are as follows:

(1) Year-round, round-the-clock worry-free support system

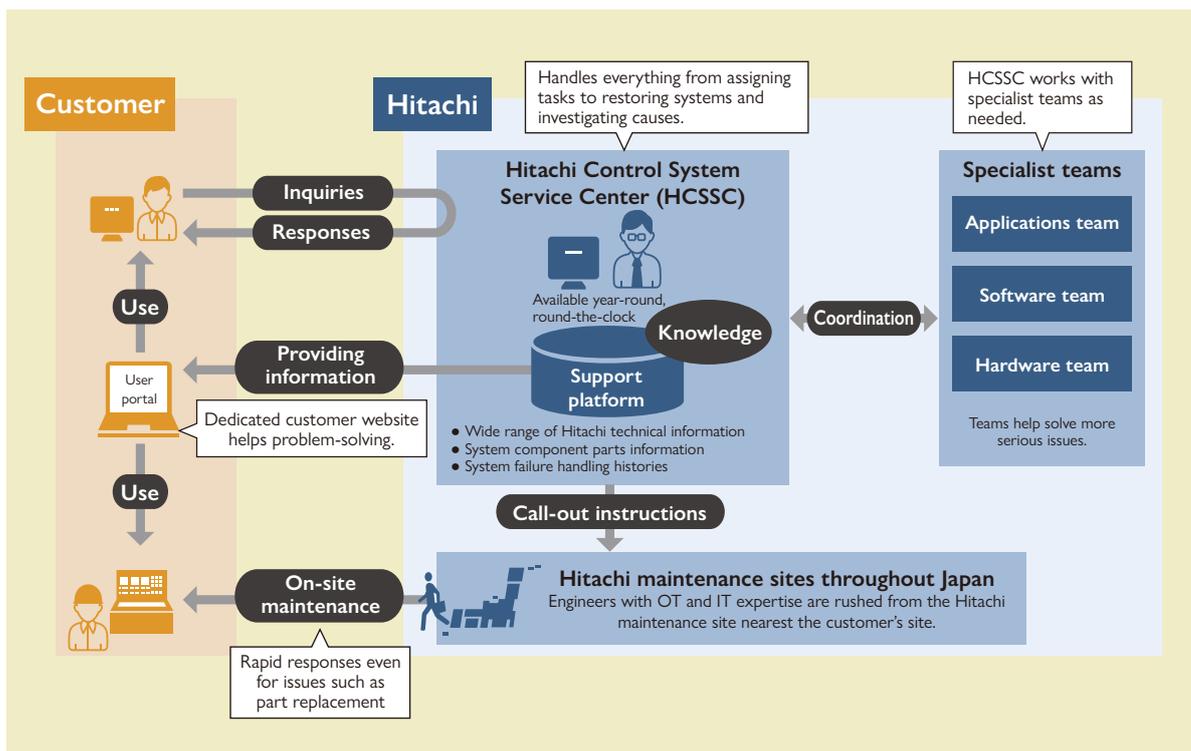
The Hitachi Control System Service Center (HCSSC) is available to handle control system inquiries and failure reports around the clock every day of the year. When a problem occurs in a customer's control system, HCSSC works with Hitachi's specialist teams to assign tasks as required by the nature of the problem or inquiry.

(2) Knowledge and component parts information shared with customers

Control system operation/maintenance-related technical information and handling histories are stored and shared on a support platform. Customers can access and use this information at any time from a user portal, helping them gain expertise and knowledge about operation and maintenance.

(3) Help with evening-out maintenance costs

Signing up for a selection of options that closely match the needs of their systems can help customers even-out yearly maintenance costs and ensure that their operation and maintenance work is done in an organized manner.



19 How stable operation service for control systems is provided