

Services & Platforms

1 Hitachi's Lumada: Accelerating Innovation

The 2021 Mid-term Management Plan announced in May 2019 sets objectives of improving people's quality of life and add values for customers in the five key business sectors of IT, Energy, Industry, Mobility, and Smart Life. As the engine for achieving this at a global level, Lumada continues to evolve and grow on a daily basis.

(1) Evolution and growth of Lumada

Lumada is made up of three elements with the flexibility to adapt to the changing needs of society and advances in technology, expanding its portfolio of expertise the more it is used.

(a) Co-creation methodologies and services

Hitachi's own NEXPERIENCE suite of methodologies for use in the increasingly complex business environment can uncover the issues that really matter to customers in a timely manner and seek out business opportunities in collaboration with partners.

(b) Domain expertise

Hitachi is building up a portfolio of Lumada solution use cases that utilize customers' data to deliver solutions to the challenges they face, also making these available for wider use.

(c) Platform products and technologies [Internet of Things (IoT) platform]

Lumada serves as a platform for consolidating the latest information technologies such as analytics and

artificial intelligence (AI), security features that provide peace of mind, and operational technology (OT) for the control and operation of equipment and other systems.

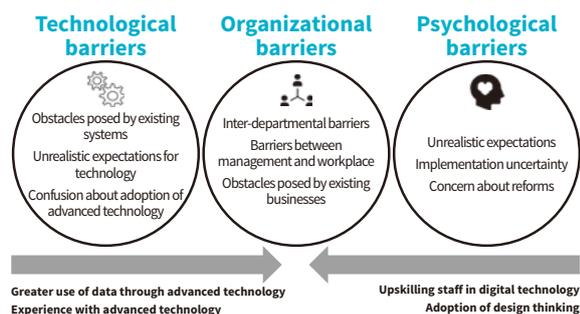
These elements are proving their worth by facilitating use of the data that underpins the accelerating pace of innovation.

(2) Facilitating the use of data

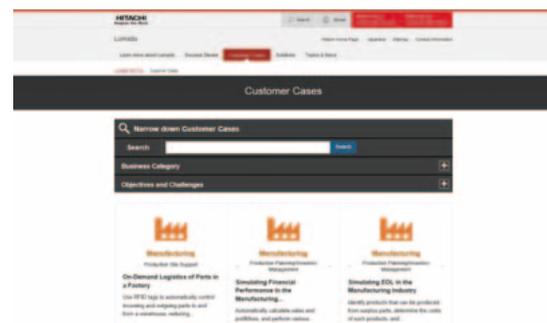
The name "Lumada" is a combination of "illuminate" and "data." The quantity of data is growing at an accelerating rate as digital technologies become more pervasive in factories, offices, and people's lives and greater use is made of networked IT and OT equipment. By providing the means to work with customers and shine a light on this data from many different angles, Lumada can be used to improve current practices and pre-emptively address concerns.

Nevertheless, it is recognized that barriers to making good use of this data take a number of different forms, including the psychological, organizational, and technological.

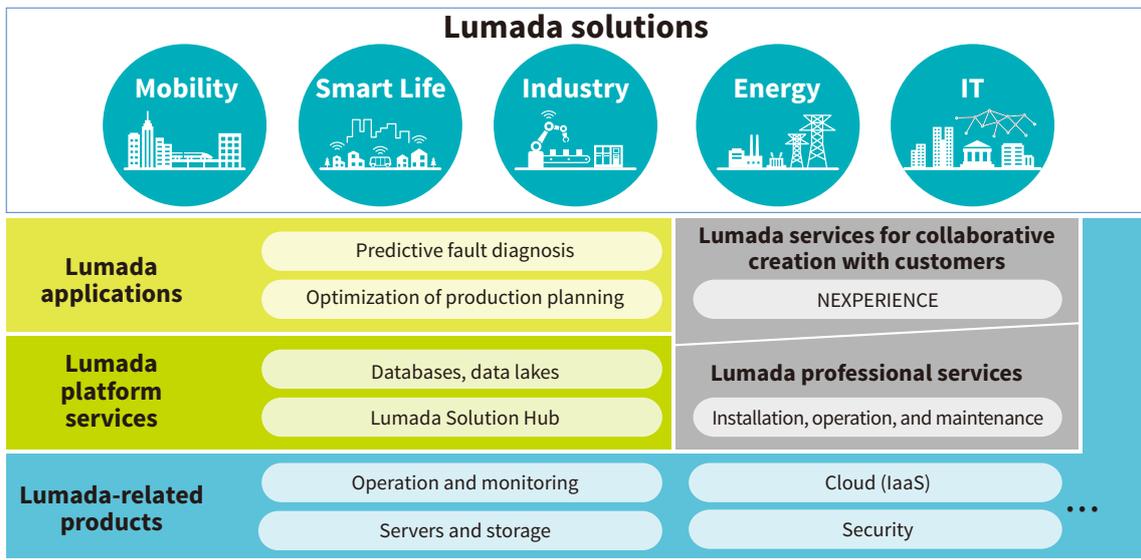
In terms of these barriers, the NEXPERIENCE methodologies referred to in (a) above include ways of minimizing the psychological barriers by providing an exploratory approach based on design thinking in which participants can gain experience in observation, empathy, and the definition and resolution of problems. What is important in this activity is not just the methodology, but also that the participants are able to understand the customer and work with them. Hitachi



1.1 Three barriers to making good use of data, and how to overcome them



1.2 Lumada customer case website



IaaS: infrastructure as a service

1.9 Example products and services used in Lumada solutions

is taking active steps to equip staff at its research facilities and elsewhere with skills in digital competence.

The domain expertise referred to in (b) is catalogued on a website* that presents this portfolio in terms of past projects with customers. This lowers organizational barriers by sharing the acquired benefits among related organizations and by providing insights that were not available through conventional business activities.

The third element, the IoT platform, lowers the technological barriers. The platform provides a wide range of resources, examples of which include the acquisition, storage, and management of equipment data; the Lumada Solution Hub for developing Lumada solutions utilizing existing use cases and deploying them globally; database and storage systems for the collection and management of data; operation and monitoring of IT and OT infrastructure; and security products and

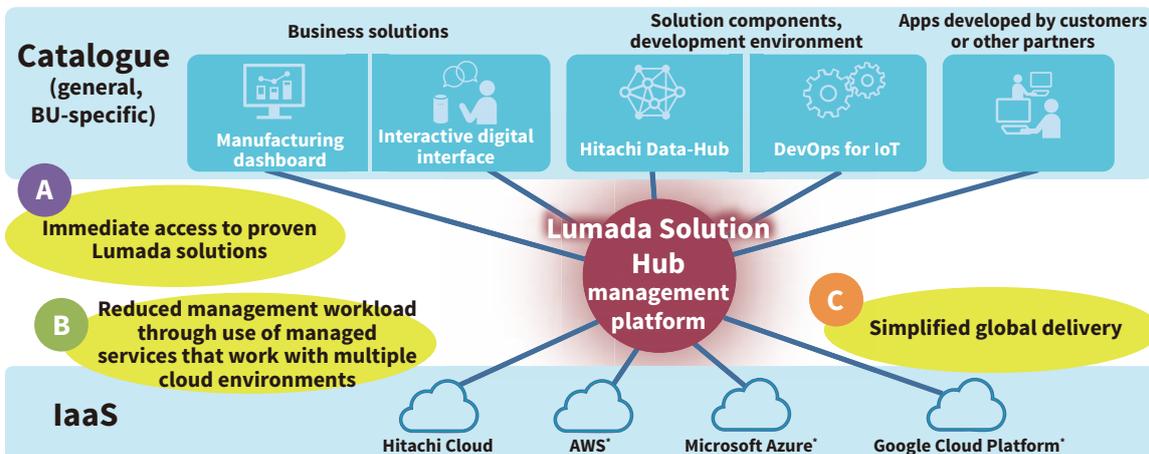
services. Hitachi has consolidated these three elements in the form of products and services for use in Lumada solutions, and intends to accelerate innovation by supplying these solutions that make use of customer data.

This section describe the features and example applications of these products and services used in Lumada solutions.

* Lumada customer cases: <https://www.hitachi.com/products/it/lumada/global/en/usecase/index.html>

2 Lumada Platform Service: Lumada Solution Hub

Time and cost are major issues when developing new services that use digital technology and engaging in an ongoing digital transformation involving the reform of business practices. These require a wide variety of



BU: business unit AWS: Amazon Web Services

* See "Trademarks" on page 151.

2 Aims of Lumada Solution Hub

specialist technology and expertise, from putting the infrastructure in place to application development, deployment, and operation and maintenance.

Lumada Solution Hub helps customers engage in digital transformation, delivering value in the following ways to overcome these difficulties.

- (1) A catalogue of proven Lumada solutions available for immediate use
- (2) Reduced management workload through use of managed services that work with multiple cloud environments
- (3) Simplified delivery utilizing an existing global network of sales offices and the infrastructure for implementation and operation

The solution delivery model used on Lumada Solution Hub works by solution owners developing packages and registering them on the hub where they can then be utilized, built on, or customized by solution integrators and delivered to customers in the form of a cloud service. The aim is to establish and grow an ecosystem in which not only Hitachi companies, but also external partners are invited to participate as owners and integrators. In this way, Hitachi is contributing to the creation of new value in customer businesses as well as in wider society.

3 Lumada Platform Service: Latest Version of Hitachi Advanced Database (05-00)

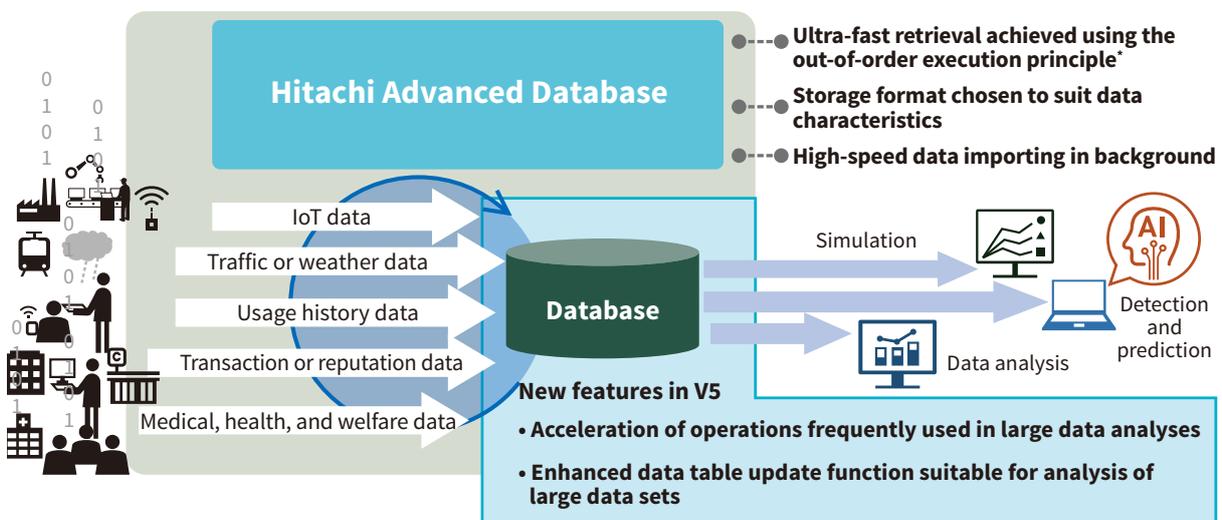
With advances in digitalization over recent years having resulted in greater use of large data sets, such as IoT data collected from sensors, open data, and user purchasing records, the development of new digital businesses and services based on the analysis of large amounts of data has become a matter of concern for customers.

Hitachi launched Hitachi Advanced Database*, a high-speed database engine, in 2012 to help customers create business value and accelerate digital innovation. The latest version is 05-00 (V5) and was released on July 1, 2019.

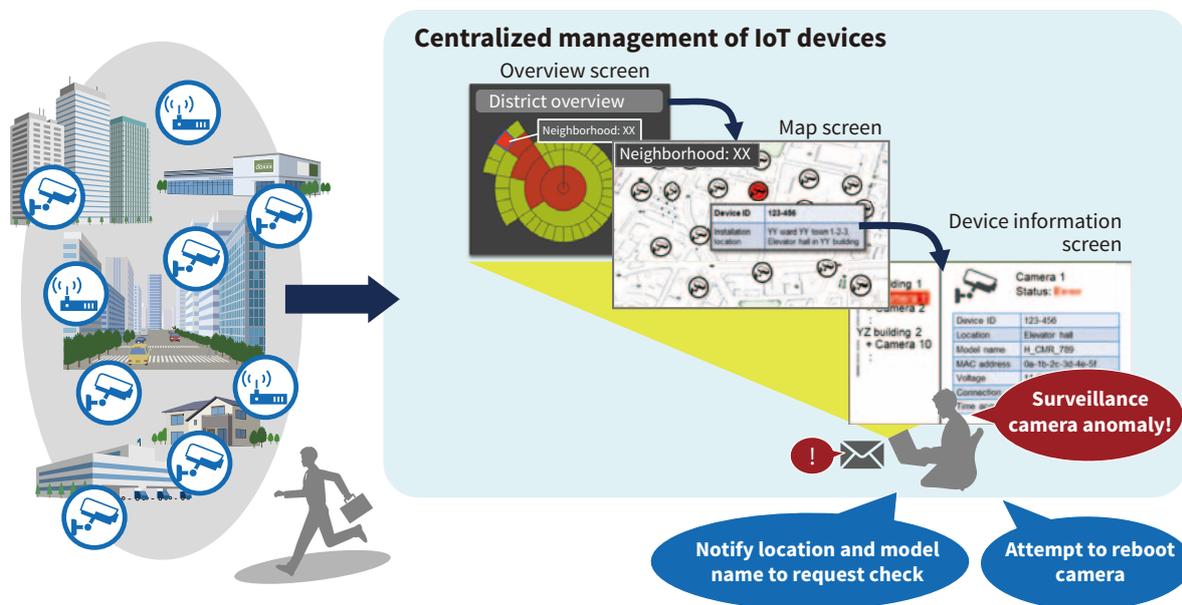
With data sets likely to continue getting bigger in the future, Hitachi Advanced Database V5 features enhanced data table updating suitable for the analysis of large data sets and greater optimization of data processing to enable even faster analysis.

Hitachi intends to go on contributing to business value creation by customers by making further enhancements to meet the diverse requirements associated with using large data sets, including the provision of enhanced functions on the cloud.

* Utilizes work undertaken as part of the “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” project (Principal Investigator: Professor Masaru Kitsuregawa of the University of Tokyo/Director General, National Institute of Informatics) of the Japanese Cabinet Office’s Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST).



* An execution principle devised by Professor Kitsuregawa (the University of Tokyo & Director General of the National Institute of Informatics) and Associate Professor Goda (the University of Tokyo)



4 JP1 for IoT – Device Management provides secure and highly reliable management of IoT devices

4 Lumada Application: Secure and Highly Reliable IoT Operation Provided by JP1 for IoT

The IoT is essential for putting digital transformation into practice. The analysis and use of the large amounts of data collected via the IoT can be a source of many different forms of value, such as improvements to plant productivity and quality, helping to keep infrastructure operating reliably, and the provision of innovative new services.

The reliability and security of the systems that underpin such services will become increasingly important the more the IoT becomes an integral part of daily work and living activities. This in turn requires the ability to identify the large numbers of IoT devices connected to a network and to respond appropriately to risks such as serious failures or information leaks resulting from computer virus infections or other forms of cyberattack.

JP1 for IoT was launched in March 2019 with an initial suite of features that included JP1 for IoT – Device Management, a service for the operational and security management of IoT devices throughout their lifecycle, and the JP1 for IoT-NX Netmonitor and JP1 for IoT-NX Usbmonitor appliances for preventing use of unauthorized PCs or Universal Serial Bus (USB) devices.

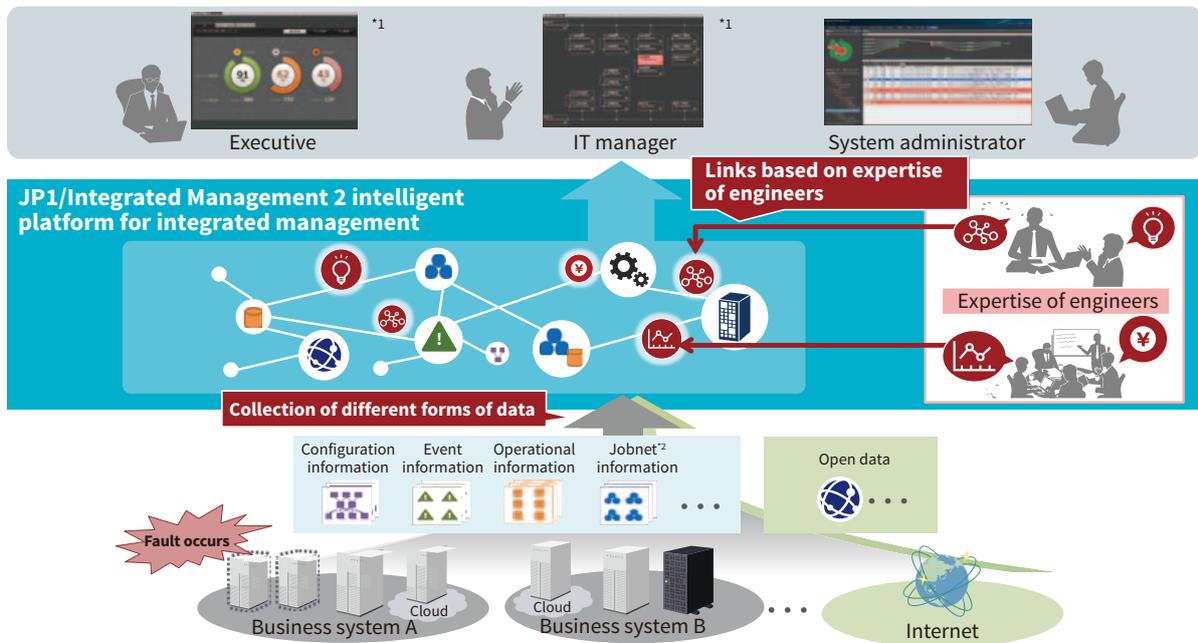
In the future, Hitachi intends to support Lumada in its role of accelerating digital innovation by providing a wide variety of services for ensuring the secure and efficient operation of the IoT.

5 Lumada-related Product: JP1 Version 12 for Integrated System Operation Management

The acceleration of activities associated with digital innovation is making it more important than ever for companies to make decisions quickly and to make good use of data across all of their business operations. On the other hand, corporate IT departments are being called upon to optimize operations throughout their diverse IT environments, which may include both mission-critical systems and a number of different cloud environments used by different divisions of the company.

JP1 Version 12, an integrated system operation management package released at the end of January 2019, features the new JP1/Integrated Management 2 (JP1/IM2) intelligent platform for integrated management that provides centralized management of IT systems that may include both on-premises and multiple different cloud environments and be managed using open source software or other third-party tools. The new software facilitates rapid decision making by collecting and linking operational data such as events and information on system configuration or application execution, and presenting the information required by different staff such as line managers and system administrators in an easily intelligible form based on their particular roles and standpoints.

When used in tandem with AI for IT Operations, a service for optimizing IT operations, the operational data collected by JP1/IM2 enables autonomous IT



*1 Customized screens

*2 A jobnet specifies the sequence in which jobs are executed (where "job" represents a single instance of computer program execution).

5 JP1/Integrated Management 2 provides efficient and comprehensive integrated management of a variety of different IT environments

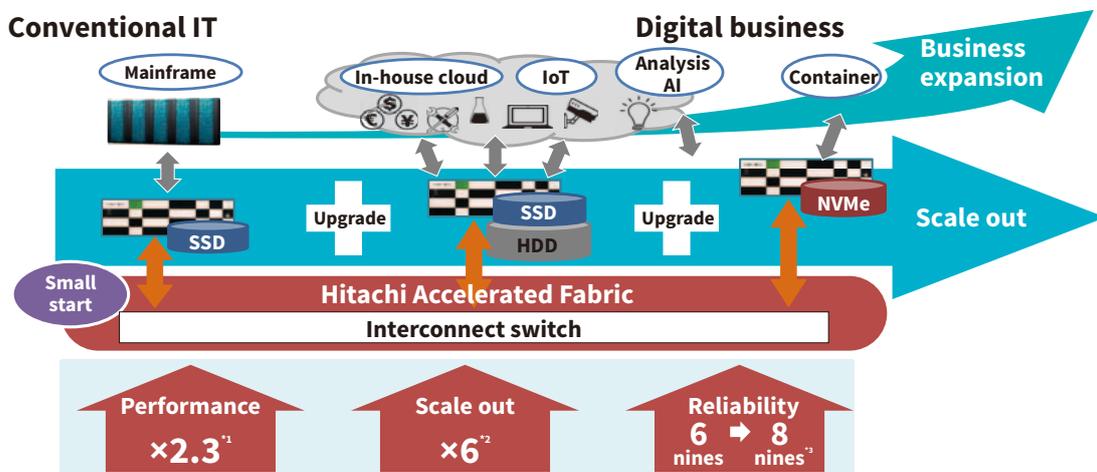
operations by means of AI. Similarly, JP1 for IoT uses JP1/IM2 as a platform while it handles the collection and centralized management of information on diverse and geographically dispersed IoT devices, and also to present an overview of what these devices are doing.

Along with helping take control and optimize IT operations, JP1 also has a track record of supporting customers with digital innovation and of making the IoT more efficient by serving as one of the services and platforms that underpin Lumada.

6 Lumada-related Product: Hitachi Virtual Storage Platform 5000 Series

Major changes in the business environment over recent years are requiring companies to maintain business growth by accelerating their digital transformation while also continuing to improve the efficiency of existing operations.

It was against this background that Hitachi launched the Hitachi Virtual Storage Platform 5000 (VSP 5000) Series in October 2019 to provide a new IT infrastructure platform on which conventional IT and digital business could coexist.



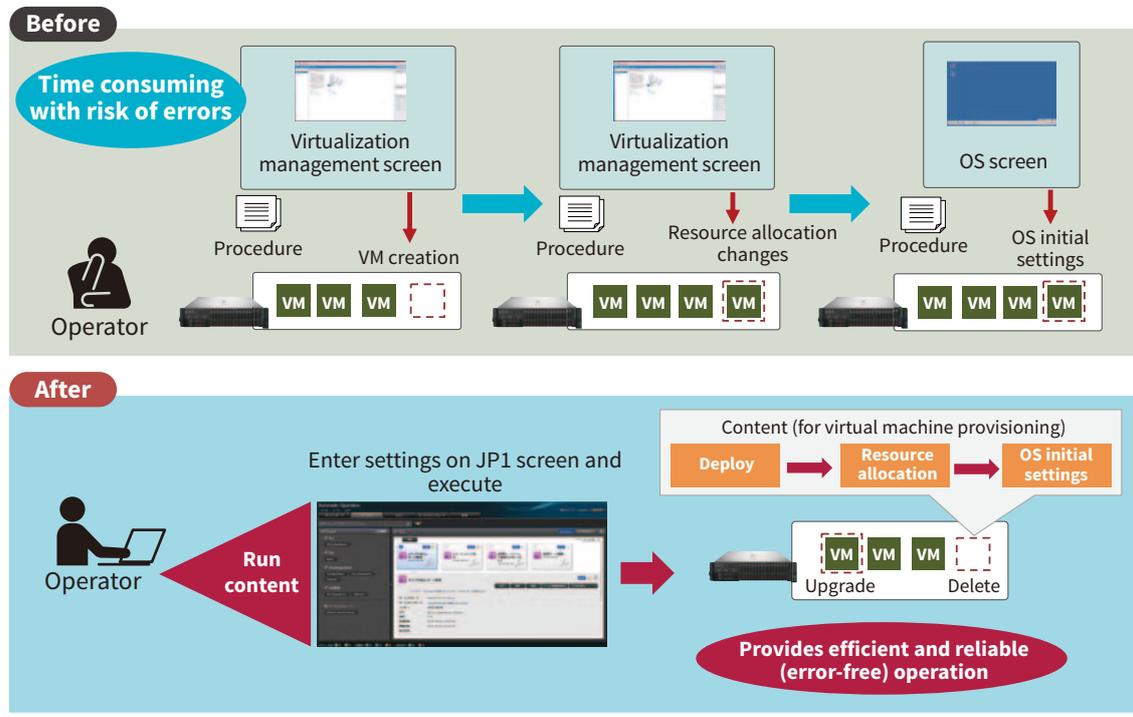
SSD: solid state drive HDD: hard disk drive

*1 Maximum throughput relative to previous model (VSP 1500)

*2 Increase in number of controllers between minimum and maximum configurations

*3 Increase from six nines (99.9999%) availability of previous model to eight nines (99.999999%) availability of VSP 5500.

6 Hitachi Virtual Storage Platform 5000 Series new flash storage system that can be scaled out



VM: virtual machine OS: operating system

7 Efficient operational management provided by Hitachi HCI Solution

The VSP 5000 Series represents a new flash storage platform that can be scaled out. Equipped with an interconnect specifically developed by Hitachi, it delivers enhanced flexibility and agility due to its linear scale-out capabilities and features automatic recovery of redundancy in the event of a fault, with performance up to 2.3 times that of previous models.

The VSP 5000 Series also facilitates the shift to digital business, being able to mix SAS [serial-attached small computer system interface (SCSI)] and high-speed non-volatile memory express (NVMe[®]) drives, allowing for different drive configurations to suit particular requirements. It also provides an application development environment that supports digital business through integration with container environments. These features provide the agility to keep pace with the business expansion of customers.

* See "Trademarks" on page 151.

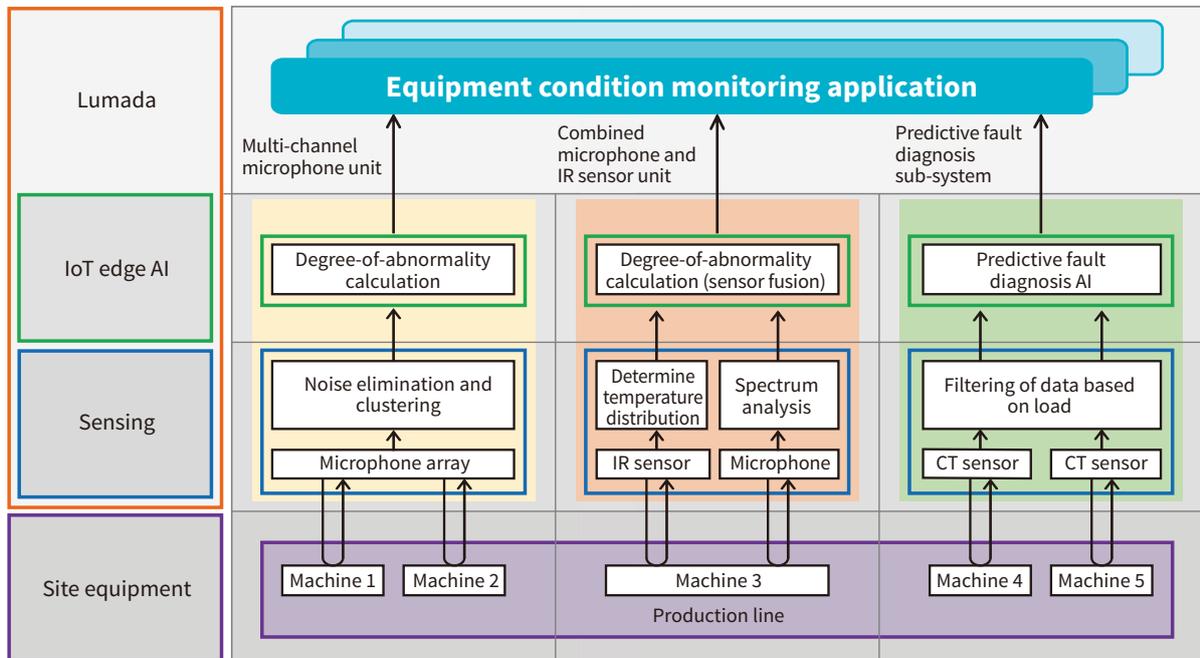
7 Lumada-related Product: Hitachi HCI Solution with Flexibility to Adapt to Business Reforms

In order to adapt to rapid changes in the business environment, an increasing number of companies are choosing to install hyper-converged infrastructure (HCI) that provides both easy operation of IT

platforms and the flexibility to expand. While a virtualization environment based on HCI makes it easy to add physical servers, it also requires accurate decision-making and robust operational management given the continued growth in what needs to be monitored in order to decide when best to add resources.

To maximize the operational benefits of adopting HCI, Hitachi has developed the Hitachi HCI Solution to serve as a one-stop solution that supports everything from installation to operation. JP1 integrated system administration (included as a standard feature) makes management more efficient by automating resource monitoring and administration across all areas of the system. To simplify the automation of operations, frequent tasks such as adding new virtual machines or installing firmware or driver updates are defined as templates and included as part of the package content, thereby ensuring reliable operation free of human error.

Hitachi plans to continue developing Hitachi HCI Solution in the future to help customers optimize their system installation and operating costs and maintain reliable operation.



8 Block diagram of equipment condition monitoring system using multiple sensors

8 Lumada Application: Equipment Condition Monitoring Using Multiple Sensors

Keeping the infrastructure essential to industrial activity and daily life operating reliably is becoming increasingly difficult due to factors such as the aging and retirement of experienced maintenance staff as well as the equipment itself getting older. This has led to a high level of interest in site digitalization involving the collection and analysis of highly valuable on-site data that relates directly to equipment, but has not been available in the past, and its use to reform practices for equipment inspection and maintenance.

Hitachi has been working on expanding its advanced sensors that incorporate AI with recognition functions that take note of the sensory perceptions of experienced staff, including the development of Retrofit Wireless Sensors that work by reading the indicated value of analog gauges. Work is also ongoing on enhancing data analysis and diagnostics by combining data from a number of different sensors installed across the equipment being monitored. The key technologies used in this work are as follows.

- (1) Sensor units that use multi-channel microphone arrays to record the sounds made by a number of different machines and perform edge-based data analysis to identify which machine is the source of abnormal sounds and also to calculate the degree of abnormality.
- (2) Use of sensor fusion to improve the accuracy with

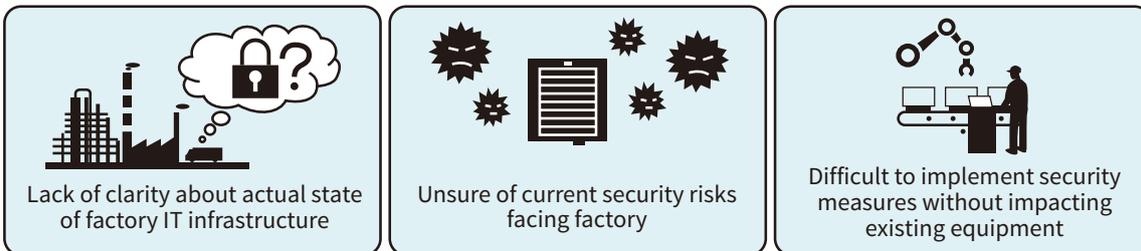
which equipment deterioration can be diagnosed by combining the results of analyzing different types of data collected by sensor units equipped with a mix of sensors, such as infrared (IR) sensors and microphones.

- (3) Proprietary algorithms for predictive fault diagnosis that minimize overtraining by filtering sensor data based on estimated equipment load, which is obtained in real time based on motor drive current waveforms collected using current transformer (CT) sensors.
- (4) A technique for configuring sensing systems so that their mix of sensor units and layout is optimal for the equipment being monitored and the measurements to be collected.

In the future, Hitachi intends to accelerate the development of products and systems that incorporate these features so as to provide open connectivity of data across ecosystems that are based on Lumada.

9 Lumada Application: IoT Security Solutions for Factories that Keep Them Secure

Recently, there has been an increase in integration of the IoT at factory sites for the purposes of passing on knowledge from experts and increasing the efficiency and quality of each factory site. But connecting factory equipment and OT (control) systems to the network means there has been an increase in new security treats. Therefore, there have been numerous problems at



IoT Security Solutions for Factories



9 Overview of IoT Security Solutions for Factories

factory sites, such as a lack of IT specialists and difficulties installing security software and patches because of unique equipment and network structure.

Hitachi draws on the knowledge and understanding it has accumulated within and outside the company to provide a secure factory through a wide range of IoT Security Solutions for Factories using 3 steps. These 3 steps are “situation assessment,” “multi-layered defense and detection,” and “operation and countermeasures.” Using these 3 steps, Hitachi supports the installation and operation of IoT Security Solutions for Factories for each individual situation matching each factory.

Furthermore, not only does this solution cover cyber security, but it also covers physical security. This enables Hitachi to provide a one-stop service by combining products and services from a wide range of IoT Security Solutions for Factories that meet the customers’ needs.

10 Lumada-related Product: Finger Vein Authentication Solution Using PBI

Hitachi is using technology it has developed itself for a public biometrics infrastructure (PBI)¹ that combines biometric authentication with public key infrastructure



10 Demonstration test of pay-by-finger authentication at retailer

(PKI) and is rolling it out primarily for business-to-business-to-consumer (B2B2C) applications.

PBI is utilized in biometric authentication systems such as those used by the general public for membership verification or payment where it is not desirable to handle raw biometric data on a server.

In 2018, Hitachi conducted a demonstration test² of pay-by-finger for the general public that ran for about two and a half months. The test involved linking users' finger vein data to pre-paid cards and tested the sequence of steps involved in making payments using only biometric authentication, without requiring use of a card, QR code, or similar (pre-paid cards are electronic-money cards that have been preloaded with funds).

While there has been rapid uptake among retailers and others of cashless payment methods that use cards or QR codes, prompted by the increase in consumption tax in Japan, payment by card or smartphone comes with issues that include unauthorized use by another person and losing or leaving the device behind. Hitachi anticipates that this trend will lead to growing interest in the future in biometric authentication using PBI as a safer means of identification.

*1 PBI: A proprietary Hitachi technology for deriving a private key from biometric information such as finger vein patterns by means of a one-way conversion process that does not allow the original information to be recovered, and generating a matching public key to create a public key certificate.

*2 Test conducted at the Sen Do! EVERY supermarket in Fukuyama-Zao run by EVERY Co., Ltd., which operates supermarkets in the Chugoku and Shikoku regions of Japan, and involving staff from the company's headquarters and Zao supermarket.

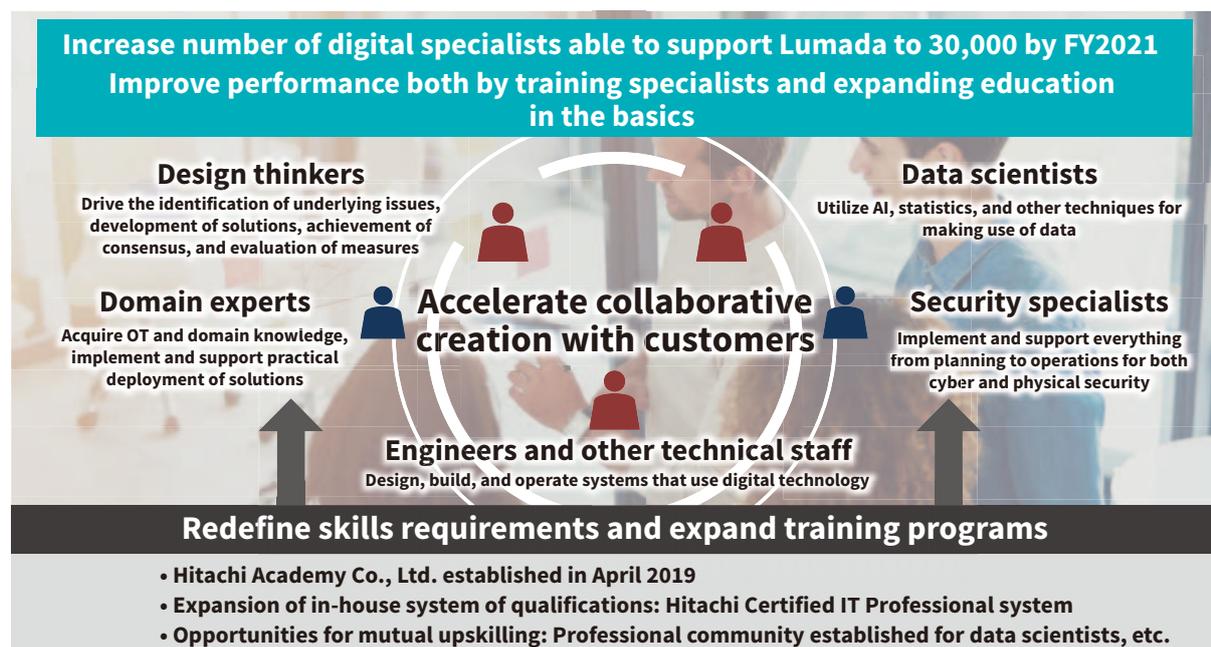
* See "Trademarks" on page 151.

11 Lumada Service for Collaborative Creation with Customers: Developing Digital Specialists to Undertake Digital Transformation

Staff with a high level of skills in digital technology play an important role in achieving digital transformation, meaning the use of data and technology to reform business practices and value. These include designers who can use design thinking to create value in innovative ways and data scientists who can use data to resolve underlying issues.

Along with structured classroom training, on the job training (OJT) is also vital for equipping staff with such high-level skills, providing practical experience with working alongside highly experienced specialists on customer projects.

At its divisions that are engaged in digital businesses in particular, Hitachi has established a training regime that includes OJT and that takes in trainees from a wide variety of different areas within Hitachi. To accelerate the creation of new value through digital transformation by combining knowledge from the many different domains in which Hitachi is involved, Hitachi is equipping large numbers of staff with the core skills needed to be digital specialists and has also established a professional community where staff can help each other hone their respective skills and share case studies and technologies from different domains.



11 Developing digital specialists to undertake digital transformation