

# Strengthen Lumada

As society and business continue to generate more data, Hitachi's Lumada acts as an engine that creates new value from these data and accelerates innovation. We launched the Lumada business in 2016, and its revenue has grown rapidly in three years, from ¥900.0 billion in fiscal 2016 to ¥1,127.0 billion in fiscal 2018. Under the 2021 Mid-term Management Plan, we are promoting measures aimed at expanding our business with the goal of achieving revenue of ¥1,600.0 billion.

## What is Lumada?

### Lumada creates value from customers' data and drives digital innovation

Hitachi will develop a global Social Innovation Business that will improve the quality of people's lives, raise corporate value for our customers and contribute to resolve social issues. We will accelerate innovation in each of the five business sectors, creating solutions that provide new value.

Lumada is a general term for the solutions, services and technologies that utilize Hitachi's advanced digital technologies to create value from customers' data and drive digital innovation. It is derived from the words "illuminate" and "data" and was created based on the idea of combining the strengths of the operational technology (OT), IT and products

cultivated within Hitachi. Along with the development of information technology (IT) and the Internet of things (IoT), social and business activities continue to generate data at an increasing rate of speed. Hitachi has focused on these data as a new source of value in future society and launched the Lumada business in 2016 with the goal of using large volumes of data to create innovation for the world.

With Lumada as a common platform, we will create new value and establish an advanced cyber-physical system that links digital and real spaces (actual physical things) in real time.

### Lumada business model

The Lumada business provides value by analyzing business issues and combining Hitachi's digital technologies to solve customer problems with the lowest amount of customization as possible. In fiscal 2018, revenue in the Lumada business was ¥1,127.0 billion, and its adjusted operating income ratio had already exceeded 8%, the level of the entire Hitachi Group. Rather than relying merely on product sales, we will build a profit model based on value created through the provision

of solutions, such as income from fees. To this end, Hitachi will leverage its strengths in OT x IT x Products to commoditize its expertise in various industries and operations. At the same time, we will make the shift to digital solutions that can be provided to a number of customers, thereby expanding the Lumada business. Furthermore, we will intensify our collaborate efforts to build new ecosystems with our customers and partners.

### Lumada Revenues

	FY2016	FY2017	FY2018	FY2019 (Forecast)	FY2021 (Target)
Revenues (¥ billion)	9,162.2	9,368.6	9,480.6	—	—
Lumada revenues (¥ billion)	900.0	1,006.0	1,127.0	1,170.0	1,600.0
Share of total revenues (%)	10%	11%	12%	—	—

\* Lumada revenue is included within Hitachi's consolidated revenue.  
The IT sector comprises about 80% of Lumada revenue while the Industry sector accounts for about 20%.

### Strengthening our overseas business structure

Currently, about 90% of Lumada business revenue comes from Japan. We are strengthening our overseas business structure, primarily in North America and Asia, with the goal of accelerating the global expansion of the Lumada business moving forward. In the future, we will continue to recruit new personnel while acquiring companies capable of collaborating with customers to produce digital solutions and investing in partners. These efforts will contribute to our goal of nearly doubling our number of relevant overseas personnel from its current level of 23,000 to 40,000.

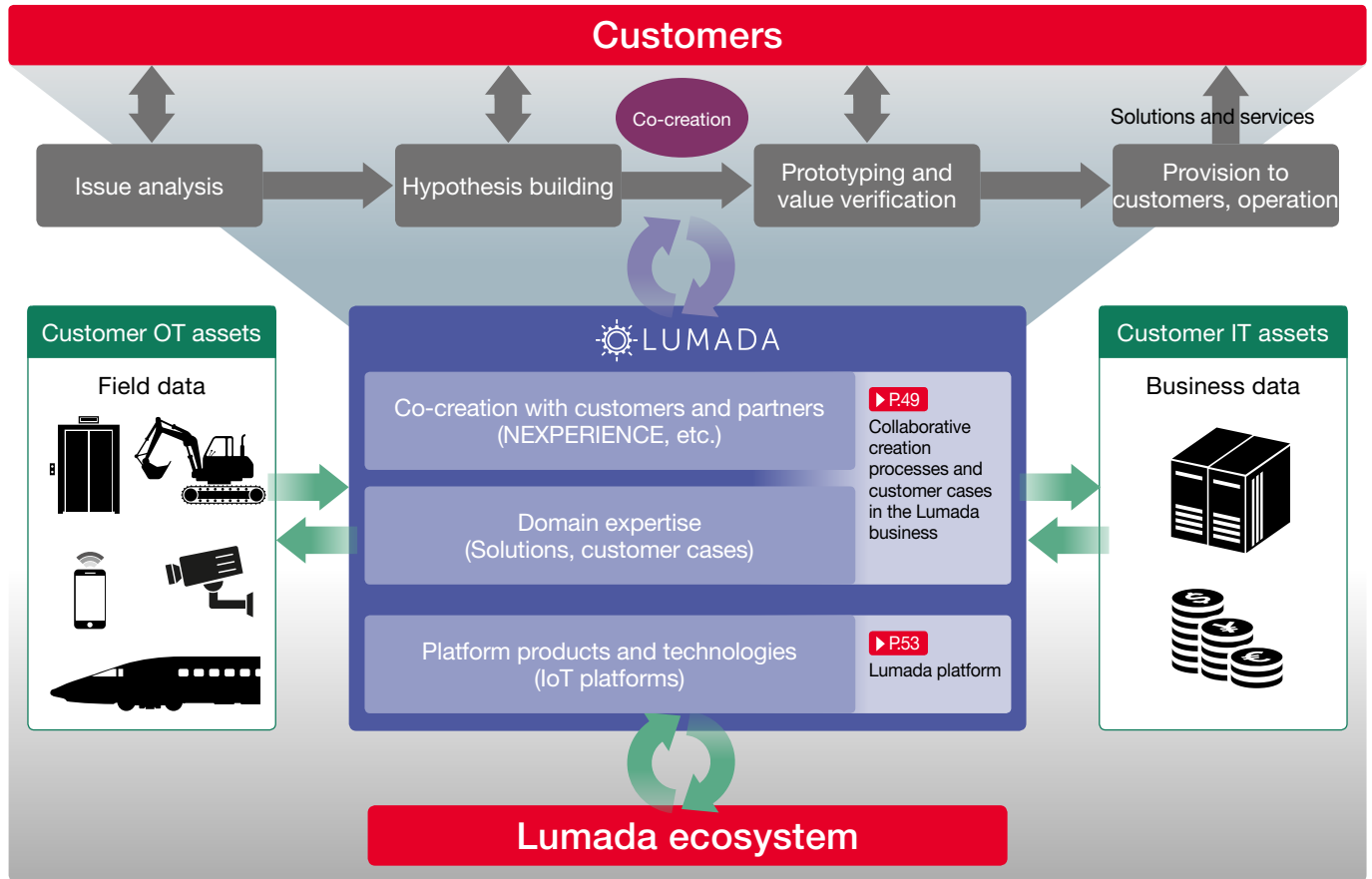
As an example of collaboration with overseas partners, in January

2019, we established a joint venture with India's largest state-owned commercial bank, State Bank of India (SBI). Through this venture, we aim to build a digital payment service platform for the next generation. By collaborating with SBI, which has about 400 million customers (equivalent to roughly one third of India's population), we are analyzing and utilizing vast amounts of digital payment data obtained from point-of-sale (POS) systems, e-commerce and transportation fare payment systems in an effort to provide high value-added services in India.

## Collaborative creation processes and customer cases in the Lumada business

Here, we will introduce collaborative creation processes of the Lumada business, as well as customer cases that are models of the digital solutions that we have cultivated thus far.

### Concept of Lumada



### Methodology and services aimed at accelerating collaboration with customers and partners

#### Support ranging from the discovery of potential issues and strategic planning to value verification

##### (1) Issue analysis and hypothesis building through NEXPERIENCE, a collaborative creation process

Before creating innovation, one must first discover potential issues. However, corporate issues are becoming more complex as society globalizes and diversifies. When collaborating using Lumada, Hitachi uses NEXPERIENCE, its unique collaborative creation process, discover issues, propose solutions and verify value.

To solve a variety of issues through collaboration with customers, NEXPERIENCE combines the perspectives of service engineering researchers and designers and systematizes methods and IT tools that support the entire collaborative creation process. Specifically, NEXPERIENCE involves analyzing issues related to management and business operations through workshops with customers and partners and designing measures, such as new services and business, that solve these issues.

##### Overview and Process of NEXPERIENCE



## Strengthen Lumada

### (2) Prototyping and value verification conducted through the Lumada Competency Center

If we can clarify issues facing customers and society, as well as hypothesized solutions, through NEXPERIENCE, we can use resources including the Lumada Competency Center to determine whether we are capable of solving these issues by using them to build solution prototypes that help us analyze whether proposed solutions will produce their intended results.

The Lumada Competency Center provides system testing environment services that support rapid prototyping conducted through the use and application of data and hypothesis verification. We support the speedy establishment of the system environments

necessary for PoC<sup>\*1</sup> that follows hypothesis planning by offering a variety of services, including Pentaho, a data integration and analysis platform that is also Lumada's core software; services with development and management tool environments that support agile development<sup>\*2</sup>; and Hitachi AI Technology/H, our own artificial intelligence technology.

<sup>\*1</sup> Proof of concept

<sup>\*2</sup> A group of development methods employed in software engineering with the goal of achieving rapid and adaptive software development.

### Accumulation of industrial and operational expertise

#### ■ Quickly providing reliable digital solutions to customers' management issues by utilizing our abundant cache of customer cases

##### (1) Customer cases

Hitachi has accumulated a wide range of industry and business expertise and knowledge in the form of Lumada customer cases with the goal of rapidly utilizing them to collaborate with customers in a variety of fields. Lumada customer cases are models of digital solutions that have created new value through collaborative creation with customers. Each customer case organizes elements such as how value was created using data and which technologies were applied in terms of artificial intelligence and analytics.

When promoting new collaborative creation with customers, Hitachi makes use of Lumada customer cases that fit customers' management issues, as well as Lumada solutions based on an abundance of expertise, to establish appropriate mechanisms for each customer and swiftly achieve digital solutions that create true value.

##### (2) Customer cases that support the entire value chain

As of the end of March 2019, we have established more than 650 customer cases and are continuing to steadily expand this number. We are also pushing forward with our establishment of customer cases that can be used by customers to support efforts common to a wide variety of industries, such as predictive maintenance for equipment and devices. Examples include cases related to medical devices, power generating equipment and other machinery equipment.

In the future, we will continue to conduct investment aimed at further strengthening our lineup of reusable solutions while working to solve customer problems throughout the value chain, including in management, sales, planning, design, procurement, manufacturing, logistics and maintenance.

### Customer Case Examples

Customer Case	Industries	Goals and issues
Revenue/Loss simulation	Manufacturing industry	Manufacturing plan, inventory management
Streamlining of cybersecurity monitoring operations	Common across industries	Security enhancement
digitalization of refined skills	Manufacturing industry	Improvement of product quality
Customer-centered marketing	Retail industry	Marketing
Improve credit analysis	Financial industry	Decision-making support
Inventory optimization	Wholesale, retail and manufacturing industries	Manufacturing plan, inventory management
Analysis of fan club member information	Service industry	Marketing
Crop growth analysis	Agriculture	Productivity improvement
Predictive maintenance	Common across industries	Preventive maintenance
Improvement of operating rates and fault diagnosis	Electricity, gas, heat and water supply industry	Facility management
Delivery optimization	Transportation industry	Delivery and transformation management

**(3) Lumada customer cases**

**CASE 1 Overall optimization of production sites used for high-mix, low-volume production in the manufacturing industry**

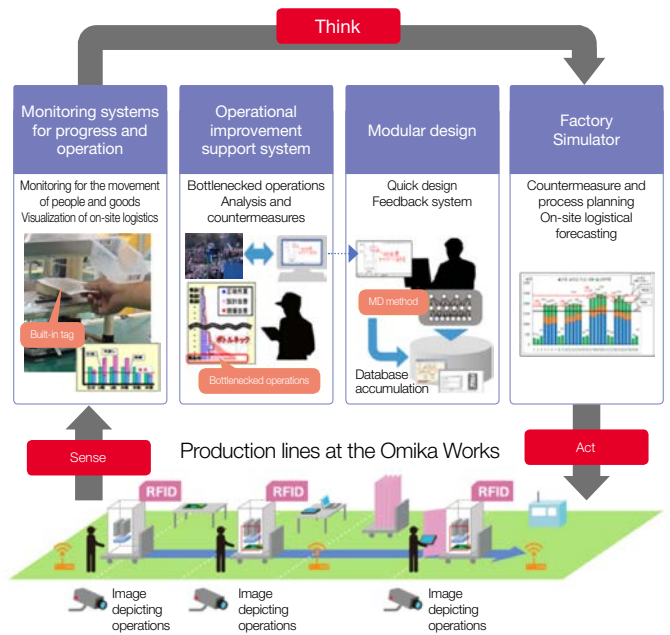
Collect and analyze various data on people and other elements of the production process to improve its efficiency

Customer needs are diversifying and digitalization is progressing at a rapid rate while global competition intensifies. These trends have resulted in demand for high-mix, low-volume production that reaches the same level of productivity as mass production through mass customization. Hitachi's Omika Works handles controls systems manufactured for social infrastructure such as electric power, railways and water and sewage systems through high-mix, low-volume production, and, under these circumstances, faces the need to monitor the progress of production processes in real time. In response, the Omika Works installed about 80,000 RFID tags and approximately 450 RFID readers, collecting detailed data concerning the progress of work conducted by employees and the flow of goods. Furthermore, the Omika Works combined and shared a variety of information gathered by existing systems, including process and production management systems, and analyzed the movement of people and goods throughout its production site. This enabled the establishment of a more precise production plan.

Furthermore, the Omika Works improved the efficiency of its design process through the effective use of design assets and improved the precision of its production plans using a factory simulator. Through these efforts, the Omika Works established a high-efficiency

production model using IoT technology and succeeded in reducing the production lead times of its flagship products by 50%.

**Overall optimization of production sites using Lumada**



**CASE 2 Predictive maintenance for machinery and equipment**

Collecting data from sensors installed in machinery and equipment to diagnose and detect issues, thereby avoiding failure and reducing maintenance costs

Failures and unplanned downtime at facilities that compose our industrial and social infrastructures have a major impact not only on our businesses but also on society. Accordingly, we recognize the need to ensure the continuous and stable operation of these facilities, which requires proper equipment maintenance and quality control.

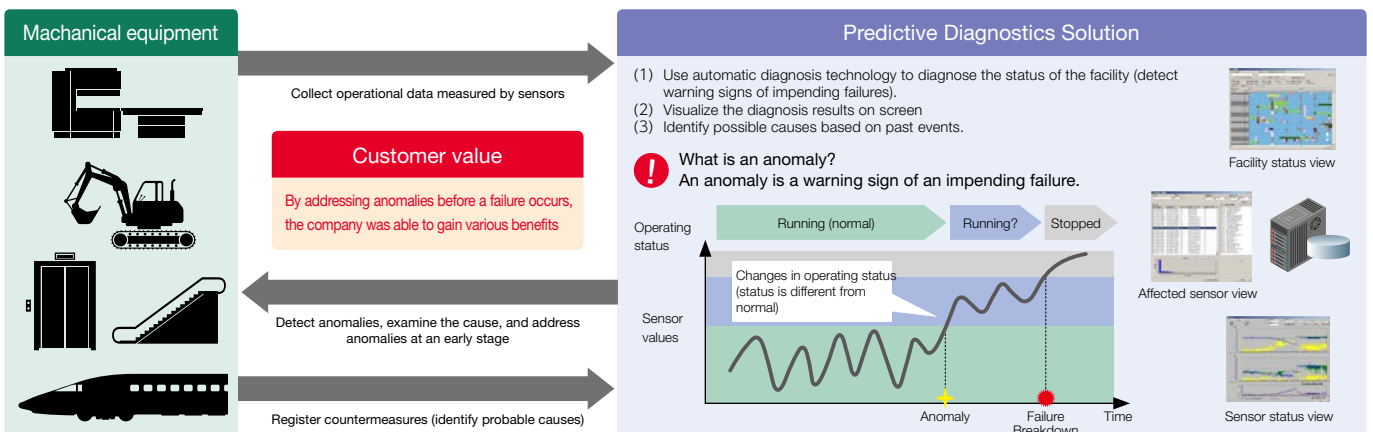
However, many operators do not have analysis methods despite having gathered data indicating the status of their equipment and resort to conducting analysis manually. This results in a large workload that prevents the proper use of valuable data.

With this customer case, we examine and analyze large volumes of

data collected from sensors attached to equipment and detect signs of abnormalities. We also color code and display various information, including equipment operation statuses, relevant changes and indications of possible defects, making it easier to view and identify.

This will enable the customer to detect situations in which equipment statuses or product quality differ from the norm at an early stage, thereby preventing breakdowns and unplanned downtime. As a result, we can expect to be able to reduce maintenance costs by raising equipment operation rates and ensuring the suitability of replacement parts.

Note: P. 39-41 "Strengthening core technologies supporting Lumada."



# Strengthen Lumada

**CASE 3 Raising credit analysis accuracy through the use of AI**

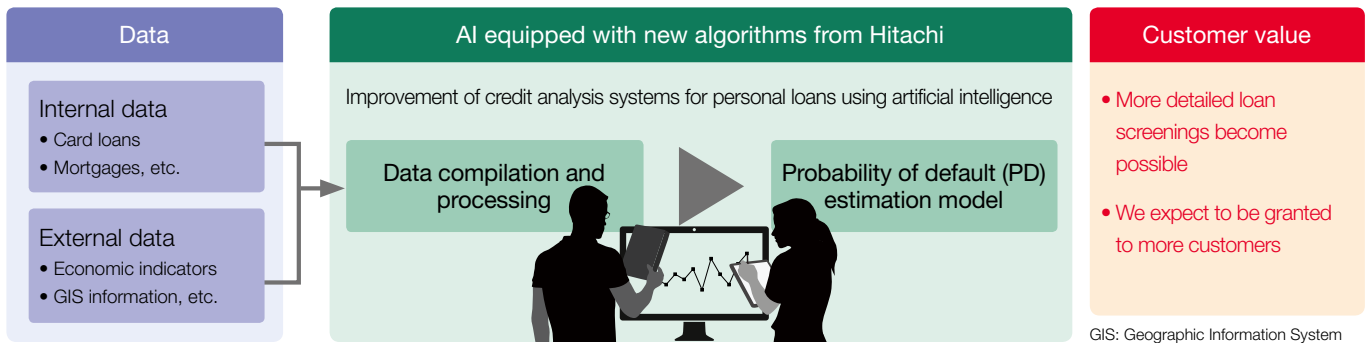
Improve the accuracy of personal loan screenings through AI-based data analysis

Upon understanding customer income and financial conditions, it becomes necessary for financial institutions to predict future credit losses based on factors such as global economic trends. This requires high-level expertise. Mortgages have been particularly difficult to predict using conventional data analysis methods due to their long payback periods.

With this customer case, Hitachi utilizes internal data from financial institutions (e.g., card loans, mortgages), as well as external data (e.g., economic indicators, GIS information) using "Hitachi AI Technology/ Prediction of Rare Case," an artificial intelligence it developed in-house to predict the occurrence of rare events, thereby ensuring highly accurate screenings. This allows for more detailed screenings, which

we expect will allow loans to be granted to more customers than was previously possible.

One developmental effort involving this customer case is Hitachi's May 2019 establishment of Dayta Consulting Co., Ltd., a joint venture formed through collaboration with SBI Sumishin Net Bank, Ltd., that provides screening services using artificial intelligence. The Company plans to provide screening services for various types of lending, including mortgages and card loans, to financial institutions including regional financial institutions.



## Development of an AI-based production planning system through collaborative creation with Suntory Beverage & Food Ltd.

In recent years, beverage manufacturers have faced the need for prompt and flexible product supply in response to diversifying consumer requirements and fluctuations in demand caused by changes in weather and climate. In addition to fulfilling these needs, it is necessary for these manufacturers to formulate optimal production plans that account for complex constraints, such as delivery times, production capacity and production and transportation costs. Suntory Beverage & Food Ltd. ("Suntory") has been basing its production plans on the experience of responsible staff. However, creating plans that account for complicated restraints requires a high level of planning ability and a huge amount of time. Furthermore, production plans are drawn up for each area, which means that the most optimal conditions will differ for each location. For these reasons, Suntory has been unable to formulate an optimal plan that effectively utilizes all of its production resources.

Under these circumstances, Suntory and Hitachi have begun collaborative creation based on the concept of "Harmony between People and AI," combining the former's expertise regarding planning and the latter's AI technology to develop a system that enables the creation of optimal production plans in the face of changing demand and complex constraints. We applied this system to production planning conducted at Suntory's actual manufacturing bases and verified that it was possible to reduce the amount of work time put into planning from its previous average of approximately 40 hours per week to approximately 1 hour. Aiming to optimize its production plans throughout Japan, Suntory launched full-scale operation of this system in January 2019 and is currently working to build a stable supply system that can provide immediate response to fluctuating demand and to improve productivity by raising operational efficiency.

## Lumada platform

### Quickly build appropriate systems by utilizing open and secure IoT platforms

#### (1) IoT platform architecture

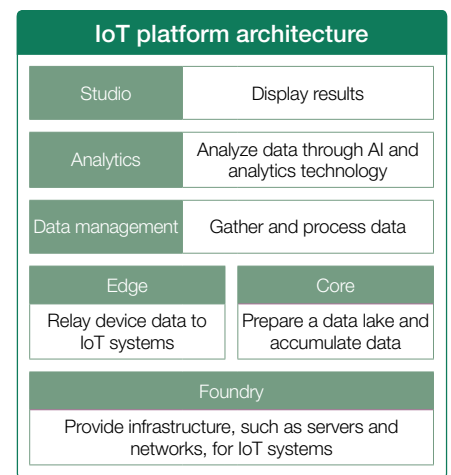
Lumada has established an open and secure IoT platform that can quickly provide digital solutions by swiftly combining advanced products and technologies from both inside and outside Hitachi Group. This platform enables us to comprehensively provide a variety of mechanisms, such as advanced analytics technology and asset management functions, thereby allowing for the prompt realization of appropriate digital solutions.

The platform's structure for flexibility combining technologies is defined by six elements. These elements make the achievement of an open and flexible platform possible with architectural specifications and connection methods that meet global and industrial standards.

Thanks to these attributes, digital solutions utilizing Lumada's IoT platform are intelligent, composable, secure and flexible.

#### Features of Lumada's digital solutions

<b>Intelligent</b>	Analytics technology such as machine learning and artificial intelligence allow for deep insight and awareness that leads to action.
<b>Composable</b>	Hitachi's core technologies can be widely combined with OSS* and third-party technologies to maximize outcomes (results). <small>* Open Source Software</small>
<b>Secure</b>	Users can ensure high levels of security by confirming the appropriateness of connecting equipment, managing the security of stored data and controlling access.
<b>Flexible</b>	We can provide flexible solutions that fit equipment, devices and IT environments currently in operation both through the cloud and on-site*. <small>* Involves installing equipment inside company facilities and implementing and operating systems from within.</small>



#### (2) Lumada Solution Hub, a mechanism enabling the speedy composition of solutions

Launched in 2019, the Lumada Solution Hub is a system that packages Lumada solutions and application development environments in forms that are easy to implement and then registers and provides them on cloud platforms. Easy-to-reuse packages that combine business solutions and application development environments are registered and stored in the Lumada Solution Hub catalog. This system enables smooth transitions from the speedy verifications of solutions, which are conducted through collaboration with customers, to production environments. Furthermore, it allows for efficient rollout to multiple locations, including those that are situated overseas.

In the future, the Lumada Solution Hub will be opened up to partners and register solutions that they have developed, in addition to the Hitachi solutions that are already a part of the Hub's catalog. With these solutions, Hitachi will accelerate the creation, distribution and utilization of digital solutions while speeding up the construction of Lumada ecosystems.

