IoT Platform Solution for Manufacturing that Connect the Manufacturing Site and Management through Data

While initiatives utilizing the IoT are on the rise in the manufacturing industry worldwide, many challenges must be overcome in adopting the IoT. Hitachi Digital Supply Chain/IoT is a solution that Hitachi supplies for facilitating the construction of IoT environments at manufacturing sites. This article looks at the challenges and solutions involved in adopting the IoT. The solutions presented are driven by data and by IoT platforms. Data-driven solutions are implemented by compiling the process flows used to collect data from the manufacturing site's devices and systems, and using the data at manufacturing sites. IoT platform solutions help improve production efficiency through systemwide optimization.

Shigenori Tanaka
Kazuhiro Koura
Motoki Suzuki
Manabu Naganuma

1. Introduction

Throughout 2016 and 2017, the Internet of Things (IoT) gained popularity even outside the IT industry as initiatives such as Industrie 4.0, the Industrial Internet Consortium (IIC), and Japan's Robot Revolution Initiative (RRI) worked on many practical IoT applications. Manufacturers seeking a competitive edge in global markets have started to more actively embrace the use of site data to continuously transform their business activities. Inside Hitachi too, the number of actual use cases of its IoT platform Lumada, designed for creating new value through
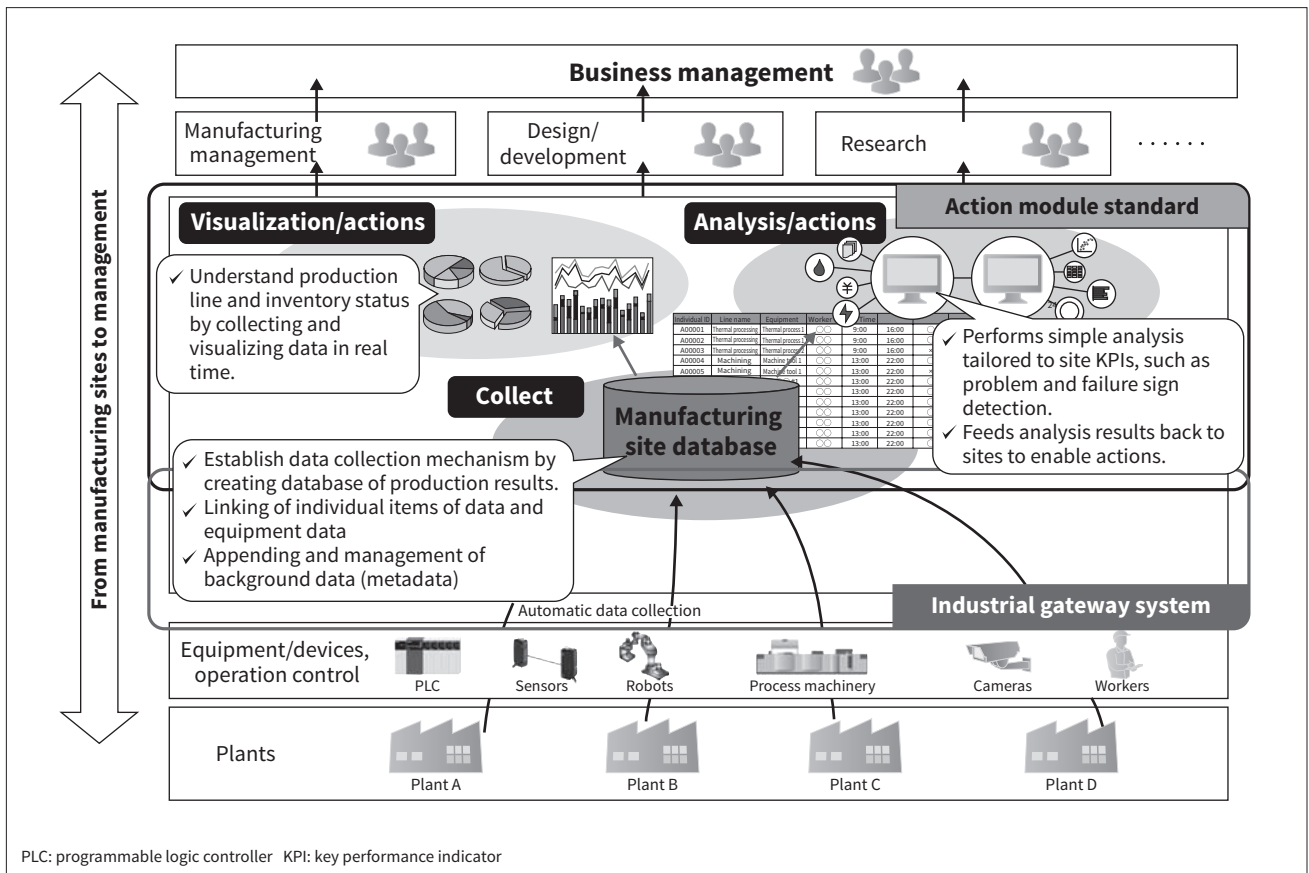
collaborative creation with customers, had grown to 203[1] by the end of March 2017.

This growth in number of IoT use cases, however, has revealed a host of challenges that companies are experiencing in making effective use of the IoT data collected from manufacturing sites. These challenges include finding methods of collecting data from equipment and devices, recovering the capital invested in adopting the IoT, and being able to effectively reap the benefits of the IoT.

This article looks at some of the challenges the manufacturing industry is experiencing in adopting the IoT. It discusses how these challenges can be overcome, and presents an IoT platform solution designed for the manufacturing industry (see **Figure 1**).

Figure 1 — Overview of Hitachi Digital Supply Chain/IoT (DSC/IoT)

DSC/IoT compiles data collection flows from devices at manufacturing sites. It provides a single unified connection to the host system, helping increase the efficiency of data usage and analysis, and solve site problems.

From manufacturing sites to management

Business management

Manufacturing management
Design/development
Research
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Visualization/actions

✓ Understand production line and inventory status by collecting and visualizing data in real time.

Analysis/actions

Action module standard

Collect

Manufacturing site database

✓ Performs simple analysis tailored to site KPIs, such as problem and failure sign detection.
✓ Feeds analysis results back to sites to enable actions.

✓ Establish data collection mechanism by creating database of production results.
✓ Linking of individual items of data and equipment data
✓ Appending and management of background data (metadata)

Automatic data collection

Industrial gateway system

Equipment/devices, operation control

PLC Sensors Robots Process machinery Cameras Workers

Plants

Plant A Plant B Plant C Plant D

PLC: programmable logic controller KPI: key performance indicator

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2. Challenges when Adopting the IoT for Manufacturing

Manufacturing sites are adding new IoT-compatible equipment and refitting existing equipment with sensors and communication functions to enable the collection of various types of manufacturing data. Wireless technologies[2],[3] developed for IoT networks are also being used to provide plants with internal networks for collecting data. But, while this IoT-related infrastructure is developing, the question of what management approach to use in adopting the IoT and how to use the collected data are becoming great challenges. This section covers these challenges in detail.

2. 1
Challenges with Each of the Two Management Approaches

There are two approaches to managing the adoption of the IoT—a bottom-up (production-driven) approach, and a top-down (IT department-driven) approach. This section discusses the challenges encountered in these two approaches.

(1) Challenges with the production-driven approach

Along with the development of an IoT infrastructure, there is a strong impetus to proceed with a production-driven approach toward adopting the IoT. The benefit of this bottom-up approach is that the specific challenges being faced by the site can be worked on by collecting the relevant data and linking it rapidly to solutions.

But, a common challenge encountered when using the production-driven approach is that the work tends to become focused on only the processes for which the person in charge is responsible. This results in the dispersion of various different data-collection methods and visualization systems throughout the plant or company, generating multiple separate 'silo' systems at each site that are inefficient and uncoordinated. The greater influence a manufacturing site has, the greater tendency it has to make its own improvements,

and the more difficult it becomes to tackle common issues that need to be resolved between processes or plants. Activities that apply to IoT should ideally be approached as management-wide or companywide reforms and implemented simultaneously under strong leadership. But, with human resources and other issues, these activities tend to be quite far from this ideal.

(2) Challenges with the IT department-driven approach

Largely a top-down approach, the IT department-driven approach to adopting the IoT has the benefit of tending to favor projects that help maximize return on investment to achieve companywide optimization. But, unlike the days when there were IT offices in plant departments, restructuring to achieve companywide optimization or efficiency gains has now created IT departments with significantly fewer staff members who can communicate in depth with the manufacturing staff at manufacturing sites or in production management. The IT department-driven approach also tends to focus more on creating IT platform infrastructure for data storage rather than for business processes, overlooking the business requirements and needs of the manufacturing site. As a result, even if a platform for analyzing big data is adopted, there are situations where data is not collected from the site, or there is no staff to help ensure effective use of the collected data.

Figure 2 — DSC/IoT Product Configuration

DSC/IoT is provided by combining an industrial gateway system and action module standard. The industrial gateway system collects data and connects applications. The action module standard is a set of common-function mini apps.
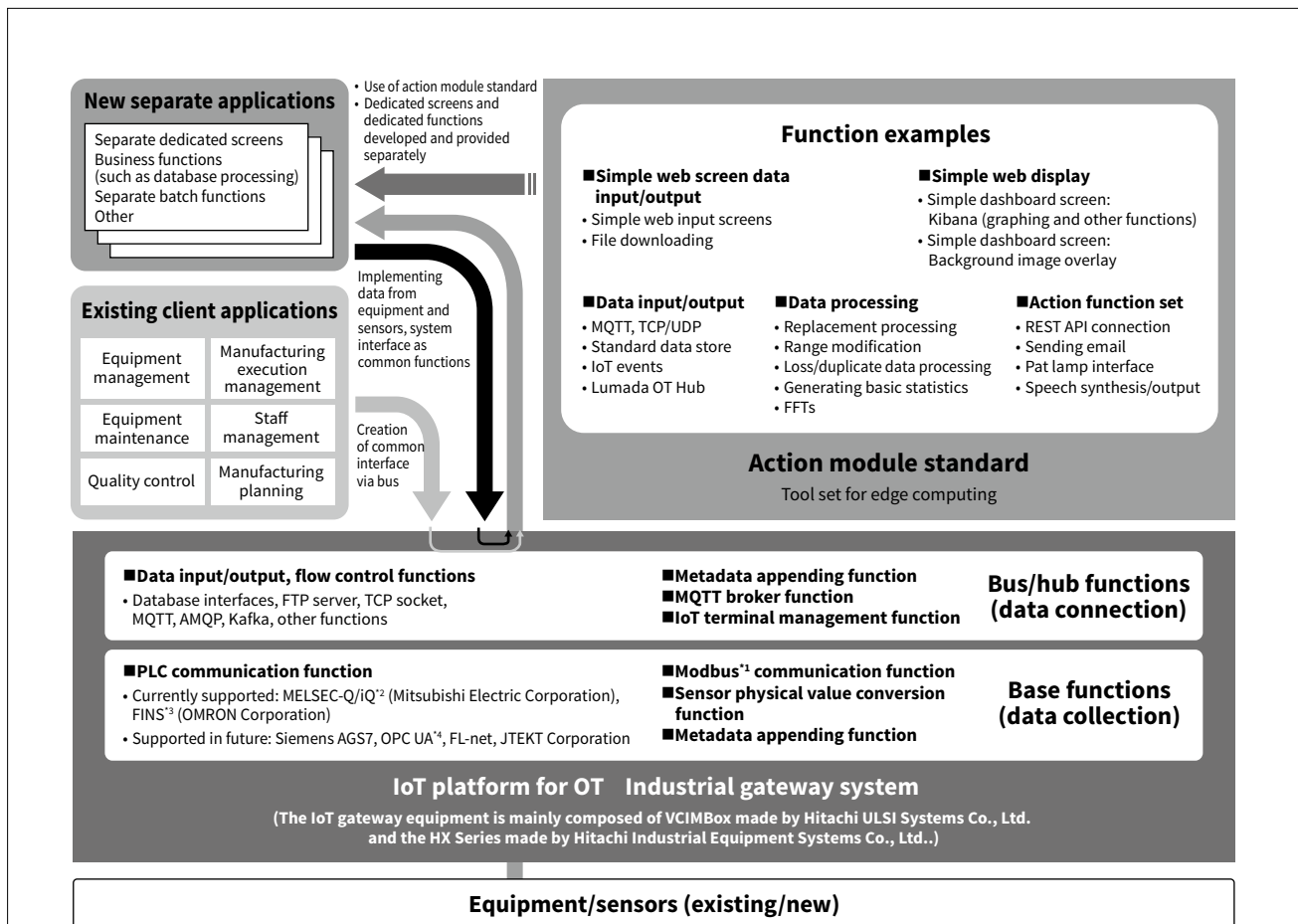
REST: representational state transfer API: application programming interface MQTT: message queuing telemetry transport TCP: transmission control protocol
UDP: user datagram protocol IoT: Internet of Things OT: operational technology FTP: file transfer protocol AMQP: advanced message queuing protocol
OPC UA: object linking and embedding for process control unified architecture FFT: fast fourier transform FINS: factory interface network service
*1 Modbus is a registered trademark of Schneider Electric USA, Inc.
*2 MELSEC is a registered trademark of Mitsubishi Electric Corporation.
*3 FINS is a registered trademark of OMRON Corporation.
*4 OPC UA is a registered trademark of the OPC Foundation.

The two approaches to adopting the IoT, and their challenges, are described above in terms of manufacturing sites and IT departments. Another aspect to consider, however, are the users in the manufacturing industry who are promoting the IoT. These users report that they prefer to quickly achieve small objectives at the start of a project and share their success stories with others around them to bring them on board. To enable big growth from a small start, it is necessary to combine the talents of both manufacturing sites and IT departments to enable smooth communication and, in addition to creating projects that include members from both organizations, it is necessary to provide inexpensive, rapidly deployable tools and platforms.

2. 2
Solutions for Quick and Easy Adoption of the IoT

Hitachi Digital Supply Chain/IoT (DSC/IoT) and the IoT platform Lumada are two solutions that Hitachi provides for adopting the IoT. DSC/IoT allows manufacturing sites to quickly and easily create IoT environments. It is an on-premises solution designed for manufacturing sites that want to start by adopting the IoT on a small scale (see **Figure 2**). Hitachi's IoT platform Lumada allows manufacturers to disseminate IoT usage expertise laterally throughout the plant or company and to perform big data analysis on a wide array of stored data. The plant's manufacturing sites and management teams can seamlessly connect to the cloud-based Lumada platform to use the shared functions it provides, such as big data analysis and artificial intelligence (AI) analytics.

The next section presents Hitachi's DSC/IoT, which collects data from manufacturing sites to quickly and easily provide visualizations—important when starting out with the IoT.

3. DSC/IoT Utilization at Manufacturing Sites

3. 1
Overview of DSC/IoT

Designed to allow users at manufacturing sites use their own data from individual processes and production lines in the plant, DSC/IoT provides functions for collecting data, visualizations, and analysis. The solution is designed for manufacturing sites that want to start by adopting the IoT on a small scale at the site, and then laterally deploying it to multiple processes.

DSC/IoT is provided as an on-premises edge-computing software product that can be implemented on-site. This feature makes it ideal for customers who want to prevent their data from leaving the manufacturing site. The software is implemented by using virtualization technology to quickly create the usage environment, enabling rapid startup of trial environments.

3. 2
DSC/IoT Product Configuration

DSC/IoT is composed of an industrial gateway system and an action module standard. The industrial gateway system collects data from production equipment and production systems in real time in a unified manner, sharing it instantly with applications. The action module standard uses the data that is collected in real time.

(1) DSC/IoT's industrial gateway system

The industrial gateway system has a Base function that collects data from equipment and devices, and a Bus function that temporarily stores that collected data and sends it to business systems.

The Base function uses an IoT gateway unit that collects data from equipment and devices with different interfaces. The Base function currently works in conjunction with a device made by Hitachi ULSI Systems Co., Ltd. called VCIMBox. VCIMBox can collect data from Mitsubishi Electric Corporation programmable logic controllers (PLCs) that support the MC protocol, and from OMRON Corporation industrial automation devices that support the Factory Interface Network Service (FINS) protocol. For use with other IoT gateway devices, VCIMBox also connects to HX Series products made by Hitachi Industrial Equipment Systems Co., Ltd., enabling the collection of required data files from various devices connected to industrial networks. DSC/IoT also provides agents that enable the real-time collection of file-format data on control PCs at sites using the File Transfer Protocol (FTP), along with monitoring and real-time collection of data files on PCs using

the Message Queuing Telemetry Transport (MQTT) communication protocol.

The bus function is the industrial gateway system's other function. It temporarily stores the collected data to enable processing and appending of metadata. The bus function uses computer network communication standards such as WebSocket and the representational state transfer application programming interface (REST API) to send data to business systems after defining data processing flows such as data connection and file output. It also calls the functions provided by the action module standard (described below) to enable data processing via decision logic.

(2) DSC/IoT's action module standard

The action module standard is a set of mini apps that monitor and statistically analyze collected data in real time. The action module standard supports the use of Kibana* as a simple graphing tool for monitoring data in real time. Kibana provides a simple way to visualize data at manufacturing sites without the need for expensive multifunctional business intelligence

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* Kibana is an open-source log data analysis/visualization tool provided by Elastic, and a trademark or registered trademark of Elasticsearch BV, registered in the U.S. and in other countries.

(BI) tools (see **Figure 3**). The action module standard also comes with a wide range functions for use with real-time data from equipment and devices. These functions can be used to supplement missing data, process duplicate data, and analyze data with fundamental statistics.

3. 3
Data Usage Environment Creation
DSC/IoT enables use of the production-driven approach to create a data usage environment. The environment is created using a tool called Node-RED that can define data processing flows using programming without the need to write source code (perform coding). The definitions apply to data output to storage devices, as well as data processing operations such as data input, output, merging and dividing. **Figure 4** shows an example Node-RED screen. From the palette on the left of the screen, the user selects a node (function list item), drags-and-drops it into the central area, and connects it to other nodes to create a process flow. Each node has a parameter setting screen used to enter numerical values or select


Figure 3 — Example Use of DSC/IoT to Create Transparency at Manufacturing Site
Kibana is a tool for visualizing log data. It makes it easy to create web screens for viewing the data that needs to be visualized at manufacturing sites.
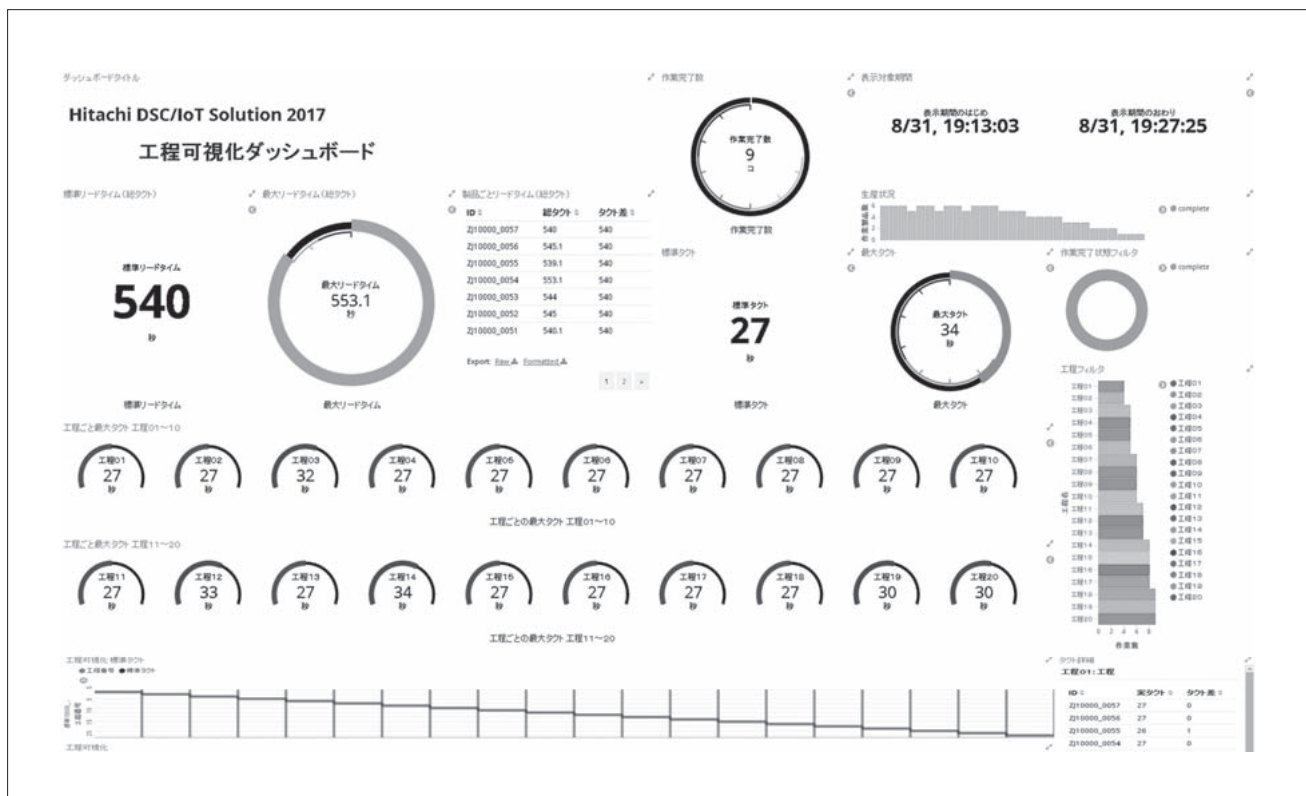
Figure 4 — Data Usage Environment Configuration Example

Node-RED can be used to easily create IoT data processing flows at manufacturing sites.
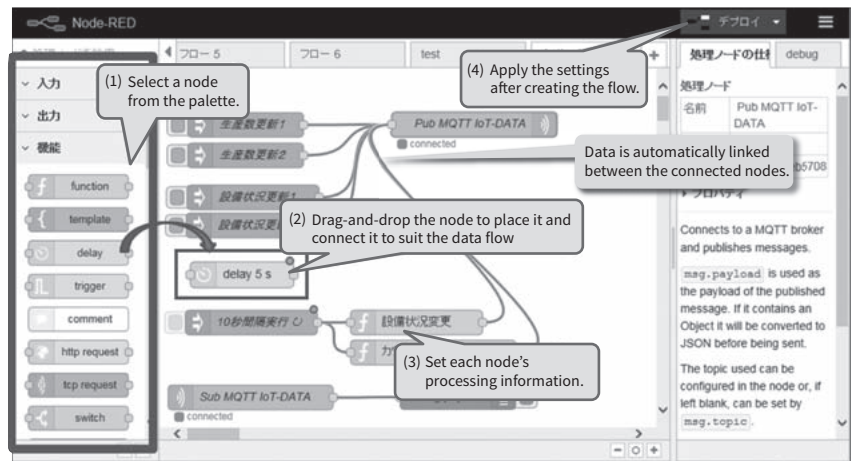
parameters. Hitachi provides templates tailored to the client's problem-solving needs. The templates are augmented to rapidly help the client reap benefits.

4. Connection to Lumada IoT Platform

DSC/IoT can be used alone or connected to Hitachi's Lumada IoT platform to provide solutions using data from multiple plants or throughout the entire company.

A plant IoT platform connecting DSC/IoT and Lumada is composed of a data collection/integration layer driven by DSC/IoT, along with a data storage layer and data usage layer. DSC/IoT adds tags or other information to the data collected from manufacturing site equipment, devices, and related systems, and provides the integrated data to the data storage layer. The data usage layer compiles and analyzes the data from throughout the plant or company using Pentaho and the Hitachi AI engine, which are advanced data usage functions. Pentaho is a tool providing extract, transform, load (ETL) and BI functions. Data from single production lines or multiple production lines can be analyzed to help bring transparency to the entire plant, provide new insights to site or plant managers, and enable greater production efficiency in terms of systemwide optimization.

A manufacturer can use a plant IoT platform to apply companywide IoT data to improvement/reform activities, share improvement results with other manufacturing processes or plants, and implement plan-do-check-act (PDCA) cycles at sites faster.

5. Conclusions

This article has presented DSC/IoT and the solutions that can be created with it. DSC/IoT lets the user collect data from their own manufacturing site equipment and devices, visualize the data, and analyze it. DSC/IoT-driven solutions are created by connecting DSC/IoT to Hitachi's Lumada IoT platform and expanding its functions to enable rapid lateral deployment of process improvements to help boost efficiency in terms of systemwide optimization.

Through DSC/IoT and solutions created on the Lumada IoT platform, Hitachi will continue to provide solutions combining IT and the operational technology (OT) we have accumulated over our long history as a manufacturer. We will also continue working on collaborative creation projects designed to let clients make rapid use of their technologies and expertise by systematizing them.

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Authors

Shigenori Tanaka
Manufacturing IoT Solutions Department, IoT Business Promotion Division, Industrial Solutions Division, Industry & Distribution Business Unit, Hitachi, Ltd. *Current work and research:* Development of manufacturing IoT solutions.

Kazuhiro Koura
Manufacturing IoT Solutions Department, IoT Business Promotion Division, Industrial Solutions Division, Industry & Distribution Business Unit, Hitachi, Ltd. *Current work and research:* Development of manufacturing IoT solutions.

Motoki Suzuki
Manufacturing IoT Solutions Department, IoT Business Promotion Division, Industrial Solutions Division, Industry & Distribution Business Unit, Hitachi, Ltd. *Current work and research:* Development of manufacturing IoT solutions.

Manabu Naganuma
Global Business Planning Department, Industrial Solutions Division, Industry & Distribution Business Unit, Hitachi, Ltd. *Current work and research:* Business planning in the field of manufacturing IoT solutions.