Establishment of Global Control Center and Use of Remote Monitoring to Expand Services

In the elevator and escalator industry, including overseas, companies are turning to the use of ICT in maintenance work to improve safety, minimize downtime, and increase the efficiency of maintenance work. In 1994, Hitachi introduced HERIOS, a remote intelligent diagnostic system for elevators, and since then has been developing and expanding the functionality of systems such as an AI-based fault recovery support system, BUILLINK, a dashboard that provides building owners and managers with information on facility operating status and maintenance, and others. This article describes Hitachi's Global Control Center, which aims to implement further advancements in HERIOS using Hitachi's Lumada's Digital Innovation Platform for expanding the monitoring coverage area in Asia. It also presents the expanded BUILLINK service menu and the "LINE-linked Touchless elevator calling service," which was introduced in response to the recent COVID-19 outbreak for allowing users to call elevators and set their destination floors without touching any buttons.

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1. Introduction

In 1994, Hitachi was one of the first companies in the industry to develop and introduce a remote intelligent diagnostic system for elevators and escalators, called HERIOS[*1]. The purpose of this system was to improve the efficiency of maintenance work, and it has since expanded and evolved to include improving safety, maintaining high quality, and providing more attractive services. Typical extended functions of HERIOS include: HERIOS remote rescue system (2003), which enables remote rescue of elevator users while checking the images in the car when passengers are trapped in an elevator; HERIOS watcher (abnormal behavior/retention detection) (2006), which detects abnormal behaviors such as acts of violence and loitering by comparing images from the camera installed in an elevator car with information on preset normal behaviors, and HERIOS Drive system (2007), which performs automatic diagnostic operations to temporarily restore elevator operation after service is shut down due to an earthquake.

In 2014, the remote monitoring line was upgraded to an Internet Protocol (IP) network, and the remote rescue time for passengers trapped in the elevator was reduced from an average of six minutes to only three minutes by increasing the speed of the communication line and enabling simultaneous voice and data communications.

Furthermore, in 2019, based on the concepts of visibility, connectivity, and mobility, Hitachi began offering BUILLINK, a dashboard that uses the functions of HERIOS to enable building owners and managers to use their PCs and smartphones to directly monitor information on the operation of elevators and other building facilities as well as the recovery status in the event of a wide-area disaster. In this way, Hitachi has been improving safety, convenience, and operational efficiency by implementing Internet of Things (IoT) technology in its systems.

*1 Hitachi equipment remote and intelligent observation system

This article presents the Global Control Center using Hitachi's remote intelligent diagnostic system, which has been developed in Japan and is further evolving using the Lumada's Digital Innovation Platform to expand the monitoring range in Asia, an artificial intelligence (AI) based fault recovery support system developed in conjunction with the Global Control Center, BUILLINK, which expands the number of target facilities and adds functions, and a LINE[*2]-linked touchless elevator calling service.

2. Establishment of Global Control Center

2. 1 Overseas Trends in Elevator and Escalator Maintenance Operations

As the demand for safety increases in overseas elevator and escalator maintenance operations, countries are adopting standardization and mandatory disclosure for maintenance work plans, implementation records, and equipment operating status. In response, companies are actively implementing IoT for remote monitoring and information and communication technology (ICT) for maintenance work.

In maintenance operations, maintenance data can be utilized to shift from the conventional time-based maintenance (TBM) to condition-based maintenance (CBM) and even predictive maintenance (PM) to minimize downtime for higher safety and convenience. Also, the level of added value is becoming more sophisticated by providing AI-based recovery support in the event of a fault and dashboards that allow visualization of performance contracts (see **Table 1**).

2. 2 Role of the Global Control Center

Hitachi's control center, which is currently operating for companies in Japan, is linked to HERIOS' remote monitoring terminals, maintenance terminals used by field engineers, and operation IT systems, enabling seamless operations from daily maintenance work to emergency failure responses. However, in Japan, it has been a challenge to cope with the increasing number of elevators and escalators needing maintenance and to devise methods for passing on maintenance expertise and knowledge that will be lost due to the generational shift as engineers retire. In addition, acquiring and training engineers has become a major issue overseas due to the expanding footprint and increasing number of elevators and escalators needing maintenance.

Given this background, there has been a need to introduce a machine-based technology that supports failure recovery by utilizing equipment status data collected by an IoT-based remote intelligent diagnostic system for elevators and escalators, and operational data such as maintenance work history, failure response records, and other data. This is the role that the Global Control Center fulfills.

2. 3 Introduction of an AI-based Fault Recovery Support System

Based on the concept of mechanizing fault recovery support, the AI-based fault recovery support system consists of the following three phases (see **Figure 1**).

(1) Collect fault and diagnostic information
(2) Identify faulty machinery and perform troubleshooting
(3) Provide recovery procedure instructions and information on obtaining parts

This section discusses (2) Identify faulty machinery and perform troubleshooting, which is a particularly important function.

The cause of a fault is identified by a combination of two methods. The first method uses the equipment status data collected by the remote monitoring terminal at the time of the fault. Equipment status data is data that contains the recorded elevator fault codes and information on various devices (HERIOS monitoring data) whenever a problem occurs. A cause estimation model is generated by machine learning of the combination of this equipment status data

*2 LINE is a registered trademark of Line Corporation.

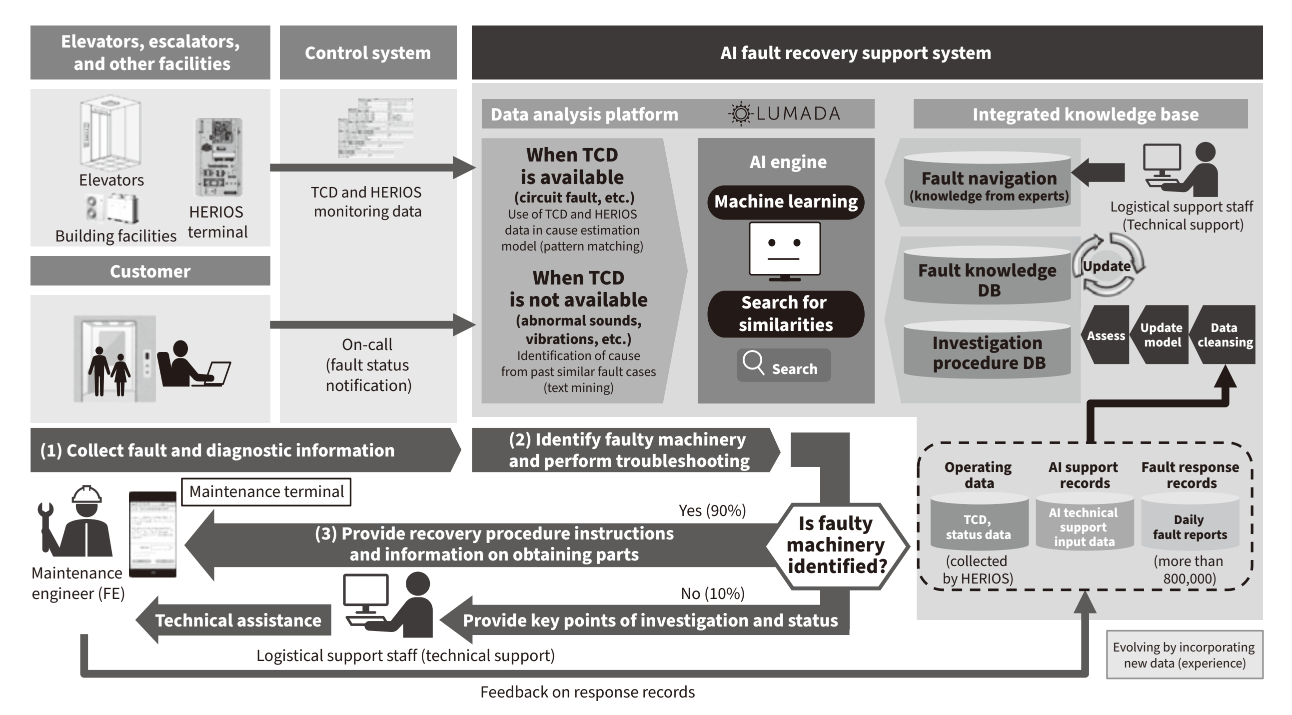
Table 1 — Use of IT and IoT in the Overseas Elevator and Escalator Industry
Companies are rapidly adopting IT and IoT by forming partnerships with IT companies.

	Company A	Company B	Company C	Company D
Higher efficiency (remote monitoring)	Remote monitoring (IoT terminal) • Fault detection • Collection of operating data	Remote monitoring (IoT terminal) • Fault detection • Collection of operating data	Remote monitoring (IoT terminal) • Fault detection • Collection of operating data • Wearable device applications	Remote monitoring (IoT terminal) • Fault detection • Collection of operating data
Higher quality (fault recovery)	Work instructions and performance management using engineers' smartphones	Work instructions and performance management using engineers' smartphones	Machine learning of remote monitoring data for predictive maintenance	AI field work support (AI-based fault recovery support)
Added value (dashboard)	Information delivery service Contracts, billing, call count, response count, operating information, etc.	Facility operating information Delivering advertisements, news, etc. Digital signage	–	Providing traffic reports and public transportation schedules

AI: artificial intelligence IoT: Internet of Things

Figure 1 — Overview of AI Fault Recovery Support System

This system minimizes downtime by improving efficiency through the use of IT, from information collection to identifying the faulty machinery, recovery procedure guidance, and logistical support.



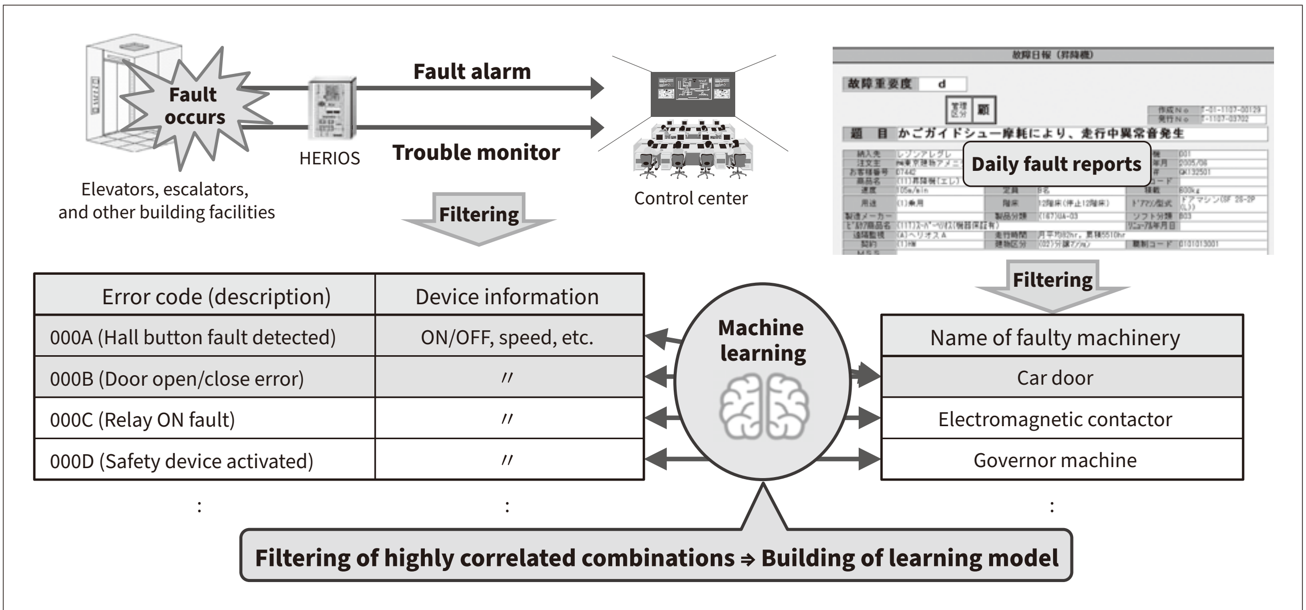
HERIOS: Hitachi equipment remote and intelligent observation system TCD: trouble code FE: field engineer DB: database

and the faulty machinery identified in past fault response records, and the probable faulty machinery is instantly identified from the equipment status data that is collected automatically whenever a fault occurs (see **Figure 2**).

In the second method, if the equipment status data cannot be obtained through remote monitoring, syntactic analysis is performed on the on-call information from the customer (fault status notification) and the on-site status entered by the engineer into the maintenance terminal, and a similar case search is conducted in the fault knowledge database created from past fault cases. The search results are then used for case-based reasoning to identify the faulty

Figure 2 — Machine Learning for Identifying Faulty Machinery

This system automates the identification of faulty machinery when a fault occurs by learning the correlation between the faulty machinery and the trouble monitor based on past fault cases.



machinery. Both methods have mechanisms to automatically improve the accuracy of diagnosis by recording the identification results and the operation and decision history of the engineer, and using this as new learning material for new fault cases.

The AI-based fault recovery support system is basically used by engineers in the field through smartphones and tablet terminals, but in the future, Hitachi aims to achieve rapid fault response through voice input by engineers and voice response by the system. This system can also be used at the technical support center, which provides logistical support to the engineers so they can understand how the cause of the failure was identified and isolated by the engineers on-site. If it is determined that it will take some time to recover, the technical support center will actively intervene to resolve the problem.

3. Expanded BUILLINK Service Menu

3. 1 Expanded Range for Target Equipment and Global Support

As mentioned above, BUILLINK is based on the concepts of visibility, connectivity, and mobility. In terms of "visibility," the system confirms the operational status of elevators and escalators, the recovery status of elevators and escalators in the event of wide-area disasters such as earthquakes, and the response status to inquiries about faults and other problems. It also provides managers and building owners with past work results and scheduled dates for future inspections. In addition to connecting with Hitachi's sales representatives and field engineers, the system's "connectivity" is designed to strengthen customer relationships by displaying announcements in a timely manner. In terms of "mobility," the system allows users to control elevator operations, such as evacuation from flooded floors and changing the standby floor, and to set the display of the in-car LCD indicator for standard and renovated elevators released in 2011 or later to improve customer convenience.

Looking forward, Hitachi plans to continue expanding the functions of the system and gradually expand it globally with a focus on Asia (see **Figure 3**).

3. 2 Introduction of LINE-linked Touchless Elevator Calling Service

In the wake of the global COVID-19 pandemic, infection control measures are required for a wide array of situations. Even for elevators used by an indefinite number of people, there are concerns about infection through contact with the buttons, and this has prompted the need for a solution that allows people to board elevators and arrive at their destination floors without touching the buttons. Therefore, one idea for providing this service to a wider range of users was to utilize smartphones, which are now widely used, with LINE, a messaging app with more than 86 million monthly active users[*3] in Japan. Using the LINE app as a service platform, Hitachi has developed a LINE-linked touchless elevator calling service that allows users to call elevators and set their destination floors using their personal smartphones by friending the official LINE account for each elevator. This service was launched in November 2020. Users can use the elevator without touching any buttons

*3 As of the end of September 2020, based on data from Line Corporation.

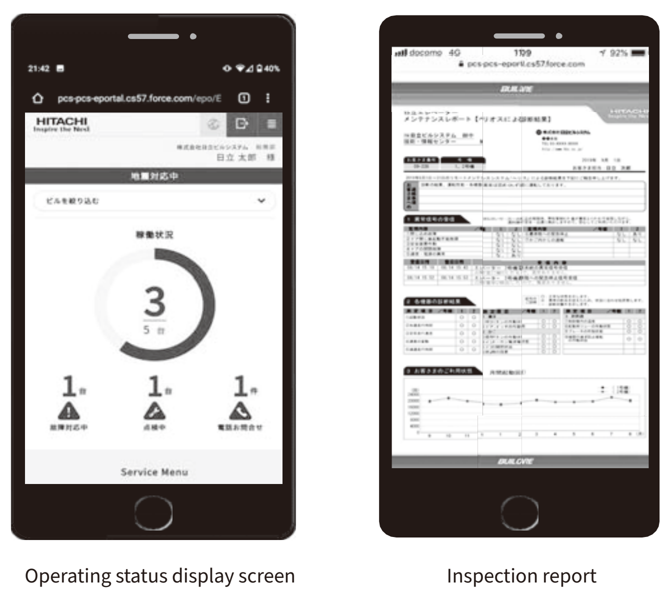


Figure 3 — BUILLINK Screen Images
The top screen of BUILLINK (left) consolidates information so that customers can grasp the operating status of elevators and building facilities that they manage at a glance, and the inspection report display screen (right) allows customers to go back and check data for the past five years.

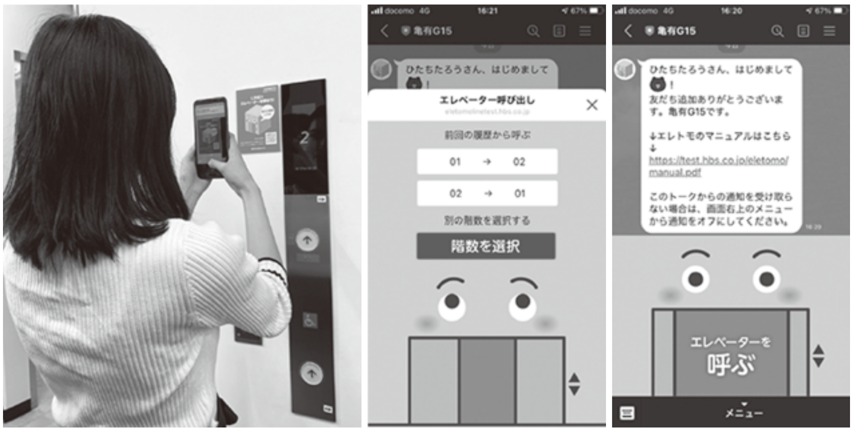


Figure 4 — LINE-linked Touchless Elevator Calling Service

The left image shows someone friending the official LINE account by scanning its QR code posted in the elevator hall (left image), and the center and right images show the screens for setting the current floor and destination floor. The screens for setting the current floor and destination floor use original characters for providing a user-friendly screen design.

by scanning the QR code*4 provided in the elevator hall or other location, friending the elevator they want to use, and then calling the elevator and setting the destination floor on the chat (message exchange) screen. By friending the official LINE accounts of the elevators in the home, office, or other buildings that users frequently use beforehand, they can enjoy even smoother service (see **Figure 4**).

4. Conclusions

This article has presented the technologies of Hitachi's remote intelligent diagnostic system for elevators and escalators that have been developed since its introduction in 1994, technologies for responding to faults in the field, and Hitachi's Global Control Center that is developing even more advanced remote intelligent diagnostic systems using the Digital Innovation Platform.

The control center will use AI to tap into the vast amount of data obtained from remote monitoring and on-site expertise to dramatically improve the quality of elevator and escalator maintenance and to enable horizontal deployment of advanced maintenance services to other Asian countries. Furthermore, by visualizing Hitachi's maintenance work for customers through BUILLINK, the company is confident that it can earn even greater customer trust in Hitachi's maintenance services and build even stronger relationships.

*4 QR Code is a registered trademark of DENSO WAVE Inc.

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