Edge Controllers Connecting Field Devices and Cyberspace

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ABSTRACT

An edge controller, used in an IoT system, collects data from field devices. Its data processing is currently becoming more advanced, called edge heavy, by sharing computing with upper layers. Fuji Electric offers advanced real-time IoT solutions by assigning edge controllers part of the analysis and prediction tasks in addition to data collection. Our IoT product line includes the display-based "MONITOUCH V9-IoT," PLC-based "SPH3000-IoT" and gateway-based "FiTSA Σ," each with device-specific attributes.

1. Introduction

An edge controller is a component of the Internet of things (IoT) system used in the industrial field, including industrial processes. It collects data from various field devices installed on-site at customer facilities. Recent edge controllers have come to perform data processing that requires more advanced functions and high-speed response by dividing the processing performed in the upper layer, in addition to collecting field device data. This is called edge-heavy computing. This paper explains the challenges of edge controllers, the function and features of Fuji Electric's edge controllers, and application examples and the future outlook.

2. Challenges and Market Trend of Edge Controllers

Edge controllers collect data from various field devices and serve as a bridge to an information system network, such as computers and clouds, in the upper layer. Thus, their main function was converting communication protocol as the gateway device that connects field networks, where field devices are connected, and information networks.

On the other hand, because of the challenges described below, computing is becoming edge-heavy, that is, edge controllers installed closer to the field divide and process data that have previously been processed by computers and clouds in the upper layer.

(1) Challenges in data processing
  (a) Increase in traffic cost due to a greater load on networks or cloud devices
  (b) Decline in real-time response accompanied by the bottleneck of processing
  (c) Concern by users about lowered security related to transmission of raw field data to the outside

The emergence of edge controllers that can realize edge-heavy computing is increasing the needs in manufacturing sites and demands for edge controllers as shown in Table 1.

On the other hand, the demand for edge controllers is expected to increase by 10% to 15% a year[1]. To meet this, however, the challenges below need to be solved.

(2) Upper system connection
  (a) Processing balance between edge controllers and the upper system, and accumulation of know-how

Table 1 Needs of manufacturing sites and demand for edge controllers

Needs of manufacturing sites	Demand for edge controllers
Improvement in manufacturing value (improvement in productivity by shortening the time required for production preparation)	Provision of higher real-time data by selecting production information at sites
Diversified and small-quantity production (realization of mass customization)	Higher processing capability to process control system and higher-level information system at sites
Reduction in programming load	Provision of easy programming tools and applications
Connection between vendors	Application in open architecture such as industrial open network
Expansion of service business of FA equipment and device manufacturers	Revitalization of services such as remote monitoring, support, and preventive maintenance, and implementation at sites on the basis of the data collected by edge controllers

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(b) Security assurance when edge controllers are connected to the upper systems and clouds

3. Fuji Electric's IoT System and the Role of Edge Controllers

3.1 Fuji Electric's IoT solution

For Fuji Electric IoT system, we provide control devices serving as execution base and a series of technologies, including field data sensing, gateway, network connection, data analysis and prediction, optimization control, and advanced control. We have various IoT solutions that utilize products and technologies to create customer values.

3.2 Position of Fuji Electric edge controllers

The edge controller of Fuji Electric is a platform that collects and accumulates various field data and serves as a gateway that utilizes network connection technology to pass the data to cyberspace.

In the future, field devices, machines, and equipment will become IoT components and directly connect to the network. Regarding the connection to cyberspace, a field device can be classified into the 3 types below (see Fig. 1). Edge controllers serve as the gateway device that connects cyberspace and the field devices in group II and group III.

(1) Group I: Direct type

Field devices that are directly connected to cyberspace. This includes monitoring and control systems, medium and large capacity uninterruptible power systems (UPSs), high function inverters, vending machines linked with IT and radiation monitoring posts.

(2) Group II: Edge controller type

Existing devices that have no function of directly connecting to cyberspace (controllers, inverters, general-purpose equipment such as measuring equipment, and analyzers). They are connected to cyberspace using the local communication function of individual products, regardless of whether they were made in-house or by other manufacturers. To connect this type of equipment to cyberspace, Fuji Electric provides edge controllers, including the "MONITOUCH V9-IoT," based on a field type display, the "FiTSA Σ," based on a general-purpose gateway device, and the "SPH3000-IoT," based on a programmable controller (PLC). These edge controllers can connect PLCs, inverters, NC machines, robots and measuring equipment of other manufacturers and greatly contributing to the building of IoT systems for field devices.

(3) Group III: Edge controller + sensor type

This type connects rotating machines, breakers and buildings, which have no local connection function or intelligent function at all. Sensors, such as those for vibration, temperature, current, are connected to edge controllers, and the state of the object is digitalized via sensors.

To achieve edge-heavy computing, edge controllers need to solve challenges, such as an increase in the communication traffic cost due to an increase in the amount of field data, decline in real-time responsiveness, and concern about lowered security, as shown in Chapter 2. In addition, to respond to the request of manufacturing sites, edge controllers need to have various performances and functions, such as a high processing capability to divide and execute the process that are performed by a control system and higher-level information system, real-time data supply, open architecture application, and service application, such as predictive maintenance in the field.

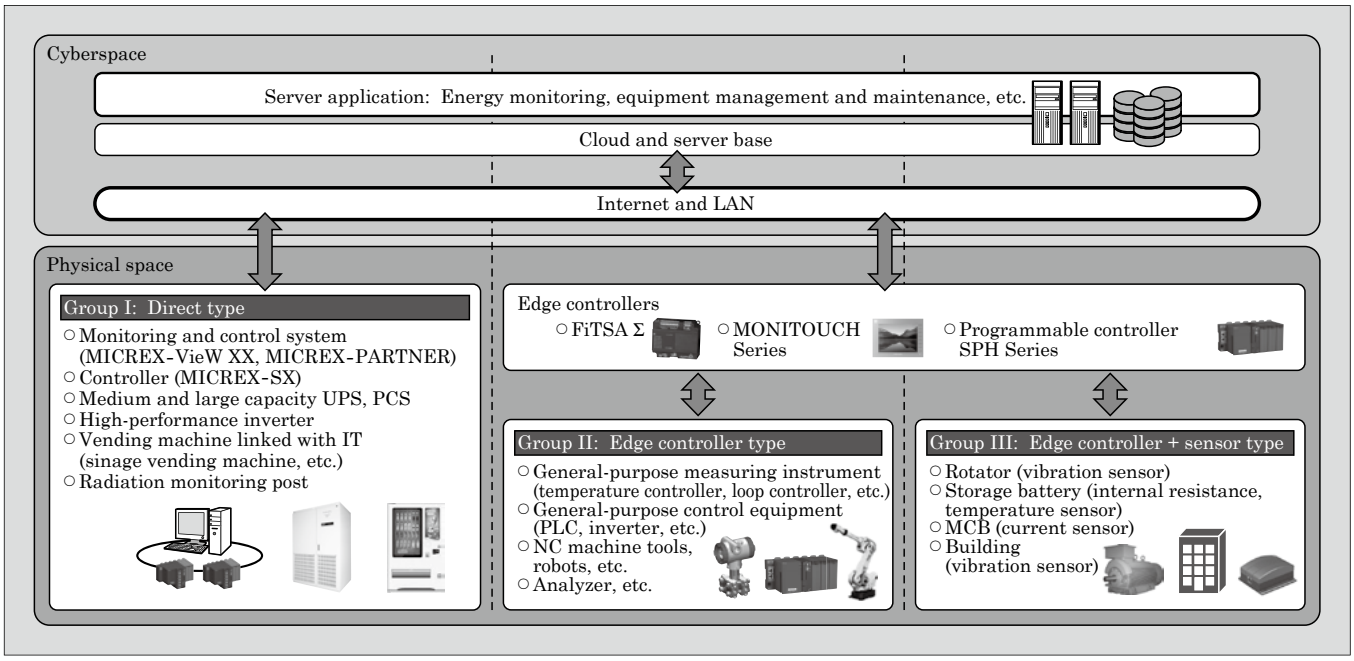

Fig. 1 Types of connection to cyberspace

We offer edge controllers based on the technologies for data collection, data analysis and prediction, optimization, and advanced control to provide IoT solutions. To cope with edge-heavy computing, edge controllers divide and implement part of the data analysis and prediction technology and optimization technology performed in cyberspace to solve challenges such as traffic cost, real-time responsiveness and security concerns. Thus, the edge controllers can respond to the request of manufacturing sites and provide solutions more in real time.

4 Characteristics of Fuji Electric Edge Controllers

Table 2 shows the characteristics of MONITOUCH V9-IoT, FiTSA Σ, and SPH3000-IoT, which are the edge controllers of Fuji Electric.

To respond to various demands shown in Chapter 2, it is necessary to enhance data handling (collection, accumulation, processing), which is the gateway function of edge controllers, connection networks, and security functions, and to provide engineering that supports the functions of the edge controllers (see Table 3). As shown in Fig. 2, it is necessary to divide and implement the functions of cyberspace and the edge controller.

Table 2 Characteristics and performance of edge controllers

Model	Characteristic	Diagnosis performance*
MONITOUCH V9-IoT	Real-time screen display on site, equipment connectivity	1,000 ms
FiTSA Σ	Small, high versatility, equipment connectivity	500 ms
SPH3000-IoT	High-speed real-time processing utilizing features of PLCs	50 ms

*The performance when provided with the real-time diagnosis function of multivariate statistical process control (MSPC), which is one of data analysis and prediction technologies, is mounted. The performance is approximately 10 seconds when the diagnosis is performed at a server in cyberspace.

Table 3 Functions required of edge controllers

Function category	Outline
Data handling	A. Data collection Collecting various data for system state analysis and equipment diagnosis B. Data accumulation Accumulating and transferring collected data C. Data processing Adding values to collected data (mounted with part of data analysis and prediction technology)
Network	○ Support for standard protocols for realizing connection among cyberspaces ○ Support for open protocols for realizing connection among field devices of various manufacturers
Security	Reducing security risk of cyberspace connection
Engineering	○ Engineering tools for realizing various functions ○ Horizontal link support among edge controllers ○ Vertical link support between cyberspace and edge

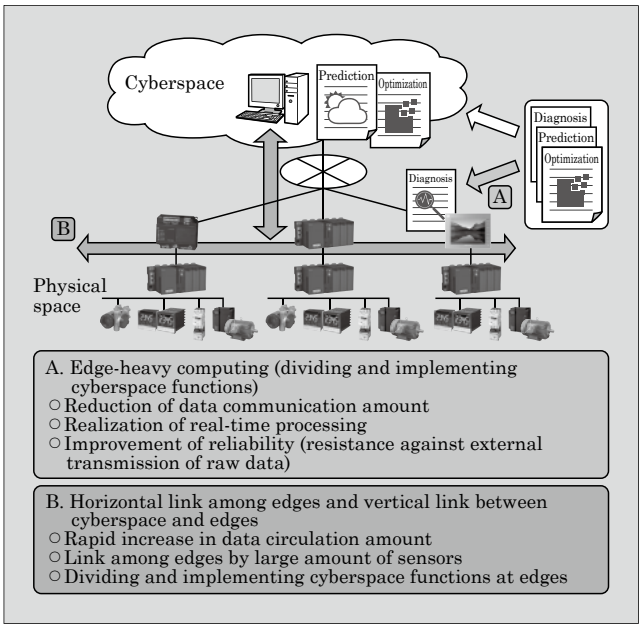

Fig. 2 Division of functions of cyberspace and edge controller

5. Application Examples of Edge Controllers

The following presents application examples of edge controllers for each issue of customers.

(1) Field data collection

Some customers are not able to connect computers to collect data because an equipment network cannot be connected, there is no installation space for computers, or high-speed sampling cannot be performed. SPH3000-IoT has rich equipment connection interfaces and data handling functions, which are the characteristics of PLCs, and can quickly collect data in a period of milliseconds. It is also small and can be installed in a limited space in a production facility, and the installation work can also be easily performed (see Fig. 3).

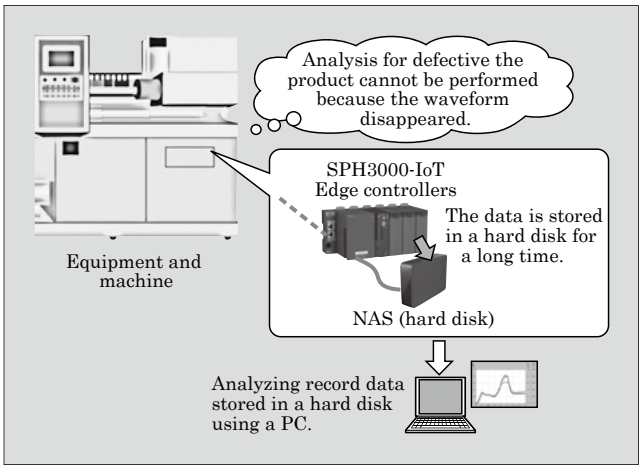

Fig. 3 Example of equipment data collection

In addition, the collected data can be stored in the external hard disk (NAS) connected to the edge controller as an archive.

(2) Introduction of field type diagnosis

Analyzing the collected data can clarify a solution to problems of customer equipment. For example, when the defective product rate increases in a large production facility, analyzing the waveform of sensors provided on the stored facility can clarify that a deterioration in a consumable component of the facility and increase in defective products are related to each other and that the consumable needs to be replaced. The MONITOUCH V9-IoT is an edge controller a single unit of which can perform a series of processing including data collection, analysis, diagnosis, and judgment display for equipment (see Fig. 4).

Thus, customers can collect data with edge controllers as an initial step of IoT introduction, and create further value from data analysis.

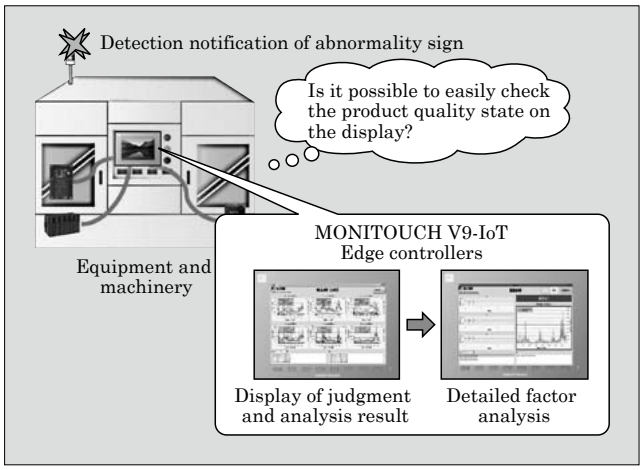

Fig. 4 Example of introduction of field type diagnosis

6. Postscript

This paper has explained edge controllers that connect field devices to cyberspace.

The need for edge-heavy computing is increasing with diversification of systems and services that use the IoT. It is becoming increasingly necessary to divide functions between the field and cyberspace.

Fuji Electric will work to develop edge controllers on the basis of utilization technology for open technologies, such as multi-core microcomputer, embedded security, real-time OS, and a general-purpose OS including Linux*1; real-time control technology that has acquired from PLC development; and engineering support technology. Through this development we will solve issues: low cost, high environmental endurance, high reliability, and high speed, which are necessary for field devices.

We will continue providing IoT solutions that lead to the creation of higher customer values.

*1: Linux: Trademark or registered trade mark of Linus Torvalds in Japan and other countries

Referemces

(1) "Industrial Network Gateways Market Research (FIVE-YEAR MARKET ANALYSIS AND TECHNOLOGY FORECAST THROUGH 2020)". ARC Advisory Group. https://www.arcweb.com/sites/default/files/Documents/study-brochures/study-industrial-network-gateways.pdf, (accessed 2018-08-17).

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