Overview of Fuji Electric IoT Platform

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ABSTRACT

There is a worldwide trend in many industries today to use the Internet of Things (IoT) for their businesses. Fuji Electric has developed the Fuji Electric IoT platform based on our various elemental technologies and system technology that combines them. This platform is the common foundation that can integrate field engineering, in which Fuji Electric excels, field-based data analytics, and multi-vendor connection technology for field devices to easily deliver customer-value creation solutions in a secure and safe manner.

1. Introduction

There is now a worldwide trend in many industries including manufacturing, distribution and social infrastructure to use the Internet of Things (IoT) for their businesses. The IoT provides means to extract data from all things in the real world to create new values and build new business models from the gathered data.

In order to provide different services using the IoT, technology for gathering data from various types of field devices and sensors, data analysis technology for utilizing the data gathered, and advanced security technology for handling data safely are essential. We have developed the Fuji Electric IoT platform based on our various elemental technologies and system technology that combines them.

2. Overall Picture of Fuji Electric IoT System

Figure 1 shows an overall picture of Fuji Electric's IoT system. Fuji Electric provides solutions to facilitate resolution of customer issues while demonstrating the effect of application of the IoT technology in in-house factories and incorporating the knowledge gained in the process. Fuji Electric provides customers with good services and values never known before by using the IoT technology for many applications, such as energy saving of factory equipment, lines and an

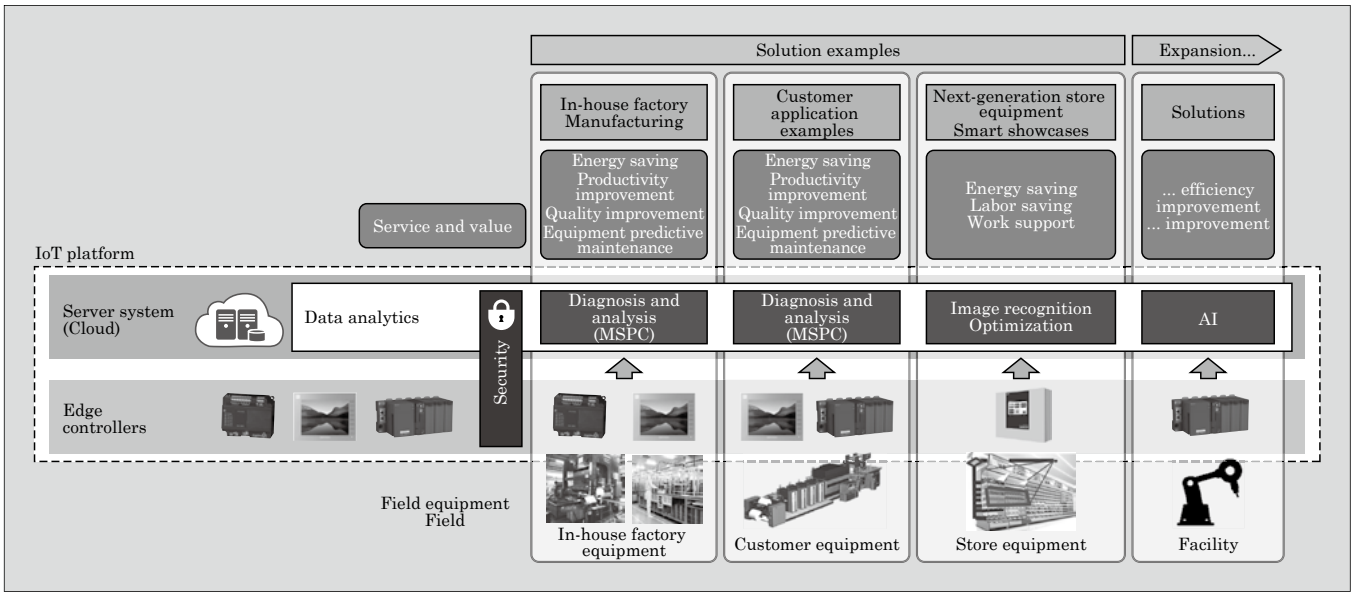

Fig.1 Overall picture of Fuji Electric IoT system

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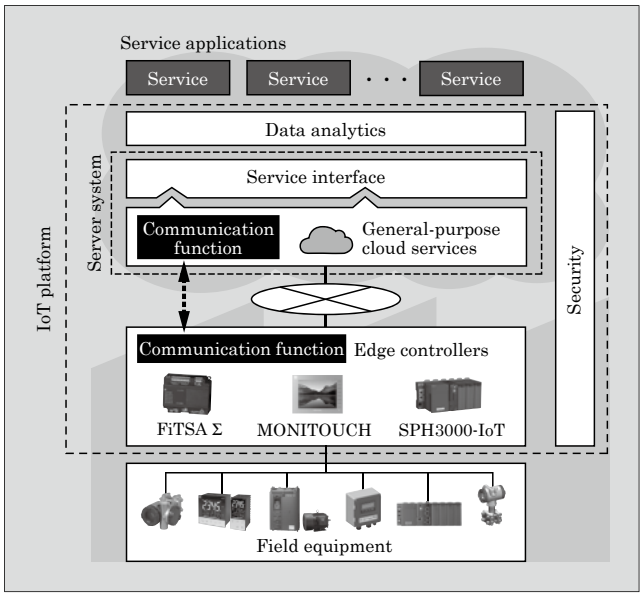

Fig.2 IoT platform

entire factory, improvement of productivity and quality and provision of predictive maintenance, and labor saving and support for workers in stores.

This platform is the common foundation that can integrate field engineering, field-based data analytics, and connection technology for multi-vendor field devices, in which Fuji Electric excels, to easily deliver customer-value creation solutions in a secure and safe manner. Figure 2 shows the configuration of the IoT platform.

The IoT platform consists of edge controllers that gather field data, a server system providing an execution environment for service applications, communication function to connect between them, security function for protecting system operation and data analytics that analyzes the data gathered.

For this platform, Fuji Electric uses open-source software for cloud services, standard technologies (de facto standards) for the communication protocol and security, and our proprietary technologies for edge controllers and data analytics to achieve the portability and differentiation of the service applications.

3. IoT Platform

3.1 Server system

The server system provides an execution environment for service applications that achieve services required by customers. The server system is required to ensure high reliability and high stability in operation of service applications, to allow operation at low cost, and to readily accommodate addition of new services, customers and devices.

To meet these requirements, we built the server system on the basis of general-purpose cloud services. Cloud services are provided by various vendors (cloud vendors) and some customers may specify certain vendors. As shown in Fig. 2, service applications are implemented via service interfaces in general-purpose cloud services in this configuration. These service interfaces realize multi-vendor support, in which functional difference between cloud services provided by various cloud vendors is absorbed, to allow service applications provided by Fuji Electric to be readily implemented in the cloud environment specified by the user.

For the communication function to exchange data with edge controllers, Message Queue Telemetry Transport (MQTT), a standard protocol, has been adopted to allow easy connection with cloud services of other companies. An authentication function is also provided to identify the edge controller to communicate with and ensure safety of communications.

In addition, server system operation management is provided for monitoring to see if service applications are running normally. The functions of this operation management include registration, addition and change management of users and service applications, performance monitoring, resource monitoring, network monitoring and log monitoring for detecting abnormal conditions and the system operator is notified of any abnormality detected (refer to "Server Systems Utilizing General-Purpose Cloud Service" on page 140).

3.2 Edge controllers

Edge controllers serve as gateway functions such as gathering field data and sending them to the server system in the upper level. Accordingly, they have the functions of security and communications with the server system in addition to interfaces for gathering data from field devices.

Fuji Electric has built many systems for plant monitoring and factory line control and provided solutions for these applications by gathering and using their field data. By taking advantage of the know-how in data gathering in the field, which we have accumulated while establishing a track record, we have developed edge controllers suited for applications and cost requirements to meet the demands from the field for use of the IoT.

Edge controllers provided by Fuji Electric shown in Table 1 can be connected to a few hundred types of field devices, including PLCs, inverters, NC machine tools and robots, allowing users to select devices suited for the respective applications and to facilitate introducing the IoT on site.

These edge controllers do not only function as data

Table 1 Fuji Electric's edge controllers and their characteristics

Model	Characteristics
FiTSA Σ	Compactness, high versatility and device connectivity
MONITOUCH V9-IoT	On-site real-time screen display and device connectivity
SPH3000-IoT	High-speed real-time processing making use of features of PLC

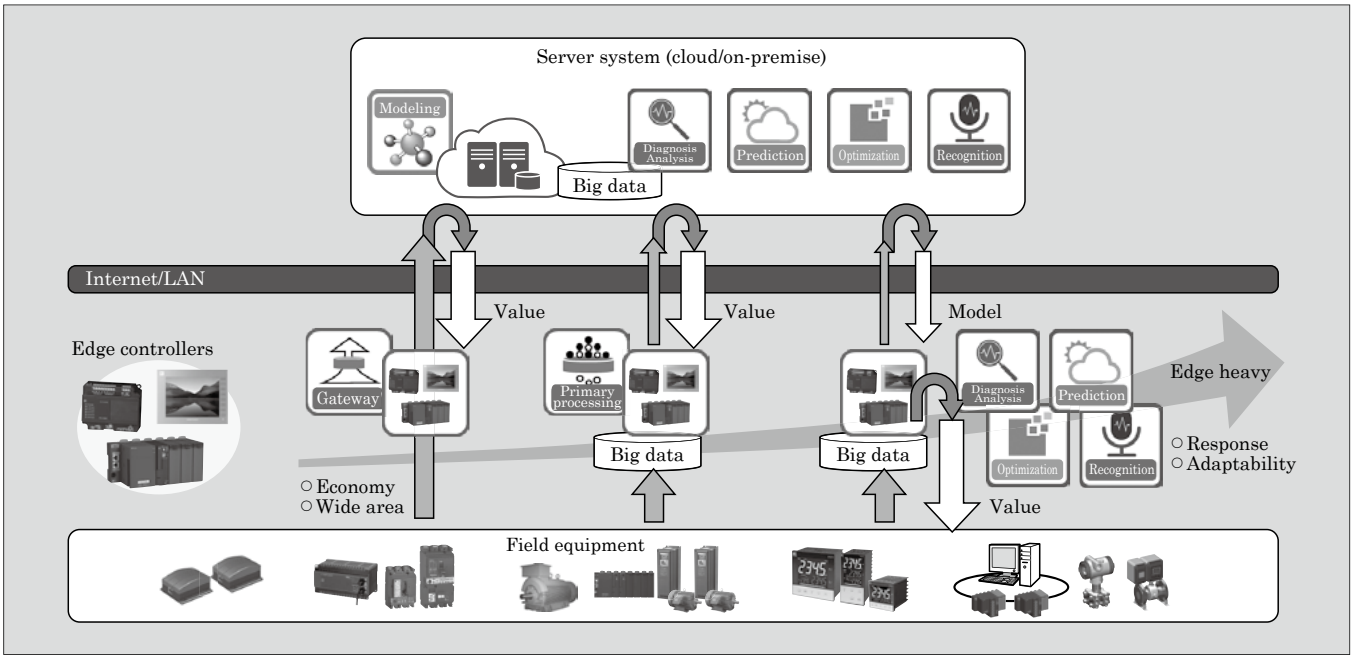

Fig.3 Schematic diagram of edge heavy processing

gathering devices as they conventionally have but also have the functionality of primary processing of data in themselves without transferring raw data from the field to the server to ensure security and reduce the load on the upper-level network. In addition, edge controllers can share real time processes for the advanced processes, such as data analysis, prediction and optimization, which have conventionally been performed only in a server system (called "edge heavy" processing). This feature provides solutions to fields where real-time response is required. Figure 3 shows the schematic diagram of edge heavy processing (refer to "Edge Controllers Connecting Field Devices and Cyberspace" on page 144).

3.3 Security

Connecting all things to the network by IoT has created new risks to things and their users.

The risks include interference in services due to unauthorized access to systems and falsification and leakage of important information such as personal data and factory production information stored in IoT devices and systems. If the extent of the impact of attack reaches control of field devices, life may be exposed to risks.

An environment must be built in which users can use field devices, systems and services with a sense of security. Accordingly, Fuji Electric has formulated new security policies for the IoT system based on ISO/IEC27017:2015[1], an international standard, and IoT Security Guidelines[2]. With the security policies at the core, we strive to reduce risks and protect important information by the management operation system for the organization and personnel and the technical and physical mechanisms, as shown in Fig. 4.

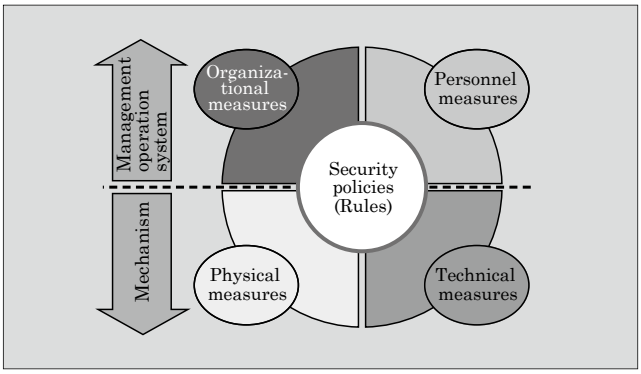

Fig.4 Concept of security

(1) Security measures by management operation system

As organizational measures Fuji Electric has built a system of systematically classifying information security-related risks and implementing management. We also have established frameworks of monitoring IoT systems and responding to incidents in the Fuji Electric Computer Security Incident Response Team (Fe-CSIRT), which responds to and prevents information security incidents generated in the Fuji Electric Group,

As personnel measures, we provide Fuji Electric employees with security education and training to raise awareness to strengthen security.

(2) Security measures in mechanisms

As physical measures, we implement physical protection of IoT devices and prevention of theft of information assets by entry management and locking up.

As technical measures, we employ advanced security technologies for each server system, edge controller and communication system to prevent information

leakage due to unauthorized access from the outside or unauthorized use (refer to "IoT System Security" on page 154).

3.4 Data analytics

Data analytics, which is a generic term for technologies for diagnosis, prediction, optimization and recognition that use statistics, machine learning, mathematical application and artificial intelligence technology. It is positioned as the core technology for this platform. Specifically, it learns operation data from plants, equipment and production lines and then generates models according to the purpose. Using these models, it often creates customer values, such as optimum use of energy, stable operation of equipment, improvement of productivity and quality and labor productivity increase. In the industry and distribution fields, there are peculiar issues: different configuration, target value, input parameters, control response characteristics and use environment for each target device, equipment, system, and their application; limited volume of collection data for learning; and typical black-box inference of AI, which tends to be avoided to ensure reliability.

For resolving these issues, Fuji Electric has continued development of data analytics for over 20 years and has many technologies. The following describes 4 representative data analytics technologies owned by Fuji Electric shown in Fig. 5.

(1) Diagnosis

In addition to multivariate statistical process control (MSPC), which has been applied in many cases, there is a technology using machine learning called kernel principal component analysis (kernel-PCA). We have solutions that use this technology such as abnormal diagnosis and remaining life estimation by nonlinear model, which have been applied to diagnosis and factor analysis for various types of equipment, photovoltaic power generation, transformers and buildings in factories.

(2) Prediction

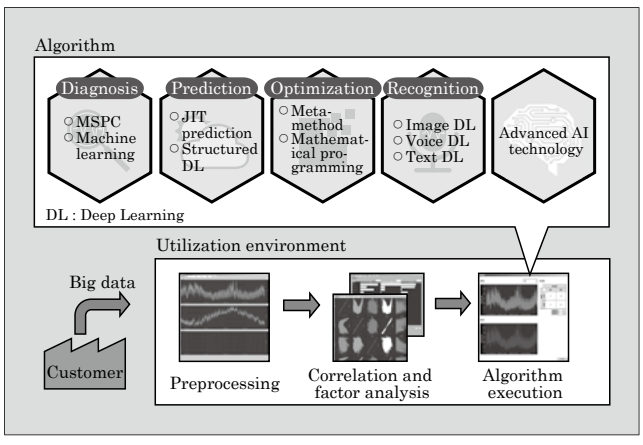

Fig.5 Data analytics

We have demand prediction and predictive detection solutions using just-in-time (JIT) prediction and multi-layered neural network technology (deep learning), which are suitable for demand prediction for industrial plants, factories, electric power, and crop yields.

(3) Optimization

We have solutions such as energy plant optimum operation and optimum power generation planning, which have been applied to various EMSs including factory energy management system (FEMS), building and energy management system (BEMS) and cluster energy management system (CEMS), energy cost optimization for plants and data centers, and power generation planning for utility companies.

(4) Recognition

We have deep learning based solutions such as voice and image recognition, which have applications including product recognition in smart showcases and maintenance work in indoor hydroponic facilities and manufacturing shop floors.

Generally, 80% of the application process of data analytics is said to be used for preprocessing. Most of this preprocessing is accounted for by tasks represented by cleansing and modeling of learning data, for which analysis engineers take time and use trial and error. For improving efficiency of this preprocessing, we have developed a tool to automate cleansing and modeling.

This tool has been used to improve the efficiency of cleansing such as elimination, replacement and supplementation of missing or abnormal values in input data, facilitate decision-making on whether or not diagnosis is possible by the visualization function, and improve the accuracy of diagnosis and prediction with overfitting prevention function. We will continue with the development to reduce working time and improve efficiency for data analysis to encourage the use of data analytics (refer to "Data Analytics as Core of Value Creation" on page 148).

4. Postscript

This paper has presented an overall picture of Fuji Electric IoT platform. In view of expansion of the IoT, while cooperating with other companies, which are providing solution services and data analytics that we do not have, Fuji Electric intend to enhance further functionality of our IoT platform to provide new customer services.

References

(1) ISO/IEC27017: 2015.
(2) IoT Security Guidelines Ver. 1.0. IoT Acceleration Consortium; Ministry of Internal Affairs and Communications; Ministry of Economy, Trade and Industry. 2016.

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