

# Instrumentation and Control Solutions in the New Age of the IoT: Current Status and Future Outlook

KONDO, Shiro\* FUKUZUMI, Mitsunori\*

## 1. Introduction

Fuji Electric has been providing the state-of-the-art instrumentation and control technologies for use in various areas, including social infrastructure such as electric power and transportation, equipment for industrial use such as iron and steel, chemicals, automobiles and electric and electronic devices and consumer products such as buildings, retail stores, vending machines and in-vehicle devices. These technologies are characterized by their diverse range of pioneering achievements, which include labor saving, automation and improved efficiency and productivity. We are currently working to contribute to the creation of safe, secure and sustainable societies through research and development for energy and environmental technologies<sup>(1)</sup>.

Recently, the Internet of Things (IoT)<sup>\*1</sup> has been attracting a great deal of attention and the instrumentation and control technologies in the industrial world are entering a phase of major change. This paper describes Fuji Electric's approach to the IoT and the current status of and future outlook for instrumentation and control solutions.

## 2. Global Trends in the Age of the IoT

The IoT related activities become very active on a global scale. Overlooking the various activities, we can see that they are essentially the same in that they are intended to create new values by using

information and communications technology (ICT), which has become available at low costs, while there are some differences such as the scope.

As the scope of the technology in the IoT is vast, it is very difficult for one company to build and provide all of it. Formation of enterprise partnerships (ecosystems<sup>\*2</sup>) thus becomes active and many companies around the world are looking for partners so that they can take advantage of their mutual strengths.

This section summarizes such trends with the focus on activities in Germany, the U.S. and Japan.

### 2.1 Trends in Germany

Since the German government announced the "High-Tech Strategy 2020 Action Plan<sup>(2)</sup>" in November 2011, efforts to realize "Industrie 4.0," or the fourth industrial revolution, have gained momentum. Its content can be roughly classified into promotion of standardization, creation of a reference architecture model, and demonstration projects of the customer value.

The IEC standardization activities of Industrie 4.0 started with a proposal from Germany in October 2013. However, since the scope of study is very wide, it is said that the standardization including coordination with existing standards will be done around 2020, and it will take another 10 years to penetrate the market. Meanwhile, with the subsidies of German governmental agencies, demonstration projects for mutually connecting equipment between multiple companies, such as It's OWL and Smart Factory KL have started, and evaluation of

#### \*1: IoT

Abbreviation for Internet of Things. In a narrow sense, it means a system in which various things are connected to the Internet to exchange information among them. Currently, the term is used to refer to entire services that create new values, which are realized by this kind of system. This concept has been devised as a result of the innovation in information and communications technologies, including inexpensive realization of In-

ternet connection and data distribution and management.

#### \*2: Enterprise partnership (ecosystem)

An enterprise partnership means an entire relationship built by cooperation of multiple companies that provide different products, technologies and services, aiming for achieving a common objective and is sometimes referred to as an ecosystem.

It sometimes takes a key role in quick and low-cost realization of a complicated system based on various technology components such as the IoT. The term "ecosystem" originally means an ecological system in which living things in the natural world and the environment surrounding them exist while interacting with each other, and it is used figuratively in the fields of economy and IT.

Table 1 IoT related activities in Japan

Establishment	Name of organization	Secretariat	Function		
			Standard	Modeling	Demonstration
April 2015	Cyber Physical System (CPS) Task Force	Japan Electronics and Information Technology Industries Association	○		○
May 2015	IEC-APC_SG8 Subcommittee (domestic committee): Smart Manufacturing IEC/TC65 (domestic committee): Strategic Group (SG) 8	International Electrotechnical Commission Activities Promotion Committee (IEC-APC) Japan Electric Measuring Instruments Manufacturers' Association	○		
	Robot Revolution Initiative	The Japan Machinery Federation	○		○
	Industrie 4.0 Working Group	Nippon Electric Control Equipment Industries Association		○	
June 2015	Industrial Value Chain Initiative (IVI)	The Japan Society of Mechanical Engineers		○	○
August 2015	Special Committee on Smart Manufacturing	The Japan Electrical Manufacturers' Association		○	
October 2015	IoT Acceleration Consortium	Mitsubishi Research Institute		○	○

the effect is proceeding.

## 2.2 Trends in the U.S.

In the U.S., 5 companies including GE launched the Industrial Internet Consortium (IIC)<sup>(3)</sup> in March 2014. More than 240 companies including Fuji Electric and other Japanese companies are participating in the IIC. The IIC mainly carries out 2 activities:

- Study of technology and security architecture
- Field verification

Field verification is called testbed in which the IIC invites ecosystem proposals and offers opportunities for their demonstration. As of April 2016, 20 testbeds have been proposed, and a total of 40 companies have participated in them. In addition, companies several times as many as that are closely watching the progress.

## 2.3 Trends in Japan

In Japan, full-scale examination of the use of the IoT has begun since December 2014. Innovative change via the IoT was mentioned as a key policy measure in the Revolution in Productivity by Investment in the Future of the “Japan Revitalization Strategy — Revised in 2015,” which was decided upon by the Cabinet on June 30, 2015<sup>(4)</sup>. It aims at a society in which interrelation between the real world and cyberspace is applied in every field to create big value as a “data-driven society.” With this as a turning point, many organizations in Japan have also started activities such as IEC standardization, modeling of architecture and demonstration of customer value (see Table 1).

## 3. Fuji Electric's Approaches to Instrumentation and Control Making Use of the IoT

Based on the global trends described in Section

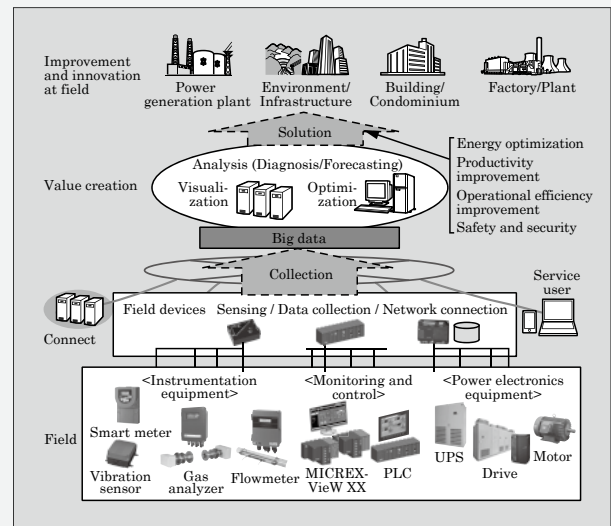


Fig.1 IoT solutions of Fuji Electric

2, this section presents Fuji Electric's approaches that make use of its technical features.

## 3.1 Fuji Electric's IoT solutions

Fuji Electric possesses a series of technologies and products that cover a wide range including field data sensing, network connectivity, data analytics such as diagnosis, forecasting and optimization, advanced control technologies, and control devices which are basis for implementing these technologies (see Fig. 1).

## 3.2 IoT concept of Fuji Electric

Figure 2 shows Fuji Electric's IoT concept. The IoT here does not simply refer to things that connect to IP networks. It is a general name for systems that digitize all types of information in customers' fields, including machinery, equipment, lines, and infrastructure, to create new values in cyberspace.

Fuji Electric makes this IoT into a platform and

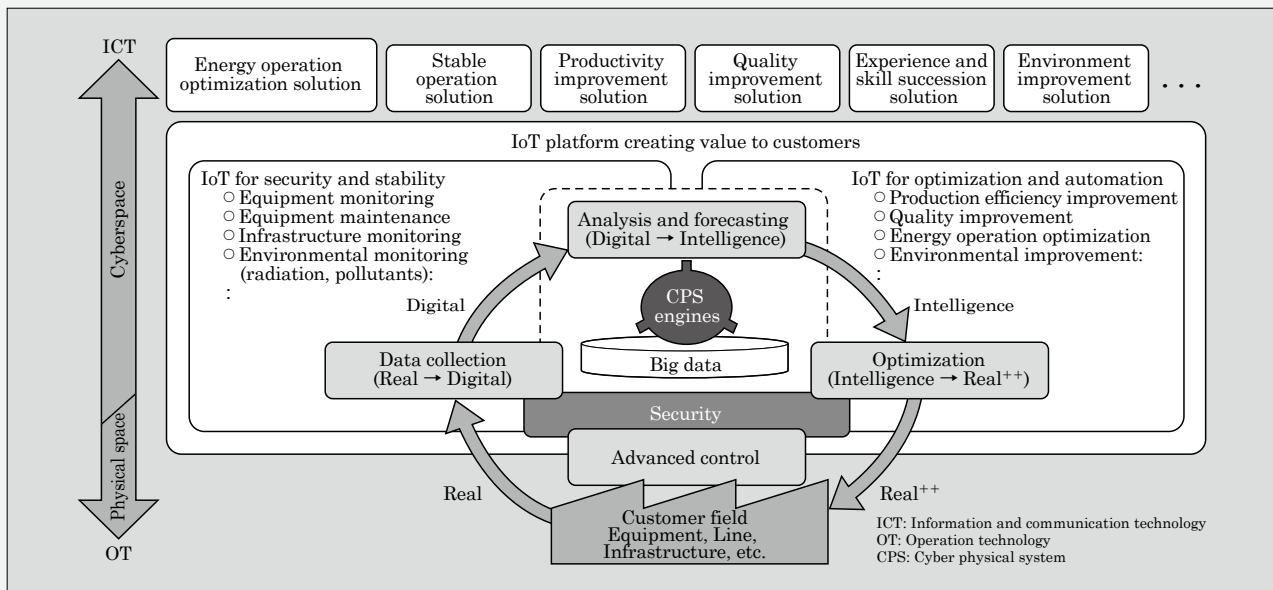


Fig.2 IoT concept of Fuji Electric

provides solutions to optimize energy operation and other solutions for stable operation, productivity improvement, quality improvement, experience and skill succession and environmental improvement as a menu of solutions. Application of the IoT is expanding in a variety of fields including the material industry, assembly industry and logistics.

### 3.3 Data collection technology

Data collection is the technology that digitizes field information and sends it to an IP network. It is composed of 2 technologies: sensing technology and network connecting technology.

#### (1) Sensing technology

Fuji Electric has a line-up of such industrial instruments as pressure and differential-pressure transmitters, flowmeters, water level meters, recorders, and controllers. In addition, we are working on developing technology for and commercializing environmental measurement. With the radiation monitoring technology, for example, we have provided distinctive products for personal dosimetry and radiation environment measurement for over 40 years. By combining a wireless new electronic personal dosimeter with a real-time remote monitoring system, a manager can grasp the radiation dose of a worker in real time. This makes it possible for the manager to give appropriate instructions and produce a positive radiation-dose-reducing effect (refer to “Real-Time Remote Monitoring System Utilizing New Electronic Personal Dosimeter” on page 182).

We also commercialized the world’s first aerosol<sup>\*3</sup> analyzer capable of measuring PM2.5 in 2015, and developed a solution for estimating the source of PM2.5 (refer to “Solution for Estimating Generation Source of PM2.5 with ‘Aerosol Analyzer’” on page 176).

#### (2) Network connection technology

In the future, as the IoT becomes widespread, field devices, machinery, equipment are expected to be increasingly incorporated into it and be autonomously connected to networks. However, measures for connection with cyberspace should be provided also for existing devices and devices that cannot be readily networked for cost reasons. Fuji Electric has commercialized field devices classified into 3 types according to the type of connection with IP networks, and this is shown in Fig. 3.

##### (a) Group I: Direct type

This type of device connects with an IP network autonomously. Devices such as smart meters, monitoring posts, IT-enabled vending machines, high-functionality drives, medium- and large-capacity uninterruptible power systems (UPSs), monitoring and control systems (refer to “Evolving of Monitoring and Control System ‘MICREX-VieW XX (Double X)’” on page 186 and “Equipment Monitoring System ‘MICREX-VieW PARTNER’ Easily Cooperating with Integrated EMS” on page 193) fall under this group. In the future, we intend to evolve major Fuji Electric products into direct-type devices.

### \*3: Aerosol

In general, aerosol refers to a state in which minute particles of liquid or solid are dispersed in the air. The diameter, shape

and electrical and chemical characteristics of aerosol particles may vary. In particular, solid particulate matter with a diameter of 2.5 μm or smaller is referred to as PM2.5. It

is feared to have adverse effects on human health and is considered as a social problem.

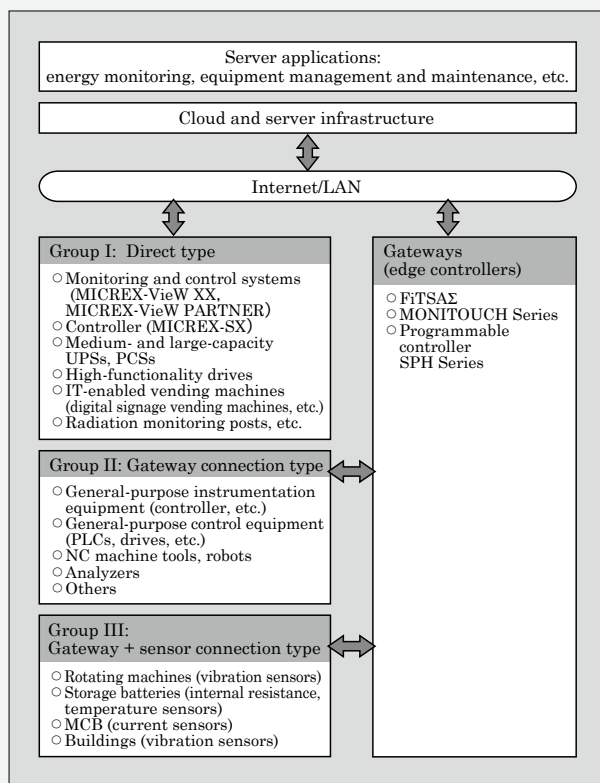


Fig.3 Three types of IP network connectivity

#### (b) Group II: Gateway connection type

This type of device realizes connectivity to IP networks for existing devices (controllers, drives, instrumentation equipment and other general-purpose devices, analyzers) that do not have connectivity to IP networks regardless of whether they are Fuji Electric's products or not. It does this by using the local communication functions of the individual products. As gateway products, Fuji Electric has a line-up of "MONITOUCH," "FiTSAE" and programmable controller "SPH Series." These gateway products have connectivity with over 500 types of products of other companies including PLCs, drives, NC machine tools, robots and instrumentation equipment and make significant contributions to incorporating field devices into the IoT (see Fig. 4(a)).

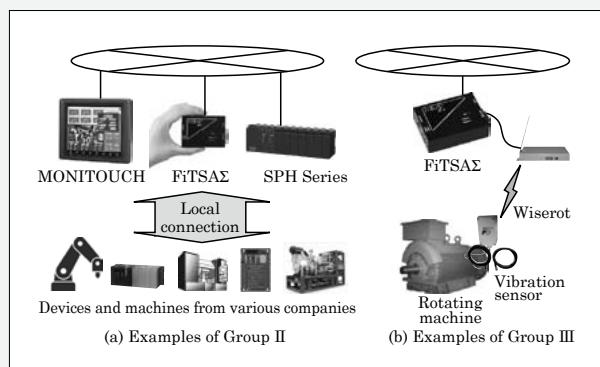


Fig.4 Network connection technologies (Groups II and III)

#### (c) Group III: Gateway + sensor connection type

This type of device connects those without any local communication functions or intelligence in the first place, such as rotating machines, circuit breakers and buildings. Vibration sensors, temperature sensors, current sensors, and other sensors are connected to the gateway to digitize the statuses of the target devices via the sensors. Figure 4(b) shows an example of connection of "Wiserot," a wireless diagnostic system to examine the vibration of a rotating machine.

### 3.4 CPS engines

Fuji Electric owns a number of technologies such as analysis technology, diagnosis and forecasting technology, optimization technology, advanced control technology and so on. Utilizing these technologies, we offer various solutions such as optimum energy use, stable operation of facilities, productivity and quality improvement. Fuji Electric calls these technologies cyber physical system (CPS) engines and positions them as the core technologies for the IoT platform. These CPS engines are composed of field technologies that Fuji Electric has spent many years developing in the instrumentation and control field and mathematical technologies for industrial applications that support them. This subsection describes the mathematical application technologies.

#### (1) Diagnostic and forecasting technology

For diagnosis to identify any process abnormality, sensors and measuring systems suited for the purpose must first be selected to collect various pieces of data such as temperature, pressure, vibration and tension. All data obtained in this way are checked to extract correlations and identify data sets that are effective for determining whether a value is normal or abnormal. From these data sets, a diagnostic model is generated and evaluated. By repeating this process, the diagnostic model is developed through learning.

Based on this series of diagnostic model generation technologies, Fuji Electric owns, as proprietary core technologies, structured neural network technology, multi-variable statistical process control technology (MSPC) for batch processes, and sign detection technology based on ensemble forecasting (refer to "Mathematical Application Technology for IoT Solutions" on page 198).

#### (2) Optimization technology

As an example, an energy management system (EMS) is used for explanation here. An EMS is intended to visualize energy consumption, detect wasted energy, and optimize the operation of energy supply equipment. Various types of know-how are required such as which piece of data to measure by which means and which indicators to use for evaluating the energy-saving effect. To optimally operate



energy supply equipment, it is necessary to model it, and this requires an understanding of the characteristics and functions of the equipment.

Fuji Electric has put various methods into practical use: mathematical programming including linear programming, particle swarm optimization<sup>\*4</sup> (PSO) as a meta-heuristic<sup>\*5</sup> optimization technology suited for nonlinear optimization problems and differential evolution<sup>\*6</sup> (DE), which is a latest optimization technology.

### (3) Advanced control technology

For advanced control technology, it is important to model the controlled object based on an understanding of it and this model is utilized for materializing various control technologies. For example, it is necessary to select an appropriate control cycle according to the time constant of the object and select a control method in view of the comprehensive characteristics of the object such as presence of any interference between inputs and disturbance characteristics, order and gain. In addition, adjusting the parameters of the control system requires know-how.

As fundamental technologies, Fuji Electric owns PID control<sup>\*7</sup> technology, model forecasting and control technology for multi-variable systems, control performance monitoring technology for monitoring control performance degradation caused by changes in the characteristics of the controlled object and automatic parameter adjustment technology. One example of this advanced control technology is the ultra-lean combustion control that we developed and commercialized, and it helps to reduce boiler fuel costs (see Section 3.6(6)).

## 3.5 Cloud structure and security

### (1) Cloud structure

Fuji Electric positions the CPS engines and their applied services as the core of its IoT platform.

In the common functional hierarchy of cloud ser-

vices shown in Table 2, Fuji Electric's group of services is positioned as SaaS. Currently, many cloud vendors have commercialized services in the cloud service layer (PaaS and IaaS) and provide similar functions. However, interfaces with SaaS vary between individual cloud vendors. It is necessary for cloud users to consider the following point in choice of a cloud vendor to expand their business globally.

- (a) Availability of servers in areas close to customers
- (b) Adequacy of the development environment and support
- (c) Cost
- (d) Connectivity with the field

### (2) Security

In June 2010, malware that makes targeted attacks called Stuxnet was found, and it focused people's attention on cyber attacks against control systems. In response, studies on security measures for control systems and standardization activities were pressed forward rapidly by all of industry, government and academia.

As the IoT become widespread, various field devices come to be more connected than ever to control systems via IP networks for data collection, analysis and value creation. The emergence of new security risks is expected due to the spread of a cloud environment. Hence, we are working on developing technologies to ensure authenticity and integrity of data between control devices in addition to further im-

Table 2 Functional layers of cloud services

Functional layers		Description
SaaS	Software as a Service	Allows use of application services via the Internet.
PaaS	Platform as a Service	Refers to middleware and OS as execution environment for SaaS.
IaaS	Infrastructure as a Service	Provides execution environment (hardware, virtual servers, etc.) for SaaS and PaaS as a service on the Internet.

### \*4: Particle swarm optimization

Sometimes abbreviated as PSO. This is one of the optimization methods based on meta-heuristics. In a group of living things, when one individual finds a good place (solution), other individuals in the group gather to search in the surrounding area, or the group go back to a place which one individual recalls as a good place found in the past. Making this behavior into an algorithm increases the probability to reach an optimum solution.

### \*5: Meta-heuristics

Empirical knowledge (experimental rule) generally regarded as valid is referred to as a heuristic. Meta-heuristics generically refers to optimization algorithms designed for general applications without being con-

fined to specific problems. It uses empirical knowledge in which behavior of living things or physical phenomena can be simulated to derive optimum answers. The initial value for the solution is corrected while searching for a better solution in a practical time period.

### \*6: Differential evolution

Sometimes abbreviated as DE. This is one of the optimization methods based on meta-heuristics. It simulates an evolution system of living things (genes), in which multiple solution candidates interact with each other through mutation and crossover and generates a new solution candidate in the process to search for an optimum solution. The differential between solutions is used in mutation, hence it is called "differential evolution." It allows a solution close

to the an optimal one to be found quickly for various types of nonlinear optimization problems.

### \*7: PID control

A type of feedback control utilized for temperature control. In order to promptly bring the process variable (PV) closer to the set variable (SV), manipulative value (MV) is adjusted based on the deviation, or the difference between the PV and SV. The MV is determined by combination of the proportional (P) operation, which varies the MV proportional to the current deviation; integral (I) operation, which varies the MV based on the cumulative value of the past deviations; and differential (D) operation, which varies the MV based on the rate of change of the deviation.

proving the existing intrusion detection and defense technologies.

As a security measure for control systems, activities for compliance with the IEC 62443 and construction of a cyber security management system (CSMS) have been carried out up to now. International standardization activities are conducted with a focus on those standards for the IoT security measures and guidelines have been formulated.

Fuji Electric has participated in the Control System Security Center (CSSC<sup>(5)</sup>), Research & Development Partnership and a corporation approved by the Minister of Economy, Trade and Industry, since its foundation. We have engaged in the construction of security measures as industry-government-academia collaboration in various fields including research and development relating to cyber security, international standardization, public awareness and human resource development.

### 3.6 Solutions

#### (1) Cloud-based comprehensive equipment management service

We developed a cloud-based comprehensive equipment management system for life cycle management of customer equipment based on the IoT concept in Fig. 2 and started providing the service in 2015. This service is a cloud service integrating the EMS service, operation monitoring service and maintenance service. Various types of information, such as equipment operating conditions, maintenance and inspection records, energy usage conditions and environmental conditions, are collected in a life cycle from introduction to replacement (disposal) of equipment. They are then used as the basis for diagnosis and optimization by CPS engines to achieve comprehensive management of the equipment conditions (energy efficiency, signs of failures and problems, equipment deterioration). In addition, production efficiency is maximized by having yield improvement, quality control, and determination of manufacturing condition (see Fig. 5).

#### (2) Approach to logistics solution

Recently, logistics services have become sophisticated as exemplified by online shops' same-day delivery and just-in-time service, which has increased the dependence on vehicle transportation. There are different types of logistics centers such as distribution centers (DCs) and transfer centers (TCs). For DCs, vehicle operation and other operation ef-

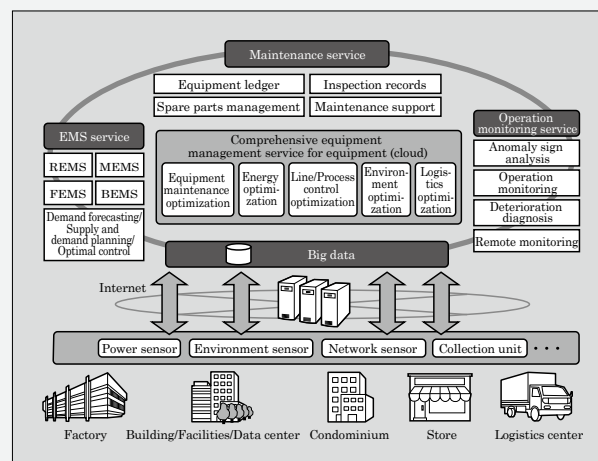


Fig.5 Cloud-based comprehensive equipment management service

iciency improvement package products are already available from various companies. However, for TCs, which are currently becoming the mainstream, conditions such as transportation time constraints and avoidance of congestion in surrounding areas are so complicated that operating the business by using existing efficiency improvement package products is extremely difficult. For this reason, the reality is that operation and control depend on experienced individuals. Fuji Electric has developed a system for optimizing vehicle guidance in a center mainly for large TCs to propose a solution for improving the dependence on experienced individuals. It lays out the most suitable sensors for individual applications and installation environments to collect information such as locations and routes about vehicles, loads and workers and to use CPS engines for quantity forecasting. In the future, we intend to migrate the system into a cloud environment to make proposals to small- and medium-scale logistics centers (refer to "Solution for Improving Efficiency in Distribution Centers" on page 154).

#### (3) Approach to plant factory solution

The enforcement of the amended Agricultural Land Act has significantly relaxed the conditions for corporations' entry into agriculture, and as a result many players are joining this field from other categories of business. In particular, new entries into the plant factory<sup>\*8</sup> business, which allows year-round production, are increasing. Tomato Farm Co., Ltd., co-funded by Fuji Electric, was selected as a "Supportive Project for Accelerating the Introduction of Next-generation Greenhouse

#### \*8: Plant factory

A plant factory is a system producing plants systematically in a closed or semi-closed space with controlled internal environment. There are 2 types. One is the com-

plete artificial lighting type, which controls the environment in a closed space such as inside a building without using sunlight for year-round planned production. The other is the sunlight use type, which basically uses

the sunlight in a greenhouse or other semi-closed environment for year-round planned production with supplemental lighting in rainy or cloudy weather or air conditioning during summer.

Horticulture” of the Ministry of Agriculture, Forestry and Fisheries and it started strawberry production in 2014. Fuji Electric has introduced a system that accurately forecasts the yields and the occurrence of cultivation failure from production process data, and then Fuji is working on improving profit, which is a universal challenge for plant factory. This forecasting system uses environmental, farm work and other data input for forecasting based on machine learning. This eliminates the need for prior experiments and mathematization, allowing forecasting operations to be started promptly. In strawberry cultivation, which requires short-period yield forecasting in units of one day, some positive results have already been achieved such as the reduction of an error margin of daily yield forecasting under certain conditions to within  $\pm 15\%$  (refer to “Plant Factory Solution with Instrumentation and Control Technology” on page 160).

#### (4) Approach to solutions to optimize plant operation

Fuji Electric has provided solutions that apply instrumentation and control technology to the fields of steel, chemicals, oil and gas pipelines, incineration and other plants and equipment. Recently, we have been not only proposing solutions that employ new techniques for stable operation, productivity and quality improvement and energy cost reduction but also working on solutions so that experience and skills can be handed on to others.

In steel plants, a drive master controller (DMC) and “f(s)NISDAS” provide a system that collects data on drive and motor statuses from a high-speed drive control system via a network for analysis with an accuracy of msec. They contribute to stable operation and quality improvement.

In chemical and other continuous process plants, we have proposed a plant simulator<sup>\*9</sup> as an experience and skill succession solution and developed a “navigation function,” in which the HMI system guides an operator to the failure cause screen, instead of skilled workers. In addition, we are working on an “operation support system,” which helps workers to avoid malfunction by automatically detecting signs of malfunction in processes from big data including plant operation information and operation history and by automatically generating the optimum operation guidance (refer to “Operation Optimization Solutions for Steel Plants” on page 141 and “Instrumentation and Control System Solutions for Optimizing Plant Operation” on page 149).

#### (5) Approach to equipment maintenance

For long-term and stable operation of production equipment and utility equipment that are becoming increasingly sophisticated, maintenance activities are gaining importance. Fuji Electric has aggregated various services spanning an entire life cycle of equipment into the cloud-based comprehensive equipment management service, of which the equipment maintenance service is deployed in a cloud. The equipment maintenance service provides support with smooth running of the PDCA cycle of a series of maintenance activities (maintenance planning, equipment deterioration prevention, diagnosis and restoration activities) across a life cycle from the introduction to replacement of equipment. Equipment diagnoses by using IoT-enabled sensors such as rotating machine vibration diagnosis, UPS storage battery deterioration diagnosis and operation monitoring of servers, networks and controllers are also provided. Furthermore, not only edge devices to collect field information for plant control systems, but also operation support and learning support via wearable devices are provided (refer to “Service Solutions to Support the Stable Operation of Equipment” on page 165).

#### (6) Boiler combustion solution

The boiler combustion solution is an advanced control solution provided by Fuji Electric. It improves the combustion efficiency by adding a software package to existing boiler control device and achieves a reduction of approximately 1% in the boiler fuel cost.

Efficiency improvement of boiler equipment has now come close to the limit with mechanical methods. This software package developed by taking a totally new approach has made it possible to achieve further efficiency improvement.

A boiler generates steam and hot water using thermal energy resulting from the combustion of fuel and air. If the amount of air injected is too large, the excess not used for combustion is discharged, which generates thermal loss. Fuji Electric has developed a technology to control combustion with the amount of air reduced to the minimum (ultra-lean air) while suppressing the amount of carbon monoxide (CO) generated, a gas which adversely affects the environment. In this way, we have successfully minimized the thermal loss of boiler combustion for the first time in the world. To this technology, the proprietary optimum combustion software and control logic and a laser CO analyzer capable of high-speed measurement have been

#### \*9: Plant simulator

The behaviors of equipment and machines to be controlled are modeled individually for simulations, and these models are

then combined according to the actual plant to construct a virtual plant on a PC. This allows to simulate the behavior of a plant in various conditions, which is applicable to

functional test or operator training in an office.

applied (refer to “Boiler Combustion Solution for Reducing Fuel Costs” on page 170).

## 4. Future Outlook

### 4.1 Development into ecosystems

Fuji Electric has demonstrated its strengths in the field based on its instrumentation and control technology. The cloud-based comprehensive equipment management service is a vertical solution system that combines Fuji Electric’s strengths in the field with the IoT. Meanwhile, the ecosystem movement is becoming active around the world. It is intended to link the strengths of one’s own company with those of other companies to create totally new customer value. We will constantly watch such trends and work on creating new customer values including distinctive sensors and the latest IT-enabled vending machines as the start (see Fig. 6).

### 4.2 IoT platform

Up to now, this paper has described data collection technology and CPS engines as a platform suited for the IoT age in the respective field. Whether as a vertically integrated system or an ecosystem, customer value is often unclear at first. In order to materialize customer value earlier, it is necessary to more easily and quickly repeat the cycle of planning a hypothesis, performing verification and evaluation, and revising the hypothesis. To that end, we will seek to strengthen an IoT platform that allows small start and quick start<sup>\*10</sup> and can be improved gradually. Specifically, we will work on the following technologies.

- Technology for simple system construction from a small scale
- Modularization of services and their conversion into assets and menu enhancement development
- Technology for linking data and services in a cloud

### 4.3 CPS engines

Fuji Electric has been developing distinctive CPS engines as its core technologies. In the future, we plan to systematize and enhance CPS engines in order to create new customer value. In addition, to develop our business by making use of CPS engines, we intend to also focus on education and reinforcement of CPS engine user-engineers.

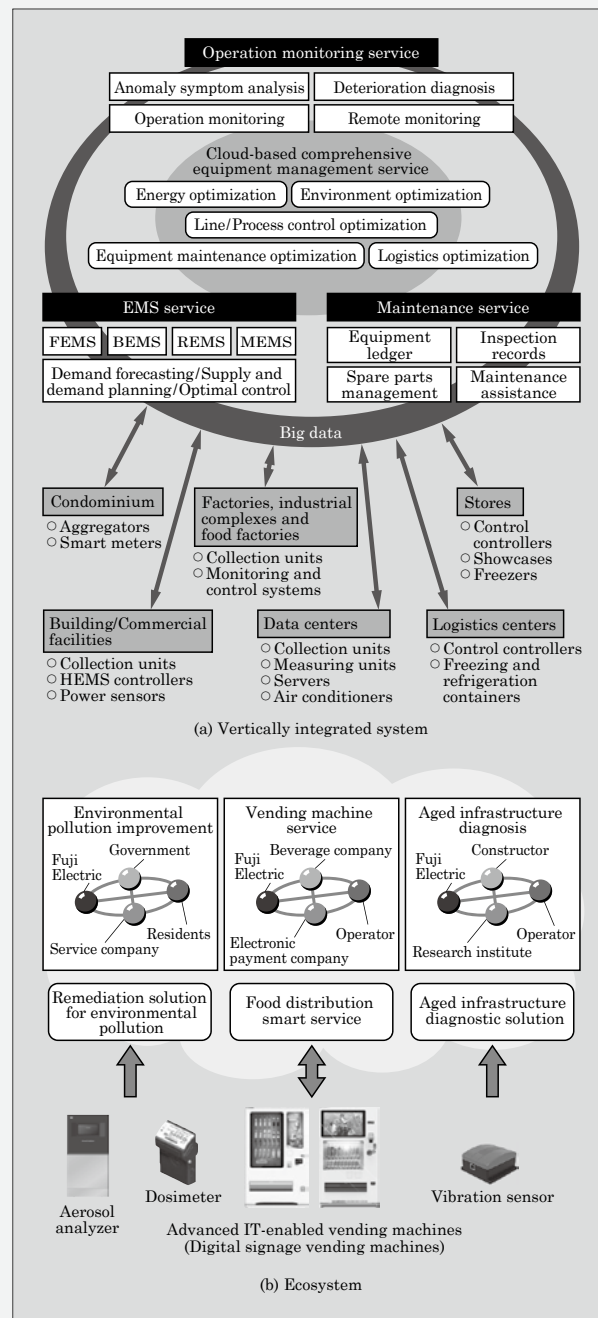


Fig.6 Vertically integrated system and ecosystem

### 4.4 Strengthening of edge controllers

As systems and services that utilize the IoT become increasingly diversified, the field data collected become larger in volume and more diverse, which leads to increased communication traffic and costs and degradation of real-time response. To resolve these issues, it is becoming increasingly important to divide functions between the field and cyberspace.

#### \*10: Small start and quick start

It means to select a local area where effect or value is expected in a confident man-

ner (small start) and to develop applications by taking a full advantage of proprietary IoT products with many installation records to

verify the effect or value in a short period of time (quick start).



Fuji Electric has its focus on the strengthening of edge controllers for industrial use as high-functionality gateways. Edge controllers are required to have data processing (collection, processing and storage) capabilities and communication protocols with various field devices as basic functions. The function of running CPS engines in real time such as model forecasting control and optimization is also required. These are positioned as applications that can be newly created and updated and engineering support functions are required at the same time. Fuji Electric's edge controller is based on following 3 core technologies: technology utilizing open ICTs, including general purpose microprocessor, real-time OS, general purpose OS (Linux etc.) and embedded security, real-time control technology cultivated through programmable controller development, and engineering supporting technology. Furthermore, we will rise to the challenges including cost, high environmental tolerance, high reliability and high speed required for field devices.

## 5. Postscript

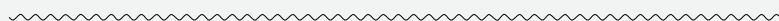
This paper has presented the current status of and future outlook for Fuji Electric's instrumentation and control solutions in view of the global trends of the IoT.

We intend to continue to expand and enhance the instrumentation and control technology at the

core of Fuji Electric's industrial solutions and work for creating new customer value by both vertically integrated systems and ecosystems through the IoT.

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