Current Status and Future Outlook

Instrumentation, Control, and Information Systems Contributing to Automation and Energy Saving: Current Status and Future Outlook

TETSUTANI, Hiroshi* **MATSUMOTO, Yasushi***

1. Introduction

In recent years, the environment around industry and daily life has changed significantly due to the increasing demand for environmental measures related to decarbonization and labor shortages. For this reason, further capital investment in decarbonization, automation and digital transformation (DX) are sought on a global scale. In the fields of factory automation equipment and systems, demand for components has remained uncertain due to the impact of the spread of COVID-19 and difficulties in the procurement of semiconductors and other parts around the world. However, market conditions in Southeast Asia and India are expected to continue to recover from the COVID-19 pandemic. In the plant control systems field, the steel and chemical sectors are expected to see demand for upgrades to improve productivity, as well as strategic investments for higher functionality, electrification and

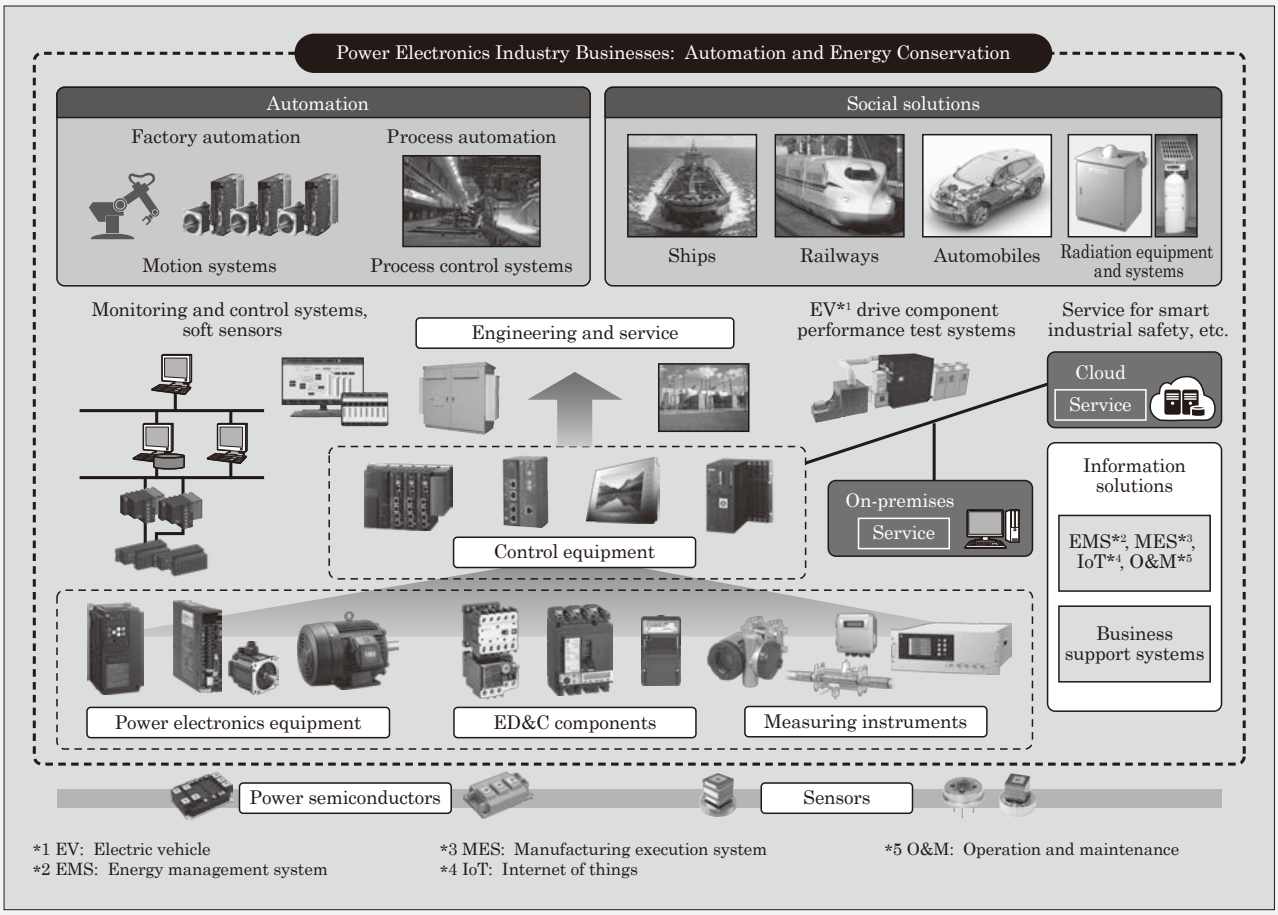


Fig.1 Overview of power electronics equipment and instrumentation, control and information systems of Fuji Electric, and their applications

* Power Electronics Industry Business Group, Fuji Electric Co., Ltd.

carbon neutrality.

Through innovation in energy and environment technology, Fuji Electric has created competitive components that contribute to the achievement of a responsible and sustainable society as it continues to further enhance systems and expand its systems business. Figure 1 shows an overview of the power electronics equipment and instrumentation, control and information systems of Fuji Electric, as well as their applications.

This paper describes Fuji Electric's new approaches and outlook for measuring instruments, control equipment, and systems that contribute to its efforts in automation and energy saving, as well as the engineering and services thereof.

2. Plant Monitoring and Control Systems

2.1 Market trend of plant monitoring and control systems

Plant monitoring and control systems have contributed to the visualization, automation and stable operations of production equipment and processes, thereby streamlining production and operations at production sites.

The market for these systems is growing mainly in regions where populations are growing, such as China and India. On the other hand, business in Japan has been centered on system updates and the extension of service life, and the market has been saturated. However, investment in plant monitoring and control systems has begun to increase as a new need for equipment modifications for DX and carbon neutrality rises.

Plant monitoring and control systems that were previously closed both in Japan and overseas are now generally connected to external networks. Accordingly, security measures and wide-area data linkage have become critical functions alongside monitoring and control functions.

2.2 Fuji Electric's approaches

(1) Monitoring and control systems

Fuji Electric supplies optimal monitoring and control systems and solutions according to the process automation field and the scale of the plant. Figure 2 shows the lineup of monitoring and control systems.

Covering all plant equipment, these monitoring and control systems constantly collect on-site information such as pressure, flow rate and temperature using measuring instruments in order to perform monitoring and control and ensure an optimal automatic operation according to the situation. Fuji Electric offers the "MICREX-VieW XX (double X)" as a core plant monitoring and control system (see right center in Fig. 1). This system is a monitoring and control system excellent in high reliability and maintainability that enables continuous operation of a plant and is suitable mainly for monitoring and control of iron and steel, cement, and waste treatment plants.

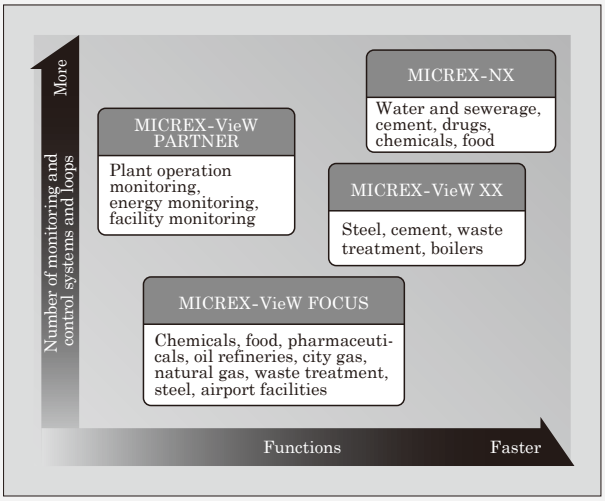
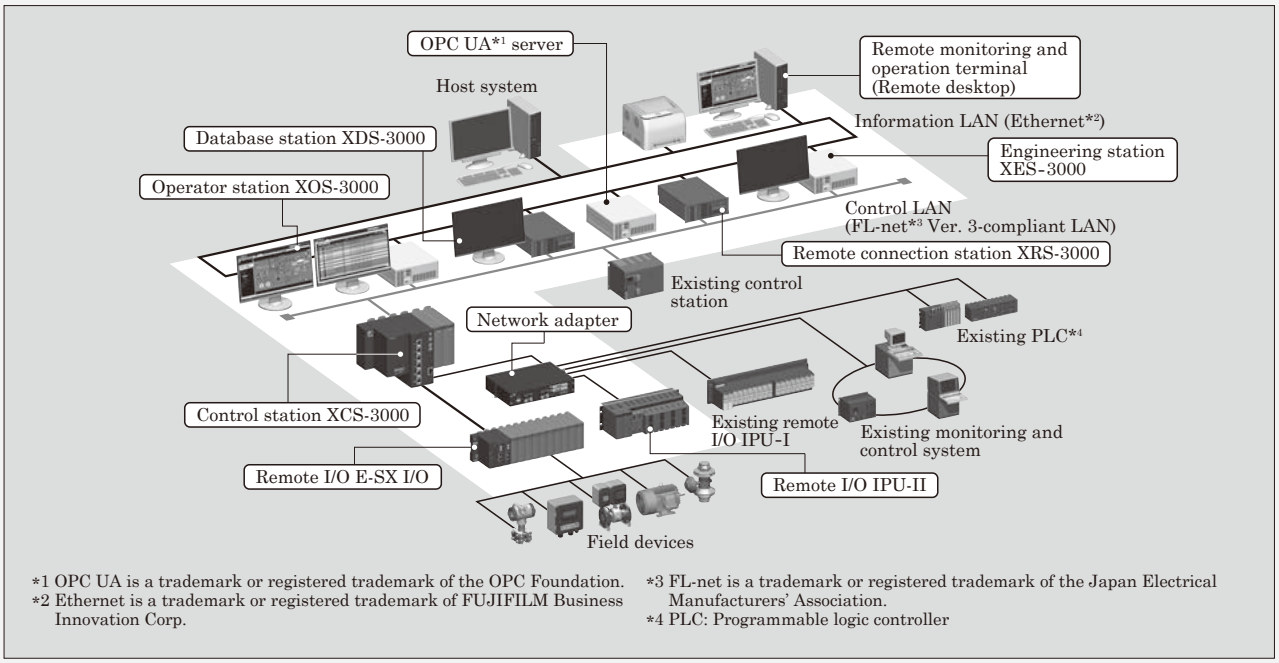


Fig.2 Lineup of monitoring and control systems

The "MICREX-NX" has high affinity with information-system and is suitable for application to large-scale plants with large number of monitoring points, such as water-treatment plants with large treatment volumes.

The "MICREX-VieW PARTNER" makes it possible to visualize the site without choosing equipment or scale, and it is suitable for application to energy-monitoring and equipment monitoring. The "MICREX-VieW FOCUS" is an open supervisory and control system with its human machine interface (HMI) introducing supervisory control and data acquisition (SCADA) for general purpose rather than system specific and is suitable for applications in chemical, food and pharmaceutical, and gas fields. This time, the product category has been expanded with the addition of the user-friendly "MICREX-VieW FOCUS Evolution" to the lineup. This monitoring and control system is easy to learn how to use, enabling customers to perform engineering work and engineers outside of Japan to complete the construction of their system at their worksites. This system integrates various programming tools and is equipped with an engineering environment in which application software can be easily and efficiently created by drag-and-drop operations on PC screen. It also has a function to easily customize the operation screen according to the customer's requirements. In the future, we will continue to increase its value and expand its applications to other industries and the outside of Japan. (Refer to "Engineering Support Tool That Reduces Lead Time and Improves Quality, Accelerating DX" on page 21.)

Figure 3 shows an example of a system configuration for the MICREX-VieW XX, which is an



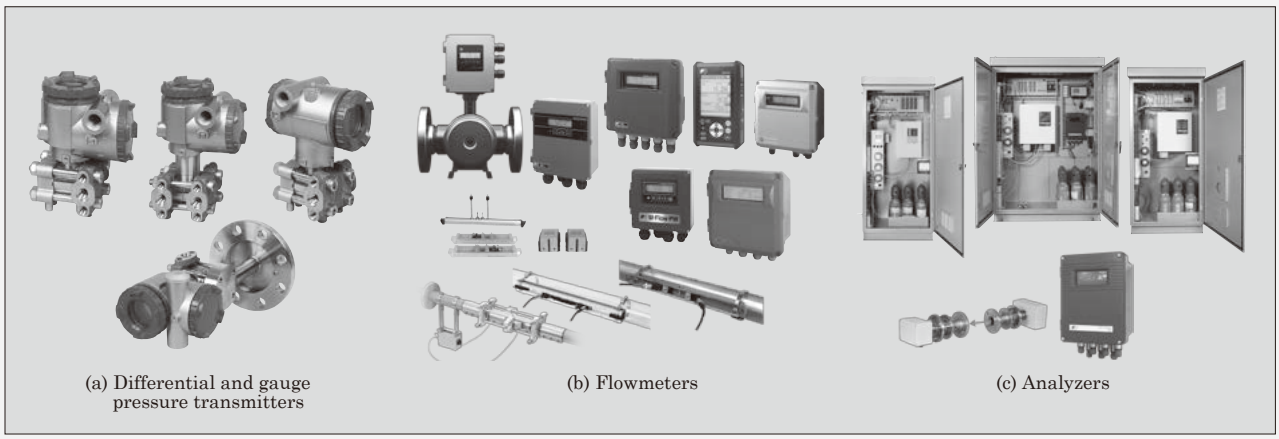
*1 OPC UA is a trademark or registered trademark of the OPC Foundation.
*2 Ethernet is a trademark or registered trademark of FUJIFILM Business Innovation Corp.
*3 FL-net is a trademark or registered trademark of the Japan Electrical Manufacturers' Association.
*4 PLC: Programmable logic controller

Fig.3 Example system configuration for the "MICREX-VieW XX"

example of a basic monitoring and control system. The engineering station is a tool environment for engineering of the operator station, which is responsible for the controllers and HMI. At the operator station, monitoring operations are performed by plant operators, and automatic control is performed by collecting and outputting the data necessary for plant operation via the control station, as well as the remote I/O and field devices. This monitoring and control system enables the combination of a variety of solution content, which can be shared with other monitoring and control systems.

For overseas product deployment, the focus is on expanding the overseas systems business by offering and standardizing primarily small-scale systems such as environmental monitors, water treatment systems and small boilers in South East Asia and India.

In the field of plant control systems, monitoring and control systems act as a platform for plant monitoring, and the issue of how data collected in such operations is handled is becoming increasingly important. In fact, sophisticated prediction technology that utilizes numerical models is being applied at worksites by combining collected data and artificial intelligence (AI) technology. As one such approach, Fuji Electric is working on the on-site application of soft sensors that calculate and estimate current values of important quality data, such as component concentrations of products regularly sampled on site, by using quality values that have already been collected. We are also expanding functions to support plant operations, such as a function to import large amounts of plant monitoring data in a fixed cycle to reproduce past plant conditions on the screen. (Refer to "Soft Sensor-Systems for Optimizing Plant Operation" on page 16.) Going forward, Fuji Electric will continue to advance efforts



(a) Differential and gauge pressure transmitters
(b) Flowmeters
(c) Analyzers

Fig.4 Fuji Electric's differential and gauge pressure transmitters, flowmeters and analyzers

in the collection and utilization of data.

(2) Supporting systems with measuring instruments

Fuji Electric contributes to environmental protection and energy saving with a lineup that includes various gas analyzers that support environmental measurement work, including air pollution measurement; flowmeters that support energy saving by measuring fluids such as saturated steam, liquid and air; and the "FCX Series" of differential and gauge pressure transmitters used in various fields around the world. Figure 4 shows various differential pressure and pressure transmitters, flowmeters and analyzers made by Fuji Electric.

Since its launch in 1989, over one million units of FCX Series product category have been sold worldwide. To further improve performance and respond to requests for new functions including measures for functional safety, Fuji Electric has developed the "FCX-AIV Series." (Refer to "Differential and Gauge Pressure Transmitters That Sophisticate Plant Monitoring and Control Systems" on page 36.)

3. Factory Automation Systems

3.1 Market trend of factory automation systems

In the market for factory automation systems, there is also a growing need for solutions that contribute to DX to enable customers to create new value by implementing the internet of things (IoT) primarily for digitization purposes. While each manufacturer engages in solutions in the specialty domain of systems, customers are seeking solutions that integrate multiple areas. Fuji Electric aims at upgrading of manufacturing, quality, inventory, maintenance, and energy control of customers by digital solutions that are hierarchical in manufacturing execution and production management (L3), monitoring control and monitoring (L2), and equipment and control (L1), based on hierarchical system model advocated by the International Society of Automation (ISA) in its standard ISA-95. Figure 5 shows an overview of DX for factory systems. Section 3.2 describes the manufacturing execution system in L3, as well as the motion control system and electric vehicle (EV) drive component performance test system in L1.

3.2 Fuji Electric's approaches

(1) Manufacturing execution system

Manufacturing execution systems (MES) are generally systems that seamlessly link core business systems such as enterprise resource planning (ERP) systems with on-site control systems to issue process-specific manufacturing instructions based on a manufacturing plan and collect manufacturing results data.

In addition to providing the basic functions above, Fuji Electric's MES is based on a concept that ensures quality traceability and supports improvement feedback through sophisticated analyses of manufacturing results.

As its latest approach, Fuji Electric has created a new MES concept to begin the development

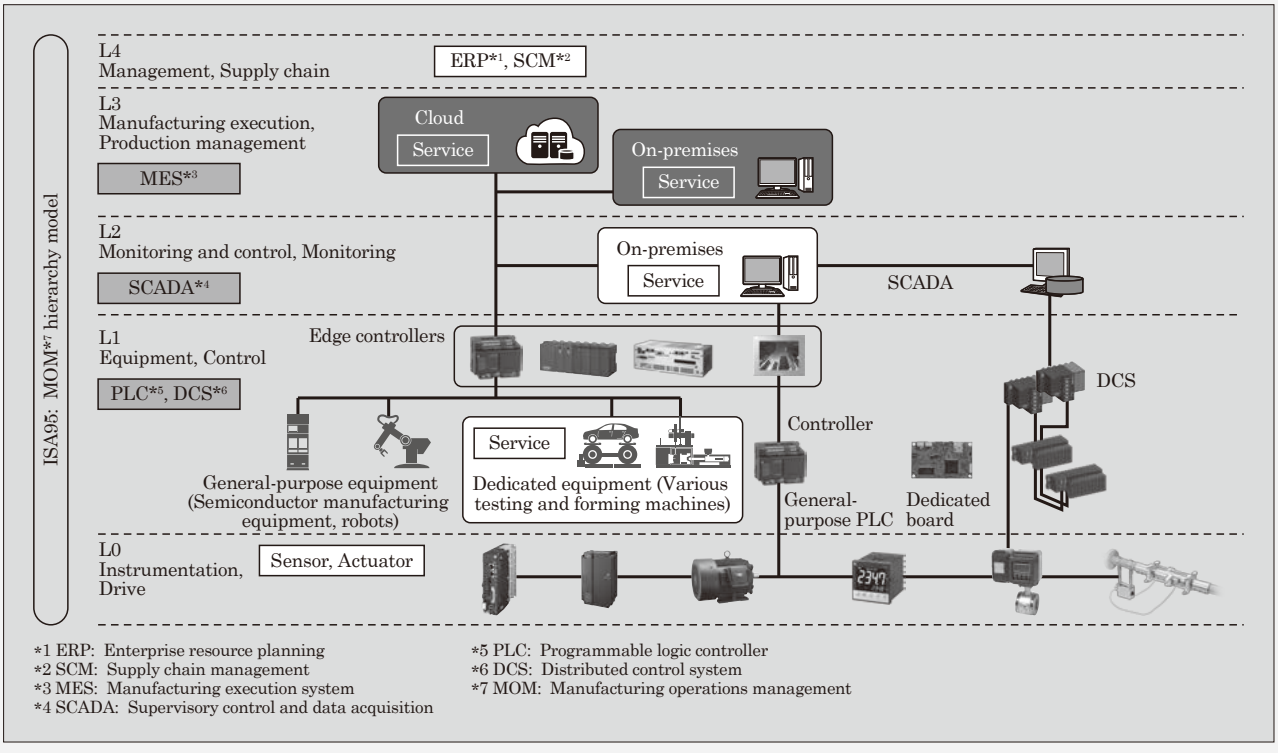


Fig.5 Overview of DX for factory systems

of an MES package with a new architecture. With a structure that is compliant with the OPC UA*1 standard data model, we aim to achieve an environment that responds to various changes in the future in a sustainable manner and analyzes various data (events, trends, text, images, voice, etc.) with the same usability.

Moreover, Fuji Electric is promoting the proposal of its "Global Smart Factory" concept for customer needs such as upgrading of plant environment, realization of digital twin environment, standardization from global viewpoint, and realization of carbon neutral. This proposal integrates packaged products, such as manufacturing, maintenance, facilities, and energy-information integrated databases at manufacturing bases, and MES, energy management systems (EMS), maintenance systems and facility monitoring systems using AI and analysis technologies as core technologies. Figure 6 shows the packages of the global smart factory.

On the other hand, as for the engineering function of MES, it has conventionally been defined specially for the function implemented, and it is efficient but difficult to change the function or use it in other applications. The new system adopts the information model that is the conception of OPC UA and can systematically manage required information, making it easier to change functions and utilize it in many applications by constructing digital twin as an information model that abstracts the manufacturing site. (Refer to "Manufacturing Execution Systems Encouraging DX on the Manufacturing Floor" on page 26.)

(2) Motion control system

A motion control system is a system that performs motion control such as precise positioning, speed control, and torque control for industrial machines and devices such as industrial robots. Motion control systems generally consist of an actuator such as servo motors, motion controllers, programmable operator interfaces, control software and so forth.

In these purposes, there are demands for coping with complicated operations and machining, shortening of process time, and higher precision, and performance that can be synchronously controlled at a higher speed control period is required with more control axes. Furthermore, in response to the increasing proliferation of EtherCAT*2 as an open network that allows users to select the optimal components from multiple manufacturers, Fuji Electric developed the "SPH5000EC," an EtherCAT-compatible controller. Figure 7 shows an EtherCAT system configuration.

This controller uses a "multi-core platform" that uses a processor with two cores, allowing it to simultaneously execute application software for two conventional programmable logic controllers (PLCs).

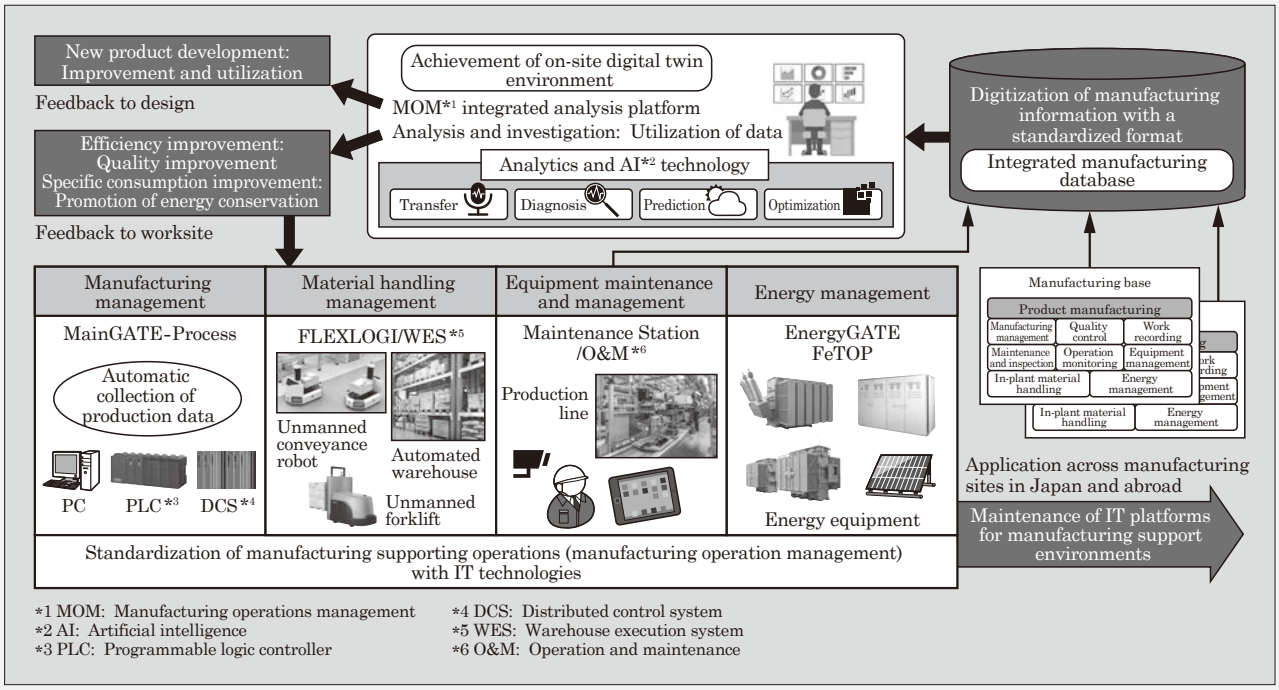


Fig.6 Global smart factory packages

***1 OPC UA**

OPC UA is a trademark or registered trademark of the OPC Foundation.

***2 EtherCAT**

EtherCAT is a trademark or registered trademark of Beckhoff Automation GmbH & Co. KG.

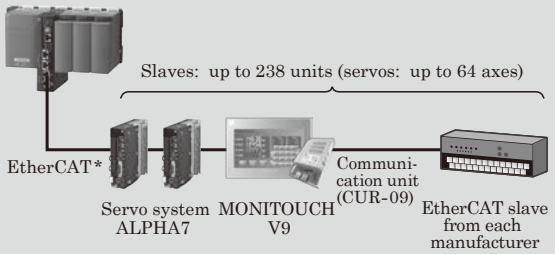


Fig.7 EtherCAT system configuration

Additionally, by simultaneously executing sequence control and motion control in parallel, it can achieve four times the motion control performance of previous models. It can also support large-scale systems through the synchronous control of multiple EtherCAT systems. (Refer to "Motion Controller Contributing to Automation of Factory Equipment" on page 31.)

(3) EV drive component performance test system

Since the control of EVs is more complicated than that of gasoline vehicles, the labor hours required for development and testing by completed vehicle manufacturers tend to be higher than those required for conventional gasoline vehicles. For this reason, there is demand for test systems that contribute to the improvement of test efficiency. Fuji Electric's EV drive component performance test system consists of an EV drive component performance testing equipment, a thermostatic chamber and a temperature control equipment. Figure 8 shows the EV drive component performance test system. The system can evaluate the performance of high-speed motor-based drive components across the entire temperature range, from low to high temperatures, while maintaining environmental factors with high accuracy.

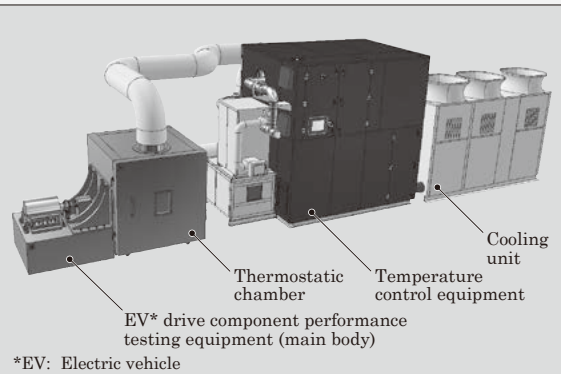


Fig.8 EV drive component performance test system

There are worries about the trouble with the testing equipment for high-speed rotation motors caused by the vibrations accompanied with its high-speed rotation, and it is required to reduce the complication of the maintenance for the trouble prevention as well as the troubleshooting. The newly developed EV drive component performance testing equipment is designed to be highly reliable as testing equipment by simulating with the finite element method and by optimizing the dynamic balance of the rotating shaft and is structured to simplify the maintenance.

Further, in order to improve the precision of the test environment conditions, it is necessary to keep the thermostatic chamber at a constant temperature by absorbing the heat generated from the parts to be tested. This time, by designing a refrigerant circuit and a control method to improve the cooling unit's response to heat generation, and by eliminating the defrosting function of the evaporator used in typical temperature control equipment, Fuji Electric developed a temperature control equipment capable of ±1°C temperature tracking in response to thermal load fluctuations. (Refer to "Performance Test System Reproduces the Usage Environment of EV Drive Components" on page 40.)

4. Other Systems, Solutions and Services

Fuji Electric offers systems, solutions and services that utilize the measurement and control technology we have cultivated in various industrial fields.

4.1 Ship IoT system

Exhaust gas cleaning systems (EGCS)*3 are increasingly being adopted in the maritime industry in response to the strengthened sulfur oxide (SOx) emissions regulations specified by the International Maritime Organization (IMO). Fuji Electric offers EGCSs that minimize operation costs by achieving optimal control using the world's smallest [10-MW class (as of 2020, according to Fuji Electric research)] SO_X scrubber and the laser gas analyzer. However, EGCSs burden ship owners, management companies and seafarers with monitoring and maintenance tasks. We developed the "Ship IoT System," which contributes to a safe and efficient ship operation through automatic collection of EGCS operation data and predictive diagnosis of faults. (Refer to "Ship IoT System for Efficient

***3 EGCS**

EGCS stands for exhaust gas cleaning system. These systems consist of SO_X scrubbers that remove sulfur from exhaust gas by cleaning the gas with sea water, measuring instruments that analyze the components of exhaust gas and discharged water, and other components.

Operation Management of Exhaust Gas Cleaning Systems" on page 45.)

4.2 Radiation control solutions

There is growing momentum around the world to depart from the use of fossil fuels and utilize nuclear power. To promote the utilization of nuclear power, thorough safety measures are essential, and to ensure safety and security in the local area, radiation management is indispensable. Fuji Electric has been contributing to the safe and secure use of nuclear energy by offering measuring instruments such as personal dosimeters, gas and dust monitors, as well as radiation monitoring systems. To further improve measurement reliability and promote automated management, we have developed monitoring posts with higher environmental resistance, dosimeters, environmental radiation monitoring telemeter systems and other equipment. (Refer to "Radiation Management Solutions Contributing to Safety and Security" on page 49.)

4.3 Service for Smart Industrial Safety

In the petroleum, chemical, power and gas industries and other energy-related infrastructure industries, the workload required for maintenance has been increasing as a result of the aging of equipment, as well as the aging and long-term shortage of security workers. Under such circumstances, there is an urgent need for the stable operation of equipment and the streamlining and sophistication of the maintenance work. Fuji Electric offers the "Comprehensive Service for Smart Industrial Safety," which addresses issues arising from existing analog maintenance operations and supports the management of highly efficient operations by utilizing IoT and AI technologies. In this way, the service optimizes equipment maintenance, encompassing everything from the development of maintenance plans to the proposal of equipment monitoring and maintenance management measures. (Refer to "Comprehensive Service for Smart Industrial Safety, Which Improves Maintenance and Inspection Efficiency and Delivers Predictive Maintenance" on page 54.)

5. Postscript

In this paper, we described the current status and future outlook of instrumentation, control and information systems that contribute to Fuji Electric's efforts in automation and energy saving. Going forward, we will continue to contribute to society by promoting automation and energy saving.

References

(1) Tetsutani, H. et al. Instrumentation and Control Solutions Contributing to Automation and Energy Savings: Current Status and Future Outlook. FUJI ELECTRIC REVIEW. 2020, vol.66, no.1, p.4-11.

Fuji Electric

Innovating Energy Technology