Information and Process Control System to Support Stabilization and Safety, "MICREX-NX"

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ABSTRACT

In control systems supporting production sites, information integration with a host system, integration with a safety-related system, strengthening of security, and the like are progressing. In such a situation, on the other hand, there is much equipment which is approaching an updating time, and it is required for succession of established property, technical innovation, and correspondence to an international standard. Fuji Electric has marketed the latest version V8.0 of information and process control system "MICREX-NX" with many delivery track records onto the market. It is a system which supports the stability and safety of plant operation with Adoption of wide screen and Windows 7, The screen design which increase visibility and operability, alarm management, security devices and safety instrumented system which are able to meet the international standards, and so forth.

1. Introduction

Control systems, which have supported production fields, are in the process of undergoing information integration with manufacturing execution and management systems and carrying out unified control of equipment and integration with safety systems. In addition, enterprises are stepping up their efforts to enhance security. Under these circumstances, production equipment about to be renewed requires a system that is adaptable to future creative technological breakthroughs while taking over existing assets.

In October 2013, Fuji Electric Co., Ltd. released the new version, V8.0, of the information and process control system "MICREX-NX," which contributes to the stable and safe operation of plants, in order to improve the safety of obsolete production equipment and, at the same time, help customers achieve stable plant operation. Since its first release in 2004, MICREX-NX has been introduced in more than 250 systems mainly in the fields of steel, chemical engineering, pharmaceutical industry and water treatment.

This paper describes the main features of the information and process control system "MICREX-NX."

2. Overview of "MICREX-NX"

MICREX-NX, among the line of Fuji Electric's control systems, is intended for controlling medium- and large-scale processes and is capable of supporting solutions compatible with many international standards such as engineering, alarm management, safety systems, control system security, batch systems and electronic records. Figure 1 shows system configurations based on MICREX-NX.

A standard system consists of an operator station (OS), which is a human machine interface (HMI), an automation system (AS), which is a controller, a process input/output module (ET200M) and an engineering system (ES). Each piece of the equipment is connected to an open network or private network via a switching hub for industrial use (SCALANCE). A dedicated personal computer for industrial use is used for the OS and the ES, and it is provided with a wide display and compatible with Windows 7*[1], and it offers a screen design combining improved visibility and usability.

MICREX-NX offers a high degree of scalability, which makes it possible to expand system configurations step by step in response to the expansion or processing capability enhancement of steel, chemical engineering, water treatment and other plants, and can be integrated with an information system covering production to management or a safety system. MICREX-NX also comes with migration products with which existing assets can be taken over.

MICREX-NX is characterized by, and provides in each phase of the life cycle, from system design to operation, maintenance and renewal, scalability adaptable to the expansion of plants, a unified engineering environment, streamlined maintenance work by cutting-edge monitoring control and equipment management functions, advanced security and safety conforming to international standards.

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*1: Windows 7 is a trademark or registered trademark of Microsoft Corporation, U.S.

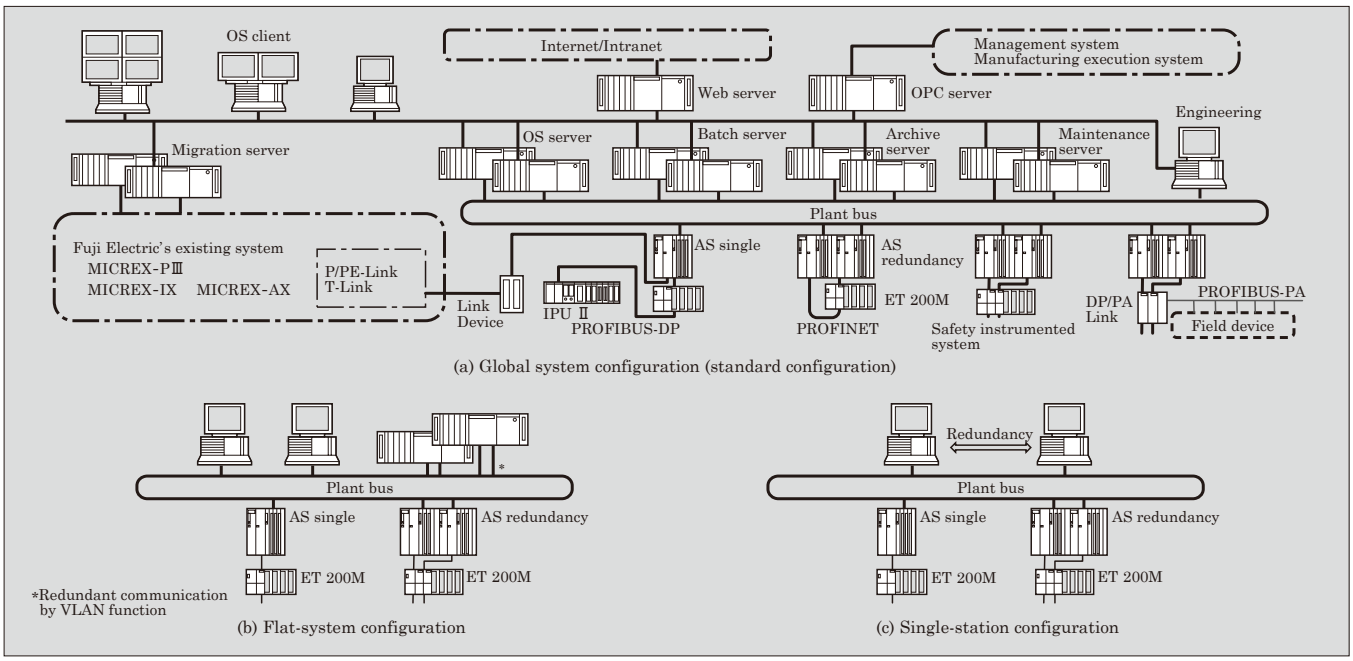

Fig.1 System configurations based on "MICREX-NX"

3. Features of "MICREX-NX"

3.1 System architecture with high expandability

(1) A variety of CPUs

For the AS, the core of MICREX-NX, a series of four types of CPUs with different processing capacities is available. A proper CPU can be selected according to the number of input/output loops or the size of application software.

(2) Diverse system configurations

MICREX-NX offers three system configuration patterns so that a system with high cost performance ratio can be constructed according to the scale of each plant. (see Fig. 1)

(a) Global system configuration

The global system configuration is the standard configuration for medium- and large-scale systems. A single system can accommodate up to 12 servers, to each of which up to 32 clients can be connected. All configurations can have redundancy. Connecting a wide variety of optional equipment also provides a system with extremely high expandability, such as longer data archive, monitoring via a web server and linkage with a host computer.

(b) Flat system configuration

The flat system configuration is intended for medium- and large-scale systems and features high cost performance ratio. This configuration is made flat by overlapping the plant bus and the terminal bus in the global system configuration by means of information technology. With the flat system configuration, the network line or SCALANCE can be shared, and such advantages as the reduction of equipment, communication cables and wiring work cost can be expected.

(c) Single-station configuration

The single-station configuration is for medium-scale systems. A single OS is endowed with engineering, data processing and monitoring operation functions. Although this configuration is compact in size, it can make the HMI and AS redundant.

(3) Complete redundancy configuration

MICREX-NX can make the HMI, AS, network and I/Os redundant, and we call this configuration the complete redundancy. The MICREX-NX's system switching function for AS redundancy, in particular, is superior to existing systems of Fuji Electric and systems of our competitors. Many controllers are designed to immediately switch their systems if any failure occurs to any of their communication routes. In the contrast, MICREX-NX, in the event of a failure

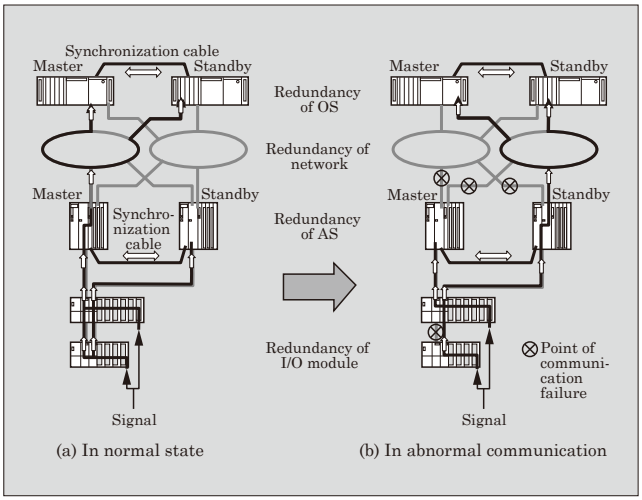

Fig.2 Concept of system switching by complete redundancy

occurring on multiple communication routes, utilizes a standby system AS to enable the operation system AS to continue operating, sending and receiving data through a normal communication route; this results in reducing the amount of switching of the AS in operation. The concept of system switching by complete redundancy is shown in Fig. 2. In other words, MICREX-NX can be said to be robust against multiple failures and extremely high in availability.

3.2 Various network connection patterns

(1) Inheritance of existing assets

For example, the energy center of a steel plant, which is generally large in scale, may require phase-in renewal. The expansion or renewal of a control system imposes a very heavy burden on the user. We offer solutions that enable users of our distributed control system (DCS) transition to the latest MICREX-NX while making effective use of their existing assets at the time of partial renewal or expansion.

DPCS-F, which is an existing control network, an FL-net compliant LAN and T-Link and P/PE-Llink used as networks for PIOs can be connected to the MICREX-NX by means of dedicated migration components (gateway or link device). This allows accessing to any existing controller from the OS, send and receive information between old and new controllers, and input and output data between existing PIOs. These features help users make the most of their existing assets and, at the same time, achieve long, stable operation.

(2) Support for open networks

It is a long time since I/O networks, field networks, information networks and so on for control systems were made open. MICREX-NX supports open networks, including PROFIBUS*2-DP, PROFINET*3, MODBUS*4, FOUNDATION Fieldbus*5 and As-i. As a result, field equipment fulfilling users' requirements or network functions can be selected and adopted, and system configurations can be provided with a higher degree of flexibility.

With regard to OPCs used for communication with host systems, MICREX-NX is compatible not only with conventional OPC-DA, A & E and HDA but also with OPC-UA featuring high communication security.

3.3 Variety of information and process control packages

More and more international standards concerning tools and applications for control systems are in the process of being established, and such tools and applications are now part of user-specified requirements. These international standards include IEC 61131-3 covering engineering tools, ISA S88.01 concerning batch systems, ISA 18.2 and IEC 62682 (under examination) defining alarm management, and IEC 61508 defining functional safety. MICREX-NX provides tools and packages conforming to these international standards.

(1) Engineering tool

MICREX-NX supports five languages (LD, FBD, SFC, ST/SCL, IL) compliant with the international program language standard, IEC 61131-3, and users can make effective use of their past program assets.

For continuous control engineering, a dedicated editor, continuous function chart (CFC), is available. CFC enables users to design layouts and terminal-to-terminal wiring simply by dragging and dropping various function blocks (FBs) and set operating condition parameters with ease.

(2) Batch system

The batch system of MICREX-NX visualizes hierarchical structures compliant with ISA S88.01. (see Fig. 3) This batch system makes it easy to reflect designs in systems, grasp them, and change combinations of recipes. The progress of processes can be constantly monitored on the monitoring screen by linking with a dedicated editor for sequence control sequential function chart (SFC). In addition, when the batch system is used in combination with a route control package, optimum transfer can be realized even if piping or transfer conditions are complicated. The batch system is also compatible with FDA 21 CFR Part 11*6 and ensures traceability (electronic signatures, electronic records, audit trails) with the aid of a package such as

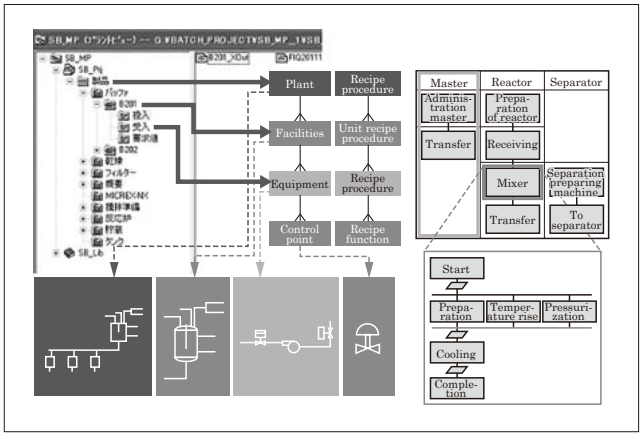

Fig.3 Visualization of batch system

*2: PROFIBUS is a trademark or registered trademark of PROFIBUS User Organization.

*3: PROFINET is a trademark or registered trademark of PROFIBUS User Organization.

*4: MODBUS is a trademark or registered trademark of Schneider Automation, Inc., France.

*5: FOUNDATION Fieldbus is a trademark or registered trademark of Fieldbus Foundation.

*6: FDA 21 CFR Part11: Regulations established by the U.S. Food and Drug Administration (FDA). Matters to be observed regarding electronic records and electronic signatures used at the time of applying for approval of sales of pharmaceutical and food products are specified there.

SIMATIC Logon, Version Cross Manager or Version Trail.

(3) Alarm management system

As the first step toward realizing plant safety, it is important to accurately monitor and manage the operating state of the plant and information about the occurrence of alarms. Many of the past alarm handling and issuing systems were designed to simply classify alarms into "high level," "medium level," and "low level." As a result, plant operators overlooked important states in the deluge of alarms and could not keep track of what dangerous state occurred to which piece of equipment, causing latent risks of the plant to multiply.

MICREX-NX is capable of breaking down priorities of alarms of each class into 16 levels in addition to the conventional three classes of alarms (see Fig. 4). If, for example, a problem occurs at a plant and causes a serious failure on multiple devices, alarms that are more important will be reported preferentially to the HMI. On the alarm display screen, a variety of filtering functions, with which necessary alarms can be retrieved from accumulated information, are available. These alarms can also be searched not only based on the abovementioned classes or priority conditions but also by equipment. With the aid of the export function, operators can store and manage detailed information about alarms in CSV format and, at the same time, facilitate the identification and analysis of trends in alarms. The function of temporarily controlling unnecessary alarms that are frequently issued during maintenance or inspection helps operators locate true alarms without fail.

The alarm management function of MICREX-NX can reduce risks in the plant operation.

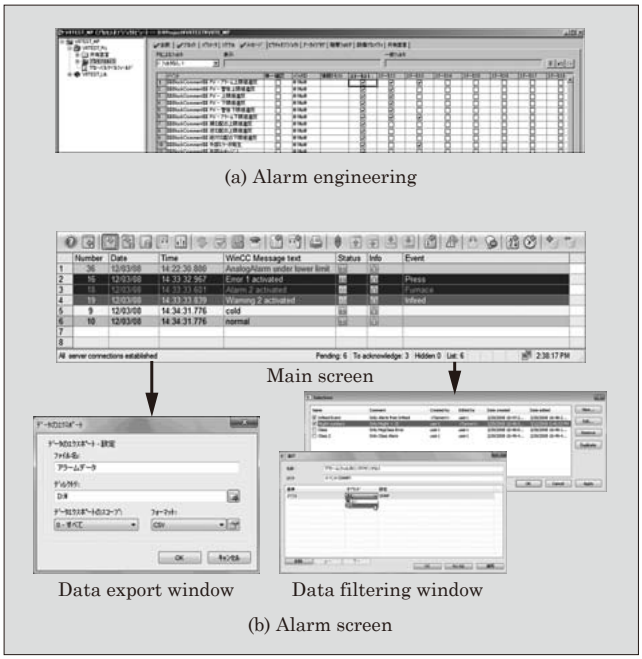

Fig.4 Alarm engineering and alarm screen

(4) Asset management

Asset management placing emphasis on maintenance is important to enable a control system to operate for many years in a stable manner. Companies have started introducing asset management aiming to improve the effect of a control system while reducing maintenance costs of the equipment making up the control system.

Asset management provided by MICREX-NX can offer, through a dedicated maintenance station, state monitoring, diagnosis, and integrated management of the OS, AS, ET200M, SCALANCE and individual components of field devices. For example, it visualizes on the screen the diagnostic status determined by the system, identification information and diagnostic messages about components, the type and current progress of maintenance operations, etc. These functions ensure effective preventive maintenance and help to reduce work time, prevent failure to perform diagnosis, and improve the operating rate of and ensure long and stable operation of the control system.

3.4 Security of control systems

The security of a control system must be maintained from the standpoint of availability, integrity and confidentiality. In parallel with the establishment of the security standard IEC 62443 Series, Japanese companies are working hard to protect the security of their control systems. MICREX-NX features the following security-related functions:

(1) Protection of operation and engineering

HMI makes it possible to set detailed access rights (scope of equipment that can be monitored, operation and setting ranges, etc.), including a password, individually for each log-on ID, allowing system operation in a flexible manner in response to the user's needs.

The user application for control systems is capable of preventing unintended changes to the software logic and the leak-out or falsification of important control know-how by further transforming software logic created by CFC into FBs and protecting the generated FBs with a password. This user application, if installed with an additional software package, also enables operators to manage and check change history, including version numbers, as well as the users who accessed the system.

(2) Connection to virtual private network (VPN)

As plant facilities are becoming gigantic or their decentralization (construction of local or overseas facilities) is accelerated and IT is further developing, wide-area networking, remote monitoring and maintenance of control systems have become easy. This situation consequently forces us to introduce measures against tapping on networks, intrusion into systems and information falsification to the control system.

MICREX-NX uses SCALANCE S (VPN or firewall construction module), which is a dedicated security product, to reduce the risk of tapping, intrusion and

falsification. SCALANCE S protects data exchanged through communication between facilities with a robust encryption protocol (IPsec). Up to 128 VPN routes can be established, and therefore, it is possible to construct a network among multiple facilities. Enabling the firewall can strongly block unauthorized access from outside.

(3) Anti-virus measures

MICREX-NX protects control systems from virus threats, which are increasing and becoming more serious year by year, with two means. One is conventional virus-scan-type software. It entails operation-related issues, such as heavy burdens on the system and the necessity to update virus patterns as appropriate. The other is a function called white listing. White listing means protecting the system from adverse effects of all viruses, whether known or unknown, by registering software and applications when the system is clean before it is infected with a virus as a "white list," and controlling all operations of unregistered software and applications. Unlike the virus-scan-type software, white listing does not need frequent updating of pattern definitions and, at the same time, can prevent damage by new viruses. It can also minimize burdens on the system because it does not require constant scanning.

(4) Third party-certified system

Achilles Certification, which is a third party certification system for control system security, qualifies products, such as controller components, that maintain a specified high level of communication security robustness. MICREX-NX can build a high-security control system consisting of components qualified as Level 2 by Achilles Certification.

3.5 Integration of control and safety

MICREX-NX serves not only as a process control system but also as a safety instrumented system (SIS). Fuji Electric markets the system as "MICREX-NX Safety." An integrated-type SIS, MICREX-NX Safety is characterized by the following features:

(1) Both safety instrumentation and process control can be achieved with one AS

In general, the SIS and the DCS are separately configured. MICREX-NX Safety can achieve a concurrent configuration of the SIS and the DCS with a single AS besides a separate configuration and ensure safety levels up to SIL 3 in any configuration.

By applying to the AS a dedicated system for realizing a safety control function, a protection mechanism different from the DCS is extended to the AS and enables it to function as the SIS. However, this feature is applicable only to ASs supporting redundancy. Software for the SIS and that for the DCS are theoretically separated from each other and run while maintaining independence. This is the technology Fuji Electric realized for the first time in the world, and certified by the German certification body, TÜV SÜD.

(2) Engineering of both the DCS and the SIS is feasible with one ES

Engineering by MICREX-NX Safety uses the same hardware and engineering tools used by the DCS. That is, both the DCS and the SIS can be designed with one ES. The SIS is provided with a different password lock function from that of the DCS to prevent changes being made to the SIS application software by personnel other than the person in charge of the SIS design. Safety Matrix, which is an engineering tool exclusively for the SIS, is capable of automatically generating safe the SIS application software simply by entering information about input signals, logic conditions and output signals on the tabular form screen (see Fig. 5).

(3) Monitoring is possible with one HMI

The operating state of the SIS is generally monitored by the HMI of the DCS. However, it is anticipated that operators may not take a thorough emergency response if only the operating state of the SIS, which works in case of emergency, is displayed on the regular monitoring screen. Nevertheless, designing a dedicated screen capable of displaying the operate state of the SIS in an easy-to-understand manner as needed incurs a heavy burden.

MICREX-NX has the function of displaying on the HMI a screen of the same design as the screen of Safety Matrix. On the matrix screen using various colors, the operator can immediately identify which sensor is activated, what logic judgment is based on, and to what equipment a signal was output, in connection with the safety function that has just operated.

(4) Configuration of a safety function loop

The safety I/O module of MICREX-NX Safety can establish duplication or redundancy (1oo2, 2oo2, 2oo3, etc.) in combination based on the safety level of input/output equipment in any position (see Fig. 6). With

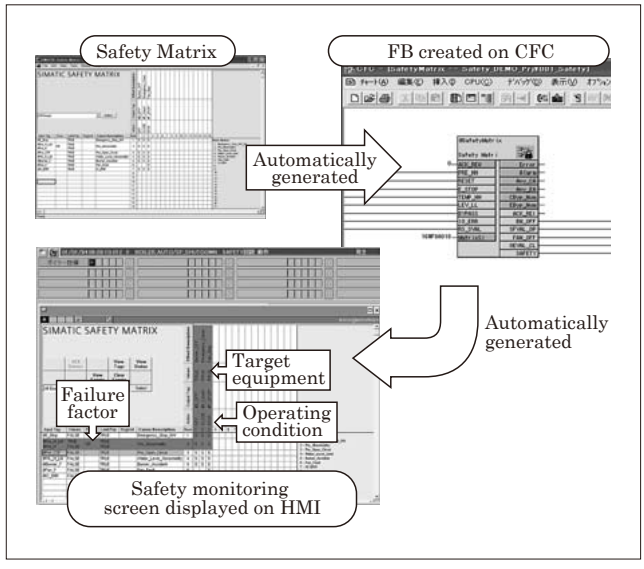

Fig.5 Automatic generation of SIS application software by Safety Matrix

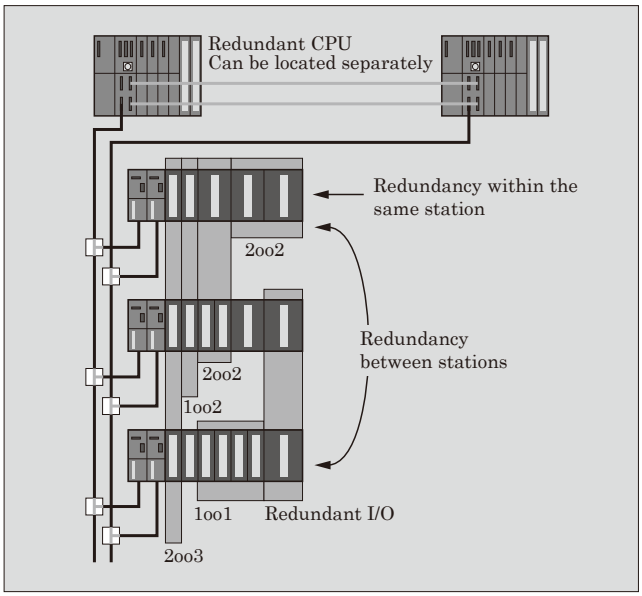

Fig.6 SIS redundancy configuration

this configuration, operators can respond to multiple concurrent failures, or reduce failures attributable to common causes.

4. Postscript

This paper described the characteristic functions of the information and process control system "MICREX-NX" that combines various technologies and solutions to help plants operate in a stable and safe manner.

In Japan, existing plants will be further expanded or refined, and the role of monitoring control systems will become more important accordingly. In particular, commitments compliant with international standards such as active adoption of safety systems, protection of system security and alarm management are expected to increase and accelerate.

We are committed to pushing forward with system development to keep MICREX-NX as the information and process control system capable of offering solutions to issues confronting customers.