

# New Progress of Control System

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*VigilantPlant is Yokogawa's concept for achieving safe, reliable, and profitable plant operations. With the key platform of the CENTUM VP integrated production control system, ProSafe-RS safety instrumented system and STARDOM network-based control system, Yokogawa provides customers with solutions that help them achieve operational excellence in their plants, aiming to become the leading company in the IA business. This paper introduces the evolution of the latest control systems and their applications.*

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## INTRODUCTION

Yokogawa proposed the VigilantPlant concept as an ideal plant that achieves fully optimized operation where all the necessary information is given to all the operators involved in the plant operation. In VigilantPlant, operators are able to quickly respond to changes in the external environment while the production activities run without any interruption. This allows operators and engineers to keep evolving and optimizing plant equipment into the future.

Under this VigilantPlant vision, Yokogawa delivers various solutions to customers to ensure ideal operation of their plants. This paper introduces how our core control systems used in these solutions have evolved, focusing on the evolution of the control platforms, system integration, and solutions.

## EVOLUTION OF CONTROL PLATFORMS

Controllers are the core components of control platforms and they are categorized in two types: one is a high-performance, large-capacity, and ultra-high-reliability controller for operating a large-scale plant such as for oil and petrochemical industries, designed for a high level of reliability; and the other is an environmentally resistant, highly autonomous, compact controller built-in to the equipment which is widely distributed.

Yokogawa released a field control station (FCS) for the

CENTUM series in 1975; this was the first type of controller which has continued to evolve ever since. In the last decade, the availability of field information has dramatically progressed with advances in field digital technology. The CENTUM VP's FCS offers high-performance controllers capable of making the best use of large volumes of field information.

As for the second type of controller, Yokogawa offers the Field Control Node (FCN) and Field Control Junction (FCJ), autonomous controllers for the STARDOM network-based control system. Customers highly evaluated these controllers because they can be operated in severe environments such as extremely high or low temperatures, high altitudes, or with limited power supply.

### High Performance, Large Capacity, and Ultra-high Reliability

Yokogawa developed and first released products conforming to the FOUNDATION fieldbus™ international standards in 1998. Since then, Yokogawa has been working hard on enhancing field digital technologies. While leading the FOUNDATION fieldbus standardization, Yokogawa optimized plant operation by reducing wiring, developing intelligent field devices, realizing asset management, and asset diagnosing.

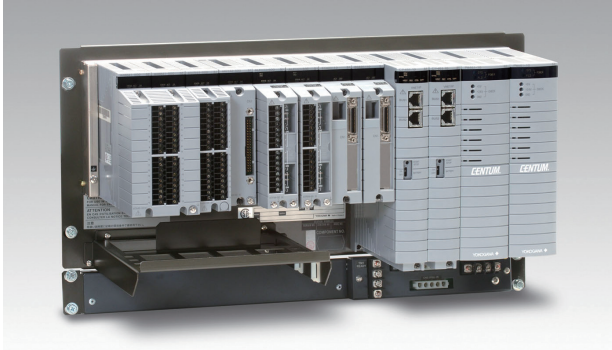
Along with advances in field digital technology, production control systems are required to have higher throughput to process large volumes of data from the field without difficulty. In order to meet this requirement, the fundamental performance of the CENTUM VP's FCS has been dramatically improved. Compared with the previous model, the new FCS shown in Figure 1 features three times the processing performance, twice the application capacity,

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and five times the control network throughput, all of which are the best in class (as of July 2011, surveyed by Yokogawa).

For details of the new architecture that helped greatly improve FCS performance, refer to the relevant article in this issue.



**Figure 1** External view of FCS

Some people may be concerned about system stability and risk hedging when all the data processing is concentrated in a single controller owing to improvements in its processing performance. With its industry-leading high reliability design, Yokogawa's FCS ensures long-term stable operation with world-leading 99.99999% availability, thus reducing operational costs even in large system configurations. Furthermore, the dramatic improvement in FCS's processing performance gives controllers the capacity to respond to unexpected alarms and events, reducing the risks in system operations. All these features help reduce the costs of the entire system throughout engineering, operation, and maintenance.

CENTUM VP adopts a high-performance Vnet/IP control network. By using this high-speed control network among control stations such as FCS, Human Interface Stations (HIS) and others, information that increases as field digital technology evolves as well as in association and integration with production management systems and other production control systems can continue to be sent and received in real time. The Vnet/IP is based on 1-Gbps Ethernet communication, and offers real-time response, high reliability, and openness (approved as the IEC 61784-2 international standard), and it has been adopted in 80% of the CENTUM systems sold overseas.

#### **Compact, Distributed, Environment-resistant Controllers**

Along with the growing worldwide demand for energy, oil and gas companies are doing their utmost to raise yields by focusing on improving exploration and production technologies.

In actively pursuing the development of oil and gas fields, such firms are moving into areas with extreme environments such as high and low temperatures, high altitudes, or places with insufficient infrastructure such as power supply and communications. This means that the control systems for natural gas and oil wellheads must be energy-efficient and

equipped to withstand harsh environments.

As gas and oil fields are scattered over large areas, the cost of maintaining production facilities such as patrolling poses a heavy financial burden on oil and gas companies. There are increasing needs for improving maintenance efficiency by centralizing the device and maintenance information of various instrumentation devices of production facilities such as individual device records and maintenance records.

To meet these needs, Yokogawa developed the Field Control Node-Remote Terminal Unit (FCN-RTU), a low-power autonomous controller which is suitable for controlling and monitoring widely distributed facilities, and added it to the STARDOM network-based control system line-up.

The standard FCN-RTU is equipped with a low-power CPU module with I/O functions and communication ports for controlling natural gas wellheads. This CPU module enables the control and monitoring of production facilities where there are limited sources of power such as by solar batteries. The adoption of environmentally resistant, highly durable components has extended the available installation environments to include extreme temperatures of  $-40$  to  $+70^{\circ}\text{C}$  and altitudes as high as 3,000 meters, enabling control and monitoring of the production facilities.

For the FCN-RTU's technical features and application examples, see the relevant paper in this issue.

#### **Security Measures for Control Systems**

Cyber attacks on industrial control systems are increasing worldwide. Although the security measures required for such systems are technically the same as ordinary IT security measures, they differ in importance and are far more critical. This is because if the security of the control system is not maintained properly, it may cause damage to human life or the environment. The seriousness of this risk is apparent from the fact that the U.S. government is directly involved in defending its social infrastructure such as power systems.

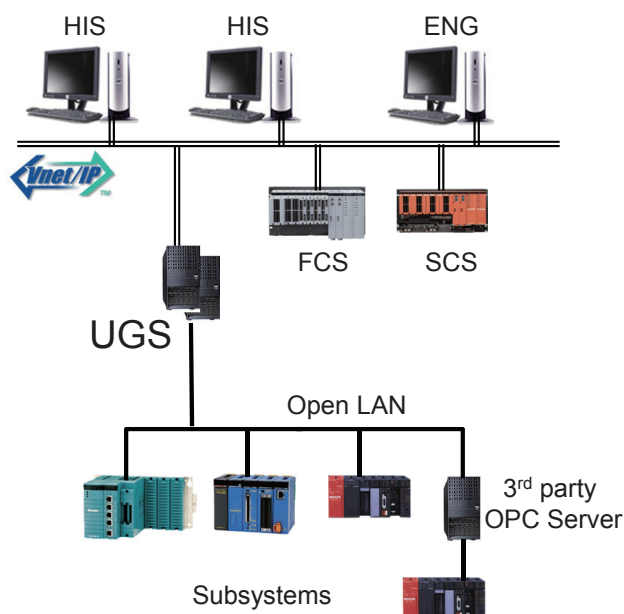
The control system is usually required to operate stably for a long time. Therefore, security is not satisfied simply by achieving a required level; measures must be taken to maintain security above a certain level. Therefore, continuous efforts for security are required throughout the life cycle of the system to prevent security measures from becoming obsolete.

For the latest information concerning security measures for the control system, see the relevant paper in this issue.

### **EVOLUTION OF SYSTEM INTEGRATION**

#### **Subsystem Integration**

As shown in Figure 2, the Unified Gateway Station (UGS) enables the CENTUM VP HIS to be used for operation and monitoring of subsystems including PLCs and other systems. The look & feel of the operation screens is made identical, and operators no longer need to learn different operational methods for respective systems.



**Figure 2** Subsystem Integration by UGS

For example, by connecting the UGS with FCN/FCJ autonomous controllers which control a number of small facilities such as utilities and oil and gas wellheads scattered over a wide area, CENTUM VP is able to configure centralized control and monitoring of such remote facilities.

The UGS processes not only subsystem data but also alarms and events from FCNs/FCJs and PLCs, and helps achieve more advanced system integration. The UGS also supports online maintenance and redundancy.

For details of the UGS functions, see the relevant paper in this issue.

### Alarm Management based on ISA18.2

Alarms are issued from various devices and systems: intelligent field devices with field digital technologies, DCSs, safety instrumented systems, and asset management systems. The number of alarms that operators must deal with also increases as the systems' information integration advances. Operators are required to deal with more advanced alarms such as preliminary alarms and diagnostic alarms quickly and appropriately.

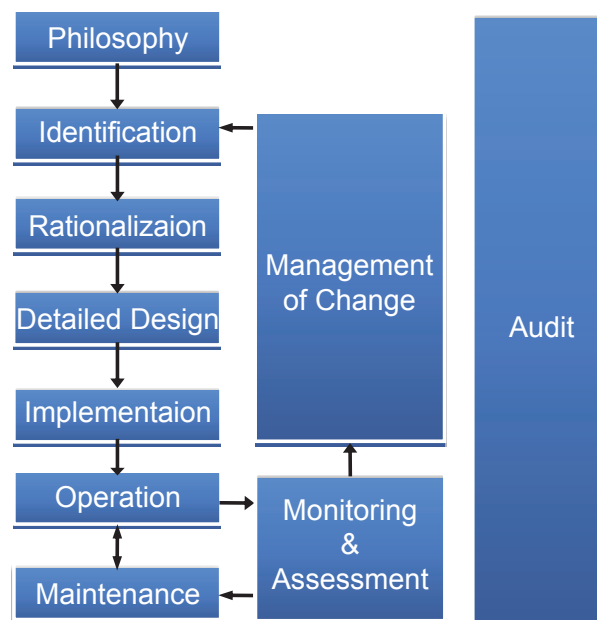
With the dramatic increase in the number and kinds of alarms, alarm management has become more important.

ISA18.2 (ANSI/ISA-18.2-2009), issued by ANSI/ISA in June 2009, is the latest alarm management standard for the process industry. This covers previous guidelines such as Publication No. 191 Alarm Systems of the Engineering Equipment and Materials Users Association (EEMUA).

As shown in Figure 3, the alarm management life cycle defined by ISA18.2 is a cyclic process of improving and optimizing the plant operation and monitoring environment by repeatedly conducting the alarm system design process, operation process and alarm analysis process. It also intends to reduce human errors by appropriately conducting change

management for the alarm system.

CENTUM VP supports CAMS for HIS, the extended alarm management functions for HIS. It also has functions to help improve not only operation but also change management. In addition, Yokogawa offers solution services to improve safety by alarm rationalization<sup>(1)</sup>. We continue to develop comprehensive solutions in compliance with ISA18.2.



**Figure 3** Life Cycle of Alarm Management

## EVOLUTION OF SOLUTIONS

### Space-saving Safety Instrumented System

Energy and material industries such as oil and natural gas, petrochemicals, and iron and steel have an increasing need for introducing safety instrumented systems to ensure safety during plant operation. This is required for preventing accidents, safely shutting down in an emergency, conserving the global environment, and meeting corporate social responsibilities.

The ProSafe-RS safety instrumented system plays an important role in preventing plant accidents by detecting abnormalities during operation and taking an emergency action such as a shutdown. ProSafe-RS conforms to the IEC61508 international safety standard and has been certified by a third-party organization as equipment satisfying the SIL3 safety level.

By being configured with CENTUM VP, ProSafe-RS integrates both the process control system and the safety instrumented system, which are usually configured separately due to their different roles and functions. This is a unique feature of ProSafe-RS.

Customers expect safety instrumented systems to have a high level of safety integrity, quick response, high availability, space-saving installation, and others. Yokogawa developed new, high-performance, space-saving temperature input

modules and their dedicated terminal boards.

These modules satisfy the need for installing a multiple-input sensor so as to make temperature sensors (thermocouples and resistance temperature detectors) redundant. The voltage signal output from the sensor can be directly input, which eliminates signal conditioners and saves space.

For details of the temperature input module conforming to SIL3, see the relevant paper in this issue.

### Application to Wind Power Generation System

There are various renewable energy resources such as solar power, wind power, wave power, and geothermal power. Today, the total worldwide generation capacity of wind power is much larger than that of solar power: in China and the U.S., it matches Japan's total nuclear power generation capacity. The increasing demand for renewable energy is leading to larger wind power generation systems and higher generation capacity. In addition to onshore wind power, offshore areas where winds are strong are promising locations for wind power generation.

Open and highly reliable STARDOM network-based control systems are built into equipment in various applications. In wind power generation systems, STARDOM controllers have been widely adopted for wind turbine control as well as for monitoring wind turbines located in remote areas.

STARDOM enjoys a good reputation as a suitable control system for wind power generation thanks to its highly accurate measurement of the wind turbine's rotation axis for protecting the turbine itself as well as to stabilize the power generation. See the relevant paper in this issue for details.

### CONCLUSION

The CENTUM VP and STARDOM systems are introduced in this paper as examples of the evolution of control platforms. CENTUM VP offers a high performance

controller designed to meet the needs of ISA100.11a field wireless applications. STARDOM, taking advantage of its small and distributed system, will become more suitable for utility applications along with increased energy demands. As for overall system integration, it is more important to integrate not just DCS alone but also to take various subsystems into consideration.

As these systems and controllers advance, the demands for continuously maintaining and improving systems from the viewpoint of life-cycle optimization will certainly increase. Security issues of the control systems have become unimaginably important. In order to achieve optimal plant operation while ensuring safety, alarm management must also be implemented appropriately. All these activities must be maintained and improved over a long period of time in terms of the system life cycle.

Yokogawa's control systems are the foundations of the customers' control platforms, and Yokogawa offers "VigilantPlant Services<sup>(2)</sup>" for maintaining and improving them. Through both approaches, Yokogawa will continue striving to achieve the VigilantPlant vision.

### REFERENCES

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