LATEST TECHNOLOGIES IN SUPERVISORY CONTROL SYSTEMS FOR WATER SUPPLY AND SEWAGE SERVICES

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Supervisory control systems for water supply and sewage services are changing dramatically in response to recent changes in the social environment and rapid progress in computer technology. In particular, the widespread availability of powerful yet inexpensive personal computers has generated demand for systems that are both low cost and versatile. However, the supervisory control systems for water supply and sewage services, which are essential "lifelines", must still be safe and reliable, as well as compatible with existing systems. This paper summarizes the functions required for the supervisory control systems based on market trends, and introduces Yokogawa's approach to meeting these needs with the latest technologies.

INTRODUCTION

The requirements for water supply and sewage services are becoming increasingly strict, such as consolidation of facilities, operational efficiency, lower cost, and information transparency due to stagnant demand. There is also demand for greater use of information technologies (IT), encouraged by the government's e-Japan strategy.

However, rapid and concurrent technological progress and environmental changes, even though they may make society more convenient, also generate uncertainty. For example, control systems need to be improved to reduce impacts and create a recycling-based society or to combat terrorist threats, yet it is becoming harder to pass on accumulated know-how due to labor cutbacks and population aging, making it harder to respond in the event of a system failure. This is an example of social changes. In terms of systems, unforeseen problems may occur due to efforts to protect against computer viruses resulting from openness or advanced functionality, or due to diversification of components.

With this background, this paper introduces the new technologies of supervisory control systems to meet market demands for high quality and reliable technologies. Figure 1 shows an example of the latest central supervisory room.

Figure 1 Example of a Modern Central Supervisory Room

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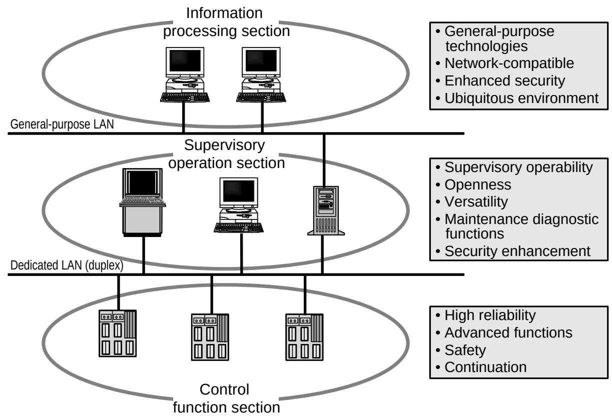

Figure 2 Configuration of the Supervisory Control System and the Characteristics of Each Section

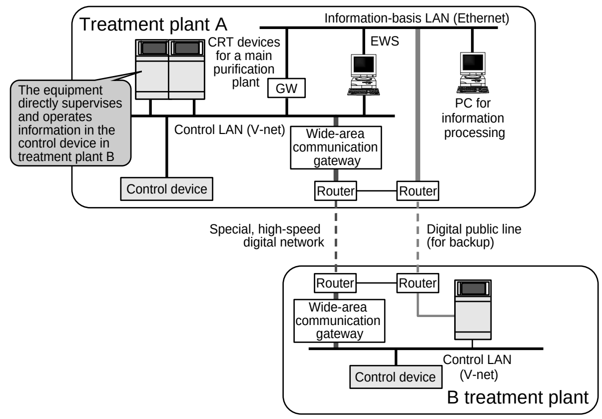

Figure 3 Configuration of a Wide-area-capable Bus Communication System

REQUIREMENTS FOR SUPERVISOR CONTROL SYSTEMS

In addition to the conventional needs of high reliability, advanced functionality, and extendibility for supervisory control systems, there has been growing concern about the following.

(1) Flexible integration of facilities
As municipalities consolidate, supervisory control systems must flexibly cope with such integration of facilities. The global management of geographically dispersed facilities is one solution.

(2) Efficiency in operation and maintenance control
Labor cutbacks are being made in operating water supply and sewage plants, so the efficiency of operation and maintenance control needs to be raised. Moreover, operation and maintenance work is being consigned to private companies in response to deregulation, so enhanced management and information sharing are essential.

(3) Utilization of IT
General-purpose technologies and products, such as Windows operating systems, personal computers, and network equipment now offer greater functionality at lower cost, and there is a similar demand for general-purpose technologies to be used in supervisory control systems. There is thus a need for operation and maintenance in a ubiquitous environment.

(4) Reduction in total cost
Local governments are pursuing efficiency and soundness of management including reconsideration of work, so systems that require a lower initial investment as well as lower total cost throughout their lifecycle are required.

FUNCTIONAL CATEGORIES OF THE SUPERVISORY CONTROL SYSTEM AND OUR APPROACHES

Figure 2 shows the functional categories of the supervisory control system. The system is classified into three main sections, which we have addressed according to their respective characteristics.

(1) Control function section
To securely operate lifeline water supply and sewage service facilities, high reliability and operability are essential. Our dedicated systems therefore feature a redundant CPU design, safe design, highly reliable hardware, and software packages custom-built for water supply and sewage services.

(2) Supervisory operation section
The operation functions have been configured using custom-built software for operating the facilities safely and efficiently. We offer two types of hardware for this section: specially designed and general-purpose machines, so that low-cost supervisory control systems are available.

(3) Information processing section
To be able to install and improve the network environment and information sharing, it is necessary to cooperate with municipal networks (intranets). This section handles data management of various processes and running a variety of applications for each facility of water supply, etc. Versatile technologies such as general-purpose PCs, Windows operating system, and MS Office applications are used, operating in conjunction with intranets and Internet to create a ubiquitous environment that can be accessed from anywhere on the network.

LATEST SUPERVISORY CONTROL TECHNOLOGIES

The following introduces specific examples of the latest supervisory control technologies offered by Yokogawa.

Technologies for Integration of Facilities

To address the consolidation of municipalities and integration of facilities, we offer technologies for centralized operation and maintenance of facilities over a wide area from a central control center, as well as technologies for easily merging information of existing, different systems (Figure 3). Our solutions, wide-area bus communication and standard interface technologies, are described below.

(1) Wide-area-capable Bus Communication

The control LAN for Yokogawa's supervisory control systems (hereafter called CENTUM) is connected through a digital network provided by a common carrier using wide-area communication gateways to achieve supervisory operations of treatment plant B, situated in a remote area, from treatment plant A. This control LAN handles more transmission data than the conventional TM/TC or modem system and allows CENTUM's internal data such as control parameters and alarm setpoints to be checked and modified. Thus, a facility that becomes unmanned due to integration of facilities can be operated and maintained remotely in the same way as manned operation.

Moreover, since both systems become similar, the communication and control functions do not overlap, thus reducing the cost of system expansion or modification.

(2) Standard interface technology

The OPC interface (OLE for Process Control) is the standardized specifications for industrial systems that make use of Microsoft's OLE technology, which allows supervisory control systems of different vendors to be connected.

In the conventional integrated systems, it was necessary to develop an interface for inter-connectivity between different vendors' systems. However, the OPC interface allows standardized data accesses between different vendors' servers. Thus, it is easy to integrate different vendors' systems that have been operating in different lines or different equipment such as water treatment or wastewater treatment equipment in large-scale facilities.

Technology for Bringing Efficiency to Operation and Maintenance Control

To cope with manpower reductions and privatization, efficient operation and maintenance control of facilities is essential. This section introduces the operation-support package, Exapilot, and information processing system, Suimei, which achieve this. It also describes Fieldbus which helps improve the efficiency of operating and maintaining equipment.

(1) Operation-support system, Exapilot

Unsteady operations in the event of a problem in a facility or during maintenance often depend on manual operations because they are difficult to automate. The operation-support system Exapilot achieves automation/semi-automation of operation in the unsteady state by systematizing skilled operators' know-how. This makes the quality of operation uniform and improves efficiency. It has the following features:

- In the operation environment, the versatile Windows OS and OPC are used, enabling easy connection to the supervisory control system.
- The operation procedures of skilled operators are converted into flowcharts, so sequences can be easily built by simply arranging process objects.
- Created flows can be used as operation manuals.

For water supply and sewage service facilities, Exapilot is applicable to the following unsteady state operations:

- Operation during maintenance and inspection with a power failure and recovery from it
- Operation during maintenance of a reservoir or machinery
- Water quantity-limiting operation due to water shortage
- Operation and maintenance when taking measures against rain water
- Water treatment stoppage, partial volume-reduction operation, and water treatment startup operation in the event of a power failure

Exapilot can also be used in the event of water contamination or as anti-disaster manuals. Furthermore, it offers guidance to alarms to prevent operators' erratic operation even during steady-state operations or a variety of simulation functions. As the number of operators continues to decline, this system ensures safety and stores operation know-how.

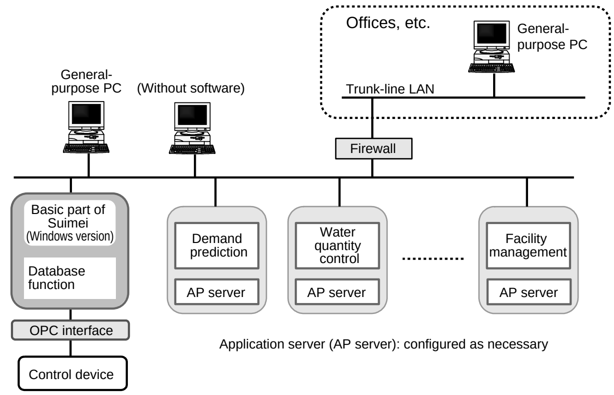

Figure 4 Information Management System, Suimei

(2) Information management system, Suimei

The information management system, Suimei, uses the Windows OS to run a variety of applications dedicated to water supply and sewage services in an open environment. Suimei performs data input/output to/from the supervisory control system via OPC, and incorporated process data is databased by an application package designed for the main process of water supply and sewage services.

Suimei comes with application packages for the operation and maintenance of water supply and sewage service facilities that Yokogawa has developed over the years.

- Examples of application in water works

  Demand prediction, water quantity management, water distribution control, water quality control function, etc.
- Examples of application in sewage works

  Waste water flow-in control function, simulator function, etc.

As shown in Figure 4, these packages are modular and so can be added as necessary, thus reducing the initial investment required.

(3) Fieldbus

In water supply and sewage service systems, there are many field devices scattered throughout the plant, so there is a strong demand for reducing the work of operating and maintaining these products.

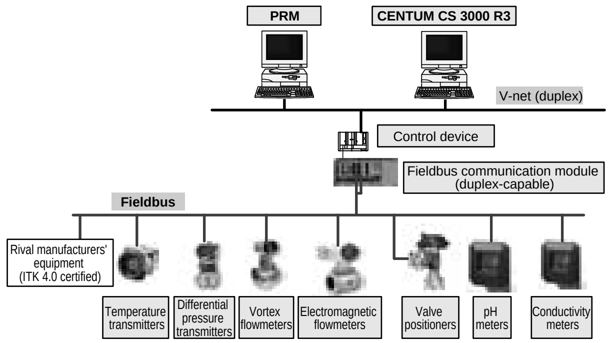

Figure 5 Example of Fieldbus Configuration

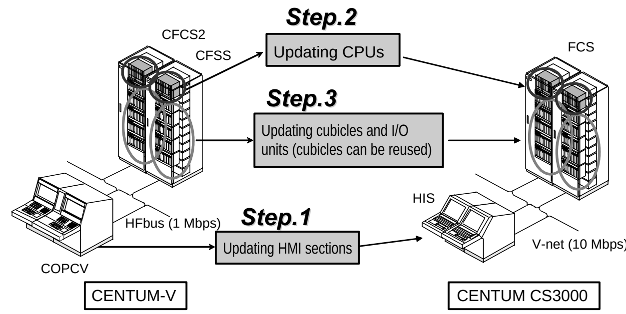

Figure 6 Example of the Stepwise Functional Upgrading Technique

Fieldbus is a digital communication system for field devices capable of performing bi-directional communication. It is defined in the international standard (IEC) for networking field information, and replaces the conventional analog signal of 4 to 20 mA.

Fieldbus has the following features:

- A single cable allows multiple devices to be connected (multidrop connection), so systems require less wiring.
- Capable of multiplex transmission, enabling much field control information to be sent and received in addition to PV and MV.
- Inter-operability is secured, allowing different manufacturers' devices to be combined.

Since various information can be obtained online through the field network in this way, Yokogawa offers Fieldbus-based integrated equipment management package PRM (Plant Resource Manager) (Figure 5), which makes maintenance control of field equipment efficient and so reduces operation and maintenance costs of facilities.

Technology for Reducing Total Costs

It often takes ten years or longer for water supply and sewage service facilities to reach their final form after annual plan-based business has started. As a result, the lifecycle costs of the system may rise due to limitations on extendibility resulting from partial aging of systems or functional limitations of the initial system.

This section introduces the partial system updating technology as reducing the total cost in an environment where new and conventional systems coexist.

(1) Stepwise updating (migration) technique

Migration is a technique for shifting to the latest functions for minimal investment while using existing assets to reduce total cost. Figure 6 shows the phase-in migration steps in Yokogawa's supervisory control system (CENTUM).

Step 1: Human interfaces (HMI) in which functional aging is significant are migrated to introduce the latest supervisory operation environment and network environment.

Step 2: Control devices' CPUs are updated to meet functional expansion or to take measures against aging in order to improve the functions and reliability.

Step 3: Cubicles or I/O units, requiring no functional changes, are used until their life expires, to reduce migration costs.

This technique smoothes out differences in the physical and functional deterioration rates occurring between devices and maintains the functions and quality in the latest and optimum conditions. Control sections and/or I/O units that have been installed at different times (mixture of new and old devices) can thus be updated at different times, hence delaying the migration of equipment that still has useful life and so reducing total cost. Moreover, because the existing field wiring can be used as is during replacement, there is almost no influence on the plant (operation hindrance) caused by replacement, ensuring very high safety. This is a major benefit of this technique.

CONCLUSION

Sophisticated water supply and sewage services have become commonplace and have entered an era of operation and maintenance control. However, these services are essential lifelines of society and their importance is increasing. For the supervisory control systems at the core of operation and maintenance of these facilities, we are committed to developing systems that meet the diverse, sophisticated market needs as well as maintaining the highest quality and operational efficiency. ◆

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