INTEGRATED CONTROL SYSTEM FOR WATER AND SEWAGE TREATMENT

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1. INTRODUCTION

The mission of water and sewage treatment in the infrastructure of modern living is important and is becoming more important with the expectation of realization of a more pleasant living environment.

Water and sewage treatment facilities are becoming larger in space, time, and scale and their management planing, maintenance management, operation, and other management work is then becoming more complex and advanced. For this background, Fuji Electric has developed an integrated control system that responds widely and with the newest technology to various control work demanded by water and sewage treatment from the standpoint of not only convention process supervision and control but also of the need for a system that contributes more to communication between man and facility, machine, process, and work. An outline of this system is introduced below.

2. PURPOSE AND CORRESPONDING TECHNOLOGY OF INTEGRATED CONTROL SYSTEM

2.1 Purpose of integrated system

Regarding the purpose of integrated control, the water and sewage treatment topics and relationship with system functions are shown in **Fig. 1**.

The results that can be expected by introduction of an integrated control system are:

(1) Improvement of customer service by supplying diverse data quickly
(2) More efficient work by standardization and centralization of data, and advancement of data management
(3) Sound business management and planning based on abundant experimental data
(4) Saving of resources and energy by efficient plant operation
(5) Unmanned operation, man-power saving, and labor saving by automated operation

2.2 Concept of integrated control system

The integrated control system is based on the concept of good communication between man and man, man and machine and machine and machine. Fuji Electric planned coordination of independently designed computer (C), instrumentation (I), and electric (E) systems and developed systems and machines based on a uniform concept and commercialized them as an integrated control system. In recent years, enhancement as an EICM integrated system with a machinery system (M) added as new technology has been planned.

Moreover, wide area network, multimedia communication, OA system, and AI technology are being taken up and

Fig. 1 Water and sewage treatment topics and integrated control system functions and effect

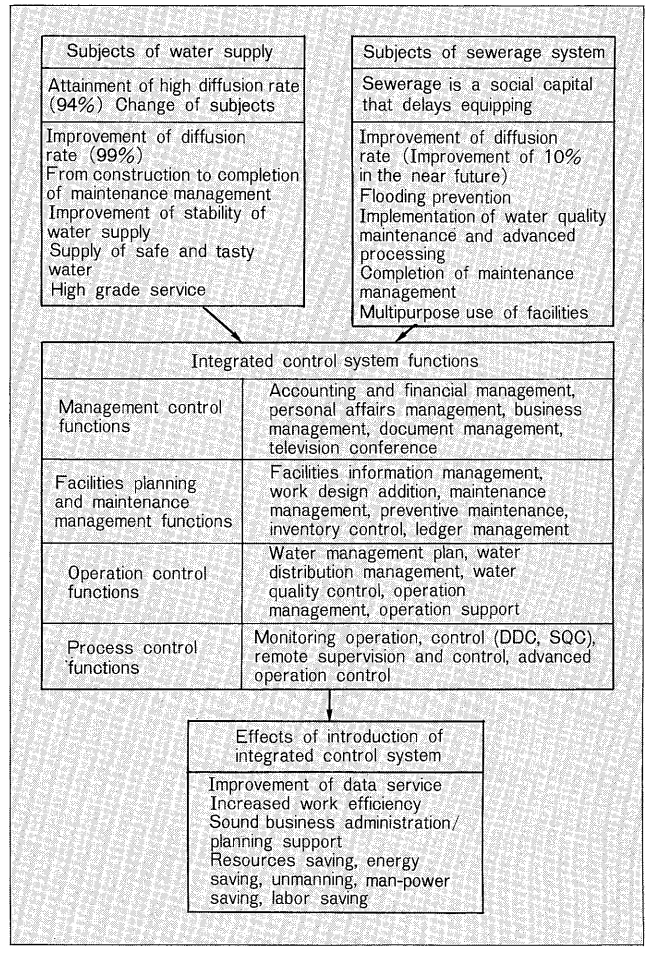


Fig. 2 Hierarchical model of EICM integrated system

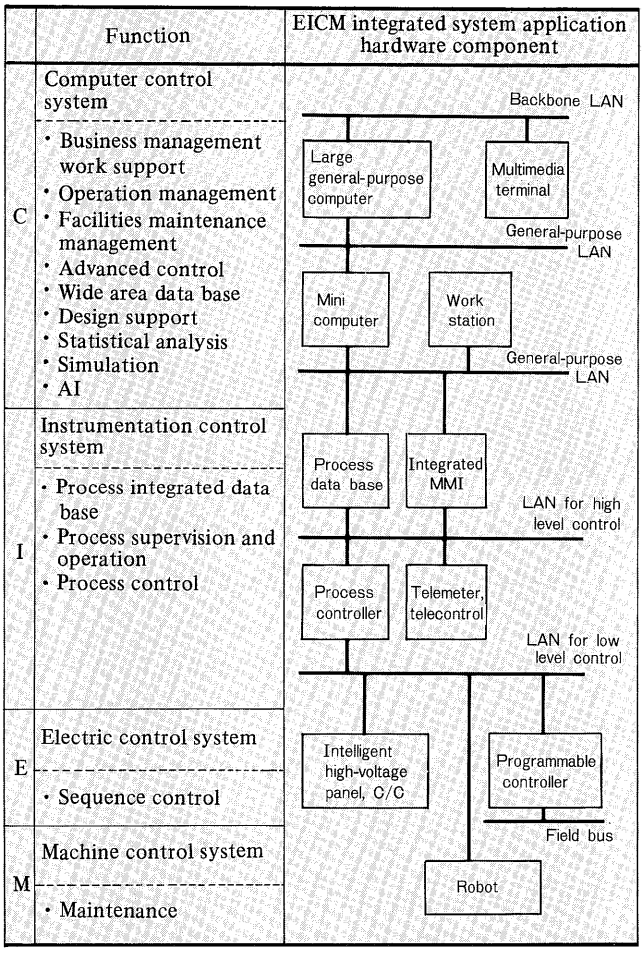


Table 1 Network components

Class	Type of LAN	Application and features
Backbone LAN (wide area, basic LAN)	• Multimedia network (F2890 Series)	• Accommodation of multiple communication line LAN, system LAN • Multimedia integration, including moving image • Large on-site high-speed basic LAN • Duplexed loop • Max. 10km between nodes
Communication LAN	• General-purpose optical dataway (F2880 Series)	• General-purpose interface, including modem interface, provided. Connection of various terminals possible. • Duplexed loop • Max. 3km between nodes
System LAN	• CSMA/CD system LAN (DSLINK)	• Construction of horizontal and vertical distributed system by host cooperation and connection of various terminals • TCP/IP
	• MAP	• Control system LAN corresponding to international standards • Connection of various computer groups and controller groups
	• Intercomputer LAN (FSL)	• High-speed communication between processors
Control LAN	• LAN for high level control (DPCS-F)	• Control system (FAINS) nucleus LAN
	• LAN for low level control (P-link)	• Link for data communication between controllers

( ): Fuji Electric product name

the system is being developed into an advanced information system to cope with the expansion, increased complexity, and increased diversity of water and sewage treatment.

2.3 Integrated control system technology

The system technologies for building an integrated control system are described below.

2.3.1 System subdivision and function distribution

The functions of the system are divided by function level and are given a vertical distribution and horizontal distribution composition that distributes the optimum components corresponding to the function in each level.

A hierarchal model and the components of an integrated control system are shown in **Fig. 2**.

2.3.2 Network

When building a hierarchal, horizontally distributed system, the most important element for each component to display its specified function and performance is the network. The network of the integrated control system is divided into levels. For high level, correspondence with an expandable and advanced information system is taken into account and an open architecture general-purpose LAN is provided and for low level, an LAN for original control stressing performance (especially human communication response speed) is provided and an optimum system for each level is used.

To standardize data access through these LAN, a distributed file system is installed at each component. The network components are shown in **Table 1**.

2.3.3 Human communication interface (HCI)

In the past, different equipment was installed for each E, I, C system and model. However, this is integrated and an optimum system for business is supplied by serializing the components with complete human communication functions installed in high performance hardware for each function and level.

2.3.4 Engineering

An engineering environment that generates the software of each component, including the controller and HCI, at one work station is offered. This allows the user to perform software maintenance (especially addition and correction of specifications such as CRT screen, document format etc.) easily.

2.3.5 High reliability system

High reliability and safety are obtained by using high reliability devices, distributing the functions, and duplexing and other redundancies, as required.

2.3.6 Advanced information system

Today, in the social trend toward realization of the information society, an advanced information system is

Table 2 Advanced information system components

Class		Item	Contents	Related system conponents	Hardware
Common enterprise administration management		Accounting and financial management	• Grasping of budget execution state, financial revenues and expenditures forecast and state grasping (planning of payment plan and accounting revenues and expenditures, management) and computation	• Application package for operation • Library	• General-purpose computer Office computer • Minicomputer • Personal computer • Work station • Various peripheral IO devices • Image transmission equipment • Network
		Personnel management	• Employee financial management, salary computation		
		Office work (business) management	• Water supply charge and collection related work, central meter reading • Water supply ledger management (water supply ledger, water supply house number map)	• Personal computer application library for operation	
		Documents and drawings management	• Electronic filing system for various documents and material	• Automatic translation system • Electronic filing, document input system	
		Television conference	• Distributed remote conference	• Image encoding equipment • Multimedia multiplex transmission equipment	
Design and maintenance management	Sewage treatment facilities	Facilities data management	• Water pipe management diagram, water supply house number map management	• Map information processing system • Water treatment facilities information integration system	
		Work design addition	• Work design, addition work	• Water distribution pipe work design addition system	
		Maintenance management and preventive maintenance	• Water treatment facilities and machinery operating time management, abnormality/ trouble history management	• Maintenance management subsystem	
		Inventory control	• Reserved and spare parts inventory control	• Facilities and machinery inventory control system	
	Water treatment facilities	Facilities information management	• Sewerage ledger management • Flush toilet ledger management	• Sewerage ledger system • Sewerage facilities and machinery ledger system • Flush toilet ledger system	
		Facilities plan	• Sewerage route planning and diffusion rate computation • Long-term sanitary sewage amount forecast • Flooding analysis • Sludge load flow out analysis	• Sewerage piping route planning system • Sewage flow in amount forecasting simulation system • Rain water flow out simulation system • Sludge load flow out analysis system • Plan planning support data base	
		Work design addition	• Piping vertical cross section diagram creation • Cable route design • Work design, addition business	• Piping vertical cross section diagram creation support system • Cable route planning system	
		Work ledger management	• Work ledger management	• Work ledger management system	

considered to have a large effect in performing healthy and more advanced water and sewage treatment operation and business management and improving various services.

Regarding data processing in water and sewage treatment, the creation of a hierarchy by clarifying the position and role of the work and serialization must be planned and unification as an advanced information system is necessary. Fuji Electric offers hardware and software which perform image data, graphic data and picture data processing and advanced decision support and also a network that distributes and shares data base and data processing.

On the other hand, a system including video signals and audio signals is offered as a means of advancing plant operation management. The components related to an advanced information system are shown in **Table 2**.

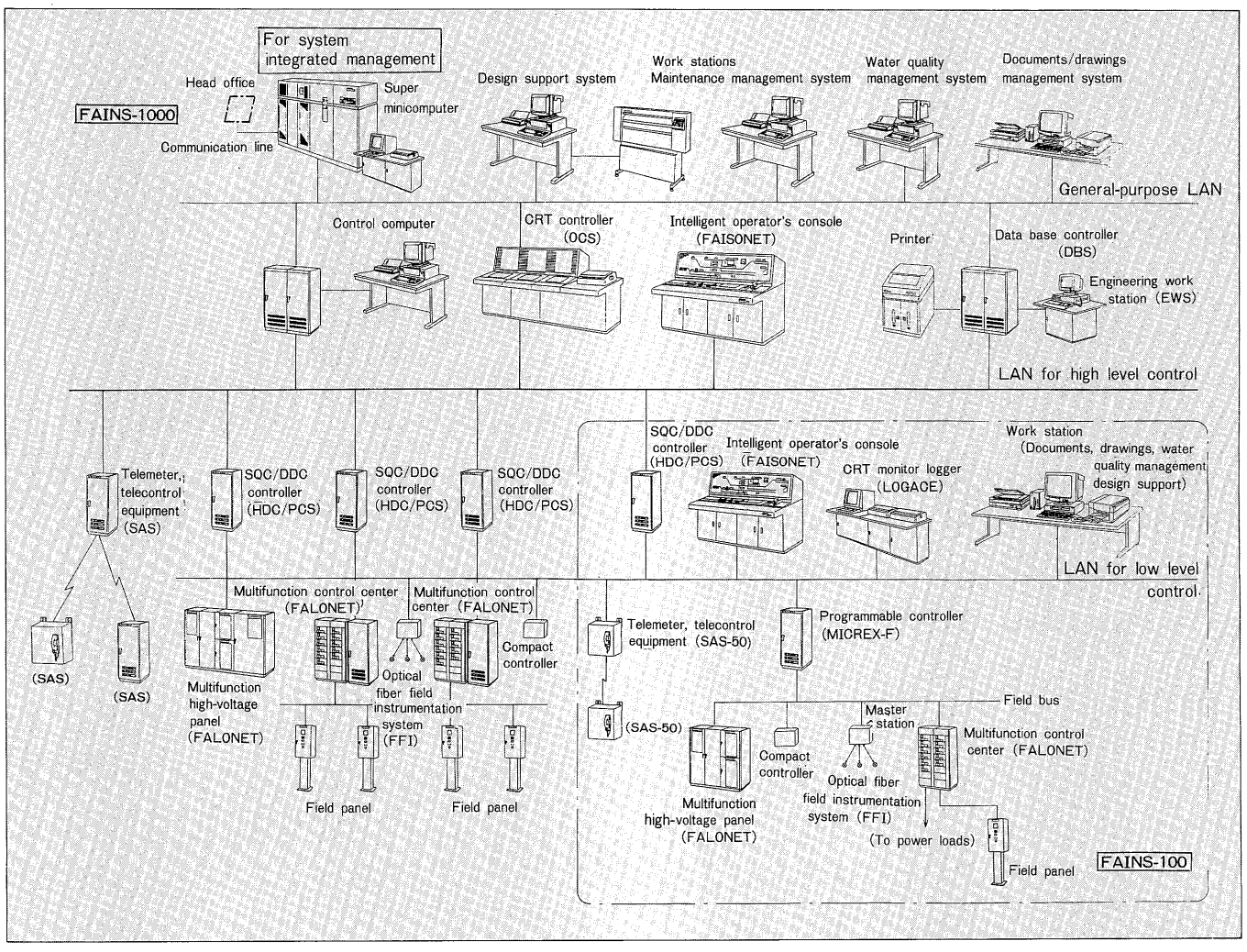
3. EICM INTEGRATED CONTROL SYSTEM (FAINS)

FAINS (Fuji Aqua INformation System) is an EICM integrated control system aimed at water and sewage treatment integrated control. The following two types matched to the scale (control contents, number of control points, control level) of the processing objective have been developed:

Small to medium scale FAINS-100
Medium to large scale FAINS-1000

The system composition is shown in **Fig. 3**. An outline is introduced below.

Fig. 3 FAINS system composition



3.1 FAINS-100

FAINS-100 is positioned as a mini EIC integrated control system and is applicable to supervision and control of small to medium scale water and sewage treatment. For this purpose, operation and maintenance management function in equal quality to that of a large system is necessary. Especially, an economical system with easy maintenance management is desired. On this background, a high costperformance system with a simple composition and standardized functions is realized. Addition of the work station described later and expansion to the FAINS-1000 are also possible.

The main system components are introduced.

(1) Local network system for electric facilities (FALONET)

This system is aimed at power receiving and transformation and power control facilities. Two types are available: multifunction high-voltage panel and multifunction control center.

This system connects the small sequencer (unit controller) provided for each circuit breaker and control center unit by means of a network.

The unit controller performs control, protection and measurement and simultaneously exchanges information with the sequencer controller and a higher level supervisory and control system and allows more detailed data management than in the past.

(2) Optical fiber field instrumentation (FFI)

Instrumentation system that uses intelligent sensors and transfers the measurement signals optically. It is unaffected by lightning and electromagnetic noise and allows remote maintenance.

(3) Intelligent operator's console (FAISONET)

The mini graphic panel and other monitoring and operation desk control circuits are all of electronic technology and display, operation, alarm, and other processings are realized without a relay panel, etc. Signal exchange with other equipment is performed over a transmission line.

(4) CRT monitoring logger (LOGACE)

This is the main HCI equipment of the FAINS-100. It has functions from plant monitoring and operation to recording (operation alarm, daily and monthly reports)

using a CRT unit. A high resolution monitor is used as the CRT monitor.

(5) Controller for operation control (MICREX-F Series)

Besides a programmable controller that realizes various plant automatic and linked control, telemeter and telecontrol equipment (SAS series) that manage distributed pumping stations and water distribution ponds is available as the controller.

3.2 FAINS-1000

FAINS-1000 is a full scale EIC integrated control system. It is suitable for supervision and control of medium to large scale water and sewage treatment. It is a system that completes conventional process supervision and control functions by advanced functions hardware, advanced software, and easy-to-use engineering and has data processing functions, including various operation support.

Besides the equipment described below, the main system components may include the equipment introduced with the FAINS-100.

(1) Integrated HCI (DBS, OCS)

DBS has an integrated process data base function and prints various messages and documents, besides the data acquisition, processing, and storage functions necessary for operation management.

OCS is a special device for CRT monitoring and operation and provides various screens for diverse monitoring. The CRT unit is a high resolution, multicolor (1,120 x 750

Fig. 4 CRT unit (OCS)

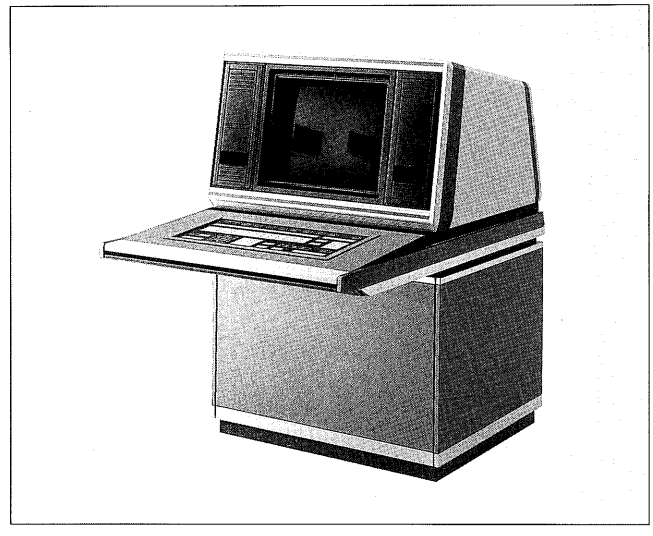
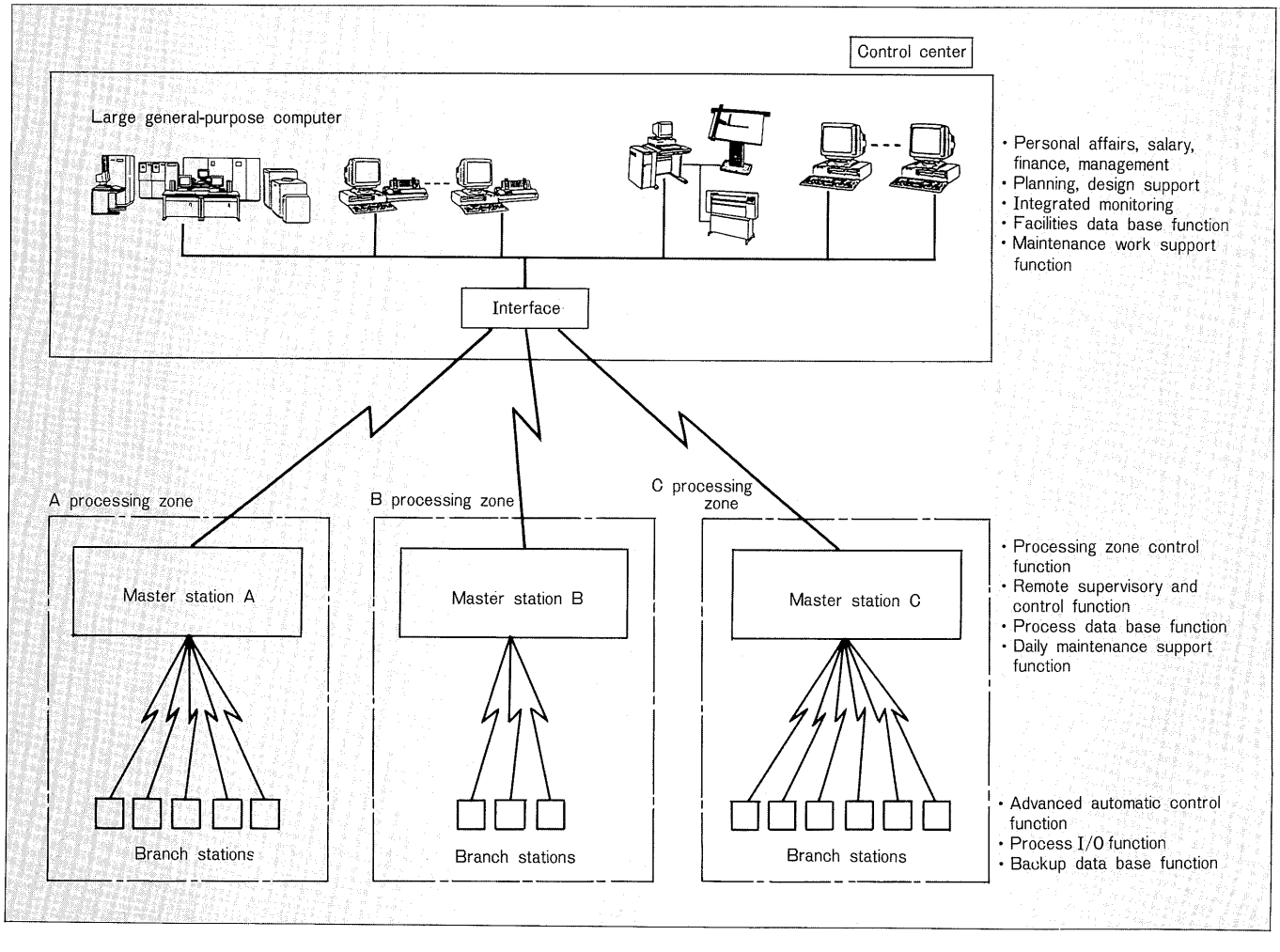


Fig. 5 Wide area advanced information system composition



dots, 16 colors) monitor. A touch screen provides excellent device operation and other monitoring operability. It also has a single window function that allows its use as a man-machine interface for a high level computer and is used as an integrated HCI. The CRT unit is shown in **Fig. 4.**

(2) Computer for operation control (Conpact A)

This computer performs advanced process control operations to realize efficient water and sewage treatment operation. It has a wide range of functions, including forecasting control, such as water distribution forecasting, inflow forecasting, and intake and water distribution operation plan, fuzzy control applied chemical injection, and pump control.

(3) Computer for integrated management (Super A)

This computer performs simulation of water distribution pressure control and rain water flooding and others, and technical calculation for process analysis and statistical analysis, and also various operation support for operation plan, information data management for facilities and quality of water, maintenance management, operation management, etc. Besides an integrated data base of various work stations (WS) used as an HCI, it is integrated with a management control system via a wide area LAN.

(4) SQC/DDC controller (HDC/PCS)

This unit executes sequence control, adjustment control, and other process control.

(5) Work station (WS)

This unit provides water quality data management, pipe network computation, charge computation, pipeline information, design integration, ledger management, and other business support and expert system applied facilities diagnosis and operation support, etc. The necessary online data is fetched via an LAN.

4. ADVANCED INFORMATION SYSTEM

The operation method, purpose, and future trend of the advanced information system are being examined and its introduction is currently being started. It will finally become a wide area public service integrated control system encompassing water and sewage treatment, river, harbor, road, park, weather, pollution monitoring, disaster prevention, etc. under a self-governing body. As a system, it is positioned above the FAINS system.

4.1 Functions of advanced information system

This system consists of administration management, facilities data management, and optimum operation and control subsystems. It is integrated by a system LAN and operates as a distributed data base.

The administration management system is centered about a large general purpose computer and has multiple office computers, work stations, and OA machines as terminals and performs charge computation, inventory control, financial management, ledger control, and other works.

of multiple EWS centered about a minicomputer and connects map and drawings information and facilities equipment information and performs design integration, drawings management, ledger management, and other works.

The optimum operation and control system uses a super-minicomputer or minicomputer and performs demand forecasting, optimum operation control, pipe network analysis, simulation, etc.

4.2 Wide area advanced information system

For integrated control of facilities distributed widely in cities, the system is built by connecting the FAINS system installed at each facility to a large general-purpose computer installed at the center by a wide area multimedia network. Its configuration is shown in **Fig. 5.**

Each facility is divided by function into three levels of control center, master station, and branch stations. The control center is centered about a large general-purpose computer and consists of personal affairs, salary, financial management, planning and design support, and integrated monitoring subsystems connected by a system LAN.

5. CONCLUSION

In the informaion society of the 21st century, the integrated control system for water and sewage treatment will be further developed and practicalized while flexibly coping with changes in the social situation and environment.