Current Distribution Management Systems in Japan

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***Abstract*--This paper presents current distribution management systems (DMSs) in Japan. Distribution management systems have been installed in control centers in order to improve distribution system reliability and effective operation of distribution equipment. Computer systems of DMS moves from concentrated computer systems (CCSs) to distributed computer systems (DCSs) because DCSs have advantages of stable operation by divided functions to computers and easy connections to information systems. This paper presents backgrounds of introduction of DCSs to DMS, software environments, introduction examples, and futures of DMS.**

***Index Terms* -- Distribution Management System, Distributed Computer System**

I. Introduction

Distribution systems becomes larger and more complex by progress of information technologies and urban social functions. It has been about fifteen years since the first introduction of distribution management systems in power utilities in Japan in order to improve distribution system reliability and effective operation of distribution equipment. DMS is a system to monitor and control switches and some substations in distribution systems remotely. DMS was a CCS using a process computer around 1985. However, since 1992, introduction of DCSs began and almost all of DMSs have been based on DCSs since 1995.

Since low cost, downsizing, and high performance UNIX workstations, compared with process computers, were appeared in the markets, a computer system of DMS changed from a CCS to a DCS. Functions of DMS can be divided into two categories. First one includes on-line functions such as monitoring distribution systems and substations, and control of switches at faults. Another one includes off-line functions such as data maintenance of the system and planning of the maintenance scheduling of various equipment. Computational load of a certain function do not bother other functions by dividing all of functions to distributed computers and stable operation of computer systems can be realized.

DCSs for DMS was difficult considering installation place and highly cost so far. However, usage of workstations realized DCSs for DMS, which divided on-line and off-line functions to different computers, and the configuration has been widely utilized in Japan. DMS requires frequent modification of system functions in order to handle various and changing user needs. In such a case, DCSs can limit the modified parts of the system and modification of the system can be realized easier than the CCSs.

Connection with information systems (office computer systems) and data transaction such as information of outage management, which are required for effective operation of the system, can be realized easily by the DCSs, which have a standard interface.

Reliable DCSs can be realized by various ways. Dual computer system configuration can be utilized especially for on-line functions, which require high reliability. When electric power is supplied from uninterruptible power supply (UPS), a degenerated operation can be realized only for on-line functions. Namely, various reliable systems can be configured considering economical efficiency.

II. Distributed Environment of Software for Distributed Computer Systems

A. Application Software

Introduction of EWS makes it possible to develop DCS reasonably and distributed environment of software has been developed. When using the software environment for CCSs in order to develop DCSs, a program of a certain function has to consider other computers in which other programs and DBs are installed. Therefore, more complicated software management should be necessary compared with designing CCSs.

Application software should be developed using international standards and defact standard platforms to realize effective development of the software in DCSs. Thus, portability is realized in development of DCSs. Moreover, DMS can handle frequent upgrade of hardware and operating systems if DMS is developed by DCSs considering portability. This feature realizes improvement of system performance economically, and usage of the application software, which is actually utilized for operation, makes reliable operation of the whole system.

B. Distributed Middleware and Data Base

The authors have developed distributed middleware for managing application programs and distributed databases

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(DBs) for DMS and have applied the middleware and DBs to develop DMS with DCSs.

Application software under the middleware has a capsule configuration, which is independent from other programs. The programs can access other programs through the middleware (see fig.1). Therefore, each program does not have to consider in which computer other programs are installed and flexible configuration of application programs in DCSs can be realized. Moreover, application programs can be easily replaced after starting operation considering actual computer loads. Even if application programs are replaced, it does not affect other programs.

The same distributed management can be utilized for DB. Each program does not have to consider in which computer each DB is installed. Each distributed DB can be easily replaced to other computers after starting operation considering actual computer loads (see fig.2).

Trouble locations of the system can be minimized using the distributed middleware. For example, when a receiving end EWS halts abruptly just after a sending end EWS requests a certain process to the receiving end EWS, the sending end EWS will wait reply from the receiving end EWS and the system is usually locked. It is difficult to handle this kind of situations easily and complicated process management should be developed. On the contrary, the distributed middleware can identify the trouble and can report the trouble to the sending end EWS. Therefore, the middleware can avoid that the sending end EWS is locked and a trouble of an EWS never affect other EWSs.

When a double computer system is developed in DCS, application programs do not have worry about management of the double computer system by using the distributed middleware for management of the double computer system. Application programs on a double computer system do not have to consider various situations including troubles of another computer and take-over of the processes and sharing DB. Each application program can be operated just like it is installed on one computer system by integrating the management layer of the double computer system under the middleware (see fig.3).

III. Application of DCS to DMS

A system configuration example of distributed DMS with above-mentioned distributed software environment is shown in fig. 4. Table 1 shows functions of the distributed DMS.

The system has several local area networks, which are for each function. Each equipment is connected through the LAN (Ethernet: TCP/IP). Substations and switches in the distribution lines are monitored and controlled through telecontroller on the (on-line) control console. Network data are maintained on the off-line console. Since the LAN configuration can be composed of control, planning, and I/Os, traffic loads of the networks can be reduced and process of a certain function does not affect other processes.

IV. DMS in the Future

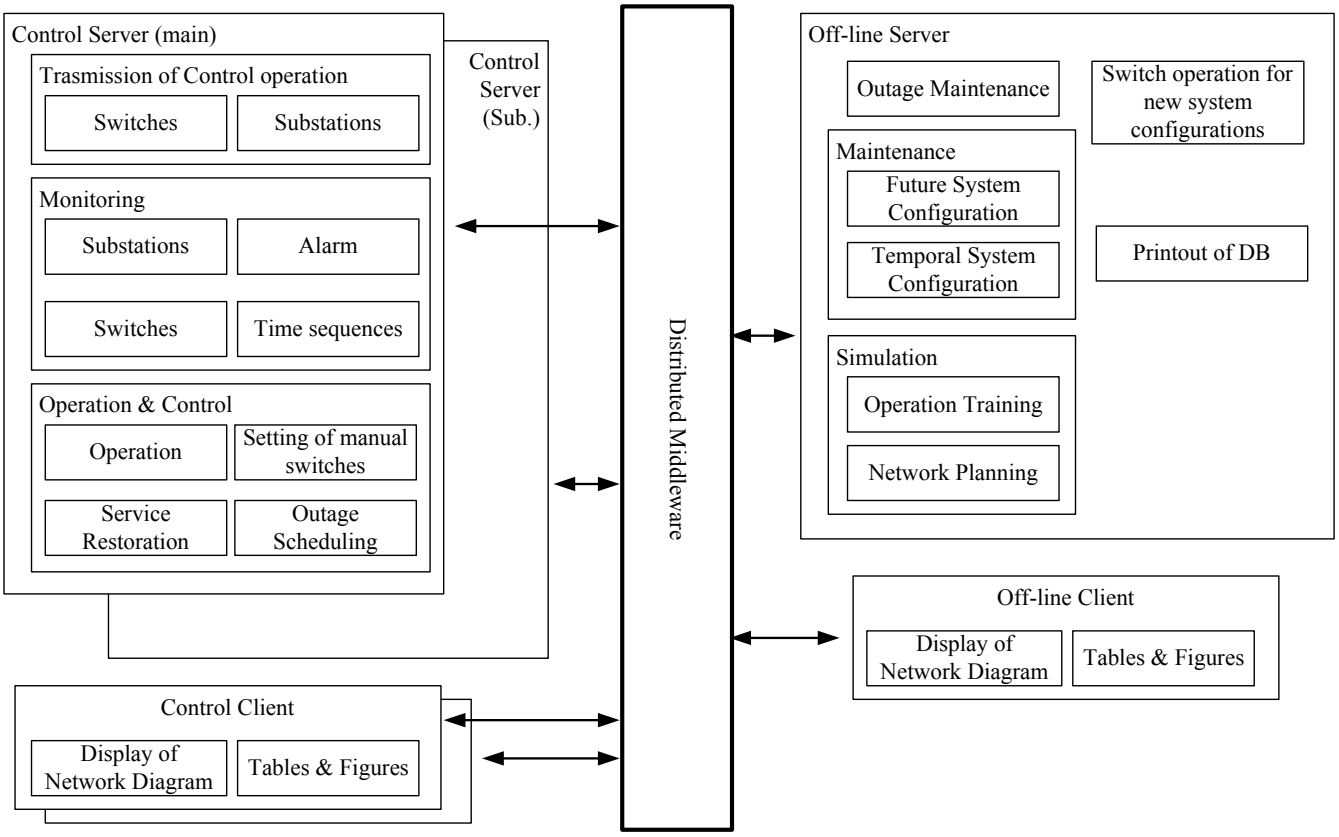

Fig. 1 An application software configuration for distributed DMS.

Almost all of current DMSs in Japan utilize flexible DCS environments. However, they utilize own platforms and DBs. Therefore, open DCS with open platform and DB is eagerly awaited in order to realize improvement of development efficiency, multi vendor development, and efficient connection with other systems. This concept is currently under development in IEC TC57 [1].

Current needs for DMS in Japan can be listed below:

(1) Mutual automatic service restoration from several distribution control centers at faults, which occur at boundaries of managing areas of the distribution control centers,

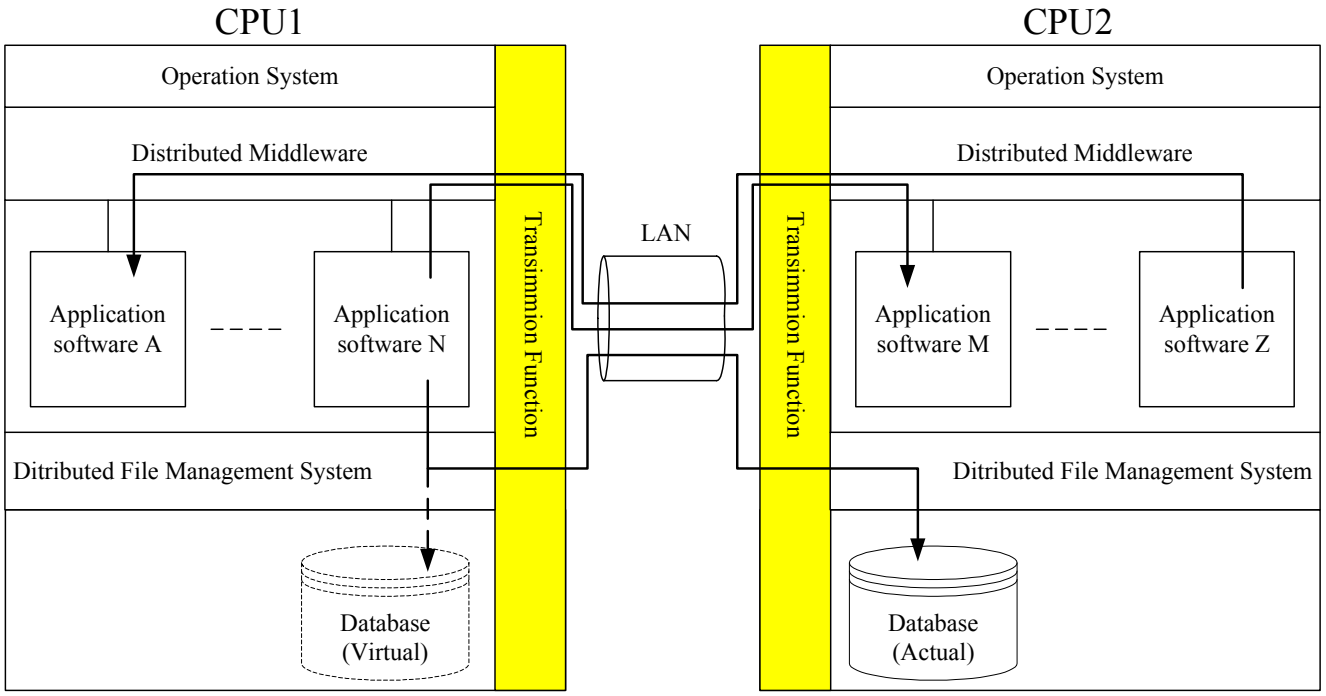

Fig. 2 Distributed middleware and distributed file management system.

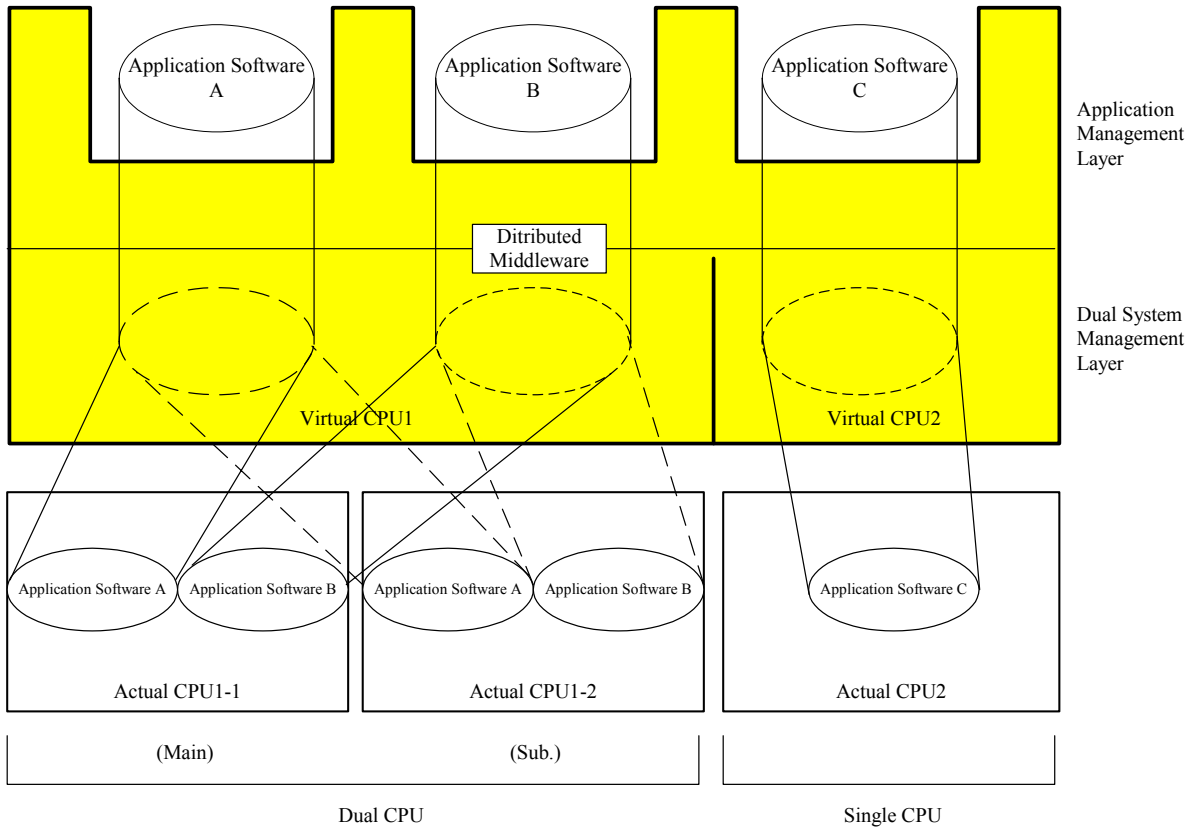

Fig. 3 Concept of dual system management by distributed middleware.

(2) Realization of automatic service restoration at faults, which occur at a wide area including managing areas of several distribution control centers,
(3) Realization of unmanned control center, especially for small control centers during nighttime and holidays.

TABLE I
SYSTEM FUNCTIONS.

Function	Summary of function
Monitoring	Constantly monitor the current status (switch ON/OFF, section energize/de-energize, etc)
Service Restoration	Automatically generate and execute switching procedures at feeder and S/S faults.
Overload Monitoring	Detect overloads by constantly monitoring the feeder current, generate and execute overload recovery switching procedures automatically
Manual Setting	Manual setting of the status of manual switches, and setting of mode, prohibited operation, etc.
Load Management Calculation	Prepare load curves, calculate section loads, and optimize the system switching procedures based on the voltage drop calculation
Record and report generation	Generate and print status change, operation record, fault report, etc.
Maintenance Processing	Facility data (switch, line, etc) and data maintenance on the screen
Network Diagram Display	Feeder skeleton and S/S skeleton display.

In order to solve the requirement, share of facility management information among several distribution control centers is necessary. Moreover, system platform should be realized by defact and international standards, open and general architecture, and easy and timely connection among DCSs (See fig. 5).

Total management of several distribution control centers can be realized by development of widely distributed DMS with general-purpose open DBs. The whole of the target distribution system can be recognized openly. Seamless operation of distribution systems without considering the border of the management area of each distribution control center such as service restoration using the whole target distribution system can be realized using the system.

Moreover, various functions of DMS can be formulated as optimization problems. Various operational constraints must be considered in distribution systems and modern heuristic techniques are suitable to handle the constraints considering the installation of distributed generators [2]. Application of the techniques to various DMS functions such as state estimation is eagerly awaited [3].

V. CONCLUSIONS

This paper summarizes the current distribution management system (DMS) in Japan. Almost all of current DMSs in Japan utilize flexible distributed computer system (DCS) environments with distributed middleware. The distributed environment realizes flexible and reliable operation and planning of distribution systems.

Current DMS utilizes own platforms and DB. Therefore, open DCS with open platform and DB is eagerly awaited in order to realize improvement of development efficiency, multi vendor development, and efficient connection with other systems.

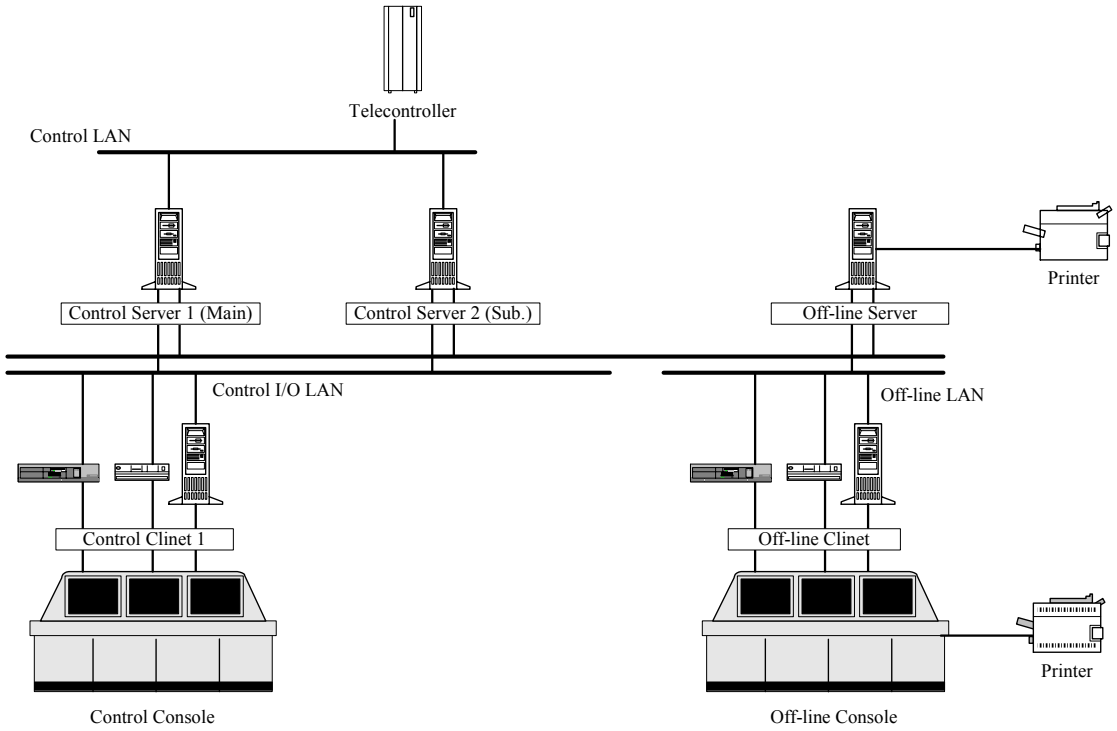

Fig. 4 A system configuration of distributed DMS.

Moreover, various functions of DMS can be formulated as optimization problems. Various operational constraints must be considered in distribution systems and modern heuristic techniques are suitable to handle the constraints considering the installation of distributed generators. In order to handle the situations, application of the techniques to various DMS functions such as state estimation is eagerly awaited.

VI. References

[1] http://standards.ces.com/iec/index.html

[2] Y. Fukuyama, et al., *Text on tutorial of Modern heuristic techniques with application to power systems*, IEEE PES Winter Power Meeting 2002.

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VII. Biographies

Kazuhiro Oohashi graduated Ikutoku technical college in 1972, Kanagawa, Japan. He has been working at Fuji Electric Co., Japan from 1972. His has been developing distribution management and automation systems. He is currently a general manger of power systems solution dept. II in power systems control & energy management division. He is a member of IEE of Japan.

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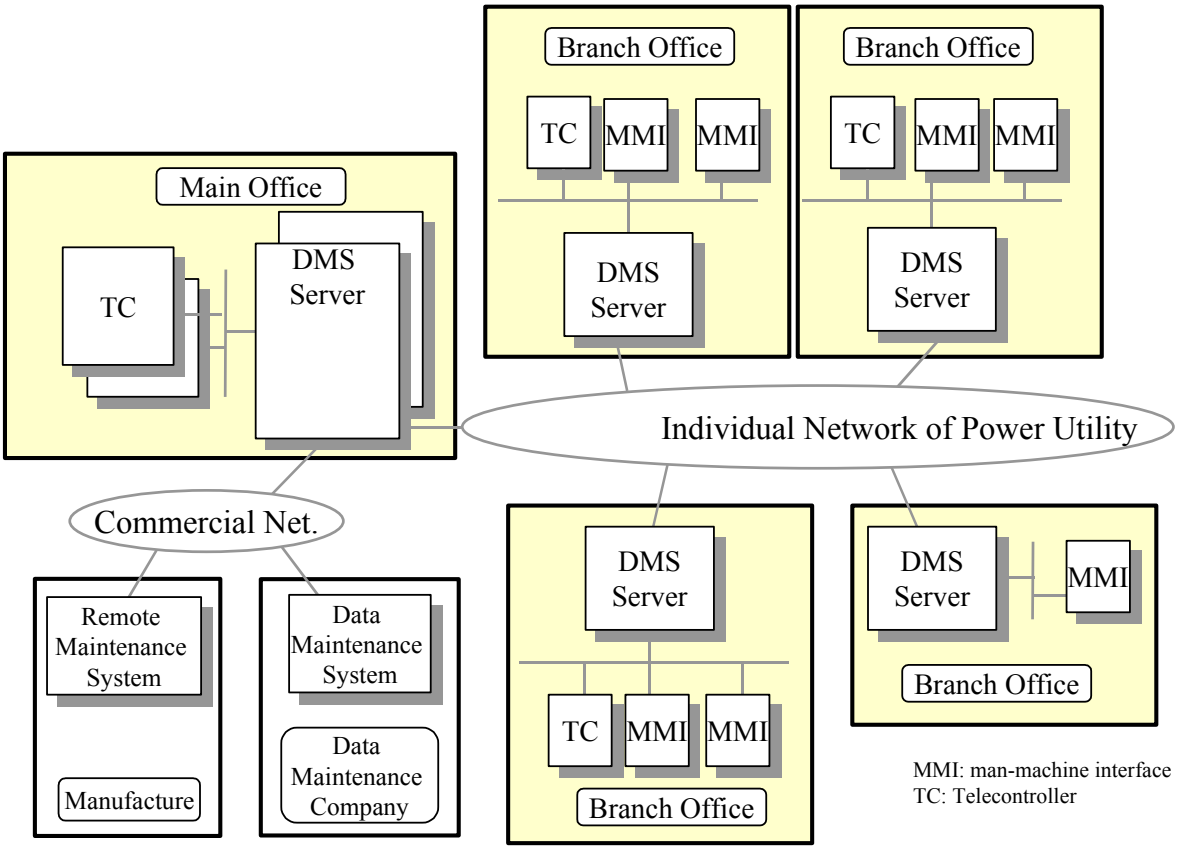

Fig. 5 Concept of a widely Distributed DMS.