Total Optimization with Synergy Solutions between Information and Control for Utility Industries

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OVERVIEW: Improvements to the operational efficiency of electric power companies have hitherto been made within individual control centers and departments. To achieve further reductions in electric power transmission costs, it will become necessary to use IT (information technology) to link these control centers and departments together. For this purpose, Hitachi proposes total optimization with synergy solutions between information and control. It consists of (1) linking these systems together by standardizing their database architectures, and (2) establishing real-time information links between different network operation support systems. With the addition of links to accounting and resource purchase systems, these solutions will provide valuable support for total optimization in electric power companies.

INTRODUCTION

JAPAN'S electric power companies need to improve the efficiency of their operations due to trends in the deregulation of the electric power industry in Japan and reduction of electric price disparity in other countries.

An essential requirement for making these improvements with regard to network operation is to integrate SCADA (supervisory control and data acquisition) systems, planning support systems and other network support systems that have hitherto been designed and operated individually. This will make it possible to construct flexible information links whereby information can be provided to and shared among all the related departments. Information sharing is of fundamental importance to the electric power industry, and will be achieved through the application of IT, which is continuing to develop rapidly.

Here, we discuss the database architecture of SCADA systems for power systems that are constructed both hierarchically and regionally, and an example of information link structures for these systems that can be achieved by standardizing their API (application program interface). We also describe how flexible and efficient data linkage can be achieved between multiple network operation support systems in the network operation department (see Fig. 1).

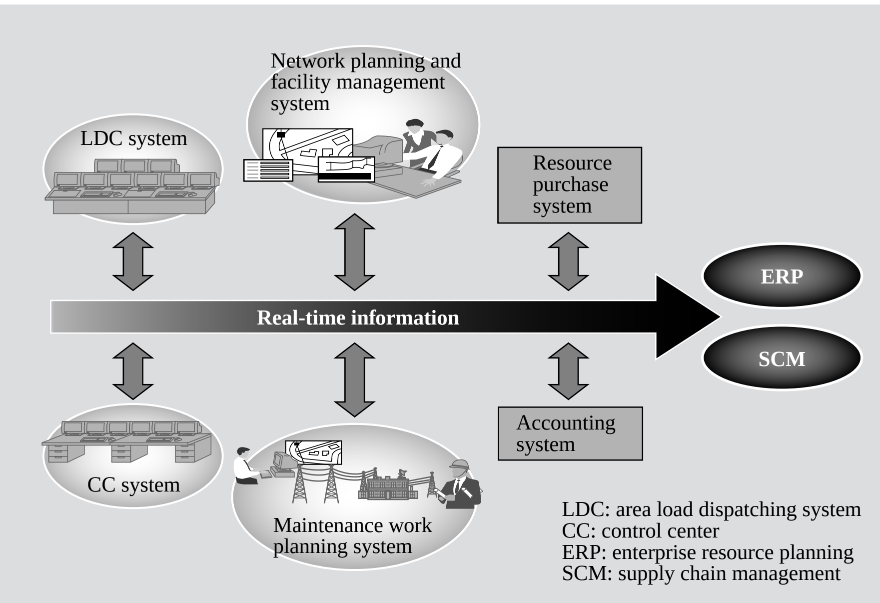

Fig. 1—Total Optimization with Synergy Solutions between Information and Control.
To exploit the benefits of real-time information links, Hitachi proposes a solution involving links between computer systems, between network operation support systems, and between resource purchase systems and accounting systems. This solution ties in with business support techniques such as ERP and ECM.

INFORMATION LINKS BETWEEN SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEMS

SCADA systems of electric power systems are hierarchically categorized into CLDC (central load dispatching center) system, LDC (area load dispatching center) systems and CC (control center) systems based on differences in their scope of operations such as providing instructions or controlling facilities.

Although data integration is achieved by communication between computers in these systems, the scope of this linkage has been somewhat limited. This is due to disparities in the application programs and software, and differences in the hardware, OS (operating system), and platforms. Furthermore, in order to increase the degree of information linkage, the only option has been to rely on means of communication such as phones and fax machines.

To resolve these problems, the Kansai Electric Power Co., Inc. has been working since 1997 in two areas:

(1) standardization of the database architecture in LDC systems and CC, and

(2) standardization of an API that defines a platform that is independent of hardware and operating systems.

Fig. 2 shows the Osaka-Kita area load dispatching center and the Furukawabashi control center system, which conform to the standardized database architecture and API. In this example, the LDC system and the CC system have the same database architecture, and are developed so that any kind of real-time information can be linked immediately by the same procedure.

Information on the switching of circuit breakers and various kinds of analog information are sent to the CC system via remote terminal units situated at substations, and is stored in the real-time database. This information is then sent via a linkage server to the real-time database in the LDC system, where the data is instantly updated. Similarly, the data is kept consistent by immediately transmitting the processing results of the LDC system to the CC system.

With this real-time database linkage, all the systems share the same information and processing results irrespective of where the data was received or where it was processed. A linkage interface has also been established between the functions in these systems, thereby allowing a system to execute functions in other systems and obtain the results produced by these functions.

These real-time links between databases and between functions, not only allow an operator at the LDC to ascertain the operational status of the CC system directly via a console, but they also allow this operator to issue any instructions which are usually performed at the CC.

In this way, the operational efficiency of the LDC

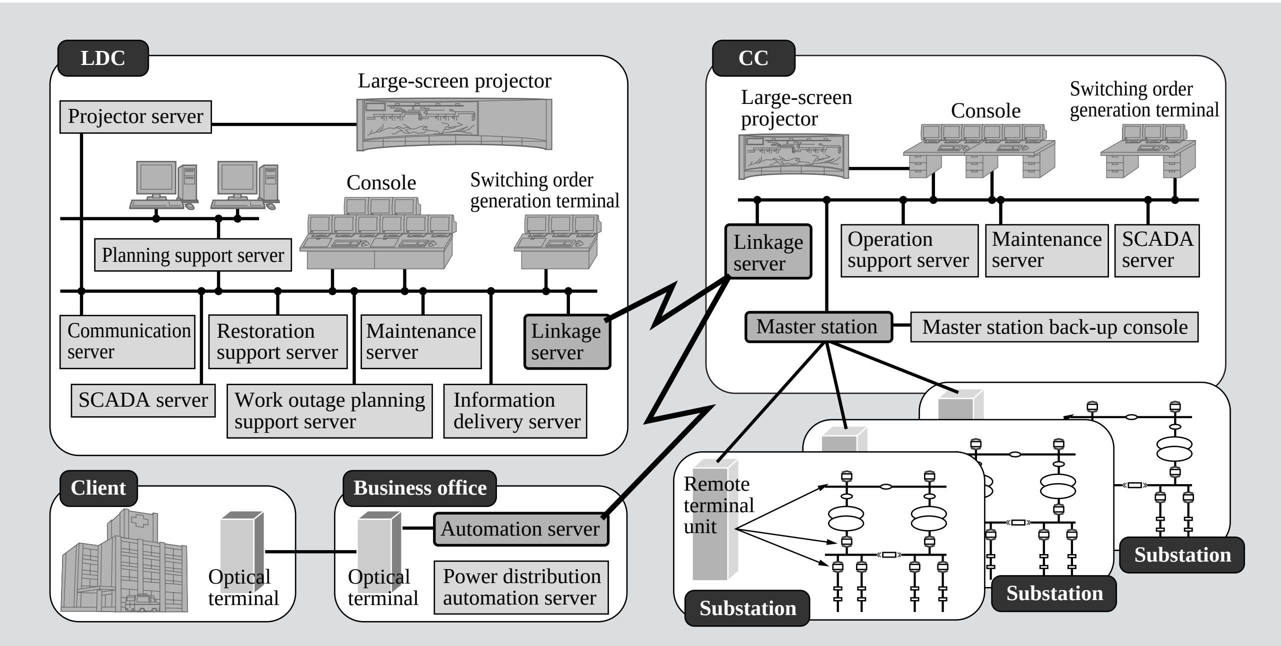

Fig. 2—Example of Information Linkage among SCADA Systems.
Links are established between the LDC and CC systems by standardizing their databases and API.

has been improved by bringing together instructions/ control operations associated with command and control which have hitherto been performed by separate systems. It has also become possible to automate processes such as large-scale network operations that affect multiple CCs. Furthermore, the real-time database linkage and the linkage interfaces between functions make it possible for the CC to commit the LDC functions (LDC back-up) when the LDC is involved in an emergency situation such as an earthquake.

INFORMATION LINKAGE BETWEEN NETWORK OPERATION SUPPORT SYSTEMS

A variety of systems that support the network operation business are provided around the SCADA system. Examples of these systems include network planning systems, maintenance scheduling systems, network analysis systems, facility management systems, and work planning systems.

The real-time sharing of information and the sharing of processing results, which are afforded by the information linkage of these support systems and SCADA systems, are indispensable for improving work efficiency and supporting management decisions. In other words, this real-time data is very useful for the efficient and appropriate implementation of network expansion plans, maintenance work, etc.

Information Linkage Problems

As in the above example of a SCADA system, the system should ideally be rebuilt by standardizing all the integrated database architectures common to all the systems.

However, since each system has a vast amount of software specified by its own background and conditions, it would be impractical to rebuild all the systems simultaneously. We therefore propose the following procedure.

Data Linkage Procedure

(1) Standardization of data items

The various databases do not have a common structure that could be directly integrated across all support systems since they need to be configured according to the nature of each support system. However, it is essential to provide some means whereby the data items and values can be recognized by all the systems. For example, if a network analysis system needs to know the impedance of a particular transformer, then the facility management system should be able to find out what the network analysis system wants and send the requested information to it in a form that it is able to understand.

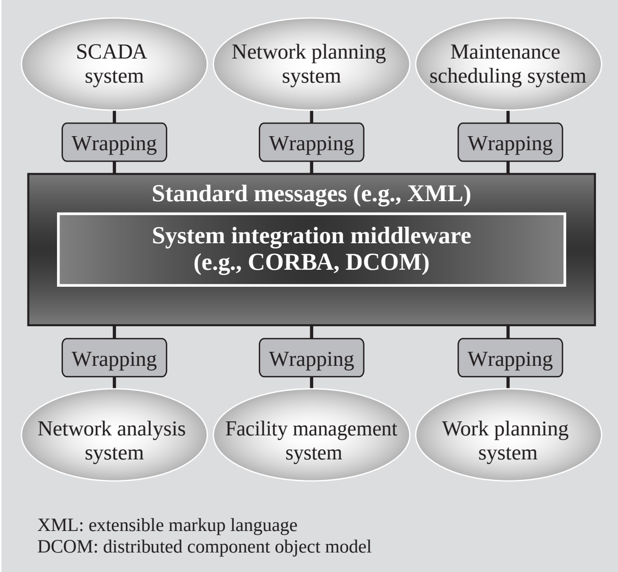

Fig. 3—The Concept of Linkage between Network Operation Support Systems.
Real-time data links between different support systems are established by using system integration middleware with standard messages and wrapping functions.

(2) Wrapping

When constructing an information linkage system, it is important to minimize the disruption by rewriting the existing programs of each system as little as possible. It is therefore necessary to use a so-called wrapping function which translates standardized data items into items that are intelligible to the existing system, and vice versa. This facilitates information linking with other systems while minimizing the effects on existing programs.

(3) Standardization of messages

Integration between systems can be achieved by using middleware such as CORBA* (common object request broker architecture) and DCOM. These are determined according to the OS and hardware of each individual system.

It is also essential to standardize the messages sent by such middleware. For example, the messages themselves should be converted into a standard readable form such as XML. XML is rapidly growing in popularity as a tool for the exchange of complex business data and for EC (electronic commerce).

*: CORBA is a trademark or registered trademark of the Object Management Group, Inc. in the U.S. and other countries.

As mentioned above, since the real-time databases have already been standardized, the real-time data can be linked to the network operation support systems by a unique interface. The above concept is illustrated in Fig. 3.

The Advantages of Information Linkage

Examples of the efficiencies and rationalizations that can be achieved using real-time information are discussed as follows:

(1) Improved accuracy of power transmission limitation values of facilities

Facility limitation values, such as the maximum power flow of transmission lines, have hitherto been determined based on the network condition during times of peak electricity demand. However, these limitation values leave appreciable margins at other times, and in practice it is possible that even greater power flows can be achieved under different conditions. Using real-time information, the facility limitation values can be set to suitable values that are appropriate for the current network condition.

This implementation of information linkage leads to achieve efficiencies and rationalizations in system operation costs, such as adjustment of the generator output performed in order to preserve the facility limitation values.

(2) Network expansion/maintenance

The availability of real-time information also allows the expansion and maintenance of power transmission facilities to be performed in a timely fashion as follows:

(a) The future trends of parameters such as load factors can be predicted based on actual load factor data gathered from each facility, suggesting additional facilities to be built in time to meet the growth in load demand.

(b) By logging the operational status of each facility, periodic maintenance can be scheduled at suitable intervals according to the operational history.

(c) The replacement of facilities can also be appropriately scheduled based on data such as the operational history of each facility and the secular changes in its operating conditions.

CONCLUSIONS

In this paper, we have described total optimization with synergy solutions aimed at increasing the operational efficiency of facilities run by electric power companies by reducing their power transmission costs. Specifically, we have discussed Hitachi's proposals for integrating systems through the use of a standardized database architecture and links between network operations support systems and real-time data in order to increase the efficiency of facility operations such as the planning and maintenance of power transmission networks.

In the future, these links between SCADA systems and between support systems will continue to be strengthened, while becoming more closely connected with business management data. It therefore seems likely that these linkages will become essential resources for supporting management of electric power industries, and that their use will become increasingly widespread.

REFERENCE

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