Application of New Framework in Computer Systems for Steel Industry

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1. Introduction

Computer systems (process computers) have been used in the steel industry for several decades and were originally installed at only the most important facilities, but with advances in technology, have come to be installed at nearly all facilities, and contribute to achieving safer operation and improved quality.

With the recent rapid expansion of networks and the trend toward open systems, the framework with which computers are configured has undergone significant changes. Computer systems consist of hardware, an operating system (OS), middleware and applications, and the hardware and OS have changed from manufacturer-proprietary to general-purpose formats.

Recently, new frameworks that incorporate general-purpose middleware are being configured instead of the unique middleware of each manufacturer.

Furthermore, due to quality and traceability considerations, MES (manufacturing execution system) related packages which have previously been applied to the food, chemical, and assembly and processing fields, are also progressing toward application to the steel industry.

This paper describes the application of a new framework and package to computer systems in the steel industry.

2. Challenges for Computer Systems in the Steel Industry

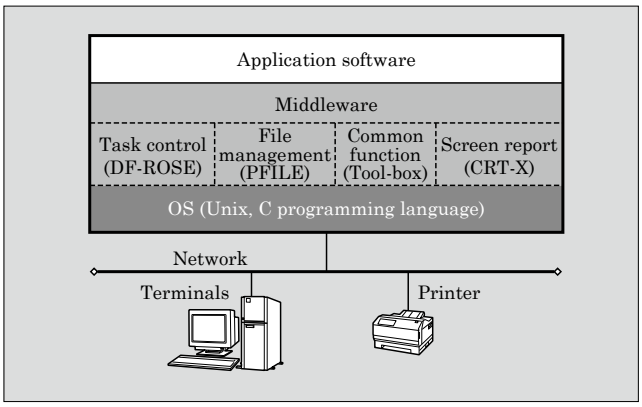
For computer systems in the steel industry, the C programming language has conventionally been used for application development, with each application being configured so that a facility can be optimally managed and controlled.

In order to configure these applications efficiently and to maintain good quality, middleware, such as shown in Fig. 1, is used as the framework. Systems using this framework differ for each manufacturer and have not sufficiently adopted open standards, and consequently face the following types of challenges.

(1) Since equipment models change when a system is replaced, the display screen and the like must be reconfigured, requiring extra labor. Furthermore, if basic components of the system are different, the compatibility between the old and new applications will be poor, and additional labor will be required.

(2) When making modifications, since the applications are highly interdependent, components that remain unchanged must also be checked as to whether they will be affected by the modification.

Fig.1 Configuration of a conventional framework



To overcome these challenges, a new framework, package and interface such as described below have been introduced, and optimal combinations according to the system characteristics are being proposed and constructed.

(a) Application of a framework for web-based system use
(b) Application of an equipment framework
(c) Application of a package for MES use
(d) Application of a standard interface

3. Framework for Web-based System Use

3.1 Overview

In the information processing field, due to the rapid expansion of networks, system formats are migrating to web-based systems. So that these sorts of web-based systems can be developed efficiently, Fuji Electric has developed and is supplying the "Web@Attach" framework product.

3.2 Features

(1) Utilization of integrated development environment (IDE)

Utilizing the IDE based on JSF (Java server faces), onscreen development for application screens is possible by dragging and dropping components.

(2) Provision of multifunction screen components

An abundance of components are provided for web design, thereby increasing the efficiency of software development.

(3) Provision of lightweight DI (dependency injection) container

Web@Attach provides DI container functionality. By defining application specifications with XML (extensible markup language) files, development can be performed while removing the dependency among applications.

(4) Provision of O/R (object/RDB) mapping tool

To improve the efficiency of creating the database access area, an O/R mapping tool is utilized to enable data access without the use of SQL (structured query language).

Specifically, a function is provided that automatically generates a data access object (DAO) and mapping class from the database definition.

(5) Support of multiple platforms

As the application server, multiple platforms such as Windows*1, Solaris*2, Linux*3 and the like are supported.

3.3 Effect of the framework application

(1) Improved quality and development efficiency

In order to improve quality assurance during system development, software for which quality has been verified is used as much as possible, and the amount of application software created is minimized. In looking at examples of web-based system development, 70% of the cases are for standard screen development such as menu, list, simple database reference, and data input. Web@Attach focuses on this area, and through source code generation, auto creation and component utilization, helps reduce the amount of the manually generated source code and achieve higher quality and developmental efficiency than in the past.

(2) Improved maintainability

During operation, system maintenance, particularly the modification and amending of applications, is an extremely important issue for system maintenance personnel. In particular, modification and amending are extremely difficult when complex interrelationships exist between applications. With Web@Attach, as a result of DI containers based on an interface definition in XML, the dependency among applications is eliminated and programs are easy to maintain.

*1: Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

*2: Solaris is a registered trademark of Sun Microsystems, Inc. in the United States and other countries.

*3: Linux is the registered trademark of Linus Torvalds in the United States and other countries.

4. Equipment Framework

For monitoring and controlling equipment in the steel industry, systems that incorporate object-oriented design as the method for application design are being constructed in order to improve system reusability and the ease of modification work. The challenges for applying object-oriented design and an equipment framework for the development support environment are described below.

4.1 Object-oriented design

Object-oriented design has the following advantages compared to the conventional system design method using the C programming language.

(1) By converting work content into objects, a 1:1 correspondence between the work and software is established, enabling improvements, additions and modifications to be implemented easily.

(2) Creating hierarchical layers for each function according to its role and standardizing the structures, as below, in order to increase the independence of each function and to improve visibility enables system improvements, additions and modifications to be implemented easily (see Fig. 2).

(a) Scenario layer

Describes the flow of each transaction, and improves the visibility of all functions

(b) Business logic layer

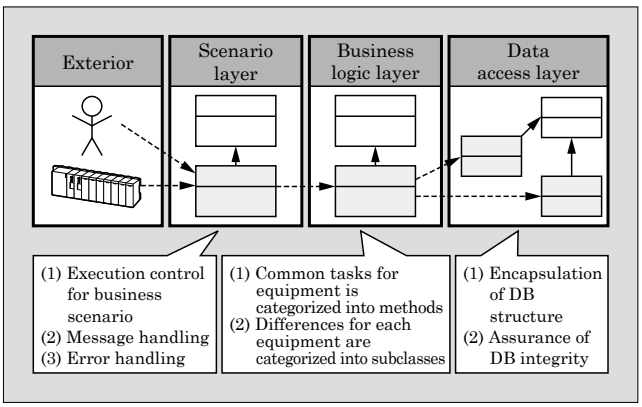
Achieves processing independency by describing the logic portion of each transaction

(c) Data access layer

Describes the access area of the database, so that database corrections during additions and modifications are implemented easily

(3) Dividing work content into common and unique components for equipment and converting them into objects increases their reusability with other

Fig.2 Example of hierarchy due to object-oriented design



equipment, enabling improved reliability and lower total cost.

4.2 Challenges in system construction with object-oriented design

Systems developed by object-oriented design have the above-described advantages throughout the entire system lifecycle. However, these systems have only just begun to be used in the steel industry and face the following challenges since existing assets are fewer than in a conventional system.

(1) With object-oriented design, application functions are designed by categorizing functions into hierarchical layers according to their role, and standardizing the structures, but in actuality, since a management function for creating this configuration was built into each system there were problems in terms of development efficiency and quality.

(2) Computer systems in the steel industry communicate with the host and other process computers, and with lower level electrical instrumentation systems, but support for this function is provided for each system, and there were problems in terms of development efficiency and quality.

(3) The message and log management and development tools for supporting application program development were insufficient.

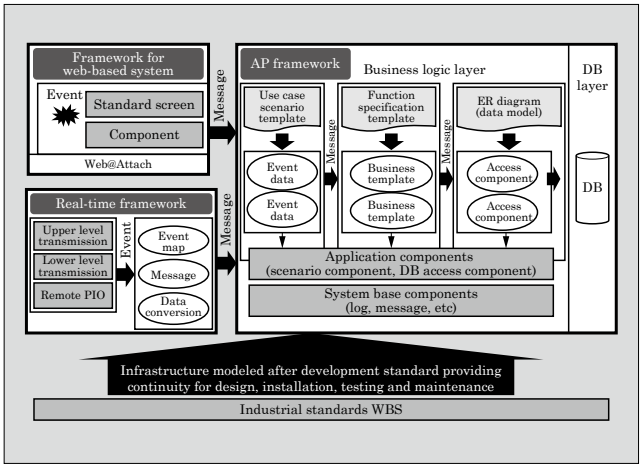
To overcome these challenges, in addition to Web@Attach, the framework mainly used for developing the above-mentioned screens, Fuji developed and is supplying an equipment framework for efficiently developing internal processing that is separate from the screen development.

4.3 Configuration of the equipment framework

Figure 3 shows the overall structure of the equipment framework that enables the efficient development of an object-oriented system. This framework has the following support functions for facilitating the construction of a system.

(1) Application (AP) framework

Fig. 3 Configuration of equipment framework



The AP framework is equipped with a management function for providing applications with a hierarchical structure as shown in Fig. 2. When creating an application, a mechanism for system construction is established by setting up the necessary logic descriptions for functions and a table describing the associations among functions.

Moreover, the AP framework also has a message management function that centrally manages error information and message information generated by the system, and notifies the operator of the operating status, the occurrence of failures and so on.

Also provided is a log management function that performs application operation traces and outputs the state when a failure occurs, and is used for application debugging during development and for quickly resolving problems.

(2) Real-time framework

A network communications-use prototype TCP/IP socket communication driver has been prepared to enable communications with other systems and electrical instrumentation systems. Moreover, functions for converting the coding of messages to be transmitted and for distributing to an application can be implemented with table definitions. A communications trace function for transmission data and a simulated message receiving function are also provided.

(3) Framework for web-based system

The Web@Attach framework is utilized to develop efficiently the above-described web screens.

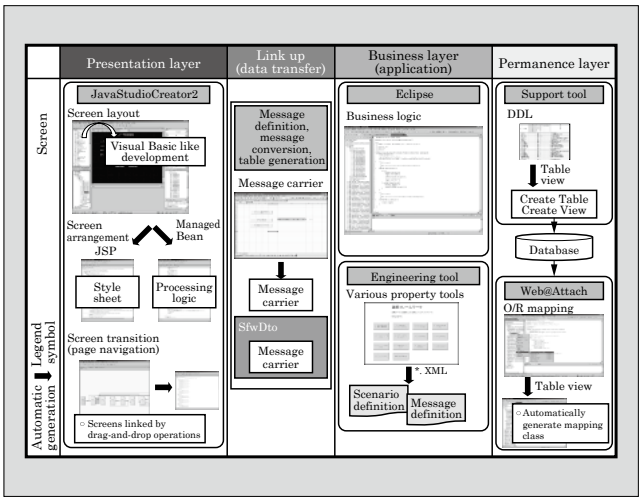
(4) Development support tools

To make system development more efficient, various required tools are provided as listed below.

(a) Message definition, conversion table creation tool

This tools links messages, which are to be transmitted to and received from other systems, and applications. The required processes can be generated automatically by inputting, in tabular format, the definition of each message and the data conversion

Fig. 4 Development support tools for equipment framework



format.

(b) Various property tools

These tools define the relationship of each process when hierarchical layers are set for an application. Relational definitions can be set by sampling defining a table.

Figure 4 shows the overall configuration of development support tools.

4.4 Applying effect

Use of the equipment framework enables a high-quality environment for constructing applications to be prepared in advance. As a result, system designers can concentrate on the object-orientated design of the application, allowing a system having better maintainability and reusability to be constructed.

Moreover, since the system is constructed using the Java programming language, even if the hardware and the OS environment are changed at the time of the next system replacing, the applications can be made compatible with minimal modifications, and the replacing cost can be minimized.

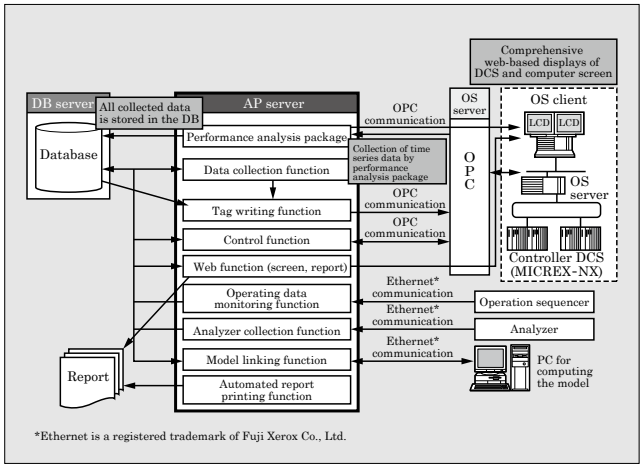
As a result, the lifecycle cost of the total system can be reduced.

5. Application of a Package for MES Use and Vertical Integration with DCS

In the steel industry, even higher quality is being requested, and the implementation of MES functions on a computer system is also requested. Thus, data is collected using Fuji's MainGATE-PPA (process performance analysis) package for MES, and the collected data is combined with a control application to construct a system that emphasizes monitoring and control.

With this combined system, all tasks such as defining the data collection, creating a screen display and generating reports of the collected data, and so on can be implemented by modifying a table with the performance analysis package engineering tool, thereby enabling significant labor savings.

Fig. 5 Configuration of the overall functions of a computer



Furthermore, a system that is vertically integrated with a DCS can also be constructed. Figure 5 shows an example configuration of a total system combined with Fuji Electric's MICREX-NX, a new information control system that is a DCS. This system, in which the DCS can be integrated with the computer screen (single window) and the communication interface can be standardized (using OPC*4), has the following features.

(1) Common screen for MICREX-NX and computer

By using a web-based display for the computer screen, the screen for the DCS and computer can be combined for a single OS client, enabling seamless monitoring operation. Moreover, since the display is configured on the web, the plant screen can also be displayed on a business-use PC within the facility.

(2) Common alarm management for MICREX-NX and computer

A failure detected by the computer is sent as an alarm tag to the MICREX-NX and an alarm message is displayed to the OS client, thereby realizing common management.

(3) Data linkage between MICREX-NX and computer

Data linkage with the MICREX-NX is realized via an OPC interface, enabling tag data to be added or modified easily even during plant operation.

(4) Operational data analysis function based on performance analysis package

Process data that has been collected with the MICREX-NX is stored and accumulated so that trend graphs, reports and the like can generated by anyone using the performance analysis package.

Of the various MES packages, an example of ap-

*4: OPC is a standard interface specification of Microsoft Corporation.

Table 1 Evaluation of MES package applied to steel industry

Representative steel equipment	Computer system requirements			Evaluation of application of MES package (MainGATE)	
	Amount of data	Data collection speed	Amount of logic	Collection system, analysis system (Main GATE-PPA)	Indicator system, event system (Main GATE-PO/EM)
Energy center	Large	Low	Small	◎	◎
Coke	Small	Low	Small	◎	◎
Blast furnace	Large	Medium	Large	◎	◎
Converter	Large	Medium	Medium	◎	○
Continuous casting	Large	Medium	Medium	◎	○
Rolling	Large	High	Medium	◎	△
Process line	Large	High	Small	◎	△

◎ : Fully applicable
○ : Must be reviewed based on project specifications
△ : Applicable but there are limitations

plication of the MainGATE-PPA performance analysis package (collection and analysis systems) to the steel industry has been presented, but the applicability of the MainGATE-PO/EM package (indication and event systems) was also evaluated. Details of the evaluations are listed in Table 1, but these packages are considered to be fully applicable to upper-level processes for steelworks, and we plan to move forward with the application of these packages in the future.

6. Standard Interface

The interface between a computer and electrical instrumentation equipment is typically implemented as a network communication interface, and TCP/IP socket communication is often used. Among such interface implementations, the OPC interface espoused by Microsoft in recent years has begun to be used as the standard interface, and OPC also is used with the MICREX-NX for transferring screen system data of the client terminal. However, OPC is based on a DCOM (distributed component object model), which is Windows technology, and therefore direct communication is not possible with most process computers for the steel industry which use a UNIX OS. For this reason, in previous communication implementations using OPC, the insertion of an intermediate gateway and protocol conversion were required. This field also is experiencing a trend toward open standards, and OPC-UA (unified architecture) is recently being proposed. OPC-UA provides the features of: (a) data structure standardization, and (b) interface standardization. If interface standardization can be realized, then free access can be achieved using the C language or Java with electrical instrumentation systems from any manufacturer, without restriction to the OS used.

Accordingly, access from either a UNIX machine or from a Windows machine can be realized with the same interface, and therefore, without modifying the interface, migration can be carried out during a system replacing, enabling an improvement in quality and labor savings.

7. Postscript

System development technology is rapidly developing as open source technology becomes more widespread. We intend to advance the applications of computer packages and frameworks that incorporate these latest technologies and are committed to further reducing lifecycle costs and to improving quality.