

Integrated Information Management System in the Network Age

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Abstract:

In these days when a home and foreign economic environment fluctuates dynamically and a systematization promotes which is typified by the diffusion of personal computer and network, a problem confronts us how the information within an enterprise and among enterprises should be organically managed and communized. Since 1995, Industrial System Solutions Div.-II of Electronics & Information Systems Div., Nippon Steel Corp., has grappled with the subject for offering "NSXPRES Solution" which makes it available to establish a synthetic information management on the whole at the level of enterprise, as a solution to the business problem in the said enterprise's environment. In this paper, the concept of NSXPRES Solution and its structural elements are outlined.

1. Introduction

With globalization and the trend to borderlessness in enterprise activities, the competition among enterprises, called mega-competition have been exacerbated. There are further requirements for improved response to customers, shortening of lead time in design/production (shortening of work period), and reduction of manufacturing costs. Social requirements of enterprise activities have already been raised for establishment of a quality system and greater environmental consideration.

Concretely, safeguards and regulations such as ISO9000, ISO14000, PL law and standards represented by CALS (Commerce At Light Speed) and STEP (Standard for The Exchange of Product model data) have been established. In addition, so-called information infrastructures have also been rapidly constructed with the diffusion of personal computers, expansion of networks such as LAN, WAN, mobile communications, etc., and development of the Internet and Intranet.

In these situations, many enterprises are aiming at BPR (Business Process Reengineering) and turning their attention to introduction of advanced IT (Information Technology). However, such

environmental conditions surrounding enterprises are causing rapid increases in the kinds and volume of information dealt with by enterprises, and merely introducing the latest system of applying IT provides no consistent solution. This brings results which do not achieve the purpose of the investment, despite investing so much for the system.

For example, within an enterprise, there are many different business applications required by each department including design, production technology, manufacturing, material purchasing, and sales, each of which has different information to be handled. Information that spans departments is also different in the form of information (format, attributes, etc.) from that used in each department. Therefore, various applications and systems have been introduced with different functions necessary for each department, but this results in lack of consistency at the enterprise level. This does not realize the integrated information exchange and communized information, and thus prevents BPR promotion at the enterprise level.

Industrial System Solutions Div.-II considers the said environmental conditions surrounding enterprises under the name of NSXPRES and aims at delivering an integrated information management solution within an enterprise and among enterprises. This paper describes the concept and the structural elements of

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NSXPRES Solution.

2. Concept of NSXPRES Solution

Information prepared and applied in an enterprise can be expressed in **Fig. 1** on a life style basis. First, the "Creation" phase starts; for example, information (e.g. documents) is prepared by a person in charge, then checked if necessary by a supervisor or persons concerned for review and revision. The result is finally approved for release (official distribution to other persons or other departments) by the person in charge. The "Creation" phase covers the above process. Next, the "Utilization" phase means that information is utilized by many persons for various purposes.

In the manufacturing industry, it is at the "Creation" phase that products are designed by CAD (Computer Aided Design) and other methods. The CAD drawing, when finished, is stamped with an approval mark and distributed to production design and manufacturing departments as an official drawing. The next step is the "Utilization" phase. Information released by the design department is frequently utilized among departments (e.g. production design and manufacturing departments) during the manufacturing process. At the "Utilization" phase, information sometimes should be modified (revised) as design changes are made. Moreover, after product manufacturing is discontinued, the process enters the "Reference" phase in which utilized information so far is referred to as necessary. This means that the "Reference" phase stores CAD drawings of the products related to PL Law and quality assurance requirements just for reference, but revising and utilizing may not continue after the product manufacturing was discontinued. As the specified storage period for the related product information expires, the "Reference" phase ends and the information may be erased (abolished).

Now, it is interesting to compare a situation before the release of information, corresponding to the "Creation" phase, and a situation after the release of information, corresponding to the "Utilization" and "Reference" phases. First, from the viewpoint of users and access frequency, the information is mainly used only by its creation section (design department for the said CAD drawings) before release. On the other hand, once released, the information is used by other departments (production design and manufacturing departments) within the enterprise. In this way, departments of information users are limited before the release and the number of users is relatively small, while after the release, users of the information spread out to the enterprise level and the number of users increases. After release, frequency of information utilization

gradually reduces with the shift from the "Utilization" phase to "Reference" phase.

When the system requirements before the release of information are considered, the information creation support function closely related to the business in the information creation departments is regarded as important. This is, for example, the information creation support function in design department for CAD drawings, which means CAD drawing applications and management functions for CAD drawings (function oriented). On the other hand, after the release of information, the support functions for delivering information quickly and accurately to users (response and security oriented) are more respected instead of the information creation support function.

Thus, the enterprise information management system differs in the number of utilizing departments and users and in the system requirements, depending on the target information life cycle (before and after the release of information). The authors give names of "Live-Document System" to the information creation support department system and "Document Center" to the utilization and reference support system of the released information, with the aim of constructing the integrated information management system (NSXPRES Solution) that integrates these systems.

Concretely, the PDM (Product Data Management) system as "Live-Document System" mainly for the design department and the EDM (Electronic Document Management) system as "Document Center" are delivered. In the next chapter, the PDM and EDM systems are introduced and PDM Solution (NSXPRES-III, MATRIX) and EDM Solution (FORMTEX system) supplied by Industrial System Solution Div.-II are outlined.

3. Structural Elements of NSXPRES Solution

3.1 PDM system

PDM is presented to promote the common & unified management of design information, mainly CAD drawings, within the design department and among departments, and for effective exchange and reuse of the design information. With the boom of BPR, PDM has been used to improve business efficiency mainly by manufacturing industries. PDM's major functions are as follows.

(1) Product Information Management Function

This function registers various design information related to products, parts, documents, drawings and design changes as an "Object"¹ to support the information management corresponding to design business by linking these objects. The object in this case usually covers the following. **Fig. 2** shows an example of product information management with NSXPRES-III.

• Folder

Object of filing other objects in a group for data arrangement. By combining objects freely, the product information is managed in various storage forms classified by uses, functions, and products.

• Data set

Object for managing data file (real data, document) created by various applications².

• Item

Basic object used for managing products, parts, and facilities as

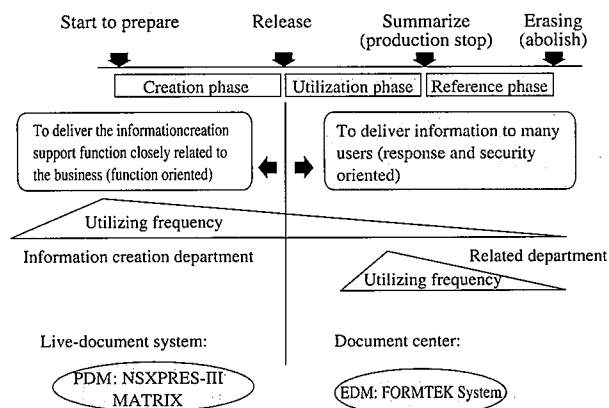


Fig. 1 Life cycle of enterprise information

¹ Object: This means a unit of real data (volume data) in the information management. Generally, it means the real data of documents, tables, and CAD drawings prepared by users. In PDM system, the object usually contains product constructing elements such as parts or facilities, and a folder for filing and containing the real data.

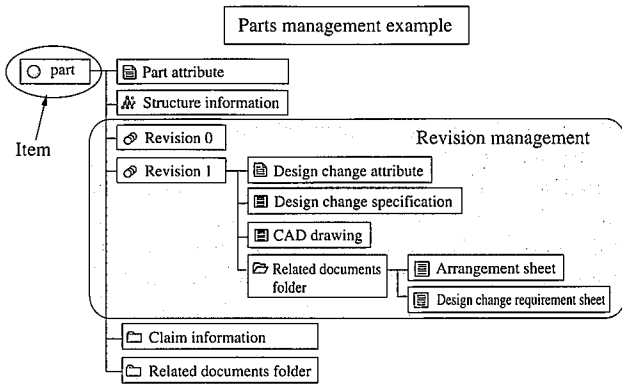


Fig. 2 Product information management function

a "Container" for storing design information related to products and parts (drawing, etc.)

(2) Product structure management function

This function is for defining the products-parts relation of the item regarding the structure information as part of the important information related to "Products" meaning "product A is composed of three parts B, C, and D." Major utilization forms are as follows.

• User retrieval

This function enables users to retrieve "which parts are used for which products" by reverse retrieval of the "Products-Parts Relation."

• Revision rule

This function enables changing structure indication from the item status³. For example, defining the rule "to use latest parts for any status" or "to use 'the latest parts among' in the approved status" enables the design department and manufacturing department to deliver different information for one product structure.

• Alternative parts

This function enables defining and managing "Alternative Parts" which can be replaced by other products (A corporation's or B corporation's parts or the like). Fig. 3 shows differences between a case in which the same information is filed by the product structure information and a case in which it is filed by documents management divisions using the said folder.

(3) Workflow function

This function realizes execution by the workflow system defining the routine business process on the basis of the business rule by the system. Arranging the information release model easily defines not only the serial workflow but also the parallel workflow and also can define the user's access privilege⁴ dynamically changing the process and security to the object. In this way, "Structured Workflow" in the design process is supplied.

(4) Linking function with CAD

This function allows parts information to be reflected in the structure information of PDM when the product is designed using plural parts in CAD, and CAD design is available without user's needing to be aware of the structure information of PDM. Such CAD information linkage is called "CAD close linkage". Originally, PDM is produced on the concept of storage of CAD parts information, and "CAD close linkage" is usually required in PDM.

3.2 EDM system

EDM system is for integrally managing various information (documents) at the enterprise level, released from each department in the enterprise. This can replace conventional paper based document management as well as an optical file, aperture card as it holds a wide range of information in common and allows reuse of the information. Therefore, the function of EDM is regarded as an important document center in which a lot of information is held in common, exchanged, utilized, and referred to among many users. The EDM's major functions are illustrated by an example of the FORMTEK System below.

(1) Retrieval function by meta data (document attribute)

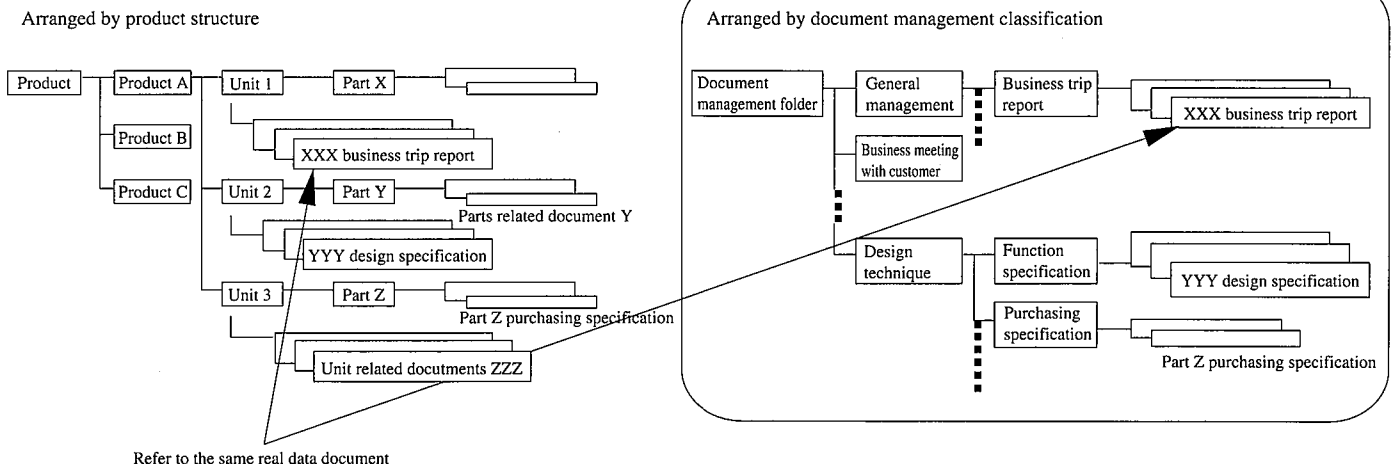


Fig. 3 Classification of document management by product structure management and Folder

² Application: This means the software program for achieving the specific purpose by applying data processing techniques. For example, it contains word processing software to prepare documents and CAD drawing software as an example of Application.

³ Status: This means the status of information managed by PDM system. For example, it shows the status of drawing preparation work process

in which CAD drawing (what is called information) is now being prepared, being checked, or already approved.

⁴ (User's) access privilege: This means that each user has the privilege of execution to information which is managed by PDM system. For example, User A is allowed only to refer and print to a file but User B is given the privilege to revise or delete the data.

This function allows management of attribute data (meta data) for each document separately from the real data (document data), which brings high speed document utilization and reference applying the meta data, allowing timely use and reference to necessary information (documents). The meta data are usually stored in RDB (Relational Data Base.) Separate management of the meta data allows flexible operation to store the voluminous real data.

(2) Storage function of real data by Class

The structure of the meta data mentioned above is usually different among the real data types. For example, the meta data of CAD drawing as shown in **Fig. 4** usually contains "Drawing Name", "Drawing Number", "Drawing Prepared By", "Drawing Prepared Date", "Drawing Size", etc., while the meta data of specification includes "Specification Name", "Specification Number", "Supplier", etc. Thus, it is desirable to classify the real data by type (Class) such as drawings and specifications to specify the optimum meta data based on type (Class). The function is to reinforce the retrieval function by the said meta data (document attribute in this case) to drastically improve retrieval efficiency.

(3) Stratified real data management function by folder

This is the function which links plural real data to each other using the folder (also stored in PDM system).

(4) Storage function of real data with plural data formats

This function allows one real data to be stored by plural data formats. For example, this function enables an operator to manage both CAD data file (vector data⁵) and its image file (raster data⁶) as one real data. EDM has many users who have different purposes for EDM utilization and different applications installed, so that this function is needed. Like the EDM system, it is usually required in the PDM system.

(5) Check-in and check-out function

This management function (exclusive control function) prevents discordance from being generated in the real data due to simultaneous revision by plural users. The real data checked-out can only be referred but not revised simultaneously by other users until the data are newly checked-in. It is also required in the PDM system.

(6) Revision management function

This function is used with the above check-in and check-out function to change the real data version when checked-in after revising the real data, for managing the revision records. Like the EDM system, it is also required in the PDM system.

(7) Distribution function of real data

This function supports management for distributing the real data in plural storage areas depending on the using frequency and its storage purpose. This is an essential function in the EDM system because real data has a large data volume and requires much time to transfer.

(8) Security control function

This function allows freely specifying the access privilege (reference privilege, revision privilege, deletion privilege, and print privilege, etc.) for each user (or for each user group) related to the real data to ensure the security of information. This is also required in the PDM system.

(9) Backup function

This function allows effective backup of the meta data and real data. This function is especially important because the data stored in the EDM system (meta data, real data) should be securely stored for a long time.

(10) Workflow function

This function allows transmission of the real data among users and requests for voting such as for approval whenever needed. PDM system sometimes requests the structured workflow to support the routine works during design, while the EDM system is usually available by relatively simple workflow (Adhoc Workflow).

Other than the above functions, the multi-platform correspondence is desirable to provide because it is used by many users in each department in the enterprise. The recent trend shows that the system should correspond to WEB⁷ and be open architecture⁸ from the viewpoint of ease of maintenance and extension of the system.

3.3 NSXPRES solution

Industrial System Solution Div.-II has offered the said PDM system denominated as NSXPRES Solution based on NSXPRES-

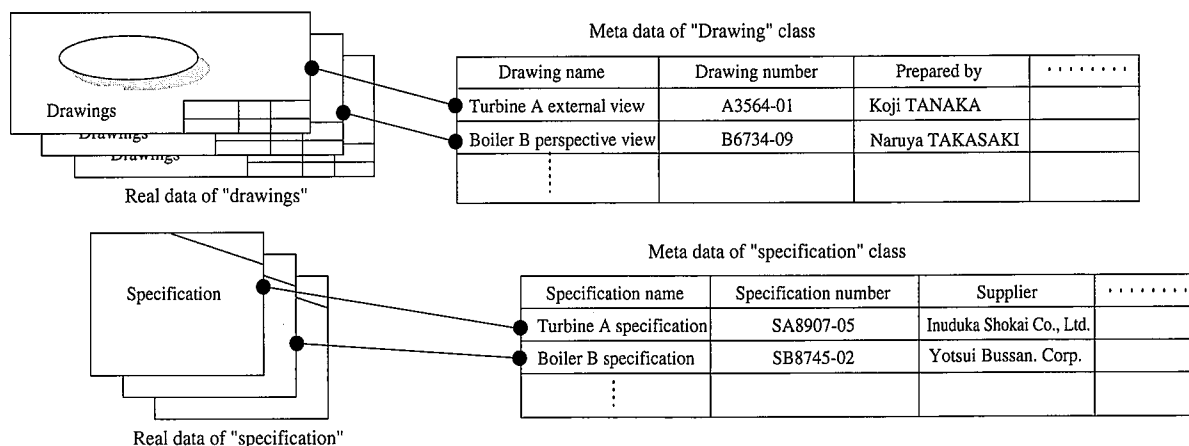


Fig. 4 Storage function of real data by class

⁵ Vector data: The data form of CAD drawings, etc. prepared by application software such as CAD software, etc. is called a vector data. Data expressed by the vector form is called a vector form.

⁶ Raster data: The form expressing data of CAD drawings, etc. as an assembly of two dimensional points is called a raster form. Data expressed by the raster form is called a raster data.

⁷ WEB: Also called WWW (World Wide Web). This wide-ranged information system allows construction of hyper text on the network to link all information seamlessly.

⁸ Open architecture: This means that the environment on which the system operates does not depend on special hardware and OS (Operating System) with diversified properties.

III and MATRIX. The EDM Solution was developed from the FORMTEK System. NSXPRES-III, MATRIX, and FORMTEK System are outlined below as well as performance of the Solution offered.

(1) NSXPRES-III

NSXPRES-III, developed by Industrial System Solution Div.-II, is the PDM system based on PDM core software of IMAN (Information Manager) developed by the U.S. EDS Corp., who has a strong record of results for 3D-CAD and the system integration field. It is modified by assembling the modularized document management function. In 1995, Industrial System Solution Div.-II introduced IMAN, modified it to Japanese language version and unified it to the said document management modules. Div.-II has offered the PDM Solution over the past three years to more than 20 users mainly in manufacturing industries.

NSXPRES-III employs RDB made by Oracle Corp. as a database to construct the control model called POM (Persistent Object Manager) at the top layer of the RDB to realize the object-oriented⁹ data model. In addition, NSXPRES-III has many APIs (Application Program Interfaces) at the top layer of POM for each object, which allows diversified customization to meet any business requirements. NSXPRES-III is also equipped with document management modules such as high-speed viewing, detailed viewing, output tools, mark-up tools as the standard version. This enables business support to be provided for every detail in the design department.

NSXPRES-III is a client-server type system, a server operates on a UNIX workstation and a client operates on a UNIX workstation or a Windows PC. This allows the database server, file server, and PC server to be distributed on different workstations.

As a typical example, take the system operating at F Corp., an integral electric machinery manufacturer. F Corp.'s design department has problems. First, cost information and inventory information for parts and products to be used in designing are not available in the design department (because such information is managed and classified by the system in the production department). Second, structure information for products and parts are shown only in the framework of design drawings, so that users (the products which use the parts) are unknown when design is changed and the size of influence is also unknown. Third, official management of CAD drawings is carried out on a paper product basis, so CAD data arrangement is very troublesome for personal work. In 1996, F Corp. decided to introduce the PDM system to support design work, as shown in **Fig. 5**, on the basis of NSXPRES-III. At present, this system produces satisfactory results including efficient design work using parts and products information, promotion of the re-use of previous design information and reduction of designer's indirect works.

(2) MATRIX

MATRIX is the PDM system developed by U.S. Matrix One Corp. and is sold worldwide. In 1994, it was first announced, and since then it has been employed in more than 200 corporations around the world, and in more than 35 domestic corporations.

One of the most important characteristics of MATRIX is in its package availability. General PDM system should be customized to use a GUI (Graphical User Interface) and specific applications, but MATRIX is equipped with potential applications in advance, which allows immediate operation though with some restrictions in its functions.

Moreover, the module for the system management to construct the database scheme¹⁰ is also provided in a package that allows

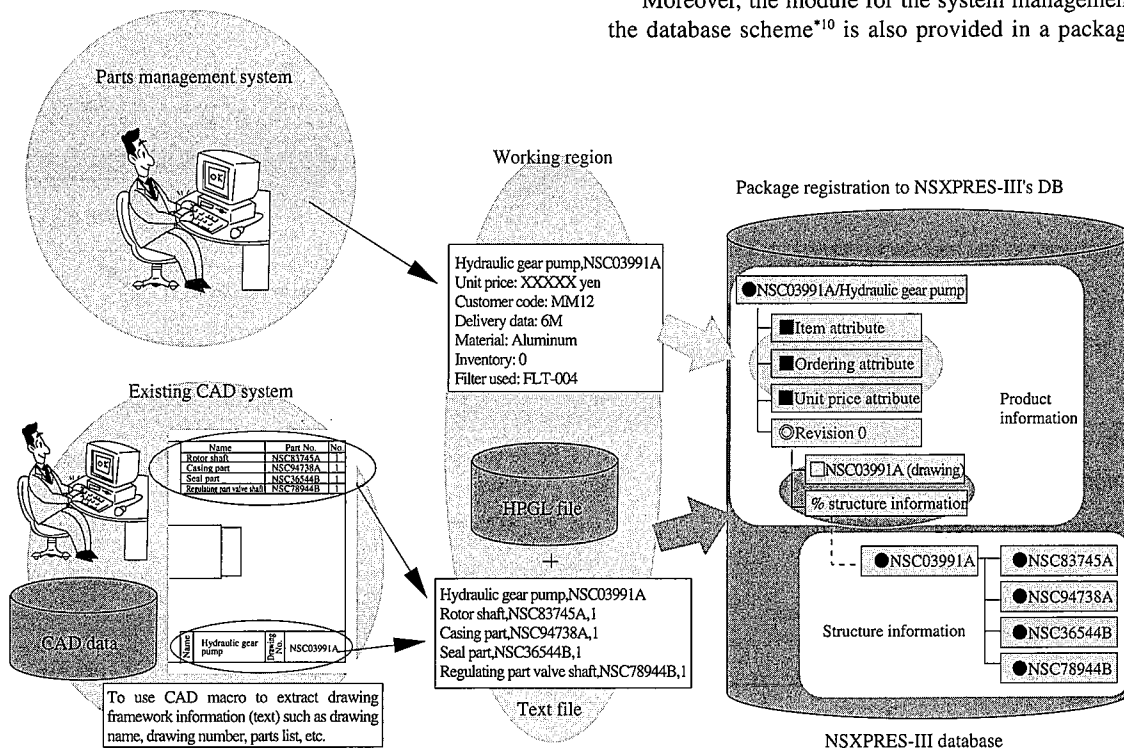


Fig. 5 Example of NSXPRES-III (Integral electric machinery manufacture, F Corp.)

⁹ Object-oriented: Generic term indicating a programming method in which the structure elements are mainly based on objects rather than on procedures and functions.

¹⁰ Database scheme: This means information defining the logical structure, housing structure, and physical structure of the database.

the system to start operation and do maintenance very easily. Concretely, this enables an operator to specify the framework of the products structure using various dialog boxes in the management module, to set the real containing file as well as definition of the status and access privilege immediately after installation of the MATRIX. In addition, user operation such as registration, retrieval, and indication of the real data is justifiably easily available.

This enables end users to grasp at an early stage the concept of PDM, which has not been settled in the domestic market, thus drastically improving introduction efficiency on the daily works including studying specification, preparation of prototyping, and evaluation/review.

The second characteristic is thorough employment of object-oriented technology. MATRIX defines all physical objects, data, and concepts as business objects to release users from troublesome tasks related to installation and operation of the application by capsulizing the involved information and algorithm. MATRIX can also take multi-media data such as CAD drawings and audio data directly into the database. In addition, MATRIX employs the object-oriented database (OODB) to realize the distributed database and client-oriented processing. In particular, the latter is innovative as a measure for solving bottlenecks in the server (also, RDB is available).

In February, 1997, Industrial System Solution Div.-II received an order from T Corp., a manufacturer of mass produced car parts, for the PDM system for parts number management for drawings and assembling of drawings numbering over 30,000 sheets (60,000 sheets in the future). They requested in April to fix the specification, and in mid-July to start the system. During that time, with the cooperation of T Corp., it was possible to realize CAD connections

and the status management (access privilege management) linked with business processes, and data connections with the parts table system in the existing system within a short period. This results from the excellent quality of MATRIX for the package application as mentioned before.

(3) FORMTEK System

FORMTEK System is the advanced EDM system developed by Formtek Corp., an enterprise affiliated with U.S. Lockheed Martin Corp. It has all functions required for EDM to realize the document center at the enterprise level. For example, FORMTEK System was employed as the EDM system for Lockheed Martin's F22 project (U.S. Air Force Next-Generation Fighter Jet Development Project) and THAAD project (U.S. Army Next-Generation Defense System Development Project) as well as a large-scale EDM world-class system including Europe and Japan. Results were satisfactory. Furthermore, FORMTEK System has applied CITIS (Contractors Integrated Technical Information Service)/ CALS developed mainly by Lockheed Martin Corp., in the worldwide limelight. While, the function has been reinforced for distribution of real data and WEB correspondence in addition to conventional functions.

In 1997, Industrial System Solution Div.-II decided to introduce FORMTEK System as a base system for the EDM solution, and it plans to offer the large-scale integrated information management solution at the enterprise level as shown in **Fig. 6**.

In addition, FORMTEK System will be further expanded for application as shown in **Fig. 7** not only for integrated information management within the enterprise but also as an information management solution among enterprises including the Extranet, typically represented by CITIS/CALS.

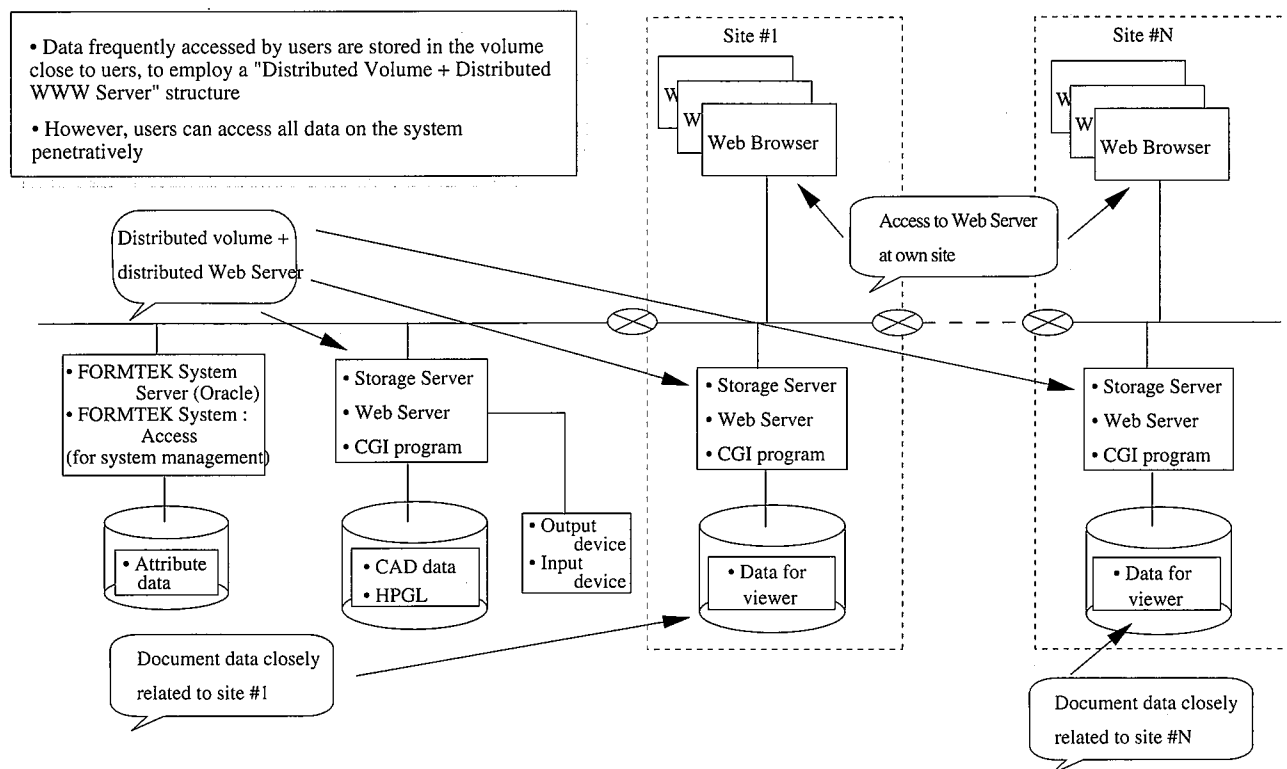


Fig. 6 Large-scale information management solution image by FORMTEK system

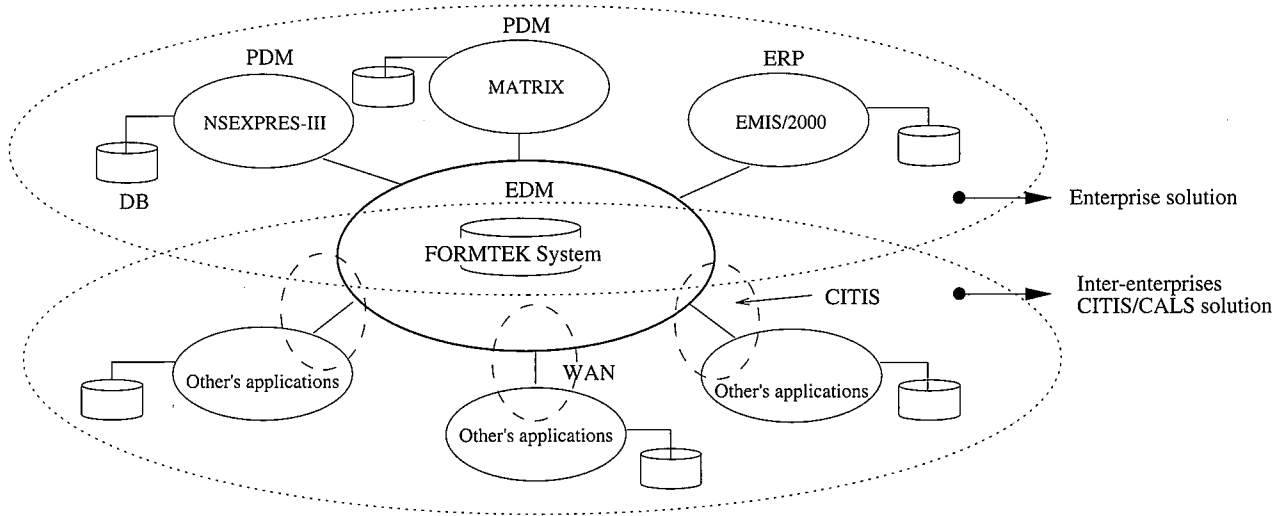


Fig. 7 NSXPRES integrated information management solution image

4. Conclusions

This paper described the concept and structure of the integrated information management solution developed by Industrial System Solutions Div.-II. There are many needs diversified in the information management field along with the environmental conditions within an enterprise and among enterprises. IT and system infrastructures are also continually progressing.

In such situations, although it is very difficult to propose and construct the optimum solution, Industrial System Solutions Div.-II will fulfill our responsibility as a best solution provider correctly sensing the market and technical needs in domestic and overseas markets.