

Development of PC-based Client/Server Multimedia Filing System "NSXPRES300X"

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Abstract:

NSXPRES300X is a client/server type multi-filing system developed on the concept of being the filing core of a business information system for integrated personal computers. NSXPRES300X makes it possible to carry out unified management of various types of data made by applications on personal computers in addition to paper-based data assets carried over from the past. It features superior cost performance, easy and broad system extensibility, practical data management system, visual operation and so on.

1. Introduction

In a promotion of BPR (business process reengineering) for dealing with changes in business environment such as increasing competition among corporations, internationalization, business fluctuations and so on, business information systems have been actively constructed for providing a structural basis for the enhancement of work efficiency and productivity by performing smooth company data exchanges and sharing data among those concerned. A filing function, one of the components of the corporate data system, was used only for keeping massive data assets including documents and drawings. However, its importance has increased as a means for enabling those concerned to share data including documents and drawings from the moments when the data are produced, on a daily basis.

Meanwhile, a paradigm shift in information technology (IT) appeared remarkably in the four fields of open systems, networks, personal computing and package software in the 1990s. This accelerated the trend toward PC-based system downsizing and client/server type multi-filing systems for constructing business information systems.

The authors have consistently developed and sold systems designed for contributing to the enhancement of work efficiency and data sharing on electronic data for drawings since 1987. In May 1996, by combining technology on automatic drawing recognition and engineering drawing management with the newest in IT, Nippon Steel Corp. developed a PC-based client/server type multi-filing system, NSXPRES300X (simply referred to as 300x,

hereinafter), on the concept that the 300X is a document management and engineering drawing management sub-system in the business information system.

2. Multi-filing System

2.1 History of filing

It is widely known that filing in corporations was started for the systematic keeping and management of paper-based documents and drawings. The form of data management has steadily changed, document and drawing libraries, microfilm, optical filing systems with taking in occasional IT.

In the case of paper-based management by the document and drawing library as an initial mode of filing, the keeping/managing of original paper including documents and drawings was the premise. Consequently, there were the following problems: Considerable space was required for keeping the increasing number of documents and drawings; the original paper was easily damaged; and the filing method was not suitable for handling a greater volume of documents and drawings. Then a method based on microfilm was introduced. Although the space problem was solved to a certain extent, problems were also inherent in this method. Specifically, a reduction occurred from the clarity of the original paper with every revision of the documents and the drawings. It took time for retrieving or outputting, and other operational difficulties occurred. In addition, there were problems with system maintenance, for example, requiring much time and increased costs for photographing microfilm, aging of microfilm facilities and so on.

At the next stage, optical filing systems appeared, taking the above described background into consideration. The optical filing

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system takes in written documents and drawings drawn on paper as image data and keeps and manages these data with retrieval conditions. A large capacity optical disc is used as the storage media. The optical filing system was very effective for reducing storing space and improving retrieving efficiency because it used electronic data. However, because it needed exclusive hardware and it was closed system exclusively used for filing image data, the system lacked wide usability and expansibility.

2.2 Integrated document management and engineering drawing management system

In manufacturing industries, mainly due to the achievement of platform high performance and low costs, the use of a CAD system has grown popular, and design work efficiency has been greatly improved. However, in many cases, graphic data made by CAD were directly stored in the storage device and, consequently, the data were only used by the designers as personal data resources but not for sharing. Meanwhile, drawings were generally stored and managed in the drawing library. It was necessary for the designer to go to the library to find drawings needed for diversion design and copy the original drawings. The time required to search out drawings as well as the interruption of work prevented improvements in work efficiency. Dual management of CAD data and paper-based drawings was burdensome, and technical documents related to the drawings were stored separately. Thus, management of massive data having different characteristics and separate locations was a very big problem.

In order to cope with such needs, an integrated document management and engineering drawing management system equipped with editing functions in addition to network functions was developed for the united management of electronic data, including paper drawings, data inputted by scanner, and CAD data. The integrated document management and engineering drawing management system is generally a client/server type, which was introduced mainly to design departments for the higher level use of CAD. The system enabled data to be shared by multiple users, and drawings could be reused as assets. However, EWS (engineering work station)-based systems were still the main products and thus prices were very high. There was also a limit to the types of data that could be handled, and the system was not open. A PC-based electronic filing system based on the same concept was made commercially available, but most of these systems were for personal use and were not yet ready for use in the corporate environment due to limited functions and size.

2.3 Corporate data system and multi-filing system

Then the world witnessed great improvements in PC performance, the appearance of Windows NT^{*1} OS for high-performance PCs and a full-fledged PC DBMS product (database management system), and the spread of PC networks which all came out with the appearance of Pentium^{*2} processors. Thus, corporate data system downsizing and, accompanying that, the use of client/server machines accelerated on the basis of PCs as the system core. An EUC (end user computing) environment of one PC per one person has now been established and reasonably-priced PC-CAD and office products^{*3} have become widespread. As a result, individual intelligent productivity has been greatly enhanced. In addition, there are now numerous types of data existing on PCs, including not only image

data of documents/drawings and CAD data but also text files of Microsoft Word or Ichitaro^{*4}, spreadsheets of Excel or Lotus 1-2-3^{*5} and color image data captured with image scanner or digital camera. This multi-filing system can improve work efficiency and productivity by involving such a wide variety of data with one another and performing integrated management to enable instant use and sharing of information.

For the multi-filing system, the provision of the following system functions and performance features is important: large filing capacity, quick retrieval, use of multimedia, sufficient network functions, openness for using commercially available software and expansibility for connection with other data systems.

2.4 Features of NSXPRES300X

300X is a multi-filing system developed to solve all the problems involved with past document and drawing management systems: specifically, functions of non-use of paper, space conservation, integrated management of large paper drawings/CAD data/document, realization of quick retrieve of massive information and information sharing, reutilization of information, and so on have been requested. Functionally connected to other company's systems or external tools, 300X can provide various solutions including facilities management system, engineering drawing management system, geographical information system and document management system. It has features of a filing core for department information systems (see Fig. 1).

The features of the system can be summarized as follows: (1) PC-based system: excellent cost performance and expansibility provided by a client/server system constructed with Windows compatible PCs; (2) Multimedia compatibility: integrated management of all data on PC based on mutual relationships; (3) Visual operating environment: easy operability provided by Windows Explorer based user interface; and (4) Compilation of NSXPRES series: collection of core technologies of NSXPRES series delivered to about 1,400 companies over a period of 10 years.

3. Function of NSXPRES300X

3.1 System architecture

As described above, 300X is a client/server system which has now been established as an architecture of a corporate information system. For the server, Windows NT is employed, which now predominates as a full-fledged department server because of the great improvement of processing performance, reliability and availability. For the client, Windows 95, which has acquired an overwhelming market share is employed. With the appearance of Windows 95, major RDB (relational database) software vendors have started to provide DBMS products for PC on a full scale. As a result, products have been put on the market that are more reasonable in price than UNIX^{*6} versions and have functions of distributed DB (department database) compatibility, SMP (symmetric multiprocessor) compatibility, parallel processing, connection

^{*1} Windows, Windows NT, Visual Basic and Visual C++ are the registered trademarks of Microsoft Corporation in the U.S. and other countries.

^{*2} Pentium is the registered trademark of Intel Corporation.

^{*3} Office product: Generic name for a product including a set of word processor, table calculation and presentation tool provided by each software vendor (e.g., Office 97 Pro, Ichitaro Office 8, Super Office 97).

^{*4} Ichitaro is the registered trademark of Justsystem (Corp.).

^{*5} Lotus 1-2-3 is the registered trademark of Lotus Development Corporation.

^{*6} UNIX is the registered trademark exclusively licensed by X/Open Co. LTD., in the U.S. and other countries. Other company names and product names described in this paper are the trademarks or the registered trademarks of respective companies.

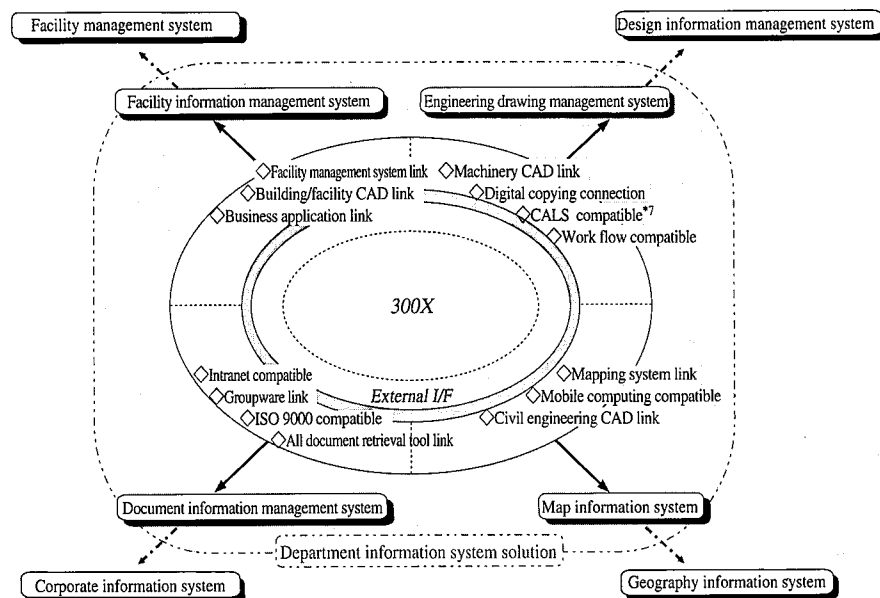


Fig. 1 Solution using 300X as core

with electronic mail and operation control tools. These products which achieved a level can be used as department DB. For developing 300X, Nippon Steel Corp. employed Microsoft SQL Server (equivalent to widely used RDBMS in Fig. 2) as DBMS because of compatibility with Windows NT, also provided by Microsoft, and the prices. As the structural basis of accessing from the application section of 300X to the SQL Server, Nippon Steel Corp. employed a structure via ODBC (open database connectivity) interface with a view toward shortening the development process and application to DMBS (see Fig. 2).

A standard system architecture used as a department system for one server and two to three clients includes, as peripheral devices, a large capacity hard disk and I/O devices of A0 and A4 sizes

(see Fig. 3). To enhance system reliability, Nippon Steel Corp. especially recommends that RAID (redundant arrays of independent system) specification disk array device should normally be used for the hard disk and a backup device of DAT (digital audio tape) or DLT (digital linear tape) and an uninterruptible power supply unit should be added. If necessary, a stand-alone style system or a system including multiple servers to serve several tens to several hundreds of clients can be constructed.

3.2 Functional configuration

300X is constituted of viewing, editing, plotting and scanning functions (tools) for database management including check-in and search (see Fig. 4).

300X comprises functions for registering non-standard tools

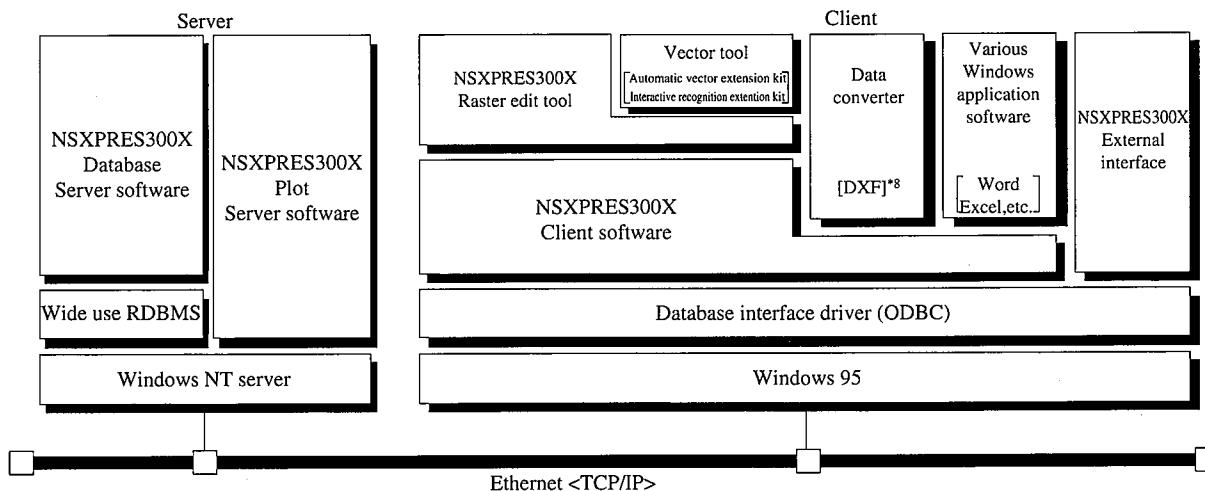


Fig. 2 300X program structure

*7 CALS (continuous acquisition and life-cycle support): Concept that the process including supply, product development, production and maintenance is made efficiently by converting various bits of information related corporate activities into electronic data and sharing information with customer companies. In Japan, verification project is under way

*8 DXF (drawing interchange file): CAD drawing format provided for by Autodesk Corp. Defacto standard as an intermediate format for conversion of different CAD data.

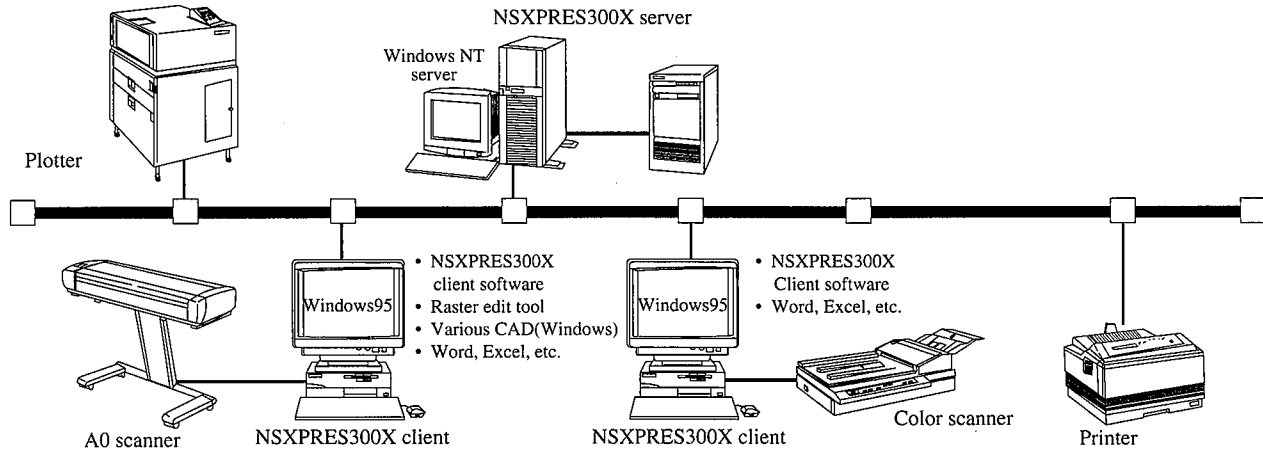


Fig. 3 Standard system configuration of 300X

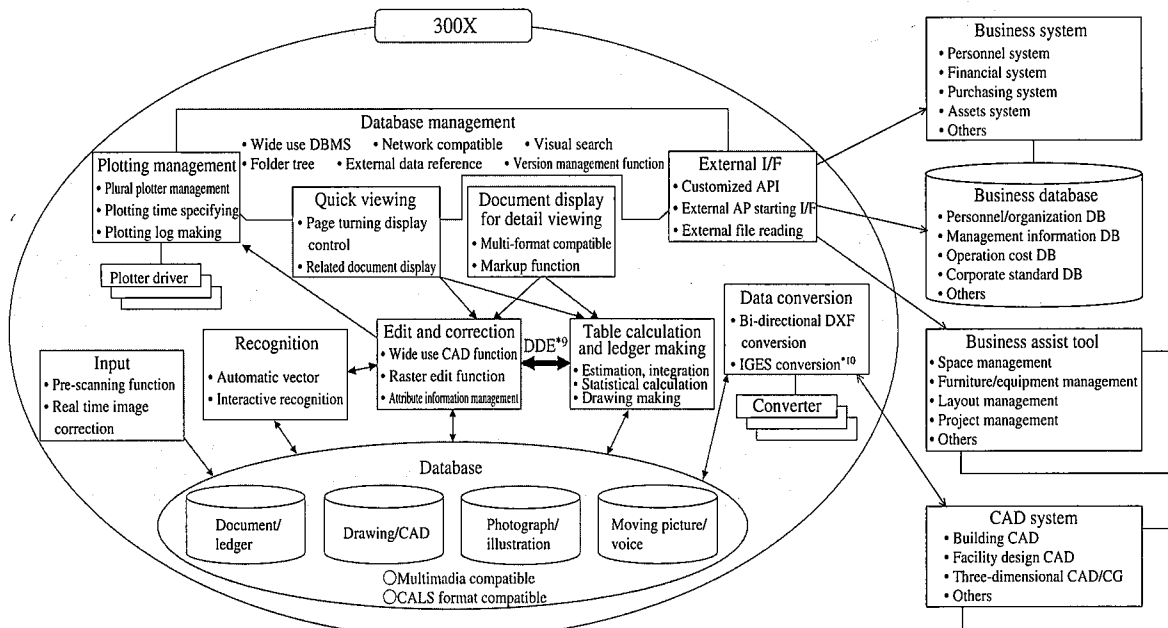


Fig. 4 Functional configuration of 300X

such as office products, commercially available tools of various CAD or user specific applications by involving these tools in the types of respective document data formats. Using these functions, the user can perform such processing as viewing, editing or plotting without being aware of the kinds of documents or a difference in tools for processing the documents (Windows AP hookup function).

300X also comprises functions of external interface (described later) and data conversion. By these functions, 300X can be functionally connected to other systems and transfer documents with external terminals in data file form.

3.2.1 Components for data management and version history management

Logical components for data management are simple, including only three kinds, a document, a folder and a database. Accordingly,

the system is very convenient for the user.

"Document" is a generic term for raw data files of drawings, documents and photographs, etc. Multiple kinds (document types) having a combination of different attribute key titles corresponding to the kinds of documents can be defined. The folder, defined as a container for documents registered in the database, stores documents and folders registered in the database. For the folder, as in the case of the document, multiple kinds (folder types) having a combination of different attribute key titles can be defined. The database is a basic unit for data management and includes registration information and link information regarding folders and documents.

Attribute keys of 50 titles at the maximum can be set, respectively, in the documents and the folders, and individual versions

*9 DDE (dynamic data exchange): One of inter-process communication specifications provided by Microsoft Corp. operable on Windows system.

*10 IGES (initial graphics exchange specification): Standard agreement for data conversion among CAD/CAM/CAE systems.

can be added to them. A version includes the following three portions, a major number, a minor number and a revision. Accordingly, elaborated version history management can be performed as occasion demands. An initial value and an update value for the version can be set optionally by the user and automatically updated when a checked-in document is revised or replaced.

3.2.2 Folder tree and document link

The most important feature of 300X is its data (folder and document) management system (see Fig. 5). The documents registered in the database are systematically classified by the folders and hierarchically managed by the tree structure of the folders. In the folder tree, an optional folder can be linked as a low-order folder to multiple other folders (folder multiple link)*¹². In this case, since an actual linked folder is managed as one, it is very useful for the management of documents regarding common parts, for example.

Further, 300X enables registered documents to be linked with one another (document link) in addition to a management system by the folder tree. For document links, the following three methods have been provided: a method of linking the documents by specifying the position of a document or not specifying the position and using the other documents or folders as child (linking between parent and child documents); a method of linking documents each to upper, lower, left, right and diagonals, 8 directions adjacent to one another in space around an original document (linking of adjacent documents) and a method of linking documents as overlay documents on the premise that the documents are overlaid on one another on a screen and used (overlaid document link). It can thus be understood that 300X provides a data management system for flexibly dealing with various user operation needs by combining the folder tree function and the document link function together.

3.2.3 Visual operation environment and various retrieval methods

An intuitive, easily used and visual operation environment is also one of the functional features of 300X (see Fig. 6). The folder tree structure is displayed on the screen by database viewer

in conformity with Windows explorer. Thus, in addition to the attribute search of the folders and the documents using normal attribute information as keys, by tree search/tree navigation, an objective folder or document can be easily searched (tree retrieve). Changes such as copy, move or remove can be made for the folder tree on the screen. Thus, the operation environment can flexibly deal with changes in the document management system.

In 300X, image data for quick viewing is automatically made irrespective of the data type of a document during its check-in. If there are multiple retrieval results coincident with the condition, the results are selected en bloc and, by starting a quick viewing tool (browser) including client software, without check-out (described later) of the raw file of the document from the database, its document can be identified at high speed and visually as if turning pages*¹³. The quick viewing function greatly increases work efficiency for retrieval. On the browser, a document or a folder of a child linked beforehand by document link is displayed on the document of a parent by a small icon corresponding to the type of document. The user can use this icon as a key to retrieve or view the low-order document (visual search). Further, the browser provides a document link function for executing document links or releases.

3.2.4 Check-out and security control

The document registered in the database is moved from its original place to its storage place set by the system after its name is changed (ciphered) and then managed. Accordingly, if the user views, edits or plots an optional document, the system makes a copy of the raw file of the document in a user work environment. This processing is called check-out. In 300X, by supporting two check-out modes of "Reference" and "Edit", access permission control can be performed for simultaneous access by multiple users to one document.

Security for 300X is controlled by user authentication based on a user name and a password at the time of log-on to the system and setting of access rights for the database or the folder. For users,

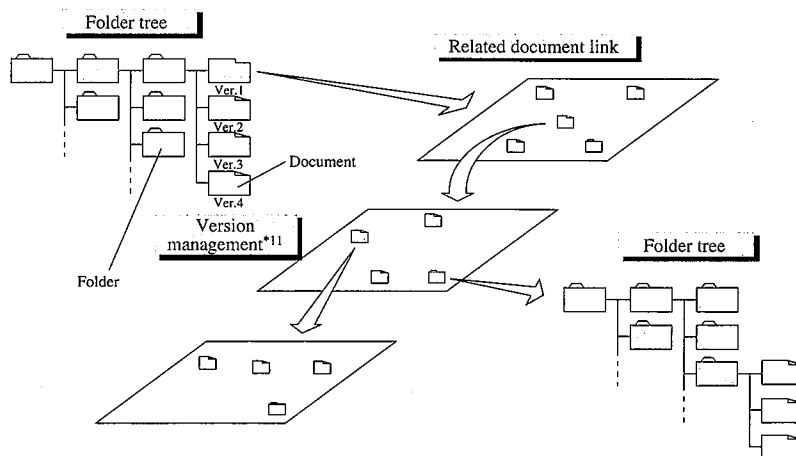
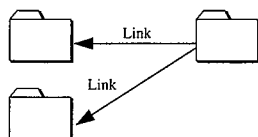


Fig. 5 Data management system of 300X

*¹¹ Document version management.

*¹² Concept of multi-link: exist physically as one folder on database.



*¹³ By using browser, images of a plurality of (pre-selected) documents are switched at a high speed to be displayed on the screen, and a document of a linked (document-linked) child is displayed on the screen by a symbol (small icon) corresponding to the kind of the document (drawing, document or photograph).

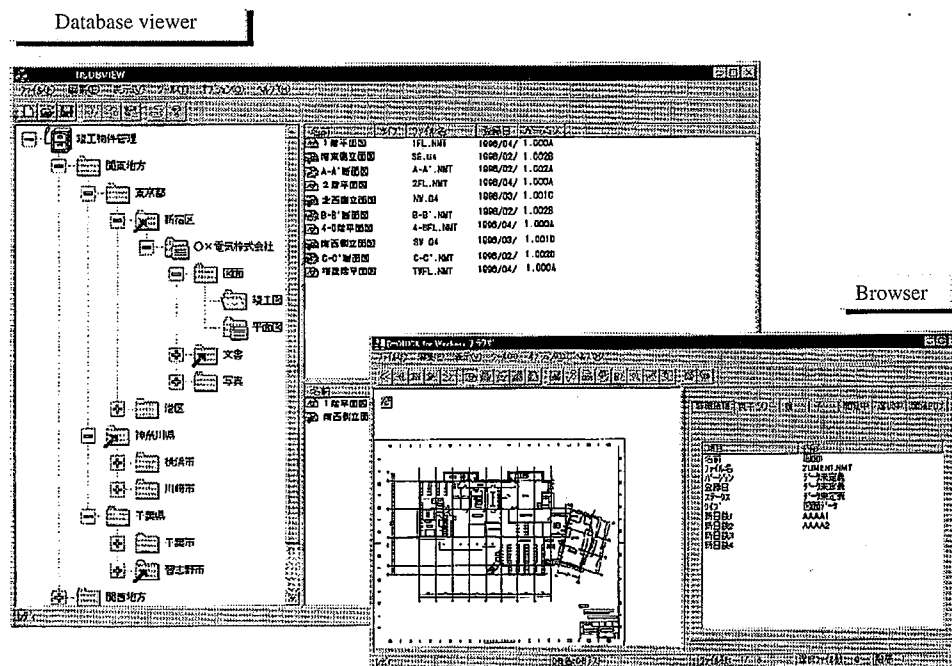


Fig. 6 User interface of 300X

a group comprising multiple users can be set, and the same access rights can be provided to the users as members of the group by setting access rights for the group. Regarding the database or the folder, for every user and group, rights can be set in a meticulous manner; for example, folder making, remove, edit check-out, reference check-out, reference and no access right, etc. Accordingly, security control can be carried out for the documents in the utilization environment involving a number of users.

3.2.5 Plotting management

This function allows selecting and outputting an optional document from the documents in the folder or the documents of retrieval results. Its tools include a plot server, a plot manager and a plotter driver. Numerous services can be provided for plotting drawings with batch plotting drawings by specifying a number of plotting drawings, plotting time reservation, automatic sorting of plotter plotting and printer output documents, a stamping function, management function of plot log and other functions.

3.3 System expansibility

Using 300X as a filing core of a corporate information system can provide higher solutions by making functional connections with the other systems. One function for this purpose is an external interface. The external interface is a library usable for accessing from programs developed in Visual Basic and Visual C++ to the database of 300X and provided in the form of DLLs (dynamic link libraries). The use of the external interface enables a user-specific user interface to be developed and functions to be linked with a CAD system, a mapping system and a business system. Further, by linking with the infrastructure of the corporate information system such as groupware or intranet, the external interface can be used as a document management and engineering drawing management sub-system in the corporate information system.

4. Cases of Introducing NSXPRES300X

There is a wide variety of successful cases of introducing 300X as indicated by a multi-filing system. Examples include: simple plotting management in manufacturing industry, plotting management in construction, facilities and engineering business, engineering document management other than drawings (e.g., reports, photographs, etc. in investigation, examination and research), completion drawing management in a real estate business, document management including application forms or ledgers as bases for administrative services in governmental agencies and offices, facilities management in public utility business for providing electricity, gas and water supply, information management for customer, and facilities management in hospitals and schools.

4.1 Introducing into gas supply company

The variety of documents to be managed in the gas supply company is quite wide, and includes gas supply plant related facilities drawings as sources for gas supply, conduit drawings showing the situations of pipelines buried in roads and other buried objects, piping drawings from conduit drawings to valves to each customer, piping drawings in the building of the customer, equipment related drawings of the customer and additional related facilities drawings.

The purposes of introduction are shortening of retrieval time by linking with customer information, drawing information and ledger, linking between the mapping system and drawing information, free retrieval of latest drawing information of all companies, effective use of customer's equipment information, systematization of maintenance work for drawing information and reduction of document storage space.

Fig. 7 illustrates the outline of a system after introduction of 300X. The gas supply company in this case includes a main office, three operation stations and five business offices; an engineering drawing management server is provided in each. Conventionally, there have been problems as follows: (1) the necessity

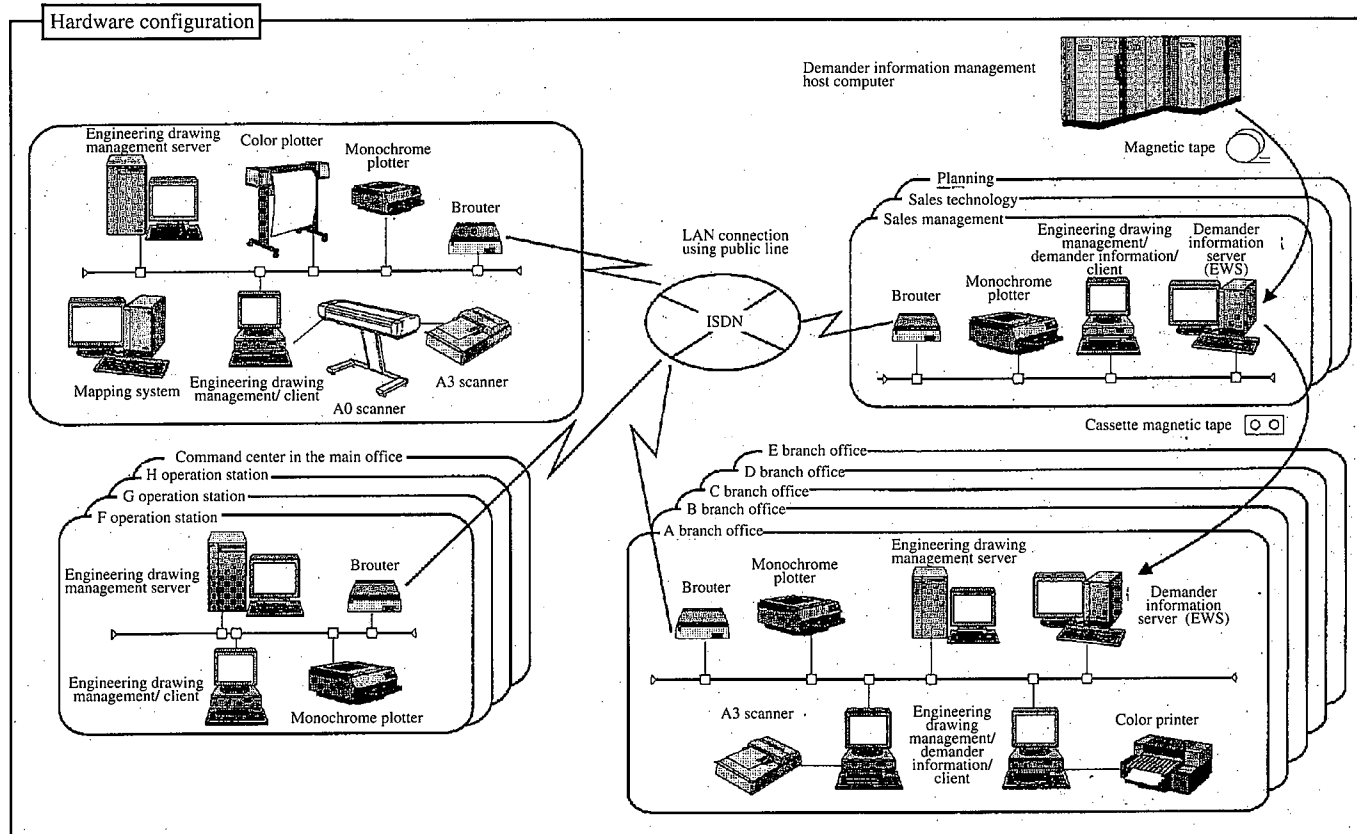


Fig. 7 Introduction case of gas supply company

of holding the same drawings in related sections resulted in differences in drawing histories, and thus it was necessary to identify whether the drawing was the newest or not, (2) emergency taking-out and not returning of original drawings resulted in losses, and (3) viewing of original drawings resulted in deterioration. The gas supply company solved all the problems by providing 300X servers in the respective stations and offices and connecting these servers by a exclusive line or a public line so as to enable free retrieval, viewing and plotting.

4.2 Introduction into plant construction business

In the case of international bidding for overseas construction, the existence of an ISO 9000 certificate now tends to be added to the items evaluated in prior qualification examinations as a bidding qualification condition. Meanwhile, plant construction businesses must consider a product's life cycle including contract, design, manufacture, operation, maintenance, disposal and reutilization as serial flow of information in the international cooperation system. For achieving this, it is essential to acquire compatibility of information on a global scale and use CALS as a new business system common throughout the world.

The purposes of introducing 300X into the plant construction company are as follows: integrated management of plant design documents during design or construction, compatibility of documents often changed to deal with severe specification demands by the order side with cooperative companies in the originating country and overseas, and document management and easy retrieval for completed plants.

ISO 9000 provides for "an organizational structure and a procedure necessary for executing quality control, a system and a provision of concept for managing process and management resources". For plant quality control, it is important to manage documents with regard to the process of making changes in design and construction sites, including the reasons for such changes. By providing 300X, and thus establishing its operation rules and linking with group software, a management system required by ISO 9000 can be realized. In addition, for formats for storing documents, an application-specific format and G4 format compatible with CCITT employed by CALS can be dealt with.

5. Conclusions

After the release of 300X in May 1996, Nippon Steel Corp. has received many orders, now numbering 150 servers or more (as of December 1997). While corporate document management and engineering drawing management objects tend to increase in number, such as measures to deal with PL law executed in 1995 or certificate acquisition of quality guarantee standards like ISO 9000, it is almost impossible to manage all the documents and drawings on paper. In addition, the process of constructing a corporate information system configuration based on functional linkage between Groupware or Intranet and the database system has further accelerated. It is therefore likely that corporate needs for a multi-filing system rather than just a simple filing system will further increase.