

Development of an information technology infrastructure for extended enterprise

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Abstract

An extended enterprise is formed in the Globeman 21 project of the international Intelligence Manufacturing Systems Initiative to investigate the problems involved in the information access and control within the extended enterprise. Since the relationship of the companies in the extended enterprise is loosely associative, that is, there is no formal legal binding mechanism to explicitly state the obligations of the partners, the information infrastructure must also reflect the openness that is required to support it. This paper discusses the development of such an Information Infrastructure and some of the work done in ascertaining the usability of the technologies adopted. Specifically, we discuss various policies and software structures, and evaluate the use of WWW versus Lotus Notes in such an infrastructure.

Keywords

Globeman 21, extended enterprise, intelligence manufacturing systems, information infrastructure

1 BACKGROUND

Manufacturing enterprises are moving towards global operations. The extended enterprise is formed when several organisations join forces to work towards a common goal (Goldman *et al*, 1995). These organisations share investigative experiences in information sharing. They discuss issues related to organisation, access, control and compatibility of information within the context of operations in the extended enterprise.

The information technology infrastructure is designed to support the operation of an extended enterprise known as VRIDGE, which is the acronym of Virtual and Real Information Driven Global Enterprise. VRIDGE aims to demonstrate that the design and construction tasks of one-of-a-kind products can be successfully carried out by a group of companies loosely associated with one another in the global environment irrespective of the geographical and cultural barriers.

A lot of research has been devoted to study to set up an effective management system for information and technology within an organisation (Sarkis *et al*, 1995; Spiegler, 1995). More research is required, however, for determining an appropriate information system architecture for the extended enterprise. In this project, VRIDGE makes use of product modelling standards, enterprise reference architecture and system engineering principles to achieve its goal. These methodologies are integrated as a Extended Enterprise Workbench which helps the extended enterprise to pull together accurate information and knowledge in a very short period for various business tasks.

The intelligence of the processes in the extended enterprise will require strong support of the appropriate information technologies (Konig *et al*, 1994, Kadobayashi *et al*, 1992). This research project evaluates information technologies from the viewpoint of how to apply them in business processes. Reference models and prototypes are proposed as a results of analyses and trials. Considering the rapid evolution of information technologies, the development will be fairly swift. The approach adopted therefore aims to be evolutionary, bringing useful results together in a step by step manner with existing systems.

The paper is organised as follows. Section 2 presents the policies adopted to govern the development of the infrastructure. Section 3 evaluates Lotus Notes in relation to the policies. Section 4 describes development of an open infrastructure based on WWW.

2 POLICIES

In order to unify the activities of partners in the virtual enterprise and simplify the synchronisation work that needs to be done, information technology policies are formulated to provide guidance for the design and implementation for the development of the Information Infrastructure.

2.1 Information policies

The information that will be exchanged on the communication media will be secure and authenticated. The use of distributed database will be minimised to reduce risks of information leaking. The security of communication will be guarded by encryption, by means such as public key encryption algorithms or secret key encryption algorithms. Digital signatures based on encryption will protect against spoofing and illegal modification of the data.

2.2 Operation policies

The wide spread application of the Internet and public networks such as ISDN, high speed telephone modems in recent years has enabled a low cost and effective way of transporting information globally. An open network can be constructed as shown in Figure 1.

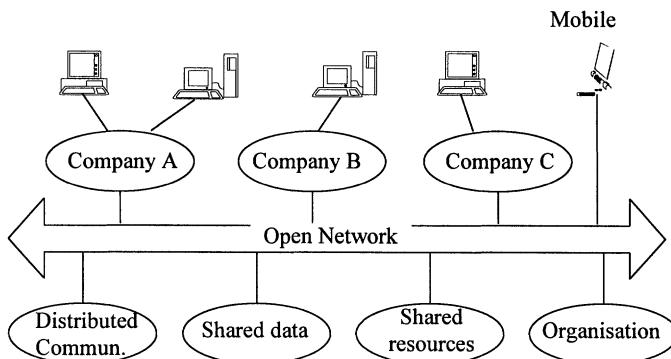


Figure 1 Open Network.

In the future, ATM (Asynchronous Transfer Mode) is anticipated to be the next generation lower level communication method to broaden the bandwidth on fibre or cable. Development of VRIDGE Information Infrastructure on the Internet will therefore ensure that the system can naturally adapt to the next generation technology.

By maintaining an open network, clients can enter the system at any time and at multiple points of the plant design. The operation will be distributed and the work environment will be collaborative and remote.

2.3 Design policies

The Information Infrastructure will use object oriented technologies, version control and dependent information will be maintained. The existing information management technology is capable of managing only alphanumeric data. Unlike alphanumeric data, data such as images, video, drawing, charts, etc. are not of much use unless the application-specific semantics or content-based interpretation embedded in such data is extracted, represented, and manipulated by an information management system. In other words, visual and audio information processing and understanding systems need to be integrated in a multimedia information management system.

Presence of multiple types of data also requires media integration. In brief, the existing information management technologies need to be extended, or new technologies need to be developed, for the management of multimedia information.

In addition, the way information is presented to users needs to be considered to enhance human communication and interaction. The goal here is to develop multimedia interfaces that can combine voice, video, graphics, and other formats, and display the data to an operator in the most effective manner.

2.4 Technology policies

Standards such as STEP and the related tools will be used wherever possible to ensure proper information exchange.

Commercial Computer Supported Collaborative Work (CSCW) tools are preferred to minimise development costs. Such tools include video conference tools with audio and white board on workstations or PC. Video conference systems are easy to operate and require only action and voice, which compare favourably to E-mail. However, they require substantial network resource and real-time transfer. Recording and replaying mechanisms on these tools are to be considered too.

Another solution is a group annotation system that supports annotations to documents anywhere on a network shared by people in a group. Many synchronous and asynchronous collaboration tools are emerging, and these are evaluated from the point of view of how to apply them most effectively in business processes and how they can provide innovation in business processes.

2.5 Security policies

All operations are performed with the presence of company firewalls. A firewall protects the network from invasion, control of access to data determined by user level, and reliability of the network and servers. A typical arrangement for such kind of firewalls is shown in Figure 2.

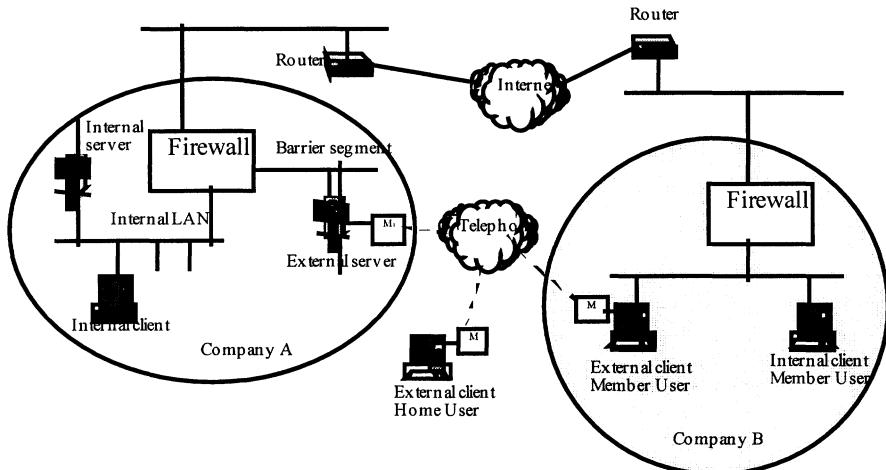


Figure 2 Firewalls integrated with public and private networks.

The use of firewall presents a lot of difficulties in the transfer of the information. Packets, irrespective of whether they are useful or not, if they come from unknown sources, the firewall will not allow them to go through. This means in an extended enterprise situation, new companies will have unnecessary hurdles to overcome when they join the Information Infrastructure. A lot of work will be required to investigate methods to maintain both requirements (security and openness).

3 SOFTWARE STRUCTURE BASED ON LOTUS NOTES

The software structure should be open and flexible for future development. Current constraints such as the firewall have been recognised by the enterprise policy and must be maintained properly. New technologies have been investigated in this project to determine their suitability to be implemented as part of the Information Infrastructure.

Figure 3 shows the software structure of a preliminary design of the Information Infrastructure.

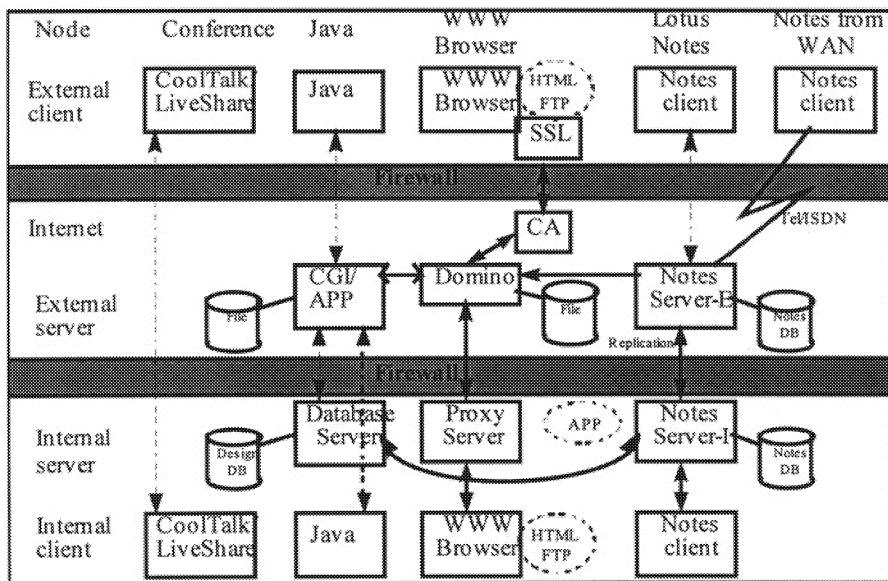


Figure 3 Initial software structure.

The system is designed around the use of Lotus Notes and taking into account the need for CSCW, email, Web browsing and information passing. Based on this software structure, a series of experiments have been carried out to ascertain the advantages and disadvantages of the structure.

3.1 Viewing of non Web based documents

A primary concern in the design of the Information Infrastructure for VRIDGE is the ability for the user to browse the information freely, irrespective of the format of the information.

One experiment on Lotus Notes was to test the portability of the information which was held in different format (Figure 4).

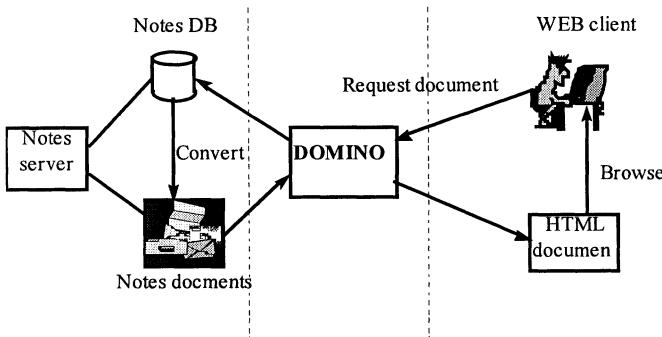


Figure 4 Experimental Lotus Notes.

In this configuration, the Domino server converts the Notes document from the Notes database to HTML format so that the user can view it using a Web browser. Hence, there is no restriction of the document type applied to the viewer.

3.2 Functional areas supported by Notes

The experiment on Lotus Notes was carried out on 5 functional areas:

- Electronic bulletin board
- Authorisation work flow
- Discussion
- Connection to the Internet
- Remote connection

The electronic bulletin board handles wide variety of documents such as images, sound and normal documents. Access control by levels of display. Particular field of the document can be undisplayed. Documents can be searched without making Index Database.

When documents are required to be authorised, Lotus Notes includes the approval of electronic signature from responsible personnel. Similarly, notification of meeting automatic notification of long absence.

Access control level can be set for individual users in Lotus Notes. However, attributes of document for Web browsing cannot be set making it difficult to customise to individual use.

3.3 Problems of Lotus Notes

Lotus Notes is a proprietary system which does not work cooperatively with third party software. However, for setting up information system within an “extended enterprise”, since each partner organisation is an autonomous entity, there is no guarantee on the other partner enterprises that Lotus Notes is available. In other words, the fundamental requirement within VRIDGE is openness which

contradicts the characteristics of Lotus Notes. Furthermore, Lotus Notes is also difficult to customise and there is serious limitation to the 64k memory model. There also can be confusion between the Lotus Notes language (Expression) and Visual Basic and is difficult to program.

4 OPEN INFRASTRUCTURE ON WWW

The experiments on Lotus Notes reveal the need for more open system architecture and components for the proper operation of the extended enterprise. The new system architecture is designed based on the application of Web technologies and generally assumes that access to the Internet is easy and low cost.

4.1 Java

Java is a computer language designed with Internet applications in mind. A program written in Java can either be executed as a resident computer program in a local Java environment or as an applet downloaded from the Internet. In the latter case, the program is activated via a Web browser. In both cases, the Java programs are in fact almost identical.

The experiment on Java is centred around whether it is allowed to access to the documents on the network. An initial test was carried out using a local Java applet communicating with a local Java program to save the information to a client's disk. The system was able to communicate with the server through the firewall (Figure 5).

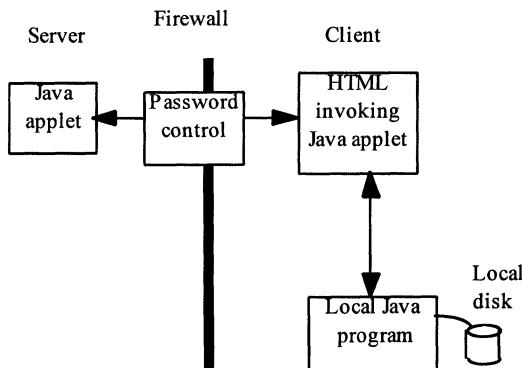


Figure 5 Java experiment.

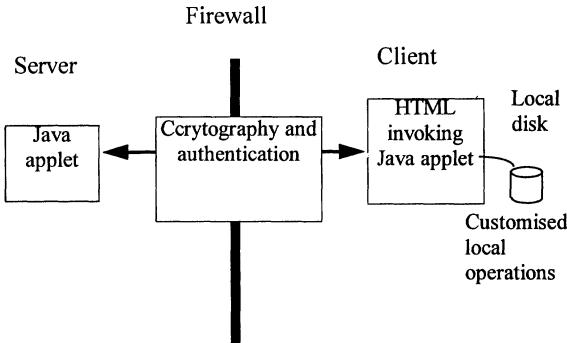


Figure 6 Java programs with security.

The situation at present has been attained relatively easily. The client has been declared as a trusted host. However, to cater for the need of any customer, it is imperative to ensure that the future situation can be attained too. Investigation on the use of special mechanism to enable the Java programs or applet to work through firewalls is currently carried out. A typical scheme is to use formal security mechanisms as shown in Figure 6.

4.2 CORBA

CORBA stands for Common Object Request Broker Architecture. It is designed for the integration of objects in an open architecture using broker concept. Two software systems supporting CORBA applications were tested in the experimental environment. The main purpose was to determine the conditions and application environments for this type of technologies to be used. The two systems were Orbix and VisiBroker.

The experiments found that the two systems were largely similar in functions. The current experiments are basically centred around the question of how client and server functions can be separated into two programs running on 2 hosts. The initial trials are successful and the advantage of network computing is apparent.

However, when it comes to some critical functions, especially when several applets and some other communicating parties are involved, security violations often occur. While good system design can generally avoid such violations, the effort to ensure the security rules are being observed seems to be excessive when a large number of hosts and clients are involved.

Moreover, these CORBA systems are not source code compatible. Programs written in one system cannot be compiled in the other system immediately unless substantial manual editing is done. Hence, selection of the right CORBA vendor with some critical functions is important to ensure effort is not wasted at later stage.

4.3 Talk Room

The partners in Globeman 21 have initially used a WWW facility to encourage people to discuss issues without the use of Email. Talk Room is an implementation of WWWBoard discussion forum and message board on WWW plus FTP. Messages from the partners are stored automatically to the central server in a hierarchical manner so that related messages are grouped together. The facility was found very efficient initially for brainstorming ideas and clarifying specific issues. However, the system becomes overloaded and messages are difficult to be located after a while.

5 CONCLUSION

Investigations made by the Globeman 21 partners to define an open information infrastructure for extended enterprises show that the WWW on the Internet is an efficient and easy to access system. However, there are many issues, especially in data and functional security areas where the partners have made significant effort to find an acceptable solution to suit the volatile extended enterprise structure.

In general, information which are organised on a WWW server in HTML format can be shared among partners easily. All partners in VRIDGE have standard Web browser facility which can access the information on the WWW effectively. When more complicated operations are required, applets which operate with Java/CORBA components can be developed. Due to complexity involved, current experiments are conducted without security mechanisms. In the future, it has been planned that public security key systems such as PGP or SSL can be used to ensure the integrity of information transmitted through the Information Infrastructure.

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7 BIOGRAPHY

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