16

DISTRIBUTED ENGINEERING ENVIRONMENT FOR INTER-ENTERPRISE COLLABORATION

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Abstract: This paper focuses on collaboration of engineering information among globally distributed companies and describes DEE (Distributed Engineering Environment) of design and production on inter-enterprise network. For DEE, the integration framework and methodology to execute engineering are described in the paper. As for the forms of information description, XML, PSLX (Planning and Scheduling Language for XML) and Web browsing technologies are used. In DEE, XML technology prescribes the communication data form that contains hierarchical functional data structure on a common specific Web browsing space. And PSLX technology prescribes the dynamic processes and their controls of the connection among the distributed business activities of the creation of product data and documents. A prototype of DEE for engineering collaboration is also introduced to evaluate the feasibility. This prototype has been developed as a part of IMS/GLOBEMEN of international project.

Key words: Virtual Enterprise, Collaborative Engineering, PLC, XML, PSLX, WWW

1. INTRODUCTION

For the total product lifecycle and by the development of the global information communication environment, each enterprise has growing recognition of the importance of the international business models, ideal and practical models, and of more close world-wide relationships with the related companies and with companies that possess characteristic products and technologies.

In IMS/GLOBEMEN (GMN), we have been studying "Global Engineering and Manufacturing in Enterprise Network" by VME (Virtual Manufacturing Enterprises) that consists of the companies with the core competence. The target of R&D in GMN, is the development of methodologies and tools necessary to the lifecycle business activities that change dynamically. This paper focuses on the DEE (Distributed Engineering Environment) in the management of the dynamic engineering business and the collaboration of the information sharing among VME.

At first, the framework and the second, DEE model to realize the environment of the information sharing among VME are mentioned. And then, a prototype of DEE for the engineering collaboration is introduced to evaluate the feasibility.

2. DEE FRAMEWORK

The framework of the requirement and the function description that shows in Fig.1 is proposed in GMN to deal with information integration in the VME [1].

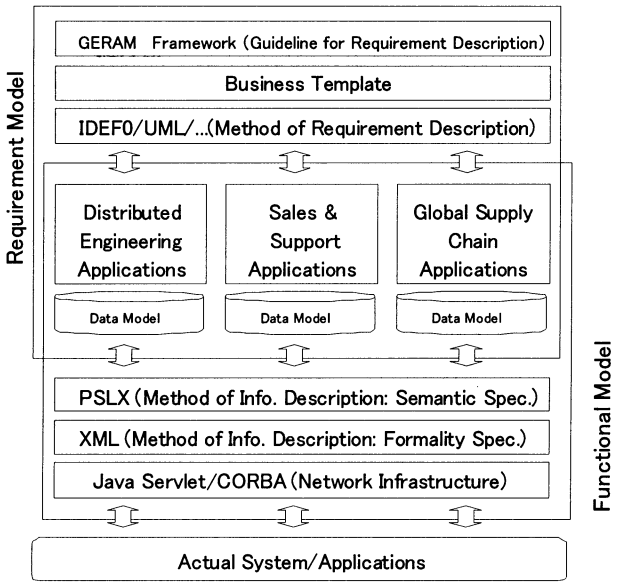

Figure 1. DEE Framework of Requirement and Functional Description

In the figure, the requirement model describes the present condition (as-is model) and the goal (to-be model) for each business and the function model shows the implementation form to realize the requirement in the VME. By the requirement model, in each business, which part is equivalent, and related, or roles of each part in the whole business model of the VME can be defined.

The function model shows implementation forms of the requirement from the requirement model in the VME on the IT infrastructure. The specifications described in the requirement model are developed into the executable model in the function model.

DEE is a system that operates and integrates the business information dispersed around the world based on the framework shown in the figure 1. It becomes the following concretely.

- The description of the requirements in each business is classified and reified by the modeling tool such as IDEF0 or UML. The abstract function of the design requirement is disassembled by the function elements into the detailed executable level for the actual production by the classification and reification. The hierarchical function structure from the abstraction to the business activities is constructed.

- The engineering is carried out by the process flow of the function elements with executable resources. The process is constructed among the process elements due to the flows of data exchange. These processes have the dynamic connections that contain the feedbacks among the process elements. The product data is created by applications in each element.

- The function of a business process element is equivalent to the requirement function element described hierarchically. And the product data is created in each process element. Therefore, function, process and product data are dependent on the mutuality and compose all the systems.

DEE is the platform to manage the mutual dynamic connections of function, process and product data on Information and Communication technology (ICT) base.

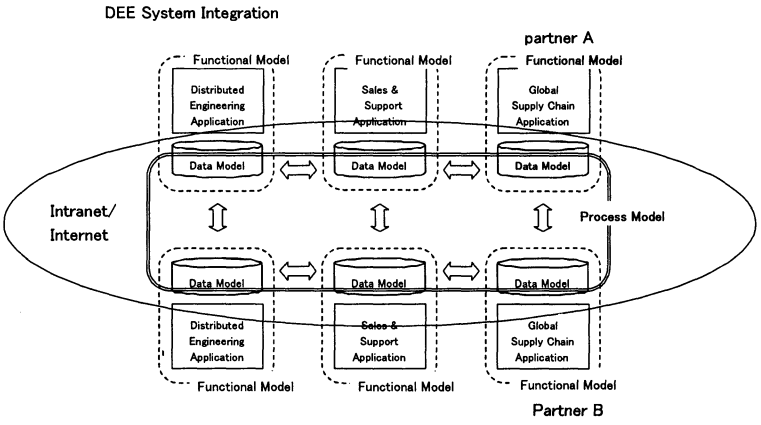

Figure 2. DEE System Integration

3. DEE MODEL

DEE has been studied as the activities of Work Package3 in the GLOBEMEN international joint research. The system concept of WP3/DEE is shown in the following.

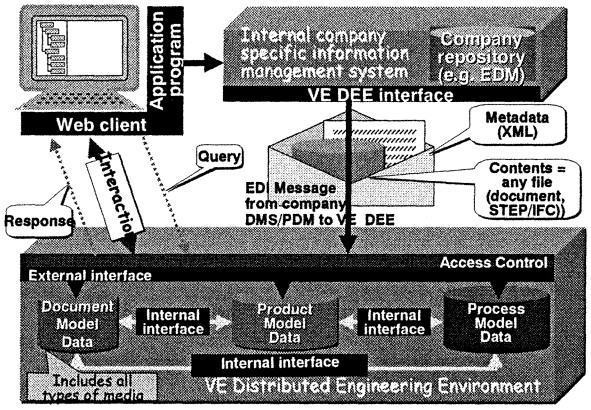

Figure 3. DEE System Concept

DEE manages document, process and product data elements independently and integrates their elements according to each engineering

phase of product life cycle. The connection model of the engineering information in DEE is shown in the following.

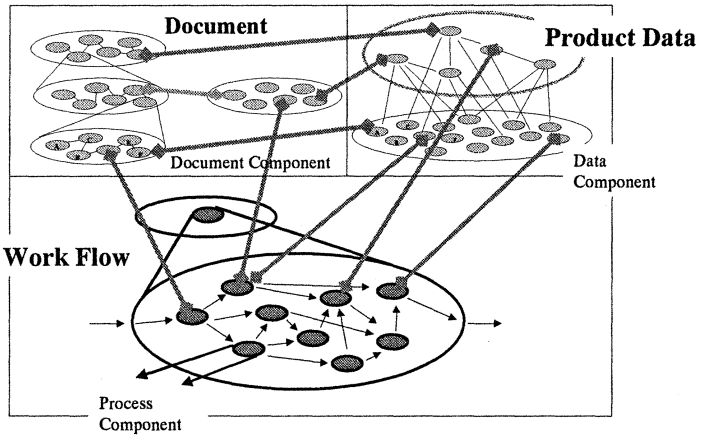

Figure 4. DEE Intercommunication Model

The workflows that show the processes of business functions are connected among groups having functional roles in VME. The functional roles have static hierarchical function layers. The business activities are connected as time-dependent flow in the execution. This concept is shown in Figure5 and Figure6.

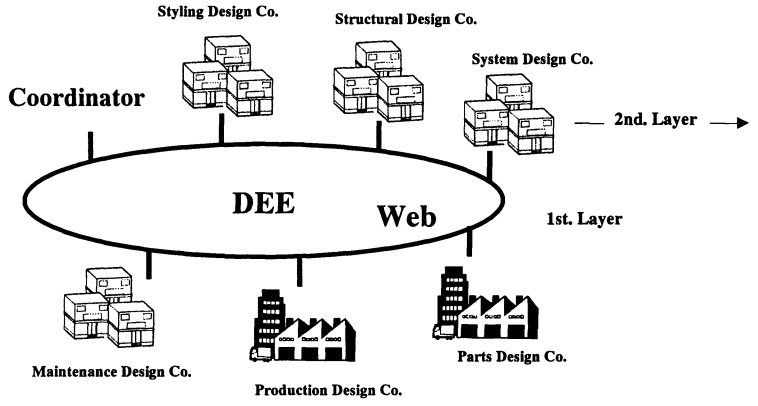

Figure 5. VME Layered Model

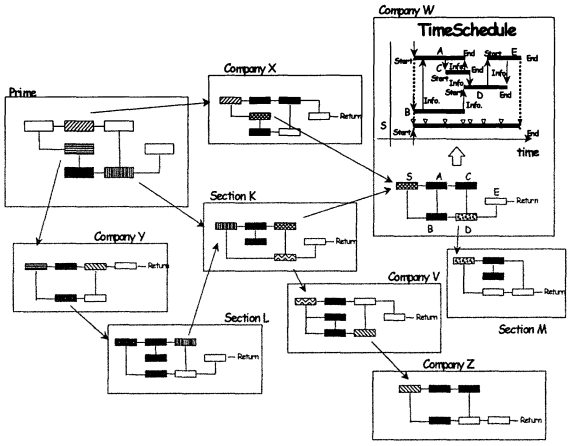

Figure 6. DEE Process Integration Model

The multimedia product data is created in each process element in the distributed engineering environment. In the process element, the product data is created by the application software (resources) using the output data from documents outputted by other process elements. The output data is included in the document description in the process element. The document elements that created in each process element are integrated according to the functional roles. That means the document can be browsed as the document of independent part, hierarchical group and all. And also, the multimedia data is seen independently. This concept is shown below.

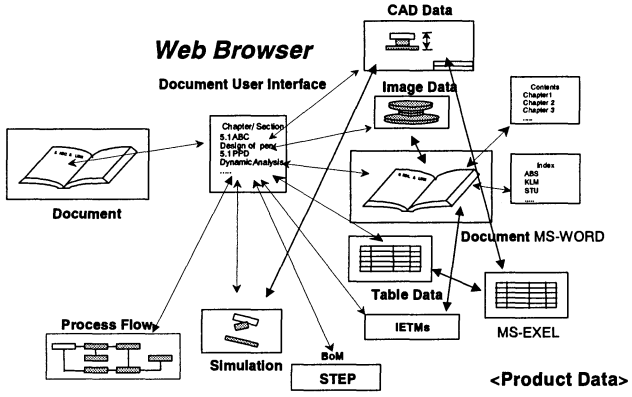

Figure 7. DEE Document Integration Model

As for the characteristics of DEE, mutual related links are constructed among process, document and product data elements by using XML. By the link structure, engineering collaboration and business management are possible on time as for the control of the whole business, the design change,

and so on. And, each element made a part becomes possible to reuse to all the product lifecycle by constructing them in the hierarchical class level and by the purpose. And, PSLX [2] is used for the dynamic business control.

4. DEE PROTOTYPE

A prototype DEE system platform has been developed to evaluate DEE model. The result is shown in Fig. This environment has a common 4D virtual space in VME on the Web browser that shows business functions, individual/integrated documents and multimedia product data in the document. The PSLX based scheduler controls the dynamic processes. The document includes HTML and word processing document, and product data such as SVG drawing and 3D XVL (eXtensible Virtual world description Language) simulation [3] and so on are called from Web data warehouses. XVL is the compression technology of 3D model transmission on the Web and has animation execution capability.

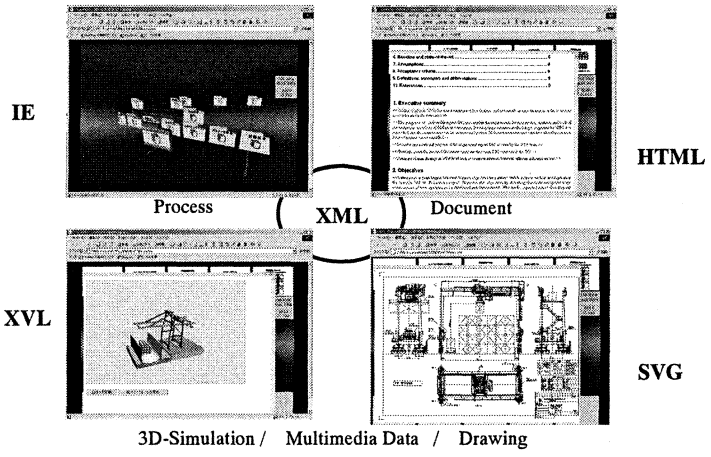

Figure 8. DEE 4D Virtual Space

5. CONCLUSION

This paper describes the collaborative engineering environment among VME for the lifecycle information integration. It is shown that such a distributed engineering environment is implemented by element parts of process, product data and document for the business and their dynamic

integration. And the functional integrated information is re-usable to each product lifecycle phase such as design, manufacturing, maintenance and customers services. Moreover, we developed the prototype platform of Web P2P browsing space based on ICT and verified the suitability and effectiveness of the environment.

Our next step will be the knowledge-based engineering of the Semantic Web RDF (Resource Description Framework) approach of OWL (Web Ontology Language) of W3C for DEE.

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