Context sensitive provision of enterprise information with a hypermedia based open system architecture

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Abstract

The paper describes the concept of a structured multidimensional space for information objects – the *Collaborative Information Space* and a new principle to locating information objects in Distributed InterNet Application (DNA) and to describe the locating of information objects and resources with an *information vector*. The information vector based on the Internet technique to localise addresses, the Uniform Resource Locator (URL); this principle is now extended with methods and accompanying parameters [4].

Keywords

Internet/Intranet based information system, context sensitive information supply, decision support, information management, knowledge management

1 INTRODUCTION

The new paradigms of enterprise organisation – extended, virtual, agile enterprises – will be very significant enablers of inter-organisational electronic business. However, these new paradigms place very stringent requirements on the enterprise operations in terms of their ability to adapt to changes and to exploit market

opportunities. Especially today markets are changing very rapidly and product life cycles are becoming shorter and shorter.

In a world of knowledge, consisting of valued or interpreted information, decisions may depend on one single bit, yes or no, acceptance or reject. Today, a systematic management of knowledge mostly takes place in large enterprises. This appears logical, since large enterprise usually have more overhead, highly qualified personal and a decentralised organisation. Small and medium size enterprises (SMEs) however cannot afford so much overhead and therefore have usually simple organisational structures. More and more SMEs begin to co-operate in trans-national networks, and hence, need support to manage their knowledge assets in a systematic way.

2 PROVIDING THE RIGHT INFORMATION

In today's corporate environments, documents, information and knowledge are critical assets. The knowledge they contain fuels a company's most vital business processes, from engineering and manufacturing to marketing and sales. In many companies, however, such important processes are often slowed and even stalled because the information objects and documents on which they depend are out-of-date, inaccurate, or simply unavailable to those who need them. This can be well demonstrated with an example from the process industry sector: During the operation of the complex equipment of a chemical plant with a high risk potential for humans and the environment the need for the same information may occur at several locations at the very same point in time. This information request has to be satisfied. It leads to a shift of decision competency to the local point of action and creates the need for decentralised utilisation of information stored in the enterprise information repository. The integration of different knowledge domains in one common enterprise knowledge base and the dynamical, real time availability of knowledge is therefore a primary requirement on information systems to support decision making.

To manage these changes in the very complex environment of industrial enterprises an up-to-date information and knowledge of the capabilities and the current state of the operation is needed. A special aspect to be considered is the need for integration across company and country boundaries. The requirements in particular are:

- Explicit knowledge of the information needed and created by the different activities in the enterprise operation. Knowledge that has to be defined as part of a dynamic model of the enterprise operation or workflow.
- Distributed information sharing systems and integration platforms capable of handling information transactions across heterogeneous environments according to the information captured in the model of the enterprise operation.
- The up-date of the operational data - information created during the operation -, as well as adapting to external changes.

- The integration of legacy applications in an open distributed environment.

The explosive growth of the World Wide Web has presented new opportunities – and new challenges – for today's corporations. The Web offers on-demand availability of information, regardless of the user's platform and location. Captivated by the ubiquity and variety of the Web as well as the ease and intuitiveness of hyperlink navigation, users are creating a huge demand for Web-based information. At the same time, Web servers and browsers are changing the economics of corporate computing. Hypermedia systems with their search engines and personal agents provide an adequate opportunity to search through vast amounts of information. Navigation is exclusively governed by hyperlinks, structuring of the information takes place within the hypertext itself. Hyperlinks have an associative character; they do not contain a structure. Problems come up with both the user interface and the excessive usage of hyperlinks. Already in a hypertext document with some hundred information entities, the navigation access via the edges of an entity is no more sufficient. A query mechanism following content, structure and presentation oriented aspects of the information must be possible, in order to select directly information entities or specific, user defined information clusters. Hence, hyperlinks are not suited for an efficient supply of structured information needed in the operational environment of enterprises.

Providing information tailored to the user needs in quantity and quality means an efficient match of information demand and supply. To fulfil this requirement, the concept of the *Collaborative Information Space* – a structured space for multimedia information objects - has been developed. *Information Objects* represent the necessary references to information, methods and relationships, they are specified in a multi-hierarchical catalogue, as a common register of the enterprise knowledge. The structured supply of *information objects* in a *Collaborative Information Space* enables a requirement-oriented availability of information using heterogeneous and distributed inventories of data, information and knowledge.

3 THE CONCEPT OF THE 'COLLABORATIVE INFORMATION SPACE'

Starting from the mental layer of individual users and their specific knowledge and perception, the '*Collaborative Information Space*' shall enable a structured presentation of interpretable, cognitive pictures on a physical layer and store it in a common knowledge base. The described concept of the '*Collaborative Information Space*' is built on the concept of 'semantic networks' introduced by Shannon and Weaver [1] and Nauta [2].

The structure of the *Collaborative Information Space* is a three dimensional cube and a set of components. The necessary references to information entities, methods and relationships are defined in relations to the three dimensions, e.g. all

information entities and their relationships are referenced, and hence, the user can select his particular information object.

Information does not fulfil a purpose in itself, but serves to support the value adding processes in the enterprise. As outlined in the CIMOSA methodology [3], business processes crossing enterprise domains can be analysed with respect to information aspects, such as the received and produced information of the constituting activities. Business processes are usually connected or may have internal loops, resulting in complex information structures with multi-dimensional relationships. To satisfy the needs of information users, three primary requirements for structuring can be postulated:

- Processes describe the behaviour of activities in the value adding processes in the enterprise
- Function Domains comprise enterprise domains, physical objects or resources such as buildings, production equipment, computers as well as humans, products, input or waste materials
- Information Aspects supply structured enterprise information.

The structure of the *Collaborative Information Space* corresponds to a classification scheme, which defines three generic, top-level object classes *Processes*, *Function Domains* and *Information Aspects*. Three dimensional information objects govern the internal structure. Additional properties of objects such as object type³ or time can be added. The mental perceptions of a human sender/provider are transformed, assembled and stored in the *Collaborative Information Space* into physical Information Objects. Information Objects should be specified in a catalogue of object classes, which represent the relevant enterprise information. Each element of a class provides a piece of information. The user receives the structured information needed for decision support, captures and interprets it in his own perception.

The structure is similar to hierarchies in a file system but exists independently of a file system. Data are stored and maintained only once in their original state. In the *Collaborative Information Space*, data are presented as Information Objects in a hierarchical structure. The hierarchy of Information Objects serves several purposes:

- The user can navigate in the three dimensions *Processes*, *Function Domains* and *Information Aspect* and the hierarchies of the *Collaborative Information Space*.
- The structure of the *Collaborative Information Space* enables the selection of information and relationships (hyperlinks).

³ An example of *Object Type* could be the different types or styles of a document appearing with the tag .doc for the representation of text, with .xls for table calculation or with .cad for a drawing.

- Additional classification into object types reduces the number of search domains (example: document types, building layouts or circuit diagrams).
- The user can search explicitly for one or several information objects or types.
- The structure supports the allocation of access rights. Some users or user groups may only read information objects of a domain, while others have the additional right to change this information.

An essential property of this new concept is the equal treatment of *Information Objects* and *Information Relationships*. *Information Relationships* are objects in itself, they are stored in a data base like objects. *Information Relationships* are extended with a multi-dimensional information vector, which describes the structure dimension of the *Collaborative Information Space*. The *Information Relationship* are not only self-referenced in the information objects, it is administrated in adjacency- matrices.

4 NAVIGATION: THE STRUCTURE BROWSER

People working in a decentralised organisation of an enterprise need structured information and navigation methods which both must be adapted to their specific work tasks. Semantic relationships should be visualised to become clear and transparent. It seems to be advantageous if the user can access the Meta⁴ data before getting the real data from the system.

The *Structure Browser* offers a new way of information space navigation. Closely coupled domains of interest can be placed side by side, as in a library with the systematic organisation of books. The user can navigate from one domain to another like on a geographical map. The dimensions of the *Collaborative Information Space*, are presented as tree structures. The trees look similar to the trees in the file structure of the Windows Explorer. The structure trees may contain nested branches, depending on the level of decomposition.

The upper row contains the function: 'Find *Information Object*' in order to start the search in the *Collaborative Information Space*, namely to select the object type as well as quick information about specific properties as for example responsibility for and validity duration of the object. Then follows the application of the *Structure Browsers* in the three primary dimensions. Navigation can also start with selecting the fourth dimension 'object type' to limit the search to objects of a class, for example documents

Example: Searching enterprise information in a paper producing enterprise - the following steps take place: Select 'all' for object type, select 'Roll and Cut Paper' in the *Process* dimension, select 'Colour/Quality' for *Information Aspects*

⁴ Classical examples of Meta data are bibliographical data of books, like author name, title, publisher name and ISDN number. In the present concept, Meta data are the description of relationships between *information objects* and *Information Relationships*.

dimension and select '(all) Function Domains'. The *Structure Browser* will start the operation in the *Collaborative Information Space* to provide the required information e.g. the quality aspects related to colour in the process 'Roll and Cut Paper' and the involved production resources.

After sending the client request to the server, the search operation for *Information Objects* matching the request is started in the server database. The *Information Objects* identified in the search are sent as lists back to the client and are inserted in his WEB-pages which hold the information content and allow the access to the remote data sources.

Together with the selection mechanism of the *Structure Browser*, the *Information Relationships* with the identified *Information Objects* can be presented. By dialling the extended URL, the user can obtain additional information about the identified objects as the so-called *Post-it Information* – e.g. Meta information as short descriptions of the object owner, his responsibilities etc. Upon dialling the *Information Relationships*, branching to each *Information Object* takes place, wherever it is located in any server in the Internet/Intranet and the object is presented to the client. The user can navigate with different methods in the structure of the *Collaborative Information Space*. The methods support the navigation creating semantic relationships between information objects. In pursuing the relationships forward or backward one obtains a deep, detailed impression of the network structure of the information object.

In the described concept several navigation options have been introduced and implemented in a prototype. Navigation with the *Structure Browser*, with block circuit diagrams or with drawings along the three primary dimensions of the *Collaborative Information Space* enables to find the desired information objects via different access paths. Making a search with the additional structure dimension object type provides an effective selection of the relevant information objects for a specific task out of a large data inventory.

Apart from the information it is important to know which employees know what. As soon as information objects are indicated the system knows who and where the related employees are, and knowledge maps of the enterprise can be produced automatically.

5 DISTRIBUTED INTERNET APPLICATION

To significantly enhance the competitiveness, particularly that of SMEs, in the global markets through enterprise model based decision support relying on real time operational data and operational support for enterprise monitoring and control. To support decentralised autonomous decision-making and help to reduce the information complexity. Enhancing the *Collaborative Information Space* concept and linking to hypermedia systems will achieve the goal. In addition, the *Collaborative Information Space* will acts as an integrating infrastructure for legacy applications and services to execute the process model. The proposed architecture follows the WEB server concept, namely a multi-tier application,

which connects to the client PCs. Standard WEB browser as Microsoft Internet Explorer 5 and TCP/IP as the network protocol will provide remote access via the Internet.

The concept demonstrates by means of an industrial pilot advanced enterprise management, monitoring and control in an extended enterprise network. A pilot modelling application will employ these capabilities which will be developed by linking some of the most developed relevant methods and architectures: CIMOSA for enterprise modelling and simulation, multi-tier-application principles for distributed management (once in place, the platform and location of the data becomes irrelevant), DCOM/COM+⁵ for object services and the environment for the multi-tier-application in distributed heterogeneous systems based on the business integration framework and the concept of Distributed InterNet Application (DNA) from Microsoft Corporation. Figure 1 show the concept for a federated network to use decentralised documents, information and systems.

Figure 1: Distributed InterNet Application

As people spend more time building distributed applications they are beginning to realise that there are two distinct types of design issue they need to address. First is how to build standalone three-tier applications. Both Transaction Services and

⁵ Component Object Model

enterprise Java Beans address that problem. Second is how to integrate multiple applications together in a distributed environment.

A tightly synchronous remote object method invocation approach, such as that required by CORBA, is incredible complex for users. Instead, customers are moving loosely coupled asynchronous model of application-to-application integration. In other words, they want to use a tightly coupled system for single applications, but they want to move to message passing or even simple HTTP Post as a way to wire applications together. This is a model that we are embracing.

Our initial focus is business-to-business and internal application integration over the web. After all, it's much easier than using CORBA. XML is a relatively simple mechanism to file hierarchical or structured data, whatever protocol you use. XML lends itself to becoming an intermediate data format for communication between applications that cannot be re-designed to support the same data format. For example, SAP has its own mechanism for declaring a customer record, and so does BAAN or PEOPLESOFT a.s.. With XML for this solution, the result is a combination of the simple but rich XML data tagging format, along with an agreed schema defining what data is, plus technology for mapping the schema into existing applications and sending these back and forth. This combination fulfils a high percentage of typical integration requirements. The cool thing is that it doesn't matter if you have enterprise java beans on one side and COM objects or ActiveX Controls on the other side.

6 CONCLUSION

A common architecture of all available objects and of the protocols in an open environment is considered a long-term goal for federated information systems. The proposed system architecture is based on the WWW- technologies and, with an object broker, allows to access databases, file systems and applications. With specified interfaces, distributed applications can employ any methods or services in federated environments supported by specific system integration functions. Consistency problems of information- relationships have been addressed and partially solved with the introduction of relationships matrices; however, further research is needed in this field. The main advantage of the reference consistency results from the representation of the *Information Relationships* and the accompanying structure information in an own data administration system. The concept provides a quick and efficient supply and handling of enterprise information, which can be easily operated by the business user.

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8 BIOGRAPHY

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