Distributed Global Enterprise Directories Implemented as Organizational Subsystems to WfMS

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Abstract

At BIS'97 we have demonstrated how structural organization design takes place in its traditional form and attributes of an effective organization design process have been examined. A vision of an organization design process has been presented together with a possible architecture of an application environment.

This report will go on from there and show the first implementation results of the GroupOrga (Groupware Based Organization Design) project.

The major concern of this manuscript is the establishment of a global enterprise directory for support of business information and workflow systems. As a first focus some impediments to distributed organization design will be named and commented upon. Since these hindrances have been encountered in discussions in practice over the last year, they are quite interesting for practitioners in the business information systems field.

In the following, parts of our concrete distributed organizational subsystem, the GroupOrga system, will be demonstrated. The GroupOrga organization repository will be dealt with, and some graphical tools (C++ and JAVA tools) from the GroupOrga toolset will also be shown. Furthermore, it will be made clear how replication technology supports data replication in the scenario of distributed organization databases. Some of the obstacles to distributed organization design will be addressed, and their possible technological circumvention will be suggested.

Concluding, recommendations are given on how to proceed in the area of global enterprise repositories and their distributed management and administration.

Keywords

Architectures, Business Process Reengineering, Data Replication, Distributed Databases, Global Enterprise Directories, Groupware, Modeling of Information Systems, Organizational Design, Organizational Structures, Organizational Subsystems, Workflow Management

1 Introduction

For organizations with complex, heterogeneous and distributed business processes and workflow computing environments, there are many good reasons to implement a global enterprise directory. Unfortunately, there are just as many impediments to setting up and fully exploiting such an organizational structure directory. The result is that only few organizations are actually implementing one, while many of them are working with workflow management (WfM) and business information systems and are planning for a global directory.

Such an organization directory is a special-purpose database used to organize, secure, and manage information about organizational entities, their structure and relations, including users (actors), units, roles, positions, knowledge/skills, workgroups, and anything else that could be workflow-addressable. A global enterprise directory is designed to manage all workflow and office resources throughout the enterprise (be it local or international/global) in a unified manner.

For instance, instead of entering and possibly changing the same user name in a loans process, a purchase workflow and a travel expenses process, the name would be designated to a role description and entered into the global directory. From here it would be considerably simple to assign this role description to various workflows without the need to keep a record of where a particular person's name has been keyed in and used. After the name or any other organizational structural information has been recorded, workflow applications can directly access it and other distributed directories can synchronize with it.

When moving in the direction of global structural directories, the reduced administration costs more than make up for the implementation effort. Such enterprise directories can also make life easier for workflow developers who need organizational information in their process descriptions and programs. Instead of having to search several application- and location-specific directories, the global, distributed directory is ready at hand for their information needs. The result is more sophisticated directory information at lower cost.

However, as our own experience from practice shows, the barriers to implementing this vision of organizational repositories include organizational politics, privacy concerns, data cleansing, and multivendor interoperability.

2 Barriers to Distributed Enterprise Directories

2.1 Organizational Politics - Or: Hands Off my Data!

Some kind of organizational data, such as user names and network access lists, already exists in application- and network operating system-specific directories. Mostly, these directories cover a fraction of the whole organizational structure's information of an organization. This already existing approach of distributed administration of structural information is a very sensible one. It allows the organizational members, who work at the core of the organization and who know the organizational details, to edit and change the structural information they

need and to introduce always up-to-date data. Hence, this concept is highly advocated in the GroupOrga project.

However, while on the one hand these advantages of distributed administration of structural data exist, distribution bears problems on the other hand.

Typically, the aforementioned organizational data may be brought into a global distributed directory from existing specific directories. Alternatively, several directories may be integrated and mended together into an apparently seamless whole without moving data. Either way, as soon as a project for a global enterprise directory lays its hand on someone's data, this is a matter of organizational politics.

Payroll, personnel, and human resource departments are not accustomed to offering their data for building a global directory for organizational structure information or modifying them to accommodate somebody else. As an example from our cooperation with a large, global, Germany based business bank: If through some bureaucratic process the human resources' database would be chosen as the center for a global enterprise directory and if then this database should be modified to suddenly store IP and email addresses or availability information, as well, the human resources responsible would not stand for this change. This single example shows, that organizational politics may derail any global enterprise directory project unless a powerful champion in the organization can be found. In case of our cooperation project such a change agent or change promoter from the bank's higher management had indeed been found to foster the trial implementation. Otherwise, it seems to be nearly impossible to do it from the bottom up.

A solution may be to set up a system where the central repository only reads information from other directories and combines them to one large directory. Any changes concerning information in the departments are to be undergone in the departments only, rather than at a central unit unless there is serious necessity for such a central line of action. This is usually ideal, because a central repository does not have to write to other directories due to the corresponding organizational regulation. Replication in real time between directories is possible and allows for fast and seamless distribution of changed information (cp. section 3.5). Nevertheless, political issues and bureaucracy seem to remain major impediments to the deployment of global distributed directories.

2.2 The Privacy Concern

When information is promoted from limited-access systems such as payroll or human resources to a much more widely accessible global directory (e.g. through replication technology to other locations), privacy will become an issue. Hence, certain information may need to be protected by password and finely tuned access rights and certificates. Integrating such strong security may complicate the directories usability but also makes it suitable for a wider range of information retrieval, as well as workflow and office management applications. In addition, searches should be reasonably limited which may have

two reasons: The first is the fact that unwanted phone calls and emails have to be dealt with, the other is that people are not wanted to download the whole directory into their mailing lists. At the other side of the coin, this search capability is the advantage a global directory offers in terms of workflow definition. Now the workflow designer can easily identify employees with certain skills and knowledge or with some extra time available to take part in a workflow procedure. While formerly design information was limited to the designer's own (locally limited) know-how he/she can now fall back on the vast knowledge of the global enterprise directory and search for and select the appropriate actors within a much wider scope of people, roles, locations and skills.

2.3 Cleaning up the Mess

Each of those aforementioned distributed repositories is likely to contain entries that are improperly formatted, not detailed enough, missing, duplicated, or outdated. Such bad structural information may cause no harm where it is currently stored, however, when replicated into a global enterprise directory a thorough checking and clean-up becomes unavoidable. The problem is multiplied by the fact that data from each source will be unsuitable in its unique way.

A related problem includes "good" structural information that is formatted differently in different databases. Apparently, the obstacle of different data schemata is not only a problem of multivendor systems, as the following section will propose, but also one of different departments in an organization.

Our cooperation with a hardware and software producer showed, that an uncountable number of directories existed in the company's intranet in 1996. An attempt to install a company wide directory by *simply* linking the different departmental directories via intranet technology was soon given up and not resumed until the varying data structures have been cleaned up.

2.4 Multivendor Systems at the Start

To integrate or synchronize directories from multiple vendors, three issues have to be addressed: standards, architecture, and schemata.

Great steps forward have been made concerning standards since April 1996, when 40 vendors made the first major announcement about LDAP, the Lightweight Directory Access Protocol. Since then, LDAP has been almost universally endorsed. However, despite LDAP interoperability of directories is still in the early stages: Infrastructure vendors have to implement LDAP, operating systems have to support these infrastructures, developers have to use the infrastructures, and users then have to deploy the resulting applications. Replication between infrastructures of multiple vendors is still far away.

In terms of architecture the most basic question is whether or not to have a physical central repository, as opposed to a virtual directory. In the latter case multiple directories synchronize with each other, but there is no central repository as such. Such a directory refers a query to other directories until the correct result can be given. The first case includes a central repository which

contains all that data from all distributed directories which is considered important to other directories, as well. Any other structural information is only stored in the distributed directories and is not replicated.

To read from and write to distributed directories, the synchronization operation must understand the different directory schemata which define organizational directory entities and their respective attributes. To give a very simple example, such common schemata are designed to provide a minimum definition of the attributes of a "person" entity, such as email address, name, knowledge and job position, etc. In other words, these schemata perform an invaluable function in telling client software (such as WfM software) what to look for in the directory. In this context it must be noted, that however many attributes are defined in such a schemata, they may be more than enough for one typical application and certainly not enough for every other conceivable application. To determine what schemata is sufficient in terms of generalness is a very complex task.

3 A Distributed Organizational Subsystem: GroupOrga Approach

Some of the previously enlisted impediments to global enterprise directories cannot be just swept away by brilliant concepts and comprehensive technological approaches. The *social* and *political* aspects of global organizational directories should not be overlooked and have to be tackled with accordingly. However, this report cannot satisfactorily come up to both expectations and will hence concentrate on the technology questions.

The following sections will present and describe aspects of the GroupOrga approach to distributed organizational design in order to address those mentioned problems that can be overcome with technological innovations.

3.1 Two Systems Interact - WfM and Organizational Design

Similar to other approaches to business process modeling (e.g. [5], [10] or [20]), GroupOrga clearly distinguishes between the aspects *what*, *when*, *how* and the aspect *who*, or in other words, between process modeling and organization modeling. The latter aspect specifies the actors, who are responsible and qualified to carry out tasks within business processes. While most implementations do not separate between processes and actor assignment specification, the implementation and continuos administration of a global enterprise directory as proposed here supports this requirement.

If at all, business information and workflow systems only support static actor assignment or strategies with simple role models (an overview of different approaches and definitions for the role concept can be found in [9], the aspect of organizational roles covers [8]). For a smooth interaction of such business information and workflow systems and the necessary organization modeling environments, a definition of arbitrary, problem oriented actor assignment strategies is inevitable. Process modeling and organization modeling aim at different goals. The first is concerned with the flow of work. The aspect *who* is also of interest

eventually but cannot be coped by process modeling experts, since they do not have the sufficient know-how about organization and how to depict it in enterprise directories. The necessary link (or better: integration) between the two sides is done through organizational references saying who has to perform which work (cp. [16], p. 547). An organizational reference relates (parts of) workflows to entities in the organizational model which is laid down in the global enterprise directory. These entities may be described through an enumeration of actor's names. Alternatively, they might be defined by means of unit, workgroup, skill-group or similar specifications, indicating that only those members of an organization can perform a piece of work, who belong to such a group and show certain properties. For example, such a list of properties would characterize managers of project groups. Workflows may be defined in such a way, that specific steps can exclusively be performed by actors who have the knowledge and skill of workgroup managers.

This separation of process modeling and organization design is quite natural and can be found in real-world organizations. Moreover, it bears some other advantages:

- *Separation of data:* If the two fields of organization are separated, they can be secured independently. This reduces the drawback mentioned in section 2.1, that some departments would not allow that their organization directory is used for other purposes than storing structural information.
- *Separation of modeling tasks:* Different duties, like process modeling vs. organization design, are carried out by different staff. This mandatory separation is supported by clearly dividing process repositories and enterprise directories.
- *Reuse of partial organizational modules:* Organizational structures are modularized according to specific criteria, like location or responsibility. These criteria differ much from those used for process modularization. Hence, a separation allows for independent definition without mixing two distinct areas.
- *Distribution:* When process and organization repositories are separated, the effect of distributing the information helps a lot. With a distributed directory structure, more organizational members can participate in the organization design process. A thought which will be further examined in section 3.4.

An investigation in Workflow Management Systems (WfMS) and process modeling software (cp. [13], [14], [11], [2], and others) reveals, that none (e.g. [21], [3], [6]) or only very few approaches in WfM pursue the design and documentation of structural organization - nevertheless, its necessity as a mandatory task for WfM is acknowledged broadly ([13]).

GroupOrga will bridge this gap between information systems and organization systems, or to be more precise, between today's WfMS and organizational structure.

3.2 A Common Schema - The GEIMM Enterprise Model

Section 2.4 has introduced a major obstacle on the way to realization of such an integration of WfMS and enterprise directories, as it was proposed in the preceding section: that of different directory schemata which define organizational directory entities and their respective attributes.

Our GroupOrga project is tackling this problem by developing a comprehensive enterprise model which allows for detailed description of organizational entities and their relations. It explains various organizational perspectives, such as the organization structure ("How does the organization structure look like and how is it populated?") and some organizational policies ("How to assign organizational entities to process steps?"). Such a clearly and precisely defined schema of an enterprise directory (be it global or local), helps to integrate various client software applications (e.g. WfMS) on different platforms. With its currently eleven entities (among them actors, skills, roles, units, workgroups, agents, etc.), the GroupOrga Enterprise Information Management Model (GEIMM) provides a framework for distributed directories to read from and write to each other. Similar models with two or three components can be found with [1], [7], [19].

The BIS'97 contribution focused in more detail on the GEIMM, so that no deeper insight will be given here (cp. [16], p. 554).

3.3 Implementation of a Global Enterprise Directory: The GroupOrga Database

The conceptual enterprise model GEIMM has been implemented as an organization repository in the course of the GroupOrga project. Such an organization database has existed so far only in the form of organizational handbooks, quality manuals and other organizational documentation. The application programs depicted in Figure 1 and Figure 2 are the graphical user interfaces for accessing the structural information stored in the GroupOrga organization repository.

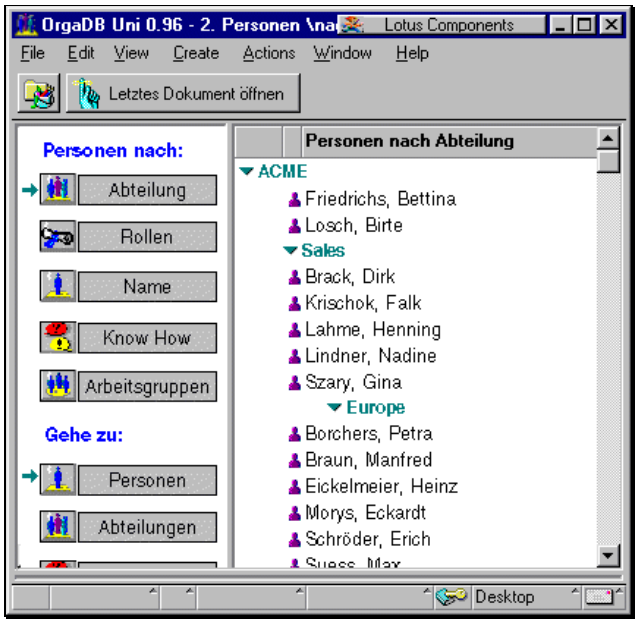

Figure 1. GroupOrga Organization Repository

This organization repository is a groupware database built in compliance with the requirements of the GEIMM. Its base, Lotus Notes, serves as the replication engine and allows for a simple and easy to maintain environment to distribute the structural information in an organization. Also, via the replication mechanism, the collection of changes and adaptations to the model undergone in different locations is easy to support.

While Lotus Notes provides a database engine which is *not* markedly set up as a relational, network or object-oriented engine, for the GroupOrga project we implemented GEIMM as a relational data structure. The big advantage of Lotus Notes as platform for the GroupOrga implementation is, that is allows for both at the same time: Rigid data organization in form of a relational framework and dynamic, distributed data administration through replication procedures. For ease-of-use purposes, a graphical ER-modeler, the GroupOrga OrganizationModeler has been developed (Figure 2).

In addition to these graphical user interfaces, repository queries are possible through an interface component which enables external applications to retrieve data, and through queries in natural language formalisms. The formalism can be compared to standard makro-languages like those which can be found in standard word processing and spreadsheet applications.

Quite recently, the GroupOrga OrganizationModeler has also been implemented as a JAVA based application, even more driving on the idea of a distributed organization design approach which integrates every organization member. The current JAVA development provides with the proper platform to easily distribute application programs without the hassle of shipping software and providing with bug-fixes and patches for traditional programming languages, such as C++, for example (cp. [15][1]).

[1] The JAVA GroupOrga OrganizationViewer can be tested at http://fb5www.uni-paderborn.de/winfo2/GroupOrga

How these various graphical and query user interfaces to the GroupOrga enterprise repository interact within the GroupOrga architecture has been outlined in [16], p. 558ff).

3.4 Distributed Organization Design

"Why plan the organization design business-wide and distributed?" is an adequate question at this point. Why an enterprise repository should be administered in a distributed way will be the focus in this section.

The major reason for coordinating the use of structural organizational data across an organization is, that it is not sufficient that different parts of an organization share a common goal. They also have to work from a common base of information about organizational structures if interaction by means of workflow control and steering is the aim. Else, they will be uncoordinated and will end up designing structures which do not match and are counterproductive. Moreover, competing in a global economy requires an organization that is designed on a global and distributed basis ([4], p. 33ff.)

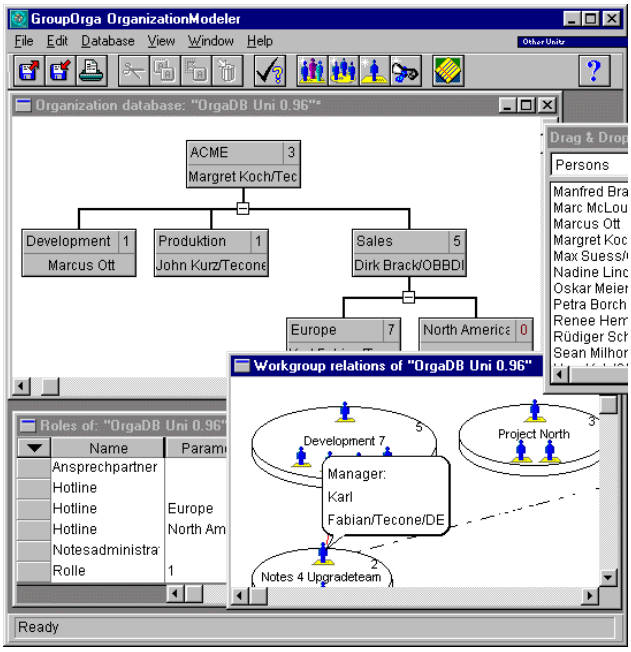

Figure 2. OrganizationModeler user interface

Information shared and communicated is probably the best means for coordinating the daily work of different organizational units in an organization[2]. However, it takes shared information about *who* has to perform what, to really coordinate the work of different parts of an organization through workflow design.

As explained in section 2, the natural tendency of individual departments to develop directories customized to the needs of their organizational units leads to a divided collection of structural information that inhibits the sharing of information. The result is uncoordinated design strategies in the organization's structure.

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[2] As an aside: This holds not only true for work controlled by WfMS, of course.

In order to leverage all advantages of data distribution, a coordinating technology, such as GroupOrga, is necessary.

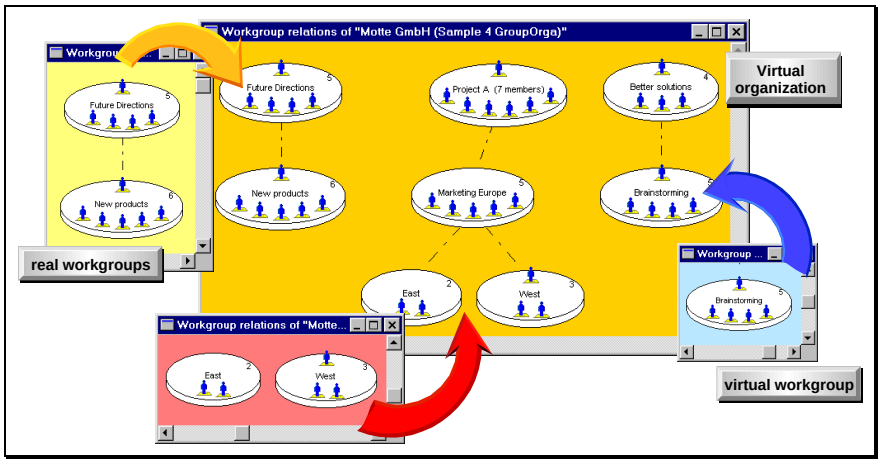

Figure 3. Distributed Organization Design Process

To obtain fast, coordinated structural design, enterprise directories that transcend intraorganizational boundaries are needed. As a next step, interorganizational boundaries may need to be crossed as well - this is illustrated in Figure 2. *But* this does not imply a central agency who administrates this common enterprise directory. Rather, each person has access to these databases so that they can collect (and deliver) the intelligence each person in the organization can give when it comes to the design of effective structures for business processes.

The underlying drive to manage distributed directories clearly should come from those who stand to benefit directly from their correct use. So, when this drive comes from units further down in the organization, such initiatives lead to many detailed and always up-to-date directories, suited to the needs of the department. Once integrated they make for a comprehensive organization repository with valuable and helpful data.

The next question is, how should-upper level management put forth a countervailing force for coordination and integration of such distributed organization repositories and their administration? In cases where upper-level management has simply taken over systems development, the result has been little helpful to dynamic workflow environments. A more effective approach is one within which the *top-level design* (in terms of a frame-giving design, the "top" of the pyramid) is done by senior management, while *bottom-level design* is carried out by those responsible for carrying out the work. Figure 4 depicts these possible design levels (cp. [17]).

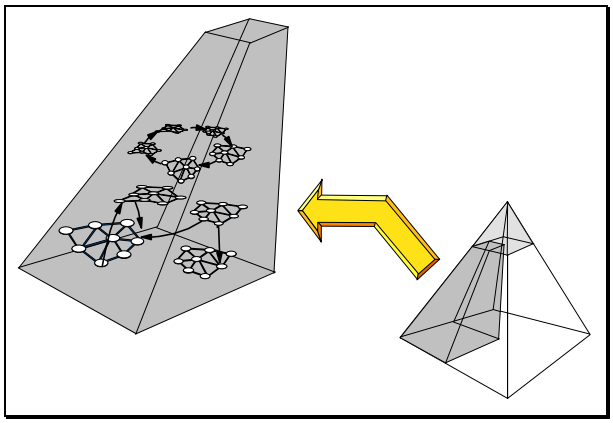

Figure 4. Top-level and bottom level design

3.5 The GroupOrga Replication Architecture

Replication is the key in GroupOrga to make a number of stand-alone directories into a distributed one. While this has not been standardized yet, the replication technology of the groupware platform Lotus Notes must be seen as the industry standard to date.

Conceptually, the GroupOrga enterprise repository is *one* self-contained repository, but technically it consists of various repositories which exchange information through replication. For such a repository, two choices exists: (1) any of these repositories contains all structural information available in the company or (2) each repository holds only some information while other information resides at other locations. Which choice is the better cannot be determined for all possible cases. Most likely, however, there will be a central repository (e.g. at the headquarters) which holds all structural information. One good reason for setting up the enterprise directory like this is that of security: If one distributed repository crashes, all information can be replicated back to it from the central enterprise repository once it is running again.

Whatever choice is taken to replicate global directories is up to the organization. In the following, both technological options will be further outlined.

In case of the *single-master replication* (gray arrows in Figure 5) the distributed repositories do not communicate with each other but only indirectly via a central repository. Each requested change (A, B and C) will be forwarded from the local directory to the single master. Once all changes have been documented in the single master (or after a certain period of time), the changes are propagated back to all local directories.

The *multimaster replication* allows changes immediately when each of the three clients requests such a change (X, Y and Z, blank arrows). Changes are then forwarded to multiple directories (and not only the single master), depending on

configuration. These changes continue to propagate until all local directories have all changes.

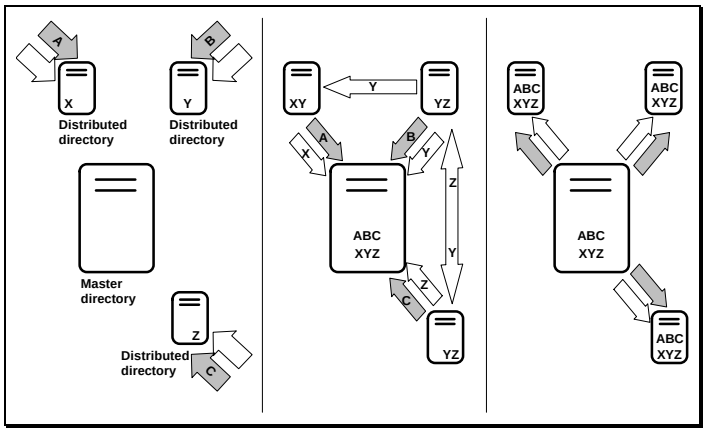

Figure 5. Single-master vs. multimaster replication

Although both configurations have one (single) central repository, their respective designation is still correct: The term *multimaster* refers to the fact that all distributed repositories have the right to realize the changes, as if they where master repositories themselves. It does not relate to the position (i.e. the center) or its importance in it (i.e. being located at HQs).

Because the single-master configuration is less scaleable and due to multimaster's quicker change propagation, the latter is the replication architecture which is mostly preferred for GroupOrga setups.

3.6 Tackling of the Multivendor and Standardization Problem in GroupOrga

The question of interoperability between multivendor systems has been dealt with early in the GroupOrga project lifetime. Siemens-Nixdorf's (SNI) *Organization Information System* (OIS, cp. [20]) is an integral part of the workflow management software *Workparty*, which is also developed by SNI. Since we saw a number of similarities between the OIS and the GroupOrga approach, a fruitful ground for a cooperation was found. However, there were various obstacles before OIS and GroupOrga could cooperate. Both application environments run on different operating systems, preventing from a simple data-exchange in the first place. Secondly, the OIS database is in a completely different format than that of GroupOrga and the respective enterprise schemata differ in certain details (cp. sections 2.3 and 2.4).

As one part of the GroupOrga project, the GroupOrga specifications have been adapted to synchronize with OIS. Most importantly, the respective organization modeling environments, OIS V1.0 (cp. Figure 6) and GroupOrga OrganizationModeler (cp. Figure 2), are currently integrated to work seamlessly together. The GroupOrga OrganizationModeler has been extended by a synchronization operation that can now read and write OIS and GroupOrga repositories and transfer organization models from one schema to the other.

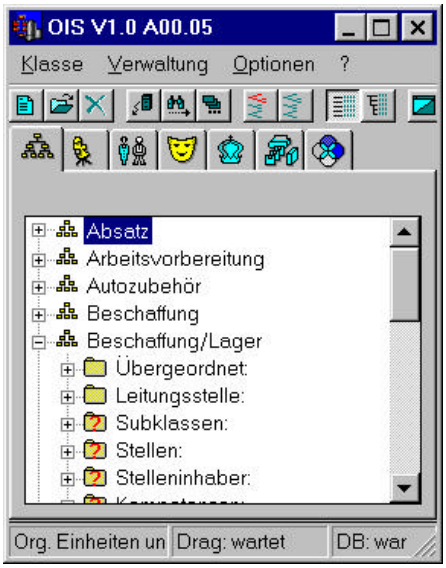

Figure 6. Siemens-Nixdorf's OIS V1.0 interface

Concerning the usage of directory standards (and thereby bridging the gap between multivendor systems, cp. section 2.4), the GroupOrga system relies on the manifold standardization options which are provided by the underlying groupware platform Lotus Notes. Both LDAP and X.500 (cp. [18]) are key components of Lotus' directory strategy.

Many of the concepts described in the X.500 recommendations are implemented in Notes in a similar way. For example, the replication concept which Lotus Notes provides is even more sophisticated than the one defined in X.525. It treats two replicas as equal parties allowing modifications in both locations without requiring one to be the master and the other one to be the slave, like X.525 does. Changes in both replicas are consolidated during the next replication.

By using the concepts provided by the groupware platform, a service that is often referred to as an X.500-like directory has been realized in GroupOrga. This is possible since the Notes server natively supports LDAP enabling any LDAP client[3] to access directory information included in GroupOrga organization databases. Moreover, each Notes client supports LDAP allowing for users to access any other enterprise directory in the distributed architecture which complies with LDAP.

Despite the industry being in an early-adopter phase for global enterprise directories, some companies are looking at third-party products that are relatively inexpensive and easy to implement. They begin to work on data cleansing and directory rationalization now. What has to be made sure is that the product is based on standards so that it is possible to integrate it with other directories and application systems. For instance, the GroupOrga organization database is LDAP-based which raises its potential for integration.

Organizations should go ahead and test global enterprise directory concepts. There is no use to standstill and say that nothing can be done due to a lack of proven products. Pilots and proof of concepts installations are suggested at this stage with four goals:

- Reduce the cost of directory administration by applying a distributed design concept.

[3] And not only Lotus Notes clients.

- Improve existing structural data by cleaning up the existing data through help of *every* member of the organization.
- Reduce the process design and administration burden by moving valuable structural information out off the workflow applications and into distributed directories.
- Make the enterprise directory available to many applications (WfMS, office systems), so that programmers will not create more new (inconsistent) directories.

4 What is coming?

Even though few companies can implement organization directories today, forward-looking users have grasped the idea of directory and application integration and are heading this way. For instance, organizations want to store directory information in easier to maintain databases, which have strong management, search, and security facilities. GroupOrga has been implemented in form of evaluation installations in various practical settings and conditions: Among others are cooperations with KPMG, Siemens Nixdorf Informationssysteme AG, Deutsche Bank AG, Deutsche Babcock Dienstleistungs GmbH, and agens Consulting GmbH. Moreover, parts of the GroupOrga toolset are integrated in an office and workflow management application offered by Pavone Informationssysteme GmbH.

In addition, companies may want directories to deal with (technical) network issues and manage a broader range of services. For example, global directories could be used to manage e-mail systems and Web services. Although, using a global directory to lookup e-mail addresses, phone numbers and room locations is advantageous, the big payoff of global enterprise directories will be more of a single point of administration for all types of distributed applications and not so much in terms of a user and access control database for network administration.

The global enterprise directory must become more of a tool and information pool for everybody involved in the business processes. It must allow for easy, scaleable administration from every desktop and simple integration with existing business information systems and workflow applications.

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