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Process Oriented Collaboration in Grid-Environments: A Case Study in the Construction Industry

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Process-Oriented Collaboration in Grid-Environments: A Case Study in the Construction Industry

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ABSTRACT

This paper addresses the process-oriented collaboration based on a grid-based platform for the support of virtual organizations (VO), illustrated on the example of the construction industry. Distributed, organizational and IT-structures of teams involved in vintage complex projects cannot be managed with conventional methods in an appropriate manner. Both using a grid platform and grid-based services, in conjunction with semantic methods for consistency saving and goal-oriented process management can increase the efficiency of collaboration processes in large-scale projects. A hybrid grid- and web service-based architecture for the next generation of VO service and a gateway solution was developed integrating the process-oriented perspective and prototypically implemented. The problem, as well as the solution on the basis of the hybrid system architecture combing the benefits of the cutting-edge technologies, the methodical concept for modeling VO processes and their automated execution on a grid platform are discussed in detail.

Keywords

Grid Services, Ontologies, Business Process Modeling, Construction Industry, Virtual Organizations, Collaboration

INTRODUCTION

Problem and Application Domain

Effective enterprise collaboration and cooperation and efficient utilization of appropriate information technology are basic prerequisites for a successful virtual organization. A virtual organization (VO) is built as a combination of persons, companies and other real organizational entities. A virtual organization has a transient nature and/ or can be subject to changes throughout its lifespan. Virtual organizations are defined through dynamic, i. e. alterable “relations” such as roles and access privileges, which in term define the participation of the involved real or virtual actors (Camarinha-Matos, Afsarmanesh and Ollus 2005).

Grid computing aims at providing VO’s with the ability to manage resources such as data, sensors, computers and computer networks and thus ensures their effective deployment for achieving a cooperative solution for a particular problem. A Grid is a system that coordinates IT resources that are not subject to centralized control (Foster 2002). Regardless to their operating characteristics, Grid computing enables heterogeneous and dispersed IT resources to be virtually shared and accessed across an industry or workgroup. Significant challenges to be addressed still exist at all levels, for example security issues or the development of grid-adopted applications (Vykoukal, Wolf and Beck 2009).

Projects within the grid community have focused mainly on high performance computing and resource sharing in research and development VO’s (Coppola et al. 2008), paying little attention to industry VO needs, even though requirements have been properly identified (e.g. Foster and Kesselmann 2003; Milke, Schiffers and Ziegler 2006). The comprehension of the significant potential of grid-technologies for solving current industrial problems leads gradually to a change in the development and implementation perspective of VO projects.

Each industry branch comes along with its own specific features and requirements, which in terms necessitates their separate consideration. Generic solutions without domain specific extensions provide little added value and lead to marginal implementation efficiency in real world problems. The field of construction is ideal for achieving trend-setting research results in regard to the problem mentioned above. The construction industry is characterized by one-of-a-kind products and one-of-a-kind projects, typically leading to complex project structures including intricate contractual relations, frequently changing tasks and high dependability on external factors, effecting in total variegated challenges. There is a continuously growing demand towards improved handling of construction industry projects on the one hand and towards securing and achieving economic efficiency and cost reduction on the other hand. The implementation of different project platforms and computer programs such as document management systems or plan-, time- and construction deficiency management systems is a common necessity. Industry specific characteristics are mostly unique constructions, which build the basis for the respective construction projects and the unique collaboration networks between the participating predominantly small partners.

The resulting project structures are characterized by high complexity. This manifests itself in complex contractual bindings, non-specific, constantly changing duties and responsibilities as well as dependence on external factors (environmental, infrastructural, socio-political aspects), all of which induce ad hoc decision-making. Virtual companies in medium and large constructional projects comprise dozens of sub-contracting partners which in turn are placed on multiple hierarchical levels with highly complex horizontal inter-connectivity. The different processes, accountability, duties and responsibilities build up to intransparent and defective combinations leading to significant time and cost inefficiencies. Resulting project information structures are mostly heterogeneous and highly redundant, as most of the participants are implementing their existing IT-infrastructure. Conventional management instruments do not pose the required abilities to ensure successful management of such a complex infrastructure.

Objective and Approach

There exist various platform approaches regarding the IT support of Virtual Organizations. However, centralized Client-Server systems based on proprietary interfaces as well as Corba-based systems are increasingly being replaced by more flexible technologies that enable stronger distribution of the information, unify the remote access to services by the use of the SOAP standard, and warrant structural data interoperability via XML-based language constructs.

The described shortcomings constitute the prerequisites for the beneficial implementation of a grid platform in the project BauVOGrid[1]. Their implementation in combination with semantic methods for tasks like consistency checking, information retrieval for the different expert-views of the participating parties, as well as goal and functionally oriented process management can create the basis for a successful grid-based implementation in the construction industry. The central assumption of this concept is that the described industry requirements can be fulfilled and the efficiency of the collaboration processes can be increased. This approach is innovative, because it allows all participants to collaborate with justifiable expenses and efforts through utilization of new universal process-oriented working methods and modern information and communication technology, based on an integrated grid platform allowing even mobile access to the platform “on the field”.

This article is organized as follows: the first section describes the central challenges for the efficient collaboration in the construction industry. Then, in the following section, an approach is introduced that is suitable to address those challenges. Emphasis is placed on the process modeling as central VO management aspect. A modeling method illustrating the proposed concept is given. A separate section deals with the grid-based execution of collaborative construction processes and addresses specifically features of the identified application domain. A summary of the results and an outlook constitute the last section of the article.

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[1] BauVOGrid stands for „Grid-Based Platform for the Virtual Organization in the Construction Industry”. The project is funded by the BMBF (German Federal Ministry of Education and Research) within the D-Grid Initiative (promotional reference: 01IG07001A).

COLLABORATION PROCESSES IN THE CONSTRUCTION INDUSTRY

Specific Challenges in the Application Domain

The challenges for virtual organizations in the construction industry result from its complex project structures. Warranting efficient and successful cooperation within a Virtual Organization in construction poses a range of specific requirements on the supporting IT system, e.g.:

- an integrated schema enabling the common understanding about the use of all resources and services, i.e., a system-wide ontology,
- standardized extensions of the integrated schema to capture discipline-specific aspects,
- flexible capturing and management of project processes together with the associated resources and services as well as the responsible and cooperating persons and partners,
- business rules and methods that enable the use of the business objects for VO management and at the same time establish the basis for a harmonized service platform for all VO participants,
- coherent information logistics providing proper authorization, rigorous access control to resources and services, and context-dependent views on the overall system for all VO participants.

Defect Management processes are vintage processes in the construction industry. Defect management involves three types of actors that need to collaborate for the achievement of fast and cheap problem solutions, even though their views and positions may often be controversial. These are usually the Owner, the Main Contractor, and the Subcontractors. Typical contractual relationship can be expressed by a 1:1:N relationship, but it does not provide sufficient consideration of complex cases. On a large construction site like the project Campeon visualized by Figure 1, the occurrence of numerous defects during the construction phase may be the case. As considerable cost factor these defects need to be duly managed, largely in parallel. The Campeon consortium involved five Main Contractors and over hundred Subcontractors. 140 locations within the construction site had to be linked, based on a heterogeneous distributed IT-architecture. The execution of the construction project involved several information systems and platforms from different sources (e.g. cross-company communication platforms and data management systems, in-house IT and SAP). Communication among each other was not or only poorly possible. Additional resources and effecting heavy extra costs resulted from the fact that data input and manipulation generated a degree of administrative effort which could not be handled from the customary manpower on the construction site. The Figure visualizes the complexity of the parallel procedures by the numerous cranes working in parallel in order to finish the construction project within the technical and financial bounds.

However, whilst circumstances, cause and effect can vary, the defect management process itself is generally the same. A reference defect management process model has been exemplary developed (illustrated partially in Figure 2). These range from simple message processing to document and media management activities. The latter include taking photos and videos, voice recordings, matching earlier photos to a specific event, classifying media data and so on. Considering the large number of parallel workflows between the involved actors, especially with regard to the main contractor, explains the importance of an adequate collaboration platform and collaborative process management.

Figure 1. Large-scale project Campeon

Application Scenario „Defect Management"

In Figure 2 a section of the model for defect management is presented. The event-driven process chain (EPC) is used as a modeling language here (Keller, Nüttgens and Scheer 1992). The process displayed in Figure 2 corresponds to one fragment starting with the event that a defect is already electronically recorded or not. Subsequently, the Owner categorizes the defect using the specific Defect Management System. Based on the decision if the defect is serious or not, the Owner directs an exact defect inspection and tracing or a simple defect inspection before the process continues. The whole developed EPC model has 57 functions on the top-most hierarchy level and is modularized into fragments containing between one and seven functions. This modularization plays an important role for the efficiency of the process management on the construction site.

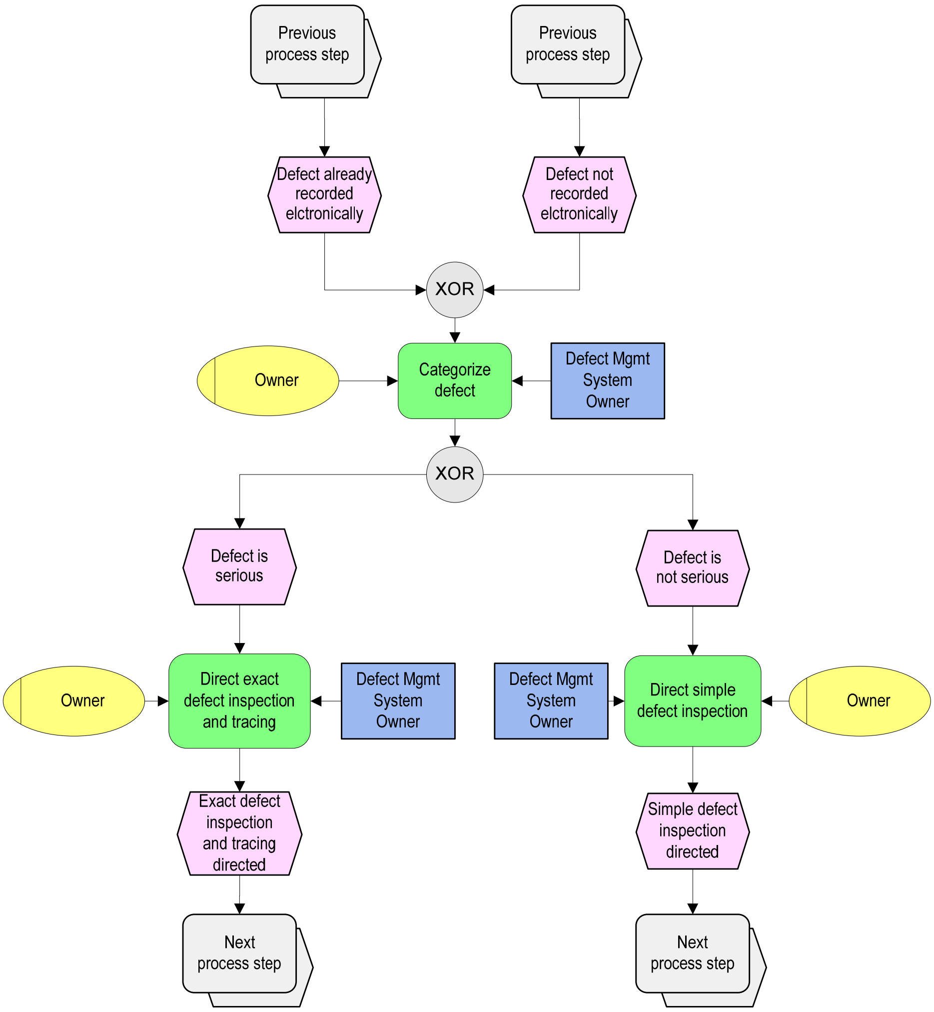

Figure 2. EPC-Model "Defect Management" (Section "Defect Processing not part of the contract")

PROCESS-CENTERED GRID INFRASTRUCTURE FOR SEMANTIC VO MANAGEMENT

Approach

The main idea of the project BauVOGrid is to substantially enhance the structure, functionality and operability of the multifaceted types of virtual organizations by means of a shared IT-system based on semantic web and grid technology. To do so, a hybrid grid- and web service-based architecture for the next generation of VO service and gateway solution was developed integrating the process-oriented perspective and prototypically implemented using the construction branch as an example. The research results can be generally applied to collaborative (virtual) organizations and allow the "gridification" of existing applications with justifiable expenses and effort.

The open, scalable and extensible system architecture should be capable to support the required security regulations and procedures regarding distributed information management in Virtual Organizations. The interfaces for service integration are therefore realized based on ontologies. The adaptivity of the services for use on mobile devices is additionally introduced in the architecture because some domain-specific services of a Construction Grid infrastructure would need to be ported on mobile devices.

The targeted process-oriented IT-platform for the semantic VO-management is realized based on a multi-layered system architecture, enabling coherent integration of the abovementioned technological issues, and allows for clear and well-defined interrelationships and interfaces between grid middleware components, basic VO services, business process services, and engineering services and applications. Furthermore, the platform should be supported by a homogeneous semantic model of the environment, facilitating the system-wide identification of all involved users, resources and services – regardless of their particular location, but implementing strict role-based access profiles. Figure 3 shows the principal layers of the suggested platform architecture extending the original Grid architecture (Foster et al. 2002).

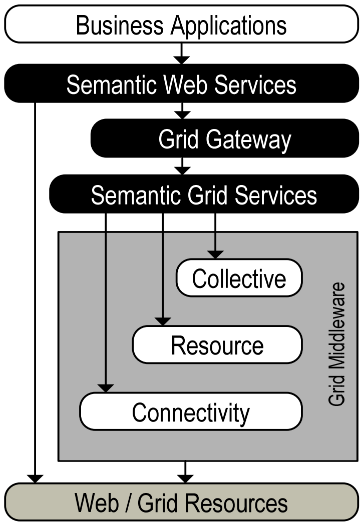

Figure 3. Layered structure of the BauVOGrid architecture

The original Grid layers are additionally extended by three new layers. The *Semantic Grid Services* layer is largely adopted from (Dolenc et al. 2008). It contains all supporting ontology-based VO management services that are responsible for the provision of semantically rich queries and assertions with regard to users, resources, service access etc. The next two layers, i.e. the *Grid Gateway* layer and the *Semantic Web Services* Layer are missing in various other known approaches focusing on pure grid environments. Their purpose is to enable co-existence of web service based subsystems and advanced fully gridified applications. Due to the high security standards imposed by the Grid middleware – a major benefit for each industry VO – such co-existence is per se not given.

The *Semantic Web Services* are in fact normal Web Services defined using WSDL. The term "semantic" is applied here to denote that, as all other high-level services, the services on that layer have to commit to the platform ontologies in their relevant areas of interest. This can be achieved by implementing them either to fully "understand" the relevant parts of the OWL-based ontology specifications or, in a more light-weight approach, by ensuring that the relevant subset of queries/responses to the ontologies are properly interpreted and served (Katranuschkov et al. 2008).

The purpose of the intermediate *Grid Gateway* layer is solely to provide the necessary mechanisms that would allow acceptance of the Web Services in the Grid environment. Engineering applications have two principal possibilities to plug-in to the platform. The first includes comprehensive gridification. However, this is also the more difficult and resource-consuming approach, requiring full or at least partial re-engineering of the application. For its achievement, various methods can be applied depending on the actual goals and the specific application context (Mateos, Zunino and Campo 2008). Here, a more pragmatic approach is used. Its essence is to first provide a web service wrapper for the application logic which is itself wrapped by a grid service wrapper via a standard conversion procedure utilizing the functionality of the Grid Gateway layer. This is an easier way towards gridification for domain developers, due to the clear separation of gridification techniques from the application logic. A further advantage is the co-existence of both grid and web services in the same VO environment and eventually for the same end-user systems, thereby avoiding a mandatory grid solution.

The scenario in Figure 4 shows the components of the resulting hybrid system architecture for VO-management in the construction industry, underpinning the hybrid nature as shown on high level in Figure 3. The basis of the environment is the web where the three major end-user Defect Management Systems (DfMS) provided by the Owner, the Main Contractor and the Subcontractors are installed. These three systems are "plugged-in" to the platform via the gateway layer as explained above. This provides access to all infrastructure services of the platform, including a Central Defect Management Service, a Workflow Management Service etc.

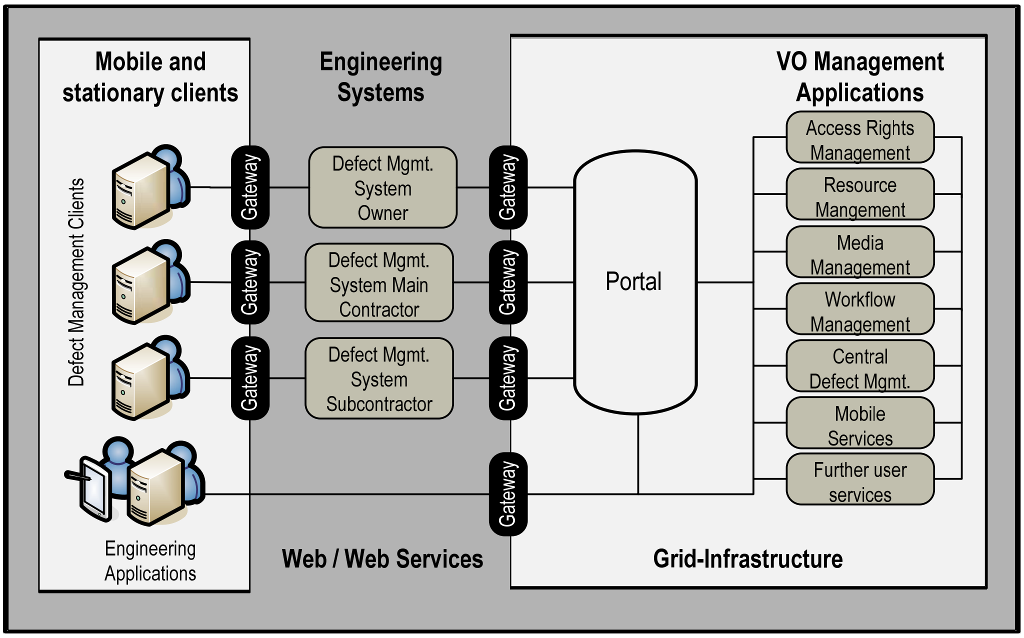

Figure 4. Hybrid BauVOGrid system architecture

The proposed approach sets out to respond the pictured challenges via a flexible and reusable grid-based platform. The implementation of the BauVOGrid methodology enables:

- controlled representation of responsibility and authorization structures
- fast configuration and management of both global VO processes and local company-specific processes in accordance with the set-up responsibility structure
- fast, flexible and secure access to information from different sources (documents, drawings, photographic material etc.), both from headquarters and from the construction site
- ad-hoc changes in the process flow, using semiautomatic process simulation
- capturing of processes and process/product data on the site making use of various mobile devices, thereby providing a basis for faster and more efficient decision making with participation of all site workers.

Achievement of these goals is grounded on the coherent, integrated use of four cutting-edge ICT technologies.

Grid Technology

Grid technology provides facilities for secure and efficient use of distributed resources and end-user applications and services in a VO as well as basic services for VO management that can be used as grounding for various domain-specific semantic services. Specifically, Grid technology enables:

- efficient data distribution and computational load balancing in a distributed heterogeneous network
- proper authorization, authentication, and access control management with regard to resources and services

- secure communication via sophisticated encryption techniques
- uniform and secure access on data and documents stored as distributed heterogeneous information sources via standardized grid-based interfaces
- standardized and secure access to computational and data storage capacities offered by service providers on the Grid

Semantic Web Technology

Semantic Web technology enables uniform formal description of the overall system, including all relevant resource, service and information types but also the actors and companies acting on the system and the actual technical processes in the overall value chain. Specifically, Semantic Web technology enables:

- common semantic commitment of all applications and services of the platform via an explicit formal ontology specification of the concepts describing resources, services, actors, and project and company organizational structures
- mapping of IT specific access rights, authorizations etc. to actual business-specific rights and responsibilities in the VO, set on the basis of contractual agreements
- context-dependent definition of work and information profiles so that each VO partner and each particular user are provided personalized views on the data and services, and company-specific information sources such as different DMS are interlinked on the platform in uniform manner

The integration of meaningful semantics and Grid technology possesses great potential, especially with regard to the use of the Grid for VO support. However, an important prerequisite for the achievement of semantic interoperability is the use of an expressive formal ontology language. The Ontology Web Language (OWL) (Smith, Welty and McGuiness 2004) is currently broadly recognized as such a language, offering great modeling flexibility and warranting syntactic interoperability to other XML-based languages as well as good tool support for developers (e.g. Protégé). Already available OWL ontologies can thereby be directly imported and used on the platform. Moreover, via formal semantic description of Grid Services with the help of OWL-S efficient VO Service Management can be supported as well. The benefit of ontologies as a basis for the semantic-based management of VO's has already been addressed (Dolenc et al. 2008).

Mobile Information Processing

Mobile information processing technology enables the use of intelligent end-user software on mobile devices. Flexible, context-aware processing of project information as well as fast, ad hoc changes of process execution according to actual specific needs and situations can thus be done on site. In particular, mobile information processing technology provides the availability of any parts of the hole information of a VO in mobile situations, timely reaction and handling in mobile work processes, efficient communication with decision makers (at headquarters or supervisors at the site) and context sensitivity, especially with regard to location, role and work profile of the end-user as well as the specific features of the mobile devices.

Process Modeling

The technique of process modeling allows a semi-formal description of technical processes including the input- and output-documents and data, the performing actors and participating organizational units as well as the required applications and tools. Moreover, it also allows describing the state of the world before and after the execution of a function which is required in order to orchestrate the execution of functions. The technique of process modeling thus can be both used to achieve a coherent semi-formal description of the business processes, to describe separate, reusable process fragments and to construct integrated process modules composed of process fragments which are part of the value added chain. The transformation of business-oriented processes into workflow models, i. e. models which are executable on the grid, is a challenging task which still requires human intervention. In order to improve this transformation, a method for the modeling of VO-processes in grid environments has been developed which constitutes the core methodical concept of the approach.

Method for Modeling of VO Processes in Grid Environments

The use of process modeling techniques – an important component of construction VO management as such – allows to put emphasis on the execution of tasks related to internal or external work orders as well as to their time and space related coordination. A key role is assigned to the creation of abstract representations of reality, adequately simplified for the specifically regarded issues of interest. Current challenges to the process management in a VO can be seen in particular in the distributed modeling imposed via the spatial distance of the VO partners, giving rise to problems related to collaborative process models and heterogeneous, distributed model data stores (Vanderhaeghen, Hofer and Kupsch 2006). Hence, it must be possible to integrate VO models on-demand as only directly interacting partners in the VO do need the VO-integrated model data. The semantic enrichment of process models with additional information can provide for easier handling of such heterogeneous models and enable (partial) automation of the integration process.

In order to improve the composition of models in the dynamic context of virtual organizations, a method for modeling VO-processes has been developed, based on the EPC as basic modeling language. This method comprises the three distinct phases *modeling, analysis and planning* as well as *execution* and is shown in Figure 5. In each phase, different tools are used. This implies that data has to be passed between different tools and thus data formats have to be transformed. Each transformation is shown by an arc and attached to it a little circle with a number indicating the sequential order of these transformations.

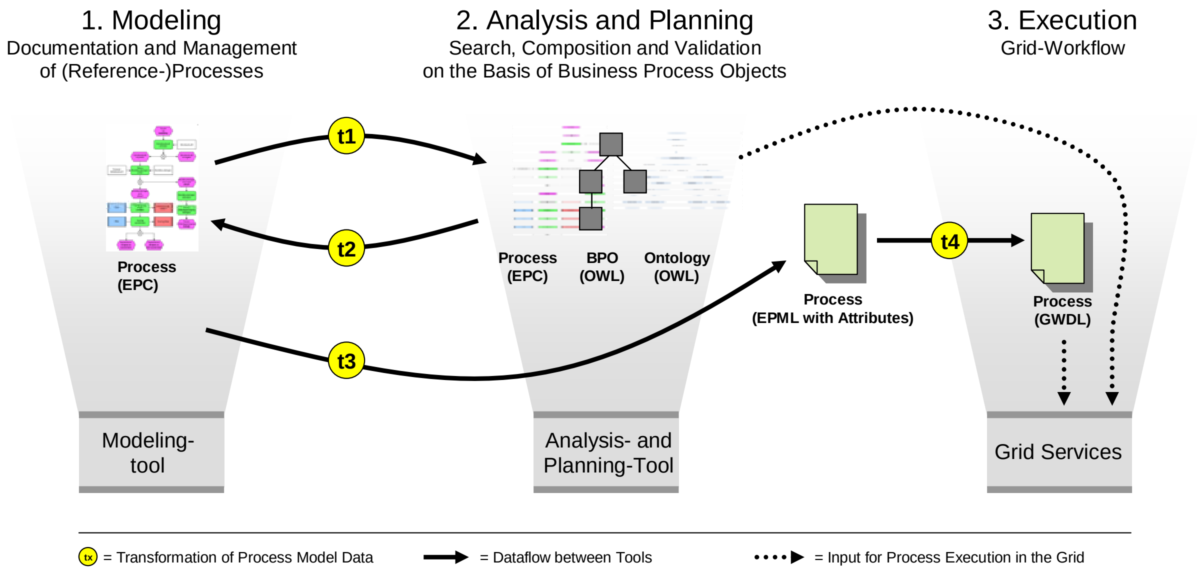

Figure 5. Phases of the method for modeling VO processes

In the phase of modeling, the initial models are developed using a standard modeling tool. These processes do not represent a whole process, but rather reusable components of business processes which are called Business Process Objects. A BPO represents a reusable process fragment that can be adapted to be used within different business processes. The BPO models are then transformed (t1) and imported in a semantic analysis and planning tool in order to construct a new process based on a set of BPOs.

The process of model construction is supported by semantic information about BPOs which is represented using an ontology. This ontology is imported in the semantic analysis and planning tool and includes an ontology-based representation of each BPO. This representation on the one hand captures the process logic depicted in the graphical model using instances of ontology classes (e.g. “Check Defect” as an instance of “Function”) and relations between them (e.g. relation “hasAfterEvent(Function, Event)”). On the other hand, this representation also captures possible adaptation possibilities of a BPO. Adaptations can be used to allow for the mapping of the organizational or technical requirements which are in effect when a process model for a specific context is constructed. The adaptation possibilities are described in the ontology using relations between instances with multiple values, e.g. different roles which may execute an instance “Check Defect” of type function can be captured by multiple values of the hasRole-relation such as hasRole(CheckDefect, GeneralContractor) or hasRole(CheckDefect, SubContractor). Other adaptation possibilities include the information systems or resources used to perform the functions which are contained in a BPO. The ontology captures a predefined set of adaptations in the form of *BPO variants*. A BPO variant is a concrete BPO with a set of preselected adaptations, e.g. all functions within a BPO are executed by a specific role etc. The BPO model together with the BPO variant descriptions can be used to construct a specific process. Figure 6 illustrates this principle by showing a BPO model in the upper left corner which is imported in the analysis and planning tool together with BPO variant descriptions.

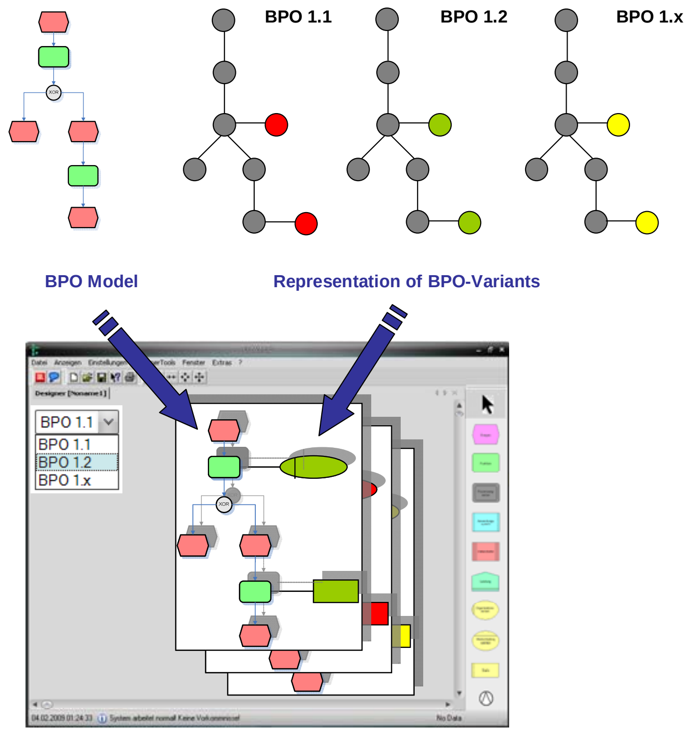

Figure 6. BPO model and BPO variant descriptions

Individual adaptations of BPO variants are allowed by manually configuring a BPO within the planning tool resulting in the creation of a new BPO variant. New BPO variants are added to the underlying ontology which allows consistency checking using simple derivation rules.

At the end of the analysis and planning phase, the planned process models are enriched with information necessary to execute the models such as web services endpoints. This information is also extracted from the ontological BPO variant description and inserted into the model representation. After the analysis and planning phase, the completed and checked process models with accompanying attributes are exported and re-imported (t2) in the standard process modeling tool. In a subsequent transformation (t3), they are transformed into a standardized intermediate format which can be transformed to multiple executable formats (t4).

GRID-BASED PROCESS EXECUTION

In order to automate the enactment of the processes the description of the business processes are mapped here to a more formal, executable workflow description language, the so-called “Grid Workflow Description Language” (GWorkflowDL) (Alt and Hoheisel et al. 2006). In contrast to other approaches, such as BPEL4WS (OASIS 2007) or SCUFL (Hull et al., 2006), the approach supports several levels of abstractions within one workflow description document, enabling ad-hoc modifications of the workflow during run time. The workflows themselves can be described independently from the underlying infrastructure, thus increasing the reusability of the processes within different execution environments, such as Service-oriented Architectures (SOA), J2EE frameworks, Grid, Cluster, or Cloud computing environments.

Preparation for the Enactment

While normally the processes modeled with Event-driven Process Chains only refer to pure business processes that are invoked by human resources, in BauVOGrid the automation of business processes as well as their corresponding IT workflows, which are mapped onto IT resources, is considered. In existing systems, often these two environments are represented by two different description formalisms, such as BPEL4People (Kloppmann et al. 2005) for automating processes on human resources and BPEL4WS (OASIS 2007) for automating processes in a SOA. Here the GWorkflowDL is used which is capable to model both scenarios within one single language. At the same time, the GWorkflowDL is much simpler and more formal than the well-known set of BPEL* description languages.

The GWorkflowDL is based on the formalism of High-Level Petri Nets (HLPN) (Hoheisel and Alt 2006), and is compatible to the international standard ISO/IEC15909-1 (2004). In contrast to ordinary Petri Nets, the tokens of HLPNs are distinguishable and can be used to model high-level values, such as real input/output data, references to data (e.g., filenames or URLs), and boolean values representing side-effects. The distribution of tokens on places is called marking and represents the state of the distributed system. In order to be able to not only model but also invoke workflows with real data, the concept of HLPN was extended by using the XPath standard to formulate edge expressions and transitions conditions.

The automatic translation from EPML onto GWorflowDL is done by an XSLT stylesheet as shown in Figure 7. To facilitate the translation from abstract (and often informal) business processes onto executable workflows, some minor semantic and syntactic extensions to the original Event-driven Process Chains are required, such as annotations for specifying the start events, relations of events or functions to real data, as well as the definition of formal operation classes for the functions that need to be mapped onto human or IT resources.

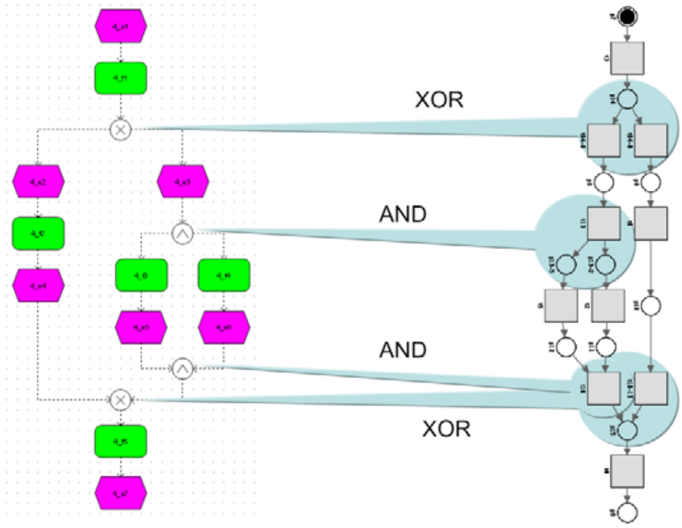

Figure 7. Example of the automatic conversion of an EPC (left side) onto the Petri-Net-based GWorkflowDL (right side)

Enactment of Processes in Distributed Environments

The Grid Workflow Management System developed by Fraunhofer FIRST enables the automation and interactive monitoring of complex processes in distributed environments (Hoheisel 2007). A unique feature of the solution is the completely virtualized resource allocation based on abstract modeling of the process structure and the powerful resource description formalism. The user is able to invoke workflows without any knowledge of underlying hardware and software specifics, allowing to concentrate on the real focus of the work.

The Grid Workflow Management System is composed of several services. The “Grid Workflow Execution Service” (GWES) is the core service, which enacts workflows automatically, fault-tolerant, and persistent on distributed environments. Besides the GWES, the Grid Workflow Management System is composed of a resource and workflow registry (XML database), a resource matcher for mapping abstract activity requirements onto available hardware and software resources or services, a monitoring system which uses distributed sensors for gathering up-to-date information about short-term (e.g., load) and long-term (e.g. structure) properties of the resources, as well as a scheduler, which optimizes and plans the selection of resources. Within the enactment of the workflow, the resource matcher first maps abstract activities onto matching resource candidates. For each of the resource candidate the scheduler calculates a quality measure (e.g., based on the current load and performance of the resource) and assigns resources that are passing a certain quality threshold to matching activities, beginning with activities that possess the highest priority. The priority of an activity can either be specified by the user or by an optimization step within the scheduling process, e.g., giving activities on the critical path a high priority.

Figure 8 shows a screenshot of the web-based user interface of the Fraunhofer Grid Workflow Management System. The example workflow depicted here transcodes a digital movie recorded in high-resolution onto several target formats to be displayed in lower resolution on mobile devices. After the transcoding step the rights for each of the target movie file is set (e.g., watermarking, encryptions, file permissions) and the files are transferred and can be uploaded to the mobile device. On the other hand, grid performance in this context could also be used to identify defects based on image recognition algorithms. Pictures from the construction site could be linked with small bar code labels while recording the defect and automatically parsed when being uploaded on the platform.

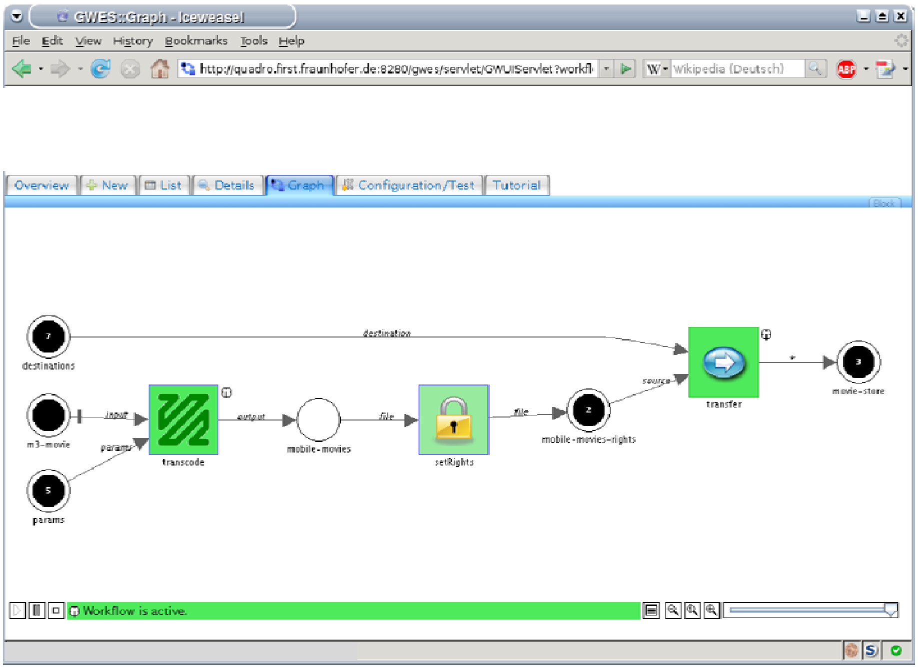

Figure 8. Web-based User Interface of the "Fraunhofer Grid Workflow Management System"

SUMMARY OF THE RESULTS AND OUTLOOK

Partners in virtual organizations must meet the challenge of collaborating more efficiently despite continuously growing demand towards improved handling of large-scale projects on the one hand and towards achieving economic efficiency and cost reduction on the other hand. Grid systems provide an outstanding technology for establishing a respective collaboration platform. The hybrid approach presented here combines different topics with each other in an innovative manner. A grid-based platform was developed integrating semantic methods for consistency saving and goal-oriented process management. These technologies are brought together to a consistent, more significant overall solution. The business process modeling acts as the methodologic basis for the efficient collaboration. The system architecture was presented that is suitable for realizing the concept, as well as a method for modeling VO processes in grid environments and their execution as grid workflows.

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