Technologies for Business Information Systems

Technologies for Business Information Systems

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Preface

Technologies for Business Information Systems

The material collected in this book covers a broad range of applications of computer science methods and algorithms in business practice. It presents a research cutting edge in development, implementation, and improvement of computer systems. We publish this book with intention that it helps to establish strong foundations for further development of research in this area and support people involved in business computer applications, those implementing computer technology in industry. The computer science and information systems topics covered in the book include data warehouses, ERP, XML, ontologies, rule languages, Web services. We divided the chapters into several areas of applications of the above. There are parts on modeling business processes, devoted to applications of formal methods and metrics that assist this crucial step for contemporary heavy-IT oriented enterprises. This is accompanied by chapters on information systems considered both from engineering and social perspectives. Particular topics on software engineering have been placed in a separate book part. We addressed also advancements in information retrieval and formal representation of knowledge using ontologies and rule languages. These topics are worth of interest due to their reemergence in recent years, significant advances and broad range of potential as well as actual applications. Last but not least comes the other area of applying IT – e-government. Several authors elaborate on methods and experiences of IT adoption for administrative purposes. We hope that with their conclusions applied our slightly unwieldy, yet necessary e-gov systems are improved.

We hope that you will find this book useful for practical and research purposes – that would be the best satisfaction for our authors, to whom we are very thankful.

The book could not be published without enormous amount of work that the colleagues from Poznan University of Economics, Poland, Agata Filipowska, Tomasz Kaczmarek and Krzysztof Węcel put in it.

Witold Abramowicz and Heinrich C. Mayr

Poznań, September 2006

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1 Conceptual Modelling for Grid Computing: Applying Collaborative Reference Modelling*

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1.1 Introduction

With the evolution of grid computing, powerful means have been developed that enable virtual organizations by sharing resources in networks. Therefore underlying business processes need to be questioned regarding the technological potentials offered. In addition, the evolution of grid computing needs to consider the business needs of virtual organizations. Methods of Business Engineering can be applied in order to align business processes of virtual organizations and grid technology. In this article, we first give a brief insight into both, grid computing and business engineering. On that basis, we argue that particularly collaborative reference modelling, as means of business engineering might be a promising approach for this kind of alignment. The potentials of collaborative reference modelling in this area are illustrated by an example. We then conclude with a short summary and an outlook for further research opportunities.

* This publication is based on work done in cooperation between the "Center for Internet Economy" at ERCIS (grant number 01AK704) and the research project "Reference Model-Based Customizing with Vague Data" at DFKI (grant number SCHE 185/25−1). The authors wish to thank the German Federal Ministry of Education and Research (BMBF) and the German Research Foundation (DFG).

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1.2 Grid Computing and Business Engineering

1.2.1 Foundations of Grid Computing

The term “the Grid” evolved the mid 1990s to denote a proposed distributed computing infrastructure for advanced science and engineering [9]. Nowadays first applications of grid computing can be found in scientific as well as in company’s practice, for example the development of an operational grid for the Large Hadron Collider (LHC) at CERN (http://lcg.web.cern.ch/LCG/) and SETI@Home [7] (http://setiathome.berkeley.edu/). As its predecessor, distributed computing, the field of grid computing deals with the potential of resource sharing for computing in networks [10]. A computational grid is an infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities [9]. The infrastructure is not limited to hardware and software but also includes people or intuitions as part of a Grid. Grid technologies enable large-scale sharing of resources within formal or informal consortia of individuals and/or institutions [4]. From a user perspective, the distributed heterogeneous resources are perceived as homogenous resources. Grid technologies are a basic precondition for the successful implementation of virtual organizations [16]. Virtual organizations offer potentials of flexibility and standardization at the same time by a mixture of market and hierarchy based coordination mechanisms [20]. Therefore, they are often referred to as hybrid organization forms [20, 34].

In order to realise the potentials of virtual organisations by grid computing, technological, methodological and organisational issues have to be taken into account. Business engineering concepts can integrate these three perspectives [35, 36] and be applied as a promising means for the design of grid based virtual organisations.

1.2.2 Foundations of Business Engineering

The field of “business engineering” emerged at the start of the 1990ies as a management trend. It aims at enriching existing approaches with respect to both the development of operational information systems and business strategies for process design [3, 21, 27]. From today’s perspective, business engineering can be seen as a method and model-based design theory for businesses in the information age [28]. Using the methods and models made available by business engineering, business information systems can be designed, implemented, and adapted according to specific business needs. At the same time, improvements to business operations made possible by innovations in information technology (IT) are also targeted. Thus, the goal of business engineering is to systematically align business applications and operations with the help of engineering principles. These principles can be applied for the alignment of grids on the technological level and virtual organizations on the business logic level.

Nowadays, business processes have established themselves as the organizational objects of design for business engineering [6, 14]. Thus, with regard to corporate strategy, both the design of business processes and the analysis of the demands for their IT-support are of importance in business engineering projects aiming at the design of a grid based virtual organization. The design of business processes must follow a comprehensive approach encompassing the planning and the control, as well as the management of the operational workflows.

Information modelling has proved useful in supporting the systematic procedure in process design [11, 15, 19, 37]. Modelling techniques such as, for example, the “unified modeling language” (UML) [29] or the “event-driven process chain” (EPC) [18], serve as methodological approaches for the construction of models. Software tools for business process modelling, such as IBM Rational or the ARIS-Toolset, can support the business engineer by way of system components for the collection, design, analysis, and simulation of business process models for grid based virtual organizations.

The extensive demand for information models in business engineering warrants the need for reference modelling concepts. The intention of reference modelling is to systematically reuse information models in systems reengineering [32, 33]. To give a definition, a reference model is a special information model that can be reused in the design process of other business process models [33]. The approach is based on the finding that, despite various differences between design processes, general design patterns can be identified capable of solving design problems for a wide range of applications. Thus, the goal of reference models is to cover these general patterns in order to raise the efficiency and effectiveness of specific modelling processes [1, 8, 23, 30]. The reuse of reliable patterns in the context of grid based virtual organisations can enhance the flexibility to reconfigure a virtual organisation and at the same time safeguard the effectiveness and efficiency of the organisation and its grid infrastructure. To achieve these potentials for grid-based organisations, specific requirements have to be met by reference modelling approaches.

1.3 Reference Modelling as means of Business Engineering for Grid based Virtual Organizations

1.3.1 Requirements for Reference Modelling

The support of distributed actors within virtual organizations is a central requirement to be met by reference modelling in this context. The need for integrating infrastructure, methods and organization in reference models is another important requirement. In order to derive relevant fields of action in design projects of reference models for grid based virtual organisations, a specific framework can be applied [33]. Figure 1 presents an overview of this framework along with the fields of action for building an reference modelling infrastructure enabling the reuse of conceptual models in business engineering projects for grid based virtual organizations. The framework emphasizes the fact that the implementation of design processes is an interdisciplinary task. Thus, the work calls for contributions from various perspectives that must be integrated according to specific requirements and opportunities. This model particularly shows that apart from the methodological aspects of model design focused on in theory, contributions in the field of technological and organizational infrastructure are needed.

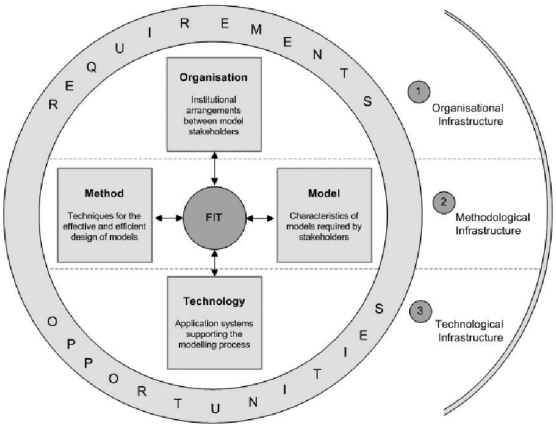

Fig. 1. Framework for the Design of Reference Modelling Infrastructures

Seen against the background of this framework, we can identify three fields of action for the design of an infrastructure for reference modelling:

Organizational Infrastructure: Relevant stakeholders in the modelling process must be identified and efficient ways of coordination between them established. In detail, this indicates the need to take into account the user's perspective at an early stage in the modelling process and provide coordination mechanism for distributed users and designers of reference models for grid based virtual organizations.

Methodological Infrastructure: Appropriate guidelines for describing business processes using models are needed. These guidelines should focus on certain characteristics which models should have in order to meet the requirements of grid based virtual organisations. Thus, rules are derived describing ways of building models accordingly.

Technological Infrastructure: In order to make use of reference modelling in practice, application systems supporting the settings considered relevant within the other fields are needed. From a methodological perspective, it is mainly the functionality of case tools that is addressed. Thus, available tools must be examined and used accordingly. In addition, seen from an organizational perspective, systems supporting various ways of cooperation are needed, e.g. knowledge management systems, work group systems, or project management systems.

Reference modelling situations are characterized by certain requirements and opportunities which direct the settings in the fields. In order to meet the situation properly, various interdependencies between the settings in the different fields must be taken into account. For example, the technological conditions in a grid have an effect as an enabler or as a restriction for both organizational and technical settings. Thus, the design follows a balanced manner, aiming at a so-called "fit of design". In the following, an example of a reference modelling infrastructure for grid based virtual organizations is introduced.

1.3.2 Collaborative Reference Modelling as an Infrastructure for Business Engineering

Introduction to Collaborative Reference Modelling

"Collaborative reference modelling" is a specific concept addressing reference modelling primarily from an organizational perspective. This reconciles with the intended purpose the design of patterns for grid based virtual organizations. Based on the organizational aspects, consecutive settings in the field of technological and methodological infrastructure can be derived. The essential idea of collaborative reference modelling is to share models with a greater range of shareholders in order to both continuously check and improve them from various perspectives. Accordingly, the infrastructure should provide efficient ways of transferring and discussing modelling results during the entire life cycle of certain business areas. Given such an infrastructure, both a division of labour and an increase in model quality could be achieved. As a result, an essential contribution to business engineering for grid based virtual organizations could be achieved in practice.

In order to design an appropriate infrastructure for collaborative reference modelling, efficient means of collaboration from an organizational perspective must first be analyzed. These findings then set the main requirements for the design of the technical infrastructure which is then used to implement the organizational processes in practice. In addition, findings in the field of methodological infrastructures can be derived which make the collaborative design of reference models in practice easier. The following passage briefly introduces these perspectives.

Organizational Infrastructure: Networking of Stakeholders

Corresponding to the intended application domain, grid based virtual organizations, mechanisms of network organizations [13, 20] can be applied in the organizational infrastructure of reference modelling. In particular, preliminary work in the field of organizing reuse-based engineering delivers insights on the organizational design [24, 26]. According to the transaction cost theory, the arrangements may be carried out by hierarchy, market or hybrid forms of coordination [2]. A deeper analysis of the alternatives to reference modelling [34] shows that the network organization, as a hybrid mode, is a promising means for reference modelling. On the one hand, it guarantees certain standardization necessary for developing shared mental models, while on the other, it leaves a critical degree of flexibility important for involving a wide range of stakeholders and possible network partners. On the basis of the AGIL-scheme [20], a brief outline of the underlying mechanisms can be given.

A strong impact on coordination comes from the individual return each stakeholder expects from his or her participation in the network. In particular, suppliers of reference models face a wide range of customers, whereas the customers themselves profit from transparency over a greater range of models. The design of reference models can focus on highly specialized solutions which significantly contribute to model quality. Thanks to a stronger coupling compared to markets, people tend to establish a common understanding of their business in networks. In reference modelling, this gives way to the establishment of shared mental models pertaining to the semantic context of an application domain. Whereas the information system infrastructure provides a methodology for describing the semantic context, its design and application are carried out on an organizational level. This shared context is vital for efficient collaboration, because the understanding of models is strongly influenced by personal perception. Due to the history of shared experiences, social relations evolve in networks. These relations are helpful in order in modelling projects. Assets, such as the reputation of stakeholders, give ground for vague requirements specifications which facilitate flexible responses in a dynamically changing environment. This way, both the quality and the efficiency of the design, are supported.

The actual organizational design of a specific design project for grid based virtual organization has to be determined on the coordination structures within the network. Depended on the distribution of power in the network (e.g. centre focused networks) a suitable mix of coordination mechanisms has to be incorporated.

Technological Infrastructure: Collaborative Platforms

To support distributed stakeholders within a network, information systems which support model sharing need to be implemented [12]. In particular, this means the support of processes for both exchanging and discussing models within a shared semantic context. The essential functionality is illustrated in Figure 2 with an example for a prototypical implementation (see www.herbie-group. de).

Features for exchanging models, i. e. the up- and downloading of models on a shared repository, build the foundation for the collaborative design. Internet-technology offers promising means for accessing the repository in a flexible manner via a web-browser. Based on standard exchange-formats like XML, higher-level formats complying with the syntax of modelling languages are path leading. For the language of EPC for example, the format EPML is provided [22]. Standards like WebDAV make it possible to integrate the platform with local file-servers which facilitate the processes of model exchange. Beyond the technical aspects, it is essential to capture the semantics of the models to be shared on the platform [25]. For this purpose, feature-based techniques can be applied. Apart from the area of domain engineering [17], these techniques are subject to the field of knowledge management, especially information retrieval. In this field, quite a number of appropriate techniques are being developed, ranging from simple taxonomies to more complex anthologies [5, 38]. However, the appropriate application of these methods in practice still seems to be challenging.

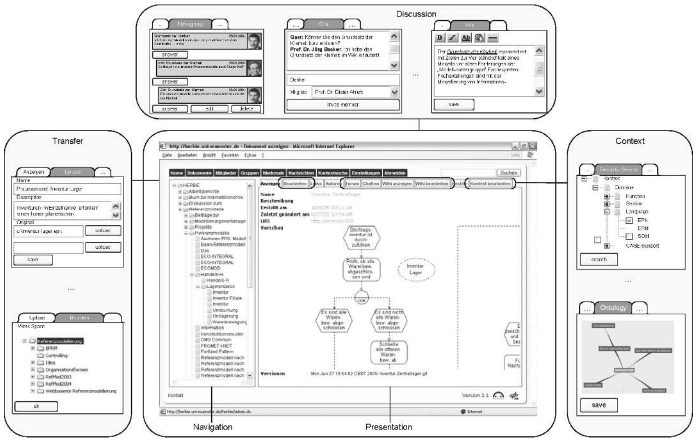

Fig. 2. Elements of a Collaborative Platform for Reference Modelling

Services for discussing models are needed in order to support the continuous improvement of the reference models disseminated on the platform. In contrast to conventional community platforms, these services should be made available in relation to each single model. In reference modeling, such a close connection is essential for directing the discussion towards special contributions and thereby, increasing the efficiency of the collaboration. To support individual preferences, various channels of communication should be offered for each model, including newsgroups (asynchronous communication) and chat rooms (synchronous communication).

Methodological Infrastructure: The Encapsulation of Models

Based on the organizational structure and the technology in use, methodological aspects have to be taken into account as well when designing reference models for grid based virtual organizations. To integrate the different relevant perspectives on virtual organizations (infrastructure, methods and organization) also different model types have to be integrated in a reference model. For example, UML and EPC models can be distributed one by one. However, the efficiency of sharing the models could be increased by encapsulating them according to certain standards [33]. An example of such a standard is shown in Figure 3. The framework incorporates principles from component-based software engineering [24, 31]. Essentially multiple models must be structured in such a way that a combination of them fulfils a certain modelling purpose. In addition, a description of the collection is given which serves to hide implementation details and to identify models by their essential semantic contribution. For this purpose, the framework provides interfaces on multiple layers: in detail, there are interfaces which specify the overall subject, the content provided to cover it and the representation available describing the content.

In the interface which specifies the subject, the overall contribution of the model is described on a pragmatic level. In addition to identifiers, the purpose of the collected models is characterized so that the component may be easily found by its contribution. For this purpose, both a textual and a taxonomy-based description are considered. The taxonomy-based description is especially helpful in large-scale networks because it builds the foundation for mechanisms of information retrieval [24]. In particular, work on semantic descriptions carried out in the field of knowledge management can be applied for collaborative reference modelling.

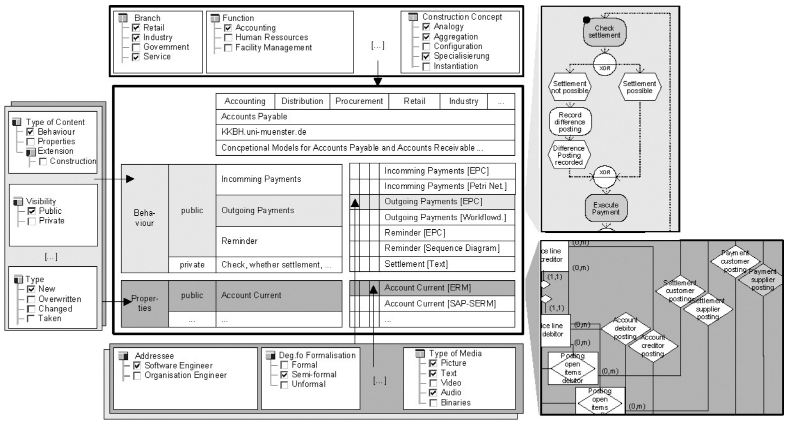

Fig. 3. Encapsulating Reference Models as Components

According to this type of specification, the component shown in Figure 3 is characterized by the framework to provide "Conceptual Models for Accounts Payable and Accounts Receivable…" a pattern that can be applied for a large variety of grid based virtual organizations.

The content that is necessary for fulfilling the overall purpose of the component is specified by an additional interface on a more detailed layer. In this interface, items of the taxonomy serve to differentiate content regarding various views in information modelling. On the basis of systems-thinking, focusing on either the behaviour or the properties of a described system can differentiate models. Further differentiations can be implemented by the taxonomy, including either a wider or a more detailed set of views. The component describing "accounts payable", for example, needs descriptions of behavioural aspects from the processing of "Incoming Payments" and "Outgoing Payments", as well as from "Reminders". As a foundation, properties described in the "Account Current" are needed.

In a collaborative environment, the content of each type can be represented in various modelling languages because stakeholders have different preferences. Therefore, a special interface must be created which specifies the representations available. The semantic description serves to characterize the stockholder's perspective for which a representation is made. The ERM representing the "Account

Current", for example, addresses "Software Engineers". Additional rules are required to support the integration of models in order to ensure a consistency in construction.

1.4 Conclusion and Further Research

Grid computing enables the evolvement of virtual organizations by delivering an appropriate infrastructure. Concepts of Business Engineering especially conceptual business process modelling can be applied in order to link the technological infrastructure with the business logic of a virtual organization. In order to enhance flexibility and safeguard effectiveness and efficiency of cooperation at the same time reference modelling is a promising means by reusing reliable patterns. Based on the specific design situation certain requirements have to be met by infrastructures for reference modelling in this context. Two requirements are essential to be met: (1) support of distributed actors and (2) integration of technological, methodological and organizational aspects. Both requirements can be met by applying collaborative reference modelling for purposes of business engineering for grid based virtual organizations. The application of collaborative reference modelling for this specific purpose is illustrated by an example in this article. By this, an integration of design and use processes of grid infrastructures and virtual organizations can be achieved.

Beside this integration, an integration of semantic structures can facilitate the design and application of reference models for virtual organizations. These structures can be applied as blueprints for collaborative knowledge management processes within virtual organizations and enhance the efficiency of cooperative business processes. Further research should focus on this integration and its automated support by application systems. Alike questions of profitability in reference modelling should be addressed in future work.

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