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An Aspect-Oriented Metamodel for Inter-Organizational Business Processes

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ABSTRACT

In this article, a proposal of business process meta-model is introduced. It shows a clear orientation to inter-organizational business processes, and, previously to its definition, a wider study on business-process meta-models was carried out. The result is a meta-model that adopts their best ideas and extends them to provide a canonic model translatable to process definition languages.

INTRODUCTION

Three requirements identify an inter-organizational business process: *interoperability, flexibility,* and *customer orientation* [WK02]. These three requirements are the key points of the CEPEME (Communication and Evolution of Processes in Multi-Enterprise Environments) project. A project carried out by our research group whose main goal is to provide a software solution to communication problems among inter-organizational and/or intra-organizational business processes, especially the first one. So, our research follows various directions: (a) to design an intermediate platform where several organizations collaborate in a business process; (b) to define a generic business process meta-model; (c) to define a meta-process for the development of business process; and (d) to develop a set of graphic tools for the design of business process and a web interface where a participant organization can consult the state of the process in a given moment. These lines fulfill the requirements of interoperability, flexibility and customer orientation introduced above.

The focus of interest in this article is the business process meta-model. Business processes, intra-organizational as well as inter-organizational, are supported by a meta-model that defines the different components attached to a business process. This meta-model must be the most generic and technology-independent, so its translation to a business process modeling language (XLANG, BPEL4WS, etc) can be tackled without problems.

This paper is structured as follows. Section 2 shows different proposals of business process meta-models. Section 3 describes our vision of meta-model. Finally, Section 4 gives some conclusions and possible extensions to this work.

RELATED WORKS

A business process meta-model specifies the elements in a business process and the main relations established between them. Although a standard meta-model accepted by the community does not exist, the Workflow Management Coalition (WfMC) meta-model [WFMC99] can be seen as a reference. Based on this meta-model, other business process meta-models have been proposed, some of them strengthening a characteristic in particular. In this article, the meta-model extensions proposed in [Pen02], [Kra00], and [Mar00] have been our main source of information.

Splitting up the meta-model into aspects

The split-up approach taken in the UML language, where several diagrams (class diagram, object diagram, activity diagram, state diagrams) make more readable and comprehensible a software system, can be adopted in the definition of a business process meta-model. So, a business process meta-model can be seen as a composition of aspects [Jab95] (also called: dimensions [LR00], perspectives [CKO92], [KB97],...). Although the number of aspects varies, depending on the consulted literature, basically the following ones are identified:

- *functional (or structural) aspect:* describes the business process structure, i.e, the set of activities in the business process.
- *behavioral aspect:* describes the execution sequence and the dependencies among the structural components. In other words, the control flow among activities.
- *data (or information) aspect:* describes the information structures and the data flow established between them.
- *organizational aspect:* identifies the organizational units, actors, and external entities who participate in the business process, highlighting the relationships (subordination, cooperation, etc.) established between them.

Which are the advantages of this approach? Mainly, it improves the flexibility (see Section 1) and evolution, at the process level as well as at the meta-model level. Thus, an aspect can be modified with a

minimal impact on the other aspects [Mar00]. Undoubtedly, there is a relationship between aspects [Zha98].

Together with these four aspects described above, others have been proposed, most of them being a variation of these. Three dimensions answering to the *what?, who?,* and *with?* questions are identified in [LR00]. Others are the *operational aspect* (describes the execution of an activity carried out by an application and the resources used) [Wes00], [Sch99]; the *flexibility aspect* (what changes can be made to a workflow and when?); the *dimension of quality of service* [CMSA02]; the *transactional model* (in the context of the WIDE project [Cas98]); and the *authorization model* [Bic98].

The research on business process meta-model is not only focused on defining new aspects. The organizational aspect is studied in [Mue04], with special attention to the assignment of resources (humans and non-humans) to tasks. The relation among the operational and functional aspects and the relation among physical aspects and logical aspects are studied in [Sch99]. Evolution is broadly studied in [Mar00], [Kra00] (evolution and versioning), [Pen02] (evolution in the OASIS metaclass), [EG02], [Gru03] (dynamic transformation of models). Temporality is also studied, with primitives for controlling temporal constraints ([Gru03],[Gru03],[ZCP01],[EP01]) and a model for checking the temporal consistency at development time as at runtime [ZCP01].

To sum up, as it can be seen, the number of proposals is wide. The essentials of the meta-model are the same in all of them, and each proposal tries to highlight an aspect not considered, by extending or improving it.

OUR PROPOSAL

Our proposal of meta-model contains the main elements (classes and relations) that should be considered in order to define a business process. Following the approach of splitting up the meta-model into aspects, as it was previously mentioned, six aspects have been considered: *functional aspect, behavioral aspect, data aspect, organizational aspect, distribution aspect, and user aspect.*

The first four aspects – functional, behavioral, data, and organizational – basically agree with the same aspect previously defined (see Section 2) although some changes have been made. However, from out point of view, new aspects need to be considered. The *distribution aspect* [WFMC02] shows the inter-organizational orientation pursued in the CEPEME project, establishing the way of allocating the activities among the different processes. The *user aspect* defines a visual representation of the business process for a certain user in a certain time. The CEPEME project aims to be a screen where a user can check the state of the process in a given moment.

These two last aspects are in accordance with [Pen02] about adding new elements to the meta-model. The first four aspects gather the main elements in a business process. However, depending on the domain of application new requirements can arise, with a need of adding new aspects or modifying the existing.

As a language broadly known, the UML language has been used to model each aspect of our meta-model. This meta-model will be later on adapted to the language of the system containing our meta-model, in our case, the ebXML [ebXML03] architecture.

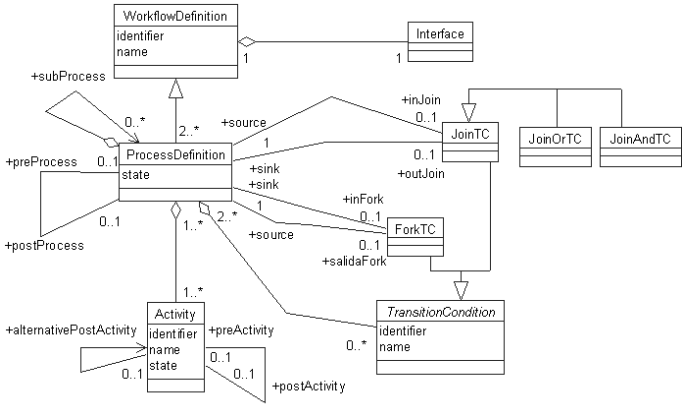
In order to clarify their comprehension, the figures below only show the main classes. Depending on its importance, the name, direction, and cardinality of the relation are also given. Data flow and control flow are not showed.

Functional aspect

The functional aspect describes the structure of the business process in terms of sub-processes, activities, and transactions. It is based on the functional aspects proposed in [Pen02] and [Kra00]. New classes have been added whereas others have been deleted or modified.

Figure 1 shows the classes and the relations in the functional aspect. The *interface* class [Kra00] is the input to the *workflowDefinition* class [Kra00], which represents the scheme to be executed in the WFMS (BizTalk, MQSeries, …) WFMS (BizTalk, MQSeries, or others). The *process definition* class represents the sub-processes (*workflowDefinition)*, activities *(activity)* and transitions conditions in the workflow [Pen00].

Figure 1. Functional aspect (adapted from [Pen02])



A fork transition (*forkTC)* represents the parallel execution of activities in a workflow and a join transition (*joinTC)* represents the synchronization of parallel activities.

Behavioral aspect

Maybe one of the most important aspects, the behavioral model sets the control-flow among the different structural entities (activities, processes, subprocesses,…) in the business process. The behavioral model proposed in [Pen02] has been considered, as it best fits our interest. The *CompoundWorkflowDefinition* class [Kra00] has been replaced by the *workflowDefinition* class, as the first is not considered in our meta-model, and in order to maintain the consistency with the functional aspect in Figure 1.

Data aspect

It describes the data-flow managed in the business process. The informational aspect in [Kra00] has been extended with new classes (see Figure 2). The *data* class represents a source data or a sink data in the dataflow declaration. A data is identified with a type (*typeDeclaration*), single or composed (*structure).* At the same time, a differentiation among data has been established. During business process runtime some data change their value whereas others remain inalterable. This distinction is set with the *dataVariableDeclaration* class and *dataVariableDefinition* class.

Figure 2. Data aspect (adopted from [Pen02])

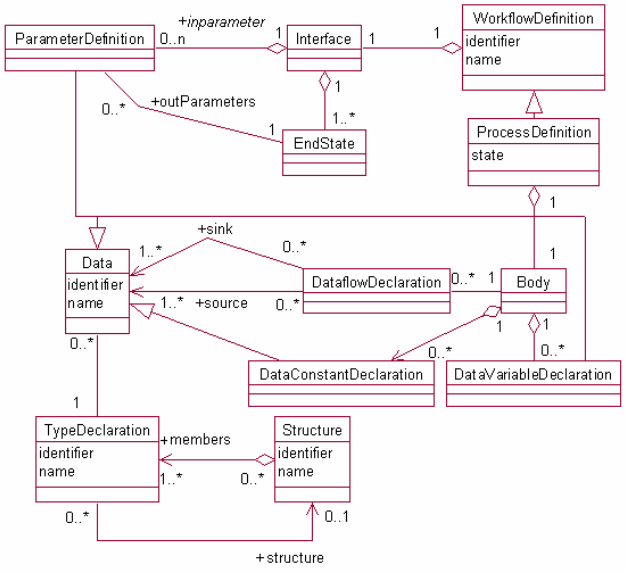
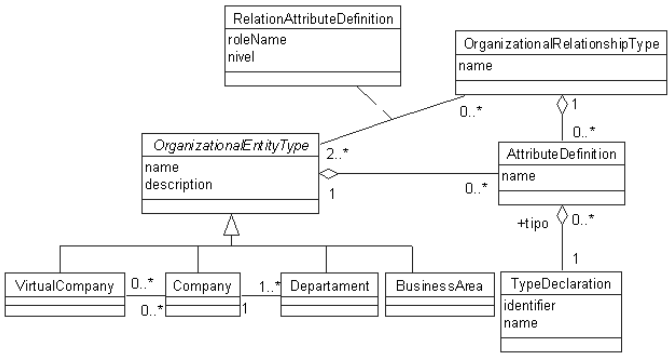


Figure 3. Organizational aspect



Organizational aspect

From our point of view, the inter-organizational perspective is not clearly defined in the classical organizational aspect. During business process lifetime, two or more organizations act as a whole in order to obtain a shared benefit. They make up what is known as a "virtual" organization. This "virtual" organization will last until the business process conclusion.

The organizational model proposed in [Kra00] has been extended (see Figure 3), by adding the "*virtual company"* class, used to establish a relation among two or more companies, represented by the *company* class, in the context of a shared business process.

Distribution aspect

In the "distribution aspect" the inter-organizational orientation of our meta-model is clearer perceived. It describes the "distribution", that is to say, the allocation of the different activities in the business process among the organizational entities that participate on it. Although it is not shown in this paper, a relation between the *workflowDefinition* class and the *organizationalEntityType* class represents this new aspect.

Distribution and interoperability among business process are concepts that have been broadly investigated [WFMC02], although their importance is not reflected in a wide number of the metamodels consulted.

An advantage of including this aspect in the metamodel is that it facilitates the business process execution in distributed environments, a key factor in inter-organizational business processes.

User aspect

The user aspect is a representation, a view of the state of the business process (total or partial). It is an upper layer where a user with a given set rights can see the elements involved in that portion of business process and how they behave. Thus, a closer relation between the user aspect and the functional and behavioral aspects is established.

CONCLUSIONES AND FUTURE WORKS

In this article a proposal of business process meta-model with a clear inter-organizational orientation is given. At the present time, our research group is working in the definition of a meta-process for the development of business-process. As it was established in a previous work [GMG03], inter-organizational or intra-organizational communication can be achieved by means of a high-level process, technology-independent, from which one or more business process can be instantiated. This high level process is the meta-process. Our idea is to "transfer" or "translate" the effort made in that work (where a meta-process for software process development was defined) to a business environment. It implies a broad research on business processes, studying and comparing different proposals of business process lifecycle and the elements in each of them (phases, activities, task, resources, actors, etc.)

Another focus of study is the evolution and versioning, both in the meta-process and meta-model, following with the research line started at [Mar00].

Moreover, as the Web interface for business process display is used, interface aspects must be considered. So, a research on web-based user interfaces modeling languages must be done, with special attention to the user-workflow nexus [BBC+03].

REFERENCES

[BCC+03] Brambilla, M., Ceri, S., Comai, S., Fraternali, P. and Manolescu, I..: Specification and Design of Workflow-Driven Hypertexts. Journal of Web Engineering (JWE), vol.1, number 2, pp.163-182, April 2003

[Bic98] Bichler, P.: Conceptual Design of secure workflow systems: An object-oriented approach to the uniform modelling of workflows, organizations and security. Dissertation, Linz 1998.

[Biz03] Microsoft BizTalk Server. http://www.microsoft.com/biztalk/

[BU01]Bachmendo, B. and Unland, K.: Aspect-Based Workflow Evolution. Proceedings at the Tutorial and Workshop on Aspect-Oriented Programming and Separation of Concerns, Lancaster University, United Kingdom, August 23-24, 2001.

[Cas98] CASATI, F.: Models, Semantics and Formal methods for the Design of Workflows and their Exceptions, PhD. Thesis, Department of Electronic & Information, Milan, Politecnico di Milano, Milan, November 1998

[CKO92] Curtis, B., Kellner, M.I., and Over, J.: Process Modelling. CACM, vol. 35, no. 9, p 75-90, 1992

[CMSA02] Cardoso, J., Miller, J.A., Sheth, A.P., and Arnold, J.: Modeling Quality of Service for Workflows and Web Service Processes, VLDB Journal, The International Journal on Very Large Data Bases (VLDBJ), Vol., No. (May 2002)

[ebXML03] http://www.ebxml.org/

[EG02] EDER, J. and GRUBER, W.L: A Meta Model for Structured Workflows Supporting Workflow Transformations. Proceedings of the Sixth East-European Confernce on Advances in Databases and Information Systems (ADBIS'2002), Bratislava, Slovakia, September 8-11, Springer Verlag (LNCS 2435), ISBN 3-540-44138-7, ISSN 0302-9743, page 326-339.

[EP02] EDER, J. and PICHLER, H.: Duration Histograms for Workflow Systems

Proceedings of the Working Conference on Engineering Information Systems in the Internet Context (IFIP TC8/WG8.1), September 25-27, 2002, Kanazawa, Japan, Kluwer Academic Publishers, ISBN 1-4020-7217-1, page 239-253.

[GMG03] Gómez, M.P., Martínez, A. and Garcí-Consuegra, J.: A meta-process model for process management and evolution. In Proceedings at the 2003 IRMA Conference, Philadelphia, USA, May 18-21, 2003

[Gru03] GRUBER, W.L.: Modeling and Transformation of Workflows with Temporal Constraints PhD thesis, University of Klagenfurt, May 2003, http://www.ifi.uni-klu.ac.at/Publications/Dissertations

[Jab95] Jablonski, S.: Workflow-Management-Systeme – Modellierung und Architektur, International Thomson Computer Press, Bonn, 1995.

[KB97] Kwan, M.M. and Balasubramanian, P.R.: Dynamic workflow management: A framework for modeling workflows. Proceedings of the Thirtieth Hawaii International Conference on System Science. Volume IV, Maui, HI, January 1997

[Kra00] Kradolfer, M.: A Workflow Metamodel Supporting Dynamic, Reuse-based Model Evolution, PhD Thesis, Wirtschaftswissenschaftlichen Fakultät der Universität Zürich, Mai 2000.

[LR00] Leymann, F. and Roller, D. Production Workflow: Concepts and Techniques, 2000, Upper Saddle River, New Jersey: Prentice-Hall

[Mar00] Martínez, A.: Examen y discusión del estado del arte en sistemas de gestión de flujos de trabajo con capacidades evolutivas. Trabajo de Investigación, Universidad de Castilla-La Mancha, 2000.

[MGC01] Martínez, A., García-Consuegra, J., and Canós, J.M.: Estudio del estado del arte en modelado y ejecución de procesos

interorganizacionales. Technical Report, DIAB-01-06-21, Departamento de Informática de Albacete, Universidad de Castilla-la Mancha, España, 2000

[Mqs03] IBM MQSeries. http://www-3.ibm.com/software/integration/mqfamily/

[Mue04] zur MUEHLEN, M.: Organizational Management in Workflow Applications. Information Technology and Management Journal. Kluwer Academic Publishers, 5 (2004) 3.

[Pen02] Penadés, M.C.: Una aproximación metodológica al desarrollo de flujos de trabajo, PhD. Thesis, Departamento de Sistemas Informáticos y Computación, Universidad Politécnica de Valencia, España, Enero 2002.

[Sch99] Schmidt, R.: Aspektorientierte Komponentensysteme zur Unterstützung weitreichender Geschäftsprozesse Fakultät für Informatik, Universität Karlsruhe, December 1999

[Wes00] Weske, M.: Workflow Management Systems: Formal Foundation, Conceptual Design, Implementation Aspects. PhD. Thesis. Westfälische Wilhelms-Universität, 2000

[WFMC99] Workflow Management Coalition. Terminology & Glossary. TC-1011, Issue 3.0, February 1999. http://www.wfmc.org

[WFMC02] Workflow Management Coalition. Workflow Process Definition Interface – XML Process Definition Language, WFMC-TC-25, October 25, 2002

[WK02] Wetzel, I. and Klischewski, R.: Serviceflow beyond Workflow? Concepts and Architectures for Supporting Inter-Organizational Service Processes, In: Advanced Information Systems Engineering. Proceedings 14th CAiSE. Springer Lecture Notes in Computer Science, Berlin, pp. 500-515, 2002.

[ZCP01] ZHUGE, H., CHEUNG, T.Y. and PUNG, H.K.: A timed workflow process model Journal of Systems and Software, Volume 55, Issue 3, 15 January 2001, Pages 231-243

[Zha98] Zhao, J.L. Knowledge management and organizational learning in workflow systems. Proceedings of AIS 98, Baltimore, August 14-16, 1998. http://citeseer.nj.nec.com/zhao98knowledge.html

ENDNOTES

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