Top-down Modeling Methodology for Model-driven SOA Construction

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Top-down Modeling Methodology for Model-Driven SOA Construction

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Abstract. Service Oriented Architecture (SOA) has been developed to enhance the integration of various systems to allow organizations to be more flexible in case of business changes. This paper will explain a top-down method in which Business Process Models can lead to a basic service orientation of business functions. This will be shown based on the principles of Model-Driven Architecture (MDA). Without model support, the translation of business needs into executable code to support IT developments is rather hard and mostly impossible. In this paper, we motivate the need for this approach as a means of focusing importance on modeling, a key enabler of communication between business analysts and IT developers.

Keywords: Business Process Management (BPM), Model Driven Architecture (MDA), Methodology, Modeling, Service Oriented Architecture (SOA).

1 Introduction

Today, core processes of organizations need to be changed frequently due to changes in strategy and the underlying organization. These constant changes of processes define the requirements for the supporting IT Systems. Depending on the degree of changes necessary, the underlying IT architecture might be impacted. Therefore it is important to stress on the top-down method as illustrated in figure 1. In order to support the flexibility required in the business processes, service oriented architectures represent a promising way to implement IT needs [1,2,3,4,5,6]. The SOA paradigm is defined as "an architectural concept in which all functions, or services, are defined using a description language and have invokable, platform-independent interfaces that are called to perform business processes" [7,8].

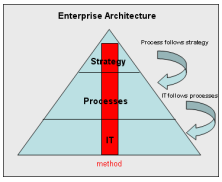

Figure 1: Architecture with three abstraction levels

The knowledge on business processes and related components (e.g. data, organization and products) can be considered as a critical success factor for the design and implementation of SOA. As a systematic support to the modeling of processes, a tool driven approach is recommended [9]. This responds to the common issue of interlinking functional and technical modeling. Different modeling notations exist (e.g. IDEF Suite, BPMN, Testbed, ARIS, UML, Structured Analysis and Design Technique, Petri Nets, Object Oriented Modeling, CIMOSA, IEM approach, Merise). By using a business process analysis tool that enables modeling principles, "bridging the business-IT gap" is possible [10].

We will therefore in this article, as part of our PhD research, show some preliminary results on one possible way of integrating company objectives down to code following a top-down approach. We are at the moment at an early stage of work and different methods and modeling languages have not been analyzed in deep so far. In section 2 an excerpt of concepts and the positioning of models will be described. Section 3 indicates related research in academia and 4 and 5 finally, summarizes and gives an outlook to remaining issues, challenges and future work. The description of automatic model translation, interoperability and matching patterns is not objective of this paper.

In a separate chapter in a long paper version with 16 pages, a concrete but fictive business example by using ARIS Toolset (one of the leading process analysis tools together with Popkin, MEGA, Casewise [11]) will illustrate the approach.

2 Concepts for Model-Driven SOA

Generally functional process models link process flow information with organizational information, whereas technical process models focus on relevant information (data, services, interfaces) required by IT systems. A well recognized approach to classify different types of models is the MDA developed by the Object Management Group (OMG) [12]. The objective is to provide an open, vendor-neutral approach of interoperability. It builds upon the Object Management Group's modeling standards: the Unified Modeling Language (UML), the Meta Object Facility (MOF), and the Common Warehouse Meta-Model (CWM). Platform-independent application descriptions built with these standards can be realized using different open or proprietary platforms, such as CORBA, Java, .NET, XMI/XML and Web Services. Currently, the MDA paradigm is fundamentally changing the way in which software is developed. MDA wants to raise the level of abstraction at which software solutions are specified by defining a framework supported by a collection of standards that sets a standard for generating code from models and vice versa. The following figure 2 aligns the classic layers with MDA framework.

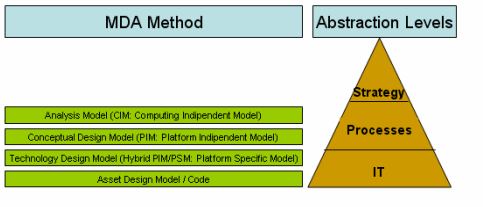

Figure 2: Matching of MDA Models vs. abstraction levels

The Computation Independent Model (CIM) cares about the requirements for the systems by describing the situation in which the system will be used. Such a model is sometimes called a domain model or a business model and hides information about the use of automated data processing systems [13].

The Platform-Independent Model (PIM) describes the operation of a system while hiding the details necessary for a particular platform. The model focus on specifications that are not changing from one platform to another e.g. BPMN (independent from Workflow engine) or UML (independent of computing platform) [13].

A Platform-Specific Model (PSM) combines the specifications in the PIM with the details that specify how theses systems are using a specific type of platform [13].

UML is considered as the “de facto” modeling language for both PIMSs and PSMs. At the CIM level, it is more complicated as we have the notion of different views. This issue is explained in the “4+1” views on architecture design defined in RUP. The “4 + 1 View Model” describes software architecture using five concurrent views, each of which addresses a specific set of concerns: The logical view describes the design's object model, the process view describes the design's concurrency and synchronization aspects; the physical view describes the mapping of the software onto the hardware and shows the system's distributed aspects, and the development view describes the software's static organization in the development environment. Software designers can organize the description of their architectural decisions around these four views and then illustrate them with a few selected use cases, or scenarios, which constitute a fifth view. The architecture is partially evolved from these scenarios. [14]. To what extend automation of mappings between the CIM and PIM layer may be possible is an ongoing research topic. In the following chapter, a possible solution path and method derived from proven practice in consulting projects [15] will be shown to implement strategic objectives through the different levels of abstraction described above. Related to the processes in scope, we can distinguish different types of models and standards used (figure 3).

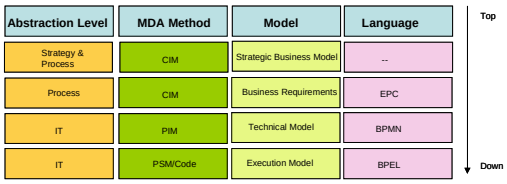

Figure 3: Framework of model-driven design for SOA

For the strategic business model, several methods could be used. In our method proposal described in this paper, we chose a well known method, the Balanced Scorecard (BSC) [16]. Kaplan and Norton introduced the BSC as a management system that helps an enterprise to clarify and implement its vision and strategy. The BSC therefore suggest to view an enterprise from four perspectives (Financial, Customer, Process and Learning and Growth) decomposed into a three-layered structure: 1. Mission (e.g. become the customers' preferred supplier) , 2.Objectives (e.g., to provide the customers with innovative products) and 3. Measures (e.g., percentage of turnover generated by new and innovative products).

The four perspectives with the three included layers can be represented in a so called "cause-and-effect" diagram. In the cause-and-effect diagram the necessary objectives and critical factors for implementing a business strategy are defined and their mutual influence is depicted using a cause-and-effect chain running over perspectives. Various tools exist on the market to visualize the departure point for SOA: the strategic objectives.

The next deeper layer describes the design of business requirements in the form of a process model. This view provides a high-level insight into the general operations of a company. The high-level overview can be shown by a value-added chain diagram (VACD) and specifies the functions in a company which directly influence the real added value of the company. The original concept of Value Chain was created by M. E. Porter [17]. The chain consists of a series of activities that create and build value. They culminate in the total value delivered by an organization. The concept of 'margin' is equal to added value. The organization is split into 'primary activities' and 'support activities. 'These functions can be linked to one another in the form of a sequence of functions and thus form a value-added chain. The value chain is a systematic approach to examining the development of competitive advantage. The drill-down of each business function is necessary to show how the functions are performed.

The complexity of business requirements can be captured in a next step by a process language. Many notations exist to describe processes. Examples include **E**vent-Driven-**P**rocess **C**hains (EPC) [18], IDEF1 and IDEF3 (which are part of the IDEF - **I**ntegrated Computer-Aided Manufacturing **Def**inition - family of languages for enterprise modeling and analysis [19]), or the Business Process Modeling Notation (BPMN) standard developed by the Business Process management Initiative (BPMI) [20].

EPC's are used to represent the procedural organization of the company, i.e. the links between the objects in the data, function and organizational view and, as a result, the processes are represented. The procedural sequence of functions is represented in process chains. In this context the start and end events of every function can be specified. Events trigger functions and are the results of functions.

The IDEF language uses five elements for the so called IDEF0 functional model: The activity, Inputs, Outputs, Constraints/controls and mechanism (equal to resource).

The BPMN standard developed by BPMI [20] who specifies a graphical notation that is to serve as a common basis for a variety of business process modeling execution

languages. The BPMI is a non-profit organization, which is looking after open standards for process design and therefore act as support of suppliers and users of business management techniques and tools. [21] The primary goal of BPMN is to provide a notation that is readily understandable by all business users, from the business analysts that create the initial drafts of the processes, to the technical developers responsible for implementing the technology that will perform those processes, and finally, to the business people who will manage and monitor those processes. Thus, BPMN creates a standardized bridge for the gap between the business process design and process implementation.

Another goal, but no less important, is to ensure that XML languages designed for the execution of business processes, such as BPEL4WS (Business Process Execution Language for Web Services), can be visualized with a business-oriented notation. As the utilization of re-usable services is a key criteria in SOA, the Web Services Description Language (WSDL) will be used. [22] WSDL is an XML-based, platform independent meta language used to describe the interface definitions of a Web service. In WSDL, the externally accessible functions of the Web service and the parameters and return values of these operations are defined. WSDL describes the communication format in which function calls to Web services are transmitted. The URL under which a Web service can be called is also specified.

BPEL links WSDL descriptions into a logic process flow. A BPEL process is following to this logic a bunch of service executions in a logical and timed sequential order. This is also well known under the term “service orchestration” [23, 6].

Due to limited space and as mentioned above, the extended paper will describe a case study with the aim to show how a consistent path can be followed across modeling techniques from strategy down to code. Please contact the author to get the extended article.

3 Critical Success Factors

Findings of this article are the critical success factors to be considered in the described scenario:

1. Top-down approach
As shown in the method, it is crucial to start with strategic objectives and to end with code and not the other way around. By respecting this, we are able to say **why** we need a SOA and where the benefit comes in. Only this way, architectural decisions provide an additional view on software architecture complementary to the traditional views explained by Kruchten [14]. SOA modeling techniques should adhere to MDA principles. By using MDA, we also bridge the issue between business and IT. Without

any doubt, new technology can influence strategy and choices for realizing those strategies. The bottom-up way called Architecture-Driven-Modernization (ADM) will also be part of the further analysis. It seems that "Meet-in-the-middle" methods might also be successful depending on the application context. This will be analyzed in the future work explained through the research plan in chapter 6.

2. Knowledge of Processes and Process Documentation
Without process knowledge in a company, it is hardly imaginable to identify all relevant functions that might be candidates for services. Consequently, the implementation of loose coupling principle and the re-utilization of web-services is hardly feasible. Without any documentation, it is very hard to speak a common language. It is needless to stress the communication aspect of SOA project teams with business analysts, technical analysts and external consultants. The quality of the documentation should be high to avoid questions and waste of time regarding the correctness and the level of detail of modeled processes.

This critical success factor is also described by academia, but the method and models used in this paper are going beyond related work [24]. In the presented case, we also include the strategic level with Balanced Scorecard and the Value Chain.

3. Tool driven approach
Without any tool offering a wide span of modeling methods, the technical connection between models can hardly be made. The higher the complexity and the number of processes, the more a robust tool is needed. Some tools with specific SOA modules are able to create automatically models and code between the two deepest layers.

4 Related Research

The latest publication of ERCIM NEWS July 2007 (European Research Consortium for Informatics and Mathematics) with a special issue on "Service-Oriented Computing" [25] shows clearly the interest and the need for the proposed research topic. Some articles highlight on current initiatives to directly linked topics and complementary subjects: Workflow Management Systems for Grid Computing with the research topic of grid modeling and the building of a process-aware Grid infrastructure (Bratosin C. et al, Eindhoven University of Technology) or the initiative to integrate semantic technology within business process management through the EU-funded project SUPER (Semantics Utilized for Process Management within and between Enterprises, Born M. et al, SAP Research, CEC Karlsruhe). Another topic is still automatic model transformation e.g. as currently researched by Pelechano V. et al (Universidad Politecnica de Valencia SpaRCIM, Spain) or model interoperability as discussed by the INTEROP project [26]. There is also research on methods for "business process driven service architecture" by Papazouglo M. (University of Tilburg, Netherlands), Pahl C. (School of Computing Dublin, Ireland) or Zdun, U., Dustdar, S. (Model Driven Integration of Process Driven SOA Models, Whitepaper

2006) or the mechanism of architectural decisions (Zimmerman O., IBM Zurich Research Lab). Another EU funded project, ATHENA (Advanced Technologies for interoperability of Heterogeneous Enterprise Networks and their Applications) [27] has interesting deliverables e.g. “Collaborative Enterprise Modelling Platform”, “Cross-Organisational Business Process Modelling and Enactment”, “Model-driven and Adaptable Interoperability Framework and Infrastructure” and the Platform-Independent Model for Service Oriented Architecture (PIM4SOA) [28]. The results out of the research initiatives will be carefully monitored and included into the basic research described in phase 1 of the research plan.

5 Conclusion and future work

In this paper, we have introduced one possible path for model driven development of process-driven SOAs that is based on proven practices but not academic research. Business process management tools describe a holistic model of business process management, ranging from strategic decisions to the design of business processes down to executable code. Such tools are integrated with standard model types and extensible with new model types. Regarding the choice of methods and models, a lot of decisions need to be taken. One way out of this complexity has been shown with the modeling method in this article. We are currently working on a PhD thesis in order to solve some of the issues involved in BPM-based SOA development. Therefore, 5 objectives need to be reached.

The first objective is to get a formal description of the different levels (Strategy, Processes, IT) and the status in academia regarding different methods proposed on each abstraction level. A considerable research work already done in European funded projects e.g. INTEROP [28] or ATHENA [29] to structure and compare modelling methods will be analyzed and reused as baseline for the first objective. Even if very common methods e.g. UML 2.2. did not play a major role in this paper, these modelling methods will of course be considered in this chapter. This phase will be concluded by a first empiric study with the aim to ask for used SOA methods, SOA maturity and their success factors.

The second objective is to discuss and compare the different methods and to end with a classification for each level.

The third objective consist in finding and describing links between the methods and levels to achieve a complete method linking strategy, processes and IT levels. To describe and translate the method on an abstraction level, models used and the description of models is part of the method.

The fourth objective is concentrating in testing the method by empiric research and case studies from various industries with the aim to refine the proposed method.

The fifth objective consists in searching for similarities in the results from the questionnaires and case studies especially in Luxembourg. If similarities can be found, a tailored adoption of the method for companies based on Luxembourg's market will be designed to allow concrete implementations of SOA. Specific criteria's will be defined and analysed. This goal might be in conjunction with Luxembourg's government initiatives to support emerging technology and trends. Therefore, collaboration with the public research institute Centre Henri Tudor (CHT) specifically with the Center for IT Innovation (CITI), collaboration is planned. To achieve the above mentioned objectives, the research needs to be decomposed into 5 phases and activities:

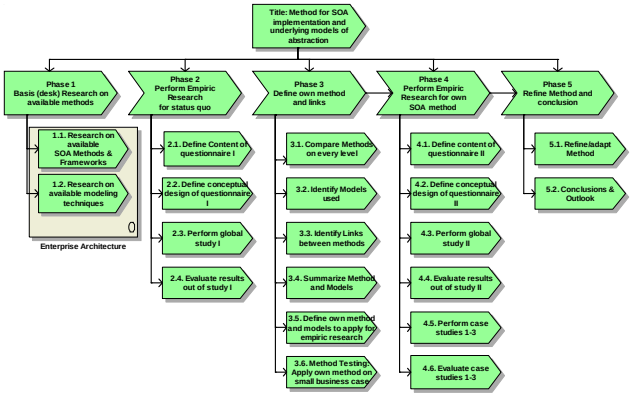

Figure 7: Decomposition of research plan

Phase 1: Basis (desk) Research on Available Methods

This phase will achieve the first objective. Therefore all different methods available on the three levels need to be gathered and classified. The different schools of thought will be structured and prepared for the comparison on each level. Furthermore, different leading methods for modelling techniques will be classified and analysed. For this topic, a lot of academic research has been done. This phase will be concluded by a first study applied on global level to find out, what Methods and models are known and used.

Phase 2: Perform Empiric Research I

The objective of the second phase is to get a "status quo" from global CIO's regarding knowledge and used methods and models, maturity of organization and plans to implement SOA. Particularly interesting will be the difference of chosen approaches and different maturity levels between companies in Luxembourg, Europe and world-wide. The content will be based on the results gathered during phase 1. The questionnaire will be online based to allow maximum efficiency for responders.

Phase 3: Define own Method and Links

The methods will be compared and condensed to one method through the different abstraction levels. The underlying utilisation of models proposed by academia e.g. MDA, Object Oriented Modeling etc and best modelling techniques used in the

practice's world will be used for that. The links and bridges between the models and the re-utilisation of objects will be a major outcome. One further outcome will be a catalogue of strengths and weaknesses regarding the available methods used (practice/academia). Once method and model catalogue are defined, requirement testing on a limited business case will be done to prepare the second empiric research.

Phase 4: Perform Empiric Research II

For the empiric study it is important to find out how the proposed method is perceived and how specific needs can be covered by the proposed method.

The research will be conducted two-fold: first a global online questionnaire for CIO's similar to phase II, will be performed. Second, 3 detailed case studies from 3 different industries in Luxembourg will be done (Logistic – Banking – Public Sector). Therefore typical companies will be chosen to reflect in the best way possible Luxembourg specificities.

Phase 5: Refine Method and Conclusions

Based on the findings during phase four, the method condensed out of phase three will be refined and adapted.

An additional research objective taking into account specific requirements of Luxembourg companies will allow adapted implementations of SOA.

The research objectives will be summarized, discussed and future research issues will be highlighted. So far, the issues and objectives of the research topic have been described and illustrated in a first article. Phase one of the research plan has already started, but is at an early stage. It is planned to describe first outcomes related to phase 1 early 2008 in a new article.

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