MDE Support for Enterprise Architecture in an Industrial Context: the TEAP Framework Experience

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Abstract. Model Driven Engineering (MDE) is often applied to support software engineering processes (i.e., from reverse to forward engineering, including maintenance and/or evolution tasks). However, as promoted by the Model Driven Organization (MDO) initiative, it can also be relevant in more business-oriented and strategic decision-making activities such as Enterprise Architecture (EA). EA is the process of translating business vision and strategy into effective change by better describing the enterprise's future state and thus enable its evolution. Even if several approaches have already proposed different kinds of support to deal with the company's EA, an integrated MDE framework combining EA data federation, EA standard adaptation and multiple viewpoint support is still missing. This paper reports on our ongoing experience of building the TEAP MDE framework (based on the TOGAF standard and SmartEA tooling) notably addressing these three challenges in an industrial EA context.

Keywords: MDE, EA, Federation, Adaptation, Traceability, View/viewpoint.

1 Introduction and Motivation

Model Driven Engineering (MDE) has already been largely applied in the general context of supporting software engineering processes (concerning both forward and reverse engineering) or when dealing with interoperability problems (e.g., data exchange, component adaptation) between different systems, environments, tools, etc. More recently, the so-called Model Driven Organization (MDO) initiative has been showing that (business-) strategic or decisional levels within companies, administrations, etc. could also benefit similarly from the application of MDE.

In this area, Enterprise Architecture (EA) [6] implies the effective representation and manipulation of many different aspects of an organization, such as notably its information system as well as depending services and people. There have been different initiatives during the last 30 years aiming to provide a unified EA representation framework, from the widely known Zachman Framework [21] to the U.S. DoDAF [9], British MODAF [15], Open Group ArchiMate [8] and currently the Open Group TOGAF standard [18]. However, fully and efficiently coping with EA is a real challenge [7] despite of the existing tools [14]. Thus *Modeling*, in the very large sense of dealing with *representations of reality*, has already been proposed as a possible solution in the EA context [5] although real effective applications of MDE have been much rarer. Among them we can cite LEAP [3], which provides a light and generic EA framework and language aiming notably at facilitating the analysis of EA representations (models) via their execution/simulation.

Complementary to this initiative, the main objective of our TOGAF Enterprise Architecture Platform (TEAP) collaborative project [19] is to provide (benefiting from MDE capabilities) a lightweight support to other standard industrial EA activities, more particularly to EA governance and decisional processes as commonly performed manually by the enterprise architects. In particular, the industrial partners in TEAP (namely Capgemini, DCNS and Obeo), based on their long-term expertise in EA and their concrete use cases, have identified some MDO shortcomings:

1. The capability of obtaining an initial cartography of the organization's system (here in terms of EA) from the relevant available information and data.
2. A standard (EA) representation facilitating interoperability that, at the same time, is flexible enough to be specialized for specific contexts and scenarios.
3. Support for the efficient handling of several views over the organization's system according to different viewpoints (here business, functional, technical, etc.).

The paper reports on the TEAP ongoing experience to target these MDO limitations in an industrial context while identifying relevant improvements to the MDE techniques themselves. We focus on three main MDE-based approaches allowing to:

- **Federate** heterogeneous data sources to **integrate** relevant EA information.
- **Adapt** more easily a standard EA solution to customer needs and potentially **trace** its different usages.
- **Support** multiple **views/viewpoints** over the same EA repository.

Resulting from this TEAP project, the SmartEA [17] tooling (continuously under development) is implementing a model-based EA framework integrating progressively the three MDE-based approaches mentioned before. Sections 2, 3 and 4 respectively introduce them with more details. Section 5 concludes by discussing our experience in TEAP and by summarizing both ongoing and future related works.

2 Model Driven Federation of Heterogeneous Data Sources

Within the context of EA, the amount of information to be considered is very large. Moreover, it can come in many different forms and quality levels (e.g., date, origin, completeness, relevance, etc.) and from several distinct data sources (e.g., XML documents, Excel files, databases, documentation, etc.). For the architects to deal more efficiently with this heterogeneity, it is important to provide them with a more advanced support for (semi-)automatically initiating their EA representation from this plethora of available data. For instance, the business processes of the organization are often already documented, at least partially or in a semi-structured format (e.g., in Excel). Thus, being able to create some EA representations from this business process information would be very helpful according to our industrial partners.

We call **data federation** such a "discovery + integration" process that populates an initial repository of interconnected models representing the company's EA.

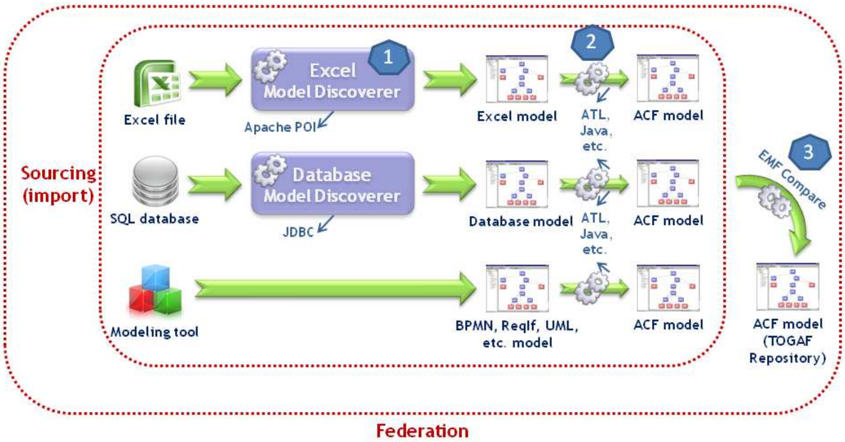

Fig. 1. Overview of the TEAP model driven data federation architecture

As shown in **Fig. 1**, our repository stores EA models (that conform to ACF, our TOGAF implementation). The objective is to get early model representations of the information from the different data sources so that we can benefit from MDE techniques when analyzing/handling them. Thus, model discoverers [1] have been implemented to automatically inject the needed initial *data* models (#1 in previous figure). Model-to-model transformations are then specifying the required *data-to-EA* transformations (#2 in figure), using DSLs (e.g., ATL [4]) or GPLs with model handling APIs (e.g., Java with EMF [13]). Finally, newly generated EA models can be integrated as part of the reference EA model(s) thanks to automated model comparison followed by manual merging decision (e.g., using EMF Compare [11]) (#3 in figure).

3 Model Driven Adaptability

Another fundamental characteristic of EA is the need for adaptability. Even if based on a well-known standard representation (e.g., TOGAF [18]), the concrete application of EA in different organizations often requires extending or specializing the core EA metamodel by reusing concepts coming from other metamodels. For instance, in our case, the core TOGAF metamodel had to be directly related with BPMN for business processes and ReqIf for requirements specifications: the EA information could more easily be linked to the data coming from different teams inside the company.

Within the context of TEAP, we address these two aspects of **adaptability** and corresponding **traceability** (between the extended EA elements and the related ones) from an MDE perspective. We first establish links (with different semantics such as *extension*, *trace*, etc.) between elements from two or more models. These links are then used to provide a global integrated representation of the different involved models, thus proposing a more general picture of the EA.

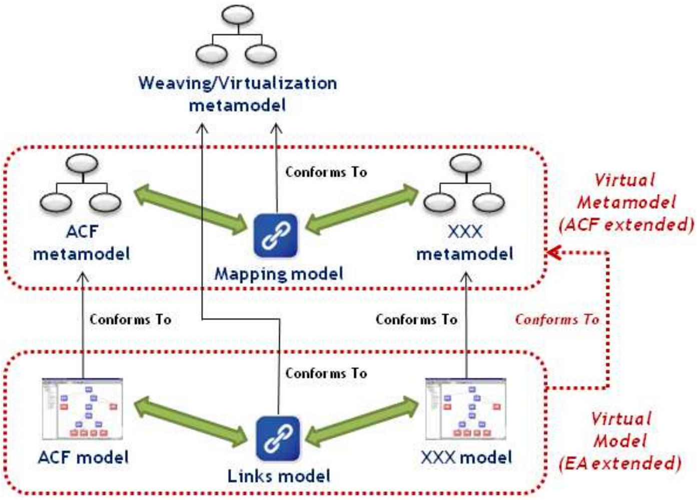

Fig. 2. Overview of the TEAP model driven adaptability and traceability architecture

As shown in **Fig. 2**, our proposal combines model weaving and virtualization techniques. Virtualization (Virtual EMF [20]) allows transparently accessing a set of related models as if they were composing a single model. The possible link types are defined at metamodel-level in a reusable *mapping model* (a weaving model) using different kinds of relationships (e.g., *isEquivalentTo*, *extends*, *refines*, etc.). Once such a mapping is specified (creating the *virtual metamodel*), a *virtual model* is automatically available based on a particular *links model (*i.e., model element-level links).

4 Multiple Model Views/Viewpoints Over a Central Repository

EA is about establishing an integrated representation of a whole organization. This is challenging as it implies visualizing EA models that can be very large and complex, notably because of the many different EA *building blocks* addressing several aspects of organizations (e.g., strategic, organizational, technological, etc.). Thus, for the framework to be actually usable, several interconnected *views* over the same EA repository are needed, targeting different user types/roles. This requires having specific viewpoints on the EA data, combining one or more predefined views.

As working with Obeo in the project, we rely on Obeo Designer [16] to support the smooth integration of several views, distinct or complementary, while working on a central EA repository. As shown on **Fig. 3**, this tool allows the definition of different graphical representations for the same model element. Thus, an element is displayed in one form or the other depending on the user's role or activity type, using an automated lock mechanism. Each viewpoint corresponds to a set of specified representations: diagrams, tables, matrices or trees that can be modified and/or extended if necessary. To realize this, Obeo Designer combines MDE techniques for model handling (EMF [13]), model comparison (EMF Compare [11]), graphical editing (GMF [12]) and model distribution (CDO [10]). The coupling between the concrete representations and the abstract syntax is minimized as much as possible to favor reusability.

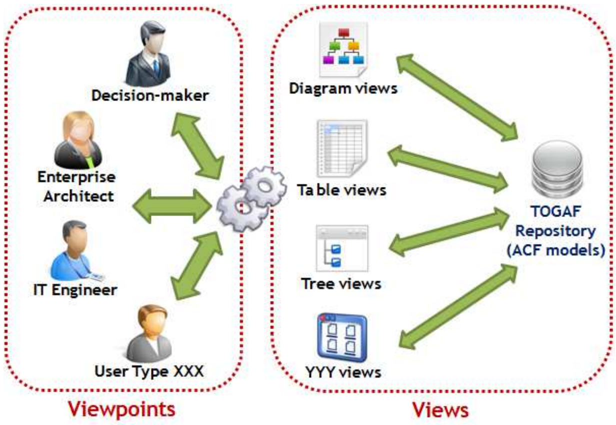

Fig. 3. Overview of the TEAP multiple model views/viewpoints

5 Discussion and Further Works

Based on our experience so far in the TEAP project, we can say that the effective combination and integration of several MDE techniques have shown to be able to bring benefits to some of the current industrial MDO shortcomings. This is particularly true when dealing with problems related to heterogeneity, adaptability or visualization. However, the main finding is that some adaptations and/or improvements from an MDE perspective have been necessary in order to tackle the targeted MDO challenges. This has notably been realized based on the constructive feedback received from the different EA experts (i.e., the end-users in our case) involved in the project.

Some of these aspects are the following. Working on the federation problem, we have to deal with quite different data sources (e.g., Excel sheets, Power Point schemas) than the ones usually considered in more standard Model Driven Reverse Engineering processes (source code, XML files, etc.). This is forcing us to modify the available model discovery support and to regularly upgrade it with new supported input formats, only having a partial (explicit) structure in some cases. While addressing the adaptability/traceability issue using model virtualization techniques, the tool integration aspects have highlighted the necessity of being able to virtualize not only models but also metamodels (which was not the case before). This has notably been required to improve model virtualization usability with already existing solutions (e.g., SmartEA in TEAP). Finally, concerning multiple views/viewpoints, we have realized that the problem was not so much on the tooling/feature side but rather on the human aspects: more particularly, how to agree on the best concrete syntax (i.e., representation) to use for each specific and different group of users [2].

We are convinced that the work in the project will continue to help us getting new relevant concrete insights, not only on how MDE can benefit EA (and potentially other related fields) but also on how EA, as a natural application field for MDE, can be valuable to guide the improvement of some of the current MDE techniques.

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