

(Multi-) Modeling Enterprises for Better Decisions

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Abstract. Enterprises typically depend on past experience and human expertise for responding to changes. This is no longer cost effective in the increasingly dynamic world of enterprises. Enterprise models are required that describe the enterprise as well as prescribe courses of action in the face of change. Owing to complexity of enterprises, multiple models need to be employed when addressing specific problems. Toward this end, we present an approach that uses number of specialized models focused on decision making. Our contributions are- first, we show how these models can be used in concert and second, we present how these models can be used in a real world case study of merger of two enterprises. Our ongoing research suggests that in spite of several challenges, this approach provides promising first steps toward enabling enterprises in responding to changes with more certainty.

Keywords: Enterprise Models, Multi-Models, Decision Making, Enterprise Analysis

1 Introduction

For the past 17 years, we have helped 70+ enterprises in their IT automation efforts. In recent times, we have witnessed that the need for automation and its actual realization in an enterprise is driven by multiple change drivers in various dimensions. Modern enterprises display a characteristic connectedness between these dimensions; change in any one dimension affects the others. Our experience suggests that lack of enterprise-wide context that encompasses all dimensions, is the key cause of enterprises' inability to change cost effectively.

This led us to posit that a model of enterprise is needed that is capable of catering to all relevant dimensions of enterprise while being machine processable and analyzable [1, 2]. Furthermore, specialized modeling languages could be used with these enterprise models for decision making in enterprises [3, 4]. Our past experience and ongoing investigations suggest that we essentially need both descriptive [5] and prescriptive models of enterprise [6]. In this paper, we describe various models that we think are needed for better decision making. Our specific contributions are twofold- first, we systematically elaborate on how these models can be used in-concert, and second, we put the proposed research in the context of Mergers and Acquisitions (M&A), a special case of enterprise transformation. By elaborating how our approach can be

used for solving prevalent M&A problems in general and M&A of two large banks in specific, we bring out further facets of our proposed research.

The paper is arranged as follows. Section 2 motivates the need for multiple kinds of models of an enterprise and based on our experience and investigation puts forth the kinds of models needed for better decision making. Section 3 describes how we are applying the proposed approach to a real world M&A case study. Section 4 concludes the paper.

2 Enterprise (Multi-) Models

2.1 Motivation

Enterprises are complex systems of systems and responding to change is extremely cost-, time-, and effort- intensive [2]. This is felt both when aiming at sustainable enterprises, i.e., maintaining business-as-usual in the face of change [7] and tackling enterprise transformation scenarios, i.e., changing enterprises substantially in response to change [8]. If we consider business, IT, and infrastructure to be roughly the key dimensions of any enterprise [5], we can see that changes in one dimension are affected by change drivers in other dimensions. Business change drivers such as economic and socio-political drivers, and more specifically drivers like dynamic supply chains, mergers, acquisitions, and divestitures, and globalization and regulatory compliances, etc., eventually lead to changes in IT and infrastructure. Similarly, changes demanded by mobile and cloud technology eventually result in changing the way business is performed.

As far as IT systems are considered, enterprises use them in particular to derive mechanical advantage through automation of operational processes catering to their strategic, tactical and operational goals [9]. Large enterprises traditionally operate in siloized manner for ease of management and control. This results in IT departments knowing only their local context. As a result, IT systems are developed independently and individually to service globally mandated goal, be it transactional (i.e., business-as-usual) or transformational in a very specific context. This leads to a plethora of IT systems servicing same goal from the global context. Furthermore, technological requirements in specific contexts may vary, resulting in widely non interoperable technologies. Together these problems result in highly escalated cost of IT to business.

In general, management relies solely on expert judgment about how to tackle changes across dimensions of enterprise and in particular resolving issues pertaining to IT systems. Our take on this is it is better to make machine-processable and analyzable models of enterprise as a whole as well as of its key parts that are respectively descriptive and prescriptive in nature [10], so that decision making is automated to the extent possible, yet always carried out in the context of all of an enterprise.

2.2 Proposed Models

In using models for better decision making in enterprises, we need models that act as inventories of all relevant information, i.e., models that are descriptive. An ArchiMate-based enterprise model that captures information about business, IT, infrastructure entities and relations while conforming to ArchiMate metamodels would be such a model.

We also need models that can use such information and prescribe course(s) of actions based on some criteria. This core distinction is at the basis of several kinds of models we are proposing for better decision making in enterprises as shown in Figure 1.

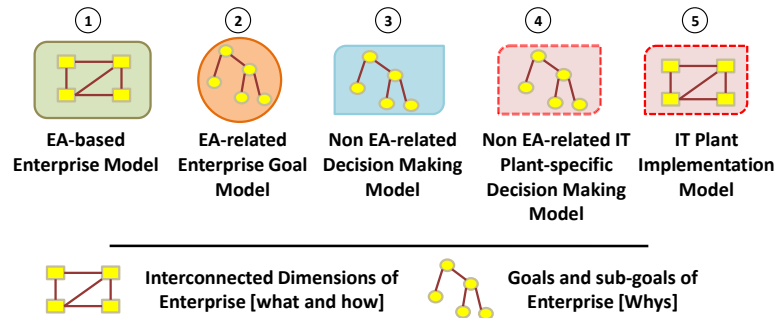


Fig. 1: Different Kinds of Models Required for Better Decision Making in Enterprises

EA-based Enterprise Model(s) In Figure 1, **①** shows an enterprise model that should be based on an enterprise architecture (EA) framework. This is a descriptive model that inventories the information about key dimensions of an enterprise. This model can be queried for stakeholder-specific information and can also be used for some informative analyses pertaining to given EA framework. Our initial results in creating such a model were presented in [1].

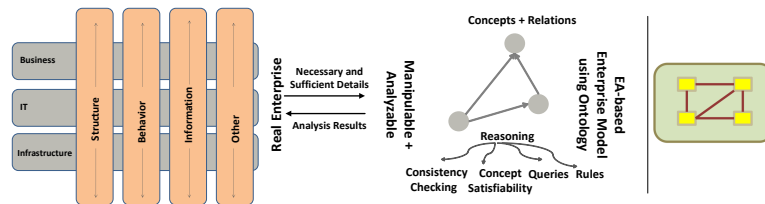


Fig. 2: EA-based Enterprise Model using Ontological Representation [1]

Figure 2 shows how an EA-based ontology representation, in this case based on ArchiMate, can essentially make enterprise models machine-processable and analyzable. Note that **①** kind of models capture *what* and *how* of an enterprise but not *whys*.

EA-related Enterprise Goal Model **②** in Figure 1 shows a prescriptive model focused on capturing *whys* or intentions behind decisions taken in enterprise. For this, we suggested first steps using intentional modeling language *i** for capturing goals in enterprise models based on ArchiMate. In contrast to goal descriptions provided by the EA framework, such as ArchiMate motivation extensions, our approach enables solving problems faced by enterprise, and select the optimum strategy from the available ones [3, 4]. This is illustrated in Figure 3. We used a bidirectional metamodel mapping to represent problems faced by our own model-driven development unit in the concerned case study.

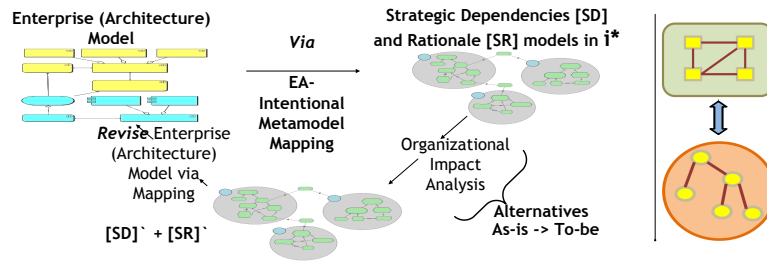


Fig. 3: Intentional Model Related to the Enterprise Model [3]

Non-EA-related Decision Making Model The prescriptive models of Figure 3 are relatable with enterprise models, i.e., based on similarity in concepts of actor, behavior, resources one could relate these models [3, 4]. But we are currently also investigating the utility of prescriptive models that are not relatable to enterprise models in the sense that there is no metamodel to which these models conform that could be mapped to enterprise metamodels in this case ArchiMate metamodels. ③ in Figure 1 illustrates such models. We describe one such model using an example of workforce planning.

Generally, spreadsheets are used to encode workforces planning parameters to monitor and to take actions based on parameter values. Essentially, operational decisions are represented using formulaic language supported by spreadsheets suitable for quantification which is cryptic and spread over number of spreadsheets. The information about why certain formulae are used remains largely unclear. What-if and if-what analyses, i.e., evaluation of alternate strategies from as-is state of enterprise to its to-be state and search of strategy that might have led the enterprise to its current as-is state respectively, are difficult to explicate with such representation. These analyses need to be conducted frequently as for a service company such as ours, workforce situation remains in flux. We are therefore investigating the use of system dynamics (SD) models to address the problem of workforce planning. The detailed description of how we propose to use SD models to capture issues of attrition, on roll skills, and on the job headcount, and how recruitment from campus, lateral hiring, on-boarding process etc. affect these is out of the scope of this paper.

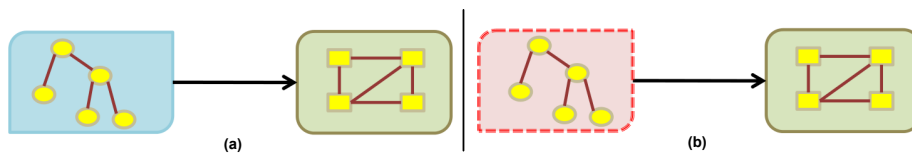


Fig. 4: (a) Using Non-relatable Prescriptive Models with Enterprise Models (b) IT Plant-specific Prescriptive Models with Enterprise Models

The core concepts of stocks, flows, and influencing variables in SD represent drastically different abstractions than those found in enterprise metamodels. Instead of metamodel mapping therefore, we propose to use these models in-concert by explicating the analysis results in the form of strategies to achieve goals which are represented with bidirectional mapping to enterprise models. This is shown in Figure 4 (a). One obvious

example where the problems of workforce planning are directly related to enterprise-wide context is finding the steps required for an organization to increase revenue by 10% quarter on quarter. Cost benefit analysis of workforce planning would need to see how revenue earned changes as a function of on roll manpower, project mix to bid, and bid success ratio etc. The results of this analysis need to be put in the overall enterprise context, in the ArchiMate sense, at the business layer, perhaps in terms of actions that resource management department may take to satisfy the strategic goal of increased revenue.

Non-EA-related IT Plant-specific Decision Making Model In Section 2.1 we referred to the problems of IT systems of an enterprise that must be addressed in both business-as-usual and transformational situations. The set of interacting IT systems of an enterprise, and technology and hardware infrastructures underneath them is what we refer to as an IT plant. We believe that to address the problems of local optimality with respect to a given property, functionality overlapping, and non-interoperability between IT systems, we need to model IT systems and their interactions with specialized models. These kinds of models are shown as ④ in Figure 1. Their usage with enterprise models is shown in Figure 4 (b).

We expect these models to be graph-like where IT systems are nodes and the edges are interactions such as depending on one another, accessing same set of data, simply relaying data, and so on between them. The analysis essentially focuses on interaction patterns of the systems of an IT plant. Such models may be constructed by observing in automated manner how IT systems use one another and how changes in underlying technology platforms and hardware infrastructure of an IT system affects other IT systems of given IT plant. By constructing models based on interaction patterns of IT systems and refining them over a period of time, we think that problems of optimality with respect to given criteria, non-interoperability, and overlapping functionalities could be addressed effectively. This constitutes part of our ongoing work. Like models illustrated earlier in Figure 4, results of IT plant-specific model analysis will have to be put in the context of enterprise as shown in Figure 4 (b).

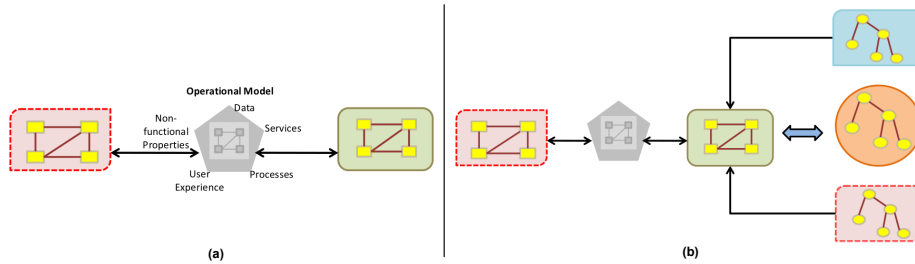


Fig. 5: (a) Relating IT Plant Implementation Model with Enterprise Model (b) Using (Multi-) Models of Enterprise in Concert

IT Plant Implementation Model While strategic and tactical goals focus on the long-term orientation of the organization and short-range planning respectively, operational goals focus on implementing tactical goals at the ground level. This is also more relevant in the case of IT as business rather than IT as support function of business. We are proposing that there should be a bidirectional traceability between enterprise model

and IT plant implementation models via operational models that translate strategic level requirements of data, services, processes, user experience, and non-functional properties to implementation level specifications from which IT plant may be generated. ⑤ in Figure 1 shows such models which are illustrated in overall context in Figure 5 (a).

We are aware of stark differences in levels of abstraction and granularity of concepts between enterprise models and IT plant implementation models and the operational models with data, service, process, non-functional properties, and user experience requirements in between are expected to bridge this gap. Earlier in Figure 1, we did not show the operational model, because we are not certain of what will be the nature of these models or if these models are required at all. We believe that it should be possible to automate to the extent possible translation of results of various analyses obtained with the rest of the models illustrated in Figure 1 into an actionable form.

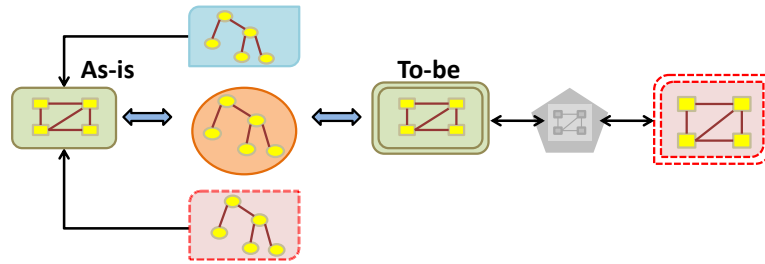


Fig. 6: Using (Multi-) Models of Enterprise in Concert for Enterprise Transformation

Figure 5 (b) shows various models illustrated so far together. While the enterprise model remains the **single version of truth**, results of analyses using non-EA-related decision making models of IT- and non-IT-specific models are to be explicated in conjunction with enterprise goal models for better decision making. Since ultimately our focus is on IT systems, we have proposed to connect enterprise models to IT plant implementation models via operational models (of kinds of requirements). In the next section we review further issues pertaining to multi-modeling of enterprises.

While Figure 5 (b) can be used straight away for decision making in business-as-usual situations, Figure 6 shows how transformational situations can be addressed using proposed models. Note that Figure 6 does not show as-is IT plant implementation models for the want of space. The as-is and to-be EA-based enterprise models are connected via EA-related goals models. Other decision making models may be used for specific problems in transformation and eventually IT plant implementation of to-be enterprise model may be obtained.

In the next section, we show how the proposed models may be applied to a case study of M&A of two wealth management companies taking into account various issues outlined above.

3 Proposed Application to M&A

Background The case study concerns two large independent Wealth Management (WM) (retail brokerage) companies (WM1 and WM2) which came together to form WM3. The combined retail brokerage house has 10000+ Financial Advisors, managing multi-billion dollars in client assets across 700+ locations in country X. WM1 and WM2 both

provide WM products such as credit, lending, annuity, insurance, banking, etc. and services like brokerage, advisory, financial planning, wealth planning, retirement planning, and trust etc., to wealthy individuals and small-to-medium size businesses across X.

WM3 was formed the expressed strategic goal of tripling WM1's revenue and gross margin in 5 years. WM3 also has strategic growth viewpoint where it needs to provide new and innovative products and services to its clients. This requires a renovated state-of-the-art IT platform to compete with its more aggressive peers and ever increasing tech-savvy clients. In the following, we discuss how various decision making models may be used to address specific problems in conjunction with the enterprise model.

Using non EA-related Decision Making Models for Business Aspects Several tactical goals were devised that would contribute positively to key strategic goal. Three of these tactical goals were optimize/rationalize branch and back-office operations, rationalize wealth management products and services, and of course, integrate workforces of WM1 and WM2. Each of these three goals can be achieved using SD or similar models, which are essentially examples non EA-related decision making models.

For the tactical goals mentioned above, particularly for workforce integration of WM1 and WM2, SD models could be used in a manner similar to the way they are used in workforce planning as discussed earlier in Section 2.2. For optimization/rationalization of branch and back-office operations, an important fact to consider is that WM1 and WM2 were competitors prior to the merger with several branches in the same locality. Consolidating the branches and their operations would result in recurring cost savings every year. The decision to which ones to keep as-is, which ones to merge, and which ones to let go of depends on branch operations related parameters such as whether it is owned/leased, cost and duration of the existing lease, importance of the location from WM3 perspective, floor capacity, terms and conditions, future growth potential at that location, etc. Decisions on optimal branch structure, e.g., how many/which branches should form a complex, how many/which complexes should be part of a region (western/eastern/northern/southern), etc., need to be taken to better manage WM3. The WM1/WM2 back-office operations also need to be optimized along similar lines.

WM1 and WM2 operate in similar business domain and hence have similar and even overlapping product and service portfolios. For rationalization of wealth management products and services, it is necessary to look at these products and services portfolios from WM3 business model perspective and take decision on keeping as-is, enhancing (modifying/merging/re-branding), decommissioning (retiring) the mix of products and services. The parameters that would be of relevance in taking decisions include product capabilities, channels, WM3 requirements, integration with other products/services, 3rd party (product/bank/vendor) involvement, etc. Also, it makes sense to look at cross-selling opportunities within WM1 and WM2 in terms of existing clients for products/services that were otherwise not available before the merger.

Using non EA-related IT Plant-specific Decision Making Models With regards IT platforms of WM1 and WM2, key goals were to integrate IT platforms of WM1 and WM2 so as to obtain optimum IT platform functionality in WM3, optimizing WM3 IT platform capacity, and come up with optimum data conversion/migration from WM2 to WM1 in WM3.

In case of optimum WM3 IT platform functionality, the alternatives are to build a new IT platform or enhance one of the existing WM1 or WM2 IT platforms to support the WM3 target operating model arrived at separately. In order for the target IT platform to support WM3 operating model, decisions need to be made on which applications to keep as-is from WM1 or WM2, which ones to enhance (modify/merge-functionality), which ones to build from scratch (nothing can be reused from WM1/WM2), which ones to decommission and when. Note that problems of IT systems of enterprise described in Section 2 get accentuated in this case because of the size and legacy of WM1 and WM2 combined together and therefore need further efforts in capturing interaction patterns of IT systems of WM1 and WM2 themselves and possible interactions between IT systems of WM1 and WM2.

To resolve the problem of optimizing WM3 IT platform capacity, current size of WM1 + WM2 needs to be considered along with the future growth plans for WM3 which is that the capacity of the WM3 platform needs to be doubled. It means the existing applications (selected for WM3) should be able to handle 3 times their current volume (# of transactions, clients, branches, financial-advisors, employees, etc.) without (negatively) impacting performance. This would require changes such as optimizing/re-writing database queries, re-architecting / re-designing, adding more hardware, etc. The changes would cut across multiple layers and applications. There could be problems similar to Y2K that need to be addressed. For example, 3 digits were sufficient to accommodate WM1 Branches, but WM3 is going to have more # of branches and 3 digits may no longer be sufficient to accommodate WM3 branches.

For data migration problem, existing and historical data needs to be converted from the source to the target platform and applications. This includes both business critical and non-critical data. Since there is terabytes of data involved and limited conversion (live cut-over) time-window available because of the nature of the business, there is very limited scope for making an error (in speed and quality of the conversion) during the entire process. The converted data should also comply with the regulatory requirements applicable for WM3. We are currently investigating how above mentioned problem descriptions can be represented using decision making models of IT plant as described in Section 2.2.

Decision making in M&A Problems in Enterprise Context Figure 7 extends the transformational situation captured in Figure 6, and shows the merger of WM1 and WM2. This merger was initiated by WM1, therefore the as-is and to-be states are depicted as that of WM1. EA-based enterprise models of WM1 and WM2 are descriptive models which capture all relevant information about WM1 and WM2 in a manner explained in [1]. The EA-related enterprise goal model using intentional modeling represents the strategic goal of revenue increment and its further breakdown into sub-goals as in [3,4]. The decomposition of goals and sub-goals here needs to continue till results of analysis on non EA-related decision making models including those that are IT plant-specific can be plugged in suitably in the EA-related enterprise goal model. Chosen alternatives to resolve specific problems are eventually implemented in the IT plant implementation of WM3 via bridge provided as discussed in Section 2.2.

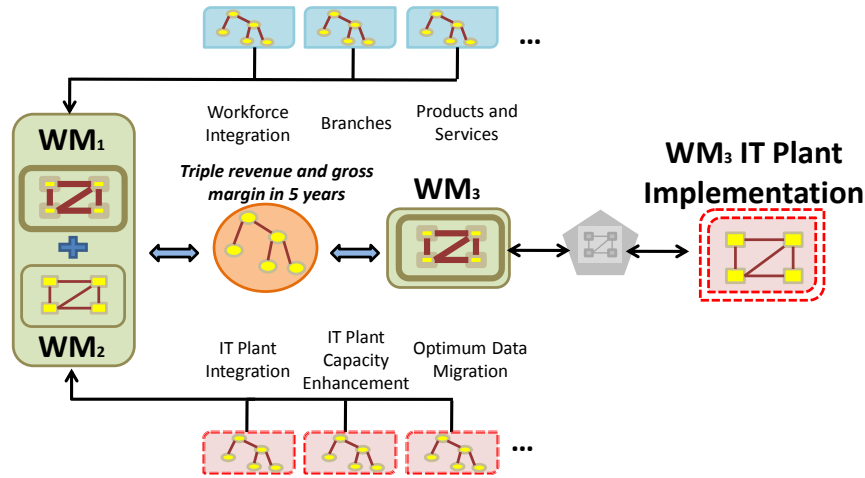


Fig. 7: Using (Multi-) Models of Enterprise in Concert for M&A

As we proceed with our approach, we found some issues that need to be addressed which we enlist below-

- **Integrating multi-models of enterprise** As discussed, multi-(level and formalism)models are needed to address problems faced by enterprises. Using common ontology to map concepts from different modeling languages to each other [11] and level-agnostic metamodeling [12] may provide some help to address this issue.
- **Keeping models and reality in sync** Reality may already have changed till the time various models are completed. We think agile concepts applied to enterprise modeling would help along the lines discussed in [13]. Furthermore, multi-models focused on specific concerns may help in keeping models and aspects of reality they capture in sync.
- **Relating strategic goals with properties of operational elements** Strategic goals and desirable properties of operational elements like IT systems are at different level of abstraction. We need ways of computing properties [14] and deliberating their tradeoff before plugging them in various decision making models.
- **Treating various uncertainties** Some of the uncertain aspects of enterprise modeling are variation in meaning of concept based on modeling language, modeling the reality completely and accurately, reconciling modeling information spread over multiple sources and multiple levels of abstraction, and ways in which enterprise phenomena affect each other. Probabilistic methods are suggested for this [15], but further research is needed for application to specific kind of uncertainty.

Many of the above issues have been recognized already by several researchers in different contexts. Complexity and size of enterprise models make addressing them as effectively as possible even more pertinent.

4 Conclusion

We proposed combination of EA-based enterprise model and set of models specialized for decision making pertaining to specific aspects of enterprise as descriptive and

prescriptive models respectively. Initial treatment of real world merger of two large enterprises using our multi-model approach indicates that problems faced by enterprise that demand specific ways of solving can be modeled and solved in separation yet maintaining the overall enterprise context. Furthermore, modeling enterprise concerns down to IT plant itself means that both business-as-usual and transformational situations can be tackled. Initial results suggest that multi-models of enterprise help in separating and localizing decision making in enterprise.

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