

## Enterprise Modelling Approach based on Maturity and Business Scope perspectives

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### Abstract

This paper introduces a framework that supports users to implement enterprise modelling within collaborative companies. These enterprise models are the basis for a holistic interoperability measurement and management methodology which will be presented in the second part of the paper.

The discipline of enterprise modelling aims at capturing all dimensions of an enterprise in a simplified model. Thus enterprise models are the appropriate basis for managing collaborative enterprise as they reduce the complexity of interoperability problems. Therefore, a first objective of this paper is to present an approach that enables companies to get the most effect out of enterprise modelling in a collaborative environment based on the maturity of their organisation relative to modelling. Within this first step, the user will get recommendations e.g. for the correct modelling language as well as the right level of detail.

### Keywords

Enterprise modelling, interoperability maturity assessment, sustainable establishment, Business Scope Orientation

## 1 INTRODUCTION

Chinese companies in the industrial sector as well as Indian ones in the IT sector are entering more and more into the high tech fields of industry by providing very competitive low-cost state of the art products. The reaction of global players in the market can, for instance, be observed in the transfer of less qualified production areas to China in order to reduce costs. This leads sometimes to a shift of the entire production. Especially for European component suppliers this process is very dangerous. Instead of leveraging personal costs, where Europeans have less influence, more offensive approaches are necessary in order to increase competitiveness. Here two aspects are proposed:

- Improving their qualification and capabilities to collaborate with networks and partners. This will enable a single company to join additional business partners in a flexible way or to choose cost-effective suppliers based in Eastern Europe.
- Enriching the reputation of the own competencies in order to be recognised in a wide field, as well as to convey trust to potential customers, similar to what Indian software companies had done by achieving CMM level 5 for convincing European and American customers to outsource IT development. The most important strength of these types of companies is not anymore exclusively their low labour costs.

Both activities will lead to higher competitiveness not only in the market of origin, but also for new segments in terms of products and regions. Major

barriers are the effort and the time needed to perform the establishment of such a collaboration, competence and trust building activities, especially for small and medium sized companies. On the other hand for SME tools and methodologies, like enterprise modelling as prerequisite for interoperability, are still too much expensive for initial investments, education as well as maintenance.

The goal is to provide an Enterprise Modelling Approach that satisfies together the following conditions:

- Reduction of the time to adopt an Enterprise Modelling Approach towards interoperability,
- Satisfaction of the users requirements concerning Enterprise Modelling leads to an Enterprise Model with sufficient level of detail, level of formalisation and model quality according to the interoperability task
- Support the daily business of employees especially for interaction between each other.

Another objective of the approach is to enable companies to evaluate their current enterprise interoperability maturity level. A framework determines discrete levels of interoperability improvement based on the successive adoption of good enterprise modelling practices in the different enterprise dimensions (process, organisation, product, systems, etc.).

## 2 STATE OF THE ART

The same principle forms the basis of well-known and – introduced maturity models, like, for instance, the CMMI, or SPICE (ISO15504) which help to assess quality aspects of software and system development. There are a lot of Capability Maturity Models available for several business sectors and

functions and supports interoperability aspects already (e.g. the collaboration maturity model). However they are not focussing how to achieve interoperability and how to proceed for improving and last but not least how to use systematic approaches like Enterprise Modelling.

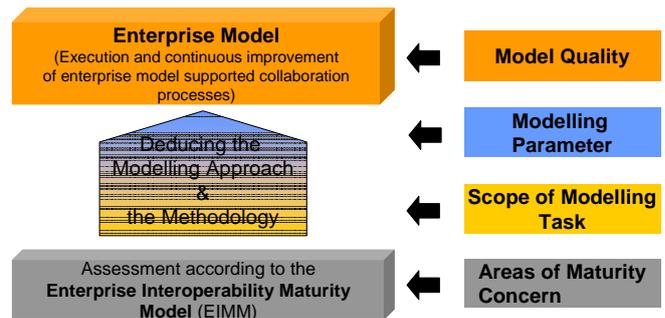
The tools commonly applied in defining the required steps to achieve a certain level of e-Business implementation come from the areas of Enterprise Modelling (EM), Business Process Modelling (BPM), Workflow Management (WfM) and the like. A plethora of tools supporting the different modelling approaches and paradigms are available on the market in a variety of flavours, features sets, sizes and costs [5]. But the sustainable use of these tools is almost missing. So today, the user of enterprise models has to deal with several problems [1]. First, too much time is needed to create a complete model, and, when finished, the developed model does not reflect the reality in a proper way anymore. Second, the models often do not fit user's requirements, e.g. the model is not detailed enough or the level of formalisation is not appropriate. Third, it is often not possible to use the modelling results to support the daily business of employees, because the users most of the time do not have the skills to read the models properly and to deduce the implications for their work. A formal definition of business processes and enterprise assets is however fundamental for being able to fully understand and analyse their strategic and operative impact on a company's objectives, and even more for implementing them as e-Business processes.

In the ATHENA project the Establishment methodology for collaborative enterprises was developed, which contains a framework, a methodology, a maturity assessment methodology including a questionnaire, modelling parameters and establishment concepts. In this paper this methodology will be enriched by the integration into the ATHENA Interoperability Framework and by quality criteria which will guide the users for modelling.

### 3 METHODOLOGY

#### 3.1 Approach

The objective of the framework in this chapter is to provide the user a recommendation how to deliver a model-based collaboration, concerning the different levels of collaboration and their optimisation. It shall provide assistance in capturing the collaborative processes of the company with the support of one of several adequate modelling approaches. And further it shall support the selection of an adequate methodology into an enterprise model and establish this model in the company. This model shall assist to achieve an efficient operation and management of collaboration processes. Figure 1 gives a review on the whole framework (comp. [1]).



**Figure 1 - Model-based collaboration maturity framework**

It consists of three parts:

1. **Assessment of Collaboration processes and Maturity:** The basis is given by the collaborative activities of the company. In order to identify the correct project approach, the maturity assessment has to be performed. Using the maturity model for enterprise modelling that is described in the following section, the result of the first step is supposed to be the maturity level of the company for participating in collaboration.
2. **Deducing the Modelling Approach and the Methodology:** This step contains the procedure how to deduce an adequate modelling approach and methodology depending on [1]. By the way the modelling parameters have to be specified (e.g. the right level of granularity) as well as the support level of the Model Generated Workplace have to be determined. The conditions are the as is and to be interoperability level according to the EIMM (Enterprise Interoperability Maturity Model), the model quality which is needed to achieve the modelling objective to manage enterprise challenges.
3. **Modelling the Enterprise and application:** The result of this part is an enterprise model that follows from applying the specific modelling approach and methodology from previous part. This holistic framework includes two levels of implementation (Organisational and Collaboration Instance). Organisational level: The purpose is to improve the overall ability of the enterprise to interoperate with others. The approach is to apply the EIMM. When the enterprise reaches higher maturity levels, it is able to establish collaboration with external entities in a faster, more effective and more efficient manner, and to make use of the full potential of enterprise modelling approaches. The purpose is to define the adequate enterprise modelling approach to establish collaboration in a specific context. The approach is to characterise the collaboration, identify the model requirements based on that characterisation, and derive the appropriate enterprise modelling recommendations for that requirements.

### 3.2 Collaboration processes and Maturity Assessment by using the EIMM

When applying a maturity assessment for enterprise modelling, we need to examine indicators that allow judging an organisation's relative ability to use approaches for representing enterprise knowledge within the organisation to improve organisational and personal performance. The traditional way of achieving this ability is to use languages for enterprise modelling, i.e. structure the knowledge representation around graphical (typically two-dimensional) diagrams. Additionally, enterprise modelling practices need to be extended to approach interoperability; this is, to facilitate collaboration with others. The following six Areas of Concern can be identified for an EIMM [1]:

- **Business Strategy and Processes** to cover the identification, specification, execution, improvement and alignment of business strategy and processes. For the purpose of interoperability, this includes and pursues the improvement of internal and external collaborative processes.
- **Organisation and Competences** to identify knowledge and skills of the targeted players. For the purpose of interoperability, this includes the identification of external entities to collaborate with.
- **Products and Services** This Area of Concern covers the identification, specification and design of the organisation's products and services, its quality characteristics and the life-cycle strategy. Most important is to check the capability of the company to externalise products and service knowledge in the right granularity and according to the context of collaboration.
- **Systems and Technology** to cover the identification, specification, design, construction/acquisition, operation, maintenance and improvement of enterprise systems. The main item is a systematic design and runtime environment to support daily business in a systematic manner.
- **Legal Environment, Security and Trust.** This Area of Concern covers the identification of legal, security and trust requirements due to the collaboration with external entities, and the provision of solutions to manage these aspects which are a key for interoperability.
- All of the previously identified Areas of Concern are directly affected by aspects of an all embracing sixth Area of Concern, which is:
- **Enterprise Modelling.** This Area of Concern covers the specification, construction, application and improvement of the enterprise models. This includes support activities such as the identification of appropriate meta-models and languages, methodologies, infrastructure,

organization (people and skills), etc. for enterprise modelling. Additionally, it deals with the interoperability of enterprise models.

Using a five level maturity scale, the following maturity levels can be identified:

- **Performed:** Enterprise modelling and collaboration is done, but in an ad-hoc and chaotic manner. The organisation collaborates with external entities (suppliers, administration, customers), but the relationships are not planned thoughtfully. Collaborative tasks and processes usually exceed budget and schedule, their past success (usually based on the people) cannot be repeated.
- **Modelled:** Enterprise modelling and collaboration is done in a similar way each time, the technique has been found applicable. People understand the enterprise model and know how to execute it, and network technologies are used to collaborate.
- **Integrated:** The enterprise modelling process has been formally documented, communicated and is consistently in use. Different dimensions of the models are integrated among themselves and the model is traceable to the enterprise systems, there is a knowledge base used to improve the models, and business collaboration is facilitated through interoperability technologies, use of standards, and externalisation of part of the enterprise models.
- **Interoperable:** Enterprise models support dynamic interoperability and adaptation to changes and evolution of external entities. The workplaces of the people are seamlessly adapted to the enterprise model. Results (for organisations and persons involved) and process metrics are defined as a basis for continuous improvement.
- **Optimising:** Enterprise models allow the organisation to react and adapt to changes in the business environment in an agile, flexible and responsive manner. Enterprise systems are systematically traced to enterprise models and innovative technologies are continuously researched and applied to improve interoperability.

The EIMM is defined as a set of Areas of Concern and a set of maturity levels provides the means to determine the current ability of an enterprise to collaborate with external entities and to specify the path to improve this ability. It provides an organisational context for more specific and technical improvements. As a third dimension, the EIMM takes into account the targeted organisational units for which a maturity level needs to be assessed, or which need to be improved, in order to achieve a certain maturity level. Each Area of Concern will be defined by a set of goals and objectives related to interoperability and collaboration issues. The level of interoperability and

collaboration maturity for each Area of Concern will be defined by the presence or absence of maturity indicators. These are typical practices and work-documents, which have to be in place to achieve a determined maturity level. In order to achieve a certain maturity level, each of the indicators needs to fulfil the threshold values or states that are specified for the respective maturity level. At the same time they illustrate the To-Be status which has to be realised if a company wants to reach the next maturity level.

### 3.3 Mapping the EIMM with Modelling Parameters and Quality Criteria

The impact and the benefit of the above described criteria to Interoperability requirements can be shown, if they were mapped to the different levels of the AIF. This mapping of the criteria to the AIF gives the assessment structure and the related procedure a new tool to differentiate and to weight the interoperability requirements for Enterprise Models. In the next two subchapters the Interoperability levels and the quality criteria will be introduced. Gaps

#### 3.3.1 Interoperability levels based on ATHENA Interoperability Framework (AIF)

The ATHENA Interoperability Framework (AIF) consist on three areas the applicative, the conceptual and the technical integration. Based on the technical framework different levels of interoperability are defined. The levels are representing layers of abstraction and the ability of automatically execution of collaboration.

The **Business Analyst Perspective** means that the involved partners only define common strategic goals which they want to achieve together but they do not define how to work together. Models only illustrate these strategic aspects.

**Technical Process Analyst Perspective:** Collaborations on this level are characterised by the attempt of the partners to align their process with each other. The detailed business logic and the requirements for IT – Support to enable interoperability between business partners can be assessed in this level.

In the third level the **Implementation Perspective** allows the invocation of existing services automatically. Collaboration can now take place on IT system level by using certain interaction protocols.

The lowest level of granularity in performing design time modelling is represented by the **Data Perspective** were data formats and semantics are clarified in order to allow collaboration support with approved data and formats.

The lowest level in terms of interoperability run-time perspective is represented by the **Execution Data Perspective**, were values of properties are consistent and comparable.

#### 3.3.2 Criteria for quality of Enterprise Modelling regarding interoperability)

Quality Criteria for Enterprise Modelling regarding interoperability are derived from “Principles of methodical modelling” [7,9] Concepts and Rules for Enterprise Models [6]. These basic criteria are extended and adapted regarding interoperability:

- **Correctness:** An Enterprise Model is correct, if real world elements are correctly represented in the model. It means syntactically (complete and consistent related to the Meta-Model) and semantically (structural, hierarchical and behavioural constancy related to the elements of the real world) correct. [7]
- **Scope and Purpose orientation:** An Enterprise Model is scope and purpose oriented, if it represents only these parts of the real world which are intended by the goals, the scope and the purpose of the modeller. [7]
- **Efficiency:** An Enterprise Model is efficient, if the creation effort is low, but the benefit regarding the intended goals, scope and purpose is high. It is also efficient when the usage duration of the model is long and itself or parts of it are reusable for other goals, scopes and purposes. [7]
- **Conformity:** An Enterprise Model is conform, if it fulfils specific language requirements, follows specific (design) rules, fulfils/covers standards, covers specific boundary conditions. [7]
- **Clearness:** An Enterprise Model is „clear“, if on one side a common well known terminology based on an application oriented ontology is used and on the other side it is readable based on a structured layout. This criterion depends on the model user and also on the modelling method/language which is used. [7]
- **Comparability:** An Enterprise Model is comparable, if it fits into a common framework, uses defined levels of abstraction and a granularity based on defined scope, goals and purpose. Comparability is influenced by the use of common patterns, the grade of formalisation and the correct usage of modelling method/language. [7]
- **Systematic Structure:** An Enterprise Model has a systematic structure, if it fits into a common framework, uses common pattern, was build with consistent, systematic applied design rules and supports the concepts of views to integrate models developed from different views. [6]
- **Life-Cycle Support:** An Enterprise Model supports the Enterprise Life-Cycle, if it allows feeding model information forward and backward in life-cycle activities and represents recursion and iteration mechanisms. Different life-cycle phases may have different models. It enables value-added iteration of enterprise processes that improves product quality. [6,9]

### 3.3.3 Mapping

In Table 1 - the mapping between the introduced parameters is shown: Scoping Business Modelling (which are the leading parameters), Modelling parameters, required minimum EIMM Assessment results and importance of the Modelling Quality parameters.

Quality Criteria	Correctness	Important	Important	Important	Important	Important
	Scope and Purpose orientation	Essential	Essential	Important	Less important	Essential
	Efficiency	Less important	Less important	Less important	Important	Important
	Conformity	Important	Important	Important	Essential	Essential
	Clearness	Essential	Important	Important	Important	Important
	Comparability	Important	Essential	Essential	Essential	Essential
	Systematic Structure	Important	Essential	Essential	Essential	Essential
Life-Cycle Support	Essential	Essential	Important	Less important	Important	
Modelling Parameters	Model granularity	Value Chain	Work Process	Activity	Properties	Property Values
	Model Completeness	Pragmatics	Syntax	Semantics Constructs	Semantics Data	Semantics Data
	Level of Formalization	Business Analyst Perspective	Technical Business Process Perspective	Implementation Perspective	Execution Data Type Perspective	Execution Data Perspective
Scoping Business Modelling	Management level	x				
	Process level		x			
	Process Support level			x		
	IT-Execution Level (Datatype)				x	
	IT-Execution Data Collection and Analysis					x
Minimum EIMM Assessment	Products & Services	Level 1 Performed	Level 2 Modelled	Level 3 Integrated	Level 4 Interoperable	Level 5 Optimized
	Enterprise Modelling					
	Legal Environment, Security and Trust					
	System & Technology					
	Business Strategy and Processes					
Organisation and Competences						

**Table 1** - Mapping the Modelling parameters according to the scope, EIMM Assessment results and Quality Criteria

The AIF levels are represented as Level of Formalisation from Business Analyst perspective to Execution Data perspective. Based on the “Business Scope” the right modelling parameters can be derived in order to define an appropriate model (see mark “X” to each level). As well the required EIMM level is indicated in the same metric. In the case that an EIMM level is not achieved for a distinct modelling task, activities for the improvement of interoperability capabilities can be identified by a simple analysis of the current maturity profile. The quality parameter which represents the outcome of the modelling task has a different behaviour. The requirements level of each parameter is increasing from left to right. So for instance becomes the “Clearness” in the Execution Data Perspective the mark important whilst in the other levels it is essential.

### 3.4 Application in the context of networked enterprises

The establishment approach is today defined in a very generic manner. This will allow the application of this concept for a lot of different purposes and the approach will become more important when adopting special needs. In the following some specific items for deriving the approach are explained [1]:

- **Interoperability Assessment (IAS) for Supplier or Supplier Network Participants:** A lot of suppliers (especially in the automotive sector) are challenged by serving to a multitude of OEM's, because of different specifications in terms of processes, IT-systems, documents and organisation.

- **Implementing Industrial Reference Models:** Companies have to take into account reference and sometimes best practice approaches (e.g. ITIL in IT Service or AIAG Inventory Visibility and

Interoperability). For being compliant to these reference models companies need very deep definitions of their own business and have to change their processes and infrastructure. Therefore the EIMM should be adopted according to the specific needs. For the other elements of the entire establishment approach there is no change required.

- **Support for performing different kind of analysis methodologies:** Based on the mapping the best suited methodology for analysis and decision support can be used. So for instance in logistics simulation the most important and as well expensive problem is data collection [10]. Logistics simulation can be located at the execution data perspective. The prerequisite for an most efficient simulation application is Level 5 of the related business environment. Levels below means to invest more in data collection and refinement.
- **Support for Certification:** A lot of reference models of the above explained challenge e.g. ITIL are a basis for several sector specific and sector independent certifications. The establishment framework can support the

process of certification preparation and bring these activity inline with the overall business activities. The EIMM itself will be applicable for most of the standards in order to measure the company situation according to the specific standard requirements.

The current version of the framework and the establishment methodology is an improvement result of the application in automotive, communication and real estate companies. The most important benefits are the reduction of modelling time (e.g. only 4 month for the entire enterprise architecture in a automotive supplier company with appr. 1000 employees ready for ISO 16949 certification) and the sustainability because of company wide acceptance (after two years up to date and support of important projects). As well less effort (here 20 person days for external people) was a very good argumentation for choosing the methodology [11].

#### 4 SUMMARY AND OUTLOOK

The Framework for the Establishment and Management Methodology and their concepts that are mainly elaborated in ATHENA A1 and described (such as EIMM and Maturity Assessment, Deducing Modelling Approach with Modelling Parameters, Establishment Methodology and Mapping Method) has as goal the improved utilisation of enterprise modelling to enable the enterprises to have efficient collaboration with each other. The application of these concepts allows the enterprises first to create the enterprise models for improving the interoperability capabilities in short time with using a modelling approach that is adapted to the specific enterprise requirements. Second to keep the developed models alive and to use them to support the daily business of employees. Third to follow incremental and thus more controllable approaches for applying enterprise modelling in order to improve the business. Last but not least this approach supports a closed loop approach from conceptual design time modelling down to executive run time perspective.

In the next steps the relationship between the deducing approach for enterprise modelling and establishment concepts has to be verified.

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## 7 BIOGRAPHY

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