A Principle-based Goal-oriented Requirements Language (GRL) for Enterprise Architecture

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Abstract. Business processes, goals, and tasks of individuals in an Enterprise must constantly be aligned with several regulations, standards, policies and EA principles imposed internally by organizations or externally by governments. Due to the complexity of these documents and their constant changes, it is not possible for organizations and individuals to ensure compliance with the descriptive and textual version of these documents. To overcome this, we propose a principle-based GRL framework which help to formally model these interactions with an extension of GRL and analyze the impact of the principles, regulations, standards and policies on the overall goals of the organization. In this paper, we discuss our proposed framework and then focus mainly on providing a GRL profile for Enterprise Architecture principles.

1 Introduction

Enterprise Architecture (EA) principles are an organization's basic philosophies that guide the development of its architecture [14, 11], and aim to bridge the gap between high-level strategic intentions and concrete design decisions [9]. EA principles establish a context for architecture design decisions by translating business criteria into a language and specification that technology managers can understand and use, delimiting decisions about the architecture [5, 9].

The development of an organization so that it meets its goals is a joint effort of involved stakeholders and employees. Each individual contributes to the development of the enterprise by fulfilling his own tasks and satisfying his own goals. To achieve organizational goals, individual goals and tasks have to be driven by processes to ensure compliance with internal and external constraints (e.g., strategy, EA principles, policies, regulations, requirements). Much work has been done to model policies, regulations and standards with goal modeling notations [7, 15]. However, in the context of EA, principles are informal in nature, and similar to regulations, quite vague and complex. Therefore, reasoning in general, and compliance in particular, becomes a difficult task to fulfill. By formalizing EA principles in a goal modeling framework and mapping their structure to GRL intentional elements, we aim to create an opening for further

reasoning. Business Motivation Model (BMM) [1], ARMOR [13], and the motivational extension to ArchiMate [6] try to formalize such principles in terms of goals and rationales. As Quartel et al. [13] state, BMM mainly focuses on business plans, their elements, and relationships between the motivations and the business elements. It does not function as a requirements modeling language. ARMOR, which is based on goal-oriented requirements engineering methods, aims to fill the gaps for modeling motivations. However, ARMOR or motivational extension of ArchiMate do not focus on modeling principles. In addition, they lacks many of the features existing in the current goal modeling notations such as i^* or GRL [4]. ARMOR is not scalable and does not include automatic analysis mechanism and tool support. GRL, on the other hand, tries to overcome the scalability issues with tool support, such as the one found in jUCMNav [3].

GRL, which is part of the User Requirements Notation (URN) [10], aims to elicit, analyze, and describe stakeholder requirements as goals. GRL supports different *evaluation mechanisms* that enable modelers to analyze the trade-offs among (often conflicting) goals of stakeholders. It also helps document the rationale behind such requirements. GRL can be extended by the help of **Metadata** and **URN links** concepts of URN. **Metadata** are name-value pairs used to annotate (e.g., for stereotyping) any model element whereas **URN links** are used to define typed links between any pair of model elements. With the use of the metadata, it is possible to annotate GRL intentional elements with stereotypes. Ghanavati *et al.* [8] discussed how to model regulations with an extension of GRL called Legal-GRL. Here, we aim to do the same for modeling principles and rationales in EA by introducing a GRL Profile for modeling EA principles.

In this paper, we introduce a principle-based GRL Profile. To that end, we first introduce a formalism for modeling the EA principles, adopting the principle structure of Greefhorst and Proper [9]. Next, we extend GRL with EA principles concepts and map EA principles elements to GRL intentional elements.

2 Proposed Framework

2.1 Principles based GRL

Our principle-based GRL framework, shown in Fig. 1., has three layers, being:
• **Organization:** The organization layer contains two GRL models. The first GRL model belongs to the organization and contains its higher levels goals. This model «contributes»to the GRL of individuals. Each individual has his own goal to achieve. By satisfying their own goals he «contributes»to the organization's goals. A decision made by an individual can be captured (at run-time or *a posteriori*) in a "decision text". This element has a «traces»link with the individual's GRL model.
• **EA Principles:** The EA Principles layer contains the textual representation of an EA principle (see Table 1) and a GRL representation of the same principle. The EA Principles GRL «complies»with the organization's goals and has the role to «restrict»the individual's goals and tasks (GRL model).
• **Knowledge base:** In this layer, we capture the decisions taken based on the

individual's GRL (the link «decides») and the previous EA Principles GRL's (the link «generates»). In the future, we aim to construct a knowledge-base system including past cases to suggest templates at run-time for individual's GRL. However, that is out of the scope of this paper.

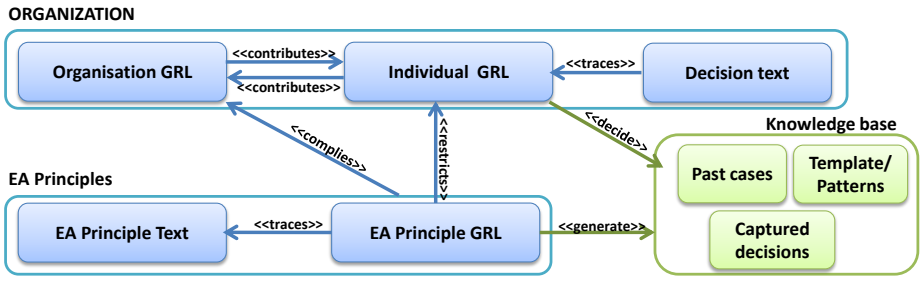

Fig. 1: Principles based GRL framework

2.2 Structure of EA Principles and Principle-based GRL Profile

There are multiple views on EA principles. We use the structure as used by the Schiphol Group, a Netherlands-based Enterprise [12](see Table 1). We extend GRL with a set of stereotypes to capture the aspects related to EA principles. This extension helps understanding the principles in GRL, make them differentiated from the original GRL and helps in compliance analysis with principles. Goals originating from the principle are mapped to softgoals or goals in GRL, annotated as «Principle»goals. The future situation which describes the «FutureState»when applying the principles, is modeled with intentional elements. When future state is achieved, they contribute to the high-level goals of the principles. Added Values which are the side-effect values achieved by enforcing the principles are modeled as «AddedValue»softgoals. They are linked to «FutureState»with correlation links. «Application»tasks, which represent alternative, should be performed to reach the «FutureState».

2.3 Example

In this example, we use one of the principles defined by a Schiphol Group. This principle shown in Table 2 is translated from Dutch internal documents of the organization. A partial definition of the same principle can be found in [9]. This EA principle is for re-use before package selection and states that "The enterprise shall re-use the already in use applications and infrastructure. If it is not possible to re-use the existing solutions, then a standard solution shall be purchased. If a standard solution is not sufficient, custom development is the third choice. Applying this principle results in more efficient use of ICT resources and reduces cost and time."

Table 1: Structure of EA Principles and our mapping to GRL elements

EA Principle Element	Definition	GRL Intentional Element
Principle	The description of the principle	–
Goal	What is aimed to be achieved	«Principle»IE
Current situation	A description of the current situation with regards to the principle	–
Future situation	A description of the situation that would be attainable if this principle is applied	«FutureState»IE
Added value	Describes what enforcing the principle should result in. This has to offset the (negative/limiting) consequences	«AddedValue»Soft goal
Constraints	Restrictions caused by enforcing principles.	«Constraint»OCL Rules
Application	The activities to be done to transform the current situation to the future situation.	«Application»task
Architecture domain	The domain where the principle applies to.	Actor

Figure 2 illustrates the GRL model of the principle. There are three alternatives for the use of applications annotated with the «Application »stereotype. Each of these alternatives contributes differently to the «FutureState». The best option, which is the re-use, has the highest contribution value and the last option which is the use of the custom-built component contributes negatively to the future state. If the enterprise reaches the «FutureState», then it contributes positively to the high-level goals, "Increase Efficiency" and "Reduce Cost". The future states also have positive side-effect (i.e. correlation) to the «AddedValue»goals. After creating this model, the organization and individual will implement one of the alternatives and establish links to the EA principle GRL model. Any changes in the state of the principle or organizational and individual GRL models impacts the satisfaction value of «Principle»and «AddedValue»goals.

3 Conclusion and Future Work

EA principles are vague, complex, informal in nature, and are usually represented in a textual format. Thus, it is difficult for organizations and individuals to align their goals and tasks with principles and manage the changes.

To deal with this, we proposed a principle-based GRL to capture the existing elements in EA principles. As a starting point, we defined the stereotypes of the principle-based GRL using the EA principle structure of the Schiphol Group. However, we need to improve this profile by capturing various principle structures and provide concrete/formal steps for modeling with principle-based

Table 2: Example of EA principle, adapted and translated from [12]

Element	Definition
Principle	As formulated in Sect. 2.3
Goal	Increase the efficiency of resources by re-using (e.g. software licenses, infrastructure), Reduce the cost of resources.
Current situation	ICT department is well aware of the trade-off between package selection, build and re-use. Regular discussions tackle these three options, Similar features are found in more than one system.
Future situation	There is a catalogue of reusable components, There is a list of criteria for re-usability (e.g., costs and ownership),
Added value	Optimal use of existing functionality, Reduce time by making clear which functionality is already available and can be re-used, Produces reliable and stable ICT environments, Lower diversity.
Constraints	The project must balance requirements and functionality that are available off-the-shelf, Purchasing more packages which increase vendor dependency, should be manageable.
Application	Re-use of components unless it is not possible, Use of custom-build component if no other option exists
Architecture domain	ICT Applications

GRL profile. We aim to provide a set of rules and constraints for modeling EA principles with GRL and means to verify the correctness and well-formedness of the created GRL models. We will use the GRL capability to include constraints associated with stereotyped and linked elements [2] and define a UML *Object Constraint Language* (OCL) library. We will also improve the linkset and the analysis algorithms in GRL for compliance with principles. Finally, we want to provide textual templates for EA principles which are aligned with the GRL models.

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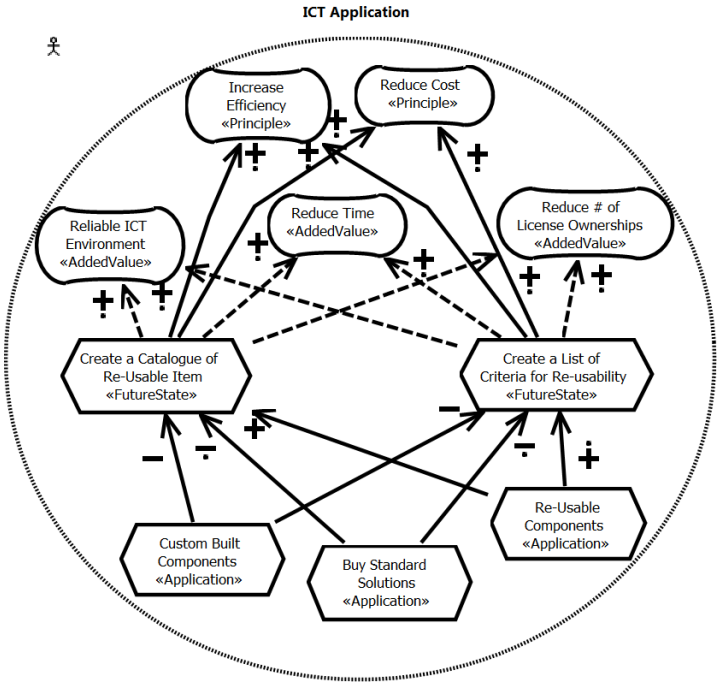

Fig. 2: An Example of EA Principle Model in GRL

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