

Modeling of User Adaptive Enterprise Applications

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Abstract: Adjustments of standard system's modelling techniques are needed for modelling specific aspects of adaptive systems. In this paper, we present a meta-model for modeling specific aspects of user adaptive enterprise applications (UAEA). For designing a system, traditional modeling languages or techniques can be applied to model basic functionalities. Proposed meta-model should be applied additionally to traditional models as complementary modeling dimensions. Proposed meta-model is based on identified key concepts of adaptive systems – stakeholder and end-user, goals and expectations, changing object, adapted object and adaptation algorithm. The described meta-model is applied to model main components of UAEA.

1 INTRODUCTION

There exists a wide spectrum of adaptive systems in the scientific literature. Regardless of the type adaptive applications have a number of common features distinguishing them from non-adaptive systems. Modeling of adaptive systems is researched in several domains, from various perspectives and for different purposes, e.g. Barth and Gomi (2005), Bielikova and Moravcik (2008), Juan and Sterling (2003).

This paper focuses on User Adaptive Enterprise Applications (UAEA), because adaptivity can be one of the solutions to addressing usability problems of large packaged applications. The main distinctive feature of adaptation of enterprise applications is a focus on improving business process execution efficiency according to business goals and needs of users. However, majority of investigations developing adaptivity methods or algorithms focus on representation of these particular methods rather than on capturing common features of user adaptive systems. Therefore, it is proposed to develop a general meta-model for modeling UAEA, which provides a common general representation of these applications, and specific adaptive method can be detailed on top of this model. The common high level representation is useful because adaptive mechanisms can change quickly.

The objective of this paper is to develop a meta-model for modeling UAEA at design time and to apply this meta-model for creating a model of

UAEA.

The rest of paper is structured as follows. Section 2 introduces the meta-model for modeling the user oriented adaptive system. The UAEA model is developed in Section 3. The paper concludes with Section 4, where research results and further research are discussed.

2 A META-MODEL

In order to construct the UAEA meta-model, key concepts relevant to user oriented adaptation are identified in Supulniece (2012) - stakeholder and end-user, goals and expectations, changing object, adapted object and adaptation algorithm.

A model of adaptive system consists of a number of sub-models corresponding to the main concepts identified:

- (SEM) Stakeholder and End-user Model presents structure of actors (human roles), which are related to adaptive system.
- (GEM) Goals and Expectations Model illustrates structure of goals towards the adaptation and individual user's expectations behind them.
- (COM) Model of Changing Object is structure of system's or environment's part, which is changing (triggers the adaptation).
- (AOM) Model of Adapted Object is structure of system's adaptive part (which reacts to changes).

- (AAM) Adaptation Algorithm Model describes rules and behavior of particular adaptation algorithms.
- (SM) System’s Model presents structure of information system (e.g., architecture).

SEM, GEM, COM, AOM and SM are structural diagrams, which present main elements of adaptive system and relationships between them. AAM is a behavioral diagram.

In Figure 1 is given a general overview of the relations between sub-models in the meta-model, where package symbols are used to denote the sub-models.

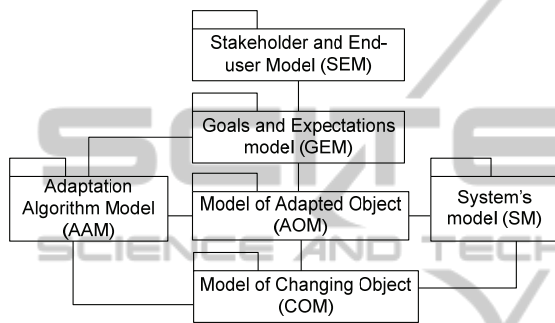


Figure 1: Model of user adaptive enterprise application – high level abstraction.

2.1 Stakeholder and End-user Model

Stakeholder and End-user model describes main counterparties in adaptive system and relations between them. *Stakeholder* is an actor, which benefits from adaptive system. We can assume that the stakeholder always formulates the goal set towards the adapted object.

Another important actor in the adaptive system is *End-User*, who has expectations in his/her mind, what should be a state of the system after adaptation process.

Relations between Stakeholder, End-user and other concepts are presented in Figure 2.

2.2 Goals and Expectations Model

Goals and Expectations model represents a set of goals and calculated/predicted expectations towards adaptive system. Expectations differ per each individual end-user, because they are based on mental model of each individual end-user. These expectations also are different in separate time moments (e.g. depend on user’s mood or particular situations) even if end-user is the same. As it is not realistic to capture fully these individual

expectations in any software system, system is predicting or calculating some of them, e.g. user preferences, which are listed on software system – further named as *Expectations/User Expectations*.

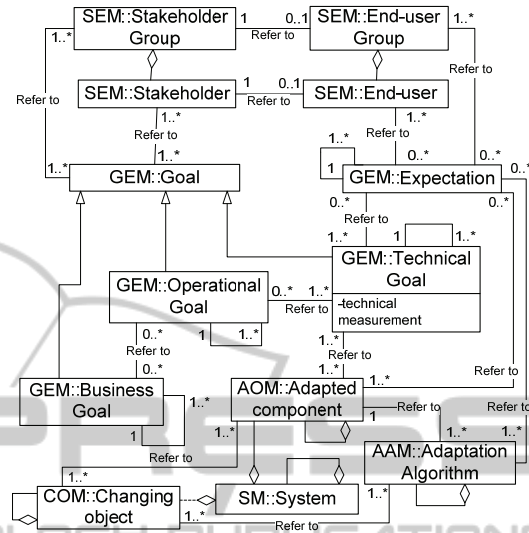


Figure 2: The meta-model for modeling UAEE.

Additionally, software system can capture *Goals* - the system under consideration should achieve.

There are available various modelling languages and techniques for goals modelling, e.g. i* modelling language (Grau, et al., 2006), goals model from EKD method (Bubenko, et al., 1998), goals diagram from KAOS methodology (Respect IT, 2007). Principles used in these methods can be applied also for user expectations.

To model the goals towards user oriented adaptive system, we use three levels of goals (see Figure 2): business goals, operational goals and technical/functional goals. Business goals and operational goals are inspired by Charles Perrow (1961). Technical goals might be evaluated using technical measurement. All types of goals from Goals model might have hierarchy and relationships presented in the model. For modeling adaptive system only technical goals are explored further, but linkage to business and operational goals is advantage as it clearly shows business benefits of adaptive system.

2.3 System’s Model and Model of Adapted Object

System’s model describes system, where adaptation is performed, e.g. system architecture or conceptual model of system with colored changing and adapted part. Model of Adapted Object is part of system’s

model, which specify *adaptive components* and explore in details adaptive part of system.

Adapted components are related to technical goals to illustrate the benefits, thus allowing selecting the best sub-set of adaptive components. Adaptive components are also related to expectations to illustrate concepts, which are used in adaptive components to achieve better adaptation result. Adaptation algorithm is linked to adapted component as it explores adaptation logics for adapted component. Relation between adapted component and changing object presents triggers for starting the processes in adapted component.

2.4 Model of Changing Object

Model of Changing Object defines the structure and interaction of those concepts, which cause the change or triggers the adaptation process. Change can happen within software system or outside of it. Thus Model of Changing Object might be part of System's model, which specify changing components and explore in details changing part of system. Or *Changing Object* might have just input/output link to System's model.

2.5 Adaptation Algorithm

Model of Adaptation Algorithm describes behaviour of each adaptive component. User expectations impacts the result of *adaptation algorithm* and changing object triggers execution of the adaptation algorithm or particular activities within this algorithm.

3 MODEL OF USER ADAPTIVE ENTERPRISE APPLICATION

Enterprise applications are used to execute business processes. Users of enterprise applications either use predefined workflows (Curran and Ladd, 2000) or use other functions provided by enterprise applications subject to their access rights to execute their business processes. That means that users have possibilities to introduce their own variations in process execution and might come up with more efficient ways of executing business processes (Topi et al., 2005). If an enterprise application supports users in identification of more efficient variations of business process execution and enables for continuous execution refinement it is referred as to User Adaptive Enterprise Application (UAEA).

UAEA is the set of adaptive components to be added to standard enterprise application: Adaptive process execution overview; Adaptive GUI (navigation); Adaptive information support; Adaptive decision support; Adaptive problem preventing; Adaptive error and exception handling.

Idea of UAEA lies in following observation (Supulniece and Grabis, 2010): users use enterprise application to accomplish their tasks usually consisting of multiple steps; each user or user group has a preferred sequence of the steps (task execution patterns). UAEA attempts to exploit such usage patterns. Given that ERP systems are mainly used for repetitive tasks (Klaus, et al., 2000), the user oriented process adaptation uses previously observed users' behavior to optimize performance of business activities.

The main stakeholder of UAEA is an abstract object named as Management of organization (see figure 3), however management is not an end-user of adaptive system if we assume that management representatives are not real users of this system. But new employee is stakeholder (because he benefits from the adaptive system) and also end-user, because we assume that new employee uses user-adaptive enterprise application to execute a business process.

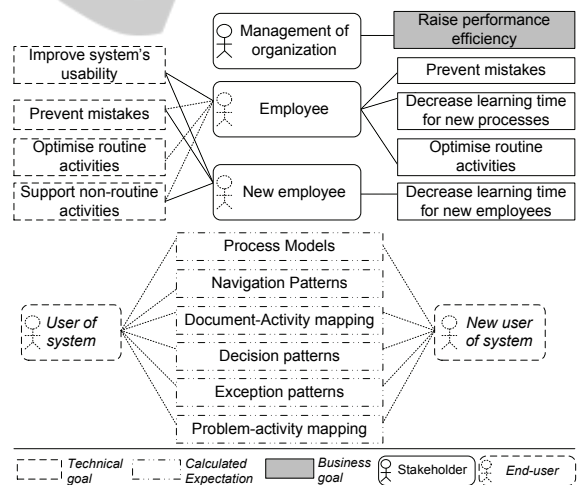


Figure 3: Relations between Stakeholder/End-User and Goals/Expectations in user adaptive enterprise application.

Relations between stakeholders – goals and end-users – expectations in UAEA are presented in Figure 3. In our model we include only those business and operational goals, which can be related to technical goals. Technical goals are set only towards the adaptive system, thus they can be evaluated purely in adaptive system, where all

measurements are available. Figure 3 hides technical measurements and hierarchy of Goals, Expectations, Stakeholders and End-users to keep the view of the model readable. But it is possible to see these relations if different view perspective is selected.

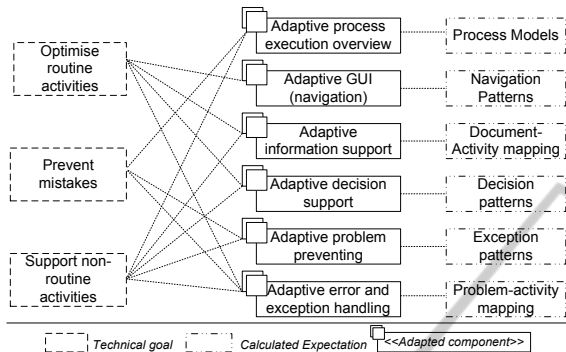


Figure 4: Relations between technical goals, expectations and adaptive components in user adaptive enterprise application.

Adapted components are linked to technical goals (see Fig. 4) to illustrate the benefits, thus allowing to select the best sub-set of adaptive components for particular user, user group, process or application module. Implementation of all adaptive components at the same time would confuse the user and decrease system's performance as result of overloaded calculation memory.

4 CONCLUSIONS

Adaptive systems are perceived differently than non-adaptive systems, thus modeling adaptive systems should highlight and emphasize adaptivity perspectives or modeling dimensions

The meta-model for modeling adaptive dimensions of user adaptive enterprise application is presented in this paper. Proposed meta-model should be applied additionally to traditional models as complementary modeling dimensions. These complementary dimensions are aimed to explore and extend adaptive characteristics of the system – to understand the goal and interested parties, system architecture and components, interaction between these concepts, and main mechanisms behind the adaptation.

Sometimes adaptive part of the system have been created integrated with other system elements (e.g. user modeling components as cited in Barth and Gomi (2005)) without a specific component responsible for it. Proposed meta-model can be

applied to describe detached adaptive component and also to identify adaptive characteristics for bounded adaptive functionalities.

The meta-model is applied to model main components of UAEA. Developed models will be used to build a prototype of the system. This application is in design phase currently, thus our future research is related to prototyping and testing of it.

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