Business Rules Approach to E-learning Systems Development

Kestutis Normantas, Olegas Vasilecas

Abstract: *The paper presents business rules approach to the development of web services based e-learning systems. The main contribution of this approach is a centralized way to capture, automate, manage and process learning knowledge in the form of rules, and to use it within e-learning system. The generic e-learning system architecture has been extended by integrating business supporting business processes and business rules management systems.*

Key words: *Business Rules, Business Rules Management System, Business Process Management System, E-learning.*

INTRODUCTION

E-learning has become an attractive form of learning both for organizations and educational institutions, because it does not depend on time and space constraints. Contemporary e-learning systems engage various tools provided by information technologies to increase the quality of learning process. As the number of such tools increase, e-learning systems must be able to adjust to changing environment.

Recently, a lot of attention is paid to the service oriented architecture (SOA) based e-learning systems, because they possess interoperability, durability, compatibility, reusability, and accessibility characteristics. Although those technological advantages distinguish SOA based e-learning systems from traditional, the drawback of flexibility to the learning needs, large expenditure of cost and time for the development and support still remain.

Business rules (BR) application into the information system (IS) domain has been recognized because of their ability to make applications flexible and amenable to change [1]. Business rules management systems (BRMS) collects, manages, and processes business knowledge in the form of BR. The interest in the rule based software systems results in numerous rules engines available today on the market. The survey made by Zacharias [16] reveals that integration of business rules management systems (BRMS) into a larger IS has a significant impact to the time and cost of development and support of software systems.

Therefore, the BR approach to the development of e-learning systems is considered in this paper. According to this approach, the learning management knowledge is stored in the centralized rules repository and processed by manual or automated learning activities over business process management system (BPMS). The main contribution of this paper is an extension to SOA based e-learning system that provides capability to gather, automate, manage and represent the knowledge in form of rules, and to reduce the time and cost of the development, adaptation and support of e-learning systems.

This paper starts by introducing the analysis of related work. Next, it discusses on BR approach and IS supporting BPMS and BRMS systems. After, it provides description of proposed architecture, and then conclusions and discussion on the further research are made.

RELATED WORK

Recently, a wide range of SOA based e-Learning systems (ELS) has been presented in research community [7, 8, 10, 12]. A survey on various SOA based e-Learning proposals has been provided by Jamuna and Ashok [9]. The paper analyses a number of approaches and classifies them into following categories: interoperable ELS, extensible ELS, distributed ELS, collaborative ELS, adaptive ELS, dynamic ELS, intelligent agent based ELS. Such classification reveals that most investigations are considered on one or

more aspects of SOA paradigm (i.e. interoperability and extensibility are features provided by SOA). However, the paper also reveals that rule-based approaches are considered relatively rarely. Nonetheless, numerous contemporary e-Learning systems declare the features of rules definition, evaluation, and execution within their solutions.

Application of BRMS for e-Learning content delivery has been discussed by Bontchev and Vassileva [2]. Their paper presents and describes formalization of an adaptation model for hypermedia learning courseware, and provides a way for content management engine's construction, which is consistent with this formalization and follows a rule-driven approach. Moreover, the paper has compared a number of BRMS, and according to appropriate criteria, it has implemented e-learning content delivery solutions based on open source BRMS. However, BRMS has a wider range of application to software systems opportunities that could be used in e-Learning systems as well.

Investigations [3, 6, 11] on business processes based e-Learning systems reveal that benefits provided by BPMS could be attained by integrating those two systems. Cesarini, Monga and Tedesco [3] indicate that following this approach a set of process description rules are coded in custom programming language and passed to the business process execution engine. However, such solutions are inflexible, difficult to maintain and extend, since the business processes are complicated enough, and they require complex decisions considering large sets of the rules.

Usually, BPMS are considered to be combined with BRMS. While the BPMS covers the complex and changing processes interconnecting people and systems, BRMS focus on the complex and changing rules within each business function. According to [15], BRMS provides the infrastructure for defining BR, or groups of rules organized into rulesets, maintaining them in a repository, and evaluating them by appropriate evaluation services. Moreover, the paper indicates that the integration of BPM and BRMS can be achieved by having a business process engine act as a BRMS client and simply invoke BR as needed through out the process. An approach to providing an integrated BPMS and BRMS solution allows BPM to automatically communicate its data model, process variables, as well as BPM system data, to the BRMS for use in BR.

THE BUSINESS RULES APPROACH, BRMS AND BPMS

The term of business rule has been considered for several decades. Numerous books written by BR pioneers Morgan [13], von Halle [5], Ross [14], Hay [4] provide great explanations of what are business rules, how to extract them from business, and how to implement them in business supporting information systems. It should be noticed, that term "business" in this paper as well as in above mentioned references is treated in a broader sense then commercial activity. According to Oxford English Dictionary, a *business is an activity that someone is engaged in*. Therefore, in the context of e-learning, the business could be treaded as entire of activities involved in e-learning (e.g. learning material or course authorization, preparation and management; course scheduling and assessments; and etc.), and respectively, the rules could be treated as the statements that defines or constraints some aspect of e-learning.

BPMS provides possibility to automate and manage human-driven business processes. Typically, BPMS supports definition of baseline of the process, simulation of the processes, tracing and monitoring execution of processes. Integration of BPMS with BRMS in e-learning systems would provide lower operational costs and faster cycle times by automating manual tasks (such as learning content preparation, approvement, and etc.), improving compliance and adaptability, ensuring consistency and providing control mechanism, and increasing agility of e-learning systems.

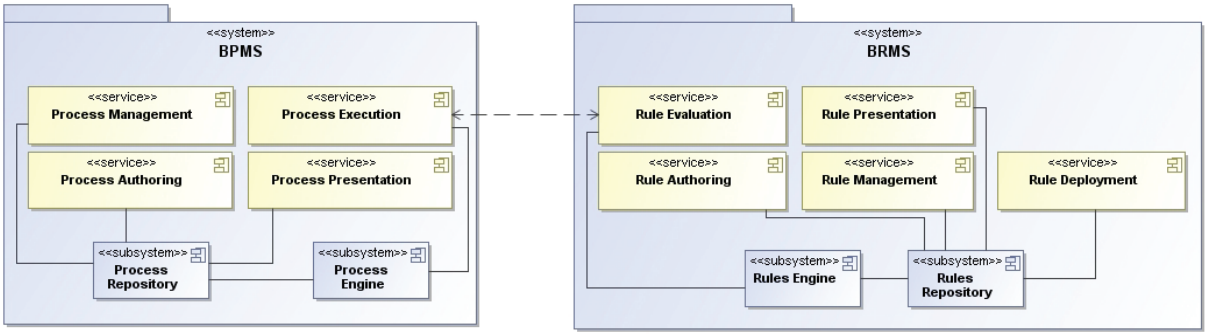

Fig.1. Simplified architectures of BPMS and BRMS, and interaction between them, UML composite structure diagram

Simplified service based BPMS and BRMS architectures and typical integration of them is presented in Fig.1. Basically, BPMS consist of process repository, process engine and services responsible for business processes development, management, presentation, and execution. Essential components of BRMS are rules repository, rules execution engine and services responsible for rule development, deployment, management, presentation, and evaluation. The integration of BPMS and BRMS is mutual. From BPMS side, during the execution of a process, when decisional situations arise, appropriate BRMS service calls decision support service provided by BRMS (namely, Rule Evaluation service). The service invokes correspondent rule execution in the rules engine, receive the result of rule evaluation and send it back to the caller. From the BRMS, in cases, when rule execution does not depend on execution of process (e.g. periodical event), the rules engine notifies rules evaluation service, which sends appropriate notification to the process execution service.

The discussion on possible integration of BPMS and BRMS with e-learning system will be provided after a brief overview of e-learning system architecture in the next section.

GENERIC E-LEARNING SYSTEM ARCHITECTURE

Typical e-learning system (Fig.2) is composed of Learning Content Management (LCMS) and Learning Management (LMS) systems. An LCMS is responsible for the development, management and publishing of the content that will be delivered over an LMS, while an LMS is a system for learning courses planning, delivering, and managing.

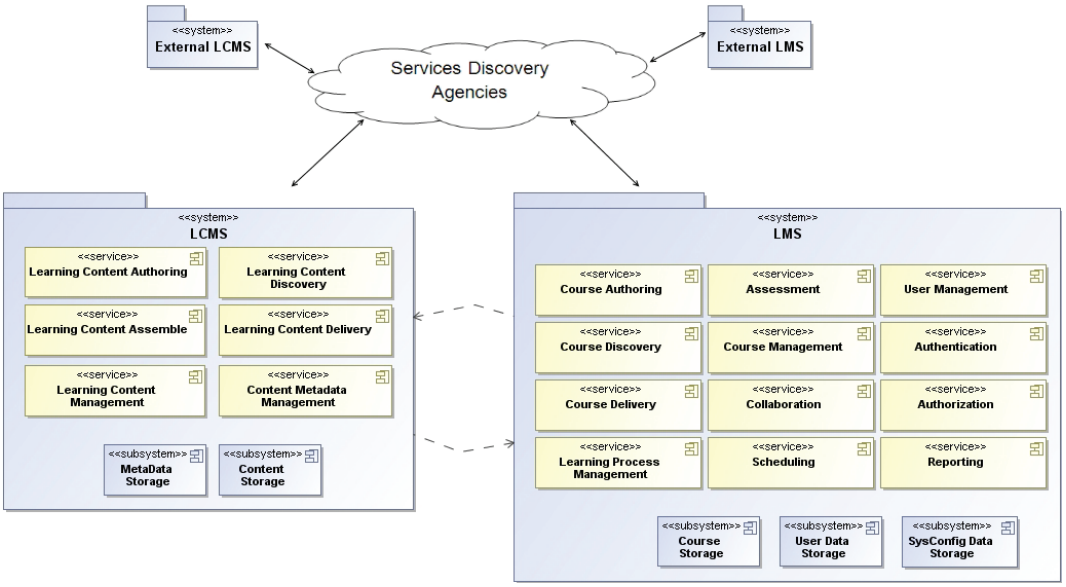

Fig.2. A generic e-learning system architecture, UML composite structure diagram

An LCMS consist of several repositories for storage of learning content and respective metadata, and services that are responsible for content authoring, assemble, management, delivery to LMS, and delivery to or discovery from external LCMS. Some of LCMS includes simple workflow engines for automating of content preparation, assemble or delivery processes. However, those engines are not sufficient enough to support automation of most content development and management processes.

An LMS consist of a number of repositories, typically intended to store the metadata of courses (plans, schedules, assignments, etc), users data (users, groups, roles, authorization, etc), or system configuration data. LMS services are responsible for creating, management and delivery of learning courses (events), user management and authentication, collaboration between users, scheduling and reporting of courses.

BUSINESS PROCESSES AND BUSINESS RULES BASED E-LEARNING SYSTEM

Most of LCMS and LMS services must provide possibility to support complex decisions based on various aspects of e-learning. Mostly it leads to redundant and inconsistent implementations of the same rules. Moreover, it increase the time and cost of development and maintenance of required solutions.

In the proposed approach, the BR are externalized from the business logic implemented in e-learning system services providing ability for the services to interact with BRMS on evaluation of particular BR. Externalized rules are stored in a BRMS rules repository that gives the instructors or any other responsible role ability to create, modify, or activate BR without additional programming knowledge or it-support. Externalized or newly defined e-learning system processes (e.g. content preparation, assembling, approving, discovering or delivering, learning courses assignment, scheduling, etc) are stored in process repository and carried out by BPMS with interaction of BRMS.

The main principles of proposed architecture are presented in Fig.3 – an abstract view of architecture emphasizing interactional aspects of involved systems. The interaction points are represented as service requester and service provider components as it is standardized by W3C.

The LCMS Learning Content Delivery service requester is the Learning Content Discovery service (Fig.2, LCMS) that intended to discover learning content from external LCMS over service discovery agencies. The Learning Course Delivery service requester is the Learning Content Management service (Fig.2, LCMS) that is able to send a request to LMS Learning Course Delivery service provider. The Rule Evaluation service requester may be any LCMS service (Fig.2, LCMS) that requires evaluation of respective BR within BRE. The Process Execution Service requester may be Learning Content Authoring, Assembling, Management, or Metadata Management service that supports business processes involved in learning content related process.

The LMS Content Delivery service requester is the Course Management service (Fig.2, LMS) that sends requests for course content to LCMS Content Delivery service provider. It may be invoked either an e-learning web portal or an external LMS call. The Course Delivery service provider gets the course information requests and provides information either to LCMS or to external LMS service requesters. The Process Execution service requester may be any LMS service that is involved in course preparation or assessment processes, i.e. Course Authoring, Learning Process Management, Assessment, Course Management, or Scheduling service. The Rule Evaluation service requester may be any LMS service (Fig.2, LMS) requiring BR evaluation within BRE.

The BPMS Process Execution service provider is the Process Execution service (Fig.1, BPMS) responsible for exploring process execution functionality to the service

requesters. The same service is BPMS Rule Evaluation service requester that invokes rules evaluation from BRMS Rule Evaluation service provider.

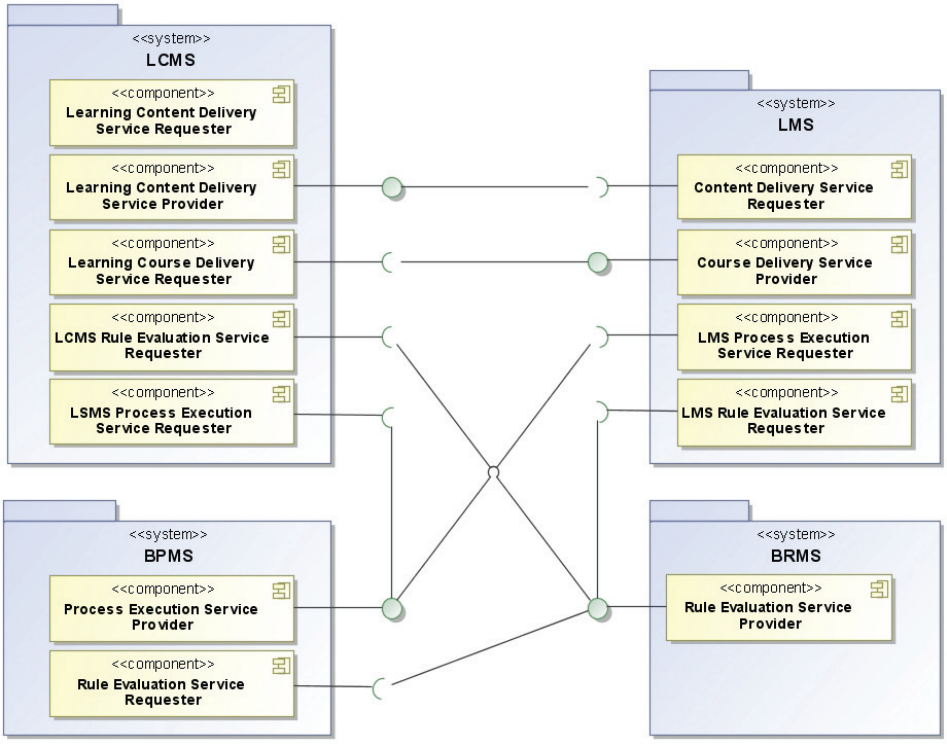

Fig.3. Extended with BPMS and BRMS e-learning system architecture, UML composite structure diagram

CONCLUSIONS AND FUTURE WORK

The research presented in this paper revealed that although the automation of e-learning processes with business processes engines (workflows) is beneficial, not much attention is paid to the centralized way to capture, automate and manage business rules and to use them within e-learning systems.

Therefore, the business rules approach to the development of e-learning systems has been considered, and possible candidate of architecture of e-learning systems integrated with business supporting systems based on standardized web service technology has been proposed. In the proposed approach, the business rules are externalized from the business logic implemented in e-learning system services providing ability for the services to interact with BRMS on evaluation of particular business rules.

The research is in very early stage; thus it was presented only conceptual point of view. The elaborated architecture with possible technological solution as well as an appropriate case study will be presented in the further research.

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