INTEGRATION OF SAKAI BASED E-LEARNING AND BUSINESSS MANAGEMENT SYSTEMS USING WORKFLOW MANAGEMENT SYSTEMS

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Abstract: This paper presents a solution for integrating workflow management, business management and Sakai based E-learning systems. Integration of workflow into the working environment enables more flexible system that allows integration of E-learning system with other parts of information system for the purpose of achieving one integrated and self-sufficient system. This work presents the improvements to the initial architecture of the Metropolitan University information system that consisted of four independent subsystems: e-Learning, content management, workflow management and business management systems.

Keywords: *E-Learning, Workflow management system, information systems*

1. INTRODUCTION

Companies have recognized that in order to stay efficient and competitive, it is necessary to change their mindset in way they conduct business processes and set business goals. In order to stay competitive, business processes need to be continuously managed and improved. Information systems have been a widely adopted solution to support redesign of business processes and their management. Much attention has been given to two distinct systems that can achieve efficient redesign and management of business processes: Workflow Management Systems (WfMSs) and Enterprise Resource Planning (ERP) systems. Although both systems are focused on the automation of business processes, data transfer, and information sharing, the approach taken by each system is distinct.

Cardoso in his work explains that ERP systems are data-centric and focused more on information management and data integration while workflow management systems are more directed toward process management [1]. ERP systems and their implementations are based on the prefabricated applications (ERP solutions) and are fitted according to the needs of a particular organization. In ERP systems, the workflow model is usually embedded in the software application, by setting parameters that are accessed by the applications. Even though more parameters allow better flexibility, this also increases the complexity. One way to overcome this problem is to incorporate workflow components into existing ERP systems. Many of the ERP vendors such as SAP are following this approach to take advantage of the

usefulness of workflow tools. Cardoso also states that workflow systems enable developers to separate the flows among a system's components (applications and data) from the workflow process model, making these applications flow independent. The separation of flows among tasks and activities keeps workflow systems outside the application domain. The flow-independence concept makes workflow technology suitable to a large number of domains. In accordance with this notion, implementation of modern information systems should be based on the use of workflow tools. On the other hand, given that workflow systems can orchestrate and start other applications, they could be viewed as a type of "middleware" platform serving to integrate diverse applications. This capability allows WfMSs to provide an important enterprise integration function [2].

This paper will outline how three systems: Sakai based E-Learning system, business management system and content management system can be adapted and integrated with Metropolitan University's WfM system. The focus of the paper is placed on the integration of Sakai based e-learning, business management system and WfMS. Sakai is adapted and personalized for the needs and business processes of Metropolitan University.

The structure of the paper is as follows: Section 2 explains the role of WfMS in Metropolitan University's information system. An example of a workflow model is demonstrated through the process for defining an academic major of studies. Also the utilization of some open source solutions for systems implementation are discussed. Section 3, proposes a method for integrations

of WfM, business management and E-learning systems Section 4 concludes the paper.

2. THE ROLE OF WFMS IN INTEGRATION OF METROPOLITAN UNIVERSITY'S INFORMATION SYSTEM

Similar to all business, Universities are trying to keep up with competitive edge and stay current with new methods in online and traditional learning. Faced with increasing competition and desire to stay current with new business and learning changes, Metropolitan University has decided to build a new information system. Cvetanovic et.al. proposed a model for the Metropolitan University's information system that integrated four different subsystems: business management system, E-learning system which is the main component of each University's system, content management system (CMS) and workflow management system (WfMS) [3]. Four subsystems were presented as individual systems, and their planned integration was conducted through Web services. Although Metropolitan University information system was originally planned as a data-centric system, like ERP, a deviation was made from the initial model. This change involved taking advantage of the WfMS and its ability to integrate different types of data and applications.

An example of a workflow model is demonstrated through the process of defining an academic major in the system. This workflow model is illustrated in Figure 1. To further explain this example, given workflow will be illustrated through the academic major Information Technology. Within this major, students are able to choose between three different modules: information systems, software engineering and software development for computer games. Curriculums for all three modules overlap in 80% of the courses, whereas 20% of the courses are provided as electives. Different electives distinguish one module from another. In each school year, students attend 10 courses, 5 each semester, in the duration of 15 weeks. Therefore, for each course there are 15 lectures provided on the E-learning system. On top of that, students are able to access not only their lectures, but their homeworks, project assignment, term paper assignments, tests and quizzes as well.

Figure 1 shows that by using WfMS course syllabus can be created in the following manner. First, academic major curriculum is defined in business management system (BMS). Parameters that are used for curriculum definition are course titles, course credits, number of modules within the major, etc. When a major has different modules, modules are also defined. WfMS continues with creation of a course or creation of course assignments. Each course is created with sets of specific parameters through business management system and Sakai. As it can be seen from Figure 1, embedded tasks are a part of different subsystems of Metropolitan University's information system. Each subsystem was created using a set of different tools. Diversity of tools used for each part of the information system will be briefly discussed.
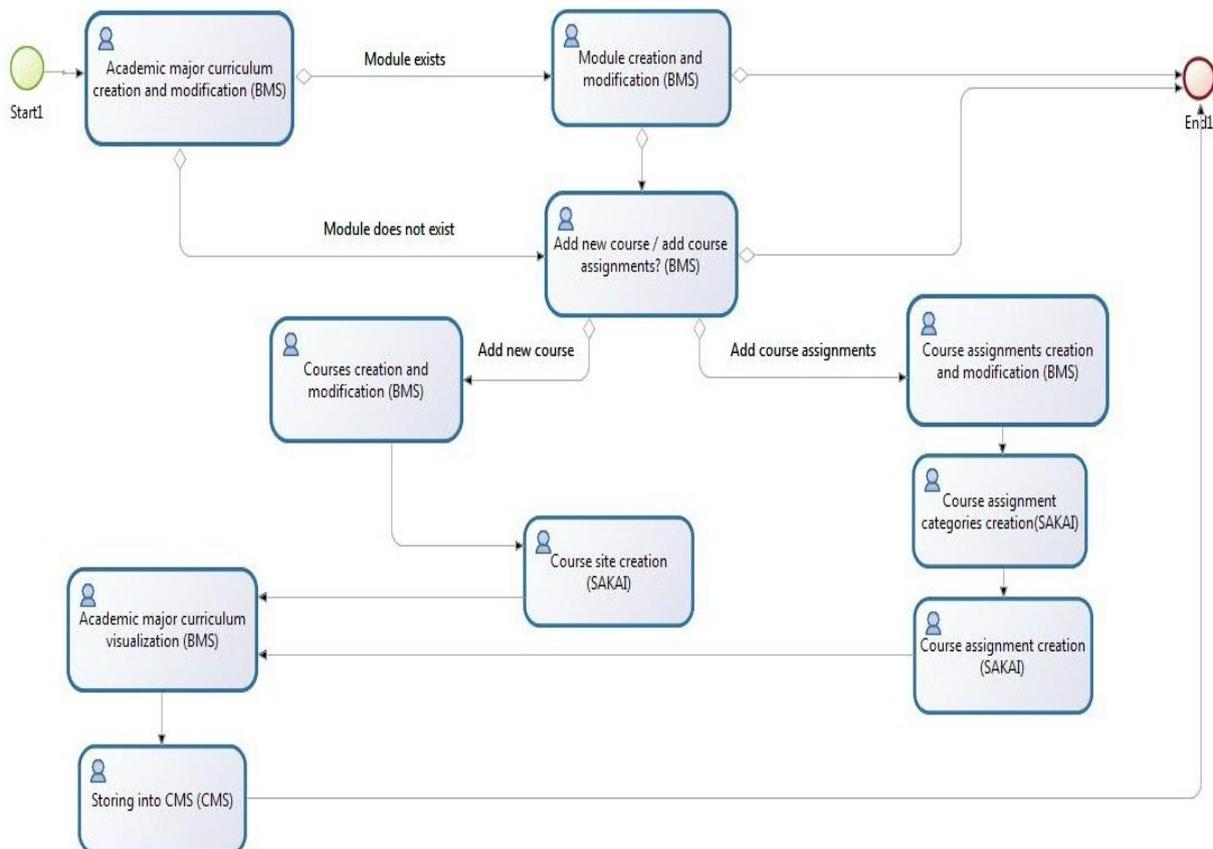

Figure 1. Workflow model for defining academic major curriculum

Business management system was designed based on the previously discussed software architecture [3]. Focus of the business processes was placed on processes that are of vital importance for Administrative office, such as student course enrollment, student admissions, capabilities to create and modify academic curriculum, etc. Software platform that was used to implement this system is Spring 3.04, JSF and RichFaces frameworks, MySQL data base, Java JDK 6 and Hibernate 3.5.

Sakai based E-learning system is based on Sakai version 2.8. Sakai represents set of Java Web applications that are executable in servlet container. Some services are shared by more than one application. Sakai is based on Spring framework, Hibernate, JUnit and other open source frameworks and technologies.

Workflow management system is designed using open source solution Bonita. Bonita has been selected as the best solution among several open source software such as JBoss, Joget, YWAL, Italio. The criteria on which the analyses were carried out were: availability of documentation, deployment, user interface, compatibility with CMS and transaction systems (ERP), standards, etc. Bonita is an easy to use workflow system due to its built in connectors for many commonly used databases. Furthermore, connectors are easily created using Bonita Studio's connector creator.

Content management system is based an open source solution Alfresco. Alfresco is an enterprise content management system. Its modular architecture uses the latest open source Java technologies. It supports document sharing, storage, workflows, collaboration, and it serves as a publishing platform.

3. INTEGRATION OF E-LEARNING IN METROPOLITAN UNIVERSITY'S WFMS

Integration of workflow management, business management and Sakai E-learning systems is necessary in order to achieve one complete, personalized and self-sufficient information system for the needs of Metropolitan University. Two methods for integration were used:

1. WfMS calls tasks from business management system, which then calls tasks from Sakai. In the case of Metropolitan University, due to the nature of business processes, this method of integration was used more as compared to the second method later described. Functions of typical web-based E-learning systems do not provide ways to define business processes that are customizable to University's needs. For example, in the Sakai, all courses and their course assignments can be defined, but the structure of syllabus, specifically the gradable assignments and their contribution to the cumulative grade, cannot be deployed into the curriculum for academic major. It is expected of system to be able to support all of the predefined syllabuses, track of the graded assignments and transfer the structure of the course, including the course grading policy into the structure of the curriculum. These tasks had to be executed by synchronizing implemented functionalities in business management system and related functionalities in Sakai, using different tools such as Gradebook, Assignment, Tests and Quizes.

2. WfMS calls tasks directly from Sakai. This method of integration was used in cases where business processes needed to directly call the task from Sakai E-learning system.

Since first integration method was mainly used, the focus will be directed in its further explanation. In order to be able to implement the method shown in Figure 1, it is necessary to synchronize three systems by developing following mechanisms:

1. Courses that are a part or academic major curriculum need to be created by WfMS. These courses are defined in the business management system and are simultaneously registered as a course (site) in Sakai E-learning system.
2. Grading policy and grade structure for each course (like homeworks, tests, project assignment, class attendance, etc.) are registered into the business management system. The grading policy and gradable assignments of each course are defined using Sakai's predefined tools, such as Assignments, Tests and Quizzes and Gradebook tools. For example it is necessary to define how many quizzes, homeworks and projects are contained in a course and how many points each assignment carries. Their grades are registered in Sakai's Gradebook.
3. Each assignment that is created by WfMs and entered in the business management system must be recorded in Sakai.

Bonita and business management system integration is planned by using iFrame that allows Bonita to specify any Web application for a task. At the same time it should be taken into account the constraints that exist in using this technique: when a user needs to perform two consecutive tasks, iFrame does not show the next form when the fist form is done. Applications must agree with the terms in order for iFrame to execute them in one step.

Synchronization between business management system and Sakai is performed using Web services. Figure 2 represents the basic functionalities of web services between business management and Sakai based E-learning systems. Since WSDL is based on XML, it is used to provide models for describing Web services. WSDL defines services as collections of network endpoints or ports. WSDL specification provides an XML document format for this purpose. To ensure the use of a web service via the Internet, WSDL is often used in combination with SOAP and XML. When client
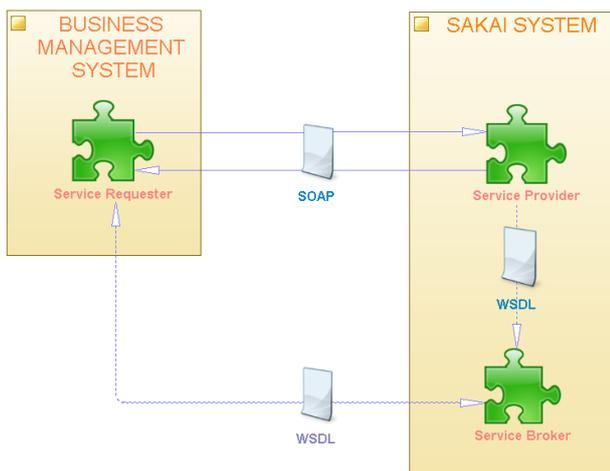
Figure 2. Integration of business management system and Sakai E-learning system using Web services

application connects to a web service to read a WSDL file it determines what operations are available on the server. Each specific type of data is embedded within the WSDL file using XML formatting.

Accordingly, the client can execute WSDL defined operation with the help of SOAP. For this implementation WSDL version 2.0 was used, due to better support for RESTful web services and simpler implementation.

Sakai Web services support is integrated through the Apache Axis. There are several strategies that be used to run Sakai Web Services, such as building a WSDL description in a file with "*.jws" extension and placing that file in Sakai-axis package. During the deployment, file is compiled into Java classes.

Entity Broker is an internal Sakai service used for handling entities. Entities in the Sakai are data sets that are utilized for representation of courses, learning material, user profiles, grade books etc. Entity Broker exposes these entities as restful services and facilitates the integration of Sakai with external information systems.

The basic Sakai Web services that are used for integration are described in Table 1.

Table 1. Sakai web services used for integration

Sakai Web service	Functionality
Sakai Login	Executed before any other web service
Sakai Portal Login	Establishes connection with the software portal
Sakai Script	Administrates users, sites, privileges
Sakai Session	Returns information about the session
Sakai Signing	Allows user authentication for external applications
Sakai Site	Administrates sites

In addition to predefined basic services provided by Sakai, users can create their own services. Since Sakai

Web services use Apache Axis framework, creating a new Web service is simple and it consists of creating a text file with a "*.jws" extension, which is lowered in / web-apps/ sakai-axis folder.. Axis and Sakai automatically compile the text file and generate Java class without having to restart the application server.

For the purpose of integrating business management system and Sakai, it should be nesessery to develop appropriate services for:

1. *Logging:* for this purpose was used Sakai Login java web service, and a part of the business management system that deals with sending requests. Within the service, "login ()" method is called. This method accepts two String parameters (uid and password), and returns String parameter (session id). By obtaining a session id, authentication of an end user is executed and a license for a valid enforcement action for his role is registered in the system.

2. *Creating courses:* In order to create courses from the business management system in Sakai, it is necessary to conduct numerous actions. Primarily it is necessary to enable using of java web services in Sakai that use Sakai API and communicate with business management system through WSDL. For this purpose, Sakai Script java web service was used. This service contains methods necessary to create courses. On the side of the business management system, the appropriate architecture that calls SakaiScript methods is also designed and implemented.

3. *Creating course assignments categories:* Using Sakai's Gradebook tool it is possible to create a system to define, chatagaorize and group course assignments. This method allows users to view their assignments and their grades in a much organized and user friendly manner. For this purpose, a software module within the business management system was created. This module calls Java web service *SakaiGradebook* which is suppose to communicate with SakaiAPI.

4. *Creating course assignments using the tools "Assignments" and "Tests & Quizzes":* When a courses in Sakai is created, one should be able to add the appropriate assignmentsfor the course which have been previously defined in the business menagement system. Also, they must be deployed in tools "Assignments" or „Tests & Quizzes". For this purpose two java web services are created *WSAssignments* and *TestAndQuizzes.* "*WSAssignments*" contains methods for handling the assignments in Sakai system, and service "*TestAndQuizzes*" refers to the creation of tests.

5. CONCLUSIONS

In this paper integration of business management, Sakai-based E-learning, and content management systems was

presented. In the proposed model it was shown how WfMS can serve as a platform to integrate diverse subsystems due to its ability to integrate diverse types of data and applications. Proposed model was based on business and educational needs of Metropolitan University and its information system. Results of this paper presented integration of Sakai based E-learning, business management system, and WfMS for the purpose of adapting and personalizing Sakai. Two integration methods were presented: a method in which WfMS calls tasks from business management system which then calls tasks from Sakai, and a method in which WfMS calls tasks directly from Sakai. Future work will focus on integrating WfMS and Sakai using iFrame, due to iFrame's ability to allow Bonita to specify any web applications for a task.

ACKNOWLEDGMENT

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