Workflow Technologies in e-Learning

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ABSTRACT
Application of workflow technologies in design and implementation of e-learning systems is considered. This is a technological solution for integrating e-learning resources and addressing e-learning applications. Examples of e-learning workflows are given. The main steps in developing e-learning systems based on workflow technologies are outlined.

General Terms
Design, Standardization, Theory

Keywords
Workflow technologies, web services, orchestration

1. INTRODUCTION
Workflow technologies can be quite successfully applied in design and implementation of e-learning management systems. All the activities in e-learning system can be modelled as processes. After that these processes should be executed by a workflow management system. In other words workflow management system plays a role of e-learning system.

The paper aims to present how workflow technologies can be used in e-learning. The rest of the paper is organized as follows. Main features of workflow are described in the next section. The advantages of applying workflow technologies are discussed. After that examples of three e-learning processes are presented. The fourth section deals with the way of developing e-learning workflow systems

2. WORKFLOW TECHOLOGIES

2.1 Brief Overview
A widely accepted definition of workflow comes from the Workflow Management Coalition [11]: "Workflow is the computerized facilitation or automation of a business process, in whole or part" [8]. An extended definition, which also can be found in [8], is "…a system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke the use of IT tools and applications."

One of the leaders in development of workflow technology is Wil van der Aalst [1, 2]. In his history review of the workflow technology he concludes that till the nineties there is no fundamental approach for the development of such systems in the business processes. Now the business process management systems are at the top of researchers' work. The peculiarity of the workflow management technology is the separation of process logic from application logic targeting flexible and highly configurable applications [5]. Seven fields are defined in [6] as the *conceptual ancestors* of workflow management technology:

- office automation,
- database management,
- e-mail,
- document management,
- software process management,
- business process modelling,
- enterprise modelling and architecture.

The following definition of workflow management system is given in [9]: "It is a system that completely defines, manages and executes "workflows" through the execution of software whose order of execution is driven by a computer representation of the workflow logic." In the terminology and glossary work [8] of the Workflow Management Coalition (WfMC) the fundamental understanding of workflow management and workflow management systems have been determined. According to it the workflow management system consists of a modelling component for the creation of workflow models, functionality for the creation of workflow instances from these workflow models, and functionality for the execution of these workflow instances. Respectively the products, which implement the workflow technology, have to follow this functional consistence with appropriate software modules. The functional component for the enactment of workflow instances is called *workflow engine.*

The structure of a workflow management systems consist of a development environment, named build time component and an execution environment, named run time component [6]. The development environment gives workflow designers tools for the design and specification of workflow models and the relevant data structures. It provides (graphical) facilities for design of the organizational model, relevant to the execution of the workflow models. The second basic part of the Workflow management system is the workflow engine, also called orchestration engine. It is a run time environment comprising modules covering different functional aspects – process management, control flow management, data handler, end-user interface, history management, facilities for integration with other applications. Usually, the modules are hierarchically organized. On the top of the hierarchy is the coordinator - an event handler, sending and receiving messages from these modules [6].

The development of workflow area is still in constant evolution and there is not yet a single emerging set of standard technologies. It can be outlined several functional building blocks: modelling languages and/or graphical notations, choreography languages, orchestration languages. Figure 1 represents aforementioned functional block as well as available technologies covering these aspects.

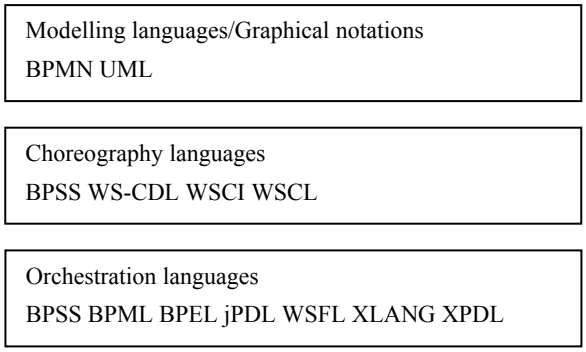

Figure 1. Workflow technologies – functional blocks

Choreography refers to global, multiparty, peer-to-peer collaborations where the component entities interact in long-lived stateful and coordinated way regardless of any programming model or supporting platform used. The W3C glossary [7] gives the following definitions of the term "choreography":

- *"A choreography defines the sequence and conditions under which multiple cooperating independent agents exchange messages in order to perform a task to achieve a goal state.*
- *Web Services Choreography concerns the interactions of services with their users. Any user of a Web service, automated or otherwise, is a client of that service. These users may, in turn, be other Web Services, applications or human beings. Transactions among Web Services and their clients must clearly be well defined at the time of their execution, and may consist of multiple separate interactions whose composition constitutes a complete transaction. This composition, its message protocols, interfaces, sequencing, and associated logic, is considered to be a choreography."*

Choreography languages (examples are WSCI, WS-CDL, etc) are mainly descriptive and cannot be directly executed. These languages are necessary to be mapped to an orchestration language in order to be executed.

Term Orchestration refers to coordinating of multiple tasks. Having in mind that a business process is composed of several single or complex services, orchestration refers to coordinating of several services (i.e. their relations and consequence of execution). The W3C glossary [7] gives the following definitions of the term "orchestration":

- "*An orchestration defines the sequence and conditions in which one Web service invokes other Web services in order to realize some useful function. I.e., an orchestration is the pattern of interactions that a Web service agent must follow in order to achieve its goal*".

Orchestration focuses on the behaviour of the composed services as a whole. Orchestration languages (e.g. BPLM, BPEL, XPDL, BPELJ, jPDL, etc) are executable languages and define a runtime environment, called orchestrator or orchestration engine, for their execution.

2.2 Application for e-learning

Each e-learning system performs different functionalities. These functionalities can be modelled as business processes. Further step is orchestration specification, which means defining the behavior of the composing services. The processes are executed by the orchestration engine. In other words e-learning system can be viewed as workflow management system executing processes closely related to e-learning activities.

The main advantages of the propose approach for e-learning system design come from the features of the workflow technologies and can be summarized in the following points:

- Standardization – implementation is based on common standards;
- an uniform data representation;
- possibilities for integration of information from different sources and locations;
- once the system is put into work, the new process are added easily – it is provided by the workflow engine functionalities;
- possibilities for simulation of e-learning processes before their deployment and execution;
- administration and monitoring capabilities;
- in a single workflow engine can be deployed not only e-learning processes, but all the other workflows within the organization.

3. EXAMPLES OF ELEARNING PROCESSES

This section presents three examples of typical e-learning processes.

3.1 Thesis assignment and reviewing

UML activity diagram on fig.2 depicts a process of thesis assignment and reviewing. It is a long running process. The process starts with choosing a problem from some subject area. The next step is thesis development and includes several sub steps as research, developments, thesis writing. The reviewing phase is after that. In case of approval the thesis is presented. On the last phase the process ends.

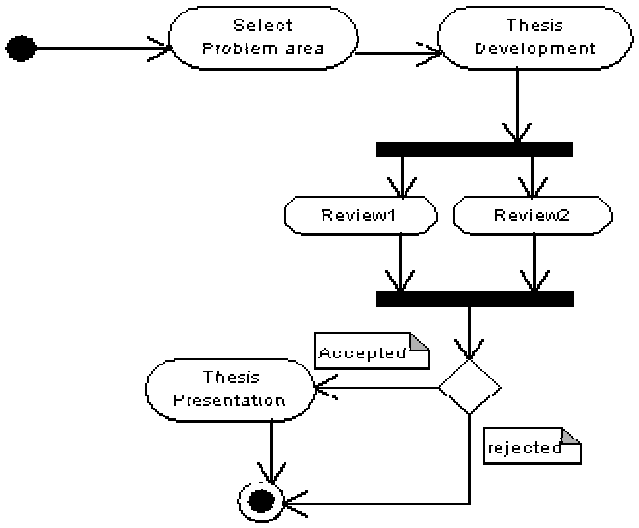

Figure 2. Thesis assignment and reviewing workflow.

3.2 Managing courses

Another possible e-learning process, "Management courses" workflow, is presented in this section [3]. Several activities are involved in this process. At the beginning, the system determines if the managed course exists. If so the possible actions are course modification or course removal.

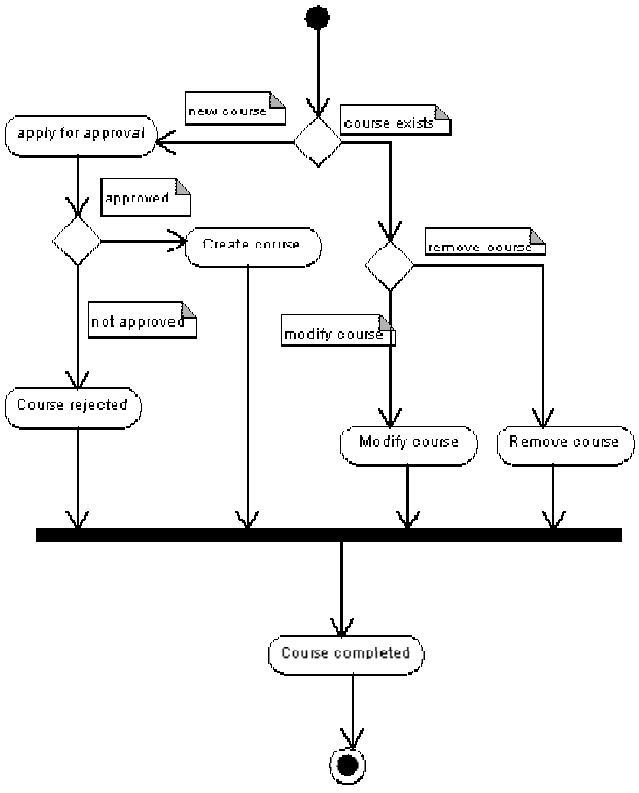

Figure 3. Management courses workflow.

If the course is new, then the next step is "apply for approval". In case of approval the course is created, otherwise the process ends.

3.3 Search for courses

A simple process of searching for courses is illustrated on fig.4. Search can be performed using several criteria.

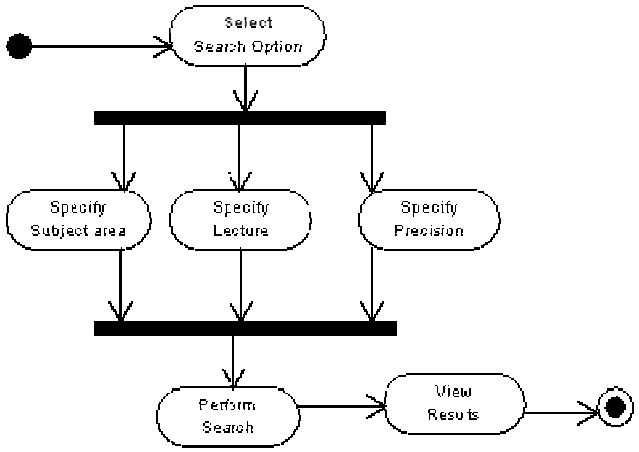

Figure 4. Search for courses workflow.

4. DESIGN, EXECUTION, MONITORING

This section describes the stages and possible implementation of e-learning system based on workflow technologies.

The main phases can be outlined as follows:

- Modelling – creating of an abstract model of a process, regardless of any programming model or supporting platform used.
- Specification - creating and specifying processes, in accordance with some orchestration standard like BPEL and XPDL;
- Simulation - simulating and testing the process execution using sample data and breakpoints;
- Deployment - deploying the process onto the appropriate server location;
- Execution - executing of the deployed processes;
- Administration and monitoring - managing and monitoring of the running processes.

The rest of this section is devoted to available workflow products, which can be used for implementation of e-learning system, based on workflow technologies. For detailed study of these products one can refer to [10].

For modelling can be used available tools, based on BPMN or UML. A short list of these products is given bellow.

BPMN based: Borland Together Desidner 2006, IntalioDesigner, Fujitsu: Interstage Business Process Manager 7.1, ITpearls

Process Modeler, AXway Process Manager™, Kaisha-Tec: ActiveModeler, others.

UML based: ARTiSAN Studio 6.0, Borlang Together Architect 2006-02-10, Poseidon for UML 3.2 (community edition), IBM Rational Software Architect 6.0, IBM Rational Software Modeller, ARIS UML Designer 7.0, objectIF 5.0, innovatorAOX 2006-02-10 EclipseUML 2.1, Enterprise Architect 5.0, Telelogic TAU 2.5.

The other phases – specification, simulation, deployment, execution, monitoring, can be performed by software applications for service orchestration. There are software orchestration tools, supporting all these functions, and others, supporting only the first three or/and the last three functions. In this way, service orchestrating products are divided into three categories, according to their major functionality: workflow editors (supporting mainly the first two functions – specification and/or simulation), workflow engines (supporting mainly deployment and execution) and complex tools (supporting all aforementioned functions).

It is very hard to itemize all the software tools for service orchestration. The study from [10] shows more than a hundred tools. The list is quite long and, of course, is not complete, but it is sufficient to illustrate the importance of the developments in such application area. The products have different level of maturity and they are presented both as market available products and as an open source software suits. Some of these products are mentioned in the lists below. The products, supporting specification and/or simulation (but not only these functions), are referred as workflow editors; these, supporting mostly execution are in workflow engines category, and the last are combined products.

Workflow Editors: ActiveBPEL Designer, Cape Clear, con-cern, enterpriseXtention , Enhydra JaWE, JBoss jBPM, ObjectWeb BONITA, OpenWFE, Oracle BPEL Process Manager, SAP NetWeaver Exchange Infrastructure, YAWL

Workflow Engines: ActiveBPEL Engine, ActiveBPEL Enterprise, Biztalk Server, Cape Clear, con-cern, Enhydra Shark, enterpriseXtention, Freefluo, , JBoss jBPM, ObjectWeb BONITA, OpenWFE, Oracle BPEL Process Manager, SAP NetWeaver Exchange Infrastructure, WfMOpen, YAWL

Combined Products(Editor + Engine): ActiveBPEL Designer + ActiveBPEL Enterprise, Cape Clear, con-cern, Enhydra JaWE + Enhydra Shark, enterpriseXtention, JBoss jBPM, ObjectWeb BONITA, OpenWFE, Oracle BPEL Process Manager, SAP NetWeaver Exchange Infrastructure, YAWL.

5. CONCLUDING REMARKS

Workflow technologies provide a powerful mechanism for integrating of dispersed informational resources and in particular this is a possible way of integrating of e-learning content. Since all the activities in e-learning can be modelled as single or complex structured services and then deployed and executed, e-learning systems can be designed as workflow management system with specific e-learning functionalities and executing e-learning related processes. A technological solution, addressing e-learning applications, based on workflow technologies was presented. The advantages of such approach were discussed. Examples of e-learning workflows were illustrated. The way of design and implementation of e-learning workflows was described.

6. ACKNOWLEDGMENTS

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